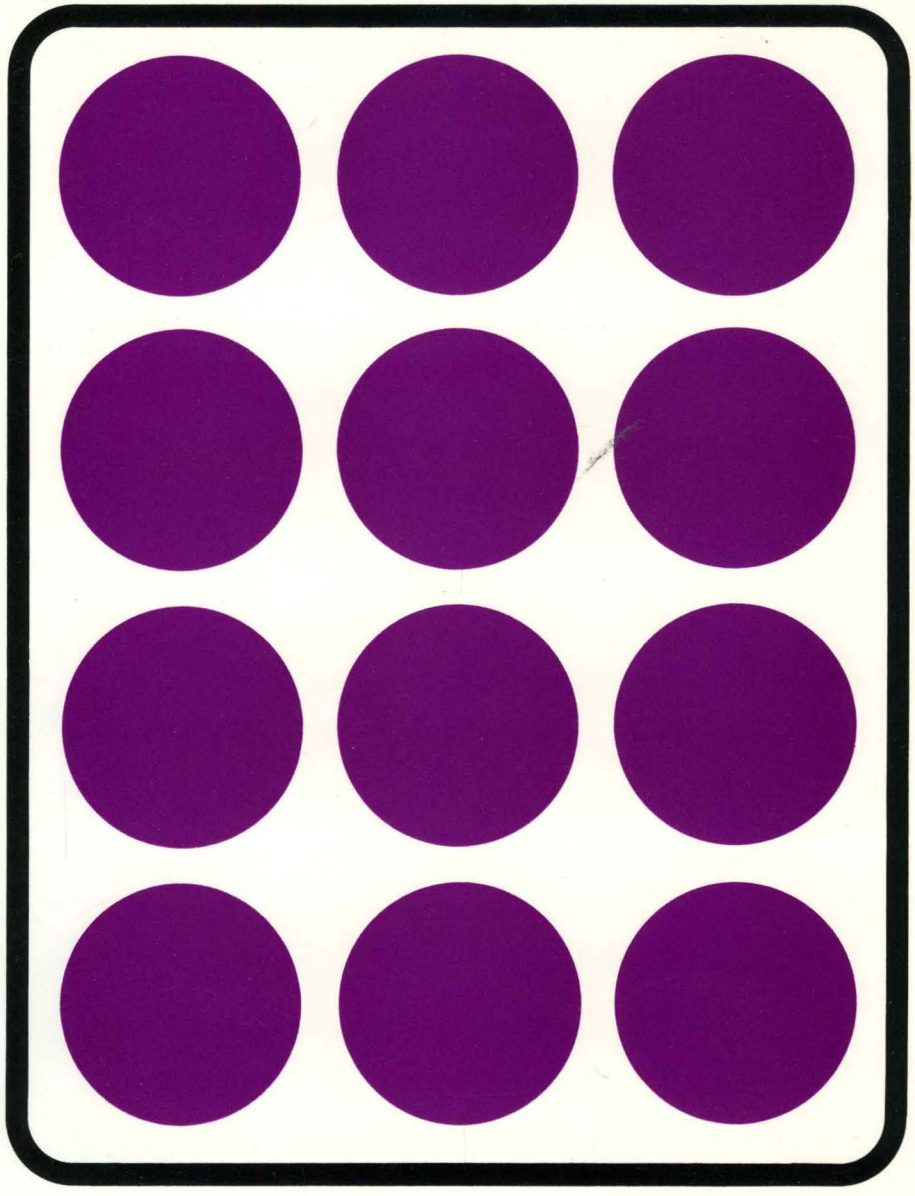
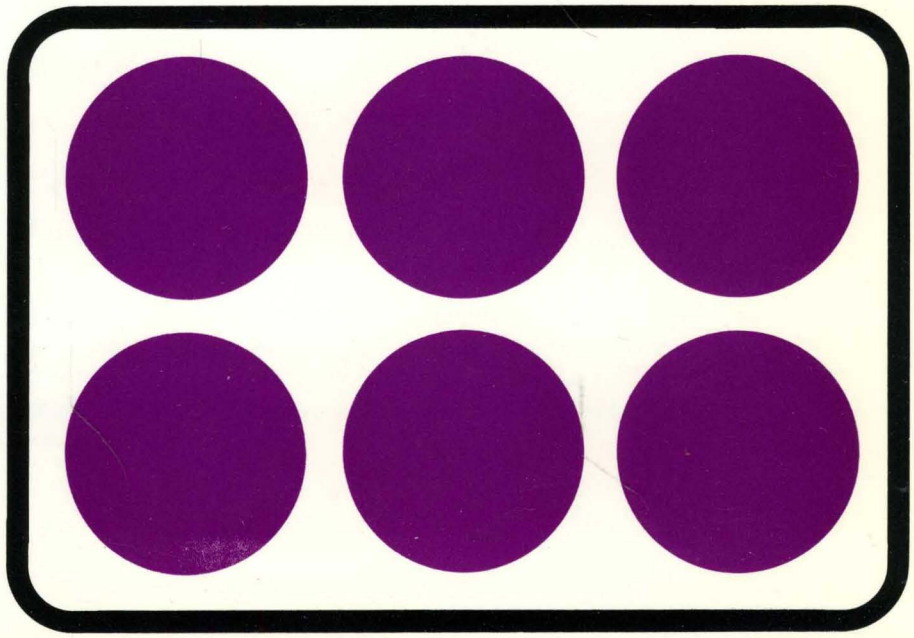


1996 DISK/TREND® REPORT



DISK
DRIVE
ARRAYS

1996 DISK/TREND® REPORT

DISK DRIVE ARRAYS

November, 1996

DISK/TREND, Inc.
1925 Landings Drive
Mountain View, California 94043

Telephone: 415-961-6209
Facsimile: 415-969-2560
E-mail: dtinfo@disktrend.com
Web: www.disktrend.com

© Copyright 1996 by DISK/TREND, Inc. All rights reserved. No portion of this report may be reproduced in whole or in part without written permission, including translation into another language or redistribution by any means in any form. All information included is believed to be reliable but cannot be guaranteed to be complete or correct. DISK/TREND is a trademark registered in the United States Patent and Trademark Office.

FOREWORD

The disk drive array business is a complex structure, blessed with overall growth, but troubled with continuing realignments in product architecture and contention between participants in rival market channels. To sort out the hues in this constantly changing kaleidoscope, we've continued to utilize the methods developed in 20 years of the DISK/TREND Report -- analysis of all aspects of the industry by direct contact with participants active in all phases of the business.

We cover all known companies originating basic disk drive array products because it's our desire to make the report as complete as possible, both in identifying all companies which are originating array products and in describing the size and nature of the industry. We believe that it is necessary to be thoroughly familiar with all aspects of an industry changing as rapidly as disk drive arrays, in order to adequately describe the key trends accurately. Since there is a considerable market in components and subassemblies within the array industry, it is also necessary to have a detailed knowledge of all participating companies, to avoid counting things twice!

We are always willing to help you at any time by providing additional information on the industry which we may have available. Your suggestions for improvements in the DISK/TREND Report are always welcome and are sincerely appreciated.

James N. Porter

Robert H. Katzive

TABLE OF CONTENTS

	Page
INTRODUCTION	SUM-1
SUMMARY	SUM-2
Industry size	SUM-2
Marketing channels	SUM-4
Product groups	SUM-6
Array product mix	SUM-12
Noncaptive market	SUM-16
DISK/TREND array definitions	SUM-25
ARRAY SYSTEM CONSIDERATIONS	SYS-1
Array characteristics and classification	SYS-2
System selection and integration checklist	SYS-7
TECHNICAL REVIEW	TECH-1
Array technology status and potential enhancements	TECH-2
Competing technologies	TECH-9
GLOSSARY	GLS-1
SINGLE USER SYSTEMS	DT60-1
NETWORKS/MIDRANGE SYSTEMS	DT61-1
MAINFRAME SYSTEMS	DT62-1
VERY HIGH PERFORMANCE SYSTEMS	DT63-1
ARRAY SPECIFICATIONS	ASPEC-1
MANUFACTURER PROFILES	MFGR-1
DISK/TREND ON DISK	DTDISK-1

LIST OF TABLES

Table		Page
1	CONSOLIDATED WORLDWIDE REVENUES, Disk Drive Arrays Revenue Summary	SUM-3
2	CONSOLIDATED WORLDWIDE REVENUES, Market Class Review	SUM-5
3	CONSOLIDATED WORLDWIDE REVENUES, Product Group Review, Revenue Summary	SUM-9
4	CONSOLIDATED WORLDWIDE SHIPMENTS, Product Group Review, Unit Shipment Summary	SUM-11
5	CONSOLIDATED WORLDWIDE SHIPMENTS, Summary by Array Type	SUM-15
6	NONCAPTIVE WORLDWIDE REVENUES, Product Group Review, Revenue Summary	SUM-17
7	NONCAPTIVE WORLDWIDE SHIPMENTS, Product Group Review, Unit Shipment Summary	SUM-19
8	1995 MARKET SHARES, Manufacturers of Disk Drive Arrays	SUM-21
9	CURRENT PRODUCT LINES, Manufacturers of Disk Drive Arrays	SUM-22
10	SINGLE USER SYSTEMS, Revenue Summary	DT60-7
11	SINGLE USER SYSTEMS, Unit Shipment Summary	DT60-8
12	SINGLE USER SYSTEMS, Revenue Breakdown by Array Type	DT60-9
13	SINGLE USER SYSTEMS, Shipment Breakdown by Array Type	DT60-10

LIST OF TABLES (Continued)

Table		Page
14	SINGLE USER SYSTEMS, Worldwide Price per Unit	DT60-11
15	SINGLE USER SYSTEMS, Market Share Summary, Noncaptive Arrays	DT60-12
16	NETWORKS/MIDRANGE SYSTEMS, Revenue Summary	DT61-13
17	NETWORKS/MIDRANGE SYSTEMS, Unit Shipment Summary	DT61-14
18	NETWORKS/MIDRANGE SYSTEMS, Revenue Breakdown by Array Type	DT61-15
19	NETWORKS/MIDRANGE SYSTEMS, Shipment Breakdown by Array Type	DT61-16
20	NETWORKS/MIDRANGE SYSTEMS, Worldwide Price per Unit	DT61-17
21	NETWORKS/MIDRANGE SYSTEMS, Server Array Attachment Analysis	DT61-18
22	NETWORKS/MIDRANGE SYSTEMS, Market Share Summary, Noncaptive Drives	DT61-19
23	MAINFRAME SYSTEMS, Revenue Summary	DT62-9
24	MAINFRAME SYSTEMS, Unit Shipment Summary	DT62-10
25	MAINFRAME SYSTEMS, Revenue Breakdown by Array Type	DT62-11
26	MAINFRAME SYSTEMS, Shipment Breakdown by Array Type	DT62-12
27	MAINFRAME SYSTEMS, Worldwide Price per Unit	DT62-13
28	MAINFRAME SYSTEMS, Market Share Summary, Noncaptive Drives	DT62-14

LIST OF TABLES (Continued)

Table		Page
29	VERY HIGH PERFORMANCE SYSTEMS, Revenue Summary	DT63-7
30	VERY HIGH PERFORMANCE SYSTEMS, Unit Shipment Summary	DT63-8
31	VERY HIGH PERFORMANCE SYSTEMS, Revenue Breakdown by Array Type	DT63-9
32	VERY HIGH PERFORMANCE SYSTEMS, Shipment Breakdown by Array Type	DT63-10
33	VERY HIGH PERFORMANCE SYSTEMS, Worldwide Price per Unit	DT63-11
34	VERY HIGH PERFORMANCE SYSTEMS, Market Share Summary, Noncaptive Drives	DT63-12

LIST OF FIGURES

Figure		Page
1	CHANGING PRODUCT MIX, Worldwide Disk Drive Array Revenue	SUM-8
2	UNIT SHIPMENT SUMMARY, Total Worldwide Shipments	SUM-10
3	ARRAY TYPE SUMMARY, Worldwide Shipments in Thousands of Units	SUM-14
4	UNIT SHIPMENT SUMMARY, Worldwide Noncaptive Shipments in Thousands of Units	SUM-18
5	1995 ESTIMATED MARKET SHARES, Worldwide Percentage Revenue for All Disk Drive Arrays	SUM-20
6	SINGLE USER SYSTEM ARRAYS, Worldwide Shipments by Array Type	DT60-4
7	NETWORKS/MIDRANGE SYSTEM ARRAYS, Worldwide Shipments by Array Type	DT61-8
8	MAINFRAME SYSTEM ARRAYS, Worldwide Shipments by Array Type	DT62-4
9	VERY HIGH PERFORMANCE SYSTEM ARRAYS, Worldwide Shipments by Array Type	DT63-4

Note: All trademarks mentioned within this report are the property of their owners.

INTRODUCTION

Adding up the value of the array business. To make good use of the statistical information in this report, it is important that you understand how we organize the data and how we count it. We count all items at the time the originating manufacturer first sells them to an outside buyer. The most important fact is that we count the key elements of each array only once! For example, when a board level array controller is sold to a system or subsystem manufacturer, we count that sale at the value of the transaction. We do not later count the array subsystem in which that board is utilized. We count the sale of a complete subsystem as such, when the array logic, in the form of a controller board or software product, is produced by the manufacturer of that array subsystem. The result is an accurate measurement of the total worldwide revenues and unit shipments generated by the original sale of the key elements in making a disk drive array.

Pricing levels can be confusing. As in all DISK/TREND Reports, we report revenues for the sale of disk drive array products at the level of the first public sale, at the estimated net transaction price, whether the sale occurs at the captive, PCM/Distributor or OEM/Integrator level -- to accurately record the value of the business to the original seller. You may find it helpful to refer to the tables in each product section which display the average unit price, broken down by each of the market channels and by each of the types of arrays. In addition to assisting many users in specific analyses, it is hoped that this information will be useful to many readers in understanding the relative price levels of captive, PCM/Distributor and OEM/Integrator array sales revenues, which is important in interpreting DISK/TREND revenue statistics.

If the language needs an interpreter. The product groups, types of products, market classes, and geographical classifications used in this report have been defined very carefully in the *DISK/TREND array definitions* at the end of the opening summary section. Individual terms used in describing disk drives and arrays have been defined in the *Glossary* section. We suggest you refer to both, as needed.

DISK/TREND ON DISK. The statistical and specification tables are available on floppy disks, as a separately purchased option to buyers of this report. For easy reference, instructions are included in the last section of this report.

SUMMARY: DISK DRIVE ARRAYS

Industry size

Sales of disk drive arrays continue to grow rapidly. Arrays are now utilized in applications such as mainframe computer systems for most of the required disk storage, limiting future shipment increases to expanding needs for disk storage, not purchases generated by conversion from nonarray disk farms. However, in numerous other applications the existing market penetration by disk drive arrays is still in midstream, with sales growth fueled by a combination of displacement of ordinary disk subsystems and expanding requirements for disk storage.

1995 worldwide sales revenues for all types of disk drive arrays were $9.8 billion, up 70.4% from the previous year. The DISK/TREND forecast for 1999 revenues is more than $18.6 billion, an average annual increase during the 1996-99 period of 17.6%. Unit shipments are projected to enjoy a faster climb, from 584,352 arrays in 1995 to 1,516,710 in 1999, an average annual increase of 27.2%.

The largest contribution to total disk drive array sales revenues is provided through captive sales by a broad range of manufacturers of personal computers, midrange computers and supercomputers. 1995 captive revenues totaled $6.4 billion, 65.4% of the worldwide revenue for all arrays, and the 1999 captive total is expected to double that level, at $12.9 billion. Revenues for arrays sold through captive channels will increase at a somewhat faster rate than for noncaptive arrays due to a greater emphasis on fully redundant complete subsystems, sold for relatively high prices.

Noncaptive sales continue to be dominated by the PCM/Distributor channel, with 27.3% of 1995 total disk drive array revenues, at $2.7 billion. Despite growth to $4.2 billion in 1999 sales revenues, the overall share of array total revenues for the PCM/Distributor channel is expected to decline to 22.5%, as the slow-down of high value subsystem shipments for the mainframe plug compatible market inhibits its growth. OEM/Integrator disk drive array sales, although smaller in revenue, are expected to maintain positive revenue growth through 1999, dominated by sales of high value complete subsystems for networks/midrange system markets, while boards, sold at low prices, decline after 1997.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

DISK DRIVE ARRAYS

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1995		Forecast							
	Revenues		1996		1997		1998		1999	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	3,503.2	6,212.8	4,333.4	7,961.2	5,025.3	9,257.9	5,781.3	10,845.9	6,658.3	12,658.8
PCM/Distributor	1,486.1	2,231.8	1,682.7	2,530.6	1,816.4	2,796.7	2,022.2	3,141.5	2,268.5	3,561.1
OEM/Integrator	341.5	577.6	611.1	934.2	687.5	1,088.9	766.8	1,218.1	801.1	1,282.8
TOTAL U.S. REVENUES	5,330.8	9,022.2	6,627.2	11,426.0	7,529.2	13,143.5	8,570.3	15,205.5	9,727.9	17,502.7
Non-U.S. Manufacturers										
Captive	.5	192.7	--	225.6	1.6	222.0	2.3	220.1	3.0	212.7
PCM/Distributor	254.1	436.9	308.5	546.1	331.5	599.0	343.5	622.4	347.5	633.4
OEM/Integrator	67.5	137.0	85.2	165.8	117.9	200.3	138.4	228.0	169.3	272.2
TOTAL NON-U.S. REVENUES	322.1	766.6	393.7	937.5	451.0	1,021.3	484.2	1,070.5	519.8	1,118.3
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	5,652.9	9,788.8	7,020.9	12,363.5	7,980.2	14,164.8	9,054.5	16,276.0	10,247.7	18,621.0

Marketing channels

Two thirds of disk drive array sales revenues are generated by computer system manufacturers which market internally produced arrays on a captive basis, and those manufacturers are expected to retain leadership through 1999. Internally developed arrays, mostly high-value complete subsystems, are being sold with their own systems as captive products by many types of system manufacturers, including supercomputer manufacturers such as Cray Research, midrange system manufacturers such as Digital Equipment, Tandem Computers, Hewlett-Packard and Data General, and by personal computer manufacturers such as Compaq Computer and Dell Computer. Captive arrays of all kinds held 65.4.% of the 1995 worldwide sales revenue total, and despite the substantial growth projected for noncaptive array manufacturers, sales revenues for the captive sales channel are expected to increase to 69.1% of the overall total in 1999, at $12.9 billion.

Despite the major role held by captive array manufacturers, the young array industry has seen enthusiastic missionary selling campaigns sponsored by the numerous noncaptive, independent manufacturers of controllers and other data storage peripherals which have entered the disk drive array business, with a full range of complete subsystems, boards and software products.

The PCM/Distributor channel is the dominant factor in noncaptive disk drive array sales, with $2.7 billion in 1995 sales revenue, 27.3% of the overall array total. 73.6% of 1995's PCM/Distributor sales revenues were derived from mainframe arrays, but arrays for the mainframe market are forecasted to decline to only 43.6% of the 1999 PCM/Distributor revenue total, held down by falling disk drive prices. Arrays for networks/midrange system applications will provide the major growth in PCM/Distributor sales, climbing to 52.4% of the 1999 revenue total for the channel.

Despite the fact that the U.S. is less than 60% of the worldwide array market, the product development and sales momentum already attained is expected to make it possible for U.S. companies to hold more than a 90% share of the worldwide disk drive array market through 1999. 158 array manufacturers are identified in this report, 128 of which are headquartered in the United States, and these manufacturers produced 92% of 1995's worldwide array revenues.

TABLE 2

CONSOLIDATED WORLDWIDE REVENUES
DISK DRIVE ARRAYS
MARKET CLASS REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1995 Revenues $M	1995 Revenues %	1996 Forecast $M	1996 Forecast %	1997 Forecast $M	1997 Forecast %	1998 Forecast $M	1998 Forecast %	1999 Forecast $M	1999 Forecast %
U.S. Manufacturers										
Captive	6,212.8	63.4%	7,961.2	64.3%	9,257.9	65.3%	10,845.9	66.5%	12,658.8	67.9%
	+85.7%		+28.1%		+16.3%		+17.2%		+16.7%	
PCM/Distributor	2,231.8	22.7%	2,530.6	20.4%	2,796.7	19.7%	3,141.5	19.3%	3,561.1	19.1%
	+32.4%		+13.4%		+10.5%		+12.3%		+13.4%	
OEM/Integrator	577.6	5.9%	934.2	7.5%	1,088.9	7.6%	1,218.1	7.4%	1,282.8	6.8%
	+48.0%		+61.7%		+16.6%		+11.9%		+5.3%	
Total U.S. Manufacturers	9,022.2	92.0%	11,426.0	92.2%	13,143.5	92.6%	15,205.5	93.2%	17,502.7	93.8%
	+66.4%		+26.6%		+15.0%		+15.7%		+15.1%	
Non-U.S. Manufacturers										
Captive	192.7	1.9%	225.6	1.8%	222.0	1.5%	220.1	1.3%	212.7	1.1%
	+308.3%		+17.1%		-1.6%		-.9%		-3.4%	
PCM/Distributor	436.9	4.4%	546.1	4.4%	599.0	4.2%	622.4	3.8%	633.4	3.4%
	+65.7%		+25.0%		+9.7%		+3.9%		+1.8%	
OEM/Integrator	137.0	1.7%	165.8	1.6%	200.3	1.7%	228.0	1.7%	272.2	1.7%
	+930.1%		+21.0%		+20.8%		+13.8%		+19.4%	
Total Non-U.S. Manufacturers	766.6	8.0%	937.5	7.8%	1,021.3	7.4%	1,070.5	6.8%	1,118.3	6.2%
	+136.5%		+22.3%		+8.9%		+4.8%		+4.5%	
Worldwide Recap										
Captive	6,405.5	65.4%	8,186.8	66.2%	9,479.9	66.9%	11,066.0	68.0%	12,871.5	69.1%
	+88.8%		+27.8%		+15.8%		+16.7%		+16.3%	
PCM/Distributor	2,668.7	27.3%	3,076.7	24.9%	3,395.7	24.0%	3,763.9	23.1%	4,194.5	22.5%
	+36.9%		+15.3%		+10.4%		+10.8%		+11.4%	
OEM/Integrator	714.6	7.3%	1,100.0	8.9%	1,289.2	9.1%	1,446.1	8.9%	1,555.0	8.4%
	+77.1%		+53.9%		+17.2%		+12.2%		+7.5%	
Total All Manufacturers	9,788.8	100.0%	12,363.5	100.0%	14,164.8	100.0%	16,276.0	100.0%	18,621.0	100.0%
	+70.4%		+26.3%		+14.6%		+14.9%		+14.4%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Product groups

During recent years, sales revenues for arrays used with mainframe computer systems have increased at a faster rate than revenues for any other array product group. During the early 1990's, EMC produced most of the revenues for mainframe arrays as the result of the company's sales success with its Symmetrix mirrored disk systems, with an assist from Hitachi Data Systems, which introduced its own mainframe disk subsystem with RAID-1 capability in mid-1993. Mainframe array sales mushroomed during the 1994-95 period, with the advent of long anticipated mainframe array shipments by IBM, Storage Technology and Hitachi.

Sales revenues for mainframe arrays reached $867.4 million in 1993, $1.8 billion in 1994, and more than $4.2 billion in 1995. However, in 1996 sales revenues are forecasted to increase only 4.8%, then decline in subsequent years, despite an expected continuing annual increase in the total amount of disk storage purchased for mainframe applications. As a result of the jump in mainframe array shipments during recent years, almost all of the disk storage now used with mainframes is in the form of disk drive arrays. Future growth in array shipments for mainframe applications will be limited to the annual increases in the mainframe market's requirement for additional disk storage capacity.

In addition, the disk drive price per megabyte will decrease much faster in the 1997-99 period than the mainframe market's increasing appetite for more storage, so the DISK/TREND sales revenue forecast for 1999 indicates a sales revenue decline to less than $3.7 billion. Mainframe array unit shipments are also expected to decline during the forecast period, as higher capacity disk drives make it possible to meet the total storage demand with fewer drives. The 1995 worldwide shipment total of 12.4 thousand mainframe array subsystems is expected to decline to 10.3 thousand in 1999.

Sales of networks/midrange array products continue to outstrip all other types of disk drive arrays. The networks/midrange array product group generated $5.4 billion in 1995 sales revenues, 55.4% of the revenues for all array product groups, as well as 91.8% of all array unit shipments. Extensive participation in this product area by more than ten U.S. systems manufacturers, selling internally developed arrays with their own computer systems on a captive basis, has

provided a large initial sales thrust for the product group, with captive revenues contributing 74.5% of the 1995 overall total for the product group. Total sales revenues for networks/midrange arrays are projected to reach $14.7 billion in 1999, with unit shipments topping 1.4 million arrays.

The impact of single user arrays and very high performance arrays on the industry's total sales revenues will be much smaller, with neither product group expected to produce as much as 1% of the overall 1995-99 revenue total. Although significant to the participating companies in each product group, the revenue totals in both groups will be modest -- but for different reasons in each product group.

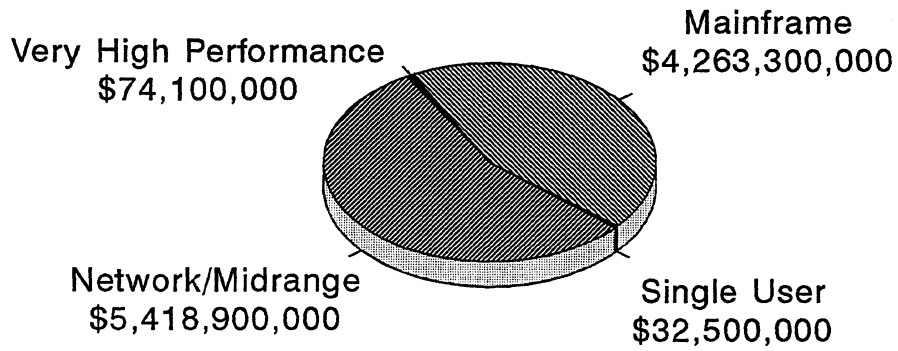
Although growth in the traditional supercomputer system market is expected to be modest compared to other computer application areas, new applications are starting to create a renewed growth market for very high performance arrays. The shipment increases for this product group through 1999 are expected to be generated by OEM/Integrator shipments to massively parallel computer manufacturers, high-end workstation producers and specialized video/imaging system manufacturers, plus PCM/Distributor shipments to the end-users of equipment sold by those manufacturers. PCM/Distributor sales revenues and unit shipments are expected to substantially exceed those for other sales channels in the product group by 1999. 1995 sales revenues for very high performance arrays were $74.1 million, and are forecasted to double by 1999, at $153.7 million. Unit shipments of all types of very high performance arrays are projected to jump from 1,385 in 1995 to 4,720 in 1999.

Shipments of single user arrays are forecasted to grow through 1999, but weak prices are expected to hold increases in sales revenues to modest levels. Growth in this product group relies heavily on noncaptive add-on sales of low cost subsystems, mostly RAID-0/1 mirrored disk arrays, with significant increases for unit shipments of software array products. PCM/Distributor sales will continue to predominate, concentrated in a narrow segment of the Macintosh, IBM compatible PC and UNIX workstation market -- serving those single users who think their work is mission critical, or who want to maximize performance, and have the funds available for highly reliable data storage. 1999 sales revenues are expected to be flat, at $44.8 million, based on shipments exceeding 79 thousand units, at least 60% of which will be relatively low cost software products.

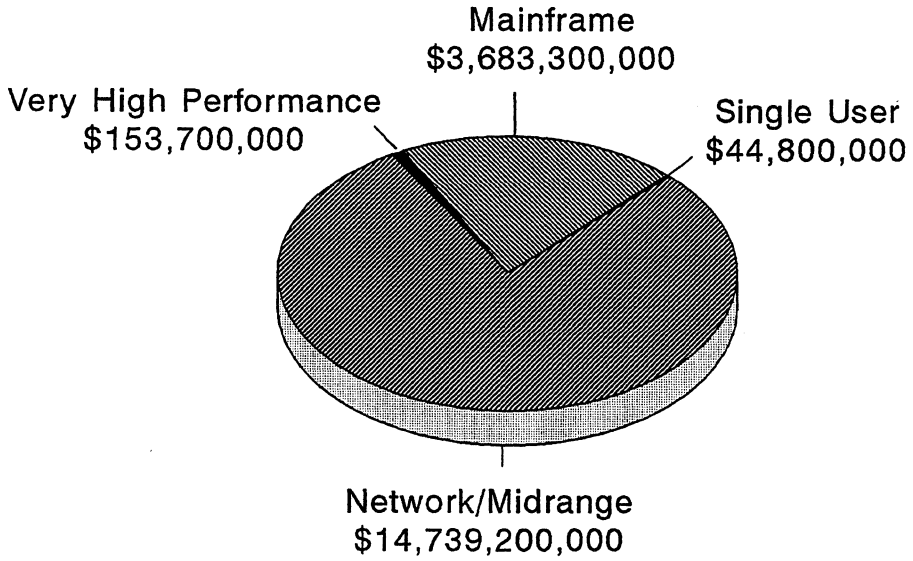
Figure 1

CHANGING PRODUCT MIX

Worldwide Disk Drive Array Revenue



1995



1999

TABLE 3

CONSOLIDATED WORLDWIDE REVENUES
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	------1995-----		----------Forecast----------							
ALL MANUFACTURERS	----Revenues---		------1996-----		------1997-----		------1998-----		------1999-----	
	$M	%	$M	%	$M	%	$M	%	$M	%
SINGLE USER SYSTEMS	32.5	.3%	39.7	.3%	43.2	.3%	44.9	.3%	44.8	.2%
	+104.4%		+22.2%		+8.8%		+3.9%		-.2%	
NETWORKS/MIDRANGE SYSTEMS	5,418.9	55.4%	7,777.8	62.9%	9,718.9	68.7%	12,104.7	74.5%	14,739.2	79.3%
	+41.8%		+43.5%		+25.0%		+24.5%		+21.8%	
MAINFRAMES	4,263.3	43.6%	4,466.0	36.1%	4,297.6	30.3%	3,994.9	24.5%	3,683.3	19.8%
	+130.1%		+4.8%		-3.8%		-7.0%		-7.8%	
VERY HIGH PERFORMANCE	74.1	.7%	80.0	.6%	105.1	.7%	131.5	.7%	153.7	.7%
	+35.7%		+8.0%		+31.4%		+25.1%		+16.9%	
Total Worldwide Revenue	9,788.8	100.0%	12,363.5	100.0%	14,164.8	100.0%	16,276.0	100.0%	18,621.0	100.0%
	+70.4%		+26.3%		+14.6%		+14.9%		+14.4%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Figure 2

UNIT SHIPMENT SUMMARY

Worldwide Shipments in Thousands of Units

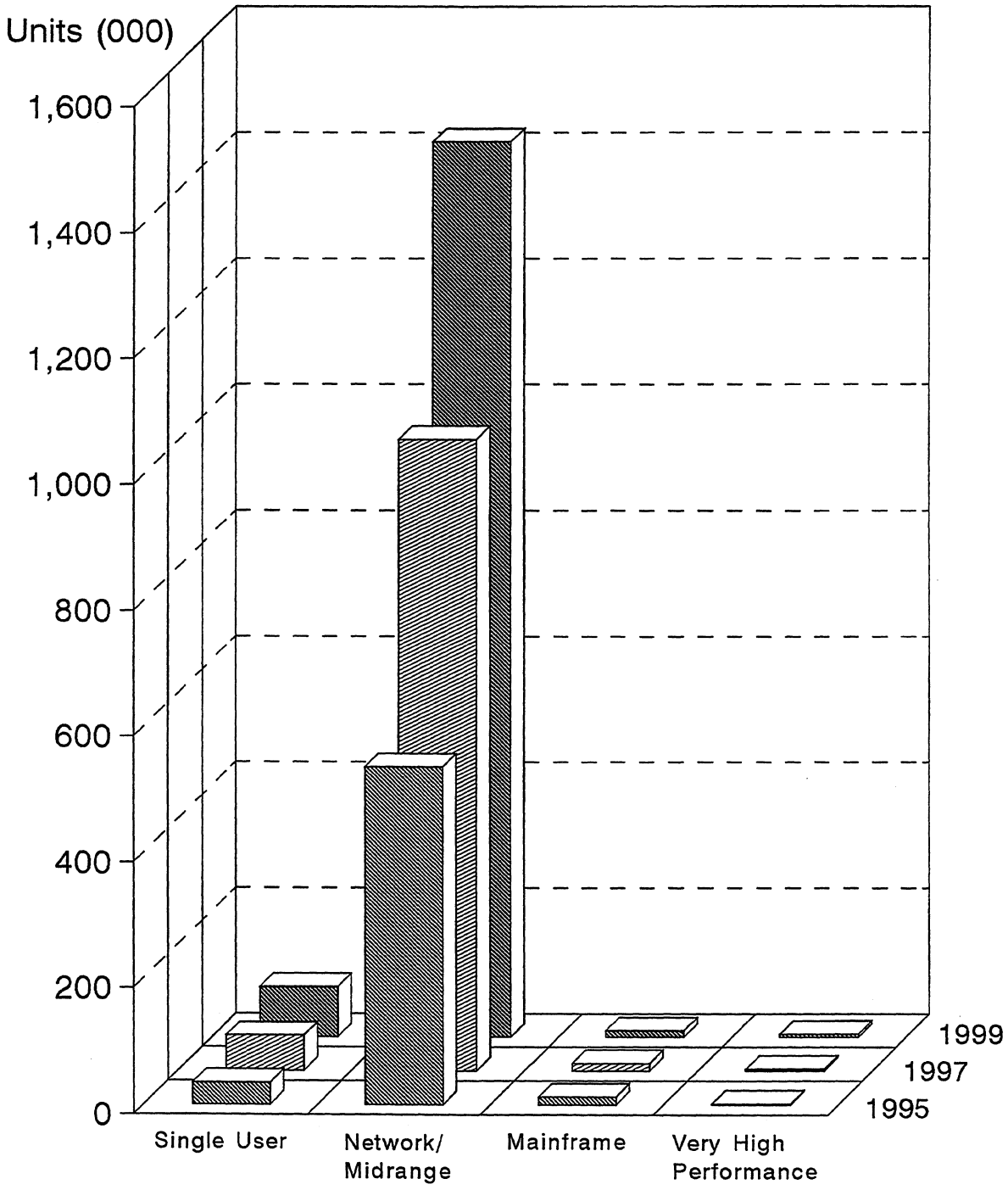


TABLE 4

CONSOLIDATED WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS	1995		Forecast							
SINGLE UNITS	Shipments		1996		1997		1998		1999	
	Units	%	Units	%	Units	%	Units	%	Units	%
SINGLE USER SYSTEMS	34,476	5.9%	44,330	5.6%	55,590	5.2%	67,370	5.2%	79,435	5.2%
	+59.3%		+28.6%		+25.4%		+21.2%		+17.9%	
NETWORKS/MIDRANGE SYSTEMS	536,074	91.8%	739,095	92.8%	1,002,110	93.6%	1,205,165	93.7%	1,422,210	93.9%
	+42.8%		+37.9%		+35.6%		+20.3%		+18.0%	
MAINFRAMES	12,427	2.1%	11,820	1.5%	11,655	1.1%	11,015	.9%	10,345	.7%
	+171.9%		-4.9%		-1.4%		-5.5%		-6.1%	
VERY HIGH PERFORMANCE	1,385	.2%	1,849	.1%	2,610	.1%	3,580	.2%	4,720	.2%
	+4.1%		+33.5%		+41.2%		+37.2%		+31.8%	
Total Worldwide Shipments	584,362	100.0%	797,094	100.0%	1,071,965	100.0%	1,287,130	100.0%	1,516,710	100.0%
	+45.0%		+36.4%		+34.5%		+20.1%		+17.8%	
% U.S. Manufacturers	92.0%		92.3%		93.2%		93.6%		93.9%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Array product mix

Disk drive array products are typically offered by manufacturers in three product types. Subsystems -- complete arrays, including disk drives, ready to use. Boards -- array controllers, sometimes including enclosures, power supplies and other array elements, but without disk drives. Software -- an individual software product providing array functionality, not part of an operating system. Array chip sets, and the expected future single chip array controllers, are not currently included in DISK/TREND statistics, although it is expected that they will be covered in future editions, when shipments become significant.

Complete subsystems have provided about half of total disk drive array unit shipments during recent years, and the share held by subsystems is expected to grow to 61% of the worldwide total for 1999. Complete subsystems constitute all of the arrays currently shipped for mainframe and very high performance systems. Shipments of complete subsystems for networks/midrange system applications are currently providing half of the shipments for the product group, but the share for complete subsystems is expected to rise to 63.1% in 1999, as users' requirements for fault tolerance move the market to more sophisticated arrays. Complete subsystems held 36% of the single user systems market, but that share is forecasted to decline to 17.9% of the 1999 total, as many users elect to use lower cost software array products.

Shipments of board level array controllers have been increasing rapidly in the networks/midrange product group for the last few years, and that trend is expected to continue through 1997, driven by OEM sales to personal computer manufacturers offering network servers. However, by 1998 networks/midrange OEM board shipments are expected to decline in the face of competition from single chip and chip set array controllers, which can be mounted on system motherboards, eliminating the need for a separate array controller board. Board shipments for single user computer systems are much smaller but are currently maintaining modest growth, due to low selling prices, from do-it-yourselfers.

Although software array products continue to maintain positive shipment growth, their share of the available market is increasing only in the single user product group, forecasted to reach 60.9% of that group's 1999 total. Software arrays tend to be favored by single users, because the usage of processor

capacity required for disk array functions is frequently not noticed in most single user applications, where the simpler mirrored disk drive arrays will continue to predominate.

DISK/TREND statistics do not count shipments by the individual RAID level of each array, because so many of today's arrays are capable of operating at multiple levels at the choice of the user, or concurrently. However, it is clear that a very high percentage of the arrays shipped to date are RAID-1 mirrored disk versions. Most single users and many users of networks/midrange and mainframe systems have found RAID-1 to be an appropriate product selection during the last few years. RAID-1 subsystems and boards have been readily available, have offered high reliability and have been cost-effective compared to the perceived alternatives. Rapidly declining disk drive prices will help to maintain the attractiveness of RAID-1 for many data storage applications, especially when limited total capacity is needed.

RAID-3 has been favored for very high performance arrays. Until recent years, it was the almost unanimous choice for supercomputers and other systems requiring the highest possible data transfer rates, but has now been supplemented with RAID-5 arrays with very high data rates. The earlier reliance on multiple disk drives, drives with multiple head parallel transfer, and RAID-0 striping is being replaced by high data rate versions of RAID-3 and RAID-5 arrays.

RAID-5 is expected to assume an ever larger role in the networks/midrange and mainframe array markets, as the availability of appropriate subsystems becomes widespread and unit prices are reduced through product simplification and competition. Since mirrored disk arrays require 100% drive redundance, while redundancy for RAID-5 is in the 20% range, RAID-5 has natural price advantages over RAID-1 when larger numbers of drives are required.

For the record, here are the total number of all types of array models included in the product specifications section of this report, arranged by the highest numerical RAID level claimed for each subsystem, board or software product:

RAID-1 and RAID-0/1 combinations	163
RAID-3 and RAID-0/1/3 combinations	41
RAID-4	4
RAID-5 and RAID-0/1/3/4/5 combinations	577

Figure 3

ARRAY TYPE SUMMARY

Worldwide Shipments in Thousands of Units

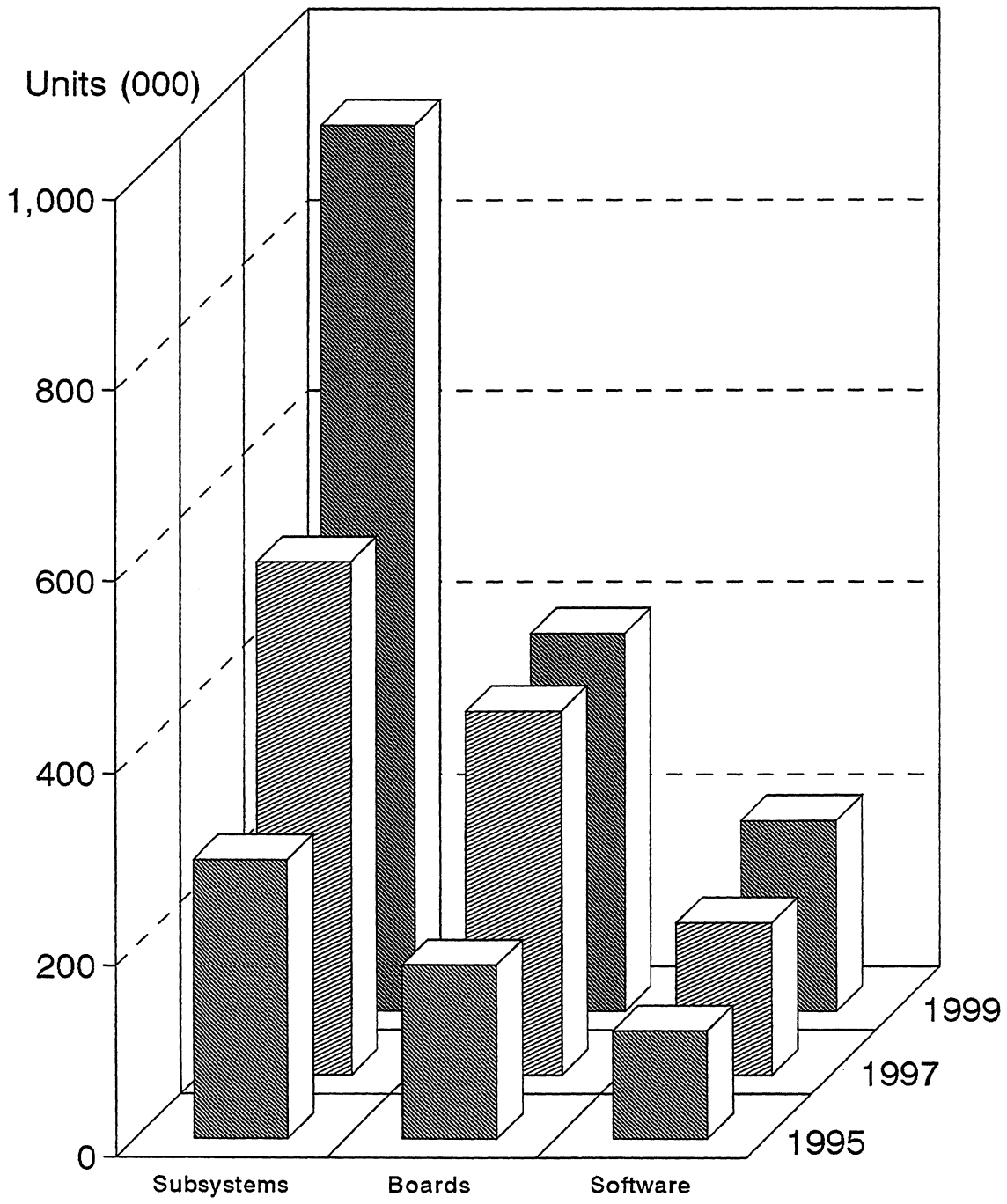


TABLE 5

CONSOLIDATED WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
SUMMARY BY ARRAY TYPE

UNIT SHIPMENTS	------1995-----		----------Forecast----------							
SINGLE UNITS	---Shipments---		------1996-----		------1997-----		------1998-----		------1999-----	
	Units	%	Units	%	Units	%	Units	%	Units	%
SUBSYSTEMS	290,952	49.8%	396,179	49.7%	534,090	49.8%	710,765	55.2%	924,825	61.0%
	+36.4%		+36.2%		+34.8%		+33.1%		+30.1%	
BOARDS	181,165	31.0%	265,690	33.3%	378,685	35.3%	395,320	30.7%	393,025	25.9%
	+54.3%		+46.7%		+42.5%		+4.4%		-.6%	
SOFTWARE	112,245	19.2%	135,225	17.0%	159,190	14.9%	181,045	14.1%	198,860	13.1%
	+55.3%		+20.5%		+17.7%		+13.7%		+9.8%	
Total Worldwide Shipments	584,362	100.0%	797,094	100.0%	1,071,965	100.0%	1,287,130	100.0%	1,516,710	100.0%
	+45.0%		+36.4%		+34.5%		+20.1%		+17.8%	

Notes: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Noncaptive market

Although growth in sales revenues for some types of disk drive arrays is expected to falter during the period covered by this year's DISK/TREND Report, continuous annual increases in unit shipments are forecasted for all four DISK/TREND product groups. While captive disk drive array shipments by many types of system manufacturers are already well established, noncaptive array product lines still have a variety of markets which are clearly not saturated, with numerous new array programs by independent manufacturers getting under way during the last few years. Noncaptive unit shipments are forecasted to increase from 334,452 in 1995 to 769,860 arrays in 1999.

As a result of a major boost in PCM/Distributor sales of mainframe arrays during 1994-95, total noncaptive array revenues reached over $3.3 billion in 1995, and the 1999 projection tops $5.7 billion. Mainframe sales have dominated DISK/TREND statistics for noncaptive array sales revenues since 1994, with the largest impact provided by EMC's spectacular growth in selling heavily cached mirrored disk subsystems in the IBM plug compatible market. However, by 1997 it is expected that noncaptive array sales revenues for networks/midrange markets will take the lead, with 53% of the total noncaptive array revenue, based on a diverse group of subsystem, board and software products from scores of manufacturers.

Networks/midrange array worldwide unit shipments in 1995 were 294,189 arrays, and the 1999 total is projected to increase to almost 680 thousand units, generating sales revenues of over $3.5 billion. Complete subsystems have become dominant in this product group and are expected to provide 97.9% of the group's 1999 sales revenues. Although noncaptive subsystem sales are not expected to catch up with captive sales by major system manufacturers, the independent array suppliers will continue to rapidly develop attractive new product features and innovative sales programs.

Shipments of boards for networks/midrange arrays are currently increasing at an even faster rate, but shipments of separate array boards are expected to peak after 1997, as growing numbers of personal computer manufacturers start to embed array controller functions on motherboards.

TABLE 6

NONCAPTIVE WORLDWIDE REVENUES
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1995		Forecast							
ALL MANUFACTURERS	Revenues		1996		1997		1998		1999	
	$M	%	$M	%	$M	%	$M	%	$M	%
SINGLE USER SYSTEMS	32.5	1.0%	39.7	1.0%	43.2	.9%	44.9	.9%	44.8	.8%
	+104.4%		+22.2%		+8.8%		+3.9%		-.2%	
NETWORKS/MIDRANGE SYSTEMS	1,166.2	34.5%	1,987.3	47.6%	2,475.1	53.0%	3,015.5	57.9%	3,586.1	62.5%
	+60.3%		+70.4%		+24.5%		+21.8%		+18.9%	
MAINFRAMES	2,135.4	63.1%	2,086.9	50.0%	2,074.6	44.2%	2,027.2	39.0%	1,971.3	34.2%
	+34.9%		-2.3%		-.6%		-2.3%		-2.8%	
VERY HIGH PERFORMANCE	49.2	1.4%	62.8	1.4%	92.0	1.9%	122.4	2.2%	147.3	2.5%
	+90.7%		+27.6%		+46.5%		+33.0%		+20.3%	
Total Worldwide Revenues	3,383.3	100.0%	4,176.7	100.0%	4,684.9	100.0%	5,210.0	100.0%	5,749.5	100.0%
	+43.8%		+23.5%		+12.2%		+11.2%		+10.4%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Figure 4

UNIT SHIPMENT SUMMARY

Worldwide Noncaptive Shipments in Thousands of Units

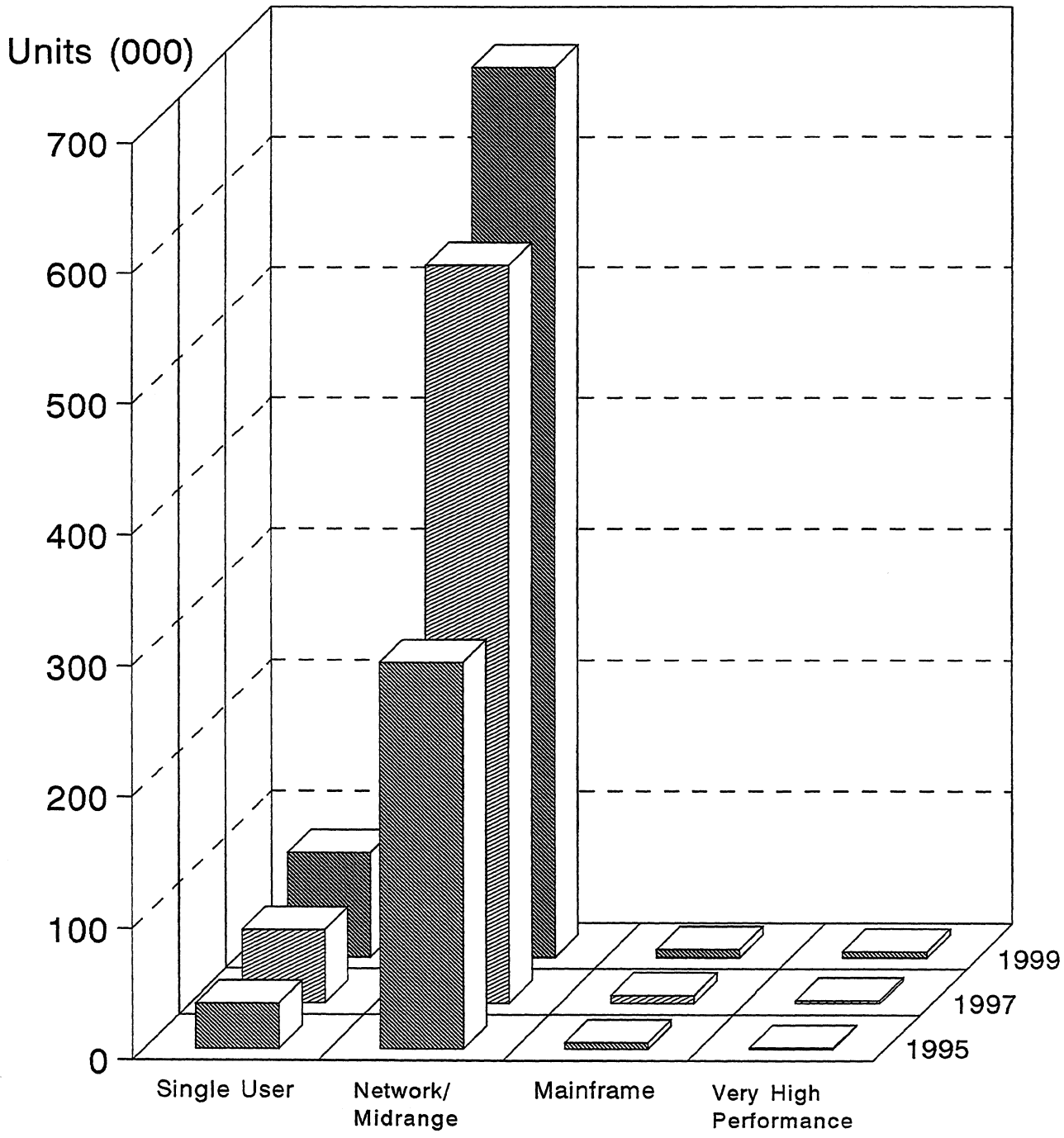


TABLE 7

NONCAPTIVE WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

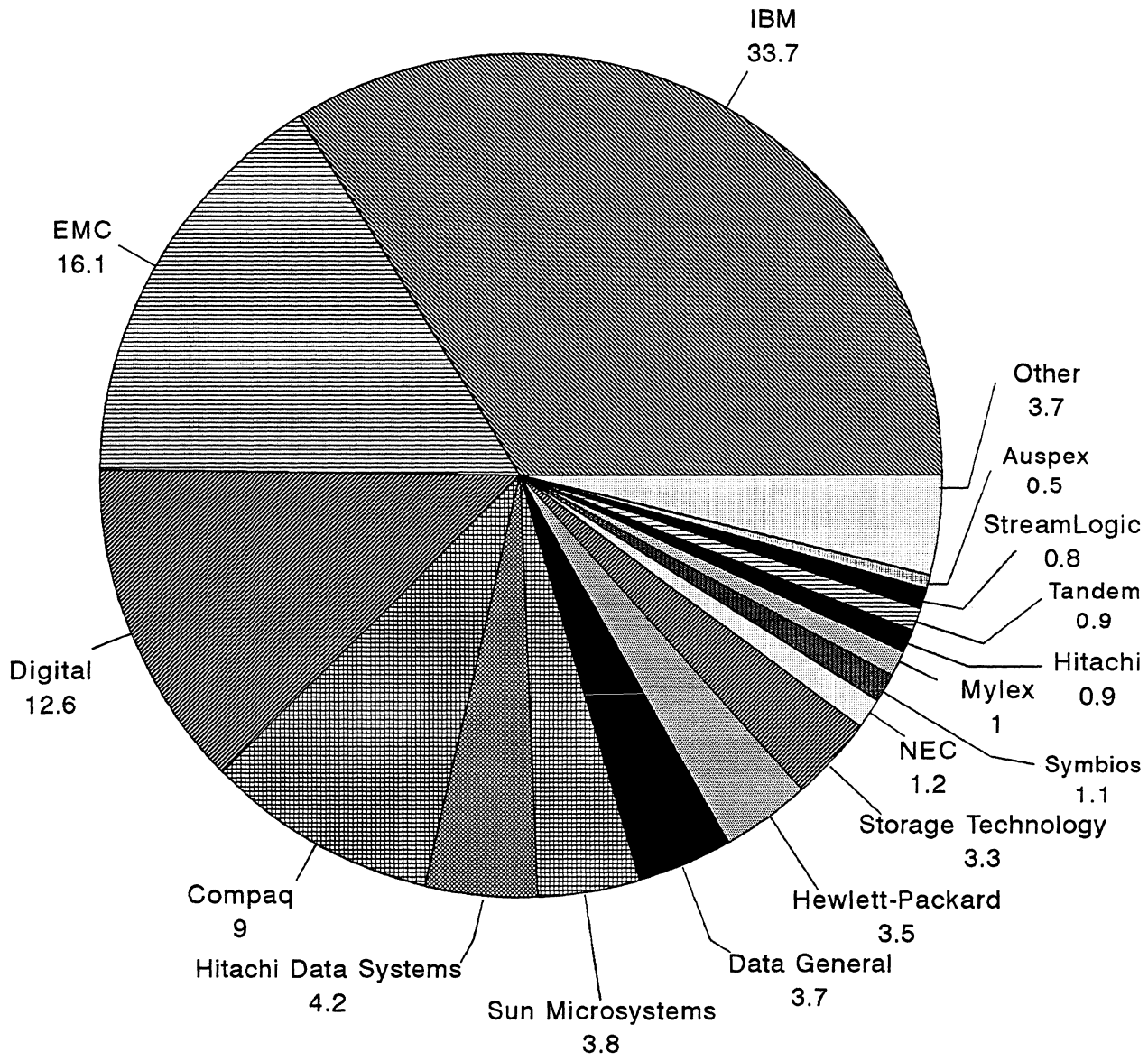
UNIT SHIPMENTS	1995		Forecast							
SINGLE UNITS	Shipments		1996		1997		1998		1999	
	Units	%	Units	%	Units	%	Units	%	Units	%
SINGLE USER SYSTEMS	34,476	10.3%	44,330	9.6%	55,590	8.9%	67,370	9.6%	79,435	10.3%
	+59.3%		+28.6%		+25.4%		+21.2%		+17.9%	
NETWORKS/MIDRANGE SYSTEMS	294,189	88.1%	410,630	89.0%	562,785	89.9%	628,295	89.2%	679,645	88.4%
	+45.6%		+39.6%		+37.1%		+11.6%		+8.2%	
MAINFRAMES	4,877	1.4%	5,605	1.2%	5,950	.9%	6,155	.8%	6,295	.8%
	+36.6%		+14.9%		+6.2%		+3.4%		+2.3%	
VERY HIGH PERFORMANCE	910	.2%	1,445	.2%	2,265	.3%	3,295	.4%	4,485	.5%
	+9.0%		+58.8%		+56.7%		+45.5%		+36.1%	
Total Worldwide Shipments	334,452	100.0%	462,010	100.0%	626,590	100.0%	705,115	100.0%	769,860	100.0%
	+46.7%		+38.1%		+35.6%		+12.5%		+9.2%	
% U.S. Manufacturers	88.0%		88.3%		89.7%		89.7%		89.3%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Figure 5

1995 ESTIMATED MARKET SHARES

Worldwide Revenue Percentages of All Disk Arrays



1995 Revenues: $9,788,800,000

TABLE 8

1995 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL DISK DRIVE ARRAYS
(Value of non-U.S. currencies estimated at average 1995 rates)

	CAPTIVE		PCM/DISTRIBUTOR		OEM/INTEGRATOR		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
Auspex Systems	--	--	46.1	1.7	--	--	46.1	.5
Compaq Computer	880.3	13.7	--	--	--	--	880.3	9.0
Data General	100.0	1.6	60.4	2.3	197.5	27.6	357.9	3.7
Dell Computer	31.5	.5	--	--	--	--	31.5	.3
Digital Equipment	1,051.0	16.4	134.0	5.0	52.5	7.3	1,237.5	12.6
EMC	--	--	1,396.1	52.3	183.6	25.7	1,579.7	16.1
Hewlett-Packard	343.1	5.4	--	--	--	--	343.1	3.5
IBM	3,297.4	51.5	--	--	--	--	3,297.4	33.7
Maximum Strategy	--	--	27.1	1.0	4.3	.6	31.4	.3
Mylex	--	--	3.4	.1	92.0	12.9	95.4	1.0
Network Appliance	--	--	31.8	1.2	--	--	31.8	.3
Storage Technology	--	--	327.8	12.3	--	--	327.8	3.3
StreamLogic	--	--	74.3	2.8	--	--	74.3	.8
Sun Microsystems	374.5	5.8	--	--	--	--	374.5	3.8
Tandem Computer	89.6	1.4	--	--	--	--	89.6	.9
Other U.S.	45.4	.7	130.8	4.9	47.7	6.7	223.9	2.3
U.S. Total	6,212.8	97.0	2,231.8	83.6	577.6	80.8	9,022.2	92.2
NON-U.S. MANUFACTURERS								
Hitachi	70.9	1.1	6.3	.2	6.5	.9	83.7	.9
Hitachi Data Systems	--	--	408.0	15.3	--	--	408.0	4.2
NEC	119.0	1.9	--	--	--	--	119.0	1.2
Symbios Logic	--	--	--	--	111.2	15.6	111.2	1.1
Other Non-U.S.	2.8	--	22.6	.8	19.3	2.7	44.7	.5
Non-U.S. Total	192.7	3.0	436.9	16.4	137.0	19.2	766.6	7.8
WORLDWIDE TOTAL	6,405.5	100.0	2,668.7	100.0	714.6	100.0	9,788.8	100.0

Note: 1. Drives sold in the PCM/Distributor market by other than the original manufacturer are valued at PCM/Distributor prices above, to avoid distortion of total market value

2. The DISK/TREND estimates of revenue for each disk drive manufacturer include net sales of disk drives only and do not represent total revenues for individual companies

TABLE 9

CURRENT PRODUCT LINES
MANUFACTURERS OF DISK DRIVE ARRAYS

Codes: C = Captive
O = OEM/Integrator
P = PCM/Distributor

SB = Subsystems
BD = Boards
SW = Software

		DISK/TREND PRODUCT GROUP			
N. American Manufacturers (128)	Type	Single User Arrays	Networks/ Midrange Arrays	Mainframe Arrays	Very High Performance Arrays
1776, Inc.	O,P		SW		
AC Technology	P		SB		
Adaptec	O,P		BD		
ADS International	P		BD,SB		
Advanced Logic Research	P		SB		
Amdahl	P		SB		
American Digital Systems	O,P		SB		
American Megatrends	O,P		BD		
ANDATACO	O,P		SB		
Antrone Research	P		SB		
Apple Computer	C,P		SB		
Applied Digital Systems	P		SB		
Artecon	P		SB		
AST Research	C,P		SB		
ATTO Technology	O,P	SW			
Auspex Systems	C,P		SB		
Aviv	P		SB		
Baystor	P	BD			
Box Hill Systems	P		SB		
Cambex	P		SB	SB	
CharisMac Engineering	O,P	SW			
Ciprico	O,P		SB		SB
CLone Star Software	P		SW		
CMD Technology	O,P		BD,SB		
Compaq Computer	C		BD,SB		
Computer Marketplace	P		SB		
Concurrent Computer	C		SW		
Conley	O,P		BD,SB,SW		
Corel	O,P		SW		
Cray Research	C				SB
Cubix	P		SB		
CyberData Systems	O,P	SB			
CyberStorage Systems	O,P		SB		
Cyranex	O,P	SW	SW		
Dallas Digital	O,P		SB		
Data General	C,O,P		SB		
Datalink	P		SB		
Data Storage Marketing	P		SB		
Data Technology Corp.	P	BD			
Dell Computer	C		SB		
Digi-Data	O		BD		
Digital Equipment Corporation	C,O,P		BD,SB,SW		
Direct Connections	P		SB		
Direct Connect Systems	P		SB		
Diverse Logistics	O,P		BD		
DPT	O,P		BD,SB		
DynaTek Automation Systems	P		SB		
ECCS	O,P		SB		
Eclipse Technologies	O,P		BD		
EMC	P		SB	SB	

N. American Manuf. (CONTINUED)	Type	Single User Arrays	Networks/ Midrange Arrays	Mainframe Arrays	Very High Performance Arrays
Encore Computer	C,P			SB	SB
Falcon Systems	P		SB		
Formation	O,P		SB		
FWB Software	P	SW			
Gainbery Computer Products	P		SB		
Gain Systems	O,P		SB		
Hewlett-Packard	C,O,P		BD,SB		
IBM	C,O,P		BD,SB	SB	
Invincible Technologies	C,P		SB		
Integrix	P		SB		
IPC Technologies	P		SB		
IPL	P		SB		
Legacy Storage Systems	O,P		SB		
Lighthouse Technology	P		SB		
Lomas Data Products	O		BD		
LAND-5	P		SB		
Macro Computer Products	P			SB	
MaxConcept	P	SB			
Maximum Strategy	O,P				SB
MegaDrive Systems	O,P		SB		
Micronet Technology	O,P	SB,SW	SB		
Microtech International	P	SB			
Morton Management	P		SB		
MountainGate Data Systems	P		SB		
MTI Technology	P		SB		
Mylex	O,P		BD		
NCR	C,O,P		SW		
NetFRAME	O,P		SB		
Network Appliance	C,P		SB		
Network Connection	P		SB		
New Design	P	SB			
Nonstop Networks	P		SW		
NStor	P		SB		
Optima Technology	P	SB	SB		
PACE Technologies	O,P		SB		
Pacific Micro Data	P		SB		
Parity Systems	P		SB		
Perceptive Solutions	O,P		BD		
Perisol Technology	P		SB		
Phoenix International	P		SB		
Polywell Computers	P		SB		
Precision Computers	O,P		SB		
Procom Technology	P		SB		
RAAC Technologies	P		SB		
RAID Power	P		SB		
Raidtec	O,P	BD,SB	BD,SB		
R Squared	P		SB		
Seek Systems	P		BD,SB		
Sequent Computer Systems	P		SB		
Sequoia Systems	C,O		SB		
Sigma	O,P		SB		
Storage Computer	O,P		SB		
Storage Concepts	O,P		SB		SB
Storage Dimensions	P		SB		
StoragePath	O,P		SB		
Storage Solutions	O		SB		
Storage Technology	P		SB		
StorNet	P		SB		
Stratus Computer	C		SB		
StreamLogic	O,P	SB	BD,SB		
Sun Microsystems	C,P		SB,SW		
Tandem Computers	C		SB		

N. American Manuf. (CONTINUED)	Type	Single User Arrays	Networks/ Midrange Arrays	Mainframe Arrays	Very High Performance Arrays
Tangent Computer	P		SB		
TD Systems	O,P		BD		
Texas Microsystems	P		SB		
Thinking Machines	C				SB
Total Tec Systems	P		SB		
Transitional Technology	P		SB		
Tricord Systems	C		BD		
Trillium Research	P	SW	SW		
Unisys	C,P		SB	SB	
Uni Solution	P		SB		
Unitrol Data Protection Sys.	O,P	SW			
Veritas Software	O,P		SW		
Western Scientific	P		SB		
Winchester Systems	P		SB		
Xistor	P	SB			
ZZYXZ Workstations & Periph.	P		SB		
Asia/Pacific Rim Manufacturers (14)					
Acer	P		SB		
Advanced Technology & Systems	O,P	SB	SB		
Aiwa (Core)	P		SB		
Fujitsu	C			SB	SB
Hitachi	C,O,P		SB	SB	
Hitachi Data Systems	P		SB	SB	
Infortrend	O,P		BD		
NEC	C,P		BD,SB		
Nippon Texa	O,P	SB	SB		
Raidar Systems	P		SB		
Sunix	O		BD		
Symbios Logic	C,O,P		BD,SB		
Systex	P		BD		
Tekram Technology	O,P	BD	BD		
European Manufacturers (16)					
Advanced Telecomm. Modules	C,O,P		SB		
Arco Electronics	P	BD			
ATON Systemes	C,O,P	BD	BD,SB		
Baydel Ltd.	O,P		SB		
Comparex	P			SB	
Dilog SA	O,P		BD		
Eurologic Systems	P		SB		
Future Computers	P		SB		
Hi-Data	O		BD		
Siemens Nixdorf	C,P		SB		
Solid Computer	P		SB		
SYRED Data Systems	O,P		BD,SB		
TwinCom	O,P		SW		
Vortex Computersysteme	O,P		BD		
Xyratex	O,P		SB		
Zenith Data Systems	P		SB		

DISK/TREND ARRAY DEFINITIONS

Many basic terms have varying meanings within the computer industry. In the DISK/TREND Report on disk drive arrays, these specific meanings are used:

Product group classification

Arrays are classified into four product groups according to the type of system attachment for which they are designed. They include:

Single user systems: Intended for use with single personal computers or workstations. Attached processors typically run under DOS, Windows, Macintosh System 7, OS/2, UNIX, etc.

Networks/Midrange systems: Consists of all midrange systems, to which individual personal computers, workstations or terminals are typically attached. Host platforms include the IBM AS/400, Compaq ProLiant, Digital Equipment and other minicomputers, engineering workstation networks and personal computer networks. Software environments include UNIX and its variants as well as other minicomputer operating systems and include network operating systems such as Novell NetWare, Windows NT, Banyan VINES, and Artisoft Lantastic.

Mainframe systems: Classic mainframe and supermini system environments.

Very high performance systems: Supercomputers, specialized video and imaging systems, and other systems with requirements for very high data transfer rates.

Product type classification

Within each product group, arrays are classified into three product types for purposes of the DISK/TREND Report. Only products specifically and primarily intended to permit disk drives to operate as an array, in accordance with the Berkeley RAID-1/2/3/4/5 definitions, are included in this classification.

Complete subsystem: Arrays consisting of controller or array software, drives and supporting elements such as fans, power supplies, enclosure, etc., ready for installation.

Board: A board or subsystem providing array capability to a system, but not including disk drives. This category includes products that are boards only, as well as boards mounted in an enclosure, with power supplies, fans and other array elements, but without drives.

Software: A specific software product that provides array functionality without requiring a separate controller. Operating systems that include array functions, such as Novell NetWare SFT III or Microsoft Windows NT Advanced Server, are not included in this category or counted in the statistics. Sales of software arrays obtained via a technology license with production rights from the licensor are credited to the licensee and not the licensor to avoid distortion of sales revenue figures.

Market classification

Market class is used here, arbitrarily, to differentiate captive, PCM/Distributor and OEM/Integrator marketing activities.

Captive: Arrays manufactured internally by a computer systems manufacturer, its subsidiary, or exclusive contractor, and sold or leased primarily for use with systems offered by the manufacturer. Note that the term is used to describe the products, not the manufacturer; arrays sold to PCM/Distributor or OEM/Integrator market classes are classified accordingly.

Example:

* Arrays sold by Digital Equipment, IBM or Compaq for use with their own systems are considered captive, if the array controller or array software is internally manufactured.

Noncaptive: Any public sale or lease by any array manufacturer, except sales or leases of internally manufactured arrays by computer system manufacturers primarily for use with their own systems. Both OEM/Integrator and PCM/Distributor shipments are included in the noncaptive sales channel.

Examples:

* Shipments by Data General's CLARiiON unit are noncaptive, except for arrays sold with computer systems made by the parent company or other subsidiaries.

* Shipments made by American Megatrends, Mylex or CMD Technology are noncaptive.

PCM/Distributor: Arrays sold or leased by "plug compatible manufacturers" or their distributing organizations directly to end users for use with systems sold by another manufacturer. Also includes arrays sold in the "aftermarket" -- shipments by array manufacturers to subsystem producers, value-added resellers, distributors, retail chains, mail order firms and individual dealers. It includes disk drive arrays to be connected to computer systems of all types, including personal computers, minicomputers and mainframes, or arrays sold as add-on devices by distributors and dealers.

Examples:

* Arrays sold by Aiwa Core or StreamLogic through distributors.

* Arrays sold by EMC to end users of IBM equipment.

OEM/Integrator: Arrays sold by the original producer to system manufacturers which resell them as part of complete computer systems. Also includes sales to system integrators which combine finished system components and software to provide complete systems for specific applications. Sales by an array manufacturer to a second manufacturer for resale are included only in shipment totals for the originating manufacturer, except when arrays are produced on a contract manufacturing basis with a design supplied by the manufacturer which finally sells the array to a third party.

Examples:

* Arrays produced by Maximum Strategy for sale to system manufacturers.

* Software produced by 1776 for sale to system manufacturers.

* Array controllers produced by Mylex for sale to system or subsystem manufacturers.

Geographic classification

Geographic analysis is based upon U.S. and non-U.S. regions. Together, these two regions comprise the worldwide market.

U.S. vs. Worldwide SHIPMENTS: Shipments are classified U.S. or worldwide depending on the country in which the headquarters of the purchasing company is located.

Examples:

* An OEM shipment by a U.S. array manufacturer to a European system manufacturer is included in worldwide totals, even if the array is integrated into a system within the U.S.

* An OEM shipment by a European array manufacturer to a U.S. based system manufacturer is included in U.S. totals, even if the array is integrated into a system in a third country, regardless of the final destination of systems in which the arrays are used.

U.S. vs. Non-U.S. MANUFACTURERS: Manufacturers are classified U.S. or non-U.S., depending on the location of the firm's headquarters, regardless of the location of individual manufacturing plants.

Units of measurement

Array units: The basic array unit consists of the electronics (or software package) required to operate multiple disk drives as an array, regardless of whether it is sold originally as a board level array, software package or complete subsystem. All DISK/TREND array unit shipments are credited to the company that makes the first public sale of the basic array unit.

Examples:

* When CMD sells a controller to a system integrator which combines the CMD controller with Seagate disk drives and an enclosure with fans and power supplies to produce a complete array subsystem, CMD is credited with the sale of an array board.

* When Compaq Computer sells a system which includes an internally built array controller, with disk drives, Compaq is credited with the sale of a complete subsystem.

* When 1776 sells a copy of its array software, it is credited with the sale of a software array unit.

Revenue: Based on sales of array units, including bundled drives (if any), as normally sold by individual manufacturers. Add-on drives sold as separate units are not included in array revenue, nor are replacement parts or service. Sale prices are estimated public sale transaction prices, whether at captive end user, PCM/Distributor or OEM/Integrator levels, and are credited to the company that makes the first public sale of the basic array unit. All prices are in 1995 constant dollars.

Forecasts: Expected shipments and revenues for current or announced products in new production. Evolutionary improvements within existing disk array architectures are included, but completely new configurations or technologies are not included.

Examples:

* Enhancements such as write latency improvements and revised compression schemes are anticipated in DISK/TREND forecasts.

* Innovations such as disk drive arrays for portable systems or video servers may require establishment of new DISK/TREND product groups.

ARRAY SYSTEM CONSIDERATIONS

1996 DISK/TREND REPORT

ARRAY SYSTEM CONSIDERATIONS

Disk drive arrays come in a variety of configurations and implementations ranging from inexpensive and simple to costly and complex. This section of the report reviews array characteristics and issues pertaining to their use.

ARRAY CHARACTERISTICS AND CLASSIFICATION

What is an array? A disk drive array is an assembly of disk drives and hardware controllers operated by array management software. The array presents itself to its host system environment as if it were a single physical disk drive. The storage devices that are members of the array can be any type of random access, non-volatile storage device with unlimited read/write capabilities, including rigid magnetic disk drives, rewritable optical disk drives and nonvolatile solid state disk drive equivalents.

Array management software can be program code, to be executed within the host system environment, or it can be implemented as firmware within the array controller, or as a hybrid combination of the two.

Implementations: For purposes of this report, arrays are considered to be implemented in one of three ways, which represent the forms in which arrays are sold:

* Complete subsystems: Array subsystems include disk drives, controllers with software to operate the array, enclosures, power supplies, fans, cables and possibly other physical elements. The array controller contains the programs necessary to operate the array and appears to the host system as a single drive. The host system is relieved of the need to manage the details of operating the array. Some controllers allow partitioning of the array drives into several types of array (each appearing to the host system as a single drive), all of which can operate concurrently with data routed by the host computer to the array type best able to handle it. Subsystem manufacturers usually include software tools to configure, manage and monitor the array subsystem, frequently for a specific host system and software environment.

* Boards: This category includes array controllers sold individually or with other subsystem elements such as enclosures, fans, power supplies and cabling, but not including disk drives.

* Software: If the array is implemented purely by use of software and without hardware specifically designed to operate an array, then it is a software implementation. Hybrid arrays combining software and hardware functions exist, but are considered as hardware implementations in

this report. Software implementations are relatively inexpensive and usually easy to integrate, but may be slower than hardware implementations and may not provide all the functions a hardware array implementation can provide. Exact performance will depend on processor load, the controllers, disk drives and drivers used with the disk drives, as well as processor performance. Array specific drivers are often provided with software arrays to improve performance. Software array implementations are often specific to the host system and may not be effective at all sites in multihost network environments.

When to use an array -- and when not: Disk drive arrays may provide several kinds of advantages over individual disk drives. Certain array configurations can improve system throughput, and the use of an array can spread data over multiple drives, avoiding unbalanced I/O loads and consequent bottlenecks. Other array configurations can improve data availability by providing a degree of fault tolerance, although the degree of improvement in either case depends upon the specific design of the array subsystem.

Disk drive arrays can provide performance enhancements or fault tolerance enhancements, but these advantages tend to be mutually exclusive, in that optimizing for one usually penalizes the other. There is always an economic penalty compared to nonarray implementations of data storage. If the needs of the system user can be met without improved throughput or improved fault tolerance, there is no need for the additional expenses associated with an array. In short, choosing an array is a balancing act between cost, performance, and data availability.

Arrays should not be viewed as a way of avoiding the need for disk drive backup. While data can be protected against a failure of a drive or other subsystem element, no protection is provided against operator error, disasters, viruses or other external disruptive influences. Furthermore, while arrays may provide for redundancy at the disk drive level, failures elsewhere in a nonredundant system can make the data stored on the array unavailable. Only by duplicating each element of a system, including processors, controllers, cables, ports, fans, power supplies, etc. can the highest probability of data availability be achieved. The need for fault tolerance must be analyzed for each processing node in a network to select the most cost-effective approach.

Choosing the right array for the application: Although some types of arrays have been used for a number of years, they received prominence after publication of a classification scheme in a technical report by researchers at the University of California in Berkeley in December, 1987 (Technical Report UCB/CSD 87/391). The authors discussed a set of array configurations which they characterized as Redundant Arrays of Inexpensive Disks, RAID by acronym, as compared to a Single Large Expensive Disk (SLED). Five configurations, or RAID levels, ranging from RAID-1 to RAID-5 were defined (an additional level, RAID-6, was proposed later). While not defined by UC, RAID-0 has been generally adopted as referring to a striped set of disks with no redundancy.

Because the prices of disk drives have declined radically since the RAID acronym was coined, the use of arrays as a means to reduce storage costs is no longer relevant, so the RAID acronym is currently interpreted by many as Redundant Arrays of Independent Disks.

The RAID configurations describe ways of organizing data on the disk drives and organizing the flow of data to and from the drives, but do not cover the details of interfaces or of controller or software operation. The RAID levels merely describe configurations: A higher RAID level does not imply anything regarding relative performance, complexity, cost or reliability, which are functions of specific configurations. Furthermore, arrays may contain design features associated with more than one RAID level, which blurs the utility of the RAID classification. However, because of broad industry usage, RAID nomenclature is used throughout this report.

The various configurations and their uses are reviewed briefly below:

* RAID-0: RAID-0 disk configurations have data striped across the drives that are included in the set. Because each drive is accessed independently, portions of data from an I/O operation can be read or written to each drive simultaneously, minimizing data transfer time. While fast, RAID-0 provides no redundancy in data storage, so if one drive in the set fails, all data becomes unavailable. If the failed drive cannot be repaired, all of the data is irretrievably lost. RAID-0 is best where high performance is desired and fault tolerance is not a consideration. It also offers the lowest cost per megabyte. Some manufacturers have referred to collections of disks without striping as RAID-0, but this runs counter to industry usage, which would refer to nonstriped, nonredundant groups of drives as JBOD (just a bunch of disks).

* RAID-1 (Mirrored disk drives): In this mode, data is written or read in identical form to two or more drives. This provides fast read performance, because the first drive to respond to an I/O request can provide the data requested, reducing latency. Furthermore, there is no need to compute and store parity blocks, a time-consuming operation in other RAID modes. Write performance may be somewhat slower than in JBOD configurations, since both drives have to complete the write operation. The strongest objection to RAID-1 is economic: The cost of the drives at least doubles for any given storage capacity. However, management is relatively simple and controllers or software need not be overly complex, which facilitates integration into a system. RAID-1 is useful where high performance is needed, high data availability is required, and data block sizes are not overly long, but doubles the cost per megabyte since twice as many drives are needed.

* RAID-2: This configuration is rarely used and was included in the Berkeley work primarily to cover a few systems that had been shipped earlier. In

RAID-2, bytes are broken into smaller units which are then transmitted in parallel to a set of disk drives. In addition, parity data, computed using Hamming codes, is sent to additional drives used specifically to store parity data. The redundancy of data provides good data availability. Read performance is good because data is transferred in parallel. Write performance is degraded because of the need to compute parity and then write it to the parity disks. Relative to other array types, RAID-2 is uneconomical because it requires a larger number of drives, and RAID-2 controllers tend to be complex and expensive. RAID-2 performance can be achieved by RAID-3 at lower cost.

* RAID-3: Data is sent to and from the disk drives in parallel, one I/O request at a time. Parity data is stored on a single additional drive. The disk spindles may be synchronized to transfer data to all drives simultaneously. Because of the high degree of parallelism, data transfers are very fast, although concurrent I/O is not possible. If a single drive fails, data is still available by using the data on the working drives plus the parity drive to reconstruct the data, although the effective data rate will be degraded as a result. RAID-3 is typically used on supercomputers, image manipulation processors and other applications where very high data transfer rates are needed. It is most efficient for long block transfers and is inefficient for short transactions with high I/O request rates. For a given capacity, fewer drives are needed than for RAID-1, as only a single drive for redundancy must be added to the data drives. However, the controller may be more complex and expensive. RAID-3 is best for situations requiring very fast data transfer rates and/or long data blocks.

* RAID-4: In RAID-4, data is striped across the array drives while parity data is accumulated on a separate drive. Data is recoverable if a drive fails. Read performance is similar to RAID-1, but writes are considerably slower than on a single disk because of the need to funnel the parity information through a single drive. RAID-4 has been supplanted by RAID-5, which offers the same read performance but much better write performance.

* RAID-5: Data in a RAID-5 array is striped across the drives in the array, but parity data is also distributed among all of the drives, eliminating some of the write bottleneck. Writes are still slow because of the need to read data from all drives to recompute parity when writing (sometimes called the read-modify-write process). Concurrent I/O transactions can be processed. Data can be recovered in the event of a single drive failure. RAID-5 is efficient for long data records, but is also reasonably efficient for short ones if the array design includes features to improve write performance, or if the application requires a high proportion of reads. It is a good choice for achieving high data availability, with acceptable performance provided that the data block size is small. RAID-5 carries only a modest cost per megabyte penalty compared to a nonarray approach.

* RAID-6: Similar to RAID-5, but with additional parity information written that permits data recovery if two drives fail. This configuration requires extra parity drives, and write performance is theoretically slower than for an equivalent implementation of RAID-5. It was proposed by UC Berkeley in late 1989. RAID-6 is also used by some manufacturers to designate a layered array with RAID-1 and RAID-0 capabilities, but this does not conform to the Berkeley definition.

* Non-Berkeley RAID levels: In addition to the RAID levels defined above, there are a variety of nomenclatures used by specific manufacturers. There is no agreement on the meanings of these; most are meant to imply the ability to operate in more than one mode simultaneously or to imply that a specific design incorporates features of more than one RAID configuration. Others, such as RAID-7, imply attempts to improve RAID-5 performance through vendor specific design features. Terms such as RAID-10, RAID-1/0 or RAID-1+0 have become commonly used to mean a layered array operating simultaneously in both modes, offering the advantages of striping and mirroring. Similar hybrids offering RAID 3 or RAID 5 and striping in a multilayered array also exist, typically identified as RAID-30 or RAID-50.

In meetings and publications of the RAID Advisory Board, an industry group attempting to create agreement on array nomenclature, test procedures, interface specifications and similar matters, a proposal has been made to classify arrays by their access method rather than by RAID level. While it is unclear that this will be adopted as standard nomenclature, it does provide an alternative way of classifying arrays.

* Parallel access arrays: All of the member disk drives in a parallel access array operate on every I/O transaction handled by the array. RAID-2 and RAID-3 arrays are examples of parallel access arrays. A few RAID-1 arrays fall into this class.

* Independent access arrays: In this category, the disk drives act independently, and may have the ability to be operating upon multiple I/O requests concurrently. RAID-4, RAID-5 and RAID-6 and most RAID-1 implementations fall into this category.

The RAID Advisory Board has not defined RAID-0 as parallel access or independent access, since it does not consider RAID-0 an array, as it does not provide any data redundancy.

Another method of classifying arrays now occasionally used in the industry divides arrays into "parity arrays", in which parity blocks are created (RAID-3/4/5), and "nonparity arrays", which use only mirroring (RAID-1) for redundancy.

Non-RAID approaches: Performance and fault tolerance issues can be addressed without using an array. System designers may choose to employ very fast disk drives, employ controllers with extensive caching and buffering, or use

drives with parallel transfer heads to meet speed requirements, or may distribute data files (nonstriped) over many drives. Fault tolerance can be addressed by mirroring (duplexing) whole disk drive subsystems (which in themselves may not be arrays) or by mirroring entire file servers, as does Novell in its SFT III fault tolerant networks.

SYSTEM SELECTION AND INTEGRATION CHECKLIST

The following discussion touches upon significant issues that system integrators and end users should take into account when choosing an array.

Host platform and operating system compatibility: Arrays must operate in the context of attachment to specific hardware platforms and software environments. The possession of a SCSI interface does not automatically guarantee proper operation with every system that has a SCSI port. Usually specific drivers and other software "glue" are necessary. The various release levels and variants of UNIX and other operating systems may have varying ability to correctly operate a given array product. Other concerns:

* Does the system have sufficient memory available to operate the array? Will operating the array slow down other host activities? These are major considerations for software implementations, but less so for hardware implementations.

* Are the software and documentation distribution media used to ship array software and documentation supported on the target system? What other devices need to be connected, and can the array controller support those devices?

* For software arrays, can the array device driver provided be coresident with the device drivers provided with the system? Are special disk partitions needed?

* Do the cables match? If SCSI is used, does the system SCSI port match the performance characteristics of the array SCSI port? Are the SCSI paths the same width? Single ended or differential? If a disk drive array board must be plugged into the host system, is there sufficient room, power, cooling available? Are special SCSI terminations needed, or are the disk drives to be utilized self-terminated? Do the terminations match the width of the path? Do you need shielded cables to solve EMI problems?

* Can the array use existing drives, if any? Can it support drives of different capacities? Can it support drives from different drive manufacturers or a preferred manufacturer? Does the array packaging limit the total capacity needed? Does drive interface performance match the array controller performance?

* Can the array controller support drives as logical units? Are resources adequately shared between logical units (no starvation if one drive or partition is hyperactive)? Can you boot from the array? Can the array create logical devices on the fly? Which SCSI level is supported? Can the array handle redundant drive controllers and dual ported drives?

* Does the array controller block low level access to the drives? Does the host system need such access and does it know how to use it?

RAID-1 or RAID-0 arrays are the simplest to integrate. Other RAID levels are more complex. Ideally, the array should look exactly like a single disk to the host environment and operate transparently with respect to file systems, applications, data base managers and system utilities once the array is configured.

Types of data used: The form of the data stored may influence the choice of array. Long blocks of data such as images or satellite dumps may best be handled by RAID-3. Short blocks typical of on-line transaction processing may best be handled by RAID-5, especially if the data availability requirements are stringent. If a mixture of performance, availability and ability to handle a variety of data is needed, RAID-1 may be most suitable. If the system handles multiple data types, arrays capable of partitioning the disks into multiple array types should be considered. The array should be capable of handling data block sizes efficiently handled by the host and by the drives.

Data availability: If data availability is an issue, then RAID-0 is inappropriate, since it provides performance but no fault tolerance. RAID-6, though not generally available, theoretically provides superior availability, but at extra cost. Ultimately, data availability may be influenced more by the overall redundancy in the storage subsystem architecture than by the RAID level chosen. If an extremely high level of data availability is mandatory, then dual ported disk drives, redundant controllers, even redundant processors and power feeds, will be required. Any element whose failure can make the system nonfault tolerant should be hot plugable. If write cache is used anywhere in the system, then backup power sufficient to keep the system operating until the contents of the write cache are written to disk is needed.

Data availability may be impacted due to performance degradation while data on a failed drive is being recreated. Performance drops of 50% during reconstruction are not unusual, and reconstruction can require time periods ranging from a few minutes to hours depending upon the drive capacity, array loading and other factors. While the data is accessible, it may not be available within the time window needed for satisfactory performance.

Performance: The question of performance revolves around the conditions under which it is measured. It is affected by the mix of reads vs. writes, the mix of sequential vs. random reads and writes, the length of the data blocks and many other factors. Controller and system design features strongly influence performance, especially the presence and configuration of cache. At present, there is no generally accepted way of measuring or specifying performance,

requiring array users to exercise caution in interpreting performance specifications. Performance may be optimized by partitioning the array drives into multiple arrays. For instance, an array could be partitioned into a RAID-1 segment and a RAID-5 segment, using the RAID-1 portion for write-intensive I/O mixes and the RAID-5 segment for read-intensive I/O mixes. Some considerations:

* Would a layered array provide better cost/performance benefits than a nonlayered approach?
* Would you benefit from a look-ahead read cache in the array controller? Where is your write cache, if any? Is its size and configuration (write-through, write-back) appropriate to the application? How is it protected from a power failure?
* Is the RAID level appropriate to the data block sizes, I/O transaction rates and other system factors?
* Does your array support queued commands? Does it need to?
* If your array uses a log structured file system, is there enough reserve storage capacity to prevent performance degradation? Would compression of data before storage avoid a capacity limitation?

Storage management: An array may be provided with the ability to support other devices, such as tape, robotic libraries, and optical drives that may be used for backup or save/restore operations. While disk drive arrays may provide a high level of insurance against hardware failures, they do not insure against the effects of operator error, fires or natural disasters. Only a rigorously managed backup program can protect data from such events. Some arrays provide for the addition of backup devices operated directly from the array controller and may be convenient where hierarchical storage management is implemented.

The ability to operate the array in several RAID modes simultaneously may be helpful in managing the flow of data. If different array types can be created using different logical partitions, not only can the data be assigned to the RAID mode most efficient in handling it, but backups can be done selectively on partitions as appropriate.

Economics: The economic considerations relevant to arrays are not limited to acquisition costs. For the system integrator there are costs of integration and testing. All array users should recognize that there will be costs of training, spare parts inventories, preventive maintenance and other indirect costs. Also to be considered are the availability and cost of upgrades and expansions for the array. An initially inexpensive array may not be a bargain if it can't be easily expanded or reconfigured to meet future needs or if it won't work with new software releases. Other considerations:

* Does the storage capacity required justify RAID-3, RAID-4, or RAID-5? Would RAID-1 be less expensive? Do performance requirements require a hardware based array, or would a software array be acceptable?

* If a high degree of fault tolerance is not initially needed, can it be economically added in the future? Can you upgrade the array by loading new firmware, or must components be replaced?

* Will an array capable of operating at multiple RAID levels concurrently be a better cost-performance choice than an array which does not have such a capability? How easy is it to migrate data from one RAID level to another?

* How much system administrator time is needed to set up and configure the array? How much system administrator time is required to deal with reconfiguration or to deal with the results of a component failure? Some manufacturers will supply tools, such as Hewlett-Packard's AutoRAID, that have the potential to significantly reduce array created stresses on system administrators.

The most important cost of all may be the cost to the organization using the array if the stored data is not available for the time required to bring the failed system back into service. For some customers, badly degraded availability is almost as costly as complete unavailability, so the array's performance when a component fails may be a critical issue, even though the array continues to operate. Furthermore, once an array element fails, there is no remaining fault tolerance in most array configurations and the system will crash and may actually lose data if further failures occur while the original failure remains unrepaired. Many disk drive array users keep critical spare parts on-site to minimize the window of vulnerability.

Manufacturer support, warranty and maintenance policies and costs vary widely. Array users need to realistically evaluate their internal abilities to support the array with the assistance realistically expected to be available from the manufacturer.

Maintenance: Maintainability issues include the costs and availability of service, the ability of the array to be serviced by an end user in case of a component failure, the ability of the array to identify a failed disk drive and start up an on-line spare (if available), and the ability to replace disk drives and other elements of the array subassembly without disrupting operations (hot plugging or hot swapping). Some arrays will automatically recognize a failed drive and rebuild missing data on a spare drive. Others require the operator to physically replace a defective drive and manually initiate data rebuild. Most disk drive arrays will continue to operate while a drive is replaced, and some allow replacement of a power supply, fan or other element without taking the array out of service. If battery backup or a UPS is used, the batteries may need to be changed periodically.

Arrays that minimize the complexity of the connections to the disk drives by employing serial interfaces or plug-in backplanes are likely to demonstrate significantly lower failure rates and repair costs than arrays constructed with parallel interfaces or connecting cables to the drives.

Some arrays make it easy to locate a failed drive, fan or power supply with indicator lights marking the defective element and software capable of reporting the failure of an array component over a network to a system administrator. Since removing the wrong drive when making an array repair will make data unavailable to users, the array design should provide protections against this kind of inadvertent error. Good fault detection systems help to insure the correct replacement parts are used.

It is often necessary to suppress I/O operations to an array member (and sometimes the array) while hot swapping is being done. The array manufacturer usually supplies utilities to do this if a host bus pause operation is required.

Another useful maintenance feature is the ability to run diagnostics in a non-intrusive manner while the system is in normal operation. This can develop useful information for service personnel and may prevent repeated service calls.

Monitoring and control: Depending upon their design, arrays can be configured by commands from a dedicated control panel, by data from the host sent through the primary data bus, or by data from a remote processor via a separate RS-232 port. Some arrays are factory preset and offer the user little ability to change configuration. Newer arrays have the ability to reconfigure themselves "on the fly" in response to changing conditions, without requiring a shutdown to change RAID modes, partitioning or other configuration aspects.

Most arrays are provided with utility software that can be used to configure the array from the host or a remote processor. Some software is easy to use and includes safeguards against the user making disastrous choices. Some require considerable skill and knowledge to use.

Another desirable feature is the ability to monitor and control the array remotely over a network. Some arrays provide performance monitoring information on request, allowing network supervisors to detect impending drive failures, overheating conditions and other matters requiring remedial action before a failure actually occurs. The actual failure of a component can be detected, and in some cases, parts ordered and maintenance personnel notified automatically.

Some other considerations:

* What kind of messages or alert signals are generated when an array component fails? Messages to the server? Messages to a master console? Audible alarms? Can alarms be cut off once acknowledged? Can the system detect an impending failure of a component and notify a service technician or system manager?

* Can the system automatically dial a remote system and notify it of a failure? Can it notify a technician via a beeper?

* Can the system support remote site mirroring, permitting data to be stored in multiple physical locations simultaneously?

Facilities requirements: Some highly fault tolerant arrays require dual AC power feeds from separate circuits. They may also require external uninterruptable power supplies (UPS) to sustain operation in case of power failure. Other requirements may exist for low noise creation by the array system, necessitating the use of quiet fans and disk drives. Variable speed fans are increasingly being used to minimize blower noise generation as well as to provide for continuation of adequate cooling in case of a fan failure.

1996 DISK/TREND REPORT

TECHNICAL REVIEW

Disk drive array configurations and implementations range from inexpensive and simple to costly and complex. This section of the report reviews some aspects of significant array technologies and issues pertaining to their use.

ARRAY TECHNOLOGY: STATUS AND POTENTIAL ENHANCEMENTS

Array architecture: The details of array architectures lie in the structure and location of the array management software, which can be host resident, array controller resident, drive controller resident, or scattered throughout the storage subsystem. Implementation can be in pure software, pure firmware, or a combination thereof. While the implementation can influence performance, economics, maintainability and other important factors, architecture is largely independent of implementation details. There are several ways to view array architectures:

* Layered versus nonlayered arrays: A nonlayered array controls array configuration at one point in the array structure, and typically operates as a pure RAID-3, RAID-5, etc. A layered array distributes different array configurations to different points in the array architecture. For instance, striping may be done in the array driver, while mirroring may be done at the disk controller level. This provides the advantages of both RAID-0 and RAID-1. Similarly, the array controller may stripe for RAID-3 while the disk controller provides a RAID-5 layer. Several array providers have implemented hybrid RAID-3/RAID-5 approaches to sidestep the write performance limitations of pure RAID-5 designs. Others have implemented dual layer RAID-5 with striping, sometimes called RAID-50.

* Host based versus controller based arrays: If all of the array capability is associated with the host system (usually as a software implementation), rather than with a storage subsystem, there is great flexibility in configuring and using the array. The host can select its array members from among multiple subsystems, stripe to individual subsystems to improve performance, and provide a level of tolerance for catastrophic disasters that affect a particular subsystem. A host based array can also create arrays with older drives and storage subsystems otherwise incapable of being so operated. The downside is that the use of host resources may be disruptive in computing intensive environments. It may also be difficult for a host based array to take full advantage of the capabilities of intelligent disk drives and controllers because the host may not support the commands needed to do so. Controller based arrays are usually able to optimize storage subsystem performance, but are less able to optimize use of all of the storage resources attached to the host. A host based array may also be difficult to integrate with some operating systems if the

operating system is not modular, with well designed software interfaces. In such cases, the controller based array may offer more functionality.

* Modular architecture: This approach, incorporates a core array management software module that can be implemented in various forms and places within the storage subsystem, including the host as a virtual device driver, the host bus adapter, the array controller, or an intelligent device controller servicing multiple drives. The core module communicates through software interfaces appropriate to the location of the core module in the array. Modular architectures allow reuse of program code (which makes development and configuration of midrange and large systems easier), but tend to be too expensive to justify in low end systems. AT&T (now Symbios Logic) has been among the active investigators of modular array architectures.

* Augmented arrays: Much of the advanced work being done in array design centers around methods to reduce or eliminate write delays associated with the read-modify-write cycles associated with RAID-5 configurations. For some developers, the inclusion of large buffers and algorithms that allow the creation of a few large transactions from the combination of many small ones is a preferred approach. Others use combinations of RAID-3 and RAID-5 technology in which data is placed upon the drives in a RAID-5 format but written to the drives from a large buffer in parallel. Still another approach involves use of log structured files in which data is written into any available space with conversion to a RAID-5 format done while the system is otherwise idle. An augmented array frequently has a non-Berkeley RAID level defined by its manufacturer.

In some cases the array is bundled into an operating system or OS-like environment, such as Microsoft's Windows NTAS. Such implementations usually provide mirroring, duplexing or both. Some, such as Novell's SFT-III, duplex entire servers rather than requiring an array of disk drives. While providing fault tolerance, these approaches don't really qualify as an array product per se and have not been counted in the array statistics in this report.

Hierarchical storage: The more advanced and flexible array controllers provide for the support of tape drives, optical drives and automated libraries, allowing the host system to move inactive data to off-line or automated library storage and to stage recalled data to the disk drives for use. Some arrays allow the use of optical disk drives or tape drives as array elements, although not intermixed with magnetic drives. While feasible, the use of removable media makes careful physical volume management mandatory to avoid data corruption. Because of the many different implementations of hierarchical storage, the absence of a common protocol for managing backups and data migration is receiving increased attention, with ad-hoc industry groups forming to define and propose standard protocols.

Packaging: Small array subsystems are usually packaged in tower or rack mount enclosures. Larger array subsystems are frequently integrated into floor standing cabinets along with other system elements. Some innovative approaches have emerged, including the modular array packaging of Micropolis (now StreamLogic) and the practice of fitting the entire array, including drives, into the volume of a single 5.25" full height drive by using 2.5" disk drives for the array, such as the array announced by Core International (now Aiwa Computer Systems Division).

The Micropolis approach packaged a disk drive, power supply, fan and controller in modules, which may be stacked to make an array of the desired size. Advantages of this approach include flexibility, plus easy installation and expansion capability. Disadvantages include higher complexity in each removable module and a vulnerability to power supply or fan failure in each module.

In the typical array, the disk drive is mounted on a removable frame, often called a sled or a canister, which may also contain a power supply, fan and other elements associated with the drive. The array is designed to permit removal of the canister without shutting down the array in most cases. Mathematically, service events are less likely in arrays that have common power supplies and fans, since there are fewer components to fail. In practice, service needs depend upon design techniques and avoidance of stress on array components. In particular, high RPM drives that generate unusual amounts of heat must receive adequate cooling to avoid unduly high failure rates.

Enclosures for arrays have elements such as power supplies and backplanes that are themselves vulnerable to failure. There is a trend toward remotely monitoring the state of the enclosure elements via a SCSI port dedicated to that purpose. The enclosure may also incorporate features to indicate failed drives, fans or power supplies and interlocks to prevent inadvertent removal of a functioning drive during maintenance operations.

Arrays implemented in software require no special additional packaging, but may influence system packaging as array drives are added or if additional memory is required in the processor to support array operations.

Driven by the need to reduce cost and improve reliability, array designers are abandoning conventional cabling for drive packages that plug into a backplane directly. Further simplification is expected after 1996 as serial interfaces begin to displace parallel SCSI interfaces. Perhaps the ultimate simplification is the anticipated migration of the board level array controller to a few chips located on a processor motherboard, a development now under way, and which has the potential to seriously impact some producers of board level controllers.

Semiconductors: Specialized semiconductors for use in disk drive arrays became available from AT&T (now Symbios Logic) in 1991, and other firms are also producing specialized chips for this purpose, including drive controllers, array management chips and specialized processors. As noted previously, basic

array controller chips may migrate to the motherboards of computing systems, much as graphics controllers, modems and other I/O functions have already done. While this has negative implications for companies providing array controller boards, it is likely that high performance needs of servers and workstations will continue to create a demand for specialized controllers not required in sufficient quantities to justify chip development expense.

Flash memory is expected to have a significant role in future array controllers as a residence for the microcode associated with array management. The ability of flash memory to be updated will make it easy to perform field upgrades of arrays as new software versions are released.

The decreasing cost per megabit of semiconductor memory will tend to increase the likelihood of cache memory being present on array controllers and will tend to expand cache size. Array controllers for even small systems may contain several megabytes of cache, and cache sizes exceeding 50 megabytes are increasingly common.

Disk drives: The trend to higher areal density will continue. The drives that offer 1.4 gigabits per square inch density today are expected to offer 10 gigabits per square inch in the year 2000. Already, over a gigabyte is available in a single platter 3.5" drive or a double platter 2.5" drive. With the reduced parts count implied, the cost per megabyte of storage is expected to steadily decline in the foreseeable future. If there are any serious concerns, they relate to the capability of read and write channels to advance performance as fast as areal density.

The 3.5" disk drive in the one inch high form factor is becoming the mainstay product for array producers because of its packaging efficiencies. Such drives with one gigabyte capacity have been available since 1993 from IBM and others. Availability of inch high 3.5" drives with 4.5 gigabytes capacity from multiple manufacturers was achieved in 1996, and 9 gigabyte low profile drives are expected in 1997. At the present time, most array producers are using a mix of one inch and half height drives in their product lines because they cannot obtain all the drive types they need in the one inch form factor, so most array drive enclosures are still fabricated with drive canisters that will accept half height drives.

Disk drive performance is expected to improve. Though only marginal improvements in seek time are expected, 7,200 RPM spindle speeds have become common. Seagate, IBM and others are shipping 7,200 RPM drives, which are now widely used in arrays. Because of the potential heat generated by drives rotating at the higher speeds, packaging of these drives for easy removability in an array is challenging. Increases in areal density and increases in RPM will combine to produce higher data transfer rates in future disk drives, although the ability of the drive read channel to support these new capabilities will be stretched. 10,000 RPM drives were announced by Seagate in late 1996. As disk drive disk rotation speeds continue to rise in future product generations, it is likely that drives will begin to incorporate fluid spindle bearings to control noise and vibration and to improve reliability.

Disk drive arrays require drives with very high MTBF. With multiple drives in a system, the overall probability of a failure within a given time increases with the number of drives. To minimize service events or the possibility of two drives failing within the same time frame, very high drive MTBF is required, and the disk drive industry has responded by extending MTBF dramatically over the last several years. Hewlett-Packard initiated the MTBF race when it announced drives with 150,000 hours MTBF. Specified MTBF has climbed steadily through 200,000 hours and 500,000 hours to the 1,000,000 hour MTBF drives announced by IBM in 1993. 1,000,000 MTBF is now the accepted MTBF specification for the high end drives used in mission critical applications.

Arrays can make use of increased drive intelligence. The ability of a drive to test itself is significant in improving the operator's ability to monitor the health of the array. If the drive can collect and report the occurrence and location of soft errors (Predictive Failure Analysis, or PFA), advance warning of impending failures is possible, as well as recognizing that a detected error may require repeating a transaction. The ability to reorder commands to improve performance by minimizing seek and rotational delays is also a useful capability. Some subsystem functions may migrate onto high end drives, including the exclusive OR computation.

For applications requiring isochronous data retrieval (equal data flow per time interval, with no interruptions), such as video servers, the drives must be able to retrieve data without interruption for such housekeeping events as thermal recalibration.

Spindle synchronization has been available for several years on some drives and is useful for RAID-3 implementations. Other drive related capabilities include the ability to be safely hot plugged and to operate with multiple controllers.

Interfaces: The interfaces involving arrays are the interface to the host computer, the interface to the drives, the interface to an array control device (which may be the host system) and the interface to the human operator.

Most array host interfaces currently use SCSI or SCSI-2, many in the fast and/or wide configuration. Arrays with Ultra SCSI interfaces became available in 1996. Arrays for PC based systems increasingly use the PCI bus, although there are also a few array controllers designed to attach to the older ISA and EISA buses, to the VESA bus, and to the NuBus. At the high performance end of the product range, a few arrays are connected through the HIPPI bus (some using the IPI-3 protocol), but fibre channel is expected to be the high performance interface for host to array controller connection in many systems. Support for SCSI tagged command queuing has become important to reduce latency delays and improve concurrent operations in RAID-4 and RAID-5 configurations. As the SCSI-3 command set is implemented it is expected to see wide use in array controllers because it will support advanced commands and high data transfer rates useful in improving array performance. The ability to queue commands at the controller and at the drive provides a significant improvement in array performance.

Drives for arrays mostly use SCSI-2 interfaces, although a few arrays have been developed to use IDE interfaces. SCSI-3 and serial interfaces (SSA and fibre channel) are expected to be widely used with arrays because they support higher data transfer rates and, in the case of SCSI-3, up to 64 devices per SCSI address rather than the 8 devices of SCSI-2. Differential SCSI is starting to become more common, but is still infrequently encountered. Low voltage differential interface configurations that extend capabilities of the SCSI bus are expected to be implemented in late 1997 as components become available.

Serial interfaces such as the fibre channel interface and IBM's SSA are expected to become more widely available in 1997. While FC-AL (fibre channel arbitrated loop) has displaced SSA in most array producers plans, SSA lives on as a preferred interface within IBM as well as for certain segments of the video systems market. Concerns about the power required by serial interface solutions and the slow rate of development and ramp up of critical components has limited the rate of acceptance, especially in desktop and small server class equipment. Ultimately, SSA and fibre channel are expected to converge in a newly proposed architecture sponsored by IBM, Adaptec and Seagate and announced at the 1996 DataStorage Forum. Implementation is not expected prior to the end of the decade.

Drives configured to plug into parallel SCSI bus backplanes are adopting the Single Connector Attachment (SCA), eliminating unwieldy, expensive and failure prone cables and making drive removal and replacement faster and simpler. Drives employing serial interfaces also will make extensive use of backplane interconnection.

Some arrays use separate RS-232 ports to communicate with a remote computer which functions as the control device for the array. Some systems provide control through the host computer, using utility routines that can be employed through the host console or across a network. These interfaces are expected to remain stable in form.

The human interface provided by arrays varies from very sophisticated and user-friendly to rudimentary and requiring expert experience (plus luck). The long-term trend is towards control and monitoring interfaces that can be used at varying levels of skill by authorized users of varying capabilities and which can be used on a server or over a network. An increased use of graphical user interfaces is expected.

Cache: The way cache is used in an array subsystem is one of the more significant determinants of performance and fault tolerance. The best way to employ cache may be nonobvious; cache may also exist within the host system or within the disk drives used in the array. Operating with all of these levels of cache active can lead to performance degradation and loss of data under fault conditions if they are not carefully coordinated, as in the multilevel caching employed in IBM's RAMAC and the shared caching of the Auspex NS7000 series. The optimum location and type of cache also varies with the architecture of the host computer and its associated storage subsystem.

Some array controllers contain cache, while others do not, anticipating that system cache or drive level cache will be adequate for performance needs. Most array controllers incorporate cache, usually both read and write cache. Many of the controllers with write cache incorporate battery backup to avoid data loss in the event of power failure. Other designs use nonvolatile semiconductors for write cache and at least one array design, the IBM 9337, employed a separate disk drive as a write cache device in its initial implementation.

Write cache in an array controller can be configured as a write-through cache, write-back cache or either. Write-through cache passes write operations directly to the disk drive, notifying the host system that the write is complete after all the drives have reported transaction completion. Write-back cache buffers the writes until the cache is full and then writes to all drives. A "write complete" status is given to the host when the data is placed in the cache. Write-through cache is typically employed in data base applications where multiple users need access to the latest possible version of a file. Write-back cache is employed where processor efficiency is of paramount concern.

Software: Array software can range from the expanded disk drivers used for simple disk mirroring on personal computers to the 300,000 plus lines of microcode needed to operate a mainframe array such as the Storage Technology Iceberg subsystem. The design complexities and testing requirements demanded by reliable interfaces to mainframe environments are major factors in determining when a high end product is ready to ship. However, array software add-on packages limited to providing mirroring and striping have been well accepted in systems running under the various types of UNIX and in Sun NFS environments. This success has been achieved primarily because well-defined interfaces between software modules have made array software relatively easy to integrate and support. Array software has become more complex as arrays have had to operate in clustered processor environments, as it must keep track of more data streams, and manage failover and recovery in multicontroller array configurations.

Array software is expected to migrate to microcode implementations at both the high end and the low end of array product lines, although array software for mirroring is expected to remain popular because of its relative ease of integration and lack of associated hardware expenses. Some operating systems already incorporate array software, usually with RAID-0/RAID-1 features.

Compression: Data compression can help improve the performance of storage subsystems by reducing the number of bytes that must be sent to and from the disk. While the best location within the system to do data compression and decompression remains a subject of controversy, in the long run the argument is expected to be settled in favor of performing compression/decompression in the originating/using system, with data stored or transmitted in compressed form until reaching the processing point at which decompression is needed for processing. In many cases, a dedicated compression/decompression coprocessor will be used to avoid loading the host computer's primary processor with such a

compute intensive task. There are many compression algorithms in use, with the choice depending upon the characteristics of the data to be compressed. Typical compression ratios range from 1.5:1 up to 200:1 depending upon the data type and content. There is no single method best for all types of data.

Some compression products for small systems require repartitioning of the disk drives, a feature not compatible with the capabilities of some arrays.

Configuration and control: The ability to easily and reliably configure, control and monitor server arrays is a significant issue for system administrators. The capabilities revealed by Hewlett-Packard in their early 1995 AutoRAID announcement have inspired several array producers to include similar features, and future array users can expect to benefit from adaptive features such as array self configuration when drives are added or removed. Acceptance of automatic migration of data between RAID-1 and RAID-5 modes as implemented in the H-P array has been more problematical.

Standards: There are a number of standards issues that impact the development of the disk drive array market, most of which have been addressed by RAID Advisory Board committees. Among these are:

* Definition of a RAID-ready disk drive interface. The intent of the standard is to specify the minimum SCSI command requirements for the drive and how it responds, as well as setting forth requirements on connectors, mechanical configuration details, optional features and compliance test requirements. The current target for the specification is the parallel SCSI-2 interface. A related issue is how to define the interface to other types of devices in an array whose status must be controlled or monitored. These include fans, power supplies, indicators, controls, etc. The SAF-TE specification originally sponsored by Conner Peripherals has received wide industry acceptance.

* Definition of standard test procedures for determining if an array is properly functioning and if a drive complies with the RAID-ready standard have been prepared under the auspices of the RAID Advisory Board.

* Definition of standard test procedures for benchmarking array performance is likely to be the most difficult area in which to reach agreement, as each manufacturer will have a set of conditions under which their array products will show optimum performance relative to competing products.

Many of the standards issues are being addressed by study groups established by the RAID Advisory Board. There is also an ANSI Technical Subcommittee (X3T10) with the charter to address RAID standards issues on a formal basis.

Hot plug capabilities: In the majority of disk drive arrays it is possible to exchange defective array components such as drives, power supplies and fans without removing power from the array or its host system. This requires that connectors be designed so when the component is removed, power is removed before the ground connection and that the ground is restored before power

upon reinsertion. Furthermore, there should be no transients produced that can disrupt other array elements, nor should the drives be sensitive to shock events that might occur during hot swap operations. The hot swap philosophy is being extended to other elements of the system, such as controllers, that might be present in multiples and need to be exchanged without shutting down the system. Hot pluggable controllers interfaced to the PCI bus were being demonstrated in late 1996 at COMDEX.

Direct network attachment: While arrays do not interface directly to networks, network attached storage servers that incorporate arrays are becoming an increasingly visible part of the product spectrum. Network Appliance, Falcon Systems, Auspex and others have successfully exploited this product niche. The ease of attachment and flexibility of network attached servers make them popular choices where storage must be located in multiple locations.

COMPETING TECHNOLOGIES

Besides the mainline technologies discussed above, other data storage technologies may provide competition to arrays in years to come.

Nonarray storage architectures: If minimizing storage costs per megabyte is a primary objective and backup is sufficient for achieving data availability needs, a nonarray architecture will probably be chosen, ranging from a single disk drive at the low end to the strings of disks common in high end systems. However, the emphasis on data availability in networks suggests, and the declining costs of both storage and array controllers also suggests, that nonarray architectures will be less appealing over time. A possible exception is the practice of mirroring complete nodes as opposed to mirroring the drives or mirroring the storage subsystem. This approach, admittedly expensive, has been promoted by Novell and others as an effective way of providing fault tolerance. However, duplexing can result in significant, extended network performance degradation if reconstruction of data from one duplexed server to another is needed.

Holographic storage: It is theoretically possible to store data at very high densities and at very high speeds using crystalline materials as the storage medium and laser scanning devices for input and output to the crystal array. Holographic storage for data is just leaving the pure research stage and entering the development stage. It is expected that there will be no competition to magnetic storage from holographic storage until well past the end of the century.

Holographic storage devices are expected to eventually offer capacities in the range of 200 megabytes to 10 gigabytes, have average access times in the 1 to 10 microsecond range and data transfer rates in the gigabyte per second range. Such devices could challenge RAID-0 and RAID-3 configurations implemented with rigid disk drives where very high data transfer rates are required.

Solid state arrays: It is possible to fabricate an array using solid state technology rather than disk drives. Although the cost per megabyte is substantially higher than for magnetic storage, if there is a requirement for very high speed or resistance to mechanical stress, solid state arrays may be appropriate. For example, Raymond Engineering has announced an array incorporating several of SanDisk's disk-emulating flash memory modules.

Because a solid state array is already very fast, performance improvement is not a primary motivation for using an array configuration, especially in large systems. However, fault tolerance is a desirable and legitimate reason for using solid state storage in an array configuration. Mirroring is the simplest, and probably most appropriate method, given the emphasis on speed in high end systems, but if utmost speed is not a requirement, RAID-5 organization could provide fault tolerance while minimizing the cost of expensive semiconductor memory.

At the smaller scale end of the systems world, arrays using flash memory cards may find a niche. Provided that each card maintains its own drive address, the cards could be placed in any PC Card slot providing disk drive support -- the exact order of insertion would not matter. However, implementation of arrays using removable media creates a storage management problem -- when the media is reinserted, there is a risk of synchronizing a recently created volume against an obsolete volume with the resultant loss of recent data.

Optical disk drive arrays: Optical disk drives can also be used in arrays. For instance, Pinnacle Micro's Orray striped data across several optical drives to achieve improved data transfer rate while retaining removability. However, the removability of the media imposes the need for keeping the disks together as a set: Loss of a disk or scrambling of disk sets could make the data unrecoverable. If RAID-3 or RAID-5 were to be employed in the future, data could be reconstructed if only a single disk in the set was lost or damaged.

The most probable uses of optical disk drive arrays will be for image and video editing and content preparation, where removability is often desired.

GLOSSARY

GLOSSARY

In addition to the definitions of individual terms included in this section, the product groups, types of products, market classes, and geographical classifications used in this report are defined in the DISK/TREND Array Definitions, at the end of the opening summary section.

Actuator: The device used to position the movable heads in a drive. Linear actuators use a straight line motion, while rotary actuators turn around a pivot point.

Actuator level cache: A cache segmented to provide separate support to each individual actuator in a drive string, preventing monopolization of the cache by an actuator with an unusually heavy level of activity.

Areal density: A measure of the information stored per unit of area on the surface of a recording medium. Normally computed by multiplying tracks per inch times bits per inch, and expressed as megabits per square inch. (Depending upon the recording code used, bits per inch may not be the same as flux changes per inch.)

Array: A group of storage devices controlled in such a way as to provide higher data transfer rates through parallel operation, higher data availability through redundancy, or both. See RAID. Array functionality is provided by a specialized controller, specialized software or both.

Array processor: The processor in the array controller, separate from the host processor, that performs the local computing and control functions within the array.

Array software, array driver: Programs that operate multiple disk drives as an array directly from the host system without the need for a specialized hardware controller. The software performs typical array functions such as striping, error correction, parity functions, data recovery, etc. An array driver is a smaller piece of code controlling basic data flow functions to the array.

Automatic rebuild: The process by which data from a failed drive in an array is automatically reconstructed using another drive in the array. Manual rebuild is the same process, but is initiated upon operator command rather than automatically upon detection of a failure. See data reconstruction, rebuilding.

Automatic swap: Describes a situation where spare array components are automatically brought into active use when a similar component fails. The array continues to operate while the exchange is taking place, possibly at a degraded rate if data on a new drive must be rebuilt. See hot spare.

Availability: The probability that data will be available when requested within an acceptable time. If averaged over all data requests, it is the percentage of data requests satisfactorily fulfilled. "Satisfactory" may have different meanings in different applications.

Average access time: The average time elapsed between the time a command to access data is received by a disk drive and the time data begins to be transmitted or received. It usually consists of average head positioning (seek) time, average rotational delay (latency) time and settling time. If the drive uses an embedded controller, there may be an addition to controller latency caused by command processing within the drive.

Average positioning (seek) time: The average time required to move the head of a disk drive between tracks in response to random positioning requests. Frequently approximated as the time to move the head one third of the distance from inner track to outer track, beginning and ending with the head at rest. The time for the head to settle into its final position after it reaches the desired track is generally included. Often, and erroneously, referred to as "average access time". See average access time.

Average rotational delay (latency): The amount of time required for the disks in a disk drive to rotate through one half of a revolution, thus the average time for the drive to bring the beginning of the requested data block under the heads.

Bandwidth: The amount of data transmitted through a data channel per unit time. Usually expressed in terms of megabytes per second. To understand channel performance, it is useful to know how many signal conductors are included in the data channel.

Bit: The fundamental unit of digital information. In digital recording, it is a single recorded information cell.

Bit density (linear density): The number of recorded bits per unit distance as placed upon the tracks of a storage device. Typically given as BPI (bits per inch).

Cache: A portion of memory dedicated to collecting and holding related data until a processing, storage, communications or other module within the system is ready to process it. Cache is usually implemented as fast semiconductor memory, but other forms of memory are sometimes used. The form and architecture of the cache used is a major influence on system performance. See read cache, write cache, segmented cache, multiple threaded cache, actuator level cache.

Check disk, parity disk: Disk drive in an array that is dedicated to storing redundancy information.

Cold swap: Describes a situation where system operation must be stopped and power removed from the system before a defective component can be exchanged. See hot swap, warm swap.

Controller: A physical module that interprets signals sent between the host processor and a peripheral device. The controller is sometimes embedded within the peripheral device, but can also be implemented as a separate PC board or as chips on a host system motherboard.

DASD: Direct Access Storage Device. Traditionally, IBM's term for a disk drive.

Data reconstruction, Data rebuild: The process of recreating data that was stored upon a failed drive or is unavailable from a drive because of component failures. The source of the recreated data is data plus parity information from the operating drives.

Data stripe: A sequence of logically consecutive "stripe units" written to the disk drives in an array. A logical I/O request to a disk array corresponds to a data stripe, which may extend across one, several, or all the drives in the array depending upon the array configuration. See stripe unit.

Data transfer rate, drive: Maximum data rate from the disk drive to the array controller. The rate is a function of the interface transfer rate, bus width, and buffer output rate from the drive. It is usually measured in megabytes per second. The burst rate from the drive is the fastest instantaneous rate between the drive interface and the controller interface. The sustained rate is the rate at which data is extracted from the disks in the drive.

Data transfer rate, host: The rate of data exchange between the host processor and the array. It can be expressed as a burst rate (maximum instantaneous rate) or as a sustained rate (combined effective rate the drives in the array can produce when operating as a group over a period of time). Sustained rate varies as a function of the number of drives in the array and the array configuration.

Degraded operation, degraded mode: The state of operation of an array after a drive has failed. Performance is reduced because of the overhead associated with reconstructing data as requested, rebuilding data on a spare drive, or both.

Disk spanning: A technique that operates several disk drives from a single controller, with the entire set of drives appearing to the host system as a single drive. Data is not striped, nor is there any redundancy, so disk spanning is not recognized as an array technique.

Duplexing: A configuration in which each element of a system or subsystem is duplicated. For instance, in a duplexed RAID-1 array, for each drive pair, each drive has its own controller and host adapter.

Dynamic reconfiguration: The capability of an array to modify its configuration (especially its RAID level or mix of RAID levels) in response to changing load and data flow conditions, or to add/subtract active drives without halting operation of the array.

Dynamic sparing: A technique that automatically transfers data to a spare drive when the detected error rate for an active drive exceeds a specified threshold.

Exclusive OR (XOR): The logical algorithm used to recover data from an array when a drive has failed.

External RAID: Array subsystem with the array controller and drives located externally to the enclosure of the host processor. Typically has a SCSI interface from host to controller. See Internal RAID.

Fault tolerance: The ability to operate normally, albeit at a degraded rate, even though one or more elements of a system have failed.

FC-EL: Fibre Channel-Enhanced Loop is a proposed merging of FC-AL and SSA technologies into a single merged serial architecture. Unlikely to be available before the end of the decade. Also called Converged Serial Interface (CSI).

Fibre Channel: A high speed serial interface. The FC specification allows implementation with fiber optic cable or metal wire. A subset, fibre channel-arbitrated loop (FC-AL), supports strings of up to 126 devices. Data transfer rates may be up to 100 megabytes per second in each direction in a dual ported configuration.

Fire Wire: See P1394.

HIPPI: High performance parallel interface.

Hot spare, hot patch, on-line spare, automatic swap: In an array, a disk drive that is present but normally unused until there is a drive failure, at which time the drive is used to substitute for the failed drive. The data from the failed drive can automatically be rebuilt upon the spare drive, but may require operator intervention in some arrays. See automatic rebuild. By contrast, a cold spare is not installed in the system; it's a shelf item. While widely used among array producers and users, the term "hot spare" is actually a trademark of Core International.

Hot swap, hot fix, automatic swap: The ability to automatically exchange a defective component without shutting down the equipment of which the component is an element. In arrays, this typically refers to exchanging a drive, but may also apply to exchanges of fans, controllers, wiring or other elements.

Input/Output operations per second (I/O per second): See transaction rate.

Interleaving, data interleaving: The process of distributing a byte of data across several storage devices. Typically used in RAID-2 and RAID-3 arrays.

Internal RAID: Array subsystem with controller located inside the enclosure of the host processor. The array controller typically plugs into an I/O bus slot.

IPI: Intelligent Peripheral Interface. An older high performance interface which may still be found in some larger systems. Two variants: IPI-2 and IPI-3.

JBOD: Just a Bunch of Disks. Term used to refer to a multiple disk drive configuration in which there is no redundancy. Used by some manufacturers to mean a RAID-0 configuration.

Log Structured File System: A method of writing data into the first available space on a disk file. The data on the disk file is compacted so that there is always a large contiguous free space on the device. This technique avoids the delay in generating parity that slows down RAID-4 and RAID-5 arrays, but requires that the system do frequent housekeeping to insure that adequate free space is available on all drives.

Mirroring: A recording technique where data is recorded identically upon two or more disk drives. If a drive fails, operation continues using the other drive. If the drives are accessed for read concurrently, the first drive responding supplies the data. Drives operated in a mirrored mode are defined as a RAID-1 configuration.

MTBDL: Mean Time Between Data Losses. A statistic indicating the elapsed time before half of a group of arrays will experience events that cause data to be lost. Frequently interpreted as the average time between data loss for a single array. For an array with redundancy, this average can exceed 1,000,000 operating hours, but an individual array may fail at any time.

MTBF: Mean Time Between Failures. A statistic indicating the elapsed time a group of devices will operate before half of them experience failure. Frequently interpreted as the average time a single device will operate between failures.

MTDA: Mean Time of Data Availability. This is the average period of time data is available to be used for its intended purpose. See availability.

Multimode operation (Universal RAID): The ability of a disk array to operate in more than one RAID configuration simultaneously.

Multithreaded cache: A cache which has been segmented and in which each segment is assigned to support one of several simultaneously executing tasks.

P1394: Informally known as "Fire Wire". A specification for a serial interface, originally sponsored by the IEEE. While capable of supporting many types of

devices, it is considered to be oriented more to video, multimedia and consumer applications. Has been supported strongly by Apple Computer.

Parity: A mathematical technique that adds bits to a data stream containing redundant information allowing reconstruction of the data stream if part of the stream is corrupted or absent. In arrays, single level parity permits data recovery from a single drive failure. Two level parity permits recovery from a two drive failure. Parity information may be held on one drive, as in RAID-3, or spread across all drives in the array, as in RAID-5.

Parity RAID: Refers to RAID level which uses a parity block to generate redundancy. Typically refers to RAID-3, RAID-4, RAID-5, RAID-6. Nonparity RAID refers to mirrored (RAID-1) or striped/mirrored (RAID-10) implementations.

PCI: Peripheral Component Interconnect. A high speed bus structure originally developed for PC compatible systems but now being offered on other platforms as well. The burst transfer rate is 132 megabytes per second, making it appropriate for use with high performance storage subsystems, especially those employing high speed serial interfaces to disk drives.

RAID: Redundant Array of Inexpensive Disks. This term was originally coined in 1987 at U.C. Berkeley, as was the initial categorization of RAID configurations. May also stand for Redundant Array of Independent Disks. See also, SLED.

RAID Advisory Board (RAB): The RAID Advisory Board is an association of organizations concerned with sales or purchases of disk drive arrays and closely related products. RAB activities include the proposal of standards for commonly used nomenclature, array interfaces, test procedures and definitions, and the promotion of disk drive array technology throughout the worldwide computer industry.

RAID level: A number designating the general configuration of an array. RAID configurations are defined and generally accepted for levels 0 through 5. Higher levels have been used by specific manufacturers to indicate additional features but are not universally accepted. See the Array Considerations section.

Read cache: A cache or cache segment dedicated to accumulating information read from the disk drives. Typically, the read cache will load a track or a few tracks of data on the assumption that the next data requested will be closely related to the initial data requested. The system will search the cache for requested information, initiating further disk accesses only if the desired information is not located in the cache.

Read-modify-write cycle: For RAID-4 and RAID-5 arrays, a write operation requires readback of data from the drives across which the data stripe is to be written, recomputation of the parity data, and rewriting the data and parity.

Read/Write ratio: The ratio of read operations to write operations in a typical host system work load. Important in selecting array configuration, because some configurations are inefficient in write intensive environments. Usually given as "x% reads" in data sheets.

Rebuild: See Reconstruction, Automatic Rebuild.

Reconstruction: The process of recreating the data from a failed disk, rebuilding the information on a new drive from data and parity information on the remaining functional drives. This can occur concurrently with normal operation in most arrays, although the processing overhead will slow the transaction rate.

Recovery period: The time required to reconstruct data from a failed disk drive.

Redundant drive: In a RAID-3 configuration, a drive dedicated to parity data.

Remote site mirroring: The ability of a system to simultaneously store data at more than one physical site, providing a degree of protection against a disastrous physical event. Each site may itself be equipped with various degrees of fault tolerance.

SCSI: Small Computer System Interface. SCSI-2 is a more recently defined advanced version. The standard SCSI burst transfer rates for SCSI and SCSI-2 are 5 megabytes/second. Fast SCSI operates at up to 10 megabytes per second. Wide SCSI, with a double width bus, operates at up to 20 megabytes per second. Serial SCSI is a new 20 megabyte per second format using fewer cable wires. Ultra SCSI drives with up to 40 megabyte per second transfer rates are now available from several manufacturers. SCSI interfaces may operate asynchronously or synchronously. They may be single ended (6 meter cable length limit) or differential (25 meter cable length limit).

Segmented cache: A large block of cache memory divided in such a way that the segments are assigned to individual disk drives, hosts, or processing tasks.

Serial interface: An interface architecture in which data is transmitted in bit serial form rather than in parallel. IBM's SSA (Serial Storage Architecture) and FC AL (fibre channel) are leading contenders for industry adoption. SSA transmits at 20 megabytes per second, while FC AL operates at 100 megabytes per second. Typical use will be with two controllers serving large numbers of attached disk drives.

SLED: Single Large Expensive Disk. The alternative to RAID.

Spindle synchronization: A technique for causing the rotational position of all the disks in an array to be identical, facilitating the flow of information in parallel to the drives in the array. Usually used for RAID-3 configurations. Disk drives must be designed specifically to provide spindle synchronization capability.

SSA: Serial Storage Architecture. This is a full duplex, 4 wire channel operating at 40 megabytes per second in each direction, providing high transfer rates and a less costly, more reliable way to connect up to 126 devices to the array controller. Originally devised by IBM, which is currently the only source for SSA disk drives.

Storage overhead, array overhead: The percentage of the total capacity of the disks in the array that is used to store redundant information needed to recover data or correct errors. The percentage varies with array configuration and number of disks in the array.

Striping: The process of recording data on several recording devices, distributing blocks of data on each device. The exact striping method depends upon the RAID configuration.

Stripe depth: The amount of data placed on a drive in the array during a transaction, measured in stripe units.

Stripe unit: A unit of data interleaving; the amount of physical data placed upon a disk drive before data flow is switched to the next disk drive in the array. Stripe units normally range from a sector to a track in length and are typically 512 bytes to 64K bytes long.

Throughput: The number of I/O requests completed in a unit of time. Usually expressed as requests per second.

Track density: The number of recording tracks per unit distance, measured perpendicularly to the direction of the recorded track. Usually given as TPI (tracks per inch).

Transaction rate (I/O per second): A transaction is the successful completion of a read or write request for a block of data. A data block access may require multiple reads or writes. Transaction rate is the number of successfully completed transactions per second. Often given with a qualification of workload mix as random requests, sequential requests, or mixed requests, and the read/write ratio.

Ultra SCSI: Also called "Fast-20"/"Fast-40". A faster version of the SCSI interface, with 20 megabyte per second transfers for 8 bit bus and 40 megabytes per second over a 16 bit bus. It uses the same interface as fast or fast/wide SCSI, and can be considered an intermediate step between SCSI and serial interface architectures.

Virtual disk drive: Virtual drives are not a single physical drive. They appear to the system as a single disk drive, but may in fact be implemented in software, semiconductor memory, or as a collection of drives, or even as a portion of a single drive. They are conceptual constructs, rather than physical entities.

Warm swap: Describes a situation where system operation must be halted in order to replace a defective component, but power need not be removed from the system. Frequently encountered in RAID-0 systems and older redundant arrays.

Write cache: A cache or cache segment used to accumulate data before writing to the disk on the theory that a single large write operation is more efficient than several smaller transfers. Can mask the write latency of the drives to the host system. Write cache is usually in semiconductor form, although IBM used a disk drive in its initial Model 9337 array models.

Write latency: As seen by the host system, the period of time between the initiation of a write transaction and the time at which the storage subsystem has indicated successful completion of write operations. If a write cache is present, write latency is considerably shortened. Depending upon the array configuration, the write latency period may incorporate multiple reads and writes by individual drives in the array. See Read-modify-write cycle.

Write-back cache: Data is accumulated in the cache and the host system is told that the write operation is complete as soon as the cache is loaded. The cache contents are transferred to the disk when the optimum block size is available.

Write-through cache: Data placed in the cache is transferred to the disk when all data relevant to a transaction have been placed in the cache. The host system is notified the write is complete when all drives involved have signaled the completion of the transaction. Typically used for data base applications.

XOR (Exclusive OR): The logical operation used to recover data from an array when a drive has failed. The function may occur within the host, on the array controller, or at the drive level of an array architecture. System efficiency tends to increase as the site of the computation moves further from the host processor.

ARRAYS: SINGLE USER SYSTEMS

1996 DISK/TREND REPORT

ARRAYS: SINGLE USER SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Advanced Technology Systems	AXRD-540A/S
Cyberdata Systems	CyberRAID
MaxConcept	SW-4100R
Micronet Technology	Raven Pro
Microtech International	Blue Streak
New Design	Precision FT
Nippon Texa	Texa RST-540
Optima Technology	4200W, 8200W
Raidtec	FlexArray M
StreamLogic	2000FMF SledgeHammer
Xistor	rd080.0

Board assembly (no drives)

Arco Electronics	AC1079MC
ATON Systemes	AREKA I-10S
Baystor	TS 200, TS 210
Data Technology	Hard Copy
Raidtec	RUAC MX
Tekram Technology	DC-690

Software arrays

ATTO Technology	Express Mirror
CharisMac Engineering	Anubis Raid
Cyranex	EZRAID Lite
FWB Software	RAID Toolkit
Micronet Technology	DiskWorks 3.0
Trillium Research	Remus Lite 1.4

The first shipments in this product group occurred in 1990, with early software and board level arrays. All disk drive arrays used primarily with single personal computers or workstations are included in this product group. Although individual arrays offering RAID-3 or RAID-5 capability are included among the above subsystem, board and software arrays, they remain the exception, and in some cases are intended for high-end workstations used for graphics and prepress applications. Most of the arrays in this product group are designed for the very price sensitive personal computer markets, and use disk mirroring, or RAID-1. A few of the new single user arrays also support IDE drives.

The majority of array products offered for single user computer systems are designed for the Macintosh market, with most offering RAID-0 and/or RAID-1 capability. The large data storage requirements for many graphics applications for which Macintosh systems are widely used have created a demand for both the high data rates offered by RAID-0 striping and the reliability provided by RAID-1 mirroring.

Market status

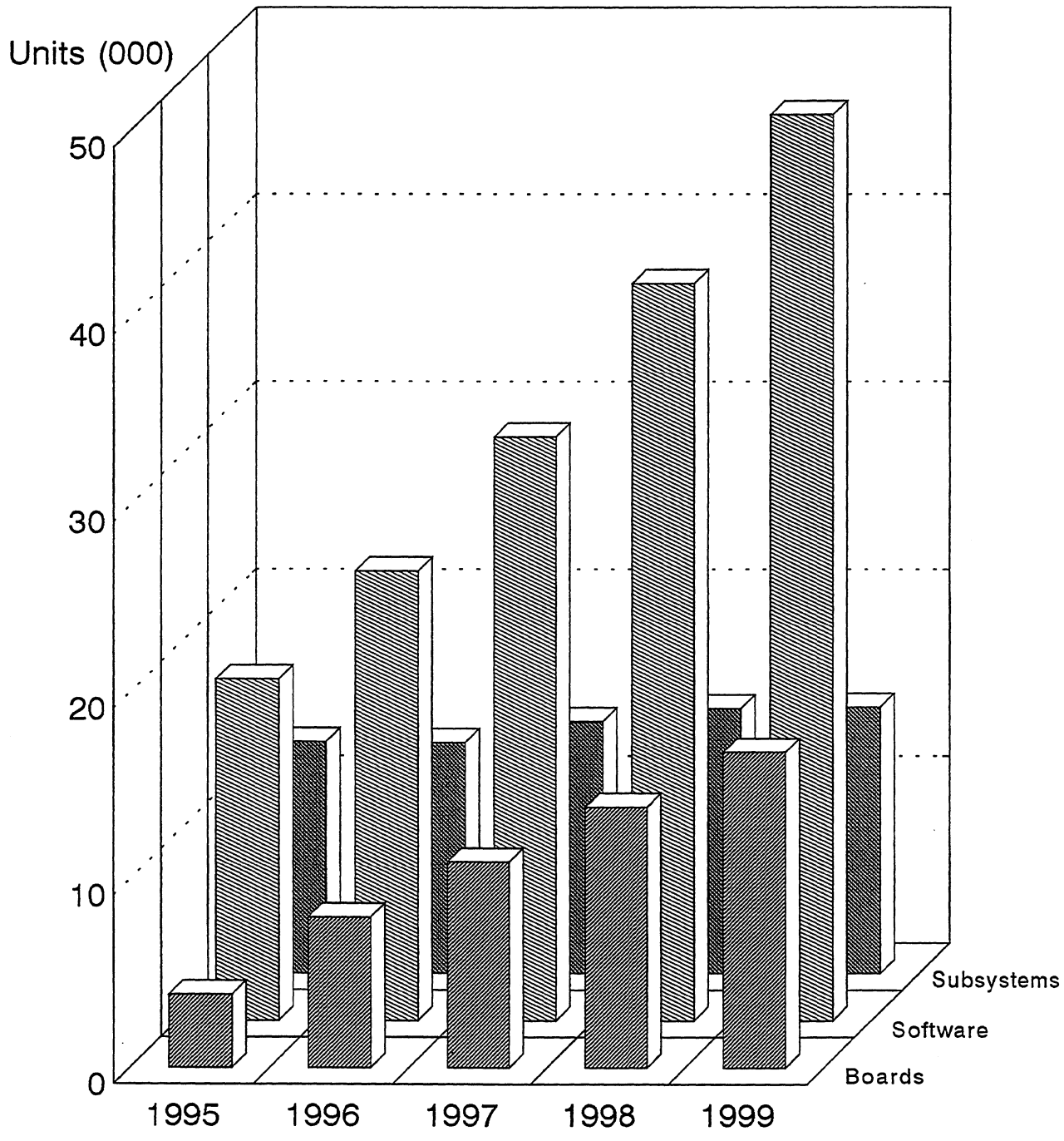
Although still the smallest DISK/TREND disk drive array product group in total sales revenues, both revenues and unit shipments of single user arrays increased faster than expected in 1995. Sales revenues jumped to $32.5 million, up 104.4%, and the unit shipment total reached 34,476, up 59.3%. Strong growth is continuing in 1996, with sales revenue forecasted to increase 22.2% and unit shipments expected to rise 28.6%. Although the markets for single user disk drive arrays remain very price sensitive, consisting mostly of Macintosh and IBM compatible personal computer users, arrays sold as complete subsystems have continued to grow in shipments and in typical disk capacity, providing the largest share of the product group's revenue increase.

The movement to complete subsystems got under way in 1994, as array controller boards lost shipment leadership to complete subsystems, with boards dropping to only 11.2% of the 1995 overall unit shipment total. However, the single user array product mix remains volatile, influenced by the combination of evolving application requirements, various product introductions and the changing fortunes of individual participating array suppliers. In 1996, shipments of complete subsystems are expected to be flat, boards will restart strong growth and software arrays will maintain a pattern of solid growth. Software array products have already passed complete subsystems for leadership in unit shipments, but not in sales revenues due to very low unit prices. With most single user applications, there is usually no probability that the array software will overload the computer processor, so software products can provide a low cost, high performance array for the serious computer do-it-yourselfer.

1995 leadership in noncaptive unit shipments for single user arrays was again held by FWB, a company which was subsequently split into two segments

Figure 6

Single User System Arrays
Worldwide Shipments by Array Type



in mid-1996, with the purchase of the hardware product lines by StreamLogic and the renaming of the remaining organization as FWB Software. In 1995, FWB's share of worldwide noncaptive unit shipments was 49.1%, split between hardware and software products. Two companies tied for second place, both holding 12.2%, with Unitrol Data Protection Systems shipping all RAID-1 software, and Nippon Texa shipping mostly complete subsystems.

Marketing trends

Despite a projected annual average growth in unit shipments of 21.5% in the 1997-99 period, growth in sales revenues for this product group is expected to decline to zero by 1999, due to the changing product mix and continuously falling average unit prices. The forecasted 1999 worldwide revenue total is $44.8 million, while the shipment total is expected to climb to 79.4 thousand units.

Although growth in unit shipments for complete subsystems is expected, the pricing expectations of single users will hold the increase to modest levels, with sales concentrated in more sophisticated video and multimedia system applications. Attractively low unit prices will stimulate more aggressive sales growth for both boards and software array products. Worldwide shipments of boards are forecasted at 16,820 for 1999, more than twice the current level, with the PCM/Distributor average price falling to $123. Software product shipments are also projected to double in sales by 1999, with 48,375 units, and the PCM/Distributor average selling price at $109.

The PCM/Distributor channel is expected to remain dominant in sales of arrays for single user systems, and is forecasted to capture 71.9% of 1999 total unit shipments for all types of single user arrays. The single user array market remains an add-on market served primarily by independent peripheral vendors specializing in the Macintosh and IBM compatible personal computer markets. Array manufacturers headquartered in the U.S. have led in development of the growth markets for single user arrays, but non-U.S. manufacturers are expanding their participation, and U.S. firms are expected to retain only a narrow 53.8% lead in 1999 worldwide revenues.

Technical trends

The availability of single user disk drive arrays at modest cost has made possible today's developing market, as individual personal computer users have found it prudent and affordable to utilize arrays for a variety of graphics, video, multimedia and complex business applications. Underlying the expansion of this market have been two key trends.

The improvement in disk drive areal density continues nonstop, providing the low cost, high capacity 3.5" drives used in most of the arrays in this product group. During the next few years 3.5" drives are expected to remain dominant, while evolving to even lower prices and higher capacities. Most arrays intended for single user applications do not stretch the capabilities of the disk drives now employed, and the performance levels available are more than adequate for most single users.

The array logic embedded in hardware controllers and software products has also continued to improve and to drop in price. The improvements include expanded user options in selecting RAID levels, simplified user interfaces, and more flexibility in modifying array configurations. The improvements have arrived in the market at the same time as product simplification, contributing to reduced selling prices and helping to broaden the market.

Forecasting assumptions

1. The market for single user arrays will continue to grow, based on purchases from only a small segment of Macintosh, PC compatible and UNIX workstation users.

2. Complete subsystems will increase in shipments due to low disk drive costs and increasing demand for user convenience, and software products will increase in shipments due to low cost and negligible degradation of system performance in typical single user applications. Boards will also increase in shipments, due to low prices. Higher typical prices will restrict unit shipment growth for complete subsystems, but they will continue to dominate sales revenues through 1999.

3. U.S. manufacturers will continue to lead the worldwide market for single user arrays, due to aggressive product development and continuously changing competitive conditions.

TABLE 10

SINGLE USER SYSTEMS

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1995		Forecast							
	Revenues		1996		1997		1998		1999	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Distributor	12.2	19.8	11.9	19.7	14.1	20.1	14.4	20.5	14.3	20.3
OEM/Integrator	1.5	3.7	2.3	5.1	2.5	4.7	2.3	4.2	2.2	3.8
TOTAL U.S. REVENUES	13.7	23.5	14.2	24.8	16.6	24.8	16.7	24.7	16.5	24.1
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Distributor	.3	7.6	.5	10.9	1.1	13.0	1.6	14.4	1.9	14.6
OEM/Integrator	.3	1.4	1.3	4.0	2.1	5.4	2.2	5.8	2.3	6.1
TOTAL NON-U.S. REVENUES	.6	9.0	1.8	14.9	3.2	18.4	3.8	20.2	4.2	20.7
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	14.3	32.5	16.0	39.7	19.8	43.2	20.5	44.9	20.7	44.8

TABLE 11

SINGLE USER SYSTEMS

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1995 Shipments		Forecast							
			1996		1997		1998		1999	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Distributor	15,030	21,876	16,450	21,710	19,140	26,300	24,190	33,380	29,050	40,165
OEM/Integrator	1,310	2,080	1,740	2,695	2,655	4,050	3,495	5,095	4,530	6,430
TOTAL U.S. SHIPMENTS	16,340	23,956	18,190	24,405	21,795	30,350	27,685	38,475	33,580	46,595
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Distributor	2,450	8,235	4,075	11,865	4,600	13,650	5,080	15,060	6,120	16,980
OEM/Integrator	1,050	2,285	4,630	8,060	6,015	11,590	6,940	13,835	7,730	15,860
TOTAL NON-U.S. SHIPMENTS	3,500	10,520	8,705	19,925	10,615	25,240	12,020	28,895	13,850	32,840
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	19,840	34,476	26,895	44,330	32,410	55,590	39,705	67,370	47,430	79,435
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	49	77	76	122	109	177	148	245	196	324

TABLE 12

SINGLE USER SYSTEMS

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1995 Revenues			Forecast											
				1996			1997			1998			1999		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
PCM/Distributor	17.3	.3	2.2	17.1	.5	2.1	17.4	.4	2.3	17.0	.7	2.8	16.3	.8	3.2
OEM/Integrator	.5	3.1	.1	.8	4.2	.1	1.0	3.6	.1	1.3	2.7	.2	1.4	2.2	.2
TOTAL U.S. REVENUES	17.8	3.4	2.3	17.9	4.7	2.2	18.4	4.0	2.4	18.3	3.4	3.0	17.7	3.0	3.4
NON-U.S. MANUFACTURERS															
PCM/Distributor	7.1	.1	.4	10.0	.4	.5	12.2	.4	.4	13.6	.4	.4	13.8	.3	.5
OEM/Integrator	--	--	1.4	--	.3	3.7	--	.3	5.1	--	.3	5.5	--	.3	5.8
TOTAL NON-U.S. REVENUES	7.1	.1	1.8	10.0	.7	4.2	12.2	.7	5.5	13.6	.7	5.9	13.8	.6	6.3
WORLDWIDE RECAP															
PCM/Distributor	24.4	.4	2.6	27.1	.9	2.6	29.6	.8	2.7	30.6	1.1	3.2	30.1	1.1	3.7
	+83.5%	-60.0%	+116.7%	+11.1%	+125.0%	--	+9.2%	-11.1%	+3.8%	+3.4%	+37.5%	+18.5%	-1.6%	--	+15.6%
OEM/Integrator	.5	3.1	1.5	.8	4.5	3.8	1.0	3.9	5.2	1.3	3.0	5.7	1.4	2.5	6.0
	--	--	+650.0%	+60.0%	+45.2%	+153.3%	+25.0%	-13.3%	+36.8%	+30.0%	-23.1%	+9.6%	+7.7%	-16.7%	+5.3%
Total Revenues	24.9	3.5	4.1	27.9	5.4	6.4	30.6	4.7	7.9	31.9	4.1	8.9	31.5	3.6	9.7
	+87.2%	+191.7%	+192.9%	+12.0%	+54.3%	+56.1%	+9.7%	-13.0%	+23.4%	+4.2%	-12.8%	+12.7%	-1.3%	-12.2%	+9.0%
ANNUAL SHARE, BY TYPE	76.7%	10.8%	12.5%	70.4%	13.6%	16.0%	70.9%	10.9%	18.2%	71.1%	9.1%	19.8%	70.4%	8.0%	21.6%

TABLE 13

SINGLE USER SYSTEMS

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1995 Shipments			Forecast 1996			1997			1998			1999		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
PCM/Distributor	8,950	1,266	11,660	7,300	150	14,260	6,960	1,490	17,850	6,550	3,330	23,500	6,020	5,060	29,085
OEM/Integrator	30	900	1,150	40	1,275	1,380	55	2,240	1,755	80	2,725	2,290	95	3,385	2,950
TOTAL U.S. SHIPMENTS	8,980	2,166	12,810	7,340	1,425	15,640	7,015	3,730	19,605	6,630	6,055	25,790	6,115	8,445	32,035
NON-U.S. MANUFACTURERS															
PCM/Distributor	3,400	1,705	3,130	5,000	3,700	3,165	6,450	3,940	3,260	7,530	4,190	3,340	8,125	4,405	4,450
OEM/Integrator	--	--	2,285	--	2,850	5,210	--	3,270	8,320	--	3,620	10,215	--	3,970	11,890
TOTAL NON-U.S. SHIPMENTS	3,400	1,705	5,415	5,000	6,550	8,375	6,450	7,210	11,580	7,530	7,810	13,555	8,125	8,375	16,340
WORLDWIDE RECAP															
PCM/Distributor	12,350	2,971	14,790	12,300	3,850	17,425	13,410	5,430	21,110	14,080	7,520	26,840	14,145	9,465	33,535
	+43.1%	-33.8%	+129.7%	-.4%	+29.6%	+17.8%	+9.0%	+41.0%	+21.1%	+5.0%	+38.5%	+27.1%	+.5%	+25.8%	+24.9%
OEM/Integrator	30	900	3,435	40	4,125	6,590	55	5,510	10,075	80	6,345	12,505	95	7,355	14,840
	--	+275.0%	+85.7%	+33.3%	+358.3%	+91.8%	+37.5%	+33.6%	+52.9%	+45.5%	+15.2%	+24.1%	+18.8%	+15.9%	+18.7%
Total Shipments	12,380	3,871	18,225	12,340	7,975	24,015	13,465	10,940	31,185	14,160	13,865	39,345	14,240	16,820	48,375
	+43.5%	-18.1%	+119.8%	-.3%	+106.0%	+31.8%	+9.1%	+37.2%	+29.9%	+5.2%	+26.7%	+26.2%	+.6%	+21.3%	+23.0%
ANNUAL SHARE, BY TYPE	36.0%	11.2%	52.8%	27.8%	18.0%	54.2%	24.2%	19.7%	56.1%	21.0%	20.6%	58.4%	17.9%	21.2%	60.9%

TABLE 14

SINGLE USER SYSTEMS

WORLDWIDE PRICE PER UNIT ($000)

ARRAY TYPE		Forecast			
	1995	1996	1997	1998	1999
Captive					
Subsystems	--	--	--	--	--
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	--	--	--	--	--
PCM/Distributor					
Subsystems	1.9	2.2	2.2	2.1	2.1
Boards	.1	.2	.1	.1	.1
Software	.1	.1	.1	.1	.1
PCM/Distributor Average	.9	.9	.8	.7	.6
OEM/Integrator					
Subsystems	15.0	19.0	18.0	16.0	14.0
Boards	3.5	1.0	.7	.4	.3
Software	.4	.5	.5	.4	.4
OEM/Integrator Average	1.1	.8	.6	.5	.4

Note: Price per unit calculations represent estimated total sales revenues for each product type by the total yearly shipped quantity of all units of that type.

TABLE 15

SINGLE USER SYSTEMS

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1995 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
StreamLogic	5,800	--	--	5,800	29.2	8,700	--	--	8,700	25.2
FWB Software	--	--	5,400	5,400	27.2	--	--	8,250	8,250	23.9
Unitrol Data Protect.	--	--	2,700	2,700	13.6	--	--	4,200	4,200	12.2
Nippon Texa	--	--	100	100	.5	3,400	--	800	4,200	12.2
Trillium Research	--	--	1,870	1,870	9.4	--	--	2,160	2,160	6.3
Other U.S.	110	1,360	1,800	3,270	16.5	280	2,166	2,400	4,846	14.1
Other Non-U.S.	--	400	300	700	3.6	--	1,705	415	2,120	6.1
TOTAL	5,910	1,760	12,170	19,840	100.0	12,380	3,871	18,225	34,476	100.0

ARRAYS: NETWORKS/MIDRANGE SYSTEMS

1996 DISK/TREND REPORT

ARRAYS: NETWORKS/MIDRANGE SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

AC Technology	Concorde
Acer	Altos 19000
ADS International	ADS/2000, ADS/5000
Advanced Logic Research	Data Station
Advanced Technology & Systems	AXRS-D1080S
Aiwa Core	RAIDstack series
Amdahl	LVS 4500
American Digital Systems	Masterdisk RAID
ANDATACO	GigaRAID/FT
Antrone Research	AccuRAID
Apple Computer	AppleRAID
Applied Digital Systems	A 510
Artecon	LynxRAID+
AST Research	Manhattan series
ATON Systemes	AREKA VDS
Auspex Systems	NS-7000 series
Aviv	Spitfire, Eclipse
Baydel	MS3-150, DAR5 series
Box Hill	RAID Box 5300
Cambex	Centurion 2000
Ciprico	AD6700, AD6710
CMD Technology	CSV-8050, CSV-8150
Compaq Computer	ProLiant, ProSignia series
Computer Marketplace	Acceleraider
Conley	SR-40, SR-50
Cubix	SafeStor/FT II
CyberStorage Systems	CyberStorage series
Dallas Digital	RAIDstor
Data General	CLARiiON series
Datalink	RS 620, RS 660
Data Storage Marketing	Datastor RAID
Dell Computer	PowerEdge series
Digital Equipment	StorageWorks series
Direct Connect Systems	Guardian RAID series
Direct Connections	DC3400W
DPT	SmartRAID series
DynaTek Automation Systems	XPRS series
ECCS	Micro DFT, Synchronix
EMC	Harmonix, ModARRAY, Symmetrix
Eurologic Systems	EL-RAID series
Falcon Systems	FalconRAID
Formation	9937 series, fd6000 series
Future Computers	RAIDER-5

Complete subsystems, with disk drives (continued)

Gainbery Computer Products	IDE Mini-RAID
Hewlett-Packard	C3609A, XLR1200 AutoRAID
Hitachi	A-6531, HT-2460
Hitachi Data Systems	57XX series
IBM	9337, 8641, 7135
Integrix	RD-10
Invincible Technologies	Ultimate 5 series
IPC Technologies	Austin Affinity
IPL	Raidtower series
LAND-5	DS300
Legacy Storage Systems	SmartArray series
Lighthouse Technology	Harbor
MegaDrive Systems	MR/5, MR/10, MX/500, Aria
Micronet Technology	RAIDbank series
Morton Management	GBR-RD series
MountainGate Data Systems	Renegade, Stampede
MTI Technology	9300, Stingray series
NEC	DAS5XX, RISCserver series
NetFRAME	8400, 8500
Network Appliance	F330, FAServer series
Network Connection	T.R.A.C Array
Network Storage Solutions	SPANStor-RAID
Nippon Texa	DAF, DAR, DAX series
NStor	CR6, CR8 series
Optima Technology	HST series
PACE Technologies	PACE RAID-5
Pacific Micro Data	MAST 9500
Parity Systems	PS6000 series
PC Expanders	Arrayserver
Perisol Technology	RAIDsafe Plus
Phoenix International	Phalanx T, D
Polywell Computers	SUMA 8000
Precision Computers	Precision RAID
Procom Technology	R2000, LFRAID series
RAAC Technologies	ESP1000
Raidar Systems	1261
Raidtec	FlexArray series
Raid Power	UltraRAID2
R Squared	EL-11
See First Technology	Array System
Seek Systems	S450
Sequent Computer Systems	Winserver 5000
Sequoia Systems	SES/RAID
Siemens Nixdorf	Storage System series
Sigma	Sentry series
Solid Computer	M10, M20
Storage Computer	R3x, SuperServer series
Storage Concepts	Concept series, UltraRAID
Storage Dimensions	LANStor, SuperFlex series
Storage Solutions	CM2 series
Storage Technology	9131

Complete subsystems, with disk drives (continued)

StoragePath	SP series
StorNet	DB-RAID
Stratus Computer	D600, D700, D800
StreamLogic	RAIDION, SledgeHammer series
Sun Microsystems	SPARCstorage series
Symbios Logic	MetaStor series
Systex	STX series
Tandem Computers	4XXX series,Integrity
Tangent Computer	Raid5Server
Texas Microsystems	SP5500
Total Tec Systems	Triad
Transitional Technology	NX Server
Uni Solution	USI RAID
Unisys	ODM 3900, ODM 5900
Western Scientific	CycloneRAID
Winchester Systems	Flashdisk RAID series
Xyratex	N9000, SR6000
Zenith Data Systems	RAID option
ZZYXZ Workstations & Peripherals	ZRS-3000

Board assembly (no drives)

Adaptec	AHA-3985, ARO-1130
ADS International	ADS/3000
American Megatrends	MD 418, MRU 428
ATON Systemes	AREKA E-10F
CMD Technology	CRD-5000, Daytona
Compaq Computer	SMART-2
Conley	SHA-400
Digi-Data	Model Z, Z9000
Digital Equipment	HSZ40, HSZ50
DPT	SmartCache series
Dilog SA	Windjammer
Diverse Logistics	Windjammer
Eclipse Technologies	Mariner 2
Hewlett-Packard	C3609A
Hi-Data	SC-510, SC-550
IBM	PC ServeRAID
Infortrend	IFT-3102U
Lomas Data Products	LDP Cache series
Mylex	DAC-960 series
NEC	OP-450-30004
Perceptive Solutions	dataSHADOW, Pathfinder
Raidtec	Ruac IX, FibreRAID-PCI
Seek Systems	Xcelerator
StreamLogic	Gandiva
Sunix	Sun-5875
Symbios Logic	3201, 3701
SYRED Data Systems	Prestige, Regency
Systex	STX-2000A
TD Systems	Omniserve 2, 3

Board assembly (continued)

Tekram Technology	DC-880B
Tricord Systems	ISS-2, 4C
Vortex Computersysteme (ICP-Vortex)	GTD2000, GTD6000

Software arrays

1776, Inc.	76SC34, 76SC34H
CLone Star Software	Reflect, Alter Ego
Concurrent Computer	SCSI DEXS
Conley	SoftRAID
Corel	Network Manager
Cyranex	EZRAID Pro
Digital Equipment	Volume Shadowing 6.0
NCR	Disk Array Plus
Nonstop Networks	No-Stop Network
Sun Microsystems	Online: DiskSuite 4.1
Trillium Research	REMUS 1.4
TwinCom	Dual Mirror, Network Mirror
Veritas Software	VxVM, VxMirror

This product group includes disk drive arrays intended primarily for use with networks, minicomputers and multiuser systems. While mirrored disk, or RAID-1, implementations have been available for many years, the group has seen an explosion of product introductions of RAID-3 and RAID-5 arrays since the early pioneering efforts in the mid-1980s. Arrays have originated with system manufacturers, disk drive manufacturers, independent peripherals resellers and controller manufacturers, network server manufacturers, software development firms, and startup companies founded for the sole purpose of making disk drive arrays.

The complete subsystems included in this product group cover a broad range of capabilities, from highly redundant fault tolerant superservers to small arrays of 2.5" drives packaged in the form factor of a 5.25" drive. Most of the subsystems are somewhere between these extremes, with a wide variation in physical size, price and redundancy of critical components.

A strong majority of the complete subsystems in this product group offer either RAID-3 or RAID-5 capability, or both -- and most of these were introduced during the last four years. A very high share of array subsystems shipped until now have been RAID-1 mirrored disk implementations. Many of the leaders in array shipments for networks/midrange systems applications have offered captive subsystems with RAID-1 capability as part of midrange computer product

lines, such as Digital Equipment, Tandem Computers and Stratus Computer, with superservers available from Auspex and NetFRAME, and with plug compatible subsystems for the IBM AS/400 add-on market from EMC and IPL.

A high percentage of the array board assemblies also now provide RAID-3 and/or RAID-5 capability. This report groups boards, array assemblies complete with everything except disk drives, and all levels in between, in the board assembly product group. Customers for the board manufacturers typically include computer system manufacturers, plus independent storage subsystem and server manufacturers, which assemble the completed array subsystem, as well as sophisticated computer users with a do-it-yourself urge. Array software is also typically purchased or licensed by the same buyers. Although the majority of array software offerings are RAID-0/1 or RAID-1, RAID-5 software is available from multiple vendors.

Market status

Total shipments and sales revenues of disk drive arrays intended for the networks/midrange systems market have continued to enjoy strong growth in 1995 and 1996. Overall unit shipments for the product group were 536,074 in 1995, up 42.8%, and more than 739 thousand are forecasted for 1996. Sales revenues for the product group were $5.4 billion in 1995, an increase of 41.8%, and revenues for 1996 are expected to exceed $7.7 billion.

Because numerous system manufacturers have found it both strategically important and profitable to offer disk drive arrays with their network and midrange computer systems, captive arrays continue to dominate sales in this product group. 78.5% of the product group's 1995 sales revenues were generated by arrays sold on a captive basis by system manufacturers, a total of $4.2 billion. In contrast, only 45.1% of the product group's total unit shipments were captive arrays. The two factors which boosted captive revenues to such a high level were very high captive shipments of complete subsystems, 79.5% of all subsystems for the entire product group, and the fact that captive arrays are typically sold at higher prices than arrays sold through PCM/Distributor marketing channels.

Captive arrays sold in this market not only earn the higher prices for products sold at the end user level, but tend to contain larger quantities of high capacity disk drives and are frequently designed for a higher level of fault tolerance, with mostly redundant key components. Strong shipments of all types of complete array subsystems by Compaq Computer, IBM, Data General, Hewlett-Packard, Digital Equipment, Dell Computer, Stratus Computer, Tandem Computers and Sun Microsystems have contributed to the high captive shipment total.

Complete subsystems also dominate PCM/Distributor unit shipments and sales revenues, and they continue to maintain a pattern of strong growth. 1995 PCM/Distributor total revenues for the product group were $635.8 thousand, of which $603.9 thousand was generated by complete subsystem sales. Complete subsystems provided 58.1% of PCM/Distributor unit shipments in 1995, and command average selling prices several times higher than those for boards and software products. Most of the more than 100 companies now active in this segment are providing arrays for use with personal computer and UNIX workstation file servers, and a few are active in the IBM AS/400 add-on market. PCM/Distributor sales of array boards and board assemblies are expected to double in 1996, as new marketing programs by significant producers take effect.

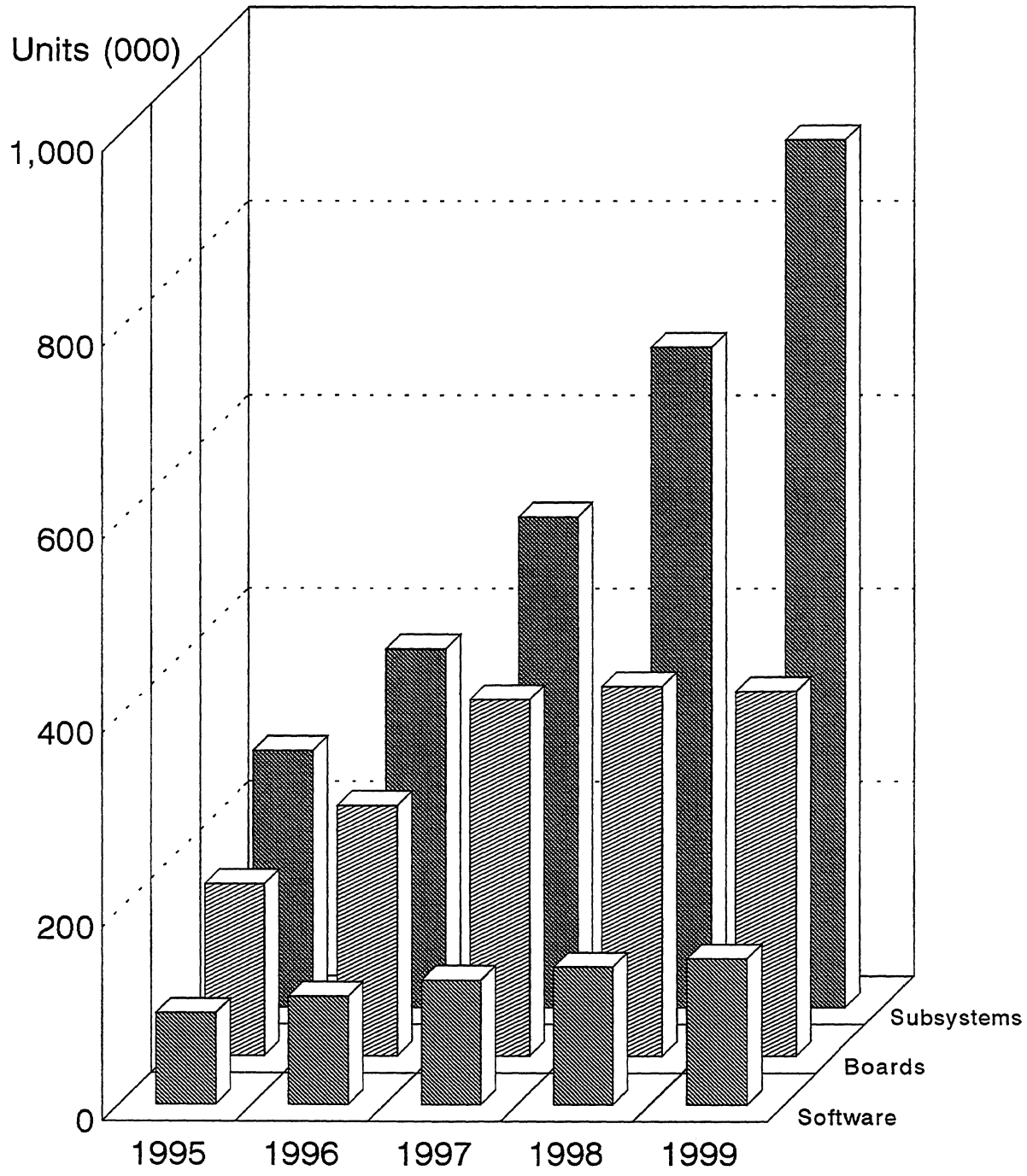
Complete subsystems continue to lead in OEM/Integrator sales revenues, but array board level products dominate shipments. Boards shipments jumped 68.3% in 1995, with 156,154 units, and a further 38.6% increase is forecasted for 1996. The success of Compaq Computer in developing personal computer network markets for its family of array subsystems has prompted a high proportion of the other personal computer manufacturers to plunge into the array subsystem market, and the majority have turned to outside suppliers for array controller boards.

Mylex's continues to maintain an overwhelming lead in noncaptive shipments in the networks/midrange systems product group as the result of the company's leadership in array board shipments for the personal computer server market. Mylex' 128,400 boards represented 43.6% of the worldwide noncaptive unit shipment total for 1995. Veritas held second place with 19.5%, based on shipments of software array products.

Figure 7

Network/Midrange System Arrays

Worldwide Shipments by Array Type



Marketing trends

Unit shipments for the networks/midrange systems product group are expected to top one million units in 1997, with worldwide sales revenues forecasted at $9.7 billion. In 1999, unit shipments are projected to reach 1.4 million units, an average annual increase of 24.6% for the 1996-99 period. 1999 sales revenues for the product group are forecasted at $18.6 billion, up an average of 23.8% in the same period. It is clear that a very high percentage of computer networks will be equipped with file servers utilizing disk drive arrays by the end of this decade.

Continuous changes in the product group's product mix are expected during the forecast period of this report. Complete subsystems are clearly destined to hold an increasing share of the product group's sales and shipments as more users move to completely assembled storage solutions, with a forecast of 63.1% of the product group's 1999 unit shipments and 97.9% of sales revenues.

Individual software packages will continue to be interesting to some users who already have computer systems using multiple disk drives, and to those who acquire systems with bundled array software. However, even though shipments of software array products are expected to increase modestly, they are forecasted to continue their decline in their share of the product group's shipments during the same period, with unit shipments projected at 10.4% of the 1999 total. It is believed the typical end users will prefer to acquire and use complete array subsystems, to avoid the nuisance and complexity of separately purchasing software, disk drives, enclosures, cables, etc.

The sales outlook for array boards and board assemblies in the 1997-99 period is more complex. Significant new chip set array controller implementations for the networks/midrange market were introduced in 1996, and these products are expected to displace array board sales in gradually increasing quantities in subsequent years. After 1997, OEM/Integrator board shipments in this product group are expected to start declining, with OEM/Integrator board shipments forecasted to drop 4.3% in 1999, following a flat year in 1998. The transition to array controller chips mounted on system motherboards will not occur overnight, but is expected to require several years. During the same period, many improvements in array architecture will make arrays more flexible and easier to use, and most of these innovations will be implemented first in board-level array products.

Captive arrays will continue to provide the lion's share of sales revenues for this product group, with a 1999 forecast of $11.2 billion, 75.7% of the total for arrays destined for the networks/midrange systems market. PCM/Distributor 1999 sales revenues are projected at $2.2 billion, more than three times greater than last year's level, also driven by subsystem sales, which are expected to be 96.5% of the 1999 total for the sales channel. 93.2% of the OEM/Integrator channel 1999 sales revenues are also expected to be derived from complete subsystems, but the picture for unit shipments is quite different. Despite the expected slowdown in board shipments, 6.2% of OEM/Integrator 1999 unit shipments are forecasted to be boards and board assemblies, with growth fueled by the demand for arrays from system manufacturers and network server manufacturers lacking the resources or time to develop their own arrays.

Average selling prices per unit are expected to decline continually during the 1997-99 period for each marketing channel. The average unit price increases realized by noncaptive subsystems during 1996 were caused by a general movement to array subsystems with a higher level of fault tolerance and more disk capacity in "client/server" applications, mostly in larger companies. Future array price declines will be driven by high shipment levels and lower disk drive pricing.

Companies headquartered in the United States dominated sales revenues for the networks/midrange product group in 1995, with 94.8% of the worldwide total. Although the array market is now spreading throughout the world, U.S. based companies are expected to retain a similar share of the 1999 worldwide revenue total. The next three years will see continuous improvements in disk array architecture, electronics, packaging and marketing techniques -- all areas of strength for most of the U.S. companies participating in development of the array market.

Technical trends

During the last few years there has been great pressure on disk drive array manufacturers to make arrays more capable of evolving with changing user requirements, and at the same time to reduce costs. Hardware based arrays are expected to benefit from a continuous stream of improvements in architecture, to

improve performance and flexibility; in packaging, through higher density disk drives and reduced chip sets; and in user convenience, improved through internal logic changes.

Hewlett-Packard's 1995 introduction of AutoRAID, which uses a new method to map host block addresses to disk drive addresses, includes many of the expected improvements, including dynamic data migration between RAID modes, the ability to expand array capacity on-line, and continuous utilization of hot spare drives. Although H-P has been slow to exploit the widespread attention AutoRAID's introduction received in the industry, it has had a significant impact on the product development activities of other disk drive array manufacturers, most of whom are moving toward increased versatility and modularity in new array designs.

The continual annual movement to lower priced disk drives inevitably affects the customers' thoughts when selecting disk drive arrays for purchase. Much of the future growth for RAID-5 arrays, especially in low-end configurations, will depend on better price comparisons with mirrored disk arrays. And larger RAID-5 arrays must minimize their price disadvantage compared to assemblies of individual disk drives, which are becoming more reliable every month. As with other electronics industry products, most of the contribution to lower costs will probably come from higher shipment volume and new product designs which lower the hardware parts count.

The impact on high-end network superservers will be higher capacity in smaller cabinets, with steadily improving price per megabyte. Midrange arrays, which today frequently sacrifice some fault tolerance for lower price tags, will combine higher reliability with even lower prices. The smallest arrays will be offered in even smaller physical packages, with new disk drives and reduced chip sets making possible complete arrays in ever smaller packages.

The possibility that disk drive array functions may be embedded in future operating systems or in chips mounted on system motherboards provides the major area of uncertainty for today's disk drive array manufacturers. The first RAID-5 implementations suitable for PC server motherboard installation were introduced by Mylex and Adaptec in 1996, eliminating the need for a separate array controller board.

Operating systems that include array functions are not included in the DISK/TREND Report shipment and revenue totals. Limited array capabilities already have been included in some existing operating systems for minicomputers and mainframes by Digital Equipment and IBM. These operating system options allow users to mirror disks available on a system, or as with Novell's SFT III network system, to mirror complete file servers on a network. It is considered likely that some of the new operating systems expected to appear during the next few years will contain disk array features. However, their probable effect on the market for hardware based arrays and separate software array packages is expected to be modest, and has been anticipated in DISK/TREND Report forecasts.

Any software based array must use a portion of the processor's capabilities to perform its tasks, and in a heavily used system the penalty is an impact on system performance. This is an insignificant factor in most single user systems, but in the networks/midrange systems market represented by this product group it is undesirable in many situations. Hardware based arrays will continue to have the performance advantage.

Forecasting assumptions

1. Networks for personal computer and workstation applications will continue to grow at a high rate.

2. U.S. manufacturers will continue to dominate the worldwide array market, due to aggressive product development and continuously changing competitive conditions.

3. Complete subsystems will achieve higher growth than software array products by providing users with the convenience of complete array subsystems and typically higher performance.

4. Growth in array board shipments will flatten starting in 1997, with declining revenues, due to competition from array chip sets mounted on system motherboards.

TABLE 16

NETWORKS/MIDRANGE SYSTEMS

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1995 Revenues		Forecast 1996		1997		1998		1999	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	2,089.4	4,127.4	2,813.7	5,635.4	3,616.5	7,086.2	4,554.2	8,925.0	5,605.5	10,986.6
PCM/Distributor	400.1	614.1	636.4	1,002.9	811.4	1,260.5	1,007.5	1,590.9	1,242.7	1,995.7
OEM/Integrator	247.5	394.8	502.0	721.6	579.6	888.2	665.2	1,036.6	708.0	1,121.9
TOTAL U.S. REVENUES	2,737.0	5,136.3	3,952.1	7,359.9	5,007.5	9,234.9	6,226.9	11,552.5	7,556.2	14,104.2
Non-U.S. Manufacturers										
Captive	.5	125.3	--	155.1	1.6	157.6	2.3	164.2	3.0	166.5
PCM/Distributor	4.9	21.7	45.0	101.0	57.7	131.5	76.2	165.8	95.3	202.4
OEM/Integrator	67.2	135.6	83.9	161.8	115.8	194.9	136.2	222.2	167.0	266.1
TOTAL NON-U.S. REVENUES	72.6	282.6	128.9	417.9	175.1	484.0	214.7	552.2	265.3	635.0
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	2,809.6	5,418.9	4,081.0	7,777.8	5,182.6	9,718.9	6,441.6	12,104.7	7,821.5	14,739.2

TABLE 17

NETWORKS/MIDRANGE SYSTEMS

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1995 Shipments		Forecast							
	1996		1997		1998		1999			
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	122,605	235,780	162,630	321,425	220,840	431,445	290,700	568,230	374,940	733,315
PCM/Distributor	41,766	59,689	62,973	91,794	87,420	129,675	113,695	171,665	139,275	214,560
OEM/Integrator	144,035	206,617	197,695	287,030	265,795	396,360	273,740	415,435	270,985	418,775
TOTAL U.S. SHIPMENTS	308,406	502,086	423,298	700,249	574,055	957,480	678,135	1,155,330	785,200	1,366,650
Non-U.S. Manufacturers										
Captive	40	6,105	--	7,040	80	7,880	120	8,640	165	9,250
PCM/Distributor	3,090	7,703	3,830	10,550	5,025	14,330	6,665	18,145	8,195	21,290
OEM/Integrator	8,635	20,180	8,818	21,256	9,730	22,420	10,695	23,050	12,605	25,020
TOTAL NON-U.S. SHIPMENTS	11,765	33,988	12,648	38,846	14,835	44,630	17,480	49,835	20,965	55,560
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	320,171	536,074	435,946	739,095	588,890	1,002,110	695,615	1,205,165	806,165	1,422,210
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	723	1,194	1,159	1,933	1,748	2,935	2,444	4,140	3,250	5,563

TABLE 18

NETWORKS/MIDRANGE SYSTEMS

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1995 Revenues			Forecast											
	1996			1997			1998			1999					
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	3,980.4	3.0	144.0	5,473.1	2.8	159.5	6,923.5	3.1	159.6	8,768.5	3.2	153.3	10,835.8	3.1	147.7
PCM/Distributor	586.8	20.2	7.1	948.1	43.0	11.8	1,200.4	49.2	10.9	1,523.3	58.7	8.9	1,925.2	62.2	8.3
OEM/Integrator	273.7	115.5	5.6	554.5	160.4	6.7	730.5	148.0	9.7	919.9	106.9	9.8	1,036.1	77.1	8.7
TOTAL U.S. REVENUES	4,840.9	138.7	156.7	6,975.7	206.2	178.0	8,854.4	200.3	180.2	11,211.7	168.8	172.0	13,797.1	142.4	164.7
NON-U.S. MANUFACTURERS															
Captive	125.3	--	--	155.1	--	--	157.6	--	--	164.2	--	--	166.5	--	--
PCM/Distributor	17.1	3.8	.8	95.9	4.8	.3	124.8	6.4	.3	158.8	6.9	.1	195.6	6.7	.1
OEM/Integrator	108.7	26.9	--	139.7	22.1	--	180.2	14.7	--	211.9	10.3	--	257.9	8.0	.2
TOTAL NON-U.S. REVENUES	251.1	30.7	.8	390.7	26.9	.3	462.6	21.1	.3	534.9	17.2	.1	620.0	14.7	.3
WORLDWIDE RECAP															
Captive	4,105.7	3.0	144.0	5,628.2	2.8	159.5	7,081.1	3.1	159.6	8,932.7	3.2	153.3	11,002.3	3.1	147.7
	+38.2%	-43.4%	+22.7%	+37.1%	-6.7%	+10.8%	+25.8%	+10.7%	--	+26.1%	+3.2%	-3.9%	+23.2%	-3.1%	-3.7%
PCM/Distributor	603.9	24.0	7.9	1,044.0	47.8	12.1	1,325.2	55.6	11.2	1,682.1	65.6	9.0	2,120.8	68.9	8.4
	+30.1%	+14.8%	-4.8%	+72.9%	+99.2%	+53.2%	+26.9%	+16.3%	-7.4%	+26.9%	+18.0%	-19.6%	+26.1%	+5.0%	-6.7%
OEM/Integrator	382.4	142.4	5.6	694.2	182.5	6.7	910.7	162.7	9.7	1,131.8	117.2	9.8	1,294.0	85.1	8.9
	+239.3%	+31.6%	-57.6%	+81.5%	+28.2%	+19.6%	+31.2%	-10.8%	+44.8%	+24.3%	-28.0%	+1.0%	+14.3%	-27.4%	-9.2%
Total Revenues	5,092.0	169.4	157.5	7,366.4	233.1	178.3	9,317.0	221.4	180.5	11,746.6	186.0	172.1	14,417.1	157.1	165.0
	+43.5%	+26.0%	+13.4%	+44.7%	+37.6%	+13.2%	+26.5%	-5.0%	+1.2%	+26.1%	-16.0%	-4.7%	+22.7%	-15.5%	-4.1%
ANNUAL SHARE, BY TYPE	94.1%	3.1%	2.8%	94.8%	3.0%	2.2%	96.0%	2.3%	1.7%	97.1%	1.5%	1.4%	97.9%	1.1%	1.0%

TABLE 19

NETWORKS/MIDRANGE SYSTEMS

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1995 Shipments			Forecast											
				1996			1997			1998			1999		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	204,560	1,000	30,220	282,405	1,000	38,020	384,635	1,200	45,610	515,790	1,350	51,090	677,240	1,400	54,675
PCM/Distributor	37,779	16,510	5,400	50,109	35,465	6,220	70,615	51,780	7,280	98,275	65,240	8,150	132,770	73,070	8,720
OEM/Integrator	10,173	140,844	55,600	18,250	202,680	66,100	26,090	296,015	74,255	36,795	297,080	81,560	47,100	285,585	86,090
TOTAL U.S. SHIPMENTS	252,512	158,354	91,220	350,764	239,145	110,340	481,340	348,995	127,145	650,860	363,670	140,800	857,110	360,055	149,485
NON-U.S. MANUFACTURERS															
Captive	6,105	--	--	7,040	--	--	7,880	--	--	8,640	--	--	9,250	--	--
PCM/Distributor	1,343	3,630	2,730	4,950	4,840	760	7,130	6,530	670	10,050	7,515	580	13,040	7,740	510
OEM/Integrator	4,800	15,310	70	7,416	13,730	110	10,010	12,220	190	12,460	10,270	320	16,120	8,410	490
TOTAL NON-U.S. SHIPMENTS	12,248	18,940	2,800	19,406	18,570	870	25,020	18,750	860	31,150	17,785	900	38,410	16,150	1,000
WORLDWIDE RECAP															
Captive	210,665	1,000	30,220	289,445	1,000	38,020	392,515	1,200	45,610	524,430	1,350	51,090	686,490	1,400	54,675
	+41.6%	-47.4%	+33.1%	+37.4%	--	+25.8%	+35.6%	+20.0%	+20.0%	+33.6%	+12.5%	+12.0%	+30.9%	+3.7%	+7.0%
PCM/Distributor	39,122	20,140	8,130	55,059	40,305	6,980	77,745	58,310	7,950	108,325	72,755	8,730	145,810	80,810	9,230
	+5.6%	+11.8%	-63.6%	+40.7%	+100.1%	-14.1%	+41.2%	+44.7%	+13.9%	+39.3%	+24.8%	+9.8%	+34.6%	+11.1%	+5.7%
OEM/Integrator	14,973	156,154	55,670	25,666	216,410	66,210	36,100	308,235	74,445	49,255	307,350	81,880	63,220	293,995	86,580
	+16.1%	+68.3%	+193.6%	+71.4%	+38.6%	+18.9%	+40.7%	+42.4%	+12.4%	+36.4%	-.3%	+10.0%	+28.4%	-4.3%	+5.7%
Total Shipments	264,760	177,294	94,020	370,170	257,715	111,210	506,360	367,745	128,005	682,010	381,455	141,700	895,520	376,205	150,485
	+33.2%	+57.3%	+47.0%	+39.8%	+45.4%	+18.3%	+36.8%	+42.7%	+15.1%	+34.7%	+3.7%	+10.7%	+31.3%	-1.4%	+6.2%
ANNUAL SHARE, BY TYPE	49.5%	33.1%	17.4%	50.2%	34.9%	14.9%	50.6%	36.7%	12.7%	56.7%	31.7%	11.6%	63.1%	26.5%	10.4%

TABLE 20

NETWORKS/MIDRANGE SYSTEMS

WORLDWIDE PRICE PER UNIT ($000)

ARRAY TYPE	1995	Forecast 1996	1997	1998	1999
Captive					
Subsystems	19.4	19.4	18.0	17.0	16.0
Boards	3.0	2.8	2.6	2.4	2.2
Software	4.7	4.1	3.5	3.0	2.7
Captive Average	17.5	17.6	16.4	15.7	15.0
PCM/Distributor					
Subsystems	15.4	18.9	17.0	15.5	14.5
Boards	1.1	1.1	.9	.9	.8
Software	.9	1.7	1.4	1.0	.9
PCM/Distributor Average	9.4	10.7	9.6	9.2	9.3
OEM/Integrator					
Subsystems	25.5	27.0	25.2	22.9	20.4
Boards	.9	.8	.5	.3	.2
Software	.1	.1	.1	.1	.1
OEM/Integrator Average	2.3	2.8	2.5	2.8	3.1

Note: Price per unit calculations represent estimated total sales revenues for each product type by the total yearly shipped quantity of all units of that type.

TABLE 21

NETWORKS/MIDRANGE SYSTEMS

SERVER ARRAY ATTACHMENT ANALYSIS
Percentage of Worldwide Shipments

ATTACHMENT	1995 Estimate Units (000)	1995 Estimate %	1999 Projection Units (000)	1999 Projection %
PERSONAL COMPUTER SERVERS				
Servers with primarily personal computers attached	290,016	54.1	945,770	66.5
WORKSTATION SERVERS				
Servers with primarily workstations attached	119,008	22.2	257,420	18.1
OTHER SERVERS				
Servers with primarily other terminal devices	127,050	23.7	219,020	15.4
Total	536,074	100.0	1,422,210	100.0

Notes: 1: Arrays are assigned to the server category indicated, based upon the predominant type of equipment attached to the associated server.

2: "Personal Computer" means IBM PC Compatible, Apple Macintosh or equivalent.

3: "Workstation" means Sun, Silicon Graphics or functional equivalent.

4: "Other" means POS terminals, dumb terminals, specialized equipment, and terminals not otherwize categorized.

TABLE 22

NETWORKS/MIDRANGE SYSTEMS

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1995 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
Mylex	--	89,400	--	89,400	45.3	--	128,400	--	128,400	43.6
Veritas	--	--	40,920	40,920	20.7	--	--	55,970	55,970	19.0
Symbios Logic	1,400	4,000	--	5,400	2.7	2,800	10,200	--	13,000	4.4
StreamLogic	14,800	--	--	14,800	7.5	21,500	--	--	21,500	7.4
Data General	5,600	--	--	5,600	2.8	9,800	--	--	9,800	3.3
Digital Equipment	4,800	--	--	4,800	2.4	8,200	--	--	8,200	2.8
Other U.S.	6,082	20,749	3,450	30,281	11.3	8,452	28,954	5,030	42,436	11.2
Other Non-U.S.	2,005	2,220	2,100	6,325	3.2	3,343	8,740	2,800	14,883	5.0
TOTAL	34,687	116,369	46,470	197,526	100.0	54,095	176,294	63,800	294,189	100.0

1996 DISK/TREND REPORT

ARRAYS: MAINFRAME SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Amdahl	Spectris
Cambex	Cascade 3X
Comparex	TETRAGON 2000
EMC	Symmetrix series
Encore Computer	Infinity SP30
Fujitsu	F6493
Hitachi	A-6591/A-6595
Hitachi Data Systems	7700, 7750
IBM	RAMAC series, Multiprise 2000
Macro Computer Products	Macro-RAID 7
Unisys	OSR 5000, USS 5100

All disk drive arrays intended primarily for use with mainframe computer systems, or physically integrated into the same housing as the mainframe computer, are included in this product group. Operating systems that include array functions, such as the ability to mirror individual disk volumes, are not included in this report or counted in the statistics. The earliest activity in the group was represented by the Control Data Systems shipments of its early RAID-3 disk drive array in 1989, now no longer available.

Complete subsystems are the only type of arrays which have been shipped in this product group. Mainframe users are not likely to constitute a market for board level arrays, nor have individual software array products been sold in significant quantities.

In the early 1990's, EMC's Symmetrix series of subsystems with RAID-1 mirrored disk capability became the dominant array product for the IBM mainframe plug compatible market, supplemented in mid-1993 with Hitachi Data Systems' 7600 subsystem with RAID-1 capability. In mid-1994, EMC increased the competitive pressure on IBM with RAID-1 Symmetrix models using Seagate's 9 gigabyte 5.25" drives at aggressive prices, and has kept up the pressure with a series of enhanced subsystems, including those with EMC's RAID-"S", which the firm claims offers advantages over conventional RAID-5.

After losing large segments of the mainframe disk storage market to competi-

tive arrays, IBM finally entered the field with a major array program in late September, 1994, under the recycled RAMAC brand name. The RAMAC I attached to the IBM 3990-6 controller, with a maximum capacity of 180 gigabytes, limiting the installation per controller to two RAMAC units, each with up to 64 3.5" drives with formatted capacities of 1.4 gigabytes. Despite the RAMAC controller capacity limitation, IBM maintained a high shipment rate through mid-1995, effectively replacing the 10.8" 3390 disk drive series in mainframe applications, and offering a lower price per megabyte combined with higher reliability. IBM doubled the disk capacity with RAMAC II, which started shipments in October, 1995, but the 3990-6 could still handle only 180 gigabytes, limiting each controller to only one RAMAC II frame of 64 drives. RAMAC III, scheduled for delivery in November, 1996, again doubles the capacity per disk drive and increases the capacity limit per array to a more realistic 726 gigabytes.

The most publicized sequence of events in the mainframe array field was Storage Technology's failure to deliver the pioneering Iceberg array on schedule. However, after a costly and embarrassing two year delay in initial shipments, Storage Technology's Iceberg array became a significant participant in the mainframe array market in 1994. In mid-1996, the company completed an agreement with IBM, under which IBM took over marketing and service for the Iceberg and STK's later mainframe arrays effective July 1, 1996, and Storage Technology withdrew from the mainframe array market.

IBM has also introduced a new variable in the mainframe disk array contest with the Multiprise 2000, a small mainframe family which incorporates RAID-1 disk storage in the same cabinet with the computer. The initial Multiprise 2000 models will offer up to 284 gigabytes per system, with shipments promised for the first quarter of 1997. Obviously, IBM's plug compatible competitors will find it difficult to compete against built-in disk arrays, and the company's future development of this product feature will undoubtedly depend on customer reaction.

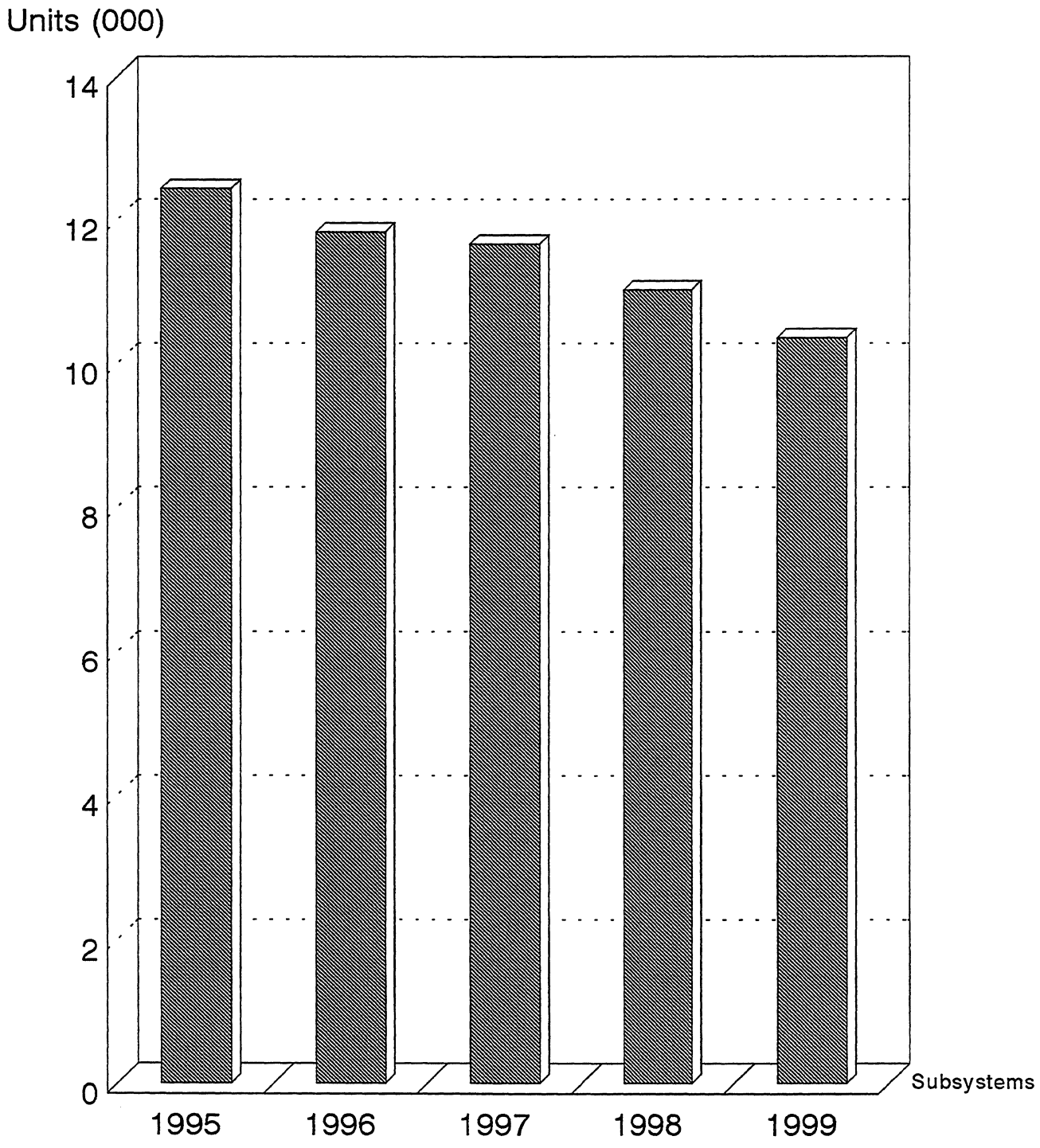
Market status

The 1994-95 transition of disk drive shipments into the mainframe computer market from traditional subsystems with individually addressable drives to subsystems with disk drive array capability has been substantially completed in

Figure 8

Mainframe System Arrays

Worldwide Shipments by Array Type



1996. It's been a difficult and costly change for some of the major mainframe disk drive suppliers, with expensive controller development and a continuing transition to higher capacity disk drives.

As disk drive capacities rapidly climb, the number of array subsystems has already started to decline. The market for mainframe disk storage is growing rapidly, but disk recording density is increasing even faster, resulting in shipment of less hardware. 1995 worldwide shipments of 12,427 mainframe array subsystems are expected to decline to 11,820 in 1996. However, total sales revenues are forecasted to increase slightly from $4.3 billion in 1995 to $4.5 billion in 1996, as disk drive array configurations displace the last of the nonarray disk subsystems.

Major changes are under way in 1996 in the PCM/Distributor sales channel for mainframe disk drive arrays. EMC's success with the Symmetrix series (initially providing RAID-0/1 and RAID-1 capability, later expanded with EMC's RAID "S") is the largest reason for the high PCM/Distributor revenue levels achieved by this product group, supplemented by Storage Technology's Iceberg starting in 1994, and Hitachi's sales of mainframe subsystems. PCM/Distributor sales revenues for 1995 were almost $2 billion, but the 1996 total is expected to decline slightly, depressed by IBM's midyear takeover of Storage Technology's mainframe disk drive array business. DISK/TREND shipment data credits Storage Technology, and the PCM/Distribution sales channel, for sales of the company's mainframe arrays through June, 1996. IBM's sales of the same products starting in July, 1996, are considered captive sales, with Storage Technology acting as a contract manufacturer. It should be noted that while many disk storage subsystems shipped to date by both EMC and Hitachi Data Systems have the capability to operate in RAID-1 mode and as nonarray disk subsystems, and are therefore included in DISK/TREND Report array totals, they are not necessarily continually operated as arrays by their purchasers.

As measured in disk drive array subsystems, EMC maintained a strong lead in 1995 noncaptive shipments for the mainframe market, which includes shipments in both the PCM/Distributor and OEM/Integrator sales channels. EMC held 54.8% of worldwide noncaptive unit shipments, a lead even stronger than it seems at first glance, since EMC's average sale was priced significantly higher than its competitors. Hitachi mainframe disk drive arrays, including those resold

by both Hitachi Data Systems and Comparex, placed second with 30.4%. Storage Technology was third with 14.5% of the worldwide total.

Marketing trends

Despite years of gloomy predictions on the outlook for the mainframe computer business by many who have never trusted a computer larger than they could carry, mainframes haven't gone away. In fact, the demand for mainframe disk storage capacity has entered a new growth phase in the 1990's, driven by growth in traditional applications, enhanced by data warehousing, worldwide networking and other new applications. Although much of the work previously accomplished by mainframe systems is now being diverted to "client/server" networks, the current market for new mainframe systems is strong and the new disk drive capacity consumed by this market, as measured in terabytes shipped, is higher than in recent years.

Although the amount of disk capacity to be shipped through 1999 is expected to sharply increase, unit shipments of disk drive mainframe array subsystems, as well as total sales revenues, are forecasted to gradually decline. Total unit shipments are projected to decline to 10,345 subsystems in 1999, an average annual decline during the 1996-99 period of 4.3%. Worldwide sales revenues are forecasted to drop to less than $3.7 billion in the same period, an average annual decline of 6.2%, due to rapid drops in disk drive price per megabyte.

Despite the decline expected for overall unit shipments, PCM/Distributor shipments of disk drive array subsystems are expected to maintain modest growth through 1999, as independent disk subsystem builders maintain full array product lines and continue to respond quickly to sales opportunities created by new applications. However, despite increasing unit shipments, the inevitable decline in disk drive prices will put a cap on increases in sales revenues, with slight declines expected through 1999.

Technical trends

IBM has dominated the mainframe computer system business for three decades. For the most part, add-on data storage peripherals in the mainframe market must exist within the limitations defined by IBM for channels, operating

systems, disk controllers and storage architecture. IBM's mainframes provide the principal PCM market, and many of today's competitive mainframe computers use storage devices compatible with IBM's own subsystems. Any changes made by IBM affect everything in the competitive product offerings.

Because of IBM's dominance in mainframe computer systems, other participants in the mainframe data storage business have been nervously awaiting the arrival of IBM's planned Seascape storage architecture -- which for the last few years has been rumored, preannounced, and delayed. Supposedly, Seascape will wipe out the barriers between mainframes and open systems, complete the transition to logical storage addressing, enhance the modularity of storage devices, and pave the way to new generations of higher performance drives. Apparently the delays have been caused by the complexity of the microcode development tasks and the need to fine-tune the final implementations for optimum performance.

Whatever the final timetable, Seascape or its derivatives will define the environment for which independent peripherals suppliers must develop storage subsystems, leaving many critical product development questions open until IBM gets its act together. Will storage resources be centrally managed, and how? How will storage typically be deployed between mainframes and other networks? What will be the interrelationship with data compression at the system level? How soon will existing types of disk controllers be replaced with something new? What will be the relationship to IBM's System Managed Storage programs? Plus numerous other issues dealing with physical interfaces, packaging, etc.

At this point, it remains unclear how the technology of mainframe storage will evolve during the next few years, but few expect it to remain unchanged. It is probably likely to follow familiar paths, however, during most of 1997. IBM has just started the RAMAC 3 cycle using 9 gigabyte drives, and has introduced a new mainframe computer family with disk storage embedded in the computer frame. The new element is not new technology, but a new way of packaging the disk storage. But by the end of 1997, many pressures could cause significant changes: IBM's RAMAC 3 will be a year old, approaching retirement age; IBM is expected to have 18 gigabyte 3.5" drives in production; *maybe* IBM will finally be ready to introduce all or part of its new storage architecture.

Forecasting assumptions

1. IBM will start to phase into new storage architecture for mainframe computers and open systems by the beginning of 1998, and will continue to introduce new disk drive array storage subsystems optimized for mainframe usage each year.

2. Manufacturers of PCM mainframe arrays will maintain aggressive product development and market introduction schedules, utilizing continually improved array architectures and higher disk drive capacities, on a timetable not significantly later than IBM's.

3. Total mainframe sales revenues and subsystem unit shipments will decline after 1996, due to slower growth in mainframe computer system shipments, combined with continuing increases in capacity per disk drive and rapidly falling disk drive price per megabyte.

TABLE 23

MAINFRAMES

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1995 Revenues		Forecast 1996		1997		1998		1999	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	1,402.8	2,062.2	1,512.3	2,309.9	1,403.4	2,159.7	1,223.4	1,912.7	1,050.3	1,666.6
PCM/Distributor	1,043.4	1,555.6	998.3	1,454.3	934.3	1,435.3	924.3	1,421.5	919.2	1,413.1
OEM/Integrator	86.1	172.2	99.2	198.4	96.9	184.8	88.8	163.5	79.5	141.8
TOTAL U.S. REVENUES	2,532.3	3,790.0	2,609.8	3,962.6	2,434.6	3,779.8	2,236.5	3,497.7	2,049.0	3,221.5
Non-U.S. Manufacturers										
Captive	--	65.7	--	69.2	--	63.3	--	55.0	--	45.4
PCM/Distributor	248.9	407.6	263.0	434.2	272.7	454.5	265.7	442.2	250.3	416.4
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. REVENUES	248.9	473.3	263.0	503.4	272.7	517.8	265.7	497.2	250.3	461.8
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	2,781.2	4,263.3	2,872.8	4,466.0	2,707.3	4,297.6	2,502.2	3,994.9	2,299.3	3,683.3

TABLE 24

MAINFRAMES

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1995 Shipments		Forecast							
			1996		1997		1998		1999	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	5,010	7,365	3,885	5,935	3,535	5,440	2,955	4,620	2,420	3,840
PCM/Distributor	1,907	2,865	2,035	2,990	2,005	3,080	2,045	3,145	2,075	3,190
OEM/Integrator	265	530	320	640	325	620	315	580	300	535
TOTAL U.S. SHIPMENTS	7,182	10,760	6,240	9,565	5,865	9,140	5,315	8,345	4,795	7,565
Non-U.S. Manufacturers										
Captive	--	185	--	280	--	265	--	240	--	210
PCM/Distributor	905	1,482	1,198	1,975	1,350	2,250	1,460	2,430	1,545	2,570
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	905	1,667	1,198	2,255	1,350	2,515	1,460	2,670	1,545	2,780
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	8,087	12,427	7,438	11,820	7,215	11,655	6,775	11,015	6,340	10,345
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	12	20	20	32	27	43	34	54	40	65

TABLE 25

MAINFRAMES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1995 Revenues Subsys.	Forecast --1996-- Subsys.	--1997-- Subsys.	--1998-- Subsys.	--1999-- Subsys.
U.S. MANUFACTURERS					
Captive	2,062.2	2,309.9	2,159.7	1,912.7	1,666.6
PCM/Distributor	1,555.6	1,454.3	1,435.3	1,421.5	1,413.1
OEM/Integrator	172.2	198.4	184.8	163.5	141.8
TOTAL U.S. REVENUES	3,790.0	3,962.6	3,779.8	3,497.7	3,221.5
NON-U.S. MANUFACTURERS					
Captive	65.7	69.2	63.3	55.0	45.4
PCM/Distributor	407.6	434.2	454.5	442.2	416.4
TOTAL NON-U.S. REVENUES	473.3	503.4	517.8	497.2	461.8
WORLDWIDE RECAP					
Captive	2,127.9 +688.1%	2,379.1 +11.8%	2,223.0 -6.6%	1,967.7 -11.5%	1,712.0 -13.0%
PCM/Distributor	1,963.2 +37.7%	1,888.5 -3.8%	1,889.8 --	1,863.7 -1.4%	1,829.5 -1.8%
OEM/Integrator	172.2 +9.3%	198.4 +15.2%	184.8 -6.9%	163.5 -11.5%	141.8 -13.3%
Total Revenues	4,263.3 +130.1%	4,466.0 +4.8%	4,297.6 -3.8%	3,994.9 -7.0%	3,683.3 -7.8%
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 26

MAINFRAMES

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1995 Shipments Subsys.	Forecast --1996-- Subsys.	--1997-- Subsys.	--1998-- Subsys.	--1999-- Subsys.
U.S. MANUFACTURERS					
Captive	7,365	5,935	5,440	4,620	3,840
PCM/Distributor	2,865	2,990	3,080	3,145	3,190
OEM/Integrator	530	640	620	580	535
TOTAL U.S. SHIPMENTS	10,760	9,565	9,140	8,345	7,565
NON-U.S. MANUFACTURERS					
Captive	185	280	265	240	210
PCM/Distributor	1,482	1,975	2,250	2,430	2,570
TOTAL NON-U.S. SHIPMENTS	1,667	2,255	2,515	2,670	2,780
WORLDWIDE RECAP					
Captive	7,550 +655.0%	6,215 -17.7%	5,705 -8.2%	4,860 -14.8%	4,050 -16.7%
PCM/Distributor	4,347 +44.5%	4,965 +14.2%	5,330 +7.4%	5,575 +4.6%	5,760 +3.3%
OEM/Integrator	530 -5.9%	640 +20.8%	620 -3.1%	580 -6.5%	535 -7.8%
Total Shipments	12,427 +171.9%	11,820 -4.9%	11,655 -1.4%	11,015 -5.5%	10,345 -6.1%
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 27

MAINFRAMES

WORLDWIDE PRICE PER UNIT ($000)

ARRAY TYPE		Forecast			
	1995	1996	1997	1998	1999
Captive					
Subsystems	281.8	382.7	389.6	404.8	422.6
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	281.8	382.7	389.6	404.8	422.6
PCM/Distributor					
Subsystems	451.6	380.3	354.5	334.3	317.6
Boards	--	--	--	--	--
Software	--	--	--	--	--
PCM/Distributor Average	451.6	380.3	354.5	334.3	317.6
OEM/Integrator					
Subsystems	325.0	310.0	298.0	282.0	265.0
Boards	--	--	--	--	--
Software	--	--	--	--	--
OEM/Integrator Average	325.0	310.0	298.0	282.0	265.0

Note: Price per unit calculations represent estimated total sales revenues for each product type by the total yearly shipped quantity of all units of that type.

TABLE 28

MAINFRAMES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1995 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
EMC	1,765	--	--	1,765	57.4	2,675	--	--	2,675	54.8
Hitachi Data Systems	905	--	--	905	29.4	1,482	--	--	1,482	30.4
Storage Technology	400	--	--	400	13.0	705	--	--	705	14.5
Other U.S.	7	--	--	7	.2	15	--	--	15	.3
Other Non-U.S.	--	--	--	--	--	--	--	--	--	--
TOTAL	3,077	--	--	3,077	100.0	4,877	--	--	4,877	100.0

ARRAYS: VERY HIGH PERFORMANCE SYSTEMS

1996 DISK/TREND REPORT

ARRAYS: VERY HIGH PERFORMANCE SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Ciprico	6500, 6900, 7000 series
Cray Research	DA-302, ND-30, ND-40
Encore Computer	Infinity 90ES
Fujitsu	K6490
Maximum Strategy	Gen 5XL, S-Series XL
Storage Concepts	C814F, C814U
Thinking Machines	CM-5

Although arrays offered for use with very high performance computer systems in the past have included both complete disk drive subsystems and individual board assemblies, all of the disk drive arrays now included in this product group are complete subsystems.

Until a few years ago, most of the arrays in this product group were RAID-3 complete subsystems, responding to the need of supercomputers and high-end imaging systems for very high sustained data transfer rates. However, a majority of the arrays now offered in this product group offer RAID-5 capability, usually in combination with other RAID modes.

The firm with the most impressive array specification is Thinking Machines, the massively parallel supercomputer manufacturer which pioneered the disk drive array configuration which became known as RAID-2. In late 1992, however, Thinking Machines replaced the old array with a new model -- a RAID-3 array initially introduced with the theoretical capability to attach 3,072 3.5" drives, for a total available capacity of 3.2 terabytes. The specification has since been reduced to a maximum of 250 drives.

In addition to the arrays offered by supercomputer manufacturers, independent array manufacturers offer RAID-3 and RAID-5 subsystems which are sold on a noncaptive basis to manufacturers of specialized very high performance systems used in a variety of high-end technical workstations, graphics and video applications, as well as to system integrators and to end users with similar requirements. With the advent of arrays designed to connect to hosts or to

networks with various new high performance interfaces, it will become increasingly difficult to group very high performance arrays into a separate product group in future years.

Market status

1995 total sales revenues for very high performance disk drive arrays were consistent with previous DISK/TREND forecasts, at $74.1 million, but the unit shipment total fell short of expectations, reflecting softening demand for supercomputers and their related disk storage subsystems. Worldwide unit shipments for 1995 consisted of 1,385 array subsystems, an increase of only 4.1%.

An inversion of 1995's revenue/unit shipment trend is occurring in 1996. While the supercomputer market for very high performance disk drive arrays remains soft, expanding demand for very fast disk storage subsystems in video, multimedia development and other imaging applications is creating new growth markets for completely different types of very high performance arrays. In 1996, the PCM/Distributor sales channel is the major beneficiary of this trend, with forecasted growth in unit shipments of 66.5%. As sales to a diverse group of expanding applications continues, 1996 noncaptive sales revenues are expected to account for 78.5% of the worldwide total, with noncaptive unit shipments equally strong, reaching 78.2% of the overall total.

Ciprico was again the leader in noncaptive shipments in 1995, with 72.5% of the worldwide unit total, composed entirely of subsystems. Maximum Strategy moved up to second place, with 19.2% of the total.

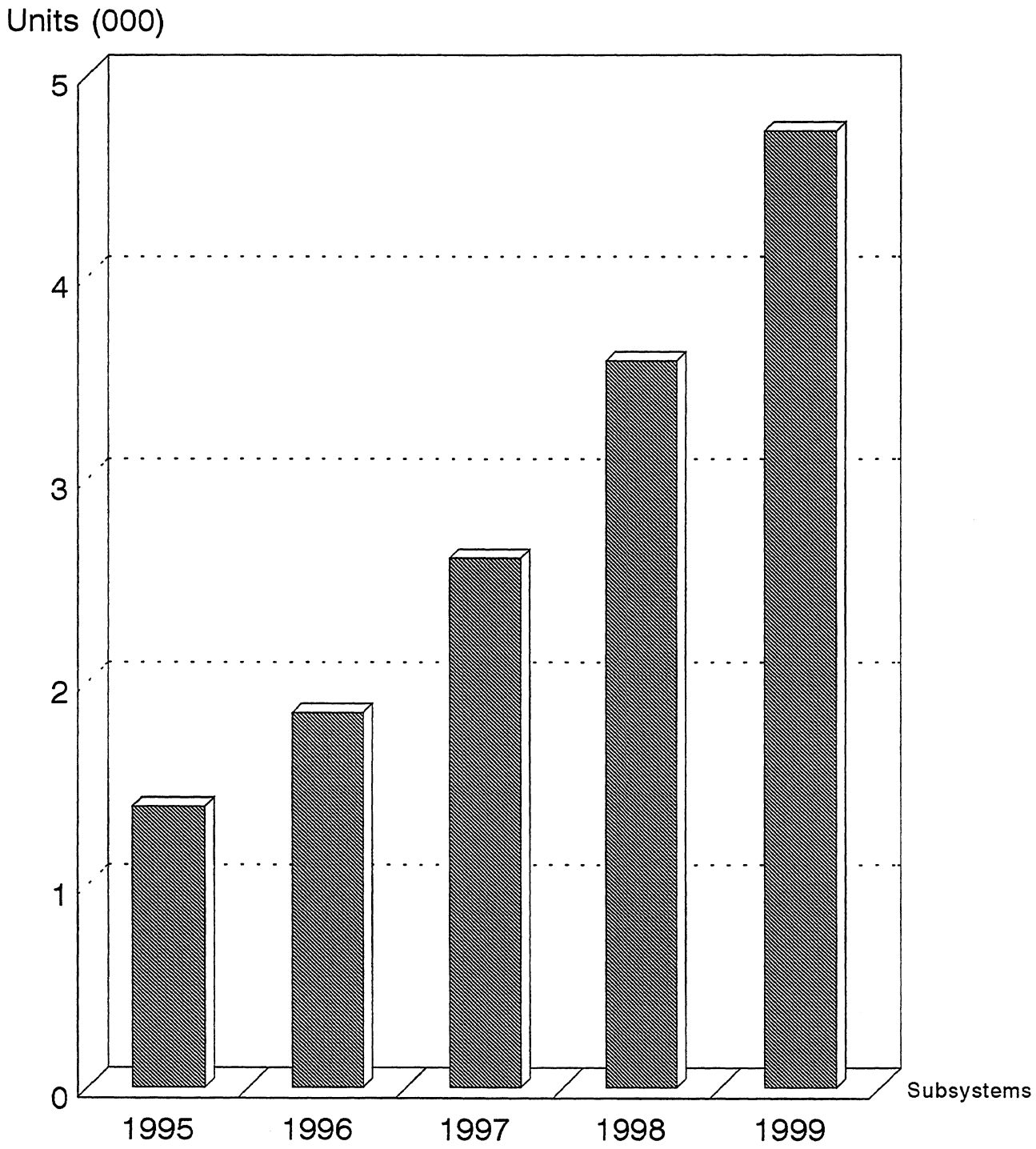
Marketing trends

The expansion of new high performance storage markets with imaging, video and multimedia applications is expected to create continued growth for this product group during the forecast period, despite weaker demand from the classic supercomputer market. Total sales revenues for very high performance disk drive arrays are projected to increase at an annual average of 24.5% during the 1997-99 period, and unit shipments are forecasted to grow at an annual average of 36.7% during the same period. However, despite an attractive growth trend, worldwide sales total for very high performance disk drive arrays are

Figure 9

Very High Performance System Arrays

Worldwide Shipments by Array Type



forecasted to reach only $153.7 million in 1999, a mere .7% of the overall revenues for all disk drive array product groups.

Due to the specialized nature of the applications for arrays in this product group, complete subsystems now provide all of the group's shipments, and only complete subsystems have been included in the current forecasts through 1999. Nevertheless, the technology utilized for both disk drives and interfaces may change the industry's product groups during the next few years, as data transfer rates rapidly increase. The high data rates available with future general purpose disk drive arrays available at lower cost will probably displace some of the specialized subsystems in this product group, but there is still uncertainty as to the timetables for general availability, product features and actual suitability for specific very high performance applications.

During the hectic development during the last few years of new storage markets in video and multimedia application, manufacturers of noncaptive subsystems have become the major source of very high performance disk drive arrays. Noncaptive arrays are forecasted to dominate both sales revenues and unit shipments in 1999. The $132 million projected for 1999 noncaptive sales revenues will be 95.8% of the overall total for the product group, and the forecasted 4,190 unit shipments provide 95.0% of the total.

Shipments in the PCM/Distributor channel are now expected to grow at a significantly faster rate than in the OEM/Integrator channel, as independent producers of very high performance disk drive array subsystems explore specialized array markets. In many applications, independent storage subsystem companies will be able to develop array markets more cost-effectively than very specialized system manufacturers with limited capabilities to develop appropriate storage subsystems. By 1999, PCM/Distributor shipments are expected to be 88.8% of the noncaptive unit shipment total.

Technical trends

In all segments of the disk drive array business, the objectives of product development programs usually involve higher performance, increased versatility and lower cost. It's no different with very high performance disk drive arrays. It is believed that most of the improvements in arrays used with very high perform-

ance systems through 1999 will involve gradual refinements made possible by improved components. Reduced count chip sets and semiconductors with higher data rates will help with both packaging, costs and performance. 3.5" disk drives with ever-higher capacities, improved performance and lower cost per megabyte will also provide gains in packaging, costs and performance. The versatility in operation desired by individual users is expected to be the result of clearer definition of actual requirements in the product group's several specialized applications, the natural result of growing field experience.

Supercomputer companies introduced high-end RAID-3 arrays in late 1992, driven by the need for storage subsystem architectures that can sustain high data transfer rates. For both traditional supercomputers and massively parallel computer applications, there is no question that transfer rate is the key requirement, and the ability of RAID-3 array configurations to meet that requirement was obvious.

For supercomputer and many other applications, however, there is enough demand for multimode arrays capable of operating in various combinations of RAID-0, RAID-1, RAID-3 and RAID-5 to justify products with these capabilities. Several manufacturers offer arrays which include RAID-5 capability and more are likely to follow. Although RAID-5 arrays in other product groups are usually designed for a balanced combination of fault tolerance, high transaction rates and data rates usable on personal computer and workstation networks, there is no reason why array designs cannot provide the higher transfer rates needed by very high performance systems.

Forecasting assumptions

1. RAID-3 implementations will remain the most frequently used type of array for very high performance systems, supplemented by growth for RAID-5 arrays with high data rates.

2. Traditional supercomputers will remain an application for arrays in this product group, but higher growth rates for massively parallel computers and video/image servers will dominate growth in shipments.

3. Complete array subsystems will continue to dominate shipments in this product group.

TABLE 29

VERY HIGH PERFORMANCE

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1995		Forecast							
	Revenues		1996		1997		1998		1999	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	11.0	23.2	7.4	15.9	5.4	12.0	3.7	8.2	2.5	5.6
PCM/Distributor	30.4	42.3	36.1	53.7	56.6	80.8	76.0	108.6	92.3	132.0
OEM/Integrator	6.4	6.9	7.6	9.1	8.5	11.2	10.5	13.8	11.4	15.3
TOTAL U.S. REVENUES	47.8	72.4	51.1	78.7	70.5	104.0	90.2	130.6	106.2	152.9
Non-U.S. Manufacturers										
Captive	--	1.7	--	1.3	--	1.1	--	.9	--	.8
PCM/Distributor	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. REVENUES	--	1.7	--	1.3	--	1.1	--	.9	--	.8
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	47.8	74.1	51.1	80.0	70.5	105.1	90.2	131.5	106.2	153.7

TABLE 30

VERY HIGH PERFORMANCE

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1995		Forecast							
	---Shipments---		------1996-----		------1997-----		------1998-----		------1999-----	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	208	447	177	380	145	323	120	265	97	217
PCM/Distributor	645	805	942	1,340	1,485	2,120	2,160	3,085	2,930	4,190
OEM/Integrator	90	105	82	105	110	145	160	210	220	295
TOTAL U.S. SHIPMENTS	943	1,357	1,201	1,825	1,740	2,588	2,440	3,560	3,247	4,702
Non-U.S. Manufacturers										
Captive	--	28	--	24	--	22	--	20	--	18
PCM/Distributor	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	--	28	--	24	--	22	--	20	--	18
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	943	1,385	1,201	1,849	1,740	2,610	2,440	3,580	3,247	4,720
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	2	3	3	5	5	7	7	11	11	16

TABLE 31

VERY HIGH PERFORMANCE

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1995 Revenues Subsys.	Forecast --1996-- Subsys.	--1997-- Subsys.	--1998-- Subsys.	--1999-- Subsys.
U.S. MANUFACTURERS					
Captive	23.2	15.9	12.0	8.2	5.6
PCM/Distributor	42.3	53.7	80.8	108.6	132.0
OEM/Integrator	6.9	9.1	11.2	13.8	15.3
TOTAL U.S. REVENUES	72.4	78.7	104.0	130.6	152.9
NON-U.S. MANUFACTURERS					
Captive	1.7	1.3	1.1	.9	.8
TOTAL NON-U.S. REVENUES	1.7	1.3	1.1	.9	.8
WORLDWIDE RECAP					
Captive	24.9 -13.5%	17.2 -30.9%	13.1 -23.8%	9.1 -30.5%	6.4 -29.7%
PCM/Distributor	42.3 +195.8%	53.7 +27.0%	80.8 +50.5%	108.6 +34.4%	132.0 +21.5%
OEM/Integrator	6.9 -25.8%	9.1 +31.9%	11.2 +23.1%	13.8 +23.2%	15.3 +10.9%
Total Revenues	74.1 +41.4%	80.0 +8.0%	105.1 +31.4%	131.5 +25.1%	153.7 +16.9%
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 32

VERY HIGH PERFORMANCE

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1995 Shipments Subsys.	Forecast --1996-- Subsys.	--1997-- Subsys.	--1998-- Subsys.	--1999-- Subsys.
U.S. MANUFACTURERS					
Captive	447	380	323	265	217
PCM/Distributor	805	1,340	2,120	3,085	4,190
OEM/Integrator	105	105	145	210	295
TOTAL U.S. SHIPMENTS	1,357	1,825	2,588	3,560	4,702
NON-U.S. MANUFACTURERS					
Captive	28	24	22	20	18
TOTAL NON-U.S. SHIPMENTS	28	24	22	20	18
WORLDWIDE RECAP					
Captive	475 -4.0%	404 -14.9%	345 -14.6%	285 -17.4%	235 -17.5%
PCM/Distributor	805 +45.0%	1,340 +66.5%	2,120 +58.2%	3,085 +45.5%	4,190 +35.8%
OEM/Integrator	105 -60.5%	105 --	145 +38.1%	210 +44.8%	295 +40.5%
Total Shipments	1,385 +5.2%	1,849 +33.5%	2,610 +41.2%	3,580 +37.2%	4,720 +31.8%
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 33

VERY HIGH PERFORMANCE

WORLDWIDE PRICE PER UNIT ($000)

ARRAY TYPE		Forecast			
	1995	1996	1997	1998	1999
Captive					
Subsystems	52.3	42.5	37.8	32.1	27.3
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	52.3	42.5	37.8	32.1	27.3
PCM/Distributor					
Subsystems	52.5	40.0	38.1	35.2	31.5
Boards	--	--	--	--	--
Software	--	--	--	--	--
PCM/Distributor Average	52.5	40.0	38.1	35.2	31.5
OEM/Integrator					
Subsystems	65.5	86.5	77.6	65.3	51.7
Boards	--	--	--	--	--
Software	--	--	--	--	--
OEM/Integrator Average	65.5	86.5	77.6	65.3	51.7

Note: Price per unit calculations represent estimated total sales revenues for each product type by the total yearly shipped quantity of all units of that type.

TABLE 34

VERY HIGH PERFORMANCE

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1995 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
Ciprico	550	--	--	550	74.8	660	--	--	660	72.5
Maximum Strategy	125	--	--	125	17.0	175	--	--	175	19.2
Other U.S.	60	--	--	60	8.2	75	--	--	75	8.3
Other Non-U.S.	--	--	--	--	--	--	--	--	--	--
TOTAL	735	--	--	735	100.0	910	--	--	910	100.0

1996 DISK/TREND REPORT

DISK DRIVE ARRAY SPECIFICATIONS

Coverage

This section includes most disk drive arrays produced by the original manufacturer of the array controller or software, which are now in new production or announced, arranged alphabetically by manufacturer. In a few cases, products are listed for which only preliminary announcements have been made because these are considered significant indicators of industry direction. Specifications are based upon data provided by manufacturers and are subject to change.

Also included, for identification purposes, are specifications on many array models purchased on an OEM basis from others or assembled with purchased controllers, software and other components, and resold by computer system manufacturers, storage subsystem manufacturers or distributors. Also included are many plug compatible arrays sold by major mainframe and midrange system PCM vendors, but which are manufactured by other firms. Not listed in some cases are captive arrays which are similar to OEM/Integrator models made by the same manufacturer.

Array type and implementation

Arrays are classified into three product types. Only products specifically intended to permit disk drives to operate as an array are included:

Subsystem: Complete array subsystems including disk drives.
Board: Controllers, or array subassemblies without drives.
Software: Implemented as program code executing in a host system.

Implementation is either software or hardware based.

Host platform and environment

The host platform is the equipment to which the array is capable of being attached. Environment refers to the operating systems and network software with which the array is compatible and supported. If the array will connect to any of a number of host systems offering a SCSI port, platform is indicated as "SCSI

host". Where the array can be connected to the large number of IBM PC compatible computers available, "PC compatible" is indicated.

RAID level

All Berkeley RAID levels supported by the array are given. If the manufacturer has used a non-Berkeley designation, it is indicated in quotes or in the comments. Most such designations refer to enhanced RAID-5 operation. Also shown is the manner in which the RAID mode is selected; by commands through the host interface channel, by an operator panel, through a separate control port, or by presetting at the factory. If RAID-10 is indicated, the array can operate in a composite combined mirrored and striped mode.

Array capacity

If multiple capacities are shown for minimum or maximum array capacity, they correspond to the listed RAID modes. The order in which they are given matches the order in which the RAID modes are listed. User available capacity for each mode is provided. If only single minimum or maximum capacities are shown, it is typically the available user capacity for the lowest RAID mode listed. Where a variety of drives are used, array capacity is shown as "Drive dependent".

Drives per array

The minimum and maximum number of drives available for user data in the array. Where indeterminate, as in the case of a software array, "--" is used.

Concurrent host channels

Where more than one channel between the host and the array is available, the standard number of channels and maximum number of channels is given.

Drive channels

Where multiple channels between the array controller and drives are available, the minimum and maximum number of channels is given.

Array interface to host and drives

Interfaces which may be used for connection of the array to the host, and between the array controller and the drives, respectively.

Cache size and function

If the array contains a cache, the minimum and maximum available sizes are given. Also indicated is whether the cache is used for read operations, write operations or both. If no cache is used, then these fields are designated by "--".

Redundancy

If the array offers dual controllers that address a common drive set or dual controllers that mirror drive sets, then the controller redundancy will be indicated by "Yes", "Optional", or "Duplexed", depending upon the manufacturer's offerings and array configuration.

If the array is equipped with multiple fans providing sufficient cooling capacity so that the array can continue operation if a fan fails, then fan redundancy is indicated as "Yes", or "Optional" if the additional fan is an option.

If the array is equipped with multiple power supplies and can continue operation if any power supply in the array fails, then power supply redundancy is indicated as "Yes", or "Optional" if the additional power supply is an option.

Spare drive

If the array has no capability to support a spare drive to replace a failed drive with the system in operation, then "None" is indicated. If no spare drive is provided, but a failed drive can be hot swapped, than "Manual" is indicated. If a spare drive is provided and it is automatically used by the system in the event of an array drive failure, then "Auto" is indicated.

Transfer rate

The data burst transfer rates between host and array controller, and between array controller and drives are given.

Drives

Where the manufacturer has indicated specific drives used in an array, the drive formatted capacity, average seek time, and average rotational latency are given. If a range of values is specified, the lowest and highest are given. An example for drive capacity, in megabytes: 2100-9100. Where manufacturers support a wide variety of drives, the drive parameters are given as "Drive dependent" and the drive models are identified as "Various".

Array size

Where appropriate, the dimensions of the array are given. If a variety of sizes is available, "Varies" is indicated. Where the array is packaged as part of a complete computer system or file server, system overall dimensions are used.

Power

Power required is given in watts or KVA. Also indicated is whether the array has internal power backup in the form of battery backup for the cache or an internal UPS for the array. If neither is present, then "None" is indicated.

Accuracy

All information in this section has been cross-checked for accuracy. However, it is anticipated that some errors may be included, since many manufacturers' published specifications do not cover all of the items listed, and numerous verbal inquiries have been required.

1996 DISK/TREND product groups for disk drive arrays

Product groups for the 1996 DISK/TREND Report on disk drive arrays include:

Single user system arrays

Networks/midrange system arrays

Mainframe system arrays

Very high performance system arrays

MANUFACTURER	1776, INC.	1776, INC.	1776, INC.	AC TECHNOLOGY	ACER
ARRAY MODEL	76SC34	76SC34A	76SC34H	Concorde	Altos 19000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Software Software	Software Software	Software Software	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible UNIX	PC compatible UNIX	PC compatible UNIX	Sun, RS/6000, HP, SGI, DEC	Acer NetWare, VINES, SCO UNIX
RAID level Configured by:	0/1/10* Host	0/1/10 Host	0/1/10* Host	0/3/5	0/1/5/10 Host
Array capacity (Gbytes) MIN MAX	NA Drive dependent	NA Drive dependent	NA Drive dependent	6 96	2/10/2/2 56/28/45/28
Minimum drives per array	2	2	2	3	2/3
Maximum drives per array	60	56	56	28	14
Concurrent host channels	1	2	1	1	1
Controller drive channels	4	4	4		1, 2
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	PCI
Drive interface	SCSI, SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	NA	NA	NA	32 RD/1 WR	4
Cache function (Read, Write)				Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Supported N/A N/A	Supported N/A N/A	Supported N/A N/A	Yes Yes Yes	-- -- Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	Host dependent Drive dependent	Host dependent Drive dependent	20 10	132 10/20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	4000	2100, 4000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	N/A	N/A	N/A	Varies	24.6 x 14 x 16
POWER: Power backup	N/A	N/A	N/A	300 watts Cache option	400 watts UPS optional
FIRST CUSTOMER SHIPMENT	1990	1993	1993	4Q93	1996
COMMENTS	*Multiple mirrored disks.	Supports second host system concurr. active Auto backup switching. Host load bal.	*Multiple mirrored disks. Supports second host system in idle mode.	CMD controller.	Complete server 1 or 2 processors. Mylex controll. Array is option

MANUFACTURER	ACER	ACER	ADAPTEC	ADAPTEC	ADAPTEC
ARRAY MODEL	Altos 900	Altos 9000	AHA-3980	AHA-3980W	AHA-3985
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	Acer NetWare, VINES, SCO UNIX	Acer NetWare, VINES, SCO UNIX	PC compatible NetWare	PC compatible NetWare	PC compatible NetWare
RAID level Configured by:	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host
Array capacity (Gbytes) MIN MAX	4 8	2/10/2/2 28/14/22/14	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2/3	2	2	2
Maximum drives per array	2	7	8	8	8
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1	2	2	3
Array interface to host	PCI	PCI	PCI	PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4	4	1	1	1
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)		-- -- No	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 10/20	132 10/20	133 10	133 20	133 10
DRIVES: Formatted capacity/drive(MB)	2100, 4000	2100, 4000	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D		23.2 x 7 x 23.2	4.2 x 12.28	4.2 x 12.28	4.2 x 12.28
POWER: Power backup	200 watts None	350 watts None			
FIRST CUSTOMER SHIPMENT	1996	1996	5/95	5/95	5/95
COMMENTS	Complete server Needs expansion cab. for RAID-5 Mylex controll. Array is option	Complete server Mylex controll. Array is option			

MANUFACTURER	ADAPTEC	ADAPTEC	ADS INTERNATIONAL	ADS INTERNATIONAL	ADS INTERNATIONAL
ARRAY MODEL	AHA-3985W	ARO-1130	ADS/1000	ADS/2000	ADS/3000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Subsystem Software	Board Hardware
Host platform, software environment	PC compatible NetWare	PCI host Windows, NT	PC compatible UNIX, NetWare, DOS	SCSI host UNIX	SCSI host
RAID level Configured by:	0/1/5/10 Host	0/1/5/10	0/1/4/5 Panel, Port	0/1 Host	0/3/5 Panel, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	3	2	3
Maximum drives per array	8	30	21	35	35
Concurrent host channels	1	1	1	--	1, 5
Controller drive channels	3	1-3	3, 5	--	1, 5
Array interface to host	PCI	PCI	EISA	SCSI-2	SCSI-2
Drive interface	SCSI-2	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1	1, 16	1, 16	--	2, 64
Cache function (Read, Write)	--	Read, Write	Read, Write	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	No Option Option	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	--	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	133 20	133 40	33 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	1000,2000,4000	1000,2000,4000	1000,2000,4000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Seagate Hawk	Seagate Hawk	Seagate Hawk
ARRAY SIZE: Inches: H x W x D	4.2 x 12.28	3.36 x 7.025	4.5 x 13	--	3.25 x 5.75 x 8
POWER: Power backup		--	None	-- None	26 watts None
FIRST CUSTOMER SHIPMENT	5/95	2Q96	1993	1993	1993
COMMENTS		Requires Adaptec RAID port connector on main board.	Array enclosure available.	Software array.	Array enclosure available. Purchased controller.

MANUFACTURER	ADS INTERNATIONAL	ADS INTERNATIONAL	ADVANCED LOGIC RESEARCH	ADVANCED LOGIC RESEARCH	ADVANCED LOGIC RESEARCH
ARRAY MODEL	ADS/4000	ADS/5000	Data Station-8	Quick Hot Swap	Revolution Series
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host	PC compatible UNIX, NetWare, OS/2	ALR NetWare, UNIX, NT, OS/2, other	ALR NetWare, UNIX, NT, OS/2, other	ALR/SMP Solaris, UNIX, NT, OS/2
RAID level Configured by:	0/1/3/5 Panel, Port	0/3/5 Panel, Port	0/1/5 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	3/1.5/2 72/36/50	3/1.5/2 12/6/8	3 72
Minimum drives per array	3	3	2/3	2/3	3
Maximum drives per array	35	35	8	6	6
Concurrent host channels	1, 5	1, 5	1	1	1
Controller drive channels	1, 5	1, 5	1, 3	1, 3	1
Array interface to host	SCSI-2	SCSI-2	PCI	EISA, PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2, 64	2, 64	4, 32	4, 32	
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	No Option Option	No Yes Yes	No Yes No	No -- Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	33, 132 10	33, 132 10	132 20
DRIVES: Formatted capacity/drive(MB)	1000,2000,4000	1000,2000,4000	1000-9100	1000, 2000	1000,2000,4000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	9	9	
Average rotational delay (msec)	Drive dependent	Drive dependent	5.6	5.6	
Drive models	Seagate Hawk	Seagate Hawk	Seagate	Seagate	Seagate
ARRAY SIZE: Inches: H x W x D	1.6 x 5.7 x 8.4	3.25 x 5.75 x 8.12	12.5 x 7.5 x 12.5	12.5 x 7.5 x 12.5	
POWER: Power backup	10 watts Battery option	300 watts None	85 watts None	85 watts None	650 watts
FIRST CUSTOMER SHIPMENT	1995	1993	10/96	12/94	2Q95
COMMENTS	Array enclosure available. Purchased controller.	Purchased controller.	Mylex controller. External module	Option for ALR system.	Complete server

MANUFACTURER	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS
ARRAY MODEL	AXRD-A360S AXRD-A720S	AXRD-M540A AXRD-M810A	AXRD-M540S AXRD-M810S	AXRS-D1080S	AXRS-D360S
DISK/TREND GROUP	Single User	Single User	Single User	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	PC host Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1/5 Jumper	0/1 Jumper	0/1 Jumper	0/1/5 Panel	0/1/5 Panel
Array capacity (Gbytes) MIN MAX	.720/1.08 1.44/2.16	.540 .810	.540 .810	1.08/2.16 3.24/5.4	.360/.720 1.08/1.8
Minimum drives per array	4	4	2	2	2
Maximum drives per array	4	4	2	6	6
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	1	1	2	2
Array interface to host	SCSI-2	IDE	SCSI-2	SCSI-2	SCSI-2
Drive interface	IDE	IDE	IDE	IDE	IDE
Cache size (min, max: MB)	.256	--	.256	2, 8	2, 8
Cache function (Read, Write)	Read, Write	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	None	None	None	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 8.3	8.3 8.3	10 8.3	10 8.3	10 8.3
DRIVES: Formatted capacity/drive(MB)	360-720	540-810	540-810	1080	360
Nominal disk diameter (mm)	65	65	65	95	95
Average positioning time (msec)	13	14	14	10.5	12
Average rotational delay (msec)	7.5	7.9	7.9	5.6	6.7
Drive models	IBM	IBM	IBM	IBM	IBM
ARRAY SIZE: Inches: H x W x D	1.625 x 4 x 5.75	1 x 4 x 5.75	1 x 4 x 5.75	11.6 x 7.1 x 15.75	11.6 x 7.1 x 15.75
POWER: Power backup	10 watts None	7.5 watts None	7.5 watts None	.1 KVA None	.1 KVA None
FIRST CUSTOMER SHIPMENT	10/94	4/94	7/94	10/94	7/94
COMMENTS					

MANUFACTURER	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TELECOMMUNICA-TIONS MODULES	AIWA CORE	AIWA CORE	AIWA CORE
ARRAY MODEL	AXRS-D720S	VS3200 VIRATA	ALA-200 ALA-400 Array 20000 COREarray 20000	AMA-50A COREarray Micro 2000	LightningArray
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	Captive,OEM,PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	ARM BASED ATMos TM	SCSI host NetWare, UNIX, OS/2, DOS, NT	SCSI host NetWare, UNIX, OS/2, DOS, NT	SCSI host NetWare, NT, OS/2, UNIX
RAID level Configured by:	0/1/5 Panel	3 Host	3/5 Host, Port	3/5 Host, Port	3/5
Array capacity (Gbytes) MIN MAX	.720/1.44 2.16/3.6	8 16	2 20	1 8	3 45
Minimum drives per array	2	5	3	3	3
Maximum drives per array	6	5	6	6	6
Concurrent host channels	1	5	2	1	2
Controller drive channels	2	5	6	5	6
Array interface to host	SCSI-2	32 bit bus(DMA)	SCSI-2	SCSI-2	SCSI-2
Drive interface	IDE	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2, 8	Configurable	2	2	8, 128
Cache function (Read, Write)	Read, Write	Configurable	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	Yes No Yes	No No Yes	No No No	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	None	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 8.3	 20	20 10	10 10	20 10
DRIVES: Formatted capacity/drive(MB)	720	2100-4200	1000,2000,4000	524, 1250	1000-9000
Nominal disk diameter (mm)	95	95	95	65	95
Average positioning time (msec)	12	9	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	6.7	4.17	Drive dependent	Drive dependent	Drive dependent
Drive models	IBM	Seagate	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	11.6 x 7.1 x 15.75	12 x 8 x 16	8 x 13.7 x 18	3.25 x 5.75 x 8	8 x 13.7 x 18
POWER: Power backup	.1 KVA None	170 watts None	144 watts None	 None	144 watts None
FIRST CUSTOMER SHIPMENT	7/94	3Q95	3Q94	3Q94	4Q95
COMMENTS				Expandable with up to 30 external drives	

MANUFACTURER	AIWA CORE	AIWA CORE	AIWA CORE	AMDAHL	AMDAHL
ARRAY MODEL	RAIDstack	RAIDstack/PCI	RAIDstack/SCSI	LVS 4500	Spectris
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Software	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host NetWare	PCI host NetWare,NT,OS/2 Wind., SCO UNIX	SCSI host NetWare, NT, OS/2, UNIX	Solaris, AIX, HP-UX, NT, NCRSVR4	IBM S/390 MVS/ESA, M/ESA, UTS
RAID level	3/5	0/1/3/5/10	3/5	0/1/3/5/10	3
Configured by:				Host	Preset
Array capacity (Gbytes) MIN	3	3	3	20	11.3
MAX	234	234	234	Multiple TB	726.4
Minimum drives per array	2	3	3	5	5
Maximum drives per array	8	30	30	90	80
Concurrent host channels	1	1	1	2-8	4, 8, 12, 16
Controller drive channels	1	2	2	2	2, 4
Array interface to host	SCSI-2	PCI	Ultra SCSI	Ult.SCSI,SCSI-2	ESCON, OEMI
Drive interface	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	Host dependent	8, 128	8, 128	32, 1024	512, 3072
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	Yes	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	132	40	80-320	20
drive (MB/Sec)	20	20	20	40	10
DRIVES: Formatted capacity/drive(MB)	1000-9000	1000-9000	1000-9000	4300	2825
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Varies	10.5
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent		5.6
Drive models	Various	Various	Various	Barracuda, Allegro-3	Fujitsu
ARRAY SIZE: Inches: H x W x D	20 x 14 x 12	20 x 14 x 12	21 x 14 x 12	72.9 x 26 x 45	70.9 x 86.8(max)x 29.5
POWER:	185	185	185		1.15 KVA
Power backup	None	None	None	Dual power	
FIRST CUSTOMER SHIPMENT	4Q95	4Q95	1Q96	4/96	12/95
COMMENTS	Rack mount option.		Rack mount option.		

MANUFACTURER	AMERICAN DIGITAL SYSTEMS	AMERICAN DIGITAL SYSTEMS	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS	ANDATACO
ARRAY MODEL	MasterDisk RAID	MasterDisk RPS	MR 418 MegaRAID	MRU 428 MegaRAID Ultra	ESP RAID Lite
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Board Hardware	Board Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	PC compatible NetWare, DOS,NT Wind.,OS/2,UNIX	PC compatible NetWare, DOS,NT Wind.,OS/2,UNIX	SCSI host UNIX, NT
RAID level Configured by:	0/1/3/5 Port, Panel	0/1/3/5 Port, Panel	0/1/3/5/10* Host	0/1/3/5/10* Host	0/1/3/5/10 Host, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	1.05 63.7	Drive dependent Drive dependent	Drive dependent Drive dependent	
Minimum drives per array	2	1	2	2	2
Maximum drives per array	28	7	45	45	14
Concurrent host channels	3	7	1	1	1
Controller drive channels	4	7	1, 3	1, 3	1
Array interface to host	Ultra SCSI, DEC	Ultra SCSI, DEC	PCI	PCI	SCSI-2
Drive interface	SCSI	SCSI	SCSI-2	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	32	0, 256	4, 128	4, 128	8, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes-optional Yes Yes	Yes-optional Yes Yes	-- -- --	-- -- --	Option (1/97) Yes Yes
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 20	Up to 40 20	132 20	132 40	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	2050-9100
Nominal disk diameter (mm)	Drive dependent	95	Drive dependent	Drive dependent	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4.17
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	5.25 x 19 x 25	5.25 x 19 x 25	4.2 x .5 x 12.3	4.2 x .5 x 12.3	22.43 x 17.2 x 25.53
POWER: Power backup	26 watts+drives None	12 watts+drives None	12 watts Battery option	12 watts Battery option	250 watts Cache battery
FIRST CUSTOMER SHIPMENT	3Q93	1/95	8/95	3/96	4Q96
COMMENTS	Mylex controller.	Mylex controller.	Uses Intel 960. *Also RAID 30 and RAID 50 modes. Flash Firmware.	Uses Intel 960. *Also RAID 30 and RAID 50 modes. Flash Firmware.	Mylex controller. Rack mount available.

MANUFACTURER	ANDATACO	ANDATACO	ANDATACO	ANTRONE RESEARCH	APPLE COMPUTER
ARRAY MODEL	GigaRAID/FT+	GigaRAID/FT	RAID Lite	AccuRAID	AppleRAID
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	Captive, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Software
Host platform, software environment	SCSI host UNIX, NT	SCSI host UNIX, NT	SCSI host UNIX, NT	SCSI host Various	Apple servers
RAID level	0/1/3/5/10	0/1/3/5/10	0/1/3/5/10	0/1/5	0/1
Configured by:	Host,Panel,Port	Host,Panel,Port	Host, Port	Host	Host
Array capacity (Gbytes) MIN	4	4	2.1		2
MAX	80	80	25.8	8.4	4-8
Minimum drives per array	2	2	2	2	2
Maximum drives per array	20	10	6	6	4
Concurrent host channels	1, 2	1, 2	1	1	1
Controller drive channels	5	5	1	6	2
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	EIDE	SCSI-2
Cache size (min, max: MB)	8, 64	8, 64	8, 32	4, 64	.5/1
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read
Redundancy: Controller (Yes/No)	Yes	Yes	Cold spare	--	No
Fan (Yes/No)	Yes	Yes	Yes	--	No
Power supply (Yes/No)	Yes	Yes	Yes	Option	No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10/20	10/20	10/20	10	10
drive (MB/Sec)	10/20	10/20	10/20		10
DRIVES: Formatted capacity/drive(MB)	2050-9100	2050-9100	2050-9100	1600	1000-4000
Nominal disk diameter (mm)	95	95	95, 130	95	95
Average positioning time (msec)	4.17	4.17	Drive dependent		11
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent		5.6/8.3
Drive models	Various	Various	Various		Various
ARRAY SIZE: Inches: H x W x D	24.8 x 14 x 30	24.8 x 10.5 x 30		16 x 7.5 x 18.5	N/A
POWER:	880 watts	880 watts	250 watts	300	N/A
Power backup	Battery	Battery	Cache battery		
FIRST CUSTOMER SHIPMENT	1996	1996	6/95	1Q96	4Q94
COMMENTS	Based on CLARiiON array.	Based on CLARiiON array.	Mylex controller. Expandable to 42 disks, 150.5 gigabytes.		Sold only with Apple servers.

MANUFACTURER	APPLE COMPUTER	APPLIED DIGITAL SYSTEMS	APPLIED DIGITAL SYSTEMS	ARCO ELECTRONICS	ARCO ELECTRONICS
ARRAY MODEL	DAC960PC Ultra DAC960PU	A 510-40	A 510-80	AC Mirror	AC1079MC
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Single User
MARKET	Captive	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Board	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Apple servers NT, UNIX, NetWare	SCSI host Various	SCSI host Various	PC compatible DOS, OS/2, NetWare,Windows	PC compatible DOS, OS/2, NetWare,Windows
RAID level Configured by:	0/1/3/5/10	0/3/5 Port	0/3/5 Port	1 Preset	1 Preset
Array capacity (Gbytes) MIN	Drive dependent			Drive dependent	Drive dependent
MAX	Drive dependent	4	8	Drive dependent	Drive dependent
Minimum drives per array	2	5	10	2	2
Maximum drives per array	8	5	10	4	2
Concurrent host channels	1, 2	1	1	1	1
Controller drive channels	4, 5	1	1, 2	2	1
Array interface to host	SCSI-3	SCSI-2	SCSI-2	PC AT	Micro Channel
Drive interface	SCSI-3	SCSI-2	SCSI-2	IDE	IDE
Cache size (min, max: MB)	4, 64	8	8	--	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	--	--
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	No	Yes	Yes	No	No
Power supply (Yes/No)	No	Yes	Yes	No	No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	10	10	1.4	1.4
drive (MB/Sec)	20	10	10	Drive dependent	Drive dependent
DRIVES: Formatted capacity/drive(MB)	Drive depend.*	2100, 4500	2100, 4500	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	65	65
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Seagate	Seagate	Various	Various
ARRAY SIZE: Inches: H x W x D		17.5 x 9.5 x 17	17.5 x 9.5 x 17	3.5 x 11.5	3.5 x 11.5
POWER: Power backup	Cache battery	Cache battery	Cache battery	6 watts+ drives None	6 watts+ drives None
FIRST CUSTOMER SHIPMENT		3Q94	3Q94	2Q95	10/92
COMMENTS	Sold only with Apple servers. *8 GB maximum; BIOS limited.				2 2.5" drives mount on card, or external drives.

MANUFACTURER	ARCO ELECTRONICS	ARTECON	ARTECON	ARTECON	ARTECON
ARRAY MODEL	DupliDisk	LynxArray LynxArray+	LynxRAID LynxTower	LynxRAID+ LynxTower+	LynxStak
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible DOS, OS/2,UNIX, NetWare,Windows	Sun,SGI,HP,PC, Macintosh, var.	Sun,SGI,IBM,HP, UNIX, NetWare, DOS, Apple	Sun,SGI,IBM,HP, UNIX, NetWare, DOS, Apple	Sun,SGI,HP,PC, Macintosh, var.
RAID level Configured by:	1 Preset	0/1/3/5/10 Host, Panel	0/1/3/5/10 Panel, Port	0/1/3/5/10 Panel, Port	0/1/3/5/10 Host, Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	4	35	14	14	7
Concurrent host channels	1	1, 2	1, 2	1, 2	1
Controller drive channels	2	1, 6	1, 2	1, 2	1, 2
Array interface to host	PCI,EISA,ISA,VL	Ultra SCSI	SCSI-2	Ultra SCSI	Ultra SCSI
Drive interface	EIDE	Ultra SCSI	SCSI-2	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	--	4, 64	64	4, 64	4, 64
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	Option Yes Yes	No Yes, per drive Yes, per drive	Option Yes, per drive Yes, per drive	Option Yes, per drive Yes, per drive
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	20/40 20/40	20/40 20/40	20/40 20/40	20/40 20/40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	2100,4300,9100	2100,4300,9100	2100,4300,9100	2100,4300,9100
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	5.6, 4.2	5.6, 4.2	5.6, 4.2	5.6, 4.2
Average rotational delay (msec)	Drive dependent	5.6, 4.2	5.6, 4.2	5.6, 4.2	5.6, 4.2
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	3.5 x 7.35	19.5 x 7 x 24	7 x 12 x 14*	7 x 12 x 14*	15.6 x 6.75 x 10.5
POWER: Power backup	6 watts+drives None	400 watts Cache battery	100 watts Battery	100 watts None	40 watts None
FIRST CUSTOMER SHIPMENT	8/96	1996	12/94	4Q96	1995
COMMENTS		Infortrend controller. Rack mount available. Dual AC.	*Also in rack mount. Infortrend.	*Also in rack mount. Infortrend.	Infortrend controller. Expandable to 14 drives.

MANUFACTURER	AST RESEARCH	AST RESEARCH	ATON SYSTEMES	ATON SYSTEMES	ATON SYSTEMES
ARRAY MODEL	Manhattan S	Manhattan P	Areka I-10S	Areka E-10F	Areka P-10F
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Single User	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	Captive, PCM	Captive,OEM,PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Board	Board	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Manhattan UNIX, NT, OS/2, NetWare	Manhattan UNIX, NT, OS/2, NetWare	PC: ISA DOS, Windows, Windows NT	PC: EISA, DOS, Windows, Windows NT	PC: PCI DOS, Windows, Windows NT,UNIX
RAID level	0/1/5	0/1/5	0/1/5/10	0/1/5/10	0/1/5/10
Configured by:	Host	Host	Host	Host	Host
Array capacity (Gbytes) MIN	2/1	1/.5	Drive dependent	Drive dependent	Drive dependent
MAX	16/8/12.8	8/4/6.4	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2/3	2/3	2	2	2
Maximum drives per array	6	6	7	7	7
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	2	1	1	1
Array interface to host	PCI	PCI	ISA	EISA	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	0	0	0
Cache function (Read, Write)	Read, Write	Read, Write	--	--	Read
Redundancy: Controller (Yes/No)	No	No	--	--	--
Fan (Yes/No)	No	No	--	--	--
Power supply (Yes/No)	Option	Option	--	--	--
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	132	132	6	33	133
drive (MB/Sec)	10	10	5	10	10
DRIVES: Formatted capacity/drive(MB)	2000, 4000	2000, 4000	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	24.9 x 8. 5 x 20.5	24.9 x 8.5 x 20.5	--	--	--
POWER:	300 watts	300 watts	10 watts	14 watts	10 watts
Power backup	None	None	--	--	--
FIRST CUSTOMER SHIPMENT	12/94	12/94	1993	1993	1995
COMMENTS					

MANUFACTURER	ATON SYSTEMES	ATTO TECHNOLOGY	ATTO TECHNOLOGY	ATTO TECHNOLOGY	AUSPEX SYSTEMS
ARRAY MODEL	Areka VDS	Express Mirror	Express Stripe	VantageRAID	NS 7000/150 NS 7000/151 NS 7000/152
DISK/TREND GROUP	Net/Midrange	Single User	Single User	Single User	Net/Midrange
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Software Software	Software Software	Software Software	Subsystem Hardware
Host platform, software environment	Various DOS, Windows, Windows NT	Macintosh	Macintosh	PC compatible Various	NFS (Sun)
RAID level Configured by:	0/1/5/10 Preset	1 Preset	0 Preset	0 Preset	0/1/10
Array capacity (Gbytes) MIN MAX	10 280	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	4 148
Minimum drives per array	2	2	2	2	2
Maximum drives per array	35	4	4	4	35
Concurrent host channels	1	1	1	1	1
Controller drive channels	5	--	--	1	6
Array interface to host	SCSI-2	SCSI	SCSI	PCI	VME
Drive interface	SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-3	SCSI-2
Cache size (min, max: MB)	0, 64	--	--	--	64, 512*
Cache function (Read, Write)	Read	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Option No No	No No No	-- -- --	No No No
Spare drive (None/Auto/Manual)	Auto	None	None	None	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	10 Drive dependent	10 Drive dependent	133	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4250
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	8-9
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4.17
Drive models	Various	Various	Various	Various	Seagate Barracuda 4
ARRAY SIZE: Inches: H x W x D	16.9 x 8.7 x 16.5	N/A	N/A	--	28.5 x 16 x 32.5**
POWER: Power backup	.45 KVA None	N/A	N/A	--	.36-.96 KVA Cache battery
FIRST CUSTOMER SHIPMENT	1994	1/92	11/92	4Q95	3Q94
COMMENTS		Requires ATTO Silicon Express controller. Can support 4 controllers.	Requires ATTO Silicon Express controller. Can support 4 controllers.	Requires ATTO PCI host adapter.	*Can share system cache. **Expandable. Complete server

MANUFACTURER	AUSPEX SYSTEMS	AUSPEX SYSTEMS	AUSPEX SYSTEMS	AVIV	AVIV
ARRAY MODEL	NS 7000/250 NS 7000/251 NS 7000/252	NS 7000/500 NS 7000/502 NS 7000/510 NS 7000/512	NS 7000/700 NS 7000/710 NS 7000/720	Eclipse	Spitfire
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	Captive, PCM	Captive, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	NFS (Sun)	NFS (Sun)	NFS (Sun)	SCSI host UNIX, NetWare, Windows NT	SCSI host UNIX, NetWare, Windows NT
RAID level Configured by:	0/1/10	0/1/10	0/1/10	0/1/0+1/3/5	0/1/0+1/3/5
Array capacity (Gbytes) MIN MAX	4 148	4 255	4 892	6.3 180.6	6.3 61.2
Minimum drives per array	2	2	2	3	3
Maximum drives per array	35	60	210	42	14
Concurrent host channels	1	1-3	1-5	2	1
Controller drive channels	6	10	6	6	2
Array interface to host	VME	VME	VME	SCSI	SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI	SCSI
Cache size (min, max: MB)	64, 512*	64, 1290***	64, 1290**	32	16
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No Yes*	No No Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10	10	10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	4250	4250	4250	2100, 4300	2100, 4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8-9	8-9	8-9	8-10	8-10
Average rotational delay (msec)	4.17	4.17	4.17	4.7-5.6	4.7-5.6
Drive models	Seagate Barracuda 4	Seagate Barracuda 4	Seagate Barracuda 4	Seagate	Seagate
ARRAY SIZE: Inches: H x W x D	28.5 x 16 x 32.5**	77 x 24 x 39.5**	77 x 24 x 39.5*		
POWER: Power backup	Cache battery	Cache battery	Cache battery	Cache BBU	Cache BBU
FIRST CUSTOMER SHIPMENT	3Q94	2Q95	3Q96	1/95	1/96
COMMENTS	*Can share system cache. **Expandable. Complete server	*Models 502,512 system cache. **Expandable. ***Can share system cache. Complete server	*Expandable. **Can share system cache. Complete server	Pedestal or rack.	Pedestal.

MANUFACTURER	BAYDEL LTD.	BAYDEL LTD.	BAYDEL LTD.	BAYDEL LTD.	BAYSTOR
ARRAY MODEL	MS3-150 Media Server	MS3-90 Media Server	O/ESR DAR3-xxx	O/ESR DAR5-xxx	TS 200 TwinStor
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Single User
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware
Host platform, software environment	SCSI host UNIX, NT, other	SCSI host UNIX, NT, other	SCSI host UNIX, NT, other	SCSI host UNIX, NT, other	PC compatible DOS, Windows, NT,NetWare,UNIX
RAID level Configured by:	3 Preset	3 Preset	3 Preset	3 Preset	1 Preset
Array capacity (Gbytes) MIN MAX	156	93	Drive dependent Drive dependent	Drive dependent Drive dependent	540 1080
Minimum drives per array	20 + 5 parity	12 + parity	4 + parity	4 + parity	2
Maximum drives per array					4
Concurrent host channels	5x1(5x2 option)	3x1(3x2 option)	1 (2 optional)	1 (2 optional)	1
Controller drive channels	5	5	5	5	2
Array interface to host	SCSI,SCSI-2,Ult	SCSI,SCSI-2,Ult	SCSI,SCSI-2,Ult	SCSI,SCSI-2,Ult	EIDE
Drive interface					EIDE
Cache size (min, max: MB)	80, 640	48, 384	16, 128	16, 128	None
Cache function (Read, Write)					--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Option Yes Yes	Option Yes Yes	No N/A N/A
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	5 x 10/20/40 5/10	3 x 10/20/40 5/10	10/20/40 5/10	10/20/40 5/10	16.6 16.6
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	540, 4000
Nominal disk diameter (mm)	130	130	95	130	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	5.6
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	10.5 x 19 x 27	10.5 x 19 x 27	7.5 x 19 x 26	10.5 x 19 x 27	2.75 x 5.5
POWER: Power backup	1750 watts Battery option	1050 watts Battery option	250 watts Battery option	350 watts Battery option	
FIRST CUSTOMER SHIPMENT	1996	1996	1992	1993	3Q96
COMMENTS			Rack, pedestal and tabletop options.	Rack, pedestal and tabletop options.	ISA plug in works with PCI/VL bus and EISA/ISA controllers.

MANUFACTURER	BAYSTOR	BOX HILL SYSTEMS	CAMBEX	CAMBEX	CAMBEX
ARRAY MODEL	TS 210 TwinStor	RAID Box 5300 Turbo	Cascade XE	Centurion 2000	Cascade 3X
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Board	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible DOS, Windows, NT,NetWare,UNIX	Sun, HP, other UNIX, Windows NT	IBM,Sun,HP,NCR, Sequent, Novell NT,MVS,VM,ESA	IBM, Sun, HP, NCR, Sequent, Novell, NT	IBM MVS, VM
RAID level	1	0/1/4/5	0/1	0/1/3/5/10	0/1
Configured by:	Preset	RS232 Port	Host	Host, Port	Host
Array capacity (Gbytes) MIN	540	4	51	17/17	68
MAX	1080	504	576	100/576	544/272
Minimum drives per array	2	2	6	5/5	8
Maximum drives per array	4	56	64	30/160	64
Concurrent host channels	1	4	4	2, 16	4
Controller drive channels	2		64	5, 40	4
Array interface to host	EIDE	SCSI-2	Parallel, ESCON	SCSI-2	ESCON, Parallel
Drive interface	EIDE	SCSI-2	SCSI	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	None	32, 256	32, 4096	16, 2048	8, 256
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	Option	Yes	Yes	Option
Fan (Yes/No)	N/A	Yes	Yes	Yes	Yes
Power supply (Yes/No)	N/A	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	None	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	16.6	15	4.5	40	4.5
drive (MB/Sec)	16.6	10	17	20	10
DRIVES: Formatted capacity/drive(MB)	540, 4000	2000-9000	4300, 9000	4300, 9000	8500
Nominal disk diameter (mm)	95	95	95	95	130
Average positioning time (msec)		Drive dependent	9	9	
Average rotational delay (msec)	5.6	Drive dependent	4	4	5.6
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	2.25 x 5.5	Varies	70 x 40 x 30	70 x 40 x 30	70.5 x 44 x 32
POWER: Power backup		450 watts None	1500 watts	1500 watts	1.6 KVA
FIRST CUSTOMER SHIPMENT	3Q96	1996	4/95	8/96	8/95
COMMENTS	External cable to cable inline adapter.				

MANUFACTURER	CHARISMAC ENGINEERING	CIPRICO	CIPRICO	CIPRICO	CIPRICO
ARRAY MODEL	Anubis RAID	AD6700 Spectra 6700	AD6710 Spectra 6710	6500 Series Spectra 6500	6900 Series Spectra 6900
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Very High Perf.	Very High Perf.
MARKET	OEM, PCM	OEM	OEM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Software Software	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Macintosh System 7	Various	Various	Various	Various
RAID level Configured by:	0/1 Host	3 Preset	3 Preset	3 Preset	3 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	5	9	9	9
Maximum drives per array	10	5	9	9	9
Concurrent host channels	1	1	1	1	1
Controller drive channels	1				
Array interface to host	Nubus, SCSI-2	SCSI-2	SCSI-2	Ultra SCSI	Ultra SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	IDE	Ultra SCSI
Cache size (min, max: MB)	--	N/A	N/A	N/A	N/A
Cache function (Read, Write)	--	N/A	N/A	N/A	N/A
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	No No Yes	No No Yes	No No No	No No Yes
Spare drive (None/Auto/Manual)	None	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	20 15	20 20	40 40	40 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	--	7 x 17 x 22	7 x 17 x 22	7 x 17 x 22	7 x 17 x 22
POWER: Power backup	-- --	200 watts --	300 watts --	300 watts --	300 watts --
FIRST CUSTOMER SHIPMENT	11/94	1Q93	1Q93	9/96	6/95
COMMENTS	Supports StreamLogic, ATTO, other.				

MANUFACTURER	CIPRICO	CLONE STAR SOFTWARE	CLONE STAR SOFTWARE	CMD TECHNOLOGY	CMD TECHNOLOGY
ARRAY MODEL	7000 Series Spectra 7000	ALTER EGO	REFLECT	CRD-5300	CRD-5400
DISK/TREND GROUP	Very High Perf.	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	PCM	PCM	OEM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Software Software	Software Software	Board Hardware	Board Hardware
Host platform, software environment	PCI, SGI Various	PC compatible MS-DOS	PC compatible MS-DOS, NetWare	SCSI host Various	SCSI host Various
RAID level Configured by:	3 Preset	1 Preset	1 Preset	0/1/4/5/10 Panel, Port	0/1/4/5/10 Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	9	2	2	2	2
Maximum drives per array	9	2	2	14	14
Concurrent host channels	1	1	1	1	1
Controller drive channels		--	--	2	2
Array interface to host	FC-AL	N/A	N/A	SCSI-2	SCSI-2
Drive interface	SCSI-2	N/A	N/A	SCSI-2	SCSI-2
Cache size (min, max: MB)	N/A	--	--	4, 64	4, 256
Cache function (Read, Write)	N/A	--	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	NA NA NA	NA NA NA	No -- --	-- -- --
Spare drive (None/Auto/Manual)	Manual	None	None	Auto	
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100	N/A N/A	N/A N/A	20 10, 20	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	7 x 17 x 22	N/A	N/A	.6 x 5.25 x 5.5	1.7 x 5.75 x 8.25
POWER: Power backup	300 watts --	N/A N/A	N/A N/A	10-15 watts Cache battery	75 watts
FIRST CUSTOMER SHIPMENT	9/96	1989	1988	4/95	
COMMENTS				MIPS R3300 RISC processor. 3.5" form factor.	

MANUFACTURER	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY	COMPAQ COMPUTER
ARRAY MODEL	CRD-5600	CSV-8050 TRIDENT	CSV-8150 TRIDENT	Daytona RAIDarray	ProLiant 1500
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	PCM	PCM	OEM, PCM	Captive
ARRAY CONFIGURATION: Type	Board Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware	Subsystem Hardware
Implementation	SCSI host Various	DEC VMS, OSF	DEC VMS, OSF	SCSI host Various	Compaq NT, NetWare, OS/2, SCO UNIX
RAID level	0/1/4/5/10	0/1	0/1	0/1/4/5/10	0/1/4/5
Configured by:	Panel	Port, Panel	Port, Panel	Panel, Port	Host
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4
MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	301*
Minimum drives per array	2			2	2
Maximum drives per array	120	42	42	6	7/14*
Concurrent host channels	1, 4	1	1, 2	1	1
Controller drive channels	1, 9	1, 6	1, 5	2	2
Array interface to host	SCSI-2	CI, FDDI	CI, DSSI, FDDI	SCSI-2	EISA, PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Ult.SCSI,SCSI-2
Cache size (min, max: MB)	128, 512	0, 512	0, 512	4, 64	4**
Cache function (Read, Write)		Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	--	Yes (option)	Yes (option)	No	With duplexing
Fan (Yes/No)	--	Yes	Yes	Yes	No
Power supply (Yes/No)	--	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)		Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10/20	10	10	20	33/133
drive (MB/Sec)	10/20	10	10	10, 20	20/40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	2100-4300
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	9.5
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4.7
Drive models	Various	Various	Various	Various	Seagate, IBM
ARRAY SIZE: Inches: H x W x D	3.25 x 5.75 x 8.1	5.2 x 19 x 24.5	5.2 x 19 x 24.5	13.25 x 6.75 x 16.5	25.8 x 8.75 x 22.4
POWER:	40 watts	100 watts	100 watts	402.5	445 watts
Power backup		Battery	Battery	Battery	Cache battery
FIRST CUSTOMER SHIPMENT		4Q94	4Q94	9/96	1Q96
COMMENTS		FDDI requires CSV-8160 option	FDDI requires CSV-8160 option	Desktop self-contained RAID enclosure solution with CRD-5300.	*With optional storage subsys. **Mirrored cache. Ultra SCSI available 1Q97.

ASPEC-25

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAREX
ARRAY MODEL	ProLiant 5000	ProSignia 300	ProSignia 500	SMART-2	TETRAGON 2000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Mainframe
MARKET	Captive	Captive	Captive	Captive	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware	Subsystem Hardware
Host platform, software environment	Compaq NT, NetWare, OS/2, SCO UNIX	Compaq NT, NetWare, OS/2, SCO UNIX	Compaq NT, NetWare, OS/2, SCO UNIX	Compaq NT, NetWare, OS/2, SCO UNIX	HDS/IBM mainframe MVS, VS, VSE
RAID level Configured by:	0/1/4/5 Host	0/1/4/5 Host	0/1/4/5 Host	0/1/4/5 Host	5 Preset
Array capacity (Gbytes) MIN MAX	4 361*	4 150*	4 240*	Drive dependent Drive dependent	22.7 723.7
Minimum drives per array	2	2	2	2	7*
Maximum drives per array	7/14*	7/14*	7/14*	7/14*	224*
Concurrent host channels	1	1	1	1	8, 16
Controller drive channels	2	2	2	2	1-32
Array interface to host	EISA, PCI	EISA, PCI	EISA, PCI	EISA, PCI	IBM
Drive interface	Ult.SCSI,SCSI-2	Ult.SCSI,SCSI-2	Ult.SCSI,SCSI-2	Ult.SCSI,SCSI-2	SCSI-2
Cache size (min, max: MB)	4**	4**	4**	4**	256, 8192
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write**
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	With duplexing No Yes	With duplexing No Yes	With duplexing No Yes	-- -- --	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33/133 20/40	33/133 20/40	33/133 20/40	33/133 20/40	17 20
DRIVES: Formatted capacity/drive(MB)	2100-4300	2100-4300	2100-4300	2100-4300	4360
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5	9.5	9.5	9.5	11.5
Average rotational delay (msec)	4.7	4.7	4.7	4.7	4.7
Drive models	Seagate, IBM	Seagate, IBM	Seagate, IBM	Seagate, IBM	Hitachi
ARRAY SIZE: Inches: H x W x D	25.8 x 8.75 x 22.4	21.9 x 8.96 x 17.25	21.9 x 8.96 x 17.25	3.9 x 13.75 x .6	70.5 x 51.2 x 31.5
POWER: Power backup	445 watts Cache battery	200 watts Cache battery	240 watts Cache battery	13.5watts+drves Cache battery	2.2 KVA Battery
FIRST CUSTOMER SHIPMENT	1Q96	1Q96	1Q96	1Q96	5/95
COMMENTS	*With optional storage subsys. **Mirrored cache. Ultra SCSI available 1Q97.	*With optional storage subsys. **Mirrored cache. Ultra SCSI available 1Q97.	*With optional storage subsys. **Mirrored cache. Ultra SCSI available 1Q97.	*With optional storage subsys. **Mirrored cache. Ultra SCSI available 1Q97.	*Plus hot spares. **Duplexed cache.

MANUFACTURER	COMPUTER MARKETPLACE	CONCURRENT COMPUTER	CONLEY	CONLEY	CONLEY
ARRAY MODEL	Acceleraider	SCSI DEXS	SHA-400 SHA-450 With SoftRAID	SoftRAID	SR-40
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	Captive	PCM	OEM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Software Software	Board Software	Software Software	Subsystem Hardware
Host platform, software environment	SCSI host Various	MAXION MAX/OS Solaris	Macintosh, Power PC, Quadra	Macintosh,Power PC, Quadra	Sun, Mac, HP, AS/6000, NT
RAID level Configured by:	0/3/5 Panel, Port	0/1	0/1	0/1	0/1/3/5/10 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	20 260
Minimum drives per array	2	2	2	2	3
Maximum drives per array	7	4	12	12	30
Concurrent host channels	1	--	2	1	2
Controller drive channels	1	--	--		6
Array interface to host	SCSI-2	N/A	SCSI-2	--	SCSI
Drive interface	SCSI-2	SCSI	SCSI-2	--	Ultra SCSI
Cache size (min, max: MB)	0, 64	--	--	--	32-128
Cache function (Read, Write)	Read, Write	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	N/A N/A N/A	NA NA NA	NA NA NA	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10, 20 10	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	20-40 20-40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	2000-9000
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	Drive dependent	95, 140
Average positioning time (msec)	Drive dependent	Drive dependent	--	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	--	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Seagate
ARRAY SIZE: Inches: H x W x D		--	NA	N/A	28 x 9 x 22
POWER: Power backup		-- --	NA	N/A	350 watts
FIRST CUSTOMER SHIPMENT	1994	4Q94	1994	11/93	8/96
COMMENTS		Supports concurrent mirroring, striping and dual porting.	SoftRAID is software option compatible with Conley accelerator cards.		

MANUFACTURER	CONLEY	COREL	CRAY RESEARCH	CRAY RESEARCH	CRAY RESEARCH
ARRAY MODEL	SR-50	Network Manager	DA-302	ND-30	ND-40
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Very High Perf.	Very High Perf.	Very High Perf.
MARKET	PCM	OEM, PCM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Software Software	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Sun, Mac, HP, AS/6000, NT	PC compatible NetWare 3.1X, NetWare 4.X	Cray Unicos	Cray Unicos	Cray Unicos
RAID level Configured by:	0/1/3/5/10 Host	4/5 Host	3 Host	1/5 Console	1/5 Console
Array capacity (Gbytes) MIN MAX	20 260	Drive dependent Drive dependent	7.2 57.6	30.1 68.8	85 376
Minimum drives per array	3	3	5	8	24
Maximum drives per array	30	16	40	16	96
Concurrent host channels	7	1	1	2	4
Controller drive channels	6	Cont. dependent			
Array interface to host	Ult. SCSI,FC-AL	SCSI-2	Proprietary	IPI-3 (HIPPI)	IPI-3 (HIPPI)
Drive interface	Ultra SCSI	SCSI-2	IPI-2	SCSI	SCSI
Cache size (min, max: MB)	32-256	--	--	20	20
Cache function (Read, Write)	Read, Write	--	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	-- -- --	No Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40-100	10/20 10/20	36 8.2	3.5-7.6	Up to 160 3.5-7.6
DRIVES: Formatted capacity/drive(MB)	2000-9000	Drive dependent	1800	4300	4300
Nominal disk diameter (mm)	95, 140	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	11	8 RD/9 WR	8 RD/9 WR
Average rotational delay (msec)	Drive dependent	Drive dependent	5.56	4.17	4.17
Drive models	Seagate	Various	IBM	Seagate Barracuda 4	Seagate Barracuda 4
ARRAY SIZE: Inches: H x W x D	28 x 9 x 22	-- --			36.5 x 29.5 x 72
POWER: Power backup	350 watts	-- --	167 watts/drive None		Up to 4.85 KVA Int. UPS
FIRST CUSTOMER SHIPMENT	9/96	1Q94*	3/95	6/95	12/94
COMMENTS		*Shipped as Corel RAID in 3Q93.	DCA-3 channel adapter controls up to 8 DA-302 array groups.		

MANUFACTURER	CUBIX	CYBERDATA SYSTEMS	CYBERSTORAGE SYSTEMS	CYBERSTORAGE SYSTEMS	CYBERSTORAGE SYSTEMS
ARRAY MODEL	SafeStor/FT II	CyberRAID	CyberStorage 5000	CyberStorage 2001	CyberStorage NFS
DISK/TREND GROUP	Net/Midrange	Single User	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Software	Hardware	Hardware	Hardware
Host platform, software environment	Cubix, other OS/2, NetWare, NT	Macintosh	SCSI host	SCSI host	SCSI host
RAID level	0/1/5	0/1	3	0/1/0+1/4/5+	0/1/0+1/4/5+
Configured by:	Host	Host	On board GUI	Host GUI panel	Host GUI panel
Array capacity (Gbytes) MIN		4/2	20	20	6
MAX	25.2	8/4	675	252	28
Minimum drives per array	2/3	2	5	5	3
Maximum drives per array	12	2	75	28	78
Concurrent host channels	1-6	1	1-2	1-4	1
Controller drive channels	*	1	5	5-8	2
Array interface to host	*	PCI, NuBus	Ultra SCSI	SCSI-2	Dir net attach
Drive interface	SCSI-2	SCSI-2	Ultra SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	*	--	16-272	8-512	4-256
Cache function (Read, Write)	Read, Write	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	Optional	No
Fan (Yes/No)	Yes	No	Yes	Yes	Yes
Power supply (Yes/No)	Yes	No	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Manual*	None	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)		133	40	20	Network depend
drive (MB/Sec)	10, 20	20	40	20	20
DRIVES: Formatted capacity/drive(MB)	1100-4200	2000, 4000	4000, 9000	4000, 9000	4000
Nominal disk diameter (mm)	95	95	95, 130	95, 130	95
Average positioning time (msec)	8.5-9	5 (Read)	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17-5.56	4.17	Drive dependent	Drive dependent	Drive dependent
Drive models	Seagate		Various	Various	Various
ARRAY SIZE: Inches: H x W x D	8.75 x 19 x 18			19 x 15.75 x 30	19 x 7 x 15.75
POWER:	153 watts	65 watts	300/400 watts	300 watts	300 watts
Power backup	None	None			
FIRST CUSTOMER SHIPMENT	3Q95	1996	4Q96	4Q96	3Q96
COMMENTS	Purchased controller. *Controller dependent. Dual AC.			CMD controller.	CMD controller.

MANUFACTURER	CYBERSTORAGE SYSTEMS	CYBERSTORAGE SYSTEMS	CYBERSTORAGE SYSTEMS	CYBERSTORAGE SYSTEMS	CYRANEX
ARRAY MODEL	CyberStorage 1500	CyberStorage 9000	CyberStorage 900	CyberStorage MultiStor W	EZRAID Lite Version 2.01
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Single User
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Software Software
Host platform, software environment	SCSI host	SCSI host	SCSI host	SCSI host	PC compatible OS/2
RAID level Configured by:	0/1/0+1/4/5+ Host GUI panel	0/1/3/5/10 On board GUI	0/1/0+1/5 Host	0/1/0+1/5 Host, Panel	0/1 Host
Array capacity (Gbytes) MIN MAX	6 126	36 1200	4 32	12 90	Drive dependent Drive dependent
Minimum drives per array	3	9	2	2	2
Maximum drives per array	14	135	8	14	2
Concurrent host channels	1	1-2	1	1	1
Controller drive channels	2	9	3	2	1
Array interface to host	SCSI-2	Ultra SCSI	PCI	SCSI-2	Various
Drive interface	SCSI-2	Ultra SCSI	Ultra SCSI	SCSI-2	Various
Cache size (min, max: MB)	4-256	16-272	4-128	4, 32	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 20	40 40	132 40	20 20	Host dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	4000, 9000	4000, 9000	2000, 4000	4000, 9000	Drive dependent
Nominal disk diameter (mm)	95, 130	95, 130	95	95, 130	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	19 x 7 x 15.75				--
POWER: Power backup	300 watts	350/400 watts	300 watts	300 watts	-- -
FIRST CUSTOMER SHIPMENT	5/96	1Q97	7/96	3/95	1994
COMMENTS	CMD controller.		AMI controller.	Mylex controller.	

MANUFACTURER	CYRANEX	DALLAS DIGITAL	DATA GENERAL	DATA GENERAL	DATA GENERAL
ARRAY MODEL	EZRAID Pro Version 2.01	RAIDstor	1100 CLARiiON	1300 CLARiiON	150 CLARiiON
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM	OEM	OEM
ARRAY CONFIGURATION: Type Implementation	Software Software	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible OS/2	SCSI host Various	Sun,AViiON,DG, Eclips.,RS/6000 AS/400,OS/2,Net	Sun,AViiON,DG, Eclips.,RS/6000 AS/400,OS/2,Net	SCSI host UNIX, NetWare, NT, OS/2
RAID level Configured by:	0/1/4/5 Host	0/1/3/5 Panel, Port	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	3 112	6 88	11 88	6 62
Minimum drives per array	2	3	3	5	3
Maximum drives per array	7 per control.	28	10	10	7
Concurrent host channels	1	3	1, 2	1, 2	1
Controller drive channels	1	7	2	2	2
Array interface to host	Various	SCSI-2/3	SCSI-2	SCSI-2	SCSI-2
Drive interface	Various	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.03-2*	32	8, 16, 32, 64	8, 16, 32, 64	8, 32
Cache function (Read, Write)	Read, Write	Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	14 20	20, 40 20	20/40 20	20 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	4300	2100,4200,8800	2100,4200,8800	2100,4200,8800
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	9	8.5-9.4	8.5-9.4	7.8-11.2
Average rotational delay (msec)	Drive dependent	5.5	4.17	4.17	5.6, 4.17
Drive models	Various	Seagate	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	--	10.5 x 19 x 17*	24.8 x 10.5 x 30	24.8 x 10.5 x 30	19.5 x 7 x 19
POWER: Power backup	-- --	 UPS option	575 watts Battery	575 watts Battery	300 watts Battery
FIRST CUSTOMER SHIPMENT	11/94	4/94	1/94	3/94	6/95
COMMENTS	*In driver.	*Customized configuration.	Concurrent RAID levels, mirrored cache, GUI management tool.	Concurrent RAID levels, mirrored cache, GUI management tool.	Concurrent RAID levels, mirrored cache, GUI management tool.

MANUFACTURER	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA STORAGE MARKETING
ARRAY MODEL	155 CLARiiON	2800 CLARiiON	2900 CLARiiON	3100 3200 CLARiiON	Datastor RAID
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host UNIX, NetWare, NT, OS/2	Sun,AViiON,DG, Eclips.,RS/6000 AS/400,OS/2,Net	Sun,AViiON,DG, Eclips.,RS/6000 AS/400,OS/2,Net	Sun,AViiON,DG, Eclipse,RS/6000 other	SCSI host Various
RAID level	0/1/3/5/10	0/1/3/5/10	0/1/3/5/10	0/1/3/5/10	0/1/0+1/4/5
Configured by:	Host, Port	Host, Port	Host, Port	Host, Port	Host
Array capacity (Gbytes) MIN	6	3	21		Drive dependent
MAX	62	76	176	264	Drive dependent
Minimum drives per array	3	3	5	5	5
Maximum drives per array	7	20	20	30	44
Concurrent host channels	1	1, 2	1, 2	1, 2	1, 3
Controller drive channels	2	5	5	5	5-8
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2, FC-AL	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 32	8,16,32,64,128	8,16,32,64,128	8-256	8, 256
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Write
Redundancy: Controller (Yes/No)	No	Yes	Yes	Yes	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	20/40	20/40	20/40/100/200	10, 20
drive (MB/Sec)	20	50	50	50	Drive dependent
DRIVES: Formatted capacity/drive(MB)	2100,4200,8800	2100,4200,8800	2100,4200,8800	2100,4200,8800	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	Drive dependent
Average positioning time (msec)	7.8-11.2	8.5-9.4	8.5-9.4	8.5-9.4	Drive dependent
Average rotational delay (msec)	5.6, 4.17	4.17	4.17	4.17	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	7 x 17.5 x 16.5	24.8 x 14 x 30	24.8 x 14 x 30	18.4 x 19 x 30	Varies
POWER:	300 watts	880 watts	880 watts	1150 watts	
Power backup	Battery	Battery	Battery	Battery option	Cache battery
FIRST CUSTOMER SHIPMENT	10/95	6/92	3/94	11/96	9/93
COMMENTS	Concurrent RAID levels, mirrored cache, GUI management tool.	Concurrent RAID levels, mirrored cache, GUI management tool.	Concurrent RAID levels, mirrored cache, GUI management tool.	Concurrent RAID levels, mirrored cache, GUI management tool.	CMD CRD-5500 controller.

MANUFACTURER	DATA TECHNOLOGY CORPORATION	DATALINK	DATALINK	DELL COMPUTER	DELL COMPUTER
ARRAY MODEL	Hard Copy	RS 620	RS 660	4100 PowerEdge	4100 PERC PowerEdge
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible DOS, Windows, NT, OS/2, other	SCSI host UNIX, Novell, NT	SCSI host UNIX, Novell, NT	Dell NetWare, NT	Dell NetWare, NT
RAID level Configured by:	1 Preset	0/1/5/10 Port	0/1/5/10 Port	0/1/5/10* Host	0/1/5/10* Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	4 127	4 870	4 54.6	4 146
Minimum drives per array	2	3	3	2	2
Maximum drives per array	4	14	96	6	16
Concurrent host channels	1	1, 1	1	1	1
Controller drive channels	2	2, 2	6, 6	2	2
Array interface to host	ISA	SCSI-2	SCSI-2	PCI	PCI
Drive interface	EIDE	SCSI-2	SCSI-2	SCSI-3	SCSI-3
Cache size (min, max: MB)	--	16, 16	32, 256	4, 32	4, 32
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No Yes Yes	Yes Yes Yes	Duplex Yes Option	Duplex Yes Option
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	20 10	20 10	132 40	132 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	2000,4000,9000	2000,4000,9000	2100-9100	2100-9100
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	8	8	9	9
Average rotational delay (msec)	Drive dependent	4.17	4.17	4.17	4.17
Drive models	Various	Quantum, Seagate	Quantum, Seagate	Seagate, Western Digital	Seagate, Western Digital
ARRAY SIZE: Inches: H x W x D	4.5 x 7.645 x 45	21 x 10 x 21	34 x 19 x 21	Varies	Varies
POWER: Power backup	5.5watts+drives None	.75 KVA AC Battery (cache)	1.5 KVA AC Battery (cache)	Host dependent Cache battery	Host dependent Cache battery
FIRST CUSTOMER SHIPMENT	2/96	--	--	4Q96	4Q96
COMMENTS		DEC StorageWorks.	DEC StorageWorks.	AMI controller. *Also RAID 30 and RAID 50 modes.	AMI controller. *Also RAID 30 and RAID 50 modes.

MANUFACTURER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER	DIGI-DATA
ARRAY MODEL	DSA	SP 166-2 PowerEdge	XE 5166-2 PowerEdge	XL 5133-4 PowerEdge	Model Z
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	OEM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Dell Lanman 2.2,Dell UNIX, NetWare	Dell NetWare, VINES, NT	Dell NetWare, VINES, NT	Dell NetWare, VINES, NT	SCSI-2 host Various
RAID level	0/1/4/5/10	0/1/5/10	0/1/5/10	0/1/5/10	0/3/5
Configured by:	Host	Host	Host	Host	Port
Array capacity (Gbytes) MIN	2/1/2/2/1	4	4	4	Drive dependent
MAX	57/28/46/46/28	36.4	144*	54.6	Drive dependent
Minimum drives per array	2	2	2	2	5
Maximum drives per array	14	4	8	6	35
Concurrent host channels	1, 2	1	1	1	1
Controller drive channels	2				1
Array interface to host	EISA	EISA	EISA	PCI	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.5	1.5	1.5	4, 32	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	Duplex	Duplex	Duplex	No
Fan (Yes/No)	Option	No	No	No	No
Power supply (Yes/No)	Option	No	No	No	No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	33	33	33	132	20
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	1050-4100	2100-9100	2100-9100	2100-9100	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	Drive dependent
Average positioning time (msec)	9	9	9	9	Drive dependent
Average rotational delay (msec)	4.17	4.17	4.17	4.17	Drive dependent
Drive models	Seagate, IBM	Seagate, IBM	Seagate, IBM	Seagate, IBM	Various
ARRAY SIZE: Inches: H x W x D	Varies	Varies	Varies	Varies	3.25 x 5.75 x 8
POWER:	Host dependent	Host dependent	Host dependent	Host dependent	26 watts+drives
Power backup	None	None	None	Cache battery	None
FIRST CUSTOMER SHIPMENT	4Q92	4Q95	4Q95	2/96	4/92
COMMENTS	RAID 1/0 shipped 11/92; other models added in 3/93.		*With expansion module.	Mylex controller.	

MANUFACTURER	DIGI-DATA	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	Model Z9000	RAID Array 210 StorageWorks	RAID Array 230 StorageWorks	RAID Array 310 StorageWorks	RAID Array 410 StorageWorks
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	PCM	Captive, PCM	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI-2 host Various	PC compatible NetWare, NT	Open VMS, Alpha Digital UNIX, Wind. NT, NetW.	Digital, Open Systems, Sun, UNIX, NT, NetW.	Digital, Open Systems, NetW., UNIX, Wind. NT
RAID level Configured by:	0/3/5 Port	0/1/5/10 Host	0/1/5/10 Host	0/1/3/5/10 Preset	0/1/3/5/10 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	3.15 90.3	3.15 90.3	6.3 60	6.3 180.6
Minimum drives per array	5	3	3	2	3
Maximum drives per array	35	21	21	14	42
Concurrent host channels	1	1	1	1	1
Controller drive channels	1, 5	1, 3	1, 3	2	6
Array interface to host	SCSI-2	EISA	PCI	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 128	4, 32	4, 32	16	32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 20	20 20	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1050,2100,4300	2100, 4300	2100, 4300	2100, 4300
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	9.5/9.5/8	8	8	8
Average rotational delay (msec)	Drive dependent	5.6/5.6/4.2	4.2	4.2	4.2
Drive models	Various	RZ26L, RZ28, RZ29	RZ28, RZ29	RZ28, RZ29	RZ28, RZ29
ARRAY SIZE: Inches: H x W x D	3.25 x 5.75 x 8	22.2 x 8.2 x 17	22.2 x 8.2 x 17	21.4 x 9.6 x 20.6	33 x 18.75 x 19
POWER: Power backup	26 watts+drives None	150 watts Battery option.	150 watts Battery option	204 watts Battery	204 watts Battery
FIRST CUSTOMER SHIPMENT	3/94	7/94	7/95	5/96	12/94
COMMENTS					Uses Digital HSZ40 controller.

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	RAID Array 450 StorageWorks	ESA Model C	ESA Model M	ESA Model L	HA720W/SC-4200
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive, PCM	Captive, PCM	Captive, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Digital, Open Systems, NetW., UNIX, NT, Sun	VAX, Alpha, Open Systems	VAX, Alpha, Open Systems	VAX, Alpha, Open Systems	SCSI host Various
RAID level Configured by:	0/1/3/5/10	0/1/3/5/10 Preset	0/1/3/5/10	0/1/3/5/10	0/1/3/5/10
Array capacity (Gbytes) MIN	Drive dependent	155	155	155	6.3
MAX	Drive dependent	10200	1160	1080	60
Minimum drives per array	2	36	36	36	3
Maximum drives per array	42	2375	270	252	14
Concurrent host channels	1	1, 66	2, 15	3, 21	1
Controller drive channels	6	6	6	6	2
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	32, 128	250-16896	512-3840	786-5376	4, 16
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Option	Yes	Yes	Yes	
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	20/Port	20/Port	20/Port	20
drive (MB/Sec)	10	20	20	20	20
DRIVES: Formatted capacity/drive(MB)	1050,2100,4290	4300	4300	4300	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	8	8	8	Drive dependent
Average rotational delay (msec)	Drive dependent	4.2	4.2	4.2	Drive dependent
Drive models	Various	RZ29B	RZ29B	RZ29B	Various
ARRAY SIZE: Inches: H x W x D	33 x 18.75 x 19	67 x 31 x 34.5	67 x 31 x 34.5	67 x 31 x 34.5	
POWER: Power backup	204 watts Battery	Battery	Battery	Battery	Cache battery
FIRST CUSTOMER SHIPMENT	11/96	3Q96	3Q96	3Q96	3Q95
COMMENTS	Uses Digital HSZ40 controller.	I/O intensive applications.	Mixed applications.	Bandwidth applications.	

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	HS211	HS221	HS241	HSD10	HSD30
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Alpha, Open VMS	Alpha, Open VMS	Alpha, Open VMS	VAX, Alpha, VMS	VAX, Alpha, VMS
RAID level Configured by:	0/1/3/5	0/1/3/5	0/1/3/5	0/1	0/1/3/5
Array capacity (Gbytes) MIN	6.3	6.3	6.3	4.2	4.2
MAX	180	154	309	30.1	90.3
Minimum drives per array	3	3	3	2	2
Maximum drives per array	42	36	72	7	21
Concurrent host channels	1	2	2	1	1
Controller drive channels	6	6	24	1	3
Array interface to host	FDDI	FDDI	FDDI	DSSI	DSSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI
Cache size (min, max: MB)	32	64	128	16, 32	16, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read,Write(opt)	Read, Write
Redundancy: Controller (Yes/No)	No	Yes	Yes	Option	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto		--
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	12	24	24	3	3.2
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	2100, 4300	2100, 4300	2100, 4300	2100, 4300	2100, 4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8	8	8	8	8
Average rotational delay (msec)	4.2	4.2	4.2	4.2	4.2
Drive models	RZ28, RZ29	RZ28, RZ29	RZ28, RZ29	RZ28, RZ29	RZ28, RZ29
ARRAY SIZE: Inches: H x W x D	67 x 31 x 34.5	67 x 31 x 34.5	67 x 31 x 34.5		
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	4Q95	4Q95	4Q95	1/94	1/94
COMMENTS					

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	HSD50	HSJ30 StorageWorks	HSJ40 StorageWorks	HSJ42 StorageWorks	HSJ44 StorageWorks
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	VAX, Alpha, VMS	VAX, Alpha, VMS	VAX, Alpha, VMS	VAX, Alpha, VMS	VAX, Alpha, VMS
RAID level Configured by:	0/1/3/5	0/1/3/5	0/1/3/5	0/1/3/5	0/1/3/5
Array capacity (Gbytes) MIN	4.2	4.2	4.2	4.2	8.4
MAX	180.6	77.4	154.8	309.6	619
Minimum drives per array	2	2	2	2	2
Maximum drives per array	42	18	36	36/72	72/144
Concurrent host channels	1	1, 8	1, 8	1, 8	1, 8
Controller drive channels	6	3	6	12	24
Array interface to host	DSSI	CI	CI	CI	CI
Drive interface	SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	64, 128	0, 32	16, 32	32, 64	64, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	--				
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	3.4	6.7	6.7	13.4	26.8
drive (MB/Sec)		10	10	10	
DRIVES: Formatted capacity/drive(MB)	2100, 4300	2100, 4300	2100, 4300	2100, 4300	2100, 4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8	8	8	8	8
Average rotational delay (msec)	4.2	4.2	4.2	4.2	4.2
Drive models	RZ28, RZ29	RZ28, RZ29	RZ28, RZ29	RZ28, RZ29	RZ28, RZ29
ARRAY SIZE: Inches: H x W x D		Various configurations	Various configurations	Various configurations	Various configurations
POWER: Power backup		1300-3140 watts	1300-3140 watts	1300-3140 watts	1300-3140 watts
FIRST CUSTOMER SHIPMENT	3Q96	1Q94	3Q93	1Q94	
COMMENTS					

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	HSJ50 StorageWorks	HSJ52 StorageWorks	HSJ54 StorageWorks	HSZ40	HSZ50
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Board	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	VAX, Alpha, VMS	VAX, Alpha, VMS	VAX, Alpha, VMS	Open Systems	Open Systems
RAID level Configured by:	0/1/3/5	0/1/3/5	0/1/3/5	0/1/3/5/10	0/1/3/5/10
Array capacity (Gbytes) MIN	4.2	4.2	8.4	4.2	4.2
MAX	154.8	309.6	619	155	155
Minimum drives per array	2	2	2	2	2
Maximum drives per array	36	36/72	72/144	42	42
Concurrent host channels	1, 8	1, 8	1, 8	1	1
Controller drive channels	6	12	24	6	6
Array interface to host	CI	CI	CI	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	32, 128	64, 256	512	16, 32	32, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes (option)	Yes (option)
Fan (Yes/No)	Yes	Yes	Yes	No	No
Power supply (Yes/No)	Yes	Yes	Yes	No	No
Spare drive (None/Auto/Manual)				Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	12.7	25.4	50.8	20	20
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	2100, 4300	2100, 4300	2100, 4300	2100, 4300	2100, 4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8	8	8	8	8
Average rotational delay (msec)	4.2	4.2	4.2	4.2	4.2
Drive models	RZ28, RZ29	RZ28, RZ29	RZ28, RZ29	RZ28, RZ29	RZ28, RZ29
ARRAY SIZE: Inches: H x W x D	Various configurations	Various configurations	Various configurations		
POWER: Power backup	1300-3140 watts	1300-3140 watts	1300-3140 watts	Cache battery	
FIRST CUSTOMER SHIPMENT	3Q96	3Q96	3Q96	1995	3Q96
COMMENTS					

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	QL-0MHA-AA QL-2YFA-AA QL-0MGAA-3B StorageWorks	RAID 211 Controller	RAID 213 Controller	RAID 231 Controller	RAID 233 Controller
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Implementation	Software Software	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	Open VMX VAX	PC compatible NetWare, NT, SCO UNIX	PC compatible NetWare, NT, SCO UNIX	PC compatible NetWare, NT	PC compatible NetWare, NT
RAID level Configured by:	0/1/5 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host
Array capacity (Gbytes) MIN MAX	-- --	3.15 30.1	3.15 90.3	3.15 30.1	 90.3
Minimum drives per array	--	3	3	2	2
Maximum drives per array	7 + parity	7	21	7	21
Concurrent host channels	--	1	1	1	1
Controller drive channels		1	3	1	3
Array interface to host	Varies	EISA	EISA	PCI	PCI
Drive interface	Varies	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	4, 32	4, 32	4, 32	4, 32
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	--	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	-- --	14 10	14 10	18 20	18 20
DRIVES: Formatted capacity/drive(MB)	1050,2100,4300	1050,2100,4300	1050,2100,4300	1050,2100,4300	1050,2100,4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5/9.5/8	9.5/9.5/8	9.5/9.5/8	8	8
Average rotational delay (msec)	5.6/5.6/4.2	5.6/5.6/4.2	5.6/5.6/4.2	4.2	4.2
Drive models	Various	RZ26L, RZ28, RZ29	RZ26L, RZ28, RZ29	RZ28, RZ29	RZ28, RZ29
ARRAY SIZE: Inches: H x W x D	--				
POWER: Power backup	-- --	150 watts Battery option	150 watts Battery option		
FIRST CUSTOMER SHIPMENT	12/93	7/94	7/94		
COMMENTS					

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	SC-4200	SC-4600	SC-4600/HA2400C	SWXNA-AX SWXNA-FX	SWXNA-BX SWXNA-GX
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM	OEM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	UNIX, Windows NT	UNIX, Windows NT
RAID level Configured by:	0/1/3/5/10 Host	0/1/3/5/10 Host	0/1/3/5/10 Host	0/1/3/5	0/1/3/5
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	6.3 103	6.3 154	6.3 309
Minimum drives per array	3	3	3	3	3
Maximum drives per array	14	36	24	36	72
Concurrent host channels	1	1, 2	1	1, 2	1, 2
Controller drive channels	2	6	6	6	12
Array interface to host	SCSI-2	SCSI-2	SCSI-2	FDDI, CDDI	FDDI, CDDI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4	32	32	2, 32	
Cache function (Read, Write)	Read, Write		Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)		Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 20	20 20	12 10	12 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	1050,2100,4300	2100, 4300	2100, 4300
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	9.5/9.5/8	8	8
Average rotational delay (msec)	Drive dependent	Drive dependent	5.6/5.6/4.2	4.2	4.2
Drive models	Various	Various	Various	RZ28, RZ29	RZ28, RZ29
ARRAY SIZE: Inches: H x W x D	1.6 x 5.75 x 8.8	12.5 x 7.75	34 x 19 x 21	67 x 31 x 34.5	67 x 31 x 34.5
POWER: Power backup	17.5 watts	27 watts	Battery		
FIRST CUSTOMER SHIPMENT		4Q94	4Q94	2Q96	2Q96
COMMENTS					

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DILOG SA	DILOG SA	DIRECT CONNECT SYSTEMS	DIRECT CONNECT SYSTEMS
ARRAY MODEL	Volume Shadowing, Version 6.0	Ultra-Windjammer	Windjammer	Guardian Advanced Array	Server 8 Guardian RAID
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	OEM, PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Software Software	Board Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	VAX, Alpha	SCSI host Various	SCSI host Various	DEC, Sun, AT&T UNIX, OS/2, NetWare	DEC, Sun, AT&T UNIX, OS/2, NetWare
RAID level Configured by:	1	0/1 Panel, Port	0/1 Panel, Port	0/1/3/5/10 Host, Port	0/1/3/5 Panel, Port
Array capacity (Gbytes) MIN MAX	-- 464	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	1	2	2	5	3
Maximum drives per array	130 x 3	14	14	20	7
Concurrent host channels	1, 130	1	1	1, 2	1
Controller drive channels		2	2	2, 5	1
Array interface to host	DSSI, SCSI, CI	Ultra SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	DSSI, SCSI, CI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	N/A	4, 16	8-64	32
Cache function (Read, Write)	--	N/A	Read	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	No N/A N/A	No N/A N/A	Yes Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	--	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Drive dependent Drive dependent	40 20	20 10	20 20	10/20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4500-9100
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Seagate
ARRAY SIZE: Inches: H x W x D	--	1.625 x 5 x 7	1.625 x 5 x 8	24.8 x 14 x 30	22.25 x 7.5 x 23
POWER: Power backup	-- --	8 watts+ drives None	8 watts+ drives None	880 watts Battery	170 watts Cache battery
FIRST CUSTOMER SHIPMENT	1990	8/96	1/94	1994	1995
COMMENTS		Byte striping in RAID 0.	Byte striping in RAID 0.	Data General CLARiiON.	DEC StorageWorks.

MANUFACTURER	DIRECT CONNECT SYSTEMS	DIRECT CONNECTIONS	DIVERSE LOGISTICS	DIVERSE LOGISTICS	DPT
ARRAY MODEL	Server 24 Guardian RAID	DC3400W	Ultra-Windjammer	Windjammer	DM4000 SmartCache III Disk Array Module
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Board	Board	Board
Implementation	Hardware	Software	Hardware	Hardware	Hardware
Host platform, software environment	DEC, Sun, AT&T UNIX, OS/2, NetWare	Macintosh System 7	SCSI host Various	SCSI host Various	PC compatible NetW.,VINES,NT, OS/2,UNIX,other
RAID level	0/1/3/5	0/1/4/5	0/1	0/1	0/1/5
Configured by:	Panel, Port	Host	Panel, Port	Panel, Port	Host
Array capacity (Gbytes) MIN	Drive dependent	4.2/2.1/2.1/2.1	Drive dependent	Drive dependent	Drive dependent
MAX	Drive dependent	15/7.5/ /	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	3	2/3	2	2	2
Maximum drives per array	24	7	14	14	7
Concurrent host channels	1, 3	1	1	1	1
Controller drive channels	1, 4	1	2	2	1
Array interface to host	SCSI-2	SCSI-2	Ultra SCSI-2	SCSI-2	PCI, EISA, ISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	32	--	N/A	4, 16	1, 64
Cache function (Read, Write)	Read, Write	--	N/A	Read	Read, Write
Redundancy: Controller (Yes/No)	Option	No	No	No	Yes
Fan (Yes/No)	Yes	Yes	N/A	N/A	No
Power supply (Yes/No)	Yes	Yes	N/A	N/A	No
Spare drive (None/Auto/Manual)	Auto	Auto (option)	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10/20	20	40	20	132/33/10
drive (MB/Sec)	10	20	20	10	10
DRIVES: Formatted capacity/drive(MB)	4500-9100	2100	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	8	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	4.17	Drive dependent	Drive dependent	Drive dependent
Drive models	Seagate	Seagate Barracuda 2	Various	Various	Various
ARRAY SIZE: Inches: H x W x D		Varies	1.625 x 5 x 7	1.625 x 5 x 8	Adapter dependent
POWER:	400 watts		8 watts+ drives	8 watts+ drives	10 watts+drives
Power backup	None	None	None	None	None
FIRST CUSTOMER SHIPMENT	1995	1Q94	8/96	1/94	3Q93
COMMENTS	DEC StorageWorks.	Remus software. ATTO controller	Byte striping in RAID 0.	Byte striping in RAID 0.	SmartCache Plus SCSI controller option. CM4000 cache module is prerequisite.

MANUFACTURER	DPT	DPT	DPT	DPT	DPT
ARRAY MODEL	DM401X SmartCache Plus Disk Array Module	EISATWR SmartRAID Subsystem	ISATWR SmartRAID Subsystem	PCITWR SmartRAID Subsystem	PM2044UWR PM2044UWRH
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware
Host platform, software environment	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	PC compatible NetWare, OS/2, NT, UNIX, other	PC compatible NetWare, OS/2, NT, UNIX, other	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	PC compatible NetW.,VINES,NT, OS/2,UNIX,other
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7	6	6	6	
Concurrent host channels	1	2	2	2	1
Controller drive channels	1	1, 2, 3	1	1, 2, 3	1
Array interface to host	EISA, ISA	EISA	ISA	PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-3
Cache size (min, max: MB)	1, 16	1, 64	1, 64	1, 64	1, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No No	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33/10 10	33 10	10 10	132 10	132 10/20/40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1100,2100,4300	1100,2100,4300	1100,2100,4300	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95	95	95	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	Adapter dependent	21.4 x 9.6 x 20.6	21.4 x 9.6 x 20.6	21.4 x 9.6 x 20.6	
POWER: Power backup	10 watts+drives None	164 watts None	164 watts None	164 watts None	11 watts+drives None
FIRST CUSTOMER SHIPMENT	3Q93	3Q94	1/95	3Q94	
COMMENTS	SmartCache Plus SCSI controller option. CM401X cache module is prerequisite.				Array kit.

MANUFACTURER	DPT	DPT	DPT	DPT	DPT
ARRAY MODEL	PM2144UWR PM2144UWRH	PM3222 SmartRAID Controller	PM3224 PM3224-Mac SmartRAID Controller	PM3224W PM3224W-Mac SmartRAID Controller	PM3332UW
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Board	Board	Board	Board	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	EISA host Various
RAID level	0/1/5	0/1/5	0/1/5	0/1/5	0/1/5
Configured by:	Host	Host	Host	Host	Host
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array		37*	37*	45	15, 45*
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1, 2, 3	1, 2, 3	1, 2, 3	1, 3*
Array interface to host	PCI	EISA	PCI	PCI	EISA
Drive interface	SCSI-3	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	1, 64	1, 64	1, 64	1, 64	1, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes	--
Fan (Yes/No)	No	No	No	No	--
Power supply (Yes/No)	No	No	No	No	--
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	132	33	132	132	33
drive (MB/Sec)	10/20/40	10	10/20	20	40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D					
POWER:	11 watts+drives	12 watts+drives	11 watts+drives	11 watts+drives	12 watts+drives
Power backup	None	None	None	None	
FIRST CUSTOMER SHIPMENT		3Q94	3Q94	1/95	6/96
COMMENTS	Array kit.	Environmental monitor sensor 68030 140 MHz processor. *37 w/ SX4000W expander option	Environmental monitor sensor 68030 140 MHz processor. *37 w/ SX4000W expander option	Environmental monitor sensor 68030 140 MHz processor.	*With SX4030. ECC cache option.

MANUFACTURER	DPT	DPT	DPT	DPT	DYNATEK AUTOMATION SYSTEMS
ARRAY MODEL	PM3334UDW	PM3334UW PM3334UW-MAC	RC4040 SmartCache IV RAID/Caching	RC4041	RDR 16.0M
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Subsystem Hardware
Host platform, software environment	PCI host Various	PCI host Various	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	DPT PM2X44 Various	SCSI host Various
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/3/5 Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	 16
Minimum drives per array	2	2	2	2	3
Maximum drives per array	15, 45*	15, 45*	7	7	5
Concurrent host channels	1	1	1	1	
Controller drive channels	1, 3*	1, 3*	1	1	
Array interface to host	PCI	PCI	PCI, EISA, ISA	--	
Drive interface	Ultra SCSI	Ultra SCSI	SCSI-3	--	
Cache size (min, max: MB)	16, 64	16, 64	1, 64	16, 32	
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	Yes No No	-- -- --	No Per drive Per drive
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	132 40	132/33/10 10/20	33/132 40	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	8.5
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4.17
Drive models	Various	Various	Various	Various	
ARRAY SIZE: Inches: H x W x D			Adapter dependent		
POWER: Power backup	12 watts+drives None	12 watts+drives	10 watts None	12 watts+drives	
FIRST CUSTOMER SHIPMENT	11/96	6/96	2/96	6/96	
COMMENTS	Differential Ultra SCSI. *With SX4030.	*With SX4030. ECC cache option. -MAC for Macintosh.	SmartCache IV SCSI adapter option.	Requires DPT PM2X44 adapter. Uses DPT DIMMS.	

MANUFACTURER	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS
ARRAY MODEL	XPR	XPR-MT	XPR-ST	XPRS 16.0F	XPRS 16.0M
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	0/3/5 Port	0/3/5 Port	0/3/5 Port	0/3/5 Port	0/3/5 Port
Array capacity (Gbytes) MIN MAX	4 64	4 64	4 16	16	16
Minimum drives per array		3	3	3	3
Maximum drives per array		20	5	5	5
Concurrent host channels		1	1		
Controller drive channels		1	1, 4		
Array interface to host		SCSI-2	SCSI-2		
Drive interface		SCSI-2	SCSI-2		
Cache size (min, max: MB)	4, 128	4	4		
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write		
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes		No Per drive Per drive	No Per drive Per drive	No Per drive Per drive
Spare drive (None/Auto/Manual)		Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)		20 10	20 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)		2000, 4000	2000, 4000	4300	4000
Nominal disk diameter (mm)		95	95		
Average positioning time (msec)		8.5	8.5	10	8.5
Average rotational delay (msec)		5.56, 4.17	5.56, 4.17	4.17	4.17
Drive models		Various	Various		
ARRAY SIZE: Inches: H x W x D		19 x 36 x 20.3	19 x 12 x 20.3	19 x 12 x 20.3	
POWER: Power backup				250	
FIRST CUSTOMER SHIPMENT		1996	1995		
COMMENTS		Digi-Data controller.	Digi-Data controller.		

MANUFACTURER	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	ECCS
ARRAY MODEL	XPRS 8.01	XPRS 8.0Q	XPRS 8.8F	XPRS 8.0M	Micro DFT-1R
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host OS/2, UNIX, other	SCSI host OS/2, UNIX, other	SCSI host Various	SCSI host Various	NCR, HP, Sun, RS/6000,NetWare Windows NT
RAID level	0/1/3/5	0/1/3/5	0/3/5	0/3/5	1/10
Configured by:	Host	Host	Port	Port	Preset
Array capacity (Gbytes) MIN	8.2	8.2			4.2
MAX	16.4	16.4	8.8	8	33.6
Minimum drives per array	2	2	3	3	2
Maximum drives per array	5	5	5	5	87
Concurrent host channels	1	1	1	1	1-4
Controller drive channels	1	1	1	1	2
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--		None
Cache function (Read, Write)	--	--	--		--
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	Per drive	Per drive	Per drive	Per drive	Yes
Power supply (Yes/No)	Per drive	Per drive	Per drive	Per drive	Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	10	10	10	10
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	2014	2100	2170	2104	2100-4200
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.95	9.5	10	8.5	8
Average rotational delay (msec)	5.6	5.6	4.17	4.17	4.17
Drive models	IBM	Quantum		Various	Seagate Barracuda
ARRAY SIZE: Inches: H x W x D	19 x	19 x	19 x	19 x	5.88 x
	12 x 22	12 x 22	12 x 20.3	12 x 20.3	17 x 16
POWER:	500 watts	500 watts	250	250 watts	300 watts
Power backup	None	None			None
FIRST CUSTOMER SHIPMENT	1/94	1/94	1994		10/94
COMMENTS	Digi-Data controller.	Digi-Data controller.	Digi-Data controller.		ECCS controller

MANUFACTURER	ECCS	ECCS	ECLIPSE TECHNOLOGIES	EMC	EMC
ARRAY MODEL	Synchronection	Synchronix	Mariner 2	3100-9 Symmetrix	3130-4
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host	NCR,HP,Sun,SCI, RS/6000,NetWare Windows NT,UNIX	SCSI host Various	Open Systems UNIX, PC	Open Systems PC, UNIX, AS/400
RAID level Configured by:	0/1/3/5/10 Port	0/1/3/5/10 Host, Port	0/1/3/4/5/10 Host, Port	0/1/"S"	0/1/"5" Preset
Array capacity (Gbytes) MIN MAX	10.2 546	10.2 270	Drive dependent Drive dependent	70/35/52 140/70/104	67/33/50 134/67/100
Minimum drives per array	2	2	2	8	16
Maximum drives per array	60	30	35	16	32
Concurrent host channels	12	2	1	8, 16	4, 8
Controller drive channels	5	5	1, 5	8	
Array interface to host	SCSI,FDDI Ether	SCSI-2,Ult.SCSI	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2,Ult.SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	64, 224	8-224	--	512, 2048	512, 2048
Cache function (Read, Write)	Read, Write	Read, Write	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 40	40 20	20 10		20 20
DRIVES: Formatted capacity/drive(MB)	2100-9000	2100-9000	Drive dependent	8730	4192
Nominal disk diameter (mm)	95	95	95	130	95
Average positioning time (msec)	8	8	Drive dependent	12	12
Average rotational delay (msec)	4.17	4.17	Drive dependent	5.6	5.6
Drive models	Seagate Barracuda	Seagate Barracuda	Various		Various
ARRAY SIZE: Inches: H x W x D	Varies	7-17.5 x 17.5 x 24	7.5 x 19 x 20	46 x 21 x 36	46 x 21 x 36
POWER: Power backup	500 watts	350-1050 watts UPS option	180 watts None	1.39-1.63 KVA Battery	1.36-1.63 KVA Battery
FIRST CUSTOMER SHIPMENT	7/96	12/94	1/95	6/95	
COMMENTS	NFS (Network) File Server with RAID. Dual 200 MHz Pentium Pro.	Dual AC feed. NEBS compliant. i960 processor. Mirrored cache. ECCS controller	Firmware in flash memory. Dual AC. Passive backplane. SNMP support.		

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	3200-9 Symmetrix	3240-4	3500-9 Symmetrix	Centriplex 1000	HX3SR-44 Harmonix
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Open Systems UNIX, PC	Open Systems PC, UNIX, AS/400	Open Systems UNIX, PC	RS/6000,HP, Sun UNIX, NetWare NT, OS/2	AS/400
RAID level	0/1/"S"	0/1/"5"	0/1/"S"	0/1/5	0/1/5
Configured by:		Preset			
Array capacity (Gbytes) MIN	140/70/104	134/67/100	279/140/209	17	7.8/3.9/6.2
MAX	279/140/209	402/201/302	1118/559/836	206	15.7/7.8/12.5
Minimum drives per array	16	32	32	4	4
Maximum drives per array	32	96	128	48	8 + spare
Concurrent host channels	8, 16	4, 16	8, 32	2, 4	1
Controller drive channels	16		32	8	
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	512, 4096	512, 4096	1024, 4096	8, 256	20, 452
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes	No
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)		20		20	20
drive (MB/Sec)		20		10	20
DRIVES: Formatted capacity/drive(MB)	8730	4192	8730	4300	1980
Nominal disk diameter (mm)	130	95	130	95	95
Average positioning time (msec)	12	12	12	8	10.5
Average rotational delay (msec)	5.6	5.6	5.6	4.17	4.17
Drive models		Various		Various	Various
ARRAY SIZE: Inches: H x W x D	73.6 x 24.3 x 36.4	73.6 x 24.3 x 36.4	74.9 x 68.7 x 36.4	7 x 19 x 29	5.25 x 17.5 x 28
POWER:	1.96-2.65 KVA	2.0-2.61 KVA	4.61-8.81 KVA	.32-2.45 KVA	.26 KVA
Power backup	Battery	Battery	Battery	Battery	None
FIRST CUSTOMER SHIPMENT	6/95		6/95	1995	2/95
COMMENTS					

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	HX3SR-48 Harmonix	ModARRAY	5100-9 Symmetrix	5100-95 Symmetrix	5100-9M Symmetrix
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Mainframe	Mainframe	Mainframe
MARKET	PCM	OEM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	AS/400	SCSI host UNIX	IBM mainframes All OS and VAR Open Systems	IBM mainframes All OS and VAR Open Systems	IBM mainframes All OS and VAR Open Systems
RAID level	0/1/5	0/1/3/5	0/1/"S"	0/1/"S"	1
Configured by:		Host	Preset	Preset	Preset
Array capacity (Gbytes) MIN	16.8/8.4/13.4	17	68/34/51	68/34/51	34
MAX	33.5/16.7/26.8	206	136/68/102	136/68/102	68
Minimum drives per array	4	4	8	8	8
Maximum drives per array	8 + spare	48	16	16	16
Concurrent host channels	1	2, 4	4, 8	4, 8	4, 8
Controller drive channels		8			
Array interface to host	SCSI-2	SCSI-2	BMX/ESCON/SCSI	BMX/ESCON/SCSI	BMX/ESCON/SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	20, 452	4, 128	512, 2048	768, 2048	512, 2048
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	Option	Yes	Yes	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	20	3/4.5/10/17	3/4.5/10/17	3/4.5/10/17
drive (MB/Sec)	20	10	Drive dependent	Drive dependent	Drive dependent
DRIVES: Formatted capacity/drive(MB)	4190	2100	8530	8530	8530
Nominal disk diameter (mm)	95	95	130	130	130
Average positioning time (msec)	10.5	9	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.17	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	5.25 x 17.5 x 28	7 x 19.75 x 29	42 x 21 x 36	42 x 21 x 36	42 x 21 x 36
POWER:	.26 KVA	2.45 KVA	1.39-1.63 KVA	1.39-1.63 KVA	1.39-1.63 KVA
Power backup	None	UPS	Battery	Battery	Battery
FIRST CUSTOMER SHIPMENT	2/95	1995	4/95	4/95	4/95
COMMENTS					

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	5200-9 Symmetrix	5200-9M Symmetrix	5200-9S Symmetrix	5230-4 Symmetrix	5230-4M Symmetrix
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	IBM mainframes All OS and VAR Open Systems	IBM mainframes All OS and VAR Open Systems	IBM mainframes All OS and VAR Open Systems	IBM mainframes All OS and VAR Open Systems	IBM mainframes All OS and VAR Open Systems
RAID level	0/1/"S"	1	0/1/"S"	0/1/"S"	1
Configured by:	Preset	Preset	Preset	Preset	Preset
Array capacity (Gbytes) MIN	68/68/51	68	68/68/51	45/22/34	67
MAX	272/136/204	136	272/136/204	363/181/272	201
Minimum drives per array	8	16	8	20	32
Maximum drives per array	32	32	16	96	96
Concurrent host channels	4, 16	4, 16	4, 16	4, 16	4, 16
Controller drive channels					
Array interface to host	BMX/ESCON/SCSI	BMX/ESCON/SCSI	BMX/ESCON/SCSI	BMX/ESCON/SCSI	BMX/ESCON/SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	512, 4096	512, 4096	1024, 4096	512, 4096	512, 4096
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	3/4.5/10/17	3/4.5/10/17	3/4.5/10/17	3/4.5/10/17	3/4.5/10/17
drive (MB/Sec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
DRIVES: Formatted capacity/drive(MB)	8530	8530	8530	4192	4192
Nominal disk diameter (mm)	130	130	130	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	73.6 x 24.3 x 36.4	73.62 x 24.25 x 36.4	73.6 x 24.3 x 36.4	73.6 x 24.3 x 36.4	73.6 x 24.3 x 36.4
POWER: Power backup	1.62-2.65 KVA Battery	1.96-2.65 KVA Battery	1.62-2.65 KVA Battery	2.0-2.61 KVA Battery	2.43-3.83 KVA Battery
FIRST CUSTOMER SHIPMENT	5/95	5/94	5/95	4/95	4/95
COMMENTS		Unisys/Bull version available.			

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	5230-4S Symmetrix	5500-3 Symmetrix	5500-9 Symmetrix	5500-9M Symmetrix	5500-9S Symmetrix
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	IBM mainframes All OS and VAR Open Systems	IBM mainframes All OS	IBM mainframes All OS and VAR Open Systems	IBM mainframes All OS and VAR Open Systems	IBM mainframes All OS and VAR Open Systems
RAID level Configured by:	0/1/"S" Preset	0/1 Preset	0/1/"S" Preset	1 Preset	0/1/"S" Preset
Array capacity (Gbytes) MIN	83/67/62	136/68	136/136/102	136	136/136/102
MAX	402/201/302	363/181	1088/544/816	544	1088/544/816
Minimum drives per array	20	48	16	32	16
Maximum drives per array	96	128	128	128	128
Concurrent host channels	4, 16	8, 16	8, 16	8, 16	8, 16
Controller drive channels					
Array interface to host	BMX/ESCON/SCSI	BMX/ESCON/SCSI	BMX/ESCON/SCSI	BMX/ESCON/SCSI	BMX/ESCON/SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1024, 4096	1792, 4096	1024, 4096	1024, 4096	1024, 4096
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	3/4.5/10/17	3/4.5/10/17	3/4.5/10/17	3/4.5/10/17	3/4.5/10/17
drive (MB/Sec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
DRIVES: Formatted capacity/drive(MB)	4192	2830	8530	8530	8530
Nominal disk diameter (mm)	95	130	130	130	130
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	73.6 x 24.3 x 36.4	74.9 x 68.7 x 36.4	74.9 x 68.7 x 36.4	74.9 x 68.7 x 36.4	74.9 x 68.7 x 36.4
POWER: Power backup	2.17-3.83 KVA Battery	5.36-8.81 KVA Battery	3.98-8.81 KVA Battery	4.67-8.81 KVA Battery	3.98-8.81 KVA Battery
FIRST CUSTOMER SHIPMENT	4/95	1Q93	5/95	5/94	5/95
COMMENTS		Unisys/Bull version available.		Unisys/Bull version available.	

MANUFACTURER	ENCORE COMPUTER	ENCORE COMPUTER	ENCORE COMPUTER	EUROLOGIC SYSTEMS LIMITED	EUROLOGIC SYSTEMS LIMITED
ARRAY MODEL	Infinity SP30 Infinity SP40	Infinity 90ES	Infinity 90SA	EL-RAID 201	EL-RAID 202
DISK/TREND GROUP	Mainframe	Very High Perf.	Very High Perf.	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	Captive	Captive	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	IBM mainframes (3990), Encore, other	Encore UMAX V, UNIX Syst V	Encore UMAX V, UNIX Syst V	SCSI host UNIX, NetWare, other	SCSI host UNIX, NetWare, other
RAID level Configured by:	0/1/5	0/1/5 Host	0/1/5 Host	0/3/5 Panel, Port	0/3/5 Panel, Port
Array capacity (Gbytes) MIN MAX	48 324*	12 240 (TB)	12 1000	5 30	7 60
Minimum drives per array	12	6	6	5	7
Maximum drives per array	108*	--	--	7	14
Concurrent host channels	4-32	324	324	1-3	1-3
Controller drive channels	--	--	--	5-7	7
Array interface to host	IBM, SCSI-2	IBM, SCSI-2	IBM, SCSI-2	SCSI-2*	SCSI-2*
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	512, 4096	64, 1024	64, 1024	4, 32	4, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes (option) Yes Yes	Yes (option) Yes Yes	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	4.5** 10	4.5*, 53** 10	4.5*, 53** 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	4200, 9100	4200	4200	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8	8	8	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.17	4.17	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	79 x 41 x 39	79 x 41 x 34	61 x 53 x 34.1		
POWER: Power backup	UPS	Opt UPS	Opt UPS	600 watts Cache battery	600 watts Cache battery
FIRST CUSTOMER SHIPMENT	4Q94	10/92	11/93	1994	1994
COMMENTS	Redundant cache Dual AC. *324 with expan cab., 1.3TB max **Per IBM block mux channel.	Interphase 4220 controller *Per IBM block mux channel. **Per memory channel.	Interphase 4220 controller *Per IBM block mux channel. **Per memory channel.	CMD controller. Optional dual AC. *Optional DSSI, CI.	CMD controller. Optional dual AC. *Optional DSSI, CI.

MANUFACTURER	EUROLOGIC SYSTEMS LIMITED	FALCON SYSTEMS	FALCON SYSTEMS	FALCON SYSTEMS	FALCON SYSTEMS
ARRAY MODEL	EL-RAID 300	FalconRAID 1000	FalconRAID 4000	FalconRAID 5000	FastfilePro
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host UNIX, NetWare, other	SCSI host Various	SCSI host Various	SCSI host Various	Falcon Various
RAID level Configured by:	0/3/5 Panel, Port	0/1/5/10 Host,Panel,Port	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port	0/1/5/10 Host, Port
Array capacity (Gbytes) MIN MAX	7 120	4 64	4 400	6 84	4 64
Minimum drives per array	7	2	2	2	2
Maximum drives per array	28	28	24	30	28
Concurrent host channels	1-3	1, 2	1, 2		1
Controller drive channels	7	1, 5			1
Array interface to host	SCSI-2*	Ultra SCSI	SCSI-2	SCSI-2	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	16, 64	32, 132	32, 128	4, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Option Yes Option	Yes Yes Yes	Yes Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	20/40 10/20	20 10/20	20/40 10/20	132 10/20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	4000-9100	4000-9100	4000-9100	4000-9100
Nominal disk diameter (mm)	95	95, 130	95	95	95
Average positioning time (msec)	Drive dependent	8, 12	8	8	8
Average rotational delay (msec)	Drive dependent	4.17, 5.6	4.17, 5.6	4.17, 5.6	4.17
Drive models	Various	Seagate	Seagate	Seagate	Seagate
ARRAY SIZE: Inches: H x W x D	40.9 x 23 x 26	Varies	33 x 18.75 x 19	22.5 x 15.25 x 32	
POWER: Power backup	600 watts Cache battery	300 watts Battery	300 watts Battery	300 watts Battery	500 watts Battery
FIRST CUSTOMER SHIPMENT	1993	1996	1996	1996	1996
COMMENTS	CMD controller. Optional dual AC. *Optional DSSI, CI.	Mylex controller. Expandable to 256 GB.	DEC controller.	Symbios Logic MetaStor. Expandable to 126 GB. Dual AC option.	Mylex controller. Direct net attach. Complete server.

MANUFACTURER	FALCON SYSTEMS	FORMATION	FORMATION	FORMATION	FORMATION
ARRAY MODEL	Reel Time	9937-440	9937-480	fd6000	fd6000 Extended
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host Various	IBM AS/400 IBM RS/6000	IBM AS/400 IBM RS/6000	IBM RS/6000,HP, Sun,DEC,Novell, Windows NT,SCO	IBM RS/6000,HP, Sun,DEC,Novell, Windows NT,SCO
RAID level Configured by:	0/1/5/10 Host, Port	0/5 Panel	0/5 Panel	0/1/3/5 Panel, Port	0/1/3/5 Panel, Port
Array capacity (Gbytes) MIN		5.9	12.58	4	4
MAX		13.77	33.58	72	144
Minimum drives per array	2	4	4	2	2
Maximum drives per array	28	8 + spare	8 + spare	18	36
Concurrent host channels	1, 2	1	1	2	4
Controller drive channels	1	4	4	6	6
Array interface to host	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 128	4, 128	4, 128	16-64RD/.512-4W	16-64RD/.512-4W
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Option	No	No	No	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Option	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20/40	10/20	10/20	10/20	10/20
drive (MB/Sec)	10/20	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	4000-9100	1967	4198	1967	4198
Nominal disk diameter (mm)	95, 130	95	95	95	95
Average positioning time (msec)	8, 12	8	8	8.94/8	8.94/8
Average rotational delay (msec)	4.17, 5.6	4.17	4.17	4.69/4.17	4.69/4.17
Drive models	Seagate			Various	Various
ARRAY SIZE: Inches: H x W x D		8.75 x 17 x 29	8.75 x 17 x 29	28 x 23 x 36	28 x 23 x 36
POWER: Power backup	300 watts Battery	250 watts	250 watts	680 watts	1360 watts
FIRST CUSTOMER SHIPMENT	4Q96	3/94	1/95	1Q94	1Q94
COMMENTS	Mylex controller. Expandable to 240 GB.	PCM IBM 9337 Up to 4 MB write cache.	PCM IBM 9337. Up to 4 MB write cache.		

MANUFACTURER	FUJITSU	FUJITSU	FUTURE COMPUTERS	FWB SOFTWARE	GAIN SYSTEMS
ARRAY MODEL	F6493 F1710	F6490A/B DIA	RAIDER-5	RAID ToolKit Version 2.0	ServerCentral
DISK/TREND GROUP	Mainframe	Very High Perf.	Net/Midrange	Single User	Net/Midrange
MARKET	Captive	Captive	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Software Software	Subsystem Hardware
Host platform, software environment	Fujitsu M series, VP series	VP2000 UNIX, proprietary	SCSI host Various	Macintosh, Quadra, Power Mac 8100	IBM compatible NetWare, UNIX
RAID level Configured by:	3 Host	3 Preset	3 Preset	0/1 Host	0/1/5
Array capacity (Gbytes) MIN MAX	5.04 181.44	15 120	Drive dependent Drive dependent	Drive dependent	Drive dependent Drive dependent
Minimum drives per array	5	10	5	2	2
Maximum drives per array	96	80	5	15	8
Concurrent host channels	4-16 (F1710)	2, 4, 8	1	1	1
Controller drive channels	2-16		5	1	1, 3
Array interface to host	Proprietary,OEM	Proprietary	SCSI-2	SCSI, NuBus	PCI
Drive interface	SCSI-2	IPI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)		--	16, 64	Drive dependent	16
Cache function (Read, Write)		--	Read, Write	Drive dependent	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	No -- Yes	No No No	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	None	None	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 20	36 4.5	10 10	Drive dependent Drive dependent	132 10/26
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1890	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	210	95	Drive dependent	95
Average positioning time (msec)	Drive dependent	12	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	6.9	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	M2671PA Swallow-7	Various	Various	Seagate
ARRAY SIZE: Inches: H x W x D	71 x 22 x 30	66 x 22 x 32		--	32 x 22 x 10
POWER: Power backup		2.2 KVA --	Battery option	-- None	600 watts None
FIRST CUSTOMER SHIPMENT	3Q95	1Q92	1993	1996	1996
COMMENTS	Sold in Japan. Up to 4 F6493 can be attached to F1710A controller.	Synchronized spindles.	Baydel controller.	Some versions require StreamLogic controllers.	AMI controller.

MANUFACTURER	GAINBERY COMPUTER PRODUCTS	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
ARRAY MODEL	IDE Mini-RAID	C3609A	C3609A-C3317A	C3609A-C3318A	C3609A-C3321A
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Board	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible DOS, Windows, NT	PC compatible Various	PC compatible NetW., OS/2,DOS SCO,VINES,NT	PC compatible NetWare, VINES, OS/2,DOS,SCO,NT	PC compatible NetWare, VINES, OS/2,DOS,SCO,NT
RAID level	0/1/5	0/1/5/10	0/1/5/10	0/1/5/10	0/1/5/10
Configured by:	Host		Host	Host	Host
Array capacity (Gbytes) MIN	Drive dependent		3	6	10
MAX	Drive dependent	10/4/8/4	10	20	20
Minimum drives per array	2	2	3	3	5
Maximum drives per array	6	14	10	10	10
Concurrent host channels	1	1	1	1	1
Controller drive channels	3	2	2	2	2
Array interface to host	PCI	EISA	EISA	EISA	EISA
Drive interface	IDE	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2	4	4	4	4
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	Yes	No	No	No	No
Power supply (Yes/No)	Option	No	No	No	No
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	132	10	10	10	10
drive (MB/Sec)	20	10	3.1	3.7	3.1
DRIVES: Formatted capacity/drive(MB)	2100	Drive dependent	1000	2000	2000
Nominal disk diameter (mm)	95	Drive dependent	95	95	95
Average positioning time (msec)	10	Drive dependent	10.7	10.7	8.9
Average rotational delay (msec)	5.6	Drive dependent	5.56	5.56	4.69
Drive models	Seagate	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	12 x 12 x 24		14.6 x 7.6 x 16.1	14.6 x 7.6 x 16.1	14.6 x 7.6 x 16.1
POWER:	200 watts		24 watts	24 watts	24 watts
Power backup			None	None	None
FIRST CUSTOMER SHIPMENT	11/96		1Q94	1Q94	1Q94
COMMENTS	Available as board.				

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HI-DATA	HI-DATA
ARRAY MODEL	C3610A	Disk Array	XLR1200 AutoRAID	SC-510	SC-520
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	Captive, PCM	OEM	OEM	OEM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware	Board Hardware
Host platform, software environment	PC compatible Various	PC compatible Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1/5/10	0/1/5/10	0/1/5	0/3/10/"53"* Host	0/3/10/"53"* Host
Array capacity (Gbytes) MIN MAX		2/1/1.5/1 10/4/8/4	3 24*	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	5	5
Maximum drives per array		5	12-1"/6-1.6"*	35	75
Concurrent host channels	2	1	1, 2	1, 2	1, 2
Controller drive channels		2		5	5
Array interface to host	PCI	EISA	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)		4	16, 24	2.5	5
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read	Read
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No		Option Yes Option	Yes -- --	Yes -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 20	33 10	20 20	10 10	20 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	510-2000	1000,2000,4000	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95	95	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	9.7-10.7	9, 10.5	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	5.56	5.6, 4.17	Drive dependent	Drive dependent
Drive models	Various	Various	Various, HP	Various	Various
ARRAY SIZE: Inches: H x W x D		14.6 x 7.6 x 16.1	18 x 17.8 x 12.5*	Array size dependent	Array size dependent
POWER: Power backup			526 watts Battery	20 watts+drives	20 watts+drives
FIRST CUSTOMER SHIPMENT	2Q95		4Q95	1990	3/92
COMMENTS			*Per enclosure. Up to 6 enclosures may be combined.	*RAID 53 is combined RAID 5 and RAID 3.	*RAID 53 is combined RAID 5 and RAID 3.

MANUFACTURER	HI-DATA	HITACHI	HITACHI	HITACHI	HITACHI
ARRAY MODEL	SC-550	A-6531-CK	A-6531-DK	A-6531-MK	A-6531-RK
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	Captive, PCM	Captive, PCM	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	SCSI host UNIX, NT, NetWare	SCSI host UNIX, NT, NetWare	SCSI host UNIX, NT, NetWare	SCSI host UNIX, NT, NetWare
RAID level Configured by:	0/3/10/"53"* Host	0/1/5 Panel, Port	0/1/5 Panel, Port	0/1/5 Panel, Port	0/1/5 Panel, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	4.1/2/8.2 174.2/69.7/39.4	4.1/2/8.2 20.8/8.3/16.6	4.1/2/8.2 43.5/17.4/34.8	4.1/2/8.2 41.6/16.6/33.3
Minimum drives per array	5	1/2/4+1	1/2/4	1/2/4	1/2/4
Maximum drives per array	75	20/16/16+4	5/4/4	5/4/4	10/8/8
Concurrent host channels	1, 2	1, 2	1	1, 2	1, 2
Controller drive channels	5	5	5	5	5
Array interface to host	Fibre	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	10	8, 128	4, 64	8, 128	8, 128
Cache function (Read, Write)	Read	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes -- --	Option Yes Option	No No Option	Option Yes Option	Option Yes Option
Spare drive (None/Auto/Manual)	Auto	Manual, Auto	None	Manual, Auto	Manual, Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	50 20	10/20 10	10/20 10	10/20 10	10/20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	2068-8712	2068-4162	2068-8712	2068-4162
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	Array size dependent	27.6 x 11.8 x 23.6	13.8 x 5.9 x 15	16.1 x 9.1 x 18.3	8.5 x 19.1 x 27.9
POWER: Power backup	20 watts+drives	800 watts	240 watts	300 watts	400 watts
FIRST CUSTOMER SHIPMENT	3/93	2Q95	2Q95	2Q95	2Q95
COMMENTS	*RAID 53 is combined RAID 5 and RAID 3.				Rack mount type

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
ARRAY MODEL	A-6531-RKH	A-6531-RKWH	HT-2460-111	HT-2460-121	A-6591/A-6595 H-6591/H-6595
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Mainframe
MARKET	Captive, PCM	Captive, PCM	Captive, PCM	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host UNIX, NT, NetWare	SCSI host UNIX, NetWare, NT	Ethernet	Ethernet	IBM, Hitachi mainframe, MVS, VSVM, VSE, VOS3
RAID level Configured by:	0/1/5 Panel, Port	0/1/5 Panel, Port	5 Host,Panel,Port	5 Host,Panel,Port	5 Preset
Array capacity (Gbytes) MIN MAX	4.1/2/8.2 87.1/34.8/69.7	4.1/2/8.2 174.2/69.7/139	8 33	16 66	22.7 (23.3) 723.7 (747.6)
Minimum drives per array	1/2/4	1/2/4	4+1	4	7*
Maximum drives per array	10/8/8	20/16/16	16+4	16	224*
Concurrent host channels	1, 2	1, 2	1	1	8, 16
Controller drive channels	5	5	5	5	1-32
Array interface to host	SCSI-2	SCSI-2	Ethernet	Ethernet	IBM, Hitachi
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 128	8, 128	64, 128	128	256, 8192
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write**
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Option	Option Yes Yes	No Yes No	No Yes No	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual, Auto	Manual, Auto	None	None	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10	10/20 10	10	10	17 20
DRIVES: Formatted capacity/drive(MB)	2068-8712	2068-8712	2068	4162	4360
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	11.5
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4.7
Drive models	Various	Various	Various	Various	Hitachi
ARRAY SIZE: Inches: H x W x D	10.4 x 19.1 x 25.8	17.3 x 18.9 x 24.9	27.6 x 15.2 x 23.6	27.6 x 15.2 x 23.6	--
POWER: Power backup	500 watts	1000 watts	1000 watts	1000 watts	11.66 KVA Battery
FIRST CUSTOMER SHIPMENT	4Q95	4Q96	1Q96	1Q96	3Q95
COMMENTS	Rack mount type	Rack mount type	Direct network attached.	Direct network attached.	*Host spares. **Duplexed cache for write data.

MANUFACTURER	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS
ARRAY MODEL	5710 Midrange Series Desktop	5730 Midrange Series Mini-Tower	574X Midrange Series Rack-Mount	5750 Midrange Series Tower	7700 Array Subsystem
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI	AS/400, SCSI	AS/400, SCSI	AS/400, SCSI	HDS/IBM mainframe MVS, VS, VSE
RAID level	0/1/5	0/1/5	0/1/5	0/1/5	5
Configured by:	Port	Port	Port	Port	Preset
Array capacity (Gbytes) MIN	4/2/8	4/2/8	4/2/8	4/2/8	22.7
MAX	20.5/8.2/16.4	21.5/8.6/17.2	41/16.4/32.8	82/32.8/65.6	726.5
Minimum drives per array	2	2	2	2	7*
Maximum drives per array	5	5	10	20	224*
Concurrent host channels	1	1	1	1	4, 8
Controller drive channels	2	5	5	5	8-32
Array interface to host	SCSI-2	SCSI-2, AS/400	SCSI-2, AS/400	SCSI-2, AS/400	IBM
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	8, 256	8, 256	8, 256	256, 8192
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write**
Redundancy: Controller (Yes/No)	No	Yes	Yes	Yes	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10-20	10-20	10-20	10-20	17
drive (MB/Sec)	10-20	10-20	10-20	10-20	12.5
DRIVES: Formatted capacity/drive(MB)	2100, 4200	2100, 4200	2100, 4200	2100, 4200	4360
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5-10.5	9.5-10.5	9.5-10.5	9.5-10.5	11.5
Average rotational delay (msec)	5.6	5.6	5.6	5.6	4.7
Drive models	Various	Various	Various	Various	Hitachi
ARRAY SIZE: Inches: H x W x D	13.8 x 5.9 x 15	16.1 x 9 x 18.3	8.5 x 19.1 x 27.9	27.6 x 11.8 x 23.6	70.5 x 51.2 x 31.5
POWER:	.240 KVA	.3 KVA	.4 KVA	.8 KVA	2.2 KVA
Power backup	Battery	Battery	Battery	Battery	Battery
FIRST CUSTOMER SHIPMENT	4Q95	4Q95	4Q95	4Q95	3Q95
COMMENTS					*Plus 1-16 hot spares. **Duplexed cache for write data.

MANUFACTURER	HITACHI DATA SYSTEMS	IBM	IBM	IBM	IBM
ARRAY MODEL	7750 Array Subsystem	32H3811 SSA RAID Adapter for PC	3527	6217 (RS/6000) SSA RAID Adapter	6218 (RS/6000) SSA RAID Adapter for PCI
DISK/TREND GROUP	Mainframe	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	Captive	Captive, PCM	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Board	Subsystem	Board	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	HDS/IBM mainframe MVS, VS, VSE	PC Server OS/2, NetWare, NT	PC OS/2, NT, NetWare	RS/6000 AIX 4.1.5	PCI host AIX 4.1.5
RAID level	5	0/1/5	0/1/5	5	5
Configured by:	Preset	Host	(Adapter depen)	Host	Host
Array capacity (Gbytes) MIN	22.7	Drive dependent	4.4	Drive dependent	Drive dependent
MAX	90.86	Drive dependent	22.5	Drive dependent	Drive dependent
Minimum drives per array	7	--	2	--	--
Maximum drives per array	28	192	5	96	96
Concurrent host channels	4, 8	1	2, 2	1	1
Controller drive channels	8, 16	2	2, 2	2	2
Array interface to host	IBM	PCI	SSA	MCA	PCI
Drive interface	SCSI-2	SSA	SSA	SSA	SSA
Cache size (min, max: MB)	256, 2560		Adapter: 0, 8		
Cache function (Read, Write)	Read, Write		Read		
Redundancy: Controller (Yes/No)	Yes	N/A	Yes	N/A	N/A
Fan (Yes/No)	Yes	N/A	No	N/A	N/A
Power supply (Yes/No)	Yes	N/A	No	N/A	N/A
Spare drive (None/Auto/Manual)	Auto	Auto	Option	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	17	132	40		132
drive (MB/Sec)	12.5	80	7-9/20	80	80
DRIVES: Formatted capacity/drive(MB)	4360	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	Drive dependent	95	Drive dependent	Drive dependent
Average positioning time (msec)	11.5	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.7	Drive dependent	4.7	Drive dependent	Drive dependent
Drive models	Hitachi	Various	IBM	Various	Various
ARRAY SIZE: Inches: H x W x D	70.5 x 29.5 x 31.5	.85 x 5 x 13.4	16 x 7.75 x 19	4.2 x 12.3	4.8 x 13.1
POWER:	2.39 KVA	16 watts	378 watts (max)	16.2 watts	19.9 watts
Power backup	Battery	N/A		N/A	N/A
FIRST CUSTOMER SHIPMENT	7/96	10/96	10/96	11/96	3/97
COMMENTS					

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	7131-405	7133-10/20 7133-500/600	7135-110 7135-210 RAIDiant	7137-412 7137-512	7137-413 7137-513
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	Captive, PCM	Captive	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	RS/6000 AIX	RS/6000, PC, AIX, OS/2, NT, NetWare	RS/6000 AIX 6000	RS/6000 AIX, HP UNIX, Sun, NCR	RS/6000 AIX, HP UNIX, Sun, NCR
RAID level Configured by:	0/1/5 (Adapter depen)	0/1/5 (Adapter depen)	0/1/3/5 Host	0/5 Panel	0/5 Panel
Array capacity (Gbytes) MIN	4.4	8.8	4/2/8/8*	2.96/1.97	6.45/4.30
MAX	45.5	145.6	133/67/108/108	7.89/6.91	17.2/15.05
Minimum drives per array	2	4	2	3	3
Maximum drives per array	5	16	30	8	8
Concurrent host channels	2, 2	8, 8	1, 2	1	1
Controller drive channels	2, 2	8, 8	5	4	4
Array interface to host	SSA	SSA	SCSI-2	SCSI-2	SCSI-2
Drive interface	SSA	SSA	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	Adapter: 0, 8	Adapter: 0, 8	2, 16**	1, 4	1, 4
Cache function (Read, Write)	Read	Read	Read, Write**	Write	Write
Redundancy: Controller (Yes/No)	Yes(2 adapters)	Yes(2 adapters)	Yes (option)	No	No
Fan (Yes/No)	No	Yes	Yes	No	No
Power supply (Yes/No)	No	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Option	Option	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	40	140	20	20	20
drive (MB/Sec)	7-9/20	7-9/20	10	10	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	1300,2200,4500	986	2151
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	7.8/9.5	7.5	7.5
Average rotational delay (msec)	4.7	4.7	5.56	4.17	4.17
Drive models	IBM	IBM	IBM	IBM	IBM
ARRAY SIZE: Inches: H x W x D	16 x 7.75 x 19	24 x 8.3 x 32.3	10.5 x 17.4 x 26.2	24 x 12.2x32.3 (412)	24 x 12.2x32.3 (413)
POWER:	378 watts (max)	532 watts (max)	660 watts	.35 KVA	.35 KVA
Power backup			None	None	None
FIRST CUSTOMER SHIPMENT	3Q95	3Q95	3Q93	4Q94	4Q94
COMMENTS		Model 10/20 drawer. Model 500/600 tower.	For RS/6000. *With 2 GB drives. **Model -210.	Dual AC feed. -412 is tower. -512 is rack mount.	Dual AC feed. -413 is tower. -513 is rack mount.

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	7137-414 7137-514	7137-415 7137-515	8640-1Y0 PC Server 320	8640-1YT PC Server 320	8640-EE1 PC Server 320
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	Captive, PCM	PCM	PCM	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	RS/6000, HP, Sun, NCR AIX, UNIX	RS/6000, HP, Sun, NCR	PC Server 320 OS/2, NT, UNIX, NetWare, SCO	PC Server 320 OS/2,NT,NetWare UNIXWare, SCO	PC Server 320 OS/2,NT,NetWare UNIXWare, SCO
RAID level Configured by:	0/5 Panel	0/5 Panel	0/1/5 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	12.92/8.61 34.44/30.14	26.56/17.7 70.83/61.98	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	3	1	1	1
Maximum drives per array	8	8	6	6	6
Concurrent host channels	1	1	1, 4	1	1
Controller drive channels	4	4	2	2	2
Array interface to host	SCSI-2	SCSI-2	PCI	PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1, 4	4	4	4	4
Cache function (Read, Write)	Write	Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	No No Yes	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	132 20	132 20	20
DRIVES: Formatted capacity/drive(MB)	4306	8854	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	8	6.9	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.17	Drive dependent	Drive dependent	Drive dependent
Drive models	IBM	IBM	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	24 x 12.2x32.3 (414)	24 x 12.2x32.3 (415)	25.6 x 12.4 x 18.6	25.6 x 12.4 x 18.6	25.6 x 12.4 x 18.6
POWER: Power backup	.35 KVA None	.35 KVA None	300 watts UPS	300 watts UPS	300 watts
FIRST CUSTOMER SHIPMENT	4Q94	11/96	6/95	6/95	8/96
COMMENTS	Dual AC feed. -414 is tower. -514 is rack mount.	Dual AC feed. -415 is tower. -515 is rack mount.			

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	8640-EES PC Server 320	8641-EDx 8641-MDx PC Server 520	8641-EE1 PC Server 520	8641-EEE PC Server 520	8641-EEL PC Server 520
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	PCM	Captive	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC Server 320 OS/2,NT,NetWare UNIXWare, SCO	PC Server 520 OS/2,NT,NetWare UNIXWare, SCO	PC Server 520 OS/2, NetWare, NT, SCO	PC Server 520 OS/2, NetWare, NT, SCO	PC Server 520 OS/2, NetWare, NT, SCO
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	1	1	1	1	1
Maximum drives per array	6	12	18	18	18
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	2	3	3	3
Array interface to host	PCI	PCI	PCI	PCI	PCI
Drive interface	SCSI-2	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	4	4	4	4	4
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No Option	No No Option	No No Option	No No Option
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20	132 20	132 40	132 40	132 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	25.6 x 12.4 x 18.6	24.5 x 13.9 x 29.7	24.5 x 13.9 x 29.7	24.5 x 13.9 x 29.7	24.5 x 13.9 x 29.7
POWER: Power backup	300 watts	434 watts UPS option	434 watts	434 watts	434 watts
FIRST CUSTOMER SHIPMENT	8/96		8/96	8/96	9/96
COMMENTS					

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	8641-EZx 8641-MZx PC Server 520	8641-0YR PC Server 500	8641-0YS PC Server 500	8642-2ZS PC Server 720	8642-4ZS PC Server 720
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC Server 520 OS/2, NT, UNIX, NetWare	IBM PC Server 500, OS/2,VINES NT,NetWare,UNIX	IBM PC Server 500, OS/2,VINES NT,NetWare,UNIX	PC Server 720 OS/2, NT, UNIX, NetWare	PC Server 720 OS/2, NT, UNIX, NetWare
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	1	1	1	1	1
Maximum drives per array	12	18	18	12	12
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	2	2	2	2
Array interface to host	PCI	MCA	MCA	MC	MC
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4	4	4	4	4
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Option	No No No	No No No	No No Option	No No Option
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 20	40 20	40 20	80 20	80 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	24.5 x 13.9 x 29.7	24.5 x 13.9 x 29.7	24.5 x 13.9 x 29.7	24.5 x 13.9 x 29.7	24.5 x 13.9 x 29.7
POWER: Power backup	434 watts UPS option	434 watts UPS option	434 watts UPS option	690 watts UPS	690 watts UPS
FIRST CUSTOMER SHIPMENT		4Q94	4Q94	7/95	7/95
COMMENTS					

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	8650-7AX PC Server 704	9337-540	9337-545	9337-580	9337-585
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC Server 704 OS/2, NetWare, NT, SCO	AS/400 OS/400	AS/400 OS/400	AS/400 OS/400	AS/400 OS/400
RAID level Configured by:	0/1/5 Host	0/5 Panel	0/5 Panel	0/5 Panel	0/5 Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	5.9 15.73	5.9 15.73	12.58 33.55	12.58 33.55
Minimum drives per array	1	4	4	4	4
Maximum drives per array	12	8	8	8	8
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	4	4	4	4
Array interface to host	PCI	IBM 6501 10P	IBM 6501 10P	IBM 6501 10P	IBM 6501 10P
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4	4 MB NV Write	4 MB NV Write	4 MB NV Write	4 MB NV Write
Cache function (Read, Write)	Read, Write	Write	Write	Write	Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Option	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 20	20 10	20 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1967	1967	4194	4194
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	7.8	7.8	8	8
Average rotational delay (msec)	Drive dependent	4.17	4.17	4.17	4.17
Drive models	Various	IBM	IBM	IBM	IBM
ARRAY SIZE: Inches: H x W x D	27.4 x 18 x 24.8	7 x 19 x 26.2	24 x 12.2 x 32.3	7 x 19 x 26.2	24 x 12.2 x 32.3
POWER: Power backup	420 watts	.35 KVA None	.35 KVA None	.35 KVA None	.35 KVA None
FIRST CUSTOMER SHIPMENT		6/96	6/96	6/96	6/96
COMMENTS		Dual AC feed. Rack.	Dual AC feed. Tower.	Dual AC feed. Rack.	Dual AC feed. Tower.

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	9595-3NG 9595-3PG 9595-3QG PS/2 Server 95	9595-3NT 9595-3PT 9595-3QT PS/2 Server 95	PC ServeRAID SCSI Adapter	PRS4-20 SSA RAID Adapter for PCI	9393-1 RAMAC Virtual Array Storage
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Mainframe
MARKET	Captive, PCM	Captive, PCM	Captive	OEM	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Board Hardware	Board Hardware	Subsystem Hardware
Host platform, software environment	IBM PS/2 Server OS/2,NetW,LAN S NT,SCO,UNIXWare	IBM PS/2 Server OS/2,LAN Server NetW.,SCO,UNIXW	PC Server OS/2, NetWare, NT, SCO	PCI host --	System/390 MVS, VM, VSE
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/3/5 Host	"6" Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	180* 720*
Minimum drives per array	1	1	1	--	32
Maximum drives per array	7	7	45	96	256
Concurrent host channels	1	1	1	1	12
Controller drive channels	2	2	3(15 drvs.each)	2	14
Array interface to host	MCA	MCA	PCI	PCI	ESCON, Parallel
Drive interface	SCSI-2	SCSI-2	Ultra SCSI	SSA	SCSI
Cache size (min, max: MB)	4	4	4	4 WR, 32 RD	1024, 3072**
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No N/A N/A	N/A N/A N/A	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto*	Auto*	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 20	40 20	40 40	132 80	18 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	1450
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4.17
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	19.75 x 8 x 20	19.75 x 8 x 20	N/A	--	72.6 x 126 (max) x 32
POWER: Power backup	560 watts	560 watts	N/A N/A	12 watts N/A	12.7 KVA (max)
FIRST CUSTOMER SHIPMENT	1Q94	1Q94	8/96		8/96
COMMENTS	*In RAID-1 mode only. Mylex controller.	*In RAID-1 mode only. Mylex controller.			*Assumes 3.3 data compress. **Effect cap. assumes 2:1 compression. (STC Iceberg).

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	9393-2 RAMAC Virtual Array Storage	9396 RAMAC Scalable Array Storage	Multiprise 2000 (Internal Disk)	RAMAC 1 Array DASD	RAMAC 1 Array Subsystem
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	System/390 MVS, VM, VSE	System/390 MVS, VM, VSE	System/390 MVS, VM, VSE	System/390 MVS, VM, VSE, TPF	System/390 MVS, VM, VSE, TPF
RAID level	"6"	5	1	5*	5
Configured by:	Preset	Preset	Preset	Preset	Preset
Array capacity (Gbytes) MIN	160*	46.47	17.8 (3390 fmt)	11.3	11.3
MAX	726*	1,394.1	284.8(3390 fmt)	181.4(2X racks)	90.8
Minimum drives per array	16		4	6	8
Maximum drives per array	64		64	128 (2X racks)	64
Concurrent host channels	12	16	N/A	**	4, 8
Controller drive channels	14	24	N/A	4**	4, 8
Array interface to host	ESCON, Parallel	ESCON, Parallel	N/A	ESCON, Parallel	ESCON, Parallel
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1024, 3072**	1024, 4096	32, 1024	32, 4096	64, 2048
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	None	Auto (option)	Auto (option)
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	18	18	N/A	18	18
drive (MB/Sec)	20	20	20	20	20
DRIVES: Formatted capacity/drive(MB)	4550	9100	9100	2048	2048
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	7.5	8.5	8.5 RD	9.2 RD/10.7 WR	9.2 RD/10.7 WR
Average rotational delay (msec)	4.17	4.17	4.17	5.6	5.6
Drive models	Ultrastar 2XP	Ultrastar 2XP	Ultrastar 2XP	IBM 0664	IBM 0664
ARRAY SIZE: Inches: H x W x D	72.6 x 47.5 x 32	72.4 x 142.1(max)x35.2	N/A	62.2 x 29.5 x 38.5	62.2 x 29.5 x 38.5
POWER:	5.1 KVA (max.)	14.9 KVA (max.)	N/A	4.1 KVA (max.)	3.98 KVA (max.)
Power backup			N/A	Battery	Battery
FIRST CUSTOMER SHIPMENT	11/96	11/96	1Q97	9/94	10/94
COMMENTS	*Assumes 3.6X data compress. **Effect cap. assumes 2:1 compression. (STC Iceberg).	Compatible with 3380, 3390. (STC Kodiak).	Internal disk option for 13 models of S/390 Multiprise 2000 Compatible with 3380, 3390.	Compat.w/3390-3 *3990 has "dual copy" RAID-1 capability. **Attaches to 3990-3/6.	Compat.w/3380-K 3390 or 9340. Attaches directly to system.

MANUFACTURER	IBM	IBM	IBM	INFORTREND	INFORTREND
ARRAY MODEL	RAMAC 2 Array DASD	RAMAC 2 Array Subsystem	RAMAC 3 Array	IFT-2101UA* IFT-2101UB	IFT-3101U
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware	Board Hardware
Host platform, software environment	System/390 MVS, VM, VSE, TPF	System/390 MVS, VM, VSE, TPF	System/390 MVS, VM, VSE, TPF	SCSI host DOS, NT, OS/2, UNIX, NetWare	SCSI host
RAID level Configured by:	5* Preset	5 Preset	5* Preset	0/1/3/5 Port	0/1/3/5 Port, Panel
Array capacity (Gbytes) MIN MAX	22.7 181.4	22.7 181.4	45.4 726 (2X racks)	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	8	8	8	2	2
Maximum drives per array	64	64	128	14	14
Concurrent host channels	**	4, 8	**	1	1, 2
Controller drive channels	4**	4, 8	4, 8**	1, 2	1-2
Array interface to host	ESCON, Parallel	ESCON, Parallel	ESCON, Parallel	PCI	Ultra SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	32, 4096	64, 2048	256, 8192	4, 32	4, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	No -- --	Yes -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	18 20	18 20	18 20	132 10	40 40
DRIVES: Formatted capacity/drive(MB)	4512	4512	9100	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	Drive dependent	Drive dependent
Average positioning time (msec)	8 RD/9.5 WR	8 RD/9.5 WR	8.5 RD	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.17	4.17	Drive dependent	Drive dependent
Drive models	Ultrastar XP	Ultrastar XP	Ultrastar 2XP	Various	Various
ARRAY SIZE: Inches: H x W x D	62.2 x 29.5 x 38.5	62.2 x 29.5 x 38.5	62.2 x 29.5 x 38.5	4.2 x 6.88	1.61 x 4.01 x 6.26
POWER: Power backup	3.2 KVA (max.) Battery	3.3 KVA (max.) Battery	3.2 KVA (max.) Battery	10 watts Battery option	6.5 watts None
FIRST CUSTOMER SHIPMENT	10/95	10/95	11/96	8/96	8/96
COMMENTS	Compat.w/3390-3 *3990 has "dual copy" RAID-1 capability. **Attaches to 3990-6.	Compatible with 3380-K or 3390-3. Attaches directly to system.	Compat.w/3390-3 *Plus "dual copy". **Attaches to 9390 or 3990-6 controller.	Flash memory firmware. *Single output channel.	Flash memory firmware.

MANUFACTURER	INFORTREND	INTEGRIX	INVINCIBLE TECHNOLOGIES	INVINCIBLE TECHNOLOGIES	INVINCIBLE TECHNOLOGIES
ARRAY MODEL	IFT-3102U	RD-10	LIFELINE Information Server	Ultimate-5 700	Ultimate-5 1000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	PCM	Captive	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host	Sun SPARC UNIX	LIFELINE, NT, UNIX	DEC, Sun, NT, Novell, RS/6000	DEC, Sun, NT, Novell, RS/6000
RAID level Configured by:	0/1/3/5 Port, Panel	0/1/3/5/10 Host, Port	0/1/5/10 Host	0/1/3/5/10 Host, Panel	0/1/3/5/10 Host, Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	4 25.2	6 180	6 61	6 88
Minimum drives per array	2	2	3	3	3
Maximum drives per array	35	6	21	7	10
Concurrent host channels	1, 5	2	N/A	1	2
Controller drive channels	2-5	1	3	2	2
Array interface to host	Ultra SCSI	SCSI-2	PCI	SCSI-2	SCSI-2
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	8, 128	16, 32	8, 32	16, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes -- --	No Yes No	No Yes Yes	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	20 20	133 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1000,2000,4000	2100,4200,8800	2100,4200,8800	2100,4200,8800
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	8	8	Drive dependent
Average rotational delay (msec)	Drive dependent	5.6	4.16	4.16	Drive dependent
Drive models	Various	Seagate	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	1.6 x 5.7 x 8.4	3 x 16 x 16		19 x 7 x 19	24 x 10.5 x 30
POWER: Power backup	7.5 watts Battery option	Battery		300 watts Battery	575 watts UPS
FIRST CUSTOMER SHIPMENT	8/96	1Q96		5/96	5/96
COMMENTS	Flash memory firmware.		Server, rack or pedestal.	Rack or tower.	Rack or pedestal.

MANUFACTURER	INVINCIBLE TECHNOLOGIES	IPC TECHNOLOGIES	IPC TECHNOLOGIES	IPL	IPL
ARRAY MODEL	Ultimate-5 2050	Austin Affinity XEPro	Austin Affinity	ENTERPRISE STORAGE SERVER	RAIDTOWER 7037-E4X
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	DEC, Sun, NT, Novell, RS/6000	Austin	Austin	RS/6000, HP, Sun, NetWare, Wind NT, AS/400	RS/6000, HP, Sun, NetWare, Wind NT, AS/400
RAID level Configured by:	0/1/3/5/10 Host, Panel	0/1/5/10 Host	0/1/5/10 Host	0/1/5	0/1/5
Array capacity (Gbytes) MIN MAX	6 176	4 24	4 24	6 268	6 30
Minimum drives per array	3	2	2	4	4
Maximum drives per array	20	12	12	64	14
Concurrent host channels	2	1	1	16	2
Controller drive channels	5	1, 2	1, 2	16	2
Array interface to host	SCSI-2	PCI	PCI	SCSI	SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI	SCSI
Cache size (min, max: MB)	16, 128	4, 32	4, 32	16, 4100	16, 512
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No Yes Option	No Yes Option	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	133 20	133 20	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	2100,4200,8800	2100	2100, 4300	2000, 4000	2000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8			8.5	9.5
Average rotational delay (msec)	4.16	4.17	4.17	4.17	5.6
Drive models	Various	Seagate	Seagate	IBM, Seagate	Seagate
ARRAY SIZE: Inches: H x W x D	24.8 x 14 x 30			Std. 19" Rack	Deskside: 24.12 x 7.5 x 28.3
POWER: Power backup	880 watts UPS	500 watts None	500 watts None	1.6 KVA	.20 KVA
FIRST CUSTOMER SHIPMENT	5/96	1996	1996	1/95	7/94
COMMENTS	Rack or pedestal.				

MANUFACTURER	IPL	LAND-5	LAND-5	LEGACY STORAGE SYSTEMS	LEGACY STORAGE SYSTEMS
ARRAY MODEL	RAIDTOWER 7037-E8X	DS200	DS300	Smart Array	Smart Array/RM
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Software	Hardware
Host platform, software environment	RS/6000, HP, Sun, NetWare, Wind NT, AS/400	SCSI host Various	SCSI host Various	Misc. networks NetWare, NT, OS/2, UNIX	Misc. networks NetWare, NT, OS/2, UNIX
RAID level Configured by:	0/1/5	0/1/3/5/10	0/1/3/5/7/10 Host	0/1/3/5/10	0/1/3/5/10
Array capacity (Gbytes) MIN	12	4	4	2	2
MAX	60	45	76	32	32
Minimum drives per array	4	2	2	3	3
Maximum drives per array	14	10	18	9	8
Concurrent host channels	2	1, 2	1, 2	1, 4	1, 4
Controller drive channels	2	2	3	1, 2, 3, 5	1, 2, 3, 5
Array interface to host	SCSI	SCSI-2	SCSI-2	EISA, ISA, MCA, PC	EISA, ISA, SCSI, P
Drive interface	SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	16, 512			0, 64	0, 64
Cache function (Read, Write)	Read, Write			Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	Yes (option)	Yes (option)
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes (option)	Yes (option)
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Auto (option)	Auto (option)
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	20	20	33	33
drive (MB/Sec)	10	20	20	10	10
DRIVES: Formatted capacity/drive(MB)	4000	4000, 9000	2000, 4000	1000,2000,4000	1000,2000,4000
Nominal disk diameter (mm)	95	95, 130	95	Drive dependent	Drive dependent
Average positioning time (msec)	8.5	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Seagate	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	Deskside: 24.12 x 7.5 x 28.3	10.5 x 28 x 17	10.5 x 28 x 17	21.4 x 8.4 x 20.6	10.5 x 19 x 22
POWER: Power backup	.20 KVA	400 watts	400 watts	250-750 watts	200-250 watts
FIRST CUSTOMER SHIPMENT	1/95	1995	1995	8/93	2/95
COMMENTS		Dual AC power.	Dual AC power.	Optical & tape drive options. Software-based subsystem. RAID-3/5 option	RAID-3/5 optional. Rack mount.

MANUFACTURER	LEGACY STORAGE SYSTEMS	LIGHTHOUSE TECHNOLOGY	LOMAS DATA	LOMAS DATA	LOMAS DATA
ARRAY MODEL	Smart Array/XE	Harbor	LDP CACHE IIP	LDP CACHE V-PCI	LDP CACHE IV
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	PCM	OEM	OEM	OEM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Board	Board	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Misc. networks NetWare, NT, OS/2, UNIX	SCSI host UNIX	ISA, EISA NetWare, UNIX, DOS, OS/2	PC compatible NetWare, UNIX, DOS, Wind. NT	PC compatible NetWare, UNIX, DOS, OS/2
RAID level	0/1/3/5/10	0/1/3/5/10	0/1	0/1/5	1
Configured by:		Panel		Host	Preset
Array capacity (Gbytes) MIN	2	Drive dependent	.1	Drive dependent	Drive dependent
MAX	48	Drive dependent	16	Drive dependent	Drive dependent
Minimum drives per array	2	3	2	2	2
Maximum drives per array	13	35	4	15	4
Concurrent host channels	1, 6	1, 4	1	1	1
Controller drive channels	1, 2, 3, 5	1	1	3	1
Array interface to host	EISA,ISA,SCSI,P	SCSI-2	ISA	PCI	ISA
Drive interface	SCSI-2	SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI, SCSI-2
Cache size (min, max: MB)	0, 64	16, 128	1, 16	2, 128	2, 16
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes (option)	Option	No	No	No
Fan (Yes/No)	Yes	Yes	--	--	--
Power supply (Yes/No)	Yes (option)	Yes	--	--	--
Spare drive (None/Auto/Manual)	Auto (option)	Auto	Manual-foregrnd	Auto	Manual-foregrnd
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	33	10/20	Host dependent	132	6
drive (MB/Sec)	10	10/20	5	40	5
DRIVES: Formatted capacity/drive(MB)	1000,2000,4000	2000-9000	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Seagate, other	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	29.4 x 8.4 x 20.6	Varies	4.7 x 13.4	3.8 x 13	4.7 x 13.4
POWER:	250-750 watts		8 watts	10 watts	9 watts
Power backup		Cache battery	None	None	None
FIRST CUSTOMER SHIPMENT	12/93	1996	1989	4Q96	4Q93
COMMENTS	RAID-3/5 optional. Tower.	CMD controller.			

ASPEC-75

MANUFACTURER	MACRO COMPUTER PRODUCTS	MAXCONCEPT	MAXCONCEPT	MAXCONCEPT	MAXCONCEPT
ARRAY MODEL	Macro-RAID 7 8000 Series	SW-18100E	SW-4100E	SW-4100R	SW-8100E
DISK/TREND GROUP	Mainframe	Single User	Single User	Single User	Single User
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Software	Subsystem Software	Subsystem Software	Subsystem Software
Host platform, software environment	Unisys A, V Other SCSI UNIX	Macintosh System 7	Macintosh System 7	Macintosh System 7	Macintosh System 7
RAID level Configured by:	"7" Preset	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	18 54	4 12	4 24	8 24
Minimum drives per array	3	2	2	2	2
Maximum drives per array	48	6	6	6	6
Concurrent host channels	1, 12	1	1	1	1
Controller drive channels	1, 48	1	1	1	1
Array interface to host	Ult. SCSI,FC-AL	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 256	--	--	--	--
Cache function (Read, Write)	Read,Write(opt)				
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	No No No	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	None	None	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20/40/100 10	20 20	20 20	20 20	20 20
DRIVES: Formatted capacity/drive(MB)	4300-9100	9100	2100	2100	4300
Nominal disk diameter (mm)	95, 130	95	95	95	95
Average positioning time (msec)	Drive dependent	8	8	8	8
Average rotational delay (msec)	Drive dependent	4.17	4.17	4.17	4.17
Drive models	Seagate, Fujitsu	Seagate Barracuda	Seagate Barracuda	Seagate Barracuda	Seagate Barracuda
ARRAY SIZE: Inches: H x W x D	Varies with configuration	Varies	Varies	Varies	Varies
POWER: Power backup	1.3 KVA None	Varies	Varies	Varies	Varies
FIRST CUSTOMER SHIPMENT	9/96	1995	1995	3Q94	1995
COMMENTS	Storage Computer controller. Nonvolatile memory option.	Trillium software array. External array.	Trillium software array. External array.	Trillium software array.	Trillium software array. External array.

MANUFACTURER	MAXIMUM STRATEGY	MAXIMUM STRATEGY	MAXIMUM STRATEGY	MAXIMUM STRATEGY	MEGADRIVE SYSTEMS
ARRAY MODEL	Gen5 L proFILE L	Gen5 XL proFILE XL	S-Series L	S-Series XL	MK/5
DISK/TREND GROUP	Very High Perf.	Very High Perf.	Very High Perf.	Very High Perf.	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Cray, IBM, SGI, Sun, Convex UNIX	Cray, IBM, SGI, Sun, Convex UNIX	Multi-SCSI host UNIX	Multi-SCSI host UNIX	SCSI host Various
RAID level	0/1/5	0/1/5	0/1/3/5	0/1/3/5	0/3/5
Configured by:	Host, Panel	Host, Panel	Host, Panel	Host, Panel	Host
Array capacity (Gbytes) MIN	64	200	64	200	2
MAX	128	800	128	800	21
Minimum drives per array	8	24	8	24	2
Maximum drives per array	16	96	16	96	5
Concurrent host channels	1-2	1-4	2-4	2-8	1
Controller drive channels	8	24	8	24	5
Array interface to host	HIPPI, FCS, ATM	HIPPI, FCS, ATM	Ultr.SCSI,FC-AL	Ultr.SCSI,FC-AL	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2
Cache size (min, max: MB)	16, 24	48, 120	8	48	0, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	Yes	No	Yes	No
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	No	Yes	No	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	100, 133, 19	100, 133, 19	20/40/133	20/40/133	20
drive (MB/Sec)	20	20	20	20	10
DRIVES: Formatted capacity/drive(MB)	9100	9100	9100	9100	1050-4294
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8	8	8	8	8-10
Average rotational delay (msec)	4.17	4.17	4.17	4.17	4.17-5.6
Drive models	Seagate Barracuda	Seagate Barracuda	Seagate Barracuda	Seagate Barracuda	Various
ARRAY SIZE: Inches: H x W x D	22.5 x 19 x 24.75	72 x 29.5 x 36.5	22.5 x 19 x 24.6	72 x 29.5 x 38.5	17 x 7 x 18
POWER:	.9-1.2 KVA	3.3-4.8 KVA	.9-1.2 KVA	4.85 KVA	200 watts
Power backup	None	Integral UPS	None	Integral UPS	None
FIRST CUSTOMER SHIPMENT	3/95	12/94	5/96	5/96	4Q93
COMMENTS	proFILE L is complete TCP/IP server. Gen5 L is array	proFILE XL is complete TCP/IP server. Gen5 XL is array.	SCSI, FC-AL and Ultra-SCSI network ports.	SCSI, FC-AL and Ultra-SCSI network ports.	Modified purchased controller. Rack mount. i960 RISC processor.

MANUFACTURER	MEGADRIVE SYSTEMS	MEGADRIVE SYSTEMS	MEGADRIVE SYSTEMS	MEGADRIVE SYSTEMS	MEGADRIVE SYSTEMS
ARRAY MODEL	MR/5	MR/10	Aria	Enterprise E-8	Enterprise E-2
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Software
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level	0/3/5	0/3/5	0/1/5/10	0/1/5/10	0/1
Configured by:	Host	Host	Host	Host	Host
Array capacity (Gbytes) MIN	2	2		1	15
MAX	21	42		36	18
Minimum drives per array	2	5		2	2
Maximum drives per array	5	10		8	8
Concurrent host channels	1	1	2	1	1
Controller drive channels	5	5		3	1
Array interface to host	SCSI-2	SCSI-2	FC-AL	SCSI-2, other*	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	0, 128	128		0, 32	--
Cache function (Read, Write)	Read, Write	Read, Write		Read, Write	--
Redundancy: Controller (Yes/No)	No	No	Yes	Yes	--
Fan (Yes/No)	Yes	Yes	Yes	Yes	--
Power supply (Yes/No)	Yes	Yes	Yes	Yes	--
Spare drive (None/Auto/Manual)	Manual	Manual	Auto	Auto	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	20	200	40	20
drive (MB/Sec)	10	10		20	20
DRIVES: Formatted capacity/drive(MB)	1050-4294	1050-4294	9090	535-4294	Drive dependent
Nominal disk diameter (mm)	95	95	95, 130	95, 130	Drive dependent
Average positioning time (msec)	8-10	8-10	8-10	8-11	Drive dependent
Average rotational delay (msec)	4.17-5.6	4.17-5.6	4.17-5.6	4.17-5.6	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	17 x 7 x 18	15.5 x 20.5 x 19		17.3 x 7 x 14	6.5 x 7 x 11
POWER:	200 watts	200 watts		200 watts	70 watts
Power backup	None	None		None	
FIRST CUSTOMER SHIPMENT	4Q92	4Q92	3Q96	1Q95	
COMMENTS	Modified purchased controller. i960 RISC processor.	Modified purchased controller. i960 RISC processor.		*EISA, MCA, PCI with adapter. Numerous options.	

MANUFACTURER	MEGADRIVE SYSTEMS	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY
ARRAY MODEL	MX/500	2000J	DiskWorks 3.0	Raven Pro	Raven
DISK/TREND GROUP	Net/Midrange	Single User	Single User	Single User	Single User
MARKET	OEM, PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Software	Software Software	Subsystem Software	Subsystem Software
Host platform, software environment	SCSI host Various	Various	Apple Power Macintosh	Macintosh	Macintosh
RAID level Configured by:	0/3/5 Host	0/1 Host	0/1 Host	0/1	0 Preset
Array capacity (Gbytes) MIN MAX	45 315	1 2	Drive dependent Drive dependent	3.6 55	2.0 17.3
Minimum drives per array	3	2	2	2	2
Maximum drives per array	31	2	90	6	2
Concurrent host channels	2	1	1, 6	1	1
Controller drive channels	5		15, 90	2	2
Array interface to host	SCSI-2		--	NuBus	SCSI-2
Drive interface	SCSI-2		SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	0, 128	--	--	--	--
Cache function (Read, Write)	Read, Write	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No No No	-- -- --	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	None	Manual	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	50 10		Drive dependent Drive dependent	Host dependent 20	Host dependent 10
DRIVES: Formatted capacity/drive(MB)	9090	1000	Drive dependent	1800-8670	1000-8670
Nominal disk diameter (mm)	130	95	Drive dependent	95	95
Average positioning time (msec)	11		Drive dependent	9, 10.5	8, 15
Average rotational delay (msec)	5.6		Drive dependent	4.8, 6.8	4.8, 6.8
Drive models	Various	Iomega Jaz	Various	Varies	Various
ARRAY SIZE: Inches: H x W x D	16.89 x 13.95 x 20.5	4 x 5 x 10	--	6.5 x 7.75 x 12	6.5 x 7.75 x 12*
POWER: Power backup	300 watts None		--	50 watts None	50 watts None
FIRST CUSTOMER SHIPMENT	1Q95	4Q95	3Q96	3/94	3/90
COMMENTS	i960 processor. Expandable to 2.2 TB.		Includes drive management features. Requires SCSI controller.	Uses Conley software.	*Size may vary depending upon drives supplied

MANUFACTURER	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICROTECH INTERNATIONAL
ARRAY MODEL	DataDock 7000	RAIDbank	RAIDbank Plus	RAIDbank Pro	Blue Streak 8220P RAID
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Single User
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Software	Subsystem Hardware	Subsystem Hardware	Subsystem Software
Host platform, software environment	SCSI host	PC compatible Various	PC compatible NetWare, UNIX, Windows NT	PC compatible NetWare, UNIX, Windows NT	Macintosh System 7
RAID level Configured by:	0/1/3/5 Port	0/1/5 Host	0/1/5 Host	0/1/3/5 Preset	0/1 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	1/.5/1 24/12/20	1/.5/1 24/12/20	1/.5/1/1 112/66/90/90	Drive dependent Drive dependent
Minimum drives per array	2	2/2/3	2/2/3	2/2/3/3	2
Maximum drives per array	7	6 + spare	6 + spare	28	10
Concurrent host channels	1	1	1, 2	2, 4	1
Controller drive channels	1	1, 2	1, 2	2, 1	1
Array interface to host	SCSI-2	SCSI-2,EISA,MCA	SCSI-2, EISA	SCSI-2	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)		--	4, 64	--	
Cache function (Read, Write)		--	Read, Write	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Yes No Yes	No No Yes	No No Yes	No Per drive Per drive
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40	Host dependent 10	11.2 10	33 10	132 10/20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1020-4000	1020-4000	1020-4000	2100-9100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	9, 10.5	9, 10.5	8, 14	8-10
Average rotational delay (msec)	Drive dependent	5.6	5.6	4.8, 6.8	5.6, 4.17
Drive models	Various	Seagate 3160NC, 12400NC,31200NC	Seagate 3160NC, 12400NC,31200NC	Various	Seagate
ARRAY SIZE: Inches: H x W x D		6.5 x 18 x 18	6.5 x 18 x 18	6.5 x 7.75 x 12*	4 x 12.8
POWER: Power backup		54 watts None	54 watts None	50 watts None	5 watts+drives None
FIRST CUSTOMER SHIPMENT	3Q96	4Q93	5/94	1/95	9/96
COMMENTS	Expandable.	Uses single connector drives. Software array.	Uses single connector drives.	*Size may vary depending upon drives supplied	Adaptec controller. Proprietary enclosure.

MANUFACTURER	MORTON MANAGEMENT	MORTON MANAGEMENT	MOUNTAINGATE DATA SYSTEMS	MOUNTAINGATE DATA SYSTEMS	MOUNTAINGATE DATA SYSTEMS
ARRAY MODEL	GBR-RD-6000	GBR-RD-NC	Renegade	Stampede	Stampede Ultra Array
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Software	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible LAN Mgr., OS/2, NetW., UNIX,DOS	PC compatible LAN Mgr., OS/2, NetW., UNIX,DOS	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	5	0/1/3/5	0/1/3/5/10 Host,Port,Panel	0/1/3/5/10	0/1/3/5/10
Array capacity (Gbytes) MIN MAX	12	6.5 6.5	10 42	8 33	Drive dependent Drive dependent
Minimum drives per array	7	6	2	2	2
Maximum drives per array	7	6	10	8	8
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1	2	2	1
Array interface to host	EISA, ISA,UChan	EISA	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	N/A	N/A	32, 16	16, 32	16, 32
Cache function (Read, Write)	N/A	N/A	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	Option Yes Yes	Option Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 5	10 10	10/20 10/20	10/20	20 20
DRIVES: Formatted capacity/drive(MB)	2000	1300	4000	4000, 9000	2100-9090
Nominal disk diameter (mm)	95	95	95	95, 130	95, 135
Average positioning time (msec)	Drive dependent	Drive dependent	12 RD/13 WR		Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17		Drive dependent
Drive models	Various	Various	Seagate Barracuda	Seagate Elite, Barracuda	Various
ARRAY SIZE: Inches: H x W x D	7 x 198 x 19	7 x 198 x 19	27 x 10.25 x 22.75		21 x 10 x 20.5
POWER: Power backup	350 watts None	350 watts None	500	500	300 watts None
FIRST CUSTOMER SHIPMENT	1993	1994	1/96	11/95	1996
COMMENTS	Software based array.	Digi-Data controller.	Redundant AC power option. Mylex controller.	Redundant AC power option. Mylex controller. Rack mount.	

MANUFACTURER	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY
ARRAY MODEL	8300	9200	9300	9500	Stingray DS StorageWare
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host Windows, NT	SCSI host UNIX, Windows NT	SCSI host UNIX, Windows NT	SCSI host UNIX, Windows NT	DEC, Sun, IBM, VMS, UNIX, other
RAID level	0/1/0+1/5	0/1/5/10	0/1/5/10	0/1/5/10	0/3/5
Configured by:	Host	Host	Host	Host	
Array capacity (Gbytes) MIN	4.3	4.3	4.3	18.2	Drive dependent
MAX	63.7	30.5	63.7	63.7	Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	8	8	16	8	
Concurrent host channels	2	1	1 or 2	1 or 2	1, 2
Controller drive channels	2	2	2	2	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	DSSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 8	16, 64	16, 64	16, 64	16, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read
Redundancy: Controller (Yes/No)	No	No	Option	No	No
Fan (Yes/No)	Yes	Yes	Yes	Yes	Option
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Option
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	20	20	20	4
drive (MB/Sec)	20	20	20	20	10
DRIVES: Formatted capacity/drive(MB)	2150,4350,9100	2150, 4350	2150,4350,9100	9100	Drive dependent
Nominal disk diameter (mm)	95	95	95	130	Drive dependent
Average positioning time (msec)	8	8	8	11	Drive dependent
Average rotational delay (msec)	4.17	4.17	4.17	5.56	Drive dependent
Drive models	Seagate Barracuda	Seagate Barracuda	Seagate Barracuda	Seagate Elite	
ARRAY SIZE: Inches: H x W x D	5.25 x 19 x 22	7 x 19 x 23 rack	8.75 x 19 x 22 rack	22 x 22 x 18	7 x 19 x 26
POWER:	150 watts	175 watts	165 watts	350 watts	60 watts
Power backup	Battery opt.	Cache BBU opt.	Cache BBU stand	Cache BBU opt.	None
FIRST CUSTOMER SHIPMENT	10/96	6/95	3/96	6/95	
COMMENTS			Dual host option, redundant controller option.	Dual host option.	

MANUFACTURER	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY
ARRAY MODEL	Stingray FDDI StorageWare	Stingray III StorageWare	StingRay NFS	SWRD-21F StorageWare	SWRD-43F StorageWare
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	DEC, Sun, IBM, VMS, UNIX, other	DEC, Sun, IBM, VMS, UNIX, other	NFS	DEC, Sun, IBM, VMS, UNIX, other	DEC, Sun, IBM, VMS, UNIX, other
RAID level Configured by:	0/3/5	0/3/5	4 Preset	3/5	3/5
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	14 20	8.4	17.2
Minimum drives per array	2	2	7	5	5
Maximum drives per array			14	5	5
Concurrent host channels	1, 2	1, 2	1, 2	--	--
Controller drive channels	3	3		--	--
Array interface to host	FDDI	CI	NI	CI, DSSI,SCSI-2	CI, DSSI,SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	16, 128	16, 128	--	16, 128	16, 128
Cache function (Read, Write)	Read	Read	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Option Option	No Option Option	No Option Option	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	None	None	Manual	N/A	N/A
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	8 10	8 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	2100-4300	2100	4300
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	9	8	9.5
Average rotational delay (msec)	Drive dependent	Drive dependent	5.56	4.17	4.17
Drive models			ST12400N Seagate	Seagate ST1550N	Seagate ST15150N
ARRAY SIZE: Inches: H x W x D	7 x 19 x 26	7 x 19 x 26	31 x 13 x 22	5.25 x 19 x 25	5.25 x 19 x 25
POWER: Power backup	122 watts None	122 watts None	287 watts	Battery	Battery
FIRST CUSTOMER SHIPMENT					
COMMENTS			NAC product.		

MANUFACTURER	MYLEX	MYLEX	MYLEX	MYLEX	MYLEX
ARRAY MODEL	DAC960-5	DAC960E-X	DAC960P-X	DAC960PD-X	DAC960PD-Ultra
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	PC compatible NetWare, OS/2, NT,UNIX,Banyan	PC compatible NetWare, OS/2, NT,UNIX,Banyan	PC compatible NetWare, OS/2, NT, UNIX	PC compatible NetWare, OS/2, NT, UNIX	PC compatible NetWare, OS/2, NT, UNIX
RAID level Configured by:	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	35	7, 14, 21	7, 14, 21	7, 14, 21	45
Concurrent host channels	1	1	1	1	1
Controller drive channels	5	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3
Array interface to host	EISA	EISA	PCI	PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	2, 32	4, 32	4, 32	4, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	No -- --	No -- --	No -- --	No -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	132 20	132 20	132 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Hewlett-Packard Seagate,Fujitsu	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	4.25 x 13	4.25 x 13	4.5 x 13	4.5 x 13	4.5 x 13
POWER: Power backup	20 watts None	20 watts Cache battery	20 watts Cache battery	20 watts Cache battery	20 watts Cache battery
FIRST CUSTOMER SHIPMENT	2Q92	2Q94	2Q94	4Q94	6/96
COMMENTS					

MANUFACTURER	MYLEX	MYLEX	MYLEX	MYLEX	MYLEX
ARRAY MODEL	DAC960PL-X	DAC960SI-X	DAC960S	DAC960PC	DAC960PG
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM	OEM	OEM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	PC compatible NetWare, OS/2, NT, UNIX	SCSI host Various	SCSI host Various	PC compatible NetWare, OS/2, NT, UNIX	PC compatible NetWare, OS/2, NT, UNIX
RAID level Configured by:	0/1/5/10 Host	0/1/3/5/10 Host,Panel,Port	0/1/3/5/10 Host,Panel,Port	0/1/3/5/10 Host	0/1/3/5/10 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7, 14, 21	14, 35*	14, 35*	15, 30, 45	15, 30, 45
Concurrent host channels	1	1, 2*	1, 2*	1	1
Controller drive channels	1, 2, 3	2, 5*	2, 5*	1, 2, 3	1, 2, 3
Array interface to host	PCI	SCSI-2 Wide	SCSI-2 Wide	PCI	PCI
Drive interface	SCSI-2	SCSI-2 Wid/Narr	SCSI-2 Wide	SCSI-3	SCSI-3
Cache size (min, max: MB)	2, 32	4, 128	4, 128	4, 128	4, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	No -- --	No -- --	No -- --	No -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 20	20 20	20 20	132 40	132 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	4.5 x 13	3.25 x 5.75 x 8.5	5.5 x 8	4.5 x 13	4.5 x 13
POWER: Power backup	20 watts Cache battery	20 watts Cache battery	20 watts Cache battery	17 watts Battery	17 watts Battery
FIRST CUSTOMER SHIPMENT	1Q95	2Q94	2Q94	1/97	1/97
COMMENTS	Mirrored cache.	*With DBI960S upgrade.	*With DBI960S upgrade.		

MANUFACTURER	MYLEX	MYLEX	NCR	NEC	NEC
ARRAY MODEL	DAC960SU	DAC960SUI-X	Disk Array Plus	DAS521	DAS522
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM	Captive,OEM,PCM	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Software Software	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	NCR UNIX	Express 5800 -7XX	Express 5800 -7XX
RAID level Configured by:	0/1/3/5/10 Host,Panel,Port	0/1/3/5/10 Host,Panel,Port	0/1/3/4/5/10/53 Host	1/3 Host	1/3 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	.5 1	1 2
Minimum drives per array	2	2	N/A	2	2
Maximum drives per array	14, 35*	14, 35*	N/A	3	3
Concurrent host channels	1, 2*	1, 2*	1-4	1	1
Controller drive channels	2, 5*	2, 5*	1	3	3
Array interface to host	Ultra SCSI	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2
Drive interface	Ultra SCSI	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 128	4, 128	--	1	1
Cache function (Read, Write)	Read, Write	Read, Write	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	No -- --	N/A N/A N/A	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	40 40	Host dependent Drive dependent	10 6	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	500	1000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	12	10.5
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	6.67	5.54
Drive models	Various	Various	Various	D3825	DKU364
ARRAY SIZE: Inches: H x W x D	5.5 x 8	3.25 x 5.75 x 8.5	N/A	205 x 140 x 245	205 x 140 x 245
POWER: Power backup	20 watts Cache battery	20 watts Cache battery	N/A	--	--
FIRST CUSTOMER SHIPMENT	8/96	9/96	6/92	2Q95	2Q95
COMMENTS	*With DBI960S upgrade.	*With DBI960S upgrade.	Online tuning. Single volume. Can span multiple drives and adapters.		

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
ARRAY MODEL	DAS523	DAS531	DAS532	DAS533	Express/II LT
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	Captive, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Express 5800 -7XX	Express 5800 -7XX	Express 5800 -7XX	Express 5800 -7XX	NEC Various
RAID level	1/3	3	3	3	0/1/3/5
Configured by:	Host	Host	Host	Host	Host
Array capacity (Gbytes) MIN	.5	1	2	4	1.1/.54/1.1/1.1
MAX	1	1	2	4	9.6/4.1/8.2/8.2
Minimum drives per array	2	3	3	3	2/3
Maximum drives per array	3	3	3	3	7
Concurrent host channels	1	1	1	1	1
Controller drive channels	3	3	3	3	
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1	1	1	1	4, 64
Cache function (Read, Write)	--	--	--	--	Read, Write
Redundancy: Controller (Yes/No)	--	--	--	--	No
Fan (Yes/No)	--	--	--	--	No
Power supply (Yes/No)	--	--	--	--	No
Spare drive (None/Auto/Manual)	None	None	None	None	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	20	20	20	33
drive (MB/Sec)	10	6	10	10	10
DRIVES: Formatted capacity/drive(MB)	2000	500	1000	2000	540, 1370
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	10.5	12	10.5	10.5	
Average rotational delay (msec)	5.54	6.67	5.54	5.54	
Drive models	DKU369	D3825	DKU364	DKU369	
ARRAY SIZE: Inches: H x W x D	205 x 140 x 245	205 x 140 x 245	205 x 140 x 245	205 x 140 x 245	24.4 x 8.5 x 23.2
POWER:	--	--	--	--	400 watts
Power backup					None
FIRST CUSTOMER SHIPMENT	4Q95	2Q95	2Q95	2Q95	1994
COMMENTS					Complete server

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
ARRAY MODEL	OP-450-30004 OP-450-30005 OP-450-31001	OP-450-30001 OP-450-30002 OP-450-30003	OP-450-5103 SCSI Mirroring Module	PC-DA12	RISCserver
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	Captive, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	NEC Express Various	NEC Express, EISA PCs	EISA PC	PC host NetWare, DOS, NT	NEC RISCserver Various
RAID level Configured by:	0/1/5	0/1/5	1 Preset	5	0/1/3/5
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	5 12.5	1.1 16
Minimum drives per array	2	2	2	3	2
Maximum drives per array	7	7	6	7	8
Concurrent host channels	1	1	1		1
Controller drive channels					
Array interface to host	EISA	EISA	EISA	SCSI-2	
Drive interface	SCSI-2	SCSI-2	SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	4, 16		
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write		
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --		
Spare drive (None/Auto/Manual)	Manual	Manual	--		Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	33 10	10 10	
DRIVES: Formatted capacity/drive(MB)	540-2000	540-2000	Drive dependent	1000, 2000	540-2000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	
Drive models	Various	Various	Varies		
ARRAY SIZE: Inches: H x W x D	-- --	-- --	EISA standard		23.25 x 7.25 x 23.25
POWER: Power backup	--	--	-- --		350 watts
FIRST CUSTOMER SHIPMENT	1/94	12/93	6/92	1996	
COMMENTS			Requires EISA SCSI host adapter OP-450-6301.		

MANUFACTURER	NEC	NEC	NEC	NETFRAME	NETFRAME
ARRAY MODEL	RISCserver 2200	RISCserver 4200	SV-98 Model 2 98 Server	8400	8500
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	Captive	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Software	Subsystem Software
Host platform, software environment	RISCserver 2200 Windows NT, NTAS	RISCserver 4200 Windows NT, NTAS	NEC PC-9800, PC NetWare, DOS, Windows NT	NetFRAME NetWare, UNIX, OS/2	NetFRAME NetWare, UNIX, OS/2
RAID level Configured by:	0/1/5 Host	0/1/5 Host	5	0/1	0/1
Array capacity (Gbytes) MIN MAX	2/1/- 42/21/30	4	12	4/2 224/112	4/2 224/112
Minimum drives per array	2	2	3	3	3
Maximum drives per array	21	21	7	120	120
Concurrent host channels	1	1	1	1, 8	1, 8
Controller drive channels	3	3			
Array interface to host	EISA	PCI	SCSI-2	NetFRAME	NetFRAME
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64		4, 32	4, 32
Cache function (Read, Write)	Read, Write	Read, Write		Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)				Duplexing Yes Yes	Duplexing Yes Yes
Spare drive (None/Auto/Manual)				Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	133 10	10 10	12.5 5, 20	12.5 5, 20
DRIVES: Formatted capacity/drive(MB)	1000, 2000	2000, 4000	1000, 2000	2000	2000
Nominal disk diameter (mm)	95, 130	95, 130	95	95	95
Average positioning time (msec)			9.5	9.5	9.5
Average rotational delay (msec)	4.2	4.2		5.6	5.6
Drive models				Hitachi, HP, Seagate	Hitachi, HP, Seagate
ARRAY SIZE: Inches: H x W x D	23.25 x 7.25 x 23.25	23.25 x 7.25 x 23.25			
POWER: Power backup	300 watts None	-- --	215 watts		
FIRST CUSTOMER SHIPMENT		4Q95			
COMMENTS	Complete server	Complete server			

ASPEC-89

MANUFACTURER	NETWORK APPLIANCE CORPORATION	NETWORK APPLIANCE CORPORATION	NETWORK APPLIANCE CORPORATION	NETWORK CONNECTION	NETWORK STORAGE SOLUTIONS
ARRAY MODEL	FAServer 540	F220	F330	T.R.A.C. Array	SPANStor-RAID
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem* Hardware	Subsystem* Hardware	Subsystem* Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	F540 NFS, CIFS (NMB) HTTP	F220 NFS, CIFS (NMB) HTTP	F330 NFS, CIFS (NMB) HTTP	T.R.A.C. DOS, OS/2, UNIX NetWare, other	Symmetrical NFS, NetWare, NT
RAID level Configured by:	4 Preset	4 Preset	4 Preset	0/1/4/5 Host	0/1/5
Array capacity (Gbytes) MIN MAX	8 204	8 52	8 108	Drive dependent Drive dependent	4 20
Minimum drives per array	2	2	2	2	2
Maximum drives per array	52	14	28	45	7
Concurrent host channels	1-12	1-9	1-9	1	1
Controller drive channels	2, 4	2	2, 4	3	1
Array interface to host	PCI	PCI	PCI	PCI	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	64, 256	64, 256	64, 256	4, 128	--
Cache function (Read, Write)	Read,Write(8MB)	Read,Write(8MB)	Read,Write(8MB)	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Option	No Yes Option	No Yes Option	No Yes Yes	No Per drive Per drive
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 20	132 10	132 10	132 10/20	10 10
DRIVES: Formatted capacity/drive(MB)	4000	4000	4000	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8	9	9	Drive dependent	
Average rotational delay (msec)	4.2	5.5	5.5	Drive dependent	
Drive models	Seagate	Seagate	Seagate	Seagate	Micropolis
ARRAY SIZE: Inches: H x W x D	13.6 x 17.5 x 22	13.6 x 17.5 x 22	13.6 x 17.5 x 22	Varies	11.75 x 10 x 11
POWER: Power backup	600 watts Battery	600 watts Battery	600 watts Battery	250 watts None	250 watts
FIRST CUSTOMER SHIPMENT	6/96	2/96	9/95	6/92	1996
COMMENTS	*Includes NFS server and network interfaces to FDDI, CDDI, Ethernet. **To network.	*Includes NFS server and network interfaces to FDDI, CDDI, Ethernet. **To network.	*Includes NFS server and network interfaces to FDDI, CDDI, Ethernet. **To network.	Complete server	Network attached server StreamLogic controller.

MANUFACTURER	NEW DESIGN	NEW DESIGN	NONSTOP NETWORKS	NSTOR	NSTOR
ARRAY MODEL	Precision	Precision FT	No-Stop Network	CR6-422DE CR6-422DP	CR6E-342DP
DISK/TREND GROUP	Single User	Single User	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Software	Subsystem	Subsystem
Implementation	Software	Software	Software	Hardware	Hardware
Host platform, software environment	Macintosh System 7	Macintosh System 7	PC compatible DOS, Windows, NetWare	PCI, EISA host NetWare, UNIX, NT, OS/2	PCI host NetWare, NT, OS/2, UNIX
RAID level	0/1	0/1/4/5	1	0/1/5	0/1/3/5
Configured by:			Preset	Host	Host
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	8/3/6	
MAX	Drive dependent	Drive dependent	Drive dependent	12/6/10	
Minimum drives per array	2	2	2	4	3
Maximum drives per array	4	10	20	6	6
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1		1	1, 2, 3
Array interface to host	SCSI-2	SCSI-2	--	EISA, PCI	PCI
Drive interface	SCSI-2	SCSI-2	--	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	4, 32	4, 128
Cache function (Read, Write)	--	--	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	--	No	No
Fan (Yes/No)	No	Yes	--	Yes	Yes
Power supply (Yes/No)	No	Per drive	--	Yes	Yes
Spare drive (None/Auto/Manual)	None	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	20	Drive dependent	33, 132	132/20
drive (MB/Sec)	20	20	Drive dependent	10/20	
DRIVES: Formatted capacity/drive(MB)	1000-9090	1000-9090	Drive dependent	2050	4200
Nominal disk diameter (mm)	95, 130	95, 130	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	9	8
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	5.56	4.17
Drive models	Various	Various	Various	Seagate	Seagate
ARRAY SIZE: Inches: H x W x D			--	12.5 x 7.5 x 12.5	
POWER:			--	85 watts	85 watts
Power backup	None	None	--	None	
FIRST CUSTOMER SHIPMENT	4Q94	4Q94	1990	9/94	4Q96
COMMENTS	Trillium array software.	Trillium array software.	Mirrored drives can be in different hosts	DP is PCI version.	Supports SAF-TE specification. Hot plug fans, drives, power. AMI controller.

MANUFACTURER	NSTOR	NSTOR	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY
ARRAY MODEL	CR8-320 CR8-340	CR8-390	18000W Concorde	4200W DisKovery	8200W DisKovery
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Single User	Single User	Single User
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Software	Subsystem Software	Subsystem Software
Host platform, software environment	SCSI, PCI host NetWare, NT, OS/2, UNIX	SCSI, PCI host NetWare, NT, OS/2, UNIX	Macintosh	Macintosh	Macintosh
RAID level Configured by:	0/1/5 Host	0/1/3/5 Host	0/1 Host	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	4/2/4 32/16/28	 72	18 18	4.2 4.2	8.2 8.2
Minimum drives per array	3	3	2	2	2
Maximum drives per array	8	8	2	2	2
Concurrent host channels	1	1	1	1	1
Controller drive channels	1, 2	1, 2, 3	1	1, 2	1, 2
Array interface to host	PCI*	PCI*	PCI	SCSI-2, NuBus	SCSI-2, NuBus
Drive interface	SCSI-2	SCSI-2	Ultra SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	4, 32	--	--	--
Cache function (Read, Write)	Read, Write	Read, Write	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	None	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 10/20	132/20 10/20	132 20/40	12.6 20	13.9 20
DRIVES: Formatted capacity/drive(MB)	2050, 4200	9100	9000	2100	4100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9	8	8-9	8	8
Average rotational delay (msec)	5.56, 4.17	4.17	4.17	4.17	4.17
Drive models	Seagate	Seagate	Seagate	Various	Various
ARRAY SIZE: Inches: H x W x D	18.75 x 7 x 23**		8.52 x 11.42 x 10.21	4.9 x 11.42 x 10.21	4.9 x 11.42 x 10.21
POWER: Power backup	140 watts None	140 watts			
FIRST CUSTOMER SHIPMENT	3Q95	4Q96	9/94	9/94	9/94
COMMENTS	Supports SAF-TE specification. i960 processor. *SCSI option. **Optional rack mount.	Supports SAF-TE specification. *SCSI option. **Rack mount option.	Software array.	Software array, uses disk array	Software array, uses disk array

MANUFACTURER	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	PACE TECHNOLOGIES	PACIFIC MICRO DATA
ARRAY MODEL	HST/10 HST/10 DAT DiskArray	HST/20 HST/20 DAT DiskArray	HST/30 HST/30 DAT DiskArray	Pace RAID-5	MAST 9500
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Macintosh, PC	Macintosh, PC	Macintosh, PC	Pace Various	Various
RAID level Configured by:	0/1/5/10 Panel	0/1/5/10 Panel	0/1/5/10 Panel	0/3/5 Host	0/1/3/5/10* Enet Port
Array capacity (Gbytes) MIN MAX	10.5/5.3/8.4 29.4/14.8/23.6	20.5/10.3/16.4 57.4/28.8/44.6	31.5/15.9/25.2 88.2/44.1/70.6	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	3	3	5	2/3
Maximum drives per array	8	8	8	20	*
Concurrent host channels	1, 2	1, 2	1, 2	1	1*
Controller drive channels	2-5	2-5	2-5	1, 5	1*
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI	SCSI-2
Cache size (min, max: MB)	4, 32	4, 32	4, 32	0, 128	*
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No No No	Option Yes Yes (per drive)
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 20	20 20	20 20	20 10	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	2100,4100,8670	2100,4100,8670	2100,4100,8670	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95, 130	95	95	Drive dependent	Drive dependent
Average positioning time (msec)	8.5	8	8	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.17	4.17	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	23.5 x 9.75 x 20.25	23.5 x 9.25 x 20.25	23.5 x 9.25 x 20.25	Varies	Varies
POWER: Power backup	300 watts	300 watts	300 watts	20 watts+drives None	Varies
FIRST CUSTOMER SHIPMENT	4Q94	4Q94	4Q94	1/93	8/96
COMMENTS	DAT tape is option.	DAT tape is option.	DAT tape is option.	Digi-Data controller.	*Various controllers used. Custom configuration.

MANUFACTURER	PARITY SYSTEMS	PARITY SYSTEMS	PARITY SYSTEMS	PARITY SYSTEMS	PARITY SYSTEMS
ARRAY MODEL	PS6000	PS6010	PS6100	PS9000	PS9013
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Sun, HP, SGI, IBM UNIX	Sun, HP, SGI, IBM UNIX	Sun, HP, SGI, IBM UNIX	Sun, HP, SGI, IBM, UNIX	Sun, HP, SGI, IBM, UNIX
RAID level Configured by:	0/3/5 Port, Panel	0/3/5 Port, Panel	0/3/5 Port, Panel	3 Preset	3 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7	7	21	7	7
Concurrent host channels	1, 3	1, 3	1, 3	1, 3	1, 3
Controller drive channels	1, 3	1, 3	1, 3	1, 3	1, 3
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	32	32	32	32	32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes	Option Yes Yes	No Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10	10/20 10	10/20 10	10/20 10	10/20 10
DRIVES: Formatted capacity/drive(MB)	1000-9100	1000-9100	1000-9100	1000-9100	1000-9100
Nominal disk diameter (mm)	95, 130	95, 130	95, 130	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	Varies	Varies	Varies		
POWER: Power backup	Cache battery	Cache battery	Cache battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	1Q93	1Q93	1Q93	1995	1995
COMMENTS	CMD controller.	CMD controller. Rack mount version of 6000	CMD controller.		

MANUFACTURER	PARITY SYSTEMS	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS
ARRAY MODEL	PS9015	1200SX Ultima	2100/2700 PATHFINDER	2401	dataSHADOW
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Board Software	Board Hardware	Board Hardware	Board Software
Host platform, software environment	Sun, HP, SGI, IBM, UNIX	PC compatible Various	PC compatible Various	PC compatible Various	PC compatible UNIX, PTPLANS OS/2, DOS
RAID level Configured by:	3 Preset	1 Preset	1 Preset	1 Preset	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	4	4	4	8	24
Concurrent host channels	1, 3	1	1	1	1
Controller drive channels	1, 3		2	4	1, 4
Array interface to host	SCSI-2	ISA, EISA	ISA, PCI	ISA/EISA	VESA, ISA, PCI
Drive interface	SCSI-2	SCSI-2	EIDE, SCSI-2	EIDE	SCSI
Cache size (min, max: MB)	32	4, 16	--	--	1, 16
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	-- -- --	-- -- --	-- -- --	N/A N/A N/A
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10	12.5, 33 10/20	4/132 10	Host dependent Drive dependent	Host dependent 2-5
DRIVES: Formatted capacity/drive(MB)	1000-9100		Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	130	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D			4 x 14	4.5 x 7.4	N/A
POWER: Power backup	Cache battery		N/A N/A	None	N/A None
FIRST CUSTOMER SHIPMENT	1995	2Q95	4Q94	3Q96	1Q90
COMMENTS		Requires PSI software for RAID-1.	Requires PSI software for RAID-1. 2700 has PCI interface.		Operates in Perceptive easyCACHE, Pathfinder and Ultima controllers.

MANUFACTURER	PERCEPTIVE SOLUTIONS	PERISOL TECHNOLOGY	PERISOL TECHNOLOGY	PHOENIX INTERNATIONAL	PHOENIX INTERNATIONAL
ARRAY MODEL	PCI 2000 Intellicache	RAIDSafe	RAIDSafe Plus	Phalanx D	Phalanx T
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Board	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible Various	SCSI host Various	SCSI host UNIX, OSF/1, VMS,NT, other	SCSI host UNIX, other	SCSI host UNIX, other
RAID level	0/1	3/5	0/1/4/5/10	0/3/5	0/3/5
Configured by:	Host	Panel, Port	Panel, Port	Port, Panel	Port, Panel
Array capacity (Gbytes) MIN	Drive dependent	1	2	Drive dependent	Drive dependent
MAX	Drive dependent	12	432	Drive dependent	Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	8	5	56	10	16
Concurrent host channels	1	1	1, 4	1, 4	1, 4
Controller drive channels	2	1	5, 7	2	2, 5
Array interface to host	PCI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-3	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	2	8, 512	8, 512	8, 512
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	--	No	Option	Option	Option
Fan (Yes/No)	--	No	Yes	Yes	Yes
Power supply (Yes/No)	--	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	132	10	10/20	10/20	10/20
drive (MB/Sec)	10/20	10	10/20	10/20	10/20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	2100-9100	2100-9100
Nominal disk diameter (mm)	Drive dependent	65	95	95	95
Average positioning time (msec)	Drive dependent	9-11	8-9	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	5.6	5.6, 4.17	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Seagate	Seagate
ARRAY SIZE: Inches: H x W x D	4 x 6.945	3.25 x 5.75 x 8	22.25 x 7.5 x 23	12 x 10 x 15	21 x 11 x 23
POWER:	N/A		300 watts	120 watts	300 watts
Power backup	None	Cache battery	Cache battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	4Q95	1995	3Q93	2/96	2/96
COMMENTS		Purchased controller.	CMD controller.	CMD controller. Dual AC.	CMD controller. Dual AC. Rack mount. Customized versions available.

MANUFACTURER	POLYWELL COMPUTERS	PRECISION COMPUTERS	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY
ARRAY MODEL	SUMA 8000	Precision RAID	LFRAID/1.1	LFRAID/2.1	LFRAID/24
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible NetWare, OS/2, SCO UNIX, NT	NetWare, UNIX, DOS OS/2	SCSI host NetWare, UNIX, NT, other	SCSI host NetWare, UNIX, NT, other	SCSI host Various
RAID level Configured by:	0/1/5 Host	0/1/4/5/10 Host	0/3/5 Host, Panel	0/3/5 Host, Panel	0/3/5 Host, Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	2.4/1.2/1.6/1.6	3.2/1.6/2.1/2.1	28/14/24/24
Minimum drives per array	2	2	2	2	7
Maximum drives per array	8	5	7	7	7
Concurrent host channels	1	1	1, 2	1, 2	1, 2
Controller drive channels	1	4	7	7	1
Array interface to host	EISA, PCI	PCI	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2, SCSI-3	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	4, 32	--*	8*	32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Option Yes Option	Option Yes Yes	Option Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33, 133 10	132 10/20	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	2100-4500	540	1050	4100
Nominal disk diameter (mm)	95, 130	95	95	95	95
Average positioning time (msec)	Drive dependent	8-9	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	4.17	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Seagate, Quantum	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	29 x 10 x 22	33.75 x 10.83 x 23.75	22.25 x 7.29 x 22.44	22.25 x 7.29 x 22.44	22.25 x 7.29 x 22.44
POWER: Power backup	750 watts UPS option	225 watts None	120 watts Cache battery	120 watts Cache battery	120 watts Cache battery
FIRST CUSTOMER SHIPMENT	1996	2Q96	4Q93	4Q93	3Q94
COMMENTS	Purchased controller. Rack mount option.	Mylex controller.	CMD controller. *Optional cache	CMD controller. *Optional cache	CMD controller.

MANUFACTURER	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY
ARRAY MODEL	LFRAID/4.2	LFRAID/4.4	R2000 LANForce	RAID Rax R2000	RAID Rax 47 R2000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host NetWare, UNIX, NT, other	SCSI host NetWare, UNIX, NT, other	SCSI host NetWare, UNIX, NT, other	SCSI host Various	SCSI host Various
RAID level	0/3/5	0/3/5	0/1/4/5/10	0/1/4/5/10	0/1/4/5/10
Configured by:	Host, Panel	Host, Panel	Panel, Port	Port	Port
Array capacity (Gbytes) MIN	6.3/3.2/4.2/4.2	6.6/3.3/4.4/4.4	Drive dependent	Drive dependent	Drive dependent
MAX			Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	3	3	3
Maximum drives per array	7	7	7	56	24
Concurrent host channels	1, 2	1, 2	1, 2	1, 2	1, 2
Controller drive channels	7	7	1, 7, 8	7, 8	7, 8
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	16	32	4, 512	4, 512	4, 512
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Option	Option	Option	Option	Option
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	10	10/20	10/20	10/20
drive (MB/Sec)	10	10	10/20	10/20	10/20
DRIVES: Formatted capacity/drive(MB)	2100	2200	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	95, 130	95, 130
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	22.25 x 7.29 x 22.44	22.25 x 7.29 x 22.44	22.25 x 7.29 x 22.44	77 x 25.25 x 36	46.25 x 23 x 32.2
POWER: Power backup	120 watts Cache battery	120 watts Cache battery	120 watts Cache battery	1.7 KVA Battery	1.7 KVA Battery
FIRST CUSTOMER SHIPMENT	4Q93	4Q93	2Q96	2/96	2/96
COMMENTS	CMD controller.	CMD controller.	Dual AC power.	CMD controller. Multiple AC feed.	CMD controller. Multiple AC feed.

MANUFACTURER	PROCOM TECHNOLOGY	R SQUARED	RAAC TECHNOLOGIES	RAAC TECHNOLOGIES	RAID POWER
ARRAY MODEL	RDT9-R960P LANForce	EL-II	ESP200	ESP1000	UltraRAID2 HP-SS
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	SCSI host UNIX	PC compatible Various	PC compatible Various	SCSI host NetWare, AUX Syst.7,VMS,oth.
RAID level Configured by:	0/1/5/10	0/1/3/5 Panel	0/1 Preset	0/1/5 Host	0/1/5/6
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	2 214	Drive dependent Drive dependent	Drive dependent Drive dependent	4 256
Minimum drives per array	2	3	2	2	2
Maximum drives per array	7	28	4	8	35
Concurrent host channels	1	1, 3	1	1	1, 2
Controller drive channels	1	3, 7	1	1	25
Array interface to host	PCI	SCSI-2,Ult SCSI	EISA/ISA	EISA/ISA	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	--, 64	4, 32	4, 32	64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Yes Yes Yes	Option Yes Yes	Option Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	16/32 20/40	33 10	33 10	20 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	2000, 9000	Drive dependent	Drive dependent	1000-9000
Nominal disk diameter (mm)	95, 130	95, 140	95	95	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Varies	Various	Various	Seagate, H-P
ARRAY SIZE: Inches: H x W x D	10 x 19 x 22	Varies	10.5 x 19 x 17	44 x 19 x 19	22.25 x 7.29 x 22.44
POWER: Power backup	Battery	300-1200 watts UPS	375 watts None	400 watts None	100 watts UPS & battery
FIRST CUSTOMER SHIPMENT	12/95	4Q95	2Q94	1992	4Q94
COMMENTS	Mylex controller.	Infortrend controller.	DPT controller. Ruggedized.	DPT controller. Ruggedized.	

MANUFACTURER	RAIDAR SYSTEMS	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC
ARRAY MODEL	Model 1261	FlexArray M	RUAC MX	FibreArray	FibreRAID-PCI
DISK/TREND GROUP	Net/Midrange	Single User	Single User	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	OEM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Board Hardware	Subsystem Hardware	Board Hardware
Host platform, software environment	Macintosh System 7.5	Various DOS, UNIX, OS/2 NetWare, Syst.7	SCSI host	FC-AL host Various	Various NT, NetWare, UNIX
RAID level Configured by:	0/1/3/5/6/10	0/1 Panel	0/1 Panel	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port
Array capacity (Gbytes) MIN MAX	4 48	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	6
Minimum drives per array	2	2	2	3	3
Maximum drives per array	12	4	14	112	112
Concurrent host channels	1	1	1	1	1
Controller drive channels	6	1, 2	1, 2	1, 2	1, 2
Array interface to host	SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	FC-AL*	FC-AL, PCI
Drive interface	SCSI-3	SCSI-2	SCSI-2	FC-AL	FC-AL
Cache size (min, max: MB)	1	--	--	8, 128	8, 18
Cache function (Read, Write)	Write (option)	--	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No Yes Yes	-- -- --	Yes* Yes Yes	Yes (option) -- --
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 20	10 10	10 10	100 100	133 100
DRIVES: Formatted capacity/drive(MB)	4000	Drive dependent	Drive dependent	2100-9100	2100, 23000
Nominal disk diameter (mm)	95	95	Drive dependent	95	Drive dependent
Average positioning time (msec)	8	Drive dependent	Drive dependent	8	Drive dependent
Average rotational delay (msec)	4.17	Drive dependent	Drive dependent	4.17	Drive dependent
Drive models	Seagate	Various	Various	Seagate	Seagate
ARRAY SIZE: Inches: H x W x D	7.1 x 8.3 x 15.7	6.5 x 9.25 x 12.75	1.625 x 5.75 x 8.12	19 x 8.7 x 20.6	
POWER: Power backup	250 watts None	150 watts	7.5 watts	300 watts Cache battery*	
FIRST CUSTOMER SHIPMENT	1996	3Q96	3Q94	1Q97	1Q97
COMMENTS		3 SCSI channels including host.	3 SCSI channels including host.	Dynamic reconfiguration *Options. Rack mount option.	Dynamic reconfiguration

MANUFACTURER	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC
ARRAY MODEL	FibreRAID-HI	FlexArray RX	FlexArray FX	FlexArray TFX	FlexArray IX
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	FC-AL host Various	SCSI host Various	SCSI host Various	Various DOS, UNIX, OS/2 NetWare, Syst.7	Various DOS, UNIX, OS/2 Netware, Syst.7
RAID level Configured by:	0/1/3/5/10 Port	0/1/3/5/10 Panel	0/1/3/5/10 Panel, Port	0/1/3/5 Panel, Port	0/1/3/5 Panel
Array capacity (Gbytes) MIN MAX	6	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	2	2	2	2
Maximum drives per array	112	5	6	75	6
Concurrent host channels	1, 2	1	1	1	1
Controller drive channels	1, 2	1	1-5	1, 5	1, 5
Array interface to host	FC-AL	SCSI, SCSI-2	SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2
Drive interface	FC-AL	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 128	--	--	--	--
Cache function (Read, Write)	Read, Write	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes (option) Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 100	10 10/20	20 20	20 20	10 10
DRIVES: Formatted capacity/drive(MB)	2100-9000	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	8	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Seagate	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	19 x 8.7 x 10.6	15.75 x 15.6 x 15.6	15.75 x 15.6 x 15.6	19 x 8.7 x 20.6	15.75 x 15.6 x 15.6
POWER: Power backup	300 watts Cache battery	300 watts	300 watts	300 watts	300 watts
FIRST CUSTOMER SHIPMENT	2Q97	3Q94	3Q94	4Q96	1Q93
COMMENTS	Dynamic reconfiguration option. Rack mount option.	Requires RUAC controller.	RUAC II controller. Remote diag. and monitoring.	6 SCSI channels including host.	6 SCSI channels including host.

MANUFACTURER	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC	SEEK SYSTEMS
ARRAY MODEL	FlexArray T	RUAC FX	RUAC II	RUAC IX	S450
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Board Hardware	Board Hardware	Board Hardware	Subsystem Hardware
Host platform, software environment	Various DOS, UNIX, OS/2 NetWare, Syst.7	SCSI host Various	SCSI host Various	Various DOS, UNIX, OS/2 Netware, Syst.7	SCSI host
RAID level Configured by:	0/1/3/5/10 Host	0/1/3/5/10 Panel, Port	0/1/3/5/10 Panel, Port	0/1/3/5 Panel	0/3/5 Panel, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	5
Maximum drives per array	6	75	75	35	35
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1-5	1-5	1, 5	5
Array interface to host	SCSI, SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	--	16, 128
Cache function (Read, Write)	--	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No -- --	No -- --	No Yes Yes	No Yes Yes (option)
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20/40 10/20/40	20 20	20 20	10 10	10, 20 10, 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	Drive dependent	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Seagate
ARRAY SIZE: Inches: H x W x D	19 x 8.7 x 20.6	3.8 x 16.6 x 13	8.5 x 10.5	3.8 x 16.6 x 13	Varies
POWER: Power backup	300 watts	140 watts	140 watts	140 watts	37 watts
FIRST CUSTOMER SHIPMENT	4Q96	3Q94	3Q94	1Q94	1993
COMMENTS	Differential option. Rack option.	6 SCSI channels including host.	6 channels including host. Remote monitor. Beeper notification. Differential.	6 SCSI channels including host.	Digi-Data controller.

MANUFACTURER	SEEK SYSTEMS	SEEK SYSTEMS	SEQUENT COMPUTER SYSTEMS	SEQUOIA SYSTEMS	SEQUOIA SYSTEMS
ARRAY MODEL	S460	Xcelerator	WINSERVER 5000	DD5003	DS310
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	Captive, PCM	Captive, OEM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	SCSI host Various, UNIX	Sequent Windows NTAS, UNIX	Sequoia series	Sequoia series 400 Wilt Topix
RAID level Configured by:	0/1/4/5/10 Panel, Port	1/3/5 Port	0/1/3/5/10	1 Preset	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	5 100		1.8 176	.9 36
Minimum drives per array	7	5	5		2
Maximum drives per array	56	60	20	100	80
Concurrent host channels	1, 4	1, 4		2	2
Controller drive channels	1, 8	10			
Array interface to host	SCSI-2	SCSI-3	SCSI-2	VME	Multibus
Drive interface	SCSI-2	SCSI-3	SCSI-2	SCSI-2	SCSI
Cache size (min, max: MB)	8, 512	32, 1000	32, 64*	1, variable	1, variable
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes (option)	Yes Yes Yes (option)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10, 20 10, 20	10, 20 10, 20	10/20 10/20	20 5.2	5 3.3
DRIVES: Formatted capacity/drive(MB)	2100, 9100	Drive dependent	4500-9100	1800	903
Nominal disk diameter (mm)	95	Drive dependent	95	95	130
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	9	13
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	5.6	8.3
Drive models	Seagate Barracuda	Various	IBM	Various	Various
ARRAY SIZE: Inches: H x W x D	Varies		24.8 x 14 x 30	5.5 x 17 x 17	5.25 x 18 x 30
POWER: Power backup	300 watts Cache battery	45 watts Cache battery	1.3 KVA Battery	300 watts Battery	500 watts Battery
FIRST CUSTOMER SHIPMENT	1996	12/94	1995	1994	1989
COMMENTS	CMD controller. UPS option.		CLARiiON array. *Mirrored cache Complete server		

ASPEC-103

MANUFACTURER	SEQUOIA SYSTEMS	SIEMENS NIXDORF	SIEMENS NIXDORF	SIEMENS NIXDORF	SIGMA
ARRAY MODEL	SES/RAID	High Performance Storage System	Modular Server Storage System	PCI Direct Storage System	510-40 Sentry
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Sequoia series	Sun, RS/6000, HP 9000 UNIX, AIX	Sun, RS/6000, HP 9000 UNIX, AIX	PCI host UNIX, NetWare	SCSI host Various
RAID level	0/1/5	0/1/3/5	0/1/3/5	0/1/3/5	3/5
Configured by:	Panel				Port
Array capacity (Gbytes) MIN		4	4	4	4
MAX	32	1000	2400	310	4
Minimum drives per array		2	2	2	5
Maximum drives per array	8	240	576	72	5
Concurrent host channels	5	24	2-32	1	1
Controller drive channels					5
Array interface to host	SCSI-2	SCSI, FC, ESCON	SCSI, FC, ESCON	PCI	SCSI-2
Drive interface	SCSI	SSA	SSA	SSA	IDE
Cache size (min, max: MB)	16, 32	256, 15360	4, 8192	4, 256	256
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	Option	Option	--	No
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Option*
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	108-480	36-160	133	10
drive (MB/Sec)	10	80	80	80	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	2000, 4300	2000, 4300	2000, 4300	1000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	10	10	10	10
Average rotational delay (msec)	Drive dependent	4.17	4.17	4.17	
Drive models	Various	IBM	IBM	IBM	Various
ARRAY SIZE: Inches: H x W x D		70.9 x 23.6 x 35.4	24 x 11.4 x 28.3	24 x 11.4 x 28.3	5 x 5.75 x 8
POWER: Power backup	500 watts UPS	4 KVA	.8-2.8 KVA	.8 KVA	45 watts Battery
FIRST CUSTOMER SHIPMENT	1996	11/96	11/96	11/96	1996
COMMENTS			19" drawer also available.	19" drawer also available.	*In external version.

MANUFACTURER	SIGMA	SIGMA	SOLID COMPUTER	SOLID COMPUTER	SOLID COMPUTER
ARRAY MODEL	510-60 Sentry	510-80 Sentry	M10	M20	M6
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	Sun, RS/6000 DG AViiON NetWare, UNIX	Sun, RS/6000, DG AViiON NetWare, UNIX	Sun,RS/6000,SGI H-P,Apple,PowPC NetWare, UNIX
RAID level Configured by:	3/5 Port	3/5 Port	0/1/3/5/10	0/1/3/5/10 Port	0/3/5
Array capacity (Gbytes) MIN	6	8	5.2	10.5	5.2
MAX	6	8	40	80	20
Minimum drives per array	5	5	3	5	3
Maximum drives per array	5	5	10	20	5
Concurrent host channels	1	1	1	1	1
Controller drive channels	5	5	2	5	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	IDE	IDE	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	256	256	4, 128	4, 64	4, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	Yes	Yes	No
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Option*	Option*	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	10	20	20	20
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	1500	2000	2000, 4000	2000, 4000	2000, 4000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	10	10	6.9, 9.2	6.9, 9.2	7.2, 9.6
Average rotational delay (msec)			5.6, 4.17	5.6, 4.17	5.6, 4.17
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	5 x 5.75 x 8	5 x 5.75 x 8	63 x 26.7 x 76.2	63.5 x 35.6 x 69.9	39 x 25 x 42
POWER: Power backup	45 watts Battery	45 watts Battery	575 watts	660 watts	250 watts
FIRST CUSTOMER SHIPMENT	1996	1996			
COMMENTS	*In external version.	*In external version.	CLARiiON controller.	CLARiiON controller.	Digi-Data controller.

MANUFACTURER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER
ARRAY MODEL	CLx	D3x	D5x	R3x	R5x
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	All PC & UNIX networks, plus midrange syst.	All PC & UNIX networks, plus midrange syst.	All PC & UNIX networks, plus midrange syst.	All PC & UNIX networks, plus midrange syst.	All PC & UNIX networks, plus midrange syst.
RAID level Configured by:	"7" Preset	"7" Preset	"7" Preset	"7" Preset	"7" Preset
Array capacity (Gbytes) MIN MAX	3 1000	3 45	3 99	3 106	2 230
Minimum drives per array	3	3	3	3	3
Maximum drives per array	48	12	12	27	27
Concurrent host channels	1 to 12	1 or 2	1, 2	1 to 4	1 to 4
Controller drive channels	3 to 48	3 to 12	3 to 12	3 to 9	3 to 9
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-1/2	SCSI-1/2	SCSI-1/2	SCSI-1/2	SCSI-1/2
Cache size (min, max: MB)	16-256	16-256	16-256	16-256	16-256
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 or 20 Drive dependent	10 or 20 Drive dependent	10 or 20 Drive dependent	10 or 20 Drive dependent	10 or 20 Drive dependent
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95, 130	95	130	95	130
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	14 x 19 x 28.5	15.5 x 14 x 16.5	15.5 x 14 x 16.5	14 x 19 x 28.5	14 x 19 x 28.5
POWER: Power backup	2.160 KVA --	1.440 KVA --	1.440 KVA --	2.160 KVA --	2.160 KVA --
FIRST CUSTOMER SHIPMENT	4Q92	2Q92	2Q92	1Q92	1Q92
COMMENTS	UPS required.	UPS required.	UPS required.	UPS required.	UPS required.

MANUFACTURER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER
ARRAY MODEL	SSC1-R9 Storage SuperServer	SSC11-C23 Storage SuperServer	SSC2-C9 Storage SuperServer	SSC2-R23 Storage SuperServer	SSC3-4TB Storage SuperServer
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	All PC & UNIX networks, plus midrange syst.	All PC & UNIX networks, plus midrange syst.	All PC & UNIX networks, plus midrange syst.	All PC & UNIX networks, plus midrange syst.	All PC & UNIX networks, plus midrange syst.
RAID level	1/3/5/"7"	1/3/5/"7"	1/3/5/"7"	1/3/5/"7"	1/3/5/"7"
Configured by:					Preset
Array capacity (Gbytes) MIN	136	351	191	280	2246
MAX	245	702	327	585	4492
Minimum drives per array	15	15	21	12	96
Maximum drives per array	27	30	36	25	192
Concurrent host channels	Up to 4	Up to 12	Up to 10	Up to 4	Up to 48
Controller drive channels	15-27	15-30	21-36	12-25	96-192
Array interface to host	Ultra SCSI*	Ultra SCSI*	SCSI-2*	Ultra SCSI*	Ultra SCSI*
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	79-728	79-776	85-872	76-696	352-4526
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	40	40	40	40	40
drive (MB/Sec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
DRIVES: Formatted capacity/drive(MB)	9090	23400	9090	23400	9090
Nominal disk diameter (mm)	130	130	130	130	130
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	62 x 24 x 36	78 x 24 x 36	78 x 24 x 36	78 x 24 x 36	
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	6/96	6/96	6/96	6/96	6/96
COMMENTS	*Optional FC-AL	*Optional FC-AL	*Optional FC-AL	*Optional FC-AL	*Optional FC-AL

MANUFACTURER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE CONCEPTS
ARRAY MODEL	SSC3-C23 Storage SuperServer	SSC3-M23 Storage SuperServer	Concept 810 Concept 810SW	Concept 812SW	C814F FibreRAID
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Very High Perf.
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	All PC & UNIX networks, plus midrange syst.	All PC & UNIX networks, plus midrange syst.	SCSI host, VME, PC AT	SCSI host Proprietary	SCSI host UNIX, NT, OS-9, VXWorks
RAID level	1/3/5/"7"	1/3/5/"7"	3	3	0/3
Configured by:			Host, Preset	Host, Port	
Array capacity (Gbytes) MIN	561	280	2	8	
MAX	1123	585	16	40	504
Minimum drives per array	24	24	4	2	9
Maximum drives per array	48	50	5	10	72
Concurrent host channels	Up to 12	Up to 14	1	1	1, 2
Controller drive channels	24-48	24-48	5	5	9
Array interface to host	Ultra SCSI*	Ultra SCSI*	VME,PCAT,SCSI-2	SCSI-2	Fibre Channel
Drive interface	Ultra SCSI	Ultra SCSI	SCSI-2	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	88-1064	88-1064	2	2	4, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	N/A	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	Yes	Yes	No	Yes	Yes
Power supply (Yes/No)	Yes	Yes	No	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	40	40	20 peak*	20+	80
drive (MB/Sec)	Drive dependent	Drive dependent	10	40	40
DRIVES: Formatted capacity/drive(MB)	23400	9090	4000	4000	4000, 9100
Nominal disk diameter (mm)	130	130	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	8.3	8	8.5
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17	4.17	
Drive models	Various	Various	Seagate ST12550	Seagate Barracuda 4LP	Seagate, Barracuda LP
ARRAY SIZE: Inches: H x W x D	78 x 48 x 36	78 x 48 x 36	3.5 x 19 x 21	5.25 x 19 x 21	5.25 x 19 x 21
POWER:			250 watts	250 watts	300
Power backup			None	Dual power supp	None
FIRST CUSTOMER SHIPMENT	6/96	6/96	1Q94	3/95	4/96
COMMENTS	*Optional FC-AL	*Optional FC-AL	*Concept 810SW has SCSI-2 interface. i960 processor.	Real time control engine. i960 processor.	Real time control engine. i960 processor.

MANUFACTURER	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS
ARRAY MODEL	C814U UltraRAID	Concept 910SW	MegaFlex	MiniFlex	SuperFlex 3000 DGR
DISK/TREND GROUP	Very High Perf.	Very High Perf.	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host UNIX, NT, OS-9, VXWorks	SCSI host Various	PC compatible NetWare, NT, Solaris, AIX	PC compatible NetWare, NT, Solaris, AIX	Solaris, AIX NT, NetWare
RAID level	0/3	3	0/1/3/5/10	0/1	0/1/3/5/10
Configured by:		Port	Host	Host	Host
Array capacity (Gbytes) MIN		16	18	2.1	4.2
MAX	504	504	127.4	8.6	127.4
Minimum drives per array	9	9	2	2	2
Maximum drives per array	72	63	14	2	14
Concurrent host channels	1	1	1	1	1
Controller drive channels	9	9	2	2	2
Array interface to host	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	Ultra SCSI	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	4	4, 32	--	4, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	--	Read, Write
Redundancy: Controller (Yes/No)	No	No	Yes	No	No
Fan (Yes/No)	Yes	Yes	Yes	No	Yes
Power supply (Yes/No)	Yes	Yes	Yes	No	Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto	--	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	40	40	10/20	10	10/20
drive (MB/Sec)	40	40	10/20	10	10/20
DRIVES: Formatted capacity/drive(MB)	4000, 9100	4000, 8000	2100,4300,9100	2105, 4300	2105,4300,9100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8.5	8.3	8.5	8.5	8.5
Average rotational delay (msec)	4	4.17	4.17	4.17	4.17
Drive models	Seagate, Barracuda LP	Seagate Barracuda	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	5.25 x 19 x 21	7 x 19 x 21	6.88 x 17.4 x 19.5	7.2 x 6.7 x 12	6.9 x 17.4 x 19.5
POWER:	300 watts	325 watts	250 watts	65 watts	250 watts
Power backup	None	None	Optional UPS	Optional UPS	Battery
FIRST CUSTOMER SHIPMENT	10/96	1/95	Battery	2/95	2/95
COMMENTS	Real time control engine.	Real time control engine. i960 processor.	Dual AC input.		Dual AC input. Dynamic reconfiguration

MANUFACTURER	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS
ARRAY MODEL	SuperFlex 4000	SuperFlex 5000	SuperFlex 2000	SuperFlex 3000	SuperFlex 5500
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host NetWare, NT, Solaris, AIX	RS/6000, Sun, HP9000, Solaris AIX, NT, NetW.	NetWare, NT	NetWare	Various NetWare, NT, Solaris, AIX
RAID level	0/1/3/5/10	0/1/3/5/10	0/1/5/10	0/1/5/10	0/1/3/5/10
Configured by:	Host	Host	Host	Host	Host
Array capacity (Gbytes) MIN	4.2	4.2	4.2	6.3	4.2
MAX	127.4	63.7	60	30.1	127.4
Minimum drives per array	2	2	2	3	2
Maximum drives per array	7	7	14	7	14
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	1	2	2	2
Array interface to host	SCSI-2	SCSI-2	SCSI-2	EISA, PCI, SCSI	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	4, 32	4, 32	4, 128	4, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write		Read, Write
Redundancy: Controller (Yes/No)	No	Yes	No	Option	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10/20	10/20	10/20	Host dependent	10/20
drive (MB/Sec)	10/20	10/20	10/20	20	10/20
DRIVES: Formatted capacity/drive(MB)	2100,4300,9100	2100,4300,9100	2100, 4300	2100, 4300	2100,4300,9100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8.5	8	9.8	8.5	8.5
Average rotational delay (msec)	4.17	4.17	5.5	4.17	4.17
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	6.9 x 17.4 x 19.5	6.9 x 17.4 x 19.5	6.9 x 17.4 x 19.5	6.9 x 17.4 x 19.5	6.9 x 17.4 x 19.5
POWER:	250 watts	250 watts	250 watts	250 watts	250 watts
Power backup		Battery		Battery	Battery
FIRST CUSTOMER SHIPMENT	9/94	7/96	9/95	9/96	9/96
COMMENTS	Dual AC input.	Dual AC input.	Dual AC input.	Dual AC input.	Dual AC input.

MANUFACTURER	STORAGE DIMENSIONS	STORAGE SOLUTIONS	STORAGE SOLUTIONS	STORAGE SOLUTIONS	STORAGE SOLUTIONS
ARRAY MODEL	SuperFlex 3000 DGR Ultra	CM2 RACa-ray	CM2 Plus RACa-ray	CM2 Plus (Rack) RACa-ray	STACa-ray
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM	OEM	OEM	OEM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Various NetWare, NT	SCSI host DOS,Wind,NT,Mac OS/2,Net,Sun,UN	SCSI host DOS,Wind,NT,Mac OS/2,Net,Sun,UN	SCSI host DOS,Wind,NT,Mac OS/2,Net,Sun,UN	SCSI host OS/2, NT, UNIX
RAID level	0/1/3/5/10	0/3/5	0/3/5	0/3/5	0/1/3/5
Configured by:	Host	Serial Port	Serial Port	Serial Port	
Array capacity (Gbytes) MIN	4.2	3	3	3	4
MAX	191.1	78 (65)	78 (65)	182 (150)	60
Minimum drives per array	2	3	3	3	3
Maximum drives per array	21	15	15	35	14
Concurrent host channels	1	1	1	1	
Controller drive channels	3	5	5	5	
Array interface to host	SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 128	--	4, 128	4, 128	8, 32
Cache function (Read, Write)	Read, Write	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	Yes	Yes
Fan (Yes/No)	Yes	No	No	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10/20/40	20	20	20	10-20
drive (MB/Sec)	10/20	10	10	20	20
DRIVES: Formatted capacity/drive(MB)	2100,4300,9100	1050,2160,4320	1050,2160,4320	1050,2160,4320	2100, 4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8.5	8.5/9.2/8.4/8	8.5/9.2/8.4/8	8.5/9.2/8.4/8	Drive dependent
Average rotational delay (msec)	4.17	5.6/5.6/4.2/5.6	5.6/5.6/4.2/5.6	5.6/5.6/4.2/5.6	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	6.9 x	18.3 x	18.3 x	10.5 x	14.5 x
	17.4 x 19.5	8.1 x 14.5	8.1 x 14.5	19 x 13.5	10.6 x 6.6
POWER:	250 watts	180-420 watts	180-420 watts	250-500 watts	
Power backup	Battery				
FIRST CUSTOMER SHIPMENT	5/96	6/93	2/95	6/94	7/95
COMMENTS	Dual AC input. Dynamic reconfiguration	Digi-Data controller.	Digi-Data controller.	Digi-Data controller.	Modular tower.

MANUFACTURER	STORAGE SOLUTIONS	STORAGE TECHNOLOGY	STORAGEPATH	STORAGEPATH	STORAGEPATH
ARRAY MODEL	STACa-ray Plus	9131	SP-18BTHT	SP-5BT	SP-9BR
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host OS/2, NT, UNIX	IBM mainframe AS/400, RS/6000 HP,Sun,PC,UNIX	SCSI host UNIX, VMS, NT, NetWare, DOS	SCSI host Various	SCSI host UNIX, VMS, NT, NetWare, DOS
RAID level	0/1/3/5	0/1/1+0/3/5	0/3/5	0/1/3/4/5	0/3/5
Configured by:		Service func.	Host		Host
Array capacity (Gbytes) MIN	18	16	2.5		2.5
MAX	110	268.8	45	16	28.7
Minimum drives per array	3	10	2	5	2
Maximum drives per array	14	80	15	5	7
Concurrent host channels		2	1	1	1
Controller drive channels		10	1	1, 2	1
Array interface to host	Ultra SCSI	IBM, SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 32	8, 64	0, 32	8, 512	--, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	No	No	No
Fan (Yes/No)	Yes	Yes	Per drive	No	Per drive
Power supply (Yes/No)	Yes	Yes	Yes	No	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual		Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	40	20	20	10	20
drive (MB/Sec)	20	20	10	10	10
DRIVES: Formatted capacity/drive(MB)	9100	2000-4000	Drive dependent	4000	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	8 RD/9 WR	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	4.17	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Seagate Barracuda	Various	Various	Various
ARRAY SIZE: Inches: H x W x D		72 x 34 x 74	20 x 24 x 24	12.2 x 10.6 x 19.9	8.75 x 19 x 21
POWER: Power backup		5.5 KVA Battery	300 watts	200 watts	300 watts
FIRST CUSTOMER SHIPMENT	10/96	1995	4Q94		4Q94
COMMENTS	Rack mount.		Purchased controllers.	Purchased controllers.	Rack mount. Purchased controller.

MANUFACTURER	STORAGEPATH	STORAGEPATH	STORNET	STORNET	STRATUS COMPUTER
ARRAY MODEL	SP-9BT	SP-9BTHT	DB-RAID	RAID-eo	D600 (K121)
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	PCM	PCM	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	SCSI host UNIX, VMS, NT, NetWare, DOS	SCSI host UNIX	SCSI host UNIX	Stratus VOS/FTX
RAID level Configured by:	0/1/3/4/5	0/3/5 Host	0/1/5/"50"	0/3/5 Panel, Port	1 Preset
Array capacity (Gbytes) MIN MAX	 28	2.5 28.7	8 268	8 64	1.46 Varies by syst.
Minimum drives per array	7	2	7	2/3	2
Maximum drives per array	7	7	56	28	Varies by syst.
Concurrent host channels	1	1	1, 8	1	2, 10
Controller drive channels	1, 4	1	1, 8	1, 7	2, 4
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Proprietary
Drive interface	SCSI-2	SCSI-1/2	SCSI-2	SCSI-2	SCSI
Cache size (min, max: MB)	8, 512	0, 32	16, 4100	8, 64	.256
Cache function (Read, Write)	Read, Write	--	Read, Write	Read, Write	Read
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	No Per drive Yes	Option Yes Yes	Option Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)		Manual	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	10/20 10/20	10/20 10/20	5 Drive dependent
DRIVES: Formatted capacity/drive(MB)	4000	Drive dependent	4300	4300	Varies
Nominal disk diameter (mm)	95	95	95	95	Varies
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	8-9	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	4.17	Drive dependent
Drive models	Various	Various	Seagate	Seagate	D602, D603, D604, D605
ARRAY SIZE: Inches: H x W x D		20 x 11.5 x 24	Varies	Varies	Varies
POWER: Power backup	300 watts	300 watts	1.6 KVA None	100 watts Cache battery	Drive dependent Battery
FIRST CUSTOMER SHIPMENT		4Q94	1996	1995	3/91
COMMENTS	Purchased controllers.	Purchased controllers.	IPL controller. Nonvolative RAM cache, mirrored.	CMD controller.	

MANUFACTURER	STRATUS COMPUTER	STRATUS COMPUTER	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC
ARRAY MODEL	D700 (K460)	D800	2000FMF SledgeHammer	17400FMF Wide SledgeHammer	1950FMF SledgeHammer
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Single User	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Stratus VOS/FTX	Stratus VOS/FTX HP UX	Macintosh, Quadra, Power Mac	Macintosh	Macintosh, Quadra, Power Mac
RAID level Configured by:	1 Preset	1 Preset	0/1 Host	0/1	0/1 Host
Array capacity (Gbytes) MIN MAX	1 Varies by syst.	2 9	2/1	17.4	1.95/9.75
Minimum drives per array	2	2	2	2	2
Maximum drives per array	Varies by syst.	52	2	2	2
Concurrent host channels	2, Varies		1	1	1
Controller drive channels	2, 4	PCI	1	1	1
Array interface to host	Proprietary	SCSI	SCSI, NuBus	SCSI-2, NuBus	SCSI, NuBus
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.256		2	2	2
Cache function (Read, Write)	Read		Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Manual	None	None	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 Drive dependent	20 Drive dependent	10/20 10/20	10/20 10/20	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	Varies	Varies	1000	8700	975
Nominal disk diameter (mm)	Varies	95	95	130	95
Average positioning time (msec)	Drive dependent	Drive dependent	8.5	11	8.5
Average rotational delay (msec)	Drive dependent		5.56	5.6	4.17
Drive models	D701, D702	Various	Seagate Hawk	Seagate Elite	Seagate Barracuda
ARRAY SIZE: Inches: H x W x D	Varies		4.5 x 9.5 x 9.75		4.5 x 9.5 x 9.75
POWER: Power backup	Drive dependent Battery	UPS	20 watts None		20 watts None
FIRST CUSTOMER SHIPMENT	1Q95	2Q96	1992	9/94	9/94
COMMENTS					

MANUFACTURER	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC
ARRAY MODEL	3500II SledgeHammer	3500W SledgeHammer	4100FMF SledgeHammer	8000FT SledgeHammer	8200FMF SledgeHammer
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh
RAID level	0/1	0/1	0/1	0/1/5	0/1
Configured by:	Host	Host	Host	Host	
Array capacity (Gbytes) MIN	3.5/1.75	3.5/1.75	4.1/2.05	4/2/--	8.2
MAX				10/5/8	
Minimum drives per array	2	2	2	2	2
Maximum drives per array	2	2	2	5	2
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1	1	1	1
Array interface to host	SCSI,PCI,NuBus	SCSI, NuBus	SCSI, NuBus	SCSI, NuBus	SCSI, NuBus
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2	2	2	5	2
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	No	No	No	Yes	No
Power supply (Yes/No)	No	No	No	Yes	No
Spare drive (None/Auto/Manual)	None	None	None	Auto	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	15.9	11.6	10/20	10/20	10/20
drive (MB/Sec)	20	20	10/20	10/20	
DRIVES: Formatted capacity/drive(MB)	1750	1750	2050	2000	4100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8.5	8.5	8.5	8.5	8.5
Average rotational delay (msec)	4.17	4.17	4.17	4.17	4.17
Drive models	Seagate Barracuda	Seagate Barracuda	Seagate Barracuda	Seagate Barracuda	Seagate Barracuda
ARRAY SIZE: Inches: H x W x D	4.5 x 9.5 x 9.75	4.5 x 9.5 x 9.75	4.5 x 9.5 x 9.75	7 x 19 x 21	
POWER:	30 watts	30 watts	30 watts	150 watts	32 watts
Power backup	None	None	None	None	None
FIRST CUSTOMER SHIPMENT	6/94	6/94	1993	1994	9/94
COMMENTS				Purchased controller.	

MANUFACTURER	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC
ARRAY MODEL	8200FMF Wide SledgeHammer	8200FMFII SledgeHammer	AV Server 50 AV Server 100 Av Server 200	FT16000 SledgeHammer FT	FT20000 SledgeHammer FT
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	SCSI host Various	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac
RAID level Configured by:	0/1 Host	0/1 Host	0/5 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	8.2/4.1	8.2/4.1	9/6 84/81	16.4	20
Minimum drives per array	2	2	3	2	
Maximum drives per array	2	2	28	5 + spare	7 + spare
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1	4	3	3
Array interface to host	SCSI-2	SCSI-2	SSA	SCSI-2, NuBus	SCSI-2, PCI
Drive interface	SCSI-2	SCSI-2	SSA	SCSI-2	SCSI-2
Cache size (min, max: MB)	2	2	8, 64	8, 32	8, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No Yes-per drive Yes per drive	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	None	None	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	10/20 10/20	100 10	10/20 10/20	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	4100	4100	2000,4000,9000	4000	4000
Nominal disk diameter (mm)	95	95	130	95	95
Average positioning time (msec)	8.5	8.5	13	8.5	
Average rotational delay (msec)	5.56	5.56	5.6	4.17	
Drive models	Seagate Barracuda	Seagate Barracuda	AV	Seagate Barracuda	
ARRAY SIZE: Inches: H x W x D	4.5 x 9.5 x 9.75	4.5 x 9.5 x 9.75	22.75 x 19 x 10		
POWER: Power backup	20 watts None	20 watts None	30 watts None		
FIRST CUSTOMER SHIPMENT	9/94	9/94	2Q95	4Q94	
COMMENTS			Video server, with 16, 32 or 64 channels.	Includes DAT tape drive.	

MANUFACTURER	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC
ARRAY MODEL	FT8000 SledgeHammer FT	GANDIVA	LM 2100 RAIDION	LM 4300 RAIDION	LS 18000 RAIDION
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Board Hardware	Subsystem Software	Subsystem Software	Subsystem Software
Host platform, software environment	Macintosh, Quadra, Power Mac	SCSI host Various	SCSI host NetWare, OS/2	SCSI host NetWare, OS/2	SCSI host NetWare, OS/2
RAID level Configured by:	0/1/5 Host	0/1/5	0/1/5 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	 8.2	N/A N/A	4 56	8 108	18.1 245
Minimum drives per array	2	2	2	2	2/3
Maximum drives per array	5 + spare	28	28	28	28*
Concurrent host channels	1	2	1	1	1, 4
Controller drive channels	3	4	1	1	1
Array interface to host	SCSI-2, NuBus	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 32	8	.512 per drive	.512 per drive	.512 per drive
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	N/A N/A N/A	No Yes-per drive Yes-per drive	No Yes-per drive Yes-per drive	No Yes-per drive Yes per drive
Spare drive (None/Auto/Manual)	Auto		Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	20 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	2000	N/A	2050	4081	9100
Nominal disk diameter (mm)	95	N/A	95	95	130
Average positioning time (msec)	8.5	N/A	8.9	8.9	12
Average rotational delay (msec)	4.17	N/A	4.17	4.17	5.6
Drive models	Seagate Barracuda	N/A	Various	Various	RM 9100
ARRAY SIZE: Inches: H x W x D		N/A	3.4 x 9.6 x 10.1	3.4 x 9.6 x 10.1	5.5 x 11 x 13.8**
POWER: Power backup		N/A N/A	30 watts/drive	30 watts/drive	50 watts None
FIRST CUSTOMER SHIPMENT	4Q94	8/94			8/94
COMMENTS	Includes DAT tape drive.	Used with RAIDION LT, LTX, RTX to provide hardware based arrays.	Rack mount version available.	Rack mount version available.	*32 with NetWare. **Per module.

ASPEC-117

MANUFACTURER	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC
ARRAY MODEL	LS 9100 RAIDION	LT 4200 RAIDION	LT 8600 RAIDION	LTA 4200 RAIDION	LTA 8600 RAIDION
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Software	Software	Software	Hardware	Hardware
Host platform, software environment	SCSI host NetWare, OS/2	SCSI host NetWare, OS/2	SCSI host NetWare, OS/2	PCI host NetWare, OS/2 Windows NT	PCI host NetWare, OS/2 Windows NT
RAID level	0/1/5	0/1/5	0/1/5	0/1/5/10	0/1/5/10
Configured by:	Host	Host	Host	Host	Host
Array capacity (Gbytes) MIN	18	4.2	8.6	6.3	12.9
MAX	245	56	116	31.5	64.5
Minimum drives per array	2	2/3	2	3	3
Maximum drives per array	28	28*	28*	15	15
Concurrent host channels	1	1	1		
Controller drive channels	1	1	1		
Array interface to host	SCSI-2	SCSI-2	SCSI-2	PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.512 per drive	.512 per drive	.512 per drive	8, 64	
Cache function (Read, Write)	Read, Write	N/A	N/A	Read, Write	
Redundancy: Controller (Yes/No)	No	No	No		
Fan (Yes/No)	Yes-per drive	Per drive	Per drive		
Power supply (Yes/No)	Yes-per drive	Per drive	Per drive		
Spare drive (None/Auto/Manual)	Auto	Auto	Auto		
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	10	10		
drive (MB/Sec)	10	10	10	20	20
DRIVES: Formatted capacity/drive(MB)	9090	2100	4300	2100	4350
Nominal disk diameter (mm)	130	95	95	95	95
Average positioning time (msec)	12	9	9		
Average rotational delay (msec)	5.7	4.2	4.2		
Drive models	Various	Taurus II	Capricorn IV		
ARRAY SIZE: Inches: H x W x D	5.5 x 11.0 x 13.8				
POWER:	65 watts/drive	30 watts/drive	30 watts/drive		
Power backup				Battery	Battery
FIRST CUSTOMER SHIPMENT		11/94	11/94	7/96	7/96
COMMENTS	Rack mount version available.	Software array. *32 with NetWare.	Software array. *32 with NetWare.		

MANUFACTURER	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC
ARRAY MODEL	LTX 12.9 RAIDION	LTX 4.2 RAIDION	LTX 6.3 RAIDION	LTX 8.6 RAIDION	RAIDION LXT PLUS
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host NetWare, OS/2
RAID level	0/1/5	0/1/5	0/1/5	0/1/5	0/1/5
Configured by:	Host, Panel	Host, panel	Host, Panel	Host, Panel	Host
Array capacity (Gbytes) MIN	12.9	4.2	6.3	8.6	8
MAX	116	56	56	116	128
Minimum drives per array	2	3	4	3	
Maximum drives per array	28	28	28	28	28
Concurrent host channels	2	1	1	1	
Controller drive channels	4	1	1	1	
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8	8, 256	8, 256	8, 256	
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	
Redundancy: Controller (Yes/No)	No	No	No	No	
Fan (Yes/No)	Per drive	Per drive	Per drive	Per drive	
Power supply (Yes/No)	Per drive	Per drive	Per drive	Per drive	
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	20	20	20	
drive (MB/Sec)	10	10	10	10	40
DRIVES: Formatted capacity/drive(MB)	4300	2100	2100	4300	
Nominal disk diameter (mm)	95	95	95	95	
Average positioning time (msec)	9	8.9	8.9	9	
Average rotational delay (msec)	4.2	4.2	4.2	4.2	
Drive models	Capricorn IV	Taurus II	Taurus II	Capricorn IV	
ARRAY SIZE: Inches: H x W x D					
POWER:	30 watts/drive	30 watts	30 watts	30 watts	
Power backup		None	None	None	
FIRST CUSTOMER SHIPMENT	11/94	1/94	1/94	11/94	
COMMENTS	Rack mount available. GANDIVA controller.	Rack mount available. GANDIVA controller.	Rack mount available. GANDIVA controller.	Rack mount available. GANDIVA controller.	

MANUFACTURER	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC	STREAMLOGIC
ARRAY MODEL	RAIDION PLUS	RS 9000 RAIDION	SledgeHammer VS	SledgeHammer-Pro FT	VOD 101 RAIDION
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Software	Software	Software	Hardware
Host platform, software environment	SCSI host NetWare, OS/2	SCSI host NetWare, OS/2	Macintosh, Power Mac	Macintosh, Quadra, Power Mac	SCSI host Various
RAID level	0/1/5	0/1/5	0/1	0/1	0/5
Configured by:	Host,RS232 Port	Host	Host	Host	Host
Array capacity (Gbytes) MIN		18	14.3	4.1	9/6
MAX	255	245	28.7	34.8	84/81
Minimum drives per array	2	2	7	2	3
Maximum drives per array	28	28	7	8	28
Concurrent host channels		1	1	1	1
Controller drive channels		1	1	1	4
Array interface to host	Ultra SCSI	SCSI-2	NuBus	SCSI-2	SCSI-2
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 128	.512 per drive	1*		8, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write		Read, Write
Redundancy: Controller (Yes/No)		No	No	--	No
Fan (Yes/No)		Yes-per drive	No	Yes	Yes-per drive
Power supply (Yes/No)		Yes-per drive	No	Yes	Yes per drive
Spare drive (None/Auto/Manual)		Auto	None	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	40	10	10/20	12.7-36	20
drive (MB/Sec)	40	10	10/20	20	10
DRIVES: Formatted capacity/drive(MB)	9090	9090	2050, 4100	2000-4350	3000
Nominal disk diameter (mm)	130	130	95	95	130
Average positioning time (msec)	12	12	8.5	Drive dependent	13
Average rotational delay (msec)	5.7	5.7	4.17	4.17	5.6
Drive models	Various	Various	Seagate Barracuda	Various	AV
ARRAY SIZE: Inches: H x W x D		5.5 x 11.0 x 13.8			22.75 x 19 x 10
POWER:		65 watts/drive	50 watts		30 watts
Power backup			None		None
FIRST CUSTOMER SHIPMENT			1995	6/96	2Q94
COMMENTS		Rack mount version available.	*On drive.	Uses FWB Software RAID ToolKit.	For video servers.

MANUFACTURER	SUN MICROSYSTEMS	SUN MICROSYSTEMS	SUN MICROSYSTEMS	SUN MICROSYSTEMS	SUNIX
ARRAY MODEL	Online: DiskSuite 4.1	SPARCstorage Model 112	SPARCstorage Model 210	SPARCstorage Model 214RSM	Sun-5875
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive, PCM	Captive, PCM	Captive, PCM	OEM
ARRAY CONFIGURATION: Type Implementation	Software Software	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware
Host platform, software environment	Sun SPARC Solaris	SPARC servers Solaris	SPARC servers Solaris	SPARC servers Solaris	PCI host DOS, Wind. NT, NetWare, other
RAID level Configured by:	0/1/5 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	6	12	18	2
Maximum drives per array	128	30	36	42	14
Concurrent host channels	--	1, 2	1, 2	1, 2	1
Controller drive channels	--	6	6	6	2
Array interface to host	--	S-bus/Fibre	S-bus/Fibre	S-bus/Fibre	PCI
Drive interface	--	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	16	16	16	128*
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option -- --	No Yes No	No Yes No	No Yes No	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Drive dependent Drive dependent	25/50 duplexed 20	25/50 duplexed 20	25/50	133 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	2100	9000	4200	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95	130	95	Drive dependent
Average positioning time (msec)	Drive dependent	9	9	9	Drive dependent
Average rotational delay (msec)	Drive dependent	4.2	5.56	5.56	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	--	8.94 x 21.06 x 19.46	19" Rack	19" Rack	.5 x 4.25 x 7.87
POWER: Power backup	-- --	.65 KVA Cache battery	4.8 KVA Cache battery	4.8 KVA Cache battery	4 watts None
FIRST CUSTOMER SHIPMENT	9/91	2Q94	1Q95	2Q96	1995
COMMENTS			Rack mount.	Rack mount.	*Needs software driver.

MANUFACTURER	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC
ARRAY MODEL	ADP-93-01	ADP-93-02	ADP-93-04	Model 3201 SCSI Lite	Model 3601 SCSI RAID
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM	OEM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	Various UNIX, OS/2, AIX NetWare	Various UNIX, OS/2, AIX NetWare	Various UNIX, OS/2, AIX NetWare	SCSI host UNIX, NT, DOS, NetWare, other	SCSI host UNIX, NT, DOS, NetWare, other
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host, Port	0/1/3/5 Host, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	1/2/3/3	1/2/3/3	1/2/3/3	2	2
Maximum drives per array	35	35	35	30	35
Concurrent host channels	1	1	1	1	1
Controller drive channels	5	5	5	2	5
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	4, 64	8, 64
Cache function (Read, Write)	--	--	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No No	Yes Supported Supported	Yes No No	No -- --	Option -- --
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 10	20/10 20/10	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	5.1 x 14.4	9.75 x 8.5	5.1 x 14.4	1.62 x 4 x 5.75	9.75 x 8.5
POWER: Power backup	None	None	None	Battery option	Battery option
FIRST CUSTOMER SHIPMENT	1993	1992	1993	1Q95	4Q94
COMMENTS				25 MHz 486 microprocessor.	33 MHz 486 microprocessor.

MANUFACTURER	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC
ARRAY MODEL	Model 3620 Ultra SCSI	Model 3701 Fibre Channel	Model 6256 FS60	RM10/DS10 Model 6210	RM10/DS10M MetaStor
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM	OEM	OEM	PCM
ARRAY CONFIGURATION: Type	Board	Board	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host UNIX, NT, DOS, NetWare, other	Fibre Channel UNIX, NT, DOS, NetWare, other	Various	SCSI host UNIX, NT, DOS, NetWare, other	Various
RAID level	0/1/3/5	0/1/3/5	0/1/3/5	0/1/3/5	0/1/3/5
Configured by:	Host, Port	Host, Port	Host, Port	Host, Port	Host, Port
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	4/2/4/4	6
MAX	Drive dependent	Drive dependent	Drive dependent	40/20/32/32	40
Minimum drives per array	2	2	2	2	2
Maximum drives per array	75	30	60	10	10
Concurrent host channels	1	1	1-6	1	1
Controller drive channels	5	5	5-30	2	2
Array interface to host	Ultra SCSI	Fibre Channel	Ultra SCSI,FC	SCSI-2	SCSI-2
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 128	8, 128	4, 128	4, 64	4, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Option	Yes	Option	No	No
Fan (Yes/No)	--	--	Yes	Yes	Yes
Power supply (Yes/No)	--	--	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	40	100	20/100	20	20
drive (MB/Sec)	40	40	20	20	20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	2000,4000,9000	2000,4000,9000	2000,4000,9000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	8.25	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	4.17	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	11.75 x 8.5	11.75 x 8.5	56 x 22 x 36	7 x 19 x 17.5 (RM)	19 x 7 x 21
POWER: Power backup	Battery option	Battery option	Cache battery Optional UPS	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	3Q95	3Q95	1995	2Q95	1995
COMMENTS	66 MHz 486 microprocessor. 100 MHz 1Q97.	66 MHz 486 microprocessor. 100 MHz 1Q97. Optical or copper connect to host.		SCSI Lite controller.	SCSI Lite controller.

MANUFACTURER	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC
ARRAY MODEL	RM20/DS20A	RM20/DS20F	RM20/DS20M MetaStor	RM20/DS20S	RM20/DS20U
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM, PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	AT&T 3400, 3500 UNIX, Solaris, AIX, NetWare	Fibre Channel UNIX	Various	SCSI host UNIX, NT, DOS, NetWare, other	SCSI host UNIX, NT, DOS, NetWare, other
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host, Port	0/1/3/5 Host, Port	0/1/3/5 Host, Port	0/1/3/5 Host, Port
Array capacity (Gbytes) MIN MAX	5.2/2.6/4.2/4.2 42/21/34/34	10/5/8/8 120/60/96/96	10 84	10/5/8/8 120/60/96/96	10/5/8/8 120/60/96/96
Minimum drives per array	5	5	2	5	5
Maximum drives per array	20	30	30	30	30
Concurrent host channels	2	1, 2	1	1, 2	1, 2
Controller drive channels	5	5	5	5	5
Array interface to host	SCSI-2	Fibre Channel	SCSI-2,Fib Chan	SCSI-2	Ultra SCSI
Drive interface	SCSI-2	Ultra SCSI	Ultra SCSI	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	N/A	8, 128	8, 128	8, 64	8, 128
Cache function (Read, Write)	N/A	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes (option) Yes Yes	Option Yes Yes	Yes (option) Yes Yes	Yes (option) Yes Yes
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	100 40	20/100 20	20 10	40 20
DRIVES: Formatted capacity/drive(MB)	2000, 4000	2000,4000,9000	2000,4000,9000	2000,4000,9000	2000,4000,9000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.7	8.25	Drive dependent	8.25	8.25
Average rotational delay (msec)	5.6	4.17	Drive dependent	4.17	4.17
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	14 x 19 x 30 (RM)	22.5 x 15.25 x 32	22.5 x 15.25 x 32	22.5 x 15.25 x 32	22.5 x 15.25 x 32
POWER: Power backup	None	Cache battery	Cache battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	4/94	3Q95	1995	4Q94	3Q95
COMMENTS	ADP-93-02 controller.	RM20 is rack mount. Uses 3701 controller. Model 6299.	Controller options: SCSI RAID ULTRA SCSI Fibre Channel.	RM20 is rack mount. Uses 3601 controller. Model 6299.	RM20 is rack mount. Uses 3620 controller. Model 6299.

MANUFACTURER	SYRED DATA SYSTEMS	SYRED DATA SYSTEMS	SYRED DATA SYSTEMS	SYRED DATA SYSTEMS	SYSTEX
ARRAY MODEL	Omega	Prestige	Prestige Plus	Regency	STX-2000A STX-2000B
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	SCSI host DEC VMS,Solaris NetWare,NT,oth.	SCSI host DEC VMS,Solaris NetWare,NT,oth.	SCSI host DEC VMS,Solaris NetWare,NT,oth.	SCSI host DEC VMS,Solaris NetWare,NT,oth.	PCI host DOS, NT, OS/2, NetWare, other
RAID level Configured by:	0/1 Panel, Port	0/1/5/10 Panel, Port	0/1/5/10 Panel, Port	0/1/3/4/5/10 Panel, Port	0/1/3/5 Host, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	4	14	21	90	15
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	2	3	6	1, 2
Array interface to host	IDE/EIDE	SCSI-2	SCSI-2	SCSI-2	PCI
Drive interface	IDE/EIDE	SCSI-2	Ultra SCSI	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	--	--	--	--	2, 32
Cache function (Read, Write)	--	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)		10 10	10/20 20/40	10/20 10/20	132 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup	11 watts+drive None	11 watts+drive None	11 watts+drive None	30 watts+drive None	None
FIRST CUSTOMER SHIPMENT					1995
COMMENTS					Expandable to 4 output channels.

MANUFACTURER	SYSTEX	SYSTEX	SYSTEX	SYSTEX	SYSTEX
ARRAY MODEL	STX-2300	STX-3100	STX-3200	STX-3200A	STX-3200B
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host	SCSI host	SCSI host	SCSI host	SCSI host
RAID level Configured by:	0/1/3/5/10 Panel	0/1/3/5/10 Panel	0/1/3/5 Panel, Port	0/1/3/5/10 Panel	0/1/3/5/10 Panel
Array capacity (Gbytes) MIN MAX	2.1 17.2	2.1 21.5	2 24	2.1 21.5	
Minimum drives per array	2	2	2	2	2
Maximum drives per array	4*	5*	8	7*	7*
Concurrent host channels	1, 2	1, 2	1-3	1, 2	1
Controller drive channels	1, 2	1, 2	1	1, 2	1, 2
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	4, 32	2, 32	4, 32	4, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Option	No Yes Option	 Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto/Manual	Auto/Manual		Auto/Manual	Auto/Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	10/20 10/20	10/20 10	10/20 10/20	20 10/20
DRIVES: Formatted capacity/drive(MB)	1050,2100,4300	1050,2100,4300	1050,2100,4300	1050,2100,4300	1050,2100,4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	14.5 x 7 x 12.7	22.2 x 8.2 x 17			
POWER: Power backup	Battery	Battery	Battery	Battery	Battery
FIRST CUSTOMER SHIPMENT					
COMMENTS	Infortrend controller. *Expandable to 13 drives.	Infortrend controller. *Expandable to 13 drives.		Infortrend controller. *Expandable to 13 drives.	*Expandable to 13 drives.

MANUFACTURER	SYSTEX	SYSTEX	SYSTEX	TANDEM COMPUTERS	TANDEM COMPUTERS
ARRAY MODEL	STX-3300	STX-3500	STX-3600	4560	4570
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host	SCSI host	SCSI host	Tandem Nonstop	Tandem Nonstop
RAID level Configured by:	0/1/3/5/10 Panel			1 Host	1 Host
Array capacity (Gbytes) MIN MAX				2 8	4.2 16.8
Minimum drives per array	2	7	6	2	2
Maximum drives per array	7*	7*	24*	8	8
Concurrent host channels	1	1, 5	1	2	2
Controller drive channels	1, 2	1, 2	6	--	--
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI over fiber	SCSI over fiber
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI	SCSI
Cache size (min, max: MB)	4, 32	4, 32	4, 32	1, 128	1, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Option	Option Yes Option	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto/Manual	Manual, Auto	Manual, Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10/20	10/20 10/20	10/20 10/20	4.5 10	5 10
DRIVES: Formatted capacity/drive(MB)	1050,2100,4300	1050,2100,4300	1050,2100,4300	2000	4200
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	10	10
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	5.6	4.17
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	21.4 x 9.6 x 20.6	21.4 x 9.6 x 20.6	34 x 19 x 21	7 x 19 x 28	7 x 19 x 28
POWER: Power backup	Battery	Battery	Battery	400 watts Dual AC	400 watts Dual AC
FIRST CUSTOMER SHIPMENT				8/94	3/95
COMMENTS	*Expandable to 13 drives.	Infortrend controller. *Expandable to 35 drives.	*Expandable to 42 drives.		

MANUFACTURER	TANDEM COMPUTERS	TANDEM COMPUTERS	TANDEM COMPUTERS	TANDEM COMPUTERS	TANGENT COMPUTER
ARRAY MODEL	4580	4604	4608	INTEGRITY NR RAID	RAID1server
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Tandem Nonstop	Tandem Nonstop UNIX	Tandem Nonstop UNIX	Tandem Nonstop UNIX	Tangent NetWare, UNIX, OS/2, NT, Other
RAID level Configured by:	1 Host	1	1	0/1/3/5 Host	0/1/10
Array capacity (Gbytes) MIN MAX	8.8 35.2	4.2 16.8	8.8 35.2	12.2 167.5	Drive dependent Drive dependent
Minimum drives per array	2	2	2	4	2
Maximum drives per array	8	8	8	48	2
Concurrent host channels	2	2	2	1, 2	1
Controller drive channels	--	--	--		1, 2
Array interface to host	SCSI over fiber	SCSI over fiber	SCSI over fiber	SCSI-2	PCI
Drive interface	SCSI	SCSI	SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	1, 128	1, 128	1, 128	16, 64	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Duplexing Option Option
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	5 10	5 10	5 10	20 10	132 10
DRIVES: Formatted capacity/drive(MB)	8800	4200	8800	4300	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	10	10	10	9	Drive dependent
Average rotational delay (msec)	4.17	4.17	4.17	4.17	Drive dependent
Drive models	Various	Various	Various	IBM	Seagate
ARRAY SIZE: Inches: H x W x D	7 x 19 x 28	--	--	42 x 19 x 29 (Rack)	Varies
POWER: Power backup	400 watts Dual AC	400 watts Dual AC	400 watts Dual AC	2.45	300 watts None
FIRST CUSTOMER SHIPMENT	3Q96	10/96	10/96	4/95	1994
COMMENTS				EMC controller.	Software array. Complete server

MANUFACTURER	TANGENT COMPUTER	TD SYSTEMS	TD SYSTEMS	TEKRAM TECHNOLOGY	TEKRAM TECHNOLOGY
ARRAY MODEL	Raid5server	OMNISERVE 2	OMNISERVE 3	690CD	DC-300B
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Single User
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM
ARRAY CONFIGURATION: Type Implementation	Subsystem Software	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	Tangent NetWare, UNIX, OS/2, NT, Other	All SCSI hosts Various	All SCSI hosts Various	PC compatible DOS, Windows	PC compatible DOS, UNIX, NT, NetWare, other
RAID level Configured by:	0/1/5 Host	1 Preset	1 Preset	1 Preset	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	1	2	2	2	2
Maximum drives per array	35	14	28	4	7
Concurrent host channels	1	1, 2	1, 2	1	1
Controller drive channels	5			1, 2	1
Array interface to host	PCI	SCSI-2	SCSI-2	PCI	ISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	IDE	SCSI-2
Cache size (min, max: MB)	4	--	--	.512-16	*
Cache function (Read, Write)	Read, Write	--	--		--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Option Option	-- -- --	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 10	Up to 10 10	Up to 20 20	33 5	5 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Seagate	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	Varies	1.625 x 5.75 x 8.25	3.25 x 5.75 x 8.25		
POWER: Power backup	450 watts None	10-20 watts --	10-20 watts --	 None	
FIRST CUSTOMER SHIPMENT	1995	1/93	1Q94	1Q95	1993
COMMENTS	Tower or rack mount. Complete server	Options to connect up to 5 hosts; dual ported controllers.	Options to connect up to 5 hosts; dual ported control. Fast and wide SCSI version.		*512K buffer.

MANUFACTURER	TEKRAM TECHNOLOGY	TEKRAM TECHNOLOGY	TEKRAM TECHNOLOGY	TEKRAM TECHNOLOGY	TEKRAM TECHNOLOGY
ARRAY MODEL	DC-600CD	DC-680CD	DC-690 DC-890*	DC-800B	DC-320E
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Net/Midrange
MARKET	OEM	OEM	OEM	OEM	OEM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	PC compatible DOS, UNIX, NT, NetWare, other	PC compatible DOS, UNIX, NT, NetWare, other	PC compatible DOS, UNIX, NT, NetWare, other	PC compatible DOS, UNIX, NT, NetWare, other	PC compatible DOS, UNIX, NT, NetWare, other
RAID level Configured by:	1 Preset	1 Preset	1 Preset	1 Preset	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	4	4	4	7	7
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	2	2	1	1
Array interface to host	ISA	VL Bus	PCI	ISA	EISA
Drive interface	IDE	IDE	IDE	SCSI-2	SCSI-2
Cache size (min, max: MB)	.256-16	.512-16	.256	.512-16	*
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	None	None	None	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	5 10	20 10	133 10	5 10	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup	2.5 watts	2.5 watts	2.5 watts		
FIRST CUSTOMER SHIPMENT	1994	1994	1995	1994	1993
COMMENTS			*DC-890 available 12/96		

MANUFACTURER	TEKRAM TECHNOLOGY	TEKRAM TECHNOLOGY	TEKRAM TECHNOLOGY	TEXA	TEXA
ARRAY MODEL	DC-380	DC-820B	DC-880B	RST-05S RST-10W RST-20W	RST-1000W RST-2000W RST-4000W
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Single User
MARKET	OEM	OEM	OEM	OEM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible DOS, UNIX, NT, NetWare, other	PC compatible DOS, UNIX, NT, NetWare, other	PC compatible DOS, UNIX, NT, NetWare, other	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host UNIX, NetWare, DOS, Mac, NT
RAID level Configured by:	1 Preset	1 Preset	1 Preset	0/3/5 Host, Panel	0/3/5 Host, Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	1/2/4 1.5/3/6
Minimum drives per array	2	2	2	3	3
Maximum drives per array	7	7	7	3	3
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1	1	3	3
Array interface to host	VL Bus	EISA	VL Bus	SCSI-3	SCSI-3
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	*	1-16	.512-16	.5, 2	1
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	No No No	No No No
Spare drive (None/Auto/Manual)	None	None	None	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	33 10	14, 12, 12 10	14, 12, 12 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	540,1000,2000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	12/9/9
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	6.6/5.5/5.5
Drive models	Various	Various	Various	Various	Seagate, Quantum
ARRAY SIZE: Inches: H x W x D				9.3 x 6.7 x 9.5	9.3 x 6.7 x 9.5
POWER: Power backup				100 watts None	100 watts None
FIRST CUSTOMER SHIPMENT	1994	1993	1994	10/94	9/94
COMMENTS	*64K buffer.			SyQuest drive.	

MANUFACTURER	TEXA	TEXA	TEXA	TEXA	TEXA
ARRAY MODEL	RST-540 RST-1000	RST-LP10	RST-N05S RST-N10W RST-N20W	RST-NL05 RST-NL10 RST-NL20	RST-NP10
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Single User
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host UNIX, NetWare, DOS, Mac, NT
RAID level Configured by:	0/3/5 Host, Panel	0/1/3/5 Host, Panel	0/1/3/5 Host, Panel	0/1/3/5 Host, Panel	0/1/3/5 Host, Panel
Array capacity (Gbytes) MIN MAX	.5/1 .8/1.5	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	1	1	1	1
Maximum drives per array	3	3	3	3	3
Concurrent host channels	1	1	1	1	1
Controller drive channels	3	3	3	3	3
Array interface to host	SCSI-2	SCSI-3	SCSI-3	SCSI-3	SCSI-3
Drive interface	SCSI-2	IDE	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.5	.5, 1	.5, 2	.5, 2	.5, 1
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	9, 8, 8 10	14, 12, 12 10	14, 12, 12 10	14, 12, 12 10	14, 12, 12 10
DRIVES: Formatted capacity/drive(MB)	270, 540	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	12	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	6.6/6.6	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Quantum	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	9.3 x 6.7 x 9.5	3.3 x 5.75 x 8.9	5 x 5.75 x 8.9	3.3 x 5.75 x 8.9	3.3 x 5.75 x 8.9
POWER: Power backup	100 watts None	70 watts None	80 watts None	70 watts None	70 watts None
FIRST CUSTOMER SHIPMENT	9/94	11/95	11/95	11/95	11/95
COMMENTS		Mounts in 5.25" drive bay. IDE drives.	Mounts in 5.25" drive bay.	Mounts in 5.25" drive bay.	Mounts in 5.25" drive bay.

MANUFACTURER	TEXA	TEXA	TEXA	TEXA	TEXAS MICROSYSTEMS
ARRAY MODEL	RST-P840 RST-P1600	DAF-4000 DAF-8000 DAF-16000	DAR-xx	DAX-xx	SP5500
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host UNIX, NetWare, DOS, Mac, NT	SP5500 server NT, NetWare, UNIX, OS/2
RAID level	0/3/5	0/3/5	0/3/5	0/3/5	0/1/5
Configured by:	Host, Panel	Host, Panel	Host, Panel	Host, Panel	Host
Array capacity (Gbytes) MIN	.85/1.7	4	4	4	Drive dependent
MAX	1.2/2.5	20	54	81	Drive dependent
Minimum drives per array	3	5	3	3	2
Maximum drives per array	3	5	6	9	6
Concurrent host channels	1	1	2, 2	2, 2	1, 2
Controller drive channels	3	5	6	6, 9	1
Array interface to host	SCSI-2	SCSI-3	Ultra SCSI	SCSI-3, Ultra	PCI
Drive interface	IDE	SCSI-2	SCSI-2, Ultra	SCSI-2	SCSI-2
Cache size (min, max: MB)	.5	1, 4	4, 32	4, 64	4, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	No	No	Yes	Yes	Yes
Power supply (Yes/No)	No	No	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	9, 8, 8	16, 14, 14	35, 25, 25	35, 32, 32	132
drive (MB/Sec)	14	10	10, 20	10	10/20
DRIVES: Formatted capacity/drive(MB)	425, 850	1000,2000,4000	2000, 9000	2000, 9000	1000-9100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	12.5	9	9/7	9/7	Drive dependent
Average rotational delay (msec)	6.7	6.6/5.5/5.5	6.6/5.5	6.6/5.5	Drive dependent
Drive models	Western Digital	Seagate, Quantum	Seagate	Seagate	Seagate SCA Connect
ARRAY SIZE: Inches: H x W x D	7 x 5.1 x 10.8	23.3 x 10.6 x 16.2	6.9 x 16.9 x 13.8	23.3 x 12.6 x 19.8	12.5 x 19 x 19.25
POWER:	80 watts	250 watts	250 watts	350 watts	400
Power backup	None	None	None	None	
FIRST CUSTOMER SHIPMENT	4/95	3/94	5/96	1/96	3Q96
COMMENTS					Mylex controller. Software array available.

MANUFACTURER	THINKING MACHINES	TOTAL TEC SYSTEMS	TRANSITIONAL TECHNOLOGY	TRICORD SYSTEMS	TRICORD SYSTEMS
ARRAY MODEL	CM-5 Scalable Disk Array	TRAID	NX Server	ISS-2	ISS-4C
DISK/TREND GROUP	Very High Perf.	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	PCM	PCM	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Software	Board Hardware	Board Hardware
Host platform, software environment	CM-5 system UNIX NFS	DEC, SCSI host UNIX, NT, NetWare, VMS	NX Server NFS	ES/133, ES/166 UNIX, NetWare, Windows NT	ES/133, ES/166 UNIX, NetWare, Windows NT
RAID level Configured by:	3 Host	0/3/5 Host	5 Preset	0/1/4/5/10 Host	0/1/4/5/10 Host
Array capacity (Gbytes) MIN MAX	16 500	Drive dependent Drive dependent	36 36	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	8	5	5	2	2
Maximum drives per array	250	28	5	180	180
Concurrent host channels	8, 32	1, 3	1	--	--
Controller drive channels	32, 128	1, 3	1	2	4
Array interface to host	Proprietary(NI)	SCSI-2, DSSI	SCSI-2	Proprietary	Proprietary
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	32	32 RD/8 WR	8	8
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No Yes Yes	No Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Auto		Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	150 5	10, 4 10		267 20	267 20
DRIVES: Formatted capacity/drive(MB)	2000	Drive dependent	9000	2000-4000	2000-4000
Nominal disk diameter (mm)	95	95	130	95	95
Average positioning time (msec)	9.2	Drive dependent		Drive dependent	Drive dependent
Average rotational delay (msec)	5.6	Drive dependent		Drive dependent	Drive dependent
Drive models	IBM Allicat 0664-M1H	Seagate, DEC RZ		DD2100SWT DD4300SWT	DD2100SWT DD4300SWT
ARRAY SIZE: Inches: H x W x D	Varies	22.25 x 7.25 x 22.5	24 x 14.25 x 15	--	--
POWER:	Varies	170 watts		--	--
Power backup	None	Cache battery		UPS	UPS
FIRST CUSTOMER SHIPMENT	10/92	4Q93	5/96	4/93	4/93
COMMENTS	Scalable.	CMD controller. Rack mount version available.	Network attached server Log structured file system.	Board mounts to syst.back panel Battery backed hot-plug. cache	Board mounts to syst.back panel Battery backed hot-plug. cache

MANUFACTURER	TRILLIUM RESEARCH	TRILLIUM RESEARCH	TWINCOM	TWINCOM	UNI SOLUTION
ARRAY MODEL	Remus Lite 1.4	Remus 1.4	Dual Mirror	Network Mirror	USI RAID
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Software Software	Software Software	Software Software	Software Software	Subsystem Hardware
Host platform, software environment	Power PC, Macintosh System 7	Power PC, Macintosh System 7	Various Most UNIX versions	Various Most UNIX versions	SCSI host UNIX, Open VMS, Solaris, other
RAID level Configured by:	0/1 Host	0/1/4/5 Host	1 Preset	1 Preset	0/3/5 Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	7 509
Minimum drives per array	2	2	2	2	2
Maximum drives per array	15	15	32	32	56
Concurrent host channels	Host dependent	Host dependent	1, 2	1, 4	1-4
Controller drive channels	Board dependent	Board dependent	--	--	3-8
Array interface to host	NuBus,SCSI,PCI	NuBus,SCSI,PCI	Host dependent	Host dependent	SCSI-2
Drive interface	SCSI-3	SCSI-3	Drive dependent	Drive dependent	SCSI-2
Cache size (min, max: MB)	--	--	Host dependent	Host dependent	32, 64
Cache function (Read, Write)	--	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	N/A N/A N/A	N/A N/A N/A	-- -- --	-- -- --	Option Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Board dependent Drive dependent	Board dependent Drive dependent	Host dependent Drive dependent	Host dependent Drive dependent	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	2100-9100
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Any supported by OS	Any supported by OS	Various
ARRAY SIZE: Inches: H x W x D	N/A	N/A	--	--	Varies
POWER: Power backup	N/A	N/A	-- --	-- --	240 watts Cache battery
FIRST CUSTOMER SHIPMENT	9/96	9/96	1986	1992	1/94
COMMENTS	SCSI manager 4.3 compliant.	SCSI manager 4.3 compliant.		Mirrors over a network.	CMD controller.

MANUFACTURER	UNISYS	UNISYS	UNISYS	UNISYS	UNISYS
ARRAY MODEL	ODM 3900	ODM 5900	ASR 9000	OSM 3000	OSR 5000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Mainframe	Mainframe	Mainframe
MARKET	Captive, PCM	Captive, PCM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Software	Subsystem Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	Unisys A series	Unisys A & V series, other UNIX, NT	Various NetWare, UNIX, NT
RAID level Configured by:	0/1/4/5/10 Host	0/1/3/5/10 Host	0/1/3/5/10 Host, Port	0/1/4/5 Port	0/1/3/5/10 Host, Port
Array capacity (Gbytes) MIN MAX	4.2 29.4	21/11/17/17 126/54/101/101	20 120	4.2 29.4	20 120
Minimum drives per array	2	5	5	2	5
Maximum drives per array	7	30	30	7	30
Concurrent host channels	1	2	1, 2	1	1, 2
Controller drive channels	1, 2	1, 2	5	1	5
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 128	16, 224	16, 224	--	16, 224
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Yes Yes Yes	Option Yes Yes	-- Yes Option	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto, Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	10/20 10/20	10 10	20 20	20 20
DRIVES: Formatted capacity/drive(MB)	2100, 4200	4200	3391	4200	4200
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8/9	8	12.2	Drive dependent	12.2
Average rotational delay (msec)	4.17/5.54	4.17	4.17	Drive dependent	4.17
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	5.05 x 17.05 x 18.44	17.5 x 17.5 x 24	17.5 x 17.5 x 24.25	5.05 x 17.5 x 18.4	17.5 x 17.5 x 24.25
POWER: Power backup	350 watts	1050 watts	746 watts UPS option	.13 KVA None	746 watts UPS option
FIRST CUSTOMER SHIPMENT	3Q96	3Q96	1995	1996	9/96
COMMENTS		Mirrored cache.			

MANUFACTURER	UNISYS	UNISYS	UNISYS	UNISYS	UNITROL DATA PROTECTION SYSTEMS
ARRAY MODEL	USP 5100	USP 5500	USR 3000	USS 5100	Immunity 2
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Single User
MARKET	Captive	Captive	Captive	Captive	PCM, OEM
ARRAY CONFIGURATION: Type Implementation	Subsystem Software	Subsystem Software	Subsystem Software	Subsystem Software	Software Software
Host platform, software environment	Unisys 2200 series, 1100/90	Unisys 2200 series 1100 O/S	Unisys A,V,2200 series	Unisys A series	IBM PC Compat. PC/MS-DOS, most LANs, Windows
RAID level Configured by:	0/1 Host, Port	0/1/5 Host, Port	0/1 Host	0/1 Host, Port	1 Preset
Array capacity (Gbytes) MIN MAX	16 134	96/136 192/363	12 28	31.8 126.7	Drive dependent Drive dependent
Minimum drives per array	2	32	3	8	2
Maximum drives per array	32	128	7	32	2
Concurrent host channels	2-4	8	1, 2	2	1, 2
Controller drive channels	8-16	32	1	8	1, 2
Array interface to host	BMCFIPS61	BMCFIPS61	SCSI-2	SCSI-2	IDE, SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	IDE, SCSI
Cache size (min, max: MB)	256, 4096	1792, 4096	--	512, 2048	1, host depend.
Cache function (Read, Write)	Read, Write	Read, Write	--	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	NA Option Option	Yes Yes Yes	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Manual-foregrnd
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	4.5 10	4.5 20	10 10	10 10	-- Drive dependent
DRIVES: Formatted capacity/drive(MB)	4210	2841	4200	3960	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	--
Average positioning time (msec)	Drive dependent	11	12.17		--
Average rotational delay (msec)	Drive dependent	5.6	4.17		--
Drive models	Various	Seagate Elite 3	Various		Various
ARRAY SIZE: Inches: H x W x D	42 x 21 x 36	74.9 x 68.7 x 36.4	5.1 x 19 x 29.7	42 x 21 x 36	--
POWER: Power backup	1.09-1.76 KVA Battery	4.8-8.8 KVA Battery	.13 KVA None	1.09-1.76 KVA Battery	-- --
FIRST CUSTOMER SHIPMENT	2Q95	4Q94	1994	4Q95	1990
COMMENTS	EMC controller. Dual AC power.	EMC controller. Dual AC power.	Software based array. Optional dual AC power.	EMC controller. Dual AC power.	Error logging to good disk. Duplexing adapter avail. Network support

MANUFACTURER	VERITAS SOFTWARE	VERITAS SOFTWARE	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)
ARRAY MODEL	VxMirror	VxVM	GDT2000	GDT2020	GDT3000A
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Software Software	Software Software	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	Various UNIX	Various,Solaris 2.X , SCO UNIX, UNIX SVR4.X, NT	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.
RAID level Configured by:	0/1 Host	0/1/5 Host	0/1	0/1/4/5	0/1
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	Host dependent	Host dependent	7	14	35
Concurrent host channels	Host dependent	Host dependent	1-2	2	2-5
Controller drive channels	Host dependent	Host dependent	1-2	2	2-5
Array interface to host	--	Various	ISA	ISA	EISA
Drive interface	--	SCSI, ESDI, IDE	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	1, 64	4, 64	4, 128
Cache function (Read, Write)	--	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Drive dependent Drive dependent	Drive dependent Drive dependent	8 10	8 10	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Drive dependent	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	--	--			
POWER: Power backup	-- --	-- --			
FIRST CUSTOMER SHIPMENT	1993	1991	1992	1993	1992
COMMENTS		Can mirror logical disks. Device driver and controller independent.	RAID 4/5 upgradable		RAID 4/5 upgradable.

MANUFACTURER	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)
ARRAY MODEL	GDT3000B	GDT3010A	GDT3020A	GDT3050A	GDT6000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.
RAID level Configured by:	0/1/4/5	0/1/4/5	0/1/4/5	0/1/4/5	0/1
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7	7	14	35	14
Concurrent host channels	1	1	2-5	5	2-5
Controller drive channels	1	1	2-5	5	2-5
Array interface to host	EISA	EISA	EISA	EISA	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1, 64	4, 64	4, 128	4, 128	2, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	Drive dependent Drive dependent	33 10	132 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	1993	1993	1993	1993	1994
COMMENTS	Array operation requires upgrade to basic board.				RAID 4/5 upgradable.

MANUFACTURER	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)
ARRAY MODEL	GDT6000B	GDT6010	GDT6020	GDT6050	GDT6110
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.
RAID level Configured by:	0/1/4/5	0/1/4/5	0/1/4/5	0/1/4/5	0/1/4/5
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7	7	14	35	7
Concurrent host channels	1	1	2-5	2-5	
Controller drive channels	1	1	2-5	2-5	1
Array interface to host	PCI	PCI	PCI	PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2, 32	4, 32	4, 32	4, 32	2, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 10	132 10	132 10	132 10	133 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	1994	1994	1994	1994	1995
COMMENTS	Array operation requires upgrade to basic board.				

MANUFACTURER	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)
ARRAY MODEL	GDT6120	GDT6510	GDT6520	GDT6530	GDT6537
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Board	Board	Board	Board	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.
RAID level	0/1/4/5	0/1/4/5	0/1/4/5	0/1/4/5	0/1/4/5
Configured by:					
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	14	7	14	21	21
Concurrent host channels					
Controller drive channels	2	1	2	3	3
Array interface to host	PCI	PCI	PCI	PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2, 32	4, 32	4, 32	4, 32	4, 64
Cache function (Read, Write)		Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	No	No	No	No	No
Power supply (Yes/No)	No	No	No	No	No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	133	133	133	133	133
drive (MB/Sec)	10	10	10	10	40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D					
POWER:					
Power backup					
FIRST CUSTOMER SHIPMENT	1995	1996	1996	1996	1996
COMMENTS					

MANUFACTURER	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	WESTERN SCIENTIFIC	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS
ARRAY MODEL	GDT6550	GDT6557	CycloneRAID	FlashCluster CI	FlashDisk RAID Workgroup
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	SCSI host UNIX	VAX, Alpha Open VMS	SCSI host Any O/S
RAID level Configured by:	0/1/4/5	0/1/4/5	0/3/5	0/1/3/5 Host	0/1/3/5/0+1
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	21 21*	1 1136	4 39
Minimum drives per array	2	2	5	1	2
Maximum drives per array	35	35	5*	284	8
Concurrent host channels			1	1, 6	1
Controller drive channels	5	5	1-6		1, 2
Array interface to host	PCI	PCI	SCSI-2	CI, DSSI	SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI
Cache size (min, max: MB)	4, 32	4, 64	32, 64, 128	--, 512	8, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No Yes Yes	Option Option Option	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	133 10	133 40	10, 20 10, 20	8.75/4 10	20 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	4300-9100	Drive dependent	4300
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95, 130	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	8	Drive dependent	9
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17	Drive dependent	5.5
Drive models	Various	Various	Various	Various	Seagate Hawk
ARRAY SIZE: Inches: H x W x D			Configuration dependent	*	12.25 x 10.25 x 14.5
POWER: Power backup			300 watts	Drive dependent Drive dependent	
FIRST CUSTOMER SHIPMENT	1996	1996	4Q96	12/93	12/95
COMMENTS			Purchased controller. *Expandable to 315 gigabytes. Multiple configurations.	*Varies with tabletop, rack, pedestal units.	

MANUFACTURER	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	XISTOR	XISTOR
ARRAY MODEL	FlashDisk RAID Departmental	FlashDisk RAID Enterprise	FlashCluster DSSI	rd040.0 XI-raid	rd080.0 XI-raid
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Single User
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Software	Software
Host platform, software environment	SCSI host Any O/S	SCSI host Any O/S	VAX, Alpha Open VMS	PCI host Various	PCI host Various
RAID level Configured by:	0/1/3/5/0+1	0/1/3/5/0+1	0/1/3/5 Host	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN	8	8	1	4.2/2.1	8.6/4.3
MAX	138	344	1372		
Minimum drives per array	2	2	1	2	2
Maximum drives per array	8	8	343	2	2
Concurrent host channels	1, 4	1, 4	5	1	1
Controller drive channels	1, 5	1, 5		2	2
Array interface to host	SCSI	SCSI	SCSI-2, DSSI	PCI	PCI
Drive interface	SCSI	SCSI	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 64	8, 64	--, 128	--	--
Cache function (Read, Write)	Read, Write	Read, Write	Read	--	--
Redundancy: Controller (Yes/No)	Yes	Yes	Option	No	No
Fan (Yes/No)	Yes	Yes	Option	No	No
Power supply (Yes/No)	Yes	Yes	Option	No	No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	20	10, 4	132	
drive (MB/Sec)	20	20	10	10	
DRIVES: Formatted capacity/drive(MB)	4300	4300	Drive dependent	2.1	4.3
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8	8	Drive dependent	8 RD/9 WR	8 RD/9 WR
Average rotational delay (msec)	4	4	Drive dependent	4.17	4.17
Drive models	Seagate Barracuda	Seagate Barracuda	Various	Seagate Barracuda	Seagate Barracuda
ARRAY SIZE: Inches: H x W x D	19 x 7 x 25	31 x 60 x 82	*	--	--
POWER:			Drive dependent	--	--
Power backup			Drive dependent	--	--
FIRST CUSTOMER SHIPMENT	10/95	3/95	12/93	1995	1995
COMMENTS			*Varies with tabletop, rack, pedestal units.		

MANUFACTURER	XISTOR	XYRATEX	XYRATEX	XYRATEX	XYRATEX
ARRAY MODEL	rd16.0 XI-raid	N3000	N9000	R9000	S9000
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Software	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Software
Host platform, software environment	PCI host Various	SCSI host NFS, Netware, NT	SCSI host NFS, NetWare, NT	SCSI host NT, NetWare	SSA , Mac, NT, NetWare
RAID level Configured by:	0/1 Host	0/1	0/1/3/5 Port	0/1/3/5 Host, Port	0/1 Host
Array capacity (Gbytes) MIN MAX	16/8	4.3 25	12 30	4 60	2 36 per tower
Minimum drives per array	2	1	4	2	2
Maximum drives per array	2	6	7	14	8 per tower
Concurrent host channels	1	1	1	1	127
Controller drive channels	2	1	1, 2	1, 2	1
Array interface to host	PCI	SCSI-2	SCSI-2	SCSI-2	SSA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SSA
Cache size (min, max: MB)	--	32	32	8, 32	N/A
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	N/A
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	None	Auto	Auto	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)		20 10	20 10	20/20 20/20	20/20 20/20
DRIVES: Formatted capacity/drive(MB)	8	4300	4300	2000,4000,9000	2000,4000,9000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8 RD/9 WR	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models		Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D		11 x x 8 11	19 x 8 x 15.2	19 x 8 x 15.2	19 x 8 x 15.2
POWER: Power backup		110 watts	2x300 watts UPS	2x300 watts UPS	2x300 watts
FIRST CUSTOMER SHIPMENT	1995	9/96	9/96	6/95	6/95
COMMENTS		Direct attach storage server with software RAID.	Direct attach storage server with hardware RAID.		

MANUFACTURER	XYRATEX	ZENITH DATA SYSTEMS	ZZYXZ WORKSTATIONS & PERIPHERALS	ZZYXZ WORKSTATIONS & PERIPHERALS	
ARRAY MODEL	SR6000	Z-RAID Option	ZRS-3000	ZRS-5000	
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	
MARKET	OEM, PCM	PCM	PCM	PCM	
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	
Host platform, software environment	SCSI host NT, NetWare	PC compatible NetWare, NT, UNIX, other	Sun, HP, SGI, other	Sun, HP, SGI, other	
RAID level Configured by:	0/1/3/5 Host	0/1/5 Host	0/3/5 Host,Panel,Port	0/3/5 Host,Panel,Port	
Array capacity (Gbytes) MIN MAX	12 24	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	
Minimum drives per array	3	4	2	2	
Maximum drives per array	6	8	28	28	
Concurrent host channels	1	1	1-3	1-3	
Controller drive channels	1, 2	1, 2	1-3	1-3	
Array interface to host	SCSI-2	PCI	SCSI-2	SCSI-2	
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	
Cache size (min, max: MB)	4, 32	4, 64	8, 32	8, 32	
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	Option Yes Yes	Option Yes Yes	
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20/20 20/20	132 10	10, 20 10	10, 20 10	
DRIVES: Formatted capacity/drive(MB)	2000, 4000	500-4000	Drive dependent	Drive dependent	
Nominal disk diameter (mm)	95	95	95	130	
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	
Drive models	Various	Seagate	Seagate Micropolis	Seagate, Micropolis	
ARRAY SIZE: Inches: H x W x D	11 x 8 x 11	Varies	24 x 24 x 30	24 x 24 x 30	
POWER: Power backup	110 watts	20 watts+drives None	-- Cache battery	-- Cache battery	
FIRST CUSTOMER SHIPMENT	1/97	1Q94	7/93	7/93	
COMMENTS		Mylex controller.	CMD CR-5000 controller.	CMD CR-5000 controller.	

1996 DISK/TREND REPORT

MANUFACTURER PROFILES

All manufacturers now producing disk drive arrays, or those which are expected to enter the market, are listed in this section. "1995 total net sales" covers the fiscal year ending in 1995 for each firm unless noted otherwise, or for the parent company if the disk drive array manufacturer is a subsidiary. The fiscal year of listed firms ends on December 31, 1995, unless otherwise noted.

Except for Canadian firms, manufacturers located in the United States that have majority owners headquartered in other countries are grouped in the geographical area in which the owner's home office is located. Canadian array manufacturers are grouped with the U.S. companies for convenience.

Exchange rates

The exchange rates used in converting the financial data of non-U.S. manufacturers to dollars are given below. The average exchange rate for 1995 is used, as cited by the Federal Reserve Bulletin.

Country	Currency	Currency units/U.S. dollar
Canada	Canadian dollar	1.37
France	French franc	4.99
Germany	Deutschmark	1.43
Japan	Yen	94.0
Taiwan	Taiwan dollar	26.5
United Kingdom	Pound	.633

Use caution in making year to year comparisons of revenue and income figures, as they are significantly impacted by exchange rate changes.

U.S. and Canadian Manufacturers

1776, INC.
8632 S. Sepulveda Blvd.
Los Angeles, CA 90045

1776, Inc. was founded in December, 1986, for the purpose of providing specialized large data storage hardware systems. In 1989, the company completed a change to become a software supplier to the users of SCO UNIX. Its current products include "1776 Disk Array Software" which is specifically designed for the Intel-architecture microcomputer UNIX environment.

A second product of 1776, Inc., is "Multi-Host", which offers a unique method of using microcomputers in mission critical applications. Multi-Host combines the high performance and fault tolerance of "1776 Disk Array Software" together with the ability for a second host computer to back up the primary UNIX system.

1776, Inc., markets its software products directly to OEMs and through distributors. The company has been successful in installations with numerous major companies currently utilizing UNIX applications.

AC TECHNOLOGY
8201 Greensboro Drive
McLean, VA 22102

Specializing in UNIX systems, AC Technology is a system integrator serving the Sun, SGI, IBM RS/6000 and other midrange system markets. The company employs the CMD controller line in its array storage subsystems.

ADAPTEC,INC.
691 South Milpitas Boulevard
Milpitas, CA 95035

1996 total net sales: $649,347.000 (FY ending 3/31/96) Net income: $103,375,000

Adaptec was an early leader in SCSI adapter boards and has become the industry leader in SCSI chip sets. While Adaptec initially did not offer a board level array product, it did offer array software bundled with some controllers, using software products from Integra and other firms.

The company entered the array controller market more directly in 1995 with a series of array products that combine host-executed code with hardware augmentation, to minimize cost while maintaining acceptable performance. These array controllers are being aggressively priced, in an attempt to rapidly capture a significant share of the entry level market. Adaptec has also initiated an OEM directed effort to encourage system designers to include support for

Adaptec RAID controllers in motherboard designs. In mid-1995, Adaptec acquired Trillium Research, a Macintosh oriented software array producer.

ADJILE SYSTEMS
5816 Roseville Road, Suite 2
Sacramento, CA 95842

Privately held Adjile was founded in 1993 as a storage subsystem integrator. The firm produces customized array subsystems using a variety of disk drives and controllers. Adjile also manufactures a line of array enclosures, which it uses in its own subsystems and also markets to other array producers. The firm's business splits evenly between the two product lines.

ADS INTERNATIONAL (AMERICAN DIGITAL DATA ASSOCIATES)
434 Cloverleaf Drive
Baldwin Park, CA 91706

ADDA was founded in 1983 to develop, manufacture and sell a family of PC motherboards for the systems integration market. The company then broadened its product line over the years to include a range of products from the low-end X-Terminal to high-end super servers including 386 and 486 based systems, with emphasis on the UNIX system user. In January, 1992, ADDA introduced its first RAID product, the model ADS 1000. It featured RAID levels 0, 1, 4 and 5 through the utilization of an UltraStor RAID controller bundled with various disk drives. In June, 1992, the company introduced it's second RAID offering. The product featured UNIX support for RAID levels 0 and 1 through packaging of the RAID software module from 1776, Inc., coupled with various disk drives. In January 1993, ADDA introduced its model ADS 3000 which supports RAID levels 0, 3 and 5 using the Digi-Data controller, combined with various high performance disk drives. The ADS 5000, which uses a CMD controller, also offers RAID levels 0, 3 and 5, but includes read and write cache in the controller. In 1993, the organization began to de-emphasize system sales and the ADDA brand and concentrate upon storage subsystems marketed under the ADS name.

ADVANCED LOGIC RESEARCH
9401 Jeronimo
Irvine, CA 92718

ALR is a producer of IBM compatible PC systems. Both internal and external array options are available on the firm's servers, both based on the Mylex controller. RAID modes 0, 1, and 5 are included.

ADVANCED SYSTEMS PRODUCTS, INC. (ADVANSYS)
1150 Ringwood Court
San Jose, CA 95131

The company was formed in March, 1993, by several engineers with experience in the controller and software industries. Host adapters have always been the focus of AdvanSys' energies, with the first product shipped in June of 1994. The close coupling between the design of a proprietary controller processor and software driver permit the use of only one driver per operating environment across a range of platforms, simplifying system configuration and improving performance. Controllers are available for ISA, EISA, and PCI bus attachment.

Production of an array controller board based upon the existing SCSI drive controllers was planned for the second half of 1995, but the company decided not to enter the array market and cancelled the project.

ALLODYNE, INC. (See Sigma Displays)

AMERICAN DIGITAL SYSTEMS
490 Boston Post Road
Sudbury, MA 01776

A storage subsystems integrator, ADS serves primarily the DEC market, but also supports other UNIX-based systems with RAID 0, 1, 3 and 5 level arrays. Third party controllers are used. The firm markets directly to large U.S. financial organizations, institutions and government agencies. Non-U.S. sales are through representatives.

AMDAHL CORPORATION
1250 East Arques Avenue
Sunnyvale, CA 94088

1995 total net sales: $1,516,388,000 Net income: $28,527,000

Since the early days of the company, Amdahl has marketed mainframe computer systems and disk storage subsystems manufactured by Fujitsu, which owns 44% of the firm. In recent years, Amdahl has also experimented with a variety of sales programs for open systems hardware from several sources. After several years of indifferent sales results in the enterprise systems disk drive market, Amdahl added the Spectris mainframe RAID-3 array jointly developed with Fujitsu in late 1995, and followed in mid-1996 with the LVS-4500 midrange array for open systems applications.

AMERICAN MEGATRENDS, INC.
6145-F Northbelt Parkway
Norcross, GA 30071

American Megatrends was founded in the Fall of 1985 as a supplier of software design services and BIOS software. The firm has since added peripheral controllers and utility software to its product line. Active participation in the disk drive array market began in late 1994, at which time the firm introduced a PCI bus array controller operating in RAID-0/1/3/5/10 modes. After a slow start, the firm has succeeded in developing some major OEM accounts. AMI's most recent array controllers, introduced in 1996, support dynamic reconfiguration of an array. Support for clustered processors was added late in 1996.

AMERIQUEST TECHNOLOGY (Formerly CMS Enhancements)
2722 Michelson Drive
Irvine, CA 92715

The firm started as CMS Enhancements, a manufacturer and distributor of computer add-on and add-in equipment and software. The firm under went management changes and changed its name to Ameriquest Technology in early 1994. It subsequently became part of the Computer 2000 Group. Disk drive array products included the "Platinum" array subsystems based upon third party software arrays and 5.25" drives.

ANDATACO
10140 Mesa Rim Road
San Diego, CA 92121

ANDATACO is a system integrator and storage subsystem producer that concentrates on Sun, Hewlett-Packard, Silicon Graphics and certain UNIX-based IBM and DEC platforms. Array products include array subsystems based on purchased controllers. A variety of drive manufacturers are supported and drives from 1 to 4 gigabytes are available. RAID-0, RAID-1, RAID-3, RAID-5, and RAID-10 are supported, with array capacities from 2.5 to 150 gigabytes available in a variety of configurations.

ANTRONE RESEARCH, INC.
1173 North Red Gum Street
Anaheim, CA 92806

Antrone offers a complete array incorporating a SCSI to IDE controller and up to 6 IDE drives. The subsystem includes multiple fans and power supplies. The array was introduced in late 1995, with updated versions introduced at COMDEX in 1996.

APPLE COMPUTER
20525 Mariani Avenue
Cupertino, CA 95014

1995 total net sales: $11,062,000,000 (FY ending 9/29/95) Net income: $424,000,000

Apple is one of the pioneers of the personal computer industry and has succeeded in creating a loyal and enthusiastic customer base among individual users. As part of its efforts to improve penetration of corporate markets, Apple began to offer disk drive arrays for its servers, beginning in late 1994, with a software based mirrored array using software licensed from Conley. Apple added hardware array support for its line of servers in 1996 based upon third party controllers.

APPLIED DIGITAL SYSTEMS
30 State Street
Fairport, NY 14450

ADS is an integrator of storage systems that got its start in 1984 as a DEC system integrator. Storage was added to the product line in 1987. A variety of array subsystems are available based upon a variety of controllers, and much of the firm's array production is done on a customized basis.

ARTECON
2460 Impala Drive
Carlsbad, CA 92008

Artecon is a subsystems and systems integrator specializing in SUN and other UNIX platforms, using a modular subsystem design approach. The firm was founded in 1984. In late 1994, the firm began shipping a modular array based upon CMD controllers. A new array family using a different controller was introduced in 1995.

AST RESEARCH, INC.
16215 Alton Parkway
Irvine, CA 92713-9658

1995 total net sales: $2,467,783,000 (FY ending 6/30/95) Net income: ($99,309,000)

AST Research was founded in 1987 to develop, manufacture and market high-performance computer systems for large corporations, small businesses and individual users. The AST product mix is broad, offering performance oriented computer systems for a wide range of applications.

AST Research's sales strategy centers on selling products through networks of VADs, VARs, national distributors, systems integrators, and large retailers. In 1991, AST made a significant move into mass merchandising with the introduction of the "Advantage!" line of personal computers developed specifically for distribution through electronic "superstore" chains.

In early 1992, AST introduced its first disk drive array product, offered on its Premium CS line of computer systems. Along with a RAID level 0, 1 and 5 capability, the product also features a "RAID-6" implementation (RAID level 0 striping and RAID level 1 mirroring capability). In late 1992, AST began offering this RAID subsystem on its new Manhattan series of high performance computer systems, and in late 1993 added a similar array to the Premia-SE series. AST obtains its array controllers from third parties.

ATTO TECHNOLOGY
1576 Sweet Home Road
Amherst, NY 14228

ATTO, founded in 1988, is today a producer of solid state disk drives, external cache subsystems, and SCSI host adapters for PC compatible and Macintosh computers. ATTO has also developed mirroring and striping software for use with its controllers on the Macintosh personal computers. Up to 4 drives may be striped or mirrored. Because there has been relatively little competition for disk arrays on Apple products until recently, ATTO has had an opportunity to hold significant market share in the Macintosh array segment as the market develops. Shipments of mirroring software began in early 1992, while striping capability was added in late 1992.

AUSPEX SYSTEMS, INC.
2952 Bunker Hill Lane
Santa Clara, CA 95054

1996 total net sales: $162,600,000 (FY ending 6/30/96) Net income: $19,800,000

Auspex is a major provider of UNIX based NFS network servers that employ a sophisticated multiprocessor architecture and a high speed internal VME bus to obtain unusually high performance. Dedicated processors are assigned to each major system function. Auspex systems employ multiple processor/controller boards dedicated to controlling the array and can provide duplexing and drive spanning as well as mirroring and striping. RAID-0, RAID-1 and RAID-10 are supported, with only two drives assigned to a SCSI channel for optimized response. Drives can be partitioned and array functions assigned to specific partitions. Cache functions are distributed between cache in the storage processor and main system cache. Auspex has steadily expanded the size of its arrays, and now can support array subsystems containing over 200 disk drives with

storage capacity of up to 900 gigabytes per server. Auspex also offers software for mirroring its servers.

The company counts Intel, Fuji Xerox and Nissho Electronics among its major customers. Between 40 to 45 percent of revenue is derived from sales of new systems, with the balance coming from upgrades, software and services.

AUSTIN COMPUTER SYSTEMS, INC.
10300 Metric Boulevard
Austin, TX 78758

Austin Computer Systems, established in 1984, manufactures a variety of 386 and 486 based EISA and ISA bus computers. In late 1992, the firm introduced a RAID-5 file server for NetWare applications, using a controller from UltraStor, but did not follow through with the product. An array was offered with the firm's "Affinity" series starting in 1996, using a purchased controller.

AVIV CORPORATION
4 Fourth Avenue
Burlington, MA 01803

Aviv offers data storage subsystems for DEC and other UNIX-based computing systems. Disk drives, tape drives, optical disk drives and automated libraries are included in the firm's subsystems. Array products include Aviv's own array controller, which provides RAID-3, RAID-5 and RAID-0 operating modes.

BAYSTOR, INC.
6840 Via Del Oro
San Jose, CA 95119

BayStor is a startup with key founders experienced in the disk drive array business. The firm designed and introduced a miniaturized RAID-1 array controller board in mid-1996 intended for use with IDE disk drives.

BOX HILL SYSTEMS CORPORATION
161 Avenue of the Americas
New York, NY 10013

Privately held Box Hill was founded in 1987 as a producer of storage subsystems for the UNIX based systems market. The current array product is a RAID-5 configuration designed around a purchased controller that supports several popular midrange systems.

BUSLOGIC INC.
4151 Burton Drive
Santa Clara, CA 95054

BusLogic was founded in 1988, but until 1992, the BusLogic product line was limited to Ethernet controllers, SCSI host adapter boards and SCSI drivers, rather than arrays. Upon the purchase of Chantal in 1992, which became the Chantal Systems Division, BusLogic began to shift its strategy to include array support in future products and to include Chantal in joint promotion of board and software packages. The Chantal Division was subsequently consolidated into BusLogic's main location. BusLogic's original disk controllers did not include specific support for arrays, and the firm introduced array controllers in the Spring of 1994 with RAID-0, 1, 3 and 5 functionality. The initial introduction misfired and few were shipped. BusLogic was subsequently acquired by Mylex in early 1996, adding the firm's line of SCSI controllers to the Mylex product line.

CAMBEX CORPORATION
360 Second Avenue
Waltham, MA 02154

1995 total net sales: $35,152,000 (FY ending 8/31/95) Net income: ($9,899,000)

Founded in 1968 to supply add-in semiconductor memory systems for the IBM mainframe market, Cambex has grown to become a leading supplier in that field. In recent years, the firm has established the Enterprise Systems Division to address its traditional market for central and expanded IBM mainframe memory systems and the Open Systems Division, which offers storage software products as well as disk, tape and semiconductor memory hardware products for the IBM RS/6000 workstation market. Cambex' ARRAY/6000 subsystem with RAID-0/1/3/5, represented the firm's entry in the RS/6000 disk array market, with a design providing a high level of redundancy for all component parts and offering up to 96 gigabytes, using 1.6 megabyte 3.5" drives. In 1995, Cambex broadened its array product line to cover a range of open system applications, plus small mainframe sites.

CHARISMAC ENGINEERING
66 P&S Lane, Suite D
Newcastle, CA 95658

Founded in 1986 as a developer of disk storage utility software for the Apple Macintosh, CharisMac has developed a number of support products for the Mac market, including RAID-0/RAID-1 software arrays. The array software is available as an option for the Anubis Storage Suite. The firm currently markets almost exclusively to resellers in the U.S.

CIPRICO, INC.
2800 Campus Drive
Plymouth, MN 55441

1995 total net sales: $15,966,000 (FY ending 9/30/95) Net income: $396,000

Ciprico was established in 1978, and produces disk drive arrays, adapters, and disk and tape drive controller boards for the workstation, network server and very high performance storage markets. Products are sold directly to system manufacturers and through a variety of resellers to end users. Ciprico introduced its first disk drive array in 1990, and succeeding product generations have expanded the firm's product line of RAID-3 arrays for SCSI based host platforms with high performance requirements, such as medical imaging and video applications. Current models utilize 5 to 9 drives, with capacity and performance dependent upon a variety of possible drive models.

CLONE STAR SOFTWARE
24102 Palo Dura
Hockley, TX 77447

CLone Star Software has produced specialized networking products since 1988, selling through VARs and system integrators. The company has developed REFLECT, a software array providing mirroring of drives located on either a local system or on a remote server. REFLECT operates with most PC based local area networks.

CLOVIS, INC. (See CYBERSTORAGE SYSTEMS, INC.)

CMD TECHNOLOGY INC.
1 Vanderbilt
Irvine, CA 92718

CMD Technology was founded in 1986 to develop and market SCSI adapters for the DEC marketplace. The company has expanded its product line to address other SCSI based systems opportunities, and its products can now be found on a variety of UNIX, Novell, Windows NT and MS-DOS platforms. The company sells worldwide through OEMs, VARs and other resellers.

In January, 1993, the company introduced its first RAID-3/5 disk array product, the model CRD-5000. Offering the user a choice of RAID level 0, 3 or 5, the CRD-5000 provided support for up to 28 individual disk drives and can service up to 3 host channels simultaneously. Utilizing the FAST SCSI-2 bus, the CDR-5000 transfers data to the host system at up to 10 megabytes/second. In order to further enhance the overall system performance, up to 32 megabytes of

cache could be implemented in the subsystem configuration. A mirrored disk controller, the SCEA/S was first shipped in February, 1993. A number of newer board and controller module products have since been introduced.

CMD made a brief foray into the PCI bus based controller market in 1995, but decided in 1996 to abandon that market segment, preferring to concentrate upon higher end controllers for the server market.

COMPAQ COMPUTER CORPORATION
20555 SH 249
Houston, TX 77070

1995 total net sales: $14,755,000,000 Net income: $1,030,000,000

Compaq is a major participant in the IBM PC compatible computer market, offering a broad product line ranging from notebook computers to multiprocessor systems intended for use as servers.

The firm was the first to offer disk drive arrays (other than mirroring) on personal computers. The company's first arrays were shipped in 1989, and Compaq currently has shipped more array subsystems than any other supplier. The array product line under went extensive revision in 1993, with almost all array based systems being replaced with newer versions. A similar extensive upgrading occurred in 1995 with the development of the SMART-2 array controller.

Compaq designs its own array controllers and supports them with storage subsystem management tools that can be operated over a network. All of the Compaq arrays are sold with Compaq computers and attach directly to the host processor EISA or PCI bus. RAID levels 0, 1, 4, and 5 are supported. The write cache is mirrored, and includes battery backup.

COMPUTER MARKETPLACE
1490 Railroad Street
Corona, CA 91720

Computer Marketplace is a national reseller of computer systems and subsystems, peripherals, and related products. The firm also integrates a line of disk drive arrays, mostly based upon the Digi-Data controller, which are made to customer specifications. The company is publicly traded.

CONCORDE TECHNOLOGIES
9770 Caroll Center Road
San Diego, CA 92121

Concorde, founded in 1989, is a system integrator and reseller specializing in solutions based on Hewlett-Packard equipment. The company attempted to

create a role as a disk drive array integrator using Raidtec controllers, but has since largely disengaged from the array market.

CONCURRENT COMPUTER CORPORATION
2 Crescent Place
Oceanport, NJ 07757

1996 total net sales: $95,800,000 (FY ending 6/30/96) Net income: ($39,712,000)

Concurrent started life as Interdata, a supplier of minicomputers, in 1966. The firm was subsequently purchased by Perkin-Elmer and operated as a subsidiary before regaining its independence and its current name in 1984. The firm specializes in high performance minicomputers and networked systems running under the UNIX operating system. RAID-0/1 arrays implemented in software are included in Concurrent's systems. An earlier hardware implementation has been discontinued.

CONLEY CORPORATION
420 Lexington Avenue
New York, NY 10017

Conley offers redundant RAID-0/1/3/5 array subsystems for Apple systems and networks as well as for UNIX-based servers and networks. Fault tolerance is stressed in systems design, with a high level of redundancy in various types of hardware used in array design. A software array for use with a Conley controller was added in late 1993, offering RAID-1, RAID-0 and combined RAID-1/0 modes. Conley has licensed its array technology to several other firms, including Apple Computer, Micronet, and others.

CONNER STORAGE SYSTEMS GROUP (See nStor)

CONSAN, INC.
7676 Executive Drive
Eden Prairie, MN 55344

Storage devices and customized subsystems are the main business of Consan, a distributor serving VARs in the mid-western U.S. The firm was founded in 1988. Customized disk drive arrays are built to specific VAR requirements. Most arrays are manufactured for workstation servers, but software based arrays for the Macintosh are also provided.

CONSENSYS COMPUTERS, INC.
35 Riviera Drive
Markham, Ontario L3R 8N4
Canada

Consensys offered an array controller that could support 8 IDE drives, plus a software driven SCSI array package. Most of the Consensys activity was directed toward the SCO UNIX-based systems market, but operation with SVR4 and Solaris was also supported. While the original RAIDIX series products have been discontinued, the company expects to introduce new array products in 1997.

CONVEX (Division of Hewlett-Packard)
3000 Waterview Parkway
Richardson, TX 75080

CONVEX is a manufacturer of air-cooled supercomputers that address the needs of scientific, engineering and technical users. CONVEX systems are used to solve complex problems in such diverse areas as seismic processing, computational chemistry, computer-aided engineering, image processing, aerospace simulations and molecular biology. The company was founded in 1982 and by 1985 had introduced its first supercomputer, the C1, which sold for $300,000. In March, 1992, CONVEX and Hewlett-Packard announced extensive business and technology agreements which included a 5% ownership in CONVEX by Hewlett-Packard. Hewlett-Packard subsequently acquired CONVEX in December, 1995, and CONVEX now operates as a division of Hewlett-Packard. Part of the 1992 agreement was that CONVEX would adopt Hewlett-Packard's PA-RISC (Precision Architecture Reduced-Instruction Set Computing) technologies in its massively parallel processing (MPP) supercomputer under development. In October, 1992, CONVEX introduced the Meta Series, a cluster system that links CONVEX supercomputers with Hewlett-Packard's PA-RISC processing nodes.

In 1992, the company introduced a RAID level 0, 1 or 5 disk subsystem offering up to 80 gigabytes of data on-line to the user with a sustained host bus data transfer rate of over 36 megabytes/second. Each array subsystem can support up to 32 disk drives and utilizes 4 host I/O channels as a standard configuration. Convex is expected to supply Hewlett-Packard and third party high performance arrays in the future. High performance storage is being implemented in JBOD configurations, as the technical applications Convex serves typically are more concerned with performance rather than data availability.

CORE INTERNATIONAL (See AIWA CO., LTD.)
7171 North Federal Highway
Boca Raton, FL 33487

CORE began in 1979 as a manufacturer of peripherals and became an early marketer of disk drives for the IBM 5100 desktop computer series, which pre-

ceded the PC. The company became a supplier of peripherals for the IBM PC market during most of the 1980s, and in 1987 introduced an early mirrored disk capability for the Novell market. Since 1991, CORE has participated in the array market for personal computers, workstations and networks with RAID-3/5 subsystems. The firm's innovative "MicroArray" uses 2.5" drives packaged with an array controller in the form factor of a full size 5.25" drive. Aiwa Co., Ltd., a Japanese manufacturer of consumer electronics products which is controlled by Sony, purchased a 23% minority interest in CORE International in 1992 and acquired control of the company in 1993. Aiwa Computer Systems Division has assumed marketing and manufacturing responsibilities for the arrays (production is in Singapore) and the Boca Raton facility is now responsible primarily for product development.

COREL CORPORATION
1600 Carling Avenue
Ottawa, Ontario K1Z 8R7
Canada

Corel is a well known supplier of graphics software and SCSI support software. In 1993, Corel introduced Corel RAID, a software package usable with a variety of SCSI controllers. The product was only marginally successful and was subsequently bundled into the CorelSCSI Network Manager, a SCSI controller package for servers that also supports optical drives and libraries.

CRANEL, INC.
8899 Gemini Parkway
Columbus, OH 43240

Founded in 1985, Cranel is a specialized distributor of storage products and subsystems. Disk drive arrays are customized for individual customers, most of which are VARs and system integrators. A few standard configurations are offered, based upon DEC's StorageWorks modules.

CRAY RESEARCH, INC. (Subsidiary of Silicon Graphics)
655A Lone Oak Drive
Eagan, MN 55121

Cray Research was founded in 1972 and claims two thirds of the worldwide market for supercomputers. With over 5,400 employees, the company transitioned through several generations of supercomputers, with continually increasing performance demands on the disk drives used with most of their installations. Cray Research's original DCA-3 RAID-3 disk array channel adapter for IPI-2 8" parallel transfer drives, has been supplemented with newer high performance

arrays using high capacity 3.5" drives covering users' RAID-3 and RAID-1/5 requirements. In 1996 Cray Research was acquired by Silicon Graphics, and it is expected that future disk storage requirements for both organizations will become part of a coordinated family.

CUBIX CORPORATION
2800 Lockheed Way
Carson City, NV 89706

Cubix, founded in 1975 as a manufacturer of specialized computer systems, added arrays and fault tolerant enclosures to its product lines in 1995. The firm uses a variety of purchased controllers and drives in customized configurations for network and telecommunications applications.

CYBERDATA SYSTEMS, INC.
831 Beacon Street
Newton, MA 02159

CyberData Systems is a company formed in 1996 by one of the New England data storage veterans to develop and market storage peripherals. The initial products include CD-ROM libraries and a software based array intended for video, graphics and multimedia applications.

CYBERSTORAGE SYSTEMS, INC. (Formerly Clovis, Inc.)
25 Porter Road
Littleton, MA 01460

The company now operating under the CyberStorage Systems, Inc., name is the result of the merger of Impulse Technologies, Inc., and Clovis, Inc., in 1993. Impulse Technologies was the company which resulted from the purchase of Alloy Computer's assets from Chapter 11 bankruptcy proceedings by some of the Alloy management personnel. Clovis was founded in 1987 by former Wang employees, and specialized in add-on products for Wang systems. Clovis developed an array operating in RAID modes 1, 3 and 5, with the mirroring mode compatible with Novell NetWare, SCO UNIX, DOS, OS/2 and Banyan VINES. The merged organization operated initially under the Clovis name, and was then renamed CyberStorage Systems. The Alloy products were still sold for several years, but during recent years the majority of revenues have come from storage servers and related products. Current array products all use purchased controllers, but the firm plans to introduce its own array controller next year.

CYRANEX CORP. (Formerly Pro Engineering)
1145 Hunt Club Road
Ottawa, Ontario K1V OY3
CANADA

Founded in May, 1992, the company provides a variety of hardware and software storage solutions for attachment to PC compatible systems, marketing to OEMs and through distribution. The firm's first array product, EZRAID for OS/2, is a software array offering RAID levels 0, 1, 4 and 5. The array software operates with most host adapters and interfaces. A change of name, for marketing reasons, occurred in March, 1995.

DALLAS DIGITAL
624 Krona St, Suite 160
Plano, TX 75074

Dallas Digital is a system reseller and storage subsystem integrator. Together with Datalink, Dallas Digital is a member of the Tripac joint venture that creates products salable by both companies, including disk drive arrays. The firm resells disk drive arrays as well as integrating its own arrays.

DATA GENERAL CORPORATION
4400 Computer Drive
Westboro, MA 01580

1996 total net sales: $1,322,300,000 (FY ending 9/28/96) Net income: $28,100,000

Founded in 1968, Data General became a leading minicomputer manufacturer, but suffered the same softening of the market for classic minicomputers that hit the entire market segment in the mid-1980s. Despite declines in its traditional market, Data General appears headed for recovery on the strength of the AViiON line of RISC servers and workstations using UNIX. Overall, the company's range of products currently includes data base servers, communications and network servers, workstations, desktop and portable systems, mass storage and many related software products.

Data General's 1990 introduction of RAID-0/1/3/5 subsystems for the AViiON family resulted in a successful storage subsystem for captive sales, and the 1992 establishment of a new Data General organization to pursue noncaptive array markets. The CLARiiON Business Unit is responsible for development of array markets with other system manufacturers and independent peripherals suppliers and integrators. The first result was a CLARiiON resale agreement with Groupe Bull, followed by numerous others, including Memorex/Telex, Amdahl, Storage Technology, and Silicon Graphics. The CLARiiON unit has become increasingly visible and has developed a market identity distinct from that of Data General.

DATALINK
7423 Washington Avenue South
Minneapolis, MN 55439

Datalink is a system reseller and storage subsystem integrator. Together with Dallas Digital and Cranel Corporation, Datalink is a member of the Tripac joint venture that creates products salable by all three companies. In the spring of 1994, Datalink announced four subsystems containing disk drive arrays. These include both software and hardware array implementations.

DATARAM CORPORATION
Route 571 Princeton Road
West Windsor Township
Princeton, NJ 08543

Dataram was established in 1967 as a supplier of memory subsystems for computers. The Dataram disk drive array attaches to Sun, DEC, H-P and other UNIX-based systems, providing RAID-3, RAID-5, and RAID-0 operating modes. Purchased controllers are used. A new generation of products offering RAID modes 0,1,3,5 and 10 began shipping in early 1995. Also in early 1995, Dataram and Symbios Logic announced a strategic partner relationship for disk drive array product development, but the company elected in 1995 to quit the array business and concentrate upon its memory products.

DATA STORAGE MARKETING
5718 Central Avenue
Boulder, CO 80303

Data Storage Marketing, founded in 1987, is a storage subsystems integrator and distributor that makes heavy use of telemarketing to sell its products. The firm's disk drive arrays have been based upon CMD controllers, Seagate drives and a variety of array enclosures.

DTC DATA TECHNOLOGY CORPORATION
1515 Centre Point Drive
Milpitas, CA 95035

DTC was founded in 1979 as a manufacturer of plug in cards for small computers, and has been through a series of ownership and product line changes since that time. The firm's current array related product, introduced in February, 1996, is a mirroring controller that operates with EIDE drives. It plugs into a PC compatible ISA bus computer.

DELL COMPUTER CORPORATION
9505 Arboretum Blvd.
Austin, TX 78758

1996 total net sales: $5,296,000,000 (FY ending 1/28/96) Net income: $272,000,000

Dell Computer, founded in 1984 to sell PCs via mail order has become legendary in the computer industry. In November of 1992, the company began shipping its first disk array product, the model DAS which offers RAID-0 and RAID-1 capabilities. In 1993, the subsystem was upgraded to support RAID levels 4 and 5, and in 1994 support for hot sparing of drives was added. Dell expected to be among the earliest companies planning to make use of the SSA serial interface in future array products, but has since altered its strategy and is employing purchased controllers supporting parallel SCSI family interfaces.

DIGI-DATA CORPORATION
8589 Dorsey Run Road
Jessup, MD 20794

Digi-Data has been active since 1962 as a manufacturer of tape cassette and cartridge drives, with an emphasis on military markets. In recent years the firm's product line has been broadened to cover a variety of commercial applications for tape drives for the Digital Equipment, Data General, Hewlett-Packard and IBM markets. Since April, 1992, Digi-Data has also been actively promoting its RAID-0/3/5 array, sold as a board-level product for a variety of host environments. The model Z-9000, an upgrade to the original model Z, includes up to 128 megabytes of cache.

DIGITAL EQUIPMENT CORPORATION
146 Main Street
Maynard, MA 01754

1996 total net sales: $14,600,000,000 (FY ending 6/29/96) Net income: ($112,000,000)

Digital Equipment was a veteran disk drive manufacturer, with production starting more than 20 years ago, during the firm's early days as a minicomputer manufacturer. Digital phased out older large diameter disk drives during the last few years, and by 1994 had become a specialist in high capacity 3.5" drives, for both captive and OEM sales. Driven by the parent company's hunger for cash, the Digital Equipment disk drive business was sold to Quantum Corporation, with the deal consummated in October, 1994. Digital Equipment retained its storage subsystems programs and has become a major buyer of disk drives from Quantum and other manufacturers.

For several years, Digital has offered a variety of disk mirroring capabilities, in both hardware implementations with drive controllers and in software RAID-0 and RAID-1 implementations. Late in 1992, Digital announced new RAID-0/1/3/5 arrays, also offered in OEM markets. In 1993, Digital announced StorageWorks, a modular family of storage subsystems and subsystem components. The family has been upgraded with larger drives and improved controllers several times since its initial introduction. Most of the announced subsystems operate in RAID-0/1/3/5 modes.

DIRECT CONNECTIONS
7668 Executive Drive
Eden Prairie, MN 55344

Founded in 1987, Direct Connections offers customized storage subsystems for the Apple Macintosh aftermarket. The firm offers a software based RAID-1/RAID-0 array, and also sells other customized hardware and software based array subsystems.

DIRECT CONNECT SYSTEMS
2260 NW Parkway, Suite O
Marietta, GA 30067

Founded in August, 1993, DCS is a storage subsystem integrator for DEC, Sun, NCR and other UNIX based equipment. Array products make use of several different arrays and array controllers from third parties, including Raidtec, CMD, Data General and TD Systems.

DISTRIBUTED PROCESSING TECHNOLOGY (DPT)
140 Candace Drive
Maitland, FL 32751

DPT has designed and sold board level controllers for the personal computer and network markets since 1977. An early producer of SCSI controllers, the firm pioneered in development of cache usage with controller boards. A SCSI host adapter chip set is also available. DPT's "disk mirroring module" attached to its ISA and EISA "SmartCache Plus" controller boards, provided RAID-1 capability. The more recent "SmartCache III", which began shipping in late 1993, and the 1996 Ultra-SCSI SmartCache IV provide RAID levels 0/1/5, plus an array manager software utility. As with previous designs, array functionality is created when additional modules are installed on the basic SCSI controller board. A new line of subsystems began shipping in late 1994. The firm markets its controllers and arrays to OEMs and through distribution in the U.S. and Europe. About 30% of sales are to non-U.S. markets.

DIVERSE LOGISTICS, INC.
2862 McGaw Avenue
Irvine, CA 92714

A wholly owned subsidiary of Dilog S.A., a Swiss company, DLI was founded in mid-1993. The company is a storage subsystems integrator selling to system integrators and system manufacturers. The "Windjammer" series of array products, based on the firm's own controller, provides RAID-0 and RAID-1 capability and attaches to SCSI host processors. First shipments were in early 1994. DLI also intends to market its controller on an OEM basis. An Ultra-SCSI version was added in 1996.

DYNATEK AUTOMATION SYSTEMS, INC.
200 Bluewater Road
Bedford, Nova Scotia B4B 1G9
Canada

DynaTek, a privately owned firm established in 1985, is a system integrator specializing in packaged SCSI-based storage systems operable with a broad variety of hardware platforms. In addition to disk drive arrays, DynaTek provides automated library systems (and purchased Cygnet in 1996) and a variety of disk and tape drive subsystems. The firm markets primarily to VARs and other types of dealer/integrators on a worldwide basis.

DynaTek offers several array products ranging from RAID-5 configurations that fit within the standard 5.25" full height form factor to larger tower mounted installations operating in RAID-0, 1, 3 and 5 modes. A variety of purchased controllers is used.

ECCS, INC.
1 Sheila Drive
Tinton Falls, NJ 07724

1995 total net sales: $31,200,000 Net income: ($3,700,000)

ECCS is a systems integrator and VAR specializing in UNIX-based systems and subsystems, including those of AT&T, H-P, IBM and Sun Microsystems. The company was founded in February, 1980, and after a period of rapid growth, went public in June of 1993. Array products include RAID-1 and RAID-1/3/5 arrays. The arrays can be operated in a combined RAID-0/1 mode which the company designates as RAID-10, in which data is striped across a set of SCSI controllers, which in turn control mirrored disks. ECCS is credited with popularizing the RAID-10 nomenclature, which has been endorsed by the RAID Advisory Board.

ECLIPSE TECHNOLOGIES
3827 Canyon Ridge DRive
San Jose, CA 95148

Founded in 1992 as an engineering consulting organization, the firm entered the LAN network adapter market and then evolved into an array supplier, selling through integrators into the UNIX server market. RAID levels 0/1/3/4/5 are offered. The firm has done particularly well in non-U.S. markets.

EMC CORPORATION
171 South Street
Hopkinton, MA 01748

1995 total net sales: $1,921,275,000 Net income: $326,845,000

Established in 1979, EMC became a born-again growth company in the 1990's, based on rapid growth since 1990 in the market for its Symmetrix family of cached disk storage systems offering mirrored disk capability for IBM and other mainframe computers, supplemented by the Harmonix subsystem family sold in the AS/400 market. The company also sells tape drive add-on products and a variety of solid state disk and main memory upgrades for several systems. Aided by IBM's failure to provide disk drive array subsystems until late 1994 and Storage Technology's delays with its Iceberg program, EMC became the leading supplier of high performance mirrored disk subsystems for the mainframe market. In early 1994, EMC acquired Array Technology's disk array product line and other selected assets from Tandem. In early 1995, EMC acquired the disk drive array operations of Sanyo Icon, which had been supplying important elements of EMC's Centriplex systems. Also in 1995, EMC announced its RAID-"S" feature for selected Symmetrix subsystem models, providing mainframe array disk redundancies similar to RAID-5, but without some of the performance limitations of RAID-5, and broadened the Symmetrix model series to cover selected open systems disk storage requirements.

ENCORE COMPUTER CORPORATION
6901 West Sunrise Blvd.
Fort Lauderdale, FL 33313-4499

Encore Computer Corporation was founded in 1963 to design, manufacture, market and service open computing solutions with mainframe performance for complex real time on-line transaction processing applications. The Encore 90 family of computers combines parallel processing and real time computing facilities by implementing a hardware and software architecture and provides open systems and standards while delivering very high performance solutions. Much of the firms sales are in Europe, but sales in the U.S. are expected to increase as the firm's direct sales force grows. The 90 Series of computers focus on a massively expandable systems configuration in order to solve complex comput-

ing problems. This configuration flexibility enables connection of multiple CPUs, I/O subsystems and intelligent communications controllers, providing the processing power formerly found only in the largest of mainframe type computer environments. Encore's fiber-optic memory channels maintain I/O bandwidths in excess of 53 megabytes/second per I/O channel.

Encore offers a RAID level 1 and 5 I/O subsystem which incorporates the Interphase Cougar 4220 SCSI-2 host bus adapter module in the high performance data I/O path. It has the capability of supporting host data transfer rates of 50 megabytes/second. The Infinity SP storage subsystems are more oriented to the mainframe market. They incorporate RAID-0, RAID-1 and RAID-5 arrays and can be interfaced to IBM or other processors. Encore is developing capabilities in remote site mirroring and real-time backup as part of its package of storage solutions.

FALCON SYSTEMS, INC.
1417 West North Market Boulevard
Sacramento, CA 95834

Falcon, founded in 1986, is a distributor and integrator of storage subsystems and UNIX based systems. The company has several sales and distribution locations. The firm customizes array configurations using a variety of purchased controllers and drives.

FORMATION, INC.
121 Whittendale Drive
Moorestown, NJ 08057

Since 1970, Formation has provided mass storage and network interconnect products to system integrators, system manufacturers, VARs and distributors. In network markets, Formation has become a specialist in air traffic control systems, tape drive and disk drive subsystems and controllers for IBM mainframes and midrange systems. Formation is offering a PCM version of the 9337 for IBM AS/400 systems and has also announced a RAID-3/5 system attachable to any SCSI host system for applications requiring high availability.

FWB SOFTWARE, LLC
185A Constitution
Menlo Park, CA 94025

FWB Software was created when StreamLogic acquired FWB in mid-1996, spinning off FWB's software products and related staff into a separate company. StreamLogic maintains a minority interest in the company. The RAID Toolkit, FWB's RAID-0/1 software array will continue to be provided to OEMs and resellers desiring to integrate an array into an Apple Macintosh.

GAIN SYSTEMS
6025-D Unity Drive
Norcross, GA 30071

Gain Systems is a system integrator producing personal computers, servers and complete disk drive array subsystems. The firm also sells subsystems less drives in a few cases. Gain arrays provide redundance in fans, power supplies and, optionally, controllers.

GAINBERY COMPUTER PRODUCTS
115 Mary Street
Aurora, Ontario L4G 1G3
Canada

Gainbery was founded in 1988 as a manufacturer of computer upgrade products. In 1994, the firm entered a strategic relationship with Nicom Electronics Corporation, a Canadian contract manufacturer specializing in surface mount technology. The firm manufactures array boards offering RAID-0/1 and RAID modes 0, 1 and 5, operating with EIDE drives.

HEWLETT-PACKARD COMPANY
3000 Hanover Street
Palo Alto, CA 94303

1995 total net sales: $31,519,000,000 (FY ending 10/31/95) Net income: $2,433,000,000

Hewlett-Packard had an extensive manufacturing operation for disk drives at Boise, Idaho, established in 1977, which is also the firm's development and manufacturing facility for disk controllers. After a long history of large diameter disk drive production, H-P transitioned to 3.5" high capacity drives, used extensively with H-P computer systems, and sold in the OEM market. In 1989, H-P startled the industry by announcing 150,000 hour MTBF and a five year warranty for its OEM drives, an action which substantially improved the firm's visibility in the OEM market. However, after failing to secure a major market share in the high-end disk drive business, the company elected in 1996 to close down all disk drive manufacturing operations.

Since early 1992, H-P has offered a family of RAID-0/1/3/5 arrays for UNIX workstation and multiuser applications, supplemented in 1993 with an array program for personal computers, using Mylex controllers. In early 1995, H-P made a technology announcement of an improved array technology it dubbed AutoRAID. AutoRAID offers a simple user interface, self-configuration, an innovative approach to hot sparing, and automatic data migration between RAID levels

depending upon the demand rate for particular files. Shipment of products incorporating AutoRAID got under way in 1996, but H-P has also entered into significant disk drive array resale agreements with EMC and Data General's Clariion operation.

HIGH PERFORMANCE STORAGE, INC.
215 Commerce Way
Portsmouth, NH 03801

Founded in the late 1980s to sell storage products in the Data General market, HPS expanded to other UNIX based systems as well. The firm's disk drive arrays operated in RAID modes 0/1/3/5, as well as combined RAID-0 and RAID-1, but failed to meet the intended performance objectives, resulting in poor sales. HPS is no longer active in the array market.

INTEGRIX, INC.
1200 Lawrence Drive, Suite 150
Newbury Park, CA 91320

Integrix, founded in 1990, is shipping a RAID subsystem for use with Sun SPARC workstations. Both parity and nonparity RAID modes are provided in the subsystem, which is packaged in a flat "pizza-box" form factor. The company specializes in Sun compatible products.

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504

1995 total net sales: $71,940,000,000 Net income: $6,300,000,000

In July, 1990, IBM created the new Storage Systems Products Division, encompassing the previous General Products Division, which held responsibility for more than twenty years for disk and tape drives for mainframe applications, and Low End Disk Operations, established during the 1980's to coordinate IBM's worldwide development and manufacturing operations for disk drives used in personal computers and midrange systems. In early 1992, SSPD briefly became "AdStaR", one of IBM's new wholly owned subsidiary companies -- until new corporate management decided it should rejoin the family as IBM's Storage Systems Division. IBM currently manufactures 3.5" and 2.5" fixed disk drives at several factories in the United States, Europe and Asia.

During the last few years, IBM has established several disk drive array programs, using both internally developed and purchased technology. One of the

most interesting arrays introduced by the industry to date is the IBM RAID-0/5 array developed at Rochester and sold as the 9337 for AS/400 applications and as the 3514 for PS/2 applications. Initial versions of this array overcame the usual RAID-5 write latency problems by utilizing a dedicated disk drive as a "write assist disk" -- in effect a write cache. Programs using externally developed array technology have included the Oasas RAID-0/1/5 software array licensed from Integra, the PS/2 file servers using Parallan and Mylex controllers, the 7051 RS/6000 RAID-0/1 using an Auspex controller, and the 9570 series of very high performance arrays using Maximum Strategy controllers. IBM still uses Mylex controllers in personal computer arrays, but developed its own controllers for the array file servers used with AS/400 and RS/6000 systems.

Of major importance to the industry is IBM's choice of array technology for use with mainframe computers. EMC developed a major plug compatible disk storage business during the 1990's based on its Symmetrix heavily cached 5.25" and 3.5" disk subsystems with RAID-1 and RAID-"S" array capability, by displacing a large number of IBM 3390 drives. Storage Technology's Iceberg RAID-5 array with enhanced features was delayed until 1994, much to STC's financial embarrassment, but became a significant revenue producer when finally available.

IBM's mainframe array introduction finally occurred in 1994, with the announcement of the RAID-5 subsystem bearing the reincarnated RAMAC brand name. Despite the limitation of using only 2 gigabyte drives and relying on a controller attachment restricting capacity to 180 gigabytes, IBM enjoyed heavy early RAMAC sales. The series has been expanded with the RAMAC 2 in October, 1995, using 4.5 gigabyte drives and the RAMAC 3 in November, 1996, using 9 gigabyte drives. IBM also announced the capability of the Multiprise 2000 mainframe computer series to package up to 285 gigabytes of RAID-1 disk storage in the same frame with the processor, presenting an interesting competitive challenge to PCM disk drive vendors. IBM also changed the mainframe disk storage competitive landscape in mid-1996 by making a deal with Storage Technology to take over sales and service of StorageTek's mainframe disk storage products, including the Iceberg and Kodiak disk drive array programs -- thus eliminating a competitor and adding significant additional disk array subsystem products to its own product line.

INVINCIBLE TECHNOLOGIES CORPORATION
31 Hayward Street
Franklin, MA 02038

ITC, founded in April of 1993, integrates disk drive arrays for DEC, Data General and other UNIX based systems. The firm's Ultimate 1 series provides a mirrored array, while the Ultimate 5, a modified DG CLARiiON, provides a redundant controller array capability for open systems applications.

IPC TECHNOLOGIES (Formerly Austin Computer)
10300 Metric Boulevard
Austin, TX 78758

Austin Computer started operations in 1984 as a direct seller of computing systems. The firm was purchased in 1993 by IPC Technologies, a subsidiary of IPC Corporation, which is based in Singapore. The current product line includes servers incorporating optional disk drive arrays, fabricated using purchased controllers. IPC Peripherals, a related company, supplies other data storage products, including CD-ROM drives.

IPL SYSTEMS, INC.
124 Acton Street
Maynard, MA 01754

1995 total net sales: $24,764,000 Net income: ($3,464,000)

IPL's primary market focus is tape and disk drive subsystems, plus memory upgrades, sold into the IBM AS/400 market. Founded in 1973, IPL distributes AS/400 data storage products through large independent distributors in the U.S. and Europe. IPL's 9336 RAID-0/1 using 5.25" drives and 9337 RAID-0/1 using 3.5" drives became the company's main thrust in the AS/400 market, since displaced by newer RAID-0/1/5 arrays using 1 and 2 gigabyte 3.5" drives aimed at the RS-6000 and open systems market.

LEGACY STORAGE SYSTEMS, INC. (See TECMAR TECHNOLOGIES)

LIGHTHOUSE TECHNOLOGY
5933 Sea Lion Place
Carlsbad, CA 92008

Founded in 1994 and specializing in scientific, aerospace and medical systems markets, Lighthouse integrates array subsystems incorporating CMD controllers and a variety of disk drives. Most sales are to end users or specialized VARS.

LOMAS DATA CORPORATION (Formerly Lomas Data Products)
420 Maple Street #2
Marlboro, MA 01752

A diversified small electronics design and manufacturing company founded in 1980, Lomas started making PC bus products in 1987. The firm's product line includes caching SCSI controllers with mirroring capability. Sales are mostly to system manufacturers, with a concentration in producers of voice mail systems.

As the result of an outside investment providing more capital for expansion, Lomas Data has modified its corporate name slightly.

LAND-5 CORPORATION
9747 Businesspark Avenue
San Diego, CA 92131

LAND-5, founded in 1994, develops and manufactures storage and communications systems for WAN and LAN environments, including complete servers and host independent disk drive arrays. Both parity and nonparity RAID configurations are implemented.

MACRO COMPUTER PRODUCTS, INC.
2523 Product Court
Rochester Hills, MI 48309

Founded in 1981, Macro Computer Products was originally a reseller of used equipment. Since its founding, it has developed its own microfiche to optical disk drive conversion software and has entered the leasing business. The firm is also an IBM reseller. In 1990, the Storage Peripherals Division was formed, and in 1991 MCPI's first array, based on the Storage Computer controller, was sold. While the company does most of its business in the Unisys mainframe add-on market, the array is also available for other SCSI interfaced platforms.

MARNER INTERNATIONAL, INC.
14524 61st St. Court North
Stillwater, MN 55082

Marner, established in March of 1991, is a subsidiary of the Swiss firm Fenner Elektronik AG, which also operates as Marner's international sales arm. The firm integrates systems based upon Sun, H-P, Digital and Silicon Graphics SPARC and UNIX platforms, with emphasis on Sun-based systems. The array products offered in recent years operated in RAID-0/3/5 modes and employed purchased controllers. Marner has been working on an internally developed high performance array controller and has de-emphasized its array marketing efforts until the new controller is available, probably in 1997.

MASPAR COMPUTER CORPORATION
749 North Mary Avenue
Sunnyvale, CA 94086

MasPar provided massively parallel processors capable of very high performance for applications such as real time image processing, simulations, complex design tasks and fast access to large data bases. The company,

founded in March, 1988, originally used Maximum Strategy RAID-3 arrays to provide its systems with fast I/O and a degree of fault tolerance. More recent products operated in RAID-5 mode and used a different controller. In 1996, the company exited the hardware systems business and became a software producer, operating under the name of Neo Vista Solutions.

MAXCONCEPT, INC.
7964 Arjons Drive, Suite 1
San Diego, CA 92126

MaxConcept was founded in May, 1994 as a subsystem integrator serving the Apple Macintosh aftermarket. The firm markets mostly in the U.S. to customers with video and graphic applications. The company offers a software RAID-0/1/3/5 subsystem that uses the ATTO SCSI controller.

MAXIMUM STRATEGY, INC.
801 Buckeye Court
Milpitas, CA 95035

Founded in September, 1986, Maximum Strategy has succeeded in becoming a supplier of very high performance array subsystems to a number of major system manufacturers, including IBM, Cray Research and others. While the firm's first products, shipped in 1987 for use by Walt Disney animators, were RAID-0 configurations, most recent shipments have been of RAID-3 and RAID-5 arrays. In 1991, the firm announced an array attaching to the IBM RS/6000 system, and in 1992 began shipping a RAID-3 HIPPI interface array controller to IBM for use in the IBM 9570 disk array subsystem.

Maximum Strategy arrays emphasize performance. The Gen 4 array subsystem, first shipped in 1992, provided HIPPI host interfaces and an IPI-2 drive interface, as well as partitioning to allow simultaneous RAID-1/3/5 operation. The more recent Gen 5 series also can support ATM and FCS attachment, but has dispensed with the IPI interface in favor of SCSI-2. The market focus of the company is shifting to providing storage subsystems for very high performance UNIX based systems.

MEGADRIVE SYSTEMS
489 S. Robertson Blvd.
Beverly Hills, CA 90211

MegaDrive Systems was founded in 1988 to provide high performance data storage solutions to fulfill users' requirements for the accurate and reliable

processing of large amounts of information. MegaDrive's strategy has been to capitalize on its removable adaptation of Winchester hard drive technology by providing a family of highly reliable, small form factor rugged mass storage subsystems with high capacity and performance as well as security.

MegaDrive's MR RAID subsystems use an intelligent disk controller to interface on the SCSI bus as a single device. The hardware based architecture operates in a manner that is fully transparent to the host operating system. The various models of the MR and MK RAID series are available in desktop, deskside and rack mount configurations. The new Enterprise array, first shipped in early 1995, offers RAID levels 0, 1, 5, and 10 with either 3.5" or 5.25" drives. Also shipping in early 1995 was the MX-500, an upgrade of the MR series, expandable to over 2 terabytes capacity. MegaDrive Systems markets its removable data storage subsystems principally to VARs, systems integrators, OEMs and large end users, and has evolved into a primary concentration on specialized video applications.

MICRONET TECHNOLOGY
20 Mason Street
Irvine, CA 92718

MicroNet Technology was founded in 1989 to supply high performance disk storage subsystems to the Apple Mac market. In March of 1990 it introduced its first disk array RAID-1 product, the Raven 30, which was followed by the MICRO MIRROR, the RAPID ACCESS series and the Raven 40 by November, 1991. The RAPID ACCESS series designed for the PC-based NetWare LAN environment was replaced by the RAIDbank in late 1993.

Over 70% of the business for MicroNet comes from the Macintosh market with the remaining portion from the PC marketplace. MicroNet Technology sells its products through a series of resellers and dealers in the Apple market and through VARs with their PC DOS products. The firm's RAIDbank series of arrays for PC compatible systems is reducing dependence on the Apple market, but support for the Macintosh remains the company focus. MicroNet is also active as an array enclosure supplier, offering its SAF-TE compliant DataDock 7000 both with and without drives.

MICROTECH INTERNATIONAL
158 Commerce Street
East Haven, CT 06512

Microtech is a distributor and integrator of products for the Apple Macintosh market. Mirroring software is bundled with a controller interfacing SCSI drives to achieve the array configuration.

MORTON MANAGEMENT, INC.
12079 Tech Road
Silver Spring, MD 20904

Morton is a network and communications system integrator. Array products are typically rack mounted, and incorporate either array software or a Digi-Data controller. The arrays attach to PC compatible systems, and support RAID-5 (software versions) or RAID-0/1/5 (hardware controller). The arrays are available in 6 or 12 gigabyte capacities.

MOUNTAINGATE DATA SYSTEMS, INC. (Division of Lockheed Corporation)
9393 Gateway Drive
Reno, NV 89511

MountainGate was formed in 1992 as the result of Lockheed's complete acquisition of Cherokee Data. The company specializes in storage for ruggedized applications and applications where removability is desired, such as desktop publishing and data security.

In mid-1994, the firm announced that it would supply an array for its PassPort XL removable disk drive family (earlier acquired from Quantum), integrating a software array solution. RAID levels 0/1/3/5/10 are supported using a software array implementation from a third party. The Stampede array family subsequently introduced also makes use of software arrays, except for the Stampede Ultra Array, which offers a hardware based array option.

MTI TECHNOLOGY CORPORATION
4905 East La Palma Ave.
Anaheim, CA 92807

MTI Technology was founded in 1983 to design, manufacture, market and service storage subsystems for the DEC VMS, UNIX and network attached computing environments. Today the company's product line encompasses on-line high-capacity storage arrays, tape backup, and archival storage products as well as fault tolerant subsystems.

The company expanded into the fault tolerant storage arena with its acquisition of SF2, Inc., a Sunnyvale, California, company that pioneered and commercially delivered the first independent RAID-5 array to the DEC marketplace. As a result of this acquisition, the company now holds 24 patents pending or issued in fault tolerant RAID technology and networking. In late 1993, MTI acquired System Industries, a pioneer marketer of storage devices in the minicomputer market. MTI Technology markets its products worldwide and in addition to its

sales offices, the company has 34 service centers in the domestic U.S. and 13 service centers overseas. To broaden its markets beyond the DEC base, in April, 1995, MTI announced the acquisition of National Peripherals, a provider of hardware and software solutions for the open UNIX systems market. Although a DEC storage market specialist during most of its history, the company's arrays are currently targeted at a broad range of open systems markets.

MYLEX CORPORATION
34551 Ardenwood Boulevard
Fremont, CA 94537

1995 total net sales: $100,420,000 Net income: $13,122,000

Mylex produces a variety of controller boards for graphics and storage devices as well as Ethernet adapters, system motherboards and disk drive array controllers and subsystems. The firm also produces its own multiprocessor server. While array activity in 1992 was nominal, Mylex succeeded in obtaining OEM contracts for array controllers from AST, Northgate and many others, and executed a spectacular ramp-up in 1993 to capture 29% of the network oriented array board market. Mylex remains the leading supplier of array controller boards, the dominant leader in array controllers for personal computer file servers. In February of 1996, Mylex acquired BusLogic, a manufacturer of host bus adapters. BusLogic products are expected to produce about 10% of Mylex revenues in 1996, although the BusLogic arrays have been discontinued.

Mylex controllers attach to the host controller bus and can be used with many PC compatible systems. Mylex controllers provide RAID levels 0, 1 and 5, plus combined striping and mirroring which Mylex designates as "Mylex RAID", or Mylex RAID-6/7. Operating system support includes Novell NetWare 3.11 and SCO UNIX 3.2 V4. In the future, Mylex expects its array controllers will also operate with Windows NT, Solaris, UNIX SV R4 and others.

Perhaps the most interesting development at Mylex has been the firm's implementation, with Intel, of a RAID chip set intended for installation on the motherboard of a PC, a development judged likely to have long term implications for the array controller board business.

NCL AMERICA COMPUTER PRODUCTS
1031 East Duane Avenue
Sunnyvale, CA 94086

Founded in 1984 as a U.S. subsidiary of a Japanese firm, NCL America became independent in 1993 when its parent went bankrupt. The firm specializes in storage controller boards which are marketed through resellers. By bundling array software from third parties with its controllers, NCL America was

able to offer RAID technology to its customers. The company has elected to focus on other areas and has discontinued its array activities.

NCR (Formerly AT&T Global Information Solutions)
1700 South Patterson Road
Dayton, OH 45479

NCR was founded in 1884 as the National Cash Register company and evolved to become one of the leading mainframe and minicomputer suppliers, although the firm was unable to keep up with IBM and Digital Equipment. AT&T purchased NCR in 1991 to improve its capabilities in combining communication and computing technologies. In early 1994, NCR became AT&T Global Information Solutions. In late 1994, Hyundai Electronics announced it would purchase the AT&T Microelectronics Product Division, including the Wichita data storage products operation. The acquired business units operate as a wholly owned Hyundai Electronics subsidiary under the name of Symbios Logic. A software array product, Disk Array Plus, was retained by AT&T and supported from the AT&T Naperville, Illinois, facility. When, in 1995, AT&T announced it would spin off Global Information Solutions and recreate NCR, the product was assigned to NCR.

NETFRAME SYSTEMS, INC.
1545 Barber Lane
Milpitas, CA 95035

1995 total net sales: $76,434,000 Net income: ($8,052,000)

NetFRAME manufactures and sells specialized, high performance multiprocessor computers for use as network servers. Novell NetWare and OS/2 LAN Manager are currently supported, and operation under UNIX SVR4 and Windows NT is anticipated in the future. The company began operation in 1987 as Carlton G. Amdahl Associates, acquired its present name in 1988, and shipped its first systems in 1989. Olivetti is a major customer and distributes NetFRAME products worldwide.

NetFRAME provided a disk controller for its systems that is optimized for striping and mirroring, but relied upon the operating system to actually provide the array function. The storage subsystem architecture allows for redundant buses, redundant I/O processors, and redundant power and cooling. At present, NetFRAME has several fault tolerant systems in its product line that make use of disk arrays, but recent storage subsystems, including arrays, have been built around Digital Equipment's StorageWorks product line.

NETWORK APPLIANCE INC.
295 North Bernardo Avenue
Mountain View, CA 94043

1996 total net sales: $46,632,000 (FY ending 4/30/96) Net income: $6,600,000

Founded in April, 1992, Network Appliance manufactures and sells high performance file servers. The systems include disk drive arrays operating in RAID-4 mode. The array controller is highly integrated into the main processor, which NAC believes allows the system to avoid the performance penalties associated with RAID-4 configurations, especially those run under UNIX, as the file handler for the system does not require UNIX services (and overhead) to operate. The firm's strategic direction is toward systems serving larger groups and offering additional functions, such as network backup.

NETWORK CONNECTION, INC.
1324 Union Hill Road
Alpharetta, GA 30201

Network Connection is a system integrator offering RAID-0/1/4/5 mode subsystems attached to its products. A variety of drives can be accommodated.

NEW DESIGN
(Alternate name for Mirror Technologies, subsidiary of MacUSA, Inc.)
5189 West 76th Street
Edina, MN 55439

New Design/Mirror Technologies was founded in 1985, serving as a manufacturing and assembly operation for MacUSA, an active direct marketer of storage and other peripheral products for the Apple Macintosh market. The original array products were software based, but the firm added hardware based array models in 1995. New Design/Mirror offers a wide variety of add-on products through DTP Direct, a catalog sales operation associated with the firm.

NEW WORLD TECHNOLOGIES
200 Homer Avenue
Ashland, MA 01721

Founded in 1991, New World is a system integrator providing built to order systems to a U.S. customer base consisting almost exclusively of VARs and other resellers. The firm also provides follow-on service through arrangements with Wang Corporation. Systems provided by New World typically use Intel family processors and operate in NetWare and various UNIX environments. Because configurations are customized, a variety of array controllers and disk drives are used.

NONSTOP NETWORKS LIMITED
20 Waterside Street
New York, NY 10010

NonStop Networks offers a software product providing RAID-1 functionality for PC compatible networks and workstations. The mirrored drives may be in one host system or scattered among several hosts on a network. However, the host systems must be running DOS.

NSTOR CORPORATION
450 Technology Park
Lake Mary, FL 32746

nStor was originally the Storage Systems Group of Conner Peripherals, established when Conner acquired Archive. Conner SSG provided add-on and add-in products incorporating disk drives, tape drives and storage management software for personal computer systems and networks.

In January, 1994, Conner SSG announced its CR6-RAID system, a prepackaged array intended for resale through distributors and easy attachment by end users. The array included six 1 gigabyte Conner drives, array management software, a BusLogic controller and an enclosure. Array software from a third party provided the required array functionality. A second version of the array used a hardware array controller. The larger CR12, also hardware based, began shipping in early 1995. The company was also instrumental in developing the SAF-TE specification for monitoring array enclosures.

After Seagate acquired Conner, SSG was spun off as nStor in June, 1996. The firm continued with the existing array product line, deleting older software based arrays and adding new hardware based models. All use purchased controllers.

OPTIMA TECHNOLOGY
17526 Von Karman
Irvine, CA 92714

System integrator Optima Technology shipped its first products in 1994. The firm's products include software based RAID-0/1 arrays for Apple systems and hardware based RAID-0/1/5/10 arrays for both Apple and IBM PC compatible computers.

PACE TECHNOLOGIES
11251 Phillips Parkway Drive East
Jacksonville, FL 32256

PACE Technologies was founded in 1987 as a service and maintenance organization for the Jacksonville area. In mid-1991, the firm expanded its activities to include sales of computer and network systems. PACE currently resells a controller board supporting RAID-0, RAID-3, and RAID-5, plus a complete server developed in conjunction with Hauppage Computer Works. The array controller uses the Intel i960 RISC processor.

PACIFIC MICRO DATA, INC.
16751 Millikan Avenue
Irvine, CA 92606

Pacific Micro Data was founded in 1988 as a systems integrator to offer RAID 0, 1 and 5 solutions to the Novell Netware, UNIX, DOS and OS/2 markets. Its first product, the MAST VI, was replaced by the MAST VII and MAST VIII, which in turn have been superseded by the MAST 9500. Supporting standards, open systems and cross platform connectivity are the cornerstones of Pacific Micro Data's price/performance strategy. The MAST 9500 product series combines an array management processor and a storage subsystem processor capable of interfacing a variety of different system environments and array controllers, supporting and configuring the array through a web browser interface. The RAID subsystem monitors drive and enclosure status, which can also be monitored using PMD's tools.

PARITY SYSTEMS
110 Knowles Drive
Los Gatos, CA 95030

Parity Systems is a subsystem integrator producing an array based upon a purchased array controller. RAID modes 0, 3 and 5 are provided, as is a RAID-3 only subsystem. The arrays attach to Sun, H-P, IBM and other UNIX based systems, and are available in rack, desktop or tower configurations. Some models are equipped with dual AC power feeds and battery backup for the cache.

PERCEPTIVE SOLUTIONS
2700 Flora Street
Dallas, TX 75201

Perceptive Solutions was founded in 1988 to develop, manufacture and market intelligent mass storage controllers, disk array subsystems, and related storage-enhancement products for microcomputers, workstations, and file serv-

ers. Both software and hardware based mirroring arrays that attach to PC compatible equipment are available. The company sells its products through several different channels. Domestic U.S. distribution includes a number of regional distributors and direct sales to VARs and systems integrators. The company has done particularly well in selected applications, such as point of sale systems, as a result of strategic alliances with major integrators. Selected products are also sold through a number of direct marketers and retailers.

PERISOL TECHNOLOGY
1148 Sonora Court
Sunnyvale, CA 94086

Perisol is a storage subsystem integrator specializing in the open systems and UNIX markets. The firm uses CMD controllers in its array subsystems.

PHOENIX INTERNATIONAL
812 West Southern Avenue
Orange, CA 92665

The Phalanx array series, based on CMD controllers, is available from subsystem integrator Phoenix International. It is offered in desktop or rack mounted configurations, and replaces the older Raidmaster product introduced in 1994.

POLYWELL COMPUTERS, INC.
1461 San Mateo Avenue, Suite 1
South San Francisco, CA 94080

Founded in 1987 as a manufacturer of PC clones, Polywell began offering a family of disk drive array subsystems in 1994. The arrays incorporate Mylex controllers.

PRECISION COMPUTERS, INC.
1111 SE Stephens
Portland, OR 97214

Precision Computers is a systems integrator offering complete subsystems for IBM compatible personal computers. The equipment is provided with Hewlett-Packard and Seagate disk drives, and Mylex controllers. The original array systems used an Intel 486 processor, but the system announced in 1994 uses the Pentium chip.

PROCOM TECHNOLOGY
2181 Dupont Drive
Irvine, CA 92715

Procom Technology was founded in 1986 to provide external 5.25" flexible disk drive products to the IBM PS/2 market. The company next expanded its product line into the Apple Mac market with a family of hard disk drive subsystems. Subsequent ventures led them into the removable media hard disk drive arena with SyQuest drives, DAT tape subsystems and TEAC tape cassette subsystems. The company designs its own ISA, EISA and SCSI-2 host bus adapters for its market requirements. Procom markets worldwide through a network of VARs, VADs and other resellers. 1996 revenues are expected to exceed $100 million.

In late 1992, Procom introduced its first RAID product, the "XCELERATOR". This RAID controller makes it possible for the host to configure the board to look like a standard SCSI-2 host bus adapter or it can be user defined to function as RAID-0, RAID-1, or both simultaneously. In 1993, reflecting a change in strategy, the company announced array subsystems attachable to any SCSI host. These arrays use third party controllers and provide RAID modes 0, 1, 3, and 5. While initial participation in the array market was modest, the firm's array shipments have increased, as have the capabilities of the arrays offered. Procom has already had some success in penetrating Fortune 500 companies and is expected to evolve into a supplier of higher performance, higher capacity storage subsystems for attachment to enterprise servers.

RAAC TECHNOLOGIES, INC.
219 North Milwaukee Street
Milwaukee, WI 53202

RAAC (pronounced "race") was founded in 1991. The company integrates ruggedized fault tolerant systems and subsystems for industrial customers, with most of its output going to the telecommunications sector. In 1991, the firm introduced its first disk drive array subsystem and several related models have since been introduced. All models provide RAID-0/1/5 and incorporate the DPT controller.

RAID POWER
210 Carnegie Center, Suite 101
Princeton, NJ 08540

Formed in 1993, RAID Power is a system integrator focused upon the New York and Central Atlantic area. The firm markets to specific industry segments, notably financial institutions and major brokerages.

RAIDTEC CORPORATION
105 Hembree Park Drive
Roswell, GA 30201

Founded in 1991, Raidtec offers RAID-0/1/3/5 arrays for Novell NetWare, UNIX and other platforms. The company manufactures its products in Georgia and in Cork, Ireland. Most sales are to integrators, although sales to OEMs and distributors are increasing. Raidtec array products are SCSI-based controllers and subsystems using 3.5" drives that offer hot replacement of key components. The FlexArray MX is a SCSI interfaced mirroring controller supporting RAID-1 and combined RAID-0/1. The FlexArray IX and its associated RUAC IX controller provide RAID levels 0, 1 and a combined RAID-3/5 mode. The more recently announced RUAC II and RUAX FX have similar array capabilities.

ROSE DATASYSTEMS
1580 Oakland Road, Suite C108
San Jose, CA 95131

Rose Datasystems was founded in 1993 as a subsystem integrator specializing in high availability storage configurations. The company is now the primary distributor for Infortrend in the United States.

R SQUARED
11211 East Arapahoe Road
Englewood, CO 80112

R Squared is a system integrator operating throughout the U.S., with a concentration on mass storage products for UNIX systems operated by major commercial and government users. Among R Squared's product offerings are high capacity disk drives, tape backup systems, and tape library systems. The firm added a RAID-3/5 array in 1993 utilizing a purchased controller. After a 1994 management buyout by key employees, which was partially financed by Fujitsu, the firm has added several arrays to the product line, frequently customized for individual customer requirements.

SEEK SYSTEMS, INC.
11014 120th Avenue NE
Kirkland, WA 98033

Seek Systems, founded in 1986, is selling disk drive arrays and related products including array performance analyzers into Sun, IBM and other UNIX platform markets. The firm produces its own caching controller that is the basis for its most recent array products. Seek also offers arrays using purchased controllers.

SEQUENT COMPUTER SYSTEMS
15450 SW Koll Parkway
Beaverton, OR 97006

Sequent is a manufacturer of midrange systems used in larger networking applications, some of which were developed using technology provided by Tricord. The firm offers software based array technology providing RAID-1 and RAID-0 capability and in 1993 added RAID-3 and RAID-5 capabilities using a purchased array controller.

SEQUOIA SYSTEMS, INC.
400 Nickerson Road
Marlborough, MA 01752

1996 total net sales: $102,222,190 (FY ending 6/30/96) Net income: ($4,517,000)

Sequoia was founded in 1981 as a manufacturer of fault tolerant on-line transaction processing systems. The company's strategy has been to offer OLTP systems based as much as possible on industry standard hardware and software, consisting of multiple processors that share memory and are managed by a single operating system. Disk drives are mirrored, with newer systems using array controllers purchased from Winchester Systems. Although Sequoia established a series of development and marketing alliances with major computer companies, including Hewlett-Packard, Samsung and Toshiba, it experienced financial problems resulting in key management changes, resulting in a narrower marketing focus. In 1995, Sequoia purchased Texas Micro, a supplier of fault tolerant industrial computers.

SIGMA DISPLAYS
46515 Landing Parkway
Fremont, CA 94538

Founded in April, 1991, as Allodyne, the firm developed an innovative array controller using ASICs of its own design and worked with disk drive producers to create array products using multiple 3.5" and 2.5" drives packaged in a 5.25" form factor. The array operates in RAID-3 or RAID-5 mode, and efficiently handles large data blocks by operating in a combined RAID-3/RAID-5 mode, avoiding excessive read-modify-write cycles. Tagged command queuing and a battery backed cache are included. The array is capable of hot swapping and rebuilds in background mode. A rackmount array using 3.5" drives with conventional packaging was introduced in late 1996. In early 1996, the company was acquired by Sigma Displays, and now operates as the Interactive Solutions division within Sigma. The firm continues to seek strategic partners for development or product marketing.

STORAGE COMPUTER CORPORATION
11 Riverside Street
Nashua, NH 03062

1995 total net sales: $23,130,384 Net income: $2,485,302

Storage Computer's array development activities started in 1984 as a project within Cab-Tek, Inc., a privately held company manufacturing computer printer accessories. Starting with what is now known as RAID-3, Storage Computer's program experimented with various array configurations, finally evolving into "RAID-7", an asynchronous subsystem with extensive cache which is designed to overcome performance limitations of other RAID implementations. The company's subsystem uses either 3.5" or 5.25" drives and is designed with a high level of redundancy. The company was established as a separate entity in 1992, and array shipments started in mid-1992. In March, 1995, Storage Computer became a publicly traded company by completing a merger with Vermont Research, with Storage Computer as the surviving company. During the last year, the company has undertaken a sales campaign with major potential customers to establish a role in the open systems storage market.

STORAGE CONCEPTS, INC.
2652 McGaw Avenue
Irvine, CA 92714

Storage Concepts was founded in May, 1984, to develop and market a series of high speed parallel disk subsystems. These products were developed to support real time image processing, super and near-supercomputer data storage and specialized government and military applications, as well as addressing the storage requirements for general purpose computer applications.

The design of the company's early disk storage controllers was differentiated in the marketplace by its dual-bus architecture, with subsystems offered by the company having the traditional host interface to the CPU plus a 16 bit data bus able to accommodate data throughput up to 25 or 50 megabytes/second. The company's family of disk array subsystems was first introduced in April, 1989, with the model Concept 51. Since that time the company has added several more models, the latest being the Concept 812 SW and Concept 910SW, the latter directed to the very high performance market, which offers up to 504 gigabytes of data storage. With its orientation to high performance, the company is emphasizing arrays for the video-on-demand market. Storage products introduced in the 1995-1996 period have deemphasized the proprietary bus structures, shifting toward the use of fibre channel for the host interface and Ultra SCSI for drive interfaces.

The company sells direct, supplemented with manufacturers' sales representatives. In 1991, the company opened a direct sales and support office in the U.K. for support of its European based business. In other parts of the world the

company sells through local distributors and systems integrators. In 1996, the firm reorganized itself into two divisions, one concerned with products for the video on demand market and the other with high performance RAID products.

STORAGE DIMENSIONS INC.
1656 McCarthy Boulevard
Milpitas, CA 93035

Storage Dimensions, founded in 1985, was purchased by Maxtor in 1987 and operated as a Maxtor subsidiary until late 1992, when the company was purchased from Maxtor by its managers and an investment group. The SDI product line includes storage subsystems containing disk drives, tape drives and optical drives for attachment to workstations, personal computers and file servers. They are available for a variety of host platforms, including Sun, IBM, and other UNIX based computers, and Novell based PC compatible systems. Sales are primarily through distribution to large end user organizations.

SDI's disk drive arrays are available in RAID 0/1/3/5/10 configurations for PC Intel based hosts with SCSI adapters. In 1993, the company expanded its product line to include subsystems ranging from software based arrays at the low end to a variety of configurations targeted to large local area network servers running under Novell NetWare. The array products are supported by array management software utilities and all offer dual AC input. Dynamic array reconfiguration, introduced in 1996, is a feature of some configurations.

STORAGEPATH (Subsidiary of SWS Corporation)
6727 Heritage Business Court, Suite 700
Chattanooga, TN 37421

StoragePath is a storage subsystem integrator serving the midrange systems market. The firm offers attractively packaged equipment using CMD array controllers into domestic and European markets. Manufacturing is done in Newbury Park, California. SWS, the parent corporation, was founded in 1978 as a NASA subcontractor.

STORAGE SOLUTIONS, INC.
417 Shippan Avenue
Stamford, CT 06902

Storage Solutions, founded in 1989, is an independent supplier of disk drive and tape drive subsystems for various personal computer networks. The firm has been shipping arrays since 1992, using purchased controllers, and in 1996 introduced subsystems designed for direct network attachment.

STORAGE TECHNOLOGY CORPORATION
2270 South 88th Street
Louisville, CO 80027

1995 total net sales: $1,929,485,000 Net income: ($142,330,000)

Storage Technology's "Iceberg" array for mainframe applications is easily the most famous disk drive array program so far, despite the fact that deliveries were embarrassingly late. After great success in the second half of the 1970's as the leader in plug compatible disk drives, STC's shipments dropped in 1982-1983, as IBM 3380 shipments started in earnest. STC's volume shipments of 3380 equivalent drives didn't start until early 1984, too late to save the company from failures in its other new business areas. The firm's management had launched expensive programs to build mainframe computers and optical disk drives -- and had acquired firms in other areas, with extensive bank borrowing. In October, 1984, the bankers wouldn't wait, and the company was thrown into Chapter 11. After a series of complex negotiations with creditors, the firm emerged from bankruptcy in mid-1987.

Orders for STC's innovative 1/2" tape cartridge library system provided several years of growth, and were instrumental in restoring STC's position in the storage products industry. However, shipments of disk drives equivalent to IBM's 3380K did not start until 1989, and the firm never regained its earlier share of the IBM disk drive plug compatible market, eventually stopping disk drive production. In 1990, the firm began discussing new products incorporating disk drive arrays to be sold into the PCM marketplace. In addition to Iceberg, the Alpine midrange array for the AS/400 market manufactured for Storage Technology by Array Technology was offered in late 1992, resulting in indifferent sales and a lawsuit with the manufacturer.

The high-end Iceberg array project, which originally used 5.25" drives, and later 3.5" models, was to be available in the first half of 1992, but the schedule slipped and Iceberg didn't generate sales revenue until 1994. STC continued with aggressive array development programs, using Data General CLARiiON array technology in its Nordique array for open systems markets, now renamed the 9131, and developing the Kodiak array for scalable mainframe applications. However, with a 1996 change in Storage Technology's top management came a change in strategic direction for the company's disk storage programs. The firm entered into a deal with IBM in which IBM took over sales and service responsibility for Storage Technology's mainframe disk storage programs effective July 1, 1996.

STORNET, INC.
1109 Saunders Court
West Chester, PA 19380

StorNet was founded in 1989 as a VAR/integrator of storage subsystems into the UNIX-based midrange systems market. The company now has nine sales

locations. Arrays are offered in both custom and standard configurations, with the standard configurations based upon CMD controllers and 3.5" disk drives.

STRATUS COMPUTER, INC.
55 Fairbanks Boulevard
Marlboro, MA 01752

1995 total net sales: $587,922,000 (FY ending 12/31/95) Net income: $17,338,000

Stratus Computer was founded in 1980 to produce fault tolerant minicomputers, which are used primarily for on-line transaction processing, communications control, distributed computing, and other applications in which high system availability is essential. Stratus has progressed through multiple generations of systems, with the latest systems employing RISC processors. IBM's System/88 was produced by Stratus on a contract manufacturing basis, and the company also has OEM arrangements with Olivetti, Ericsson Telecom and NEC. The Stratus D600, D700 and D800 Peripheral Subsystems utilize disk drive controllers which provide mirrored RAID-1 capability, using standard industry disk drives.

STREAMLOGIC CORPORATION (Formerly Micropolis)
21123 Nordhoff Street
Chatsworth, CA 91311

1995 total net sales: $211,264,000 Net income: ($84,288,000)

Known as the originator of what were then considered high capacity 5.25" flexible disk drives, Micropolis started production of 8" Winchester disk drives in 1979 and subsequently became a factor in the 5.25" marketplace after the usual Winchester early production problems, later adding high-end 3.5" drives.

After an abortive disk drive array development project in the late 1980s, Micropolis entered the array market in 1991 with its RAIDION family of RAID subsystems. The initial products were software based arrays. Beginning with initial models offering up to 10 gigabytes of storage and either RAID Level 1 or 5 functionality, the product line has grown to a series of models which range up to 245 gigabytes in capacity. The current RAIDION array family is built around the Micropolis RM family of high performance 5.25" drives and the LM series of 3.5" drives. In early 1994, Micropolis announced the RAIDION VOT 101, an array subsystem fitted with Micropolis AV series drives and aimed at the video server market. Several video servers have been announced since. In mid-1994, Micropolis began shipments of its Gandiva hardware-based array controller. It was used with the RAIDION LT, LTX and RTX series, and also incorporated into the Micropolis AV server series, which was aimed at the video server market.

Micropolis sold its disk drive operations to Singapore Technologies in early 1996, and renamed the remaining array operation StreamLogic. StreamLogic subsequently acquired FWB, broadening its product line and improving access to the Apple systems market, an FWB specialty.

SUN MICROSYSTEMS, INC.
2550 Garcia Avenue
Mountain View, CA 94043

1996 total net sales: $7,094,751,000 (FY ending 6/30/96) Net income: $476,388,000

Sun is a major producer of workstations and network servers based upon UNIX and Sun's own networking software. The firm was founded in 1982 and rapidly became a significant factor in workstation and server markets. The firm's SPARCstation and SPARCserver platforms are targets for many third party software providers. As an adjunct to its version of UNIX, Sun offers "Online: DiskSuite", a software-based file system that provides for very large file systems (up to one terabyte) to be created under UNIX and which also provides mirroring and striping. Sun licenses DiskSuite for both its desktop systems and its servers. In the first quarter of 1994, Sun announced an array operating with RAID levels 0, 1 and 5, as well as combined RAID-1/0 for attachment to its SPARCservers. Improved models were introduced in early 1995 and in 1996. Sun's arrays have been popular, and the company has obtained a significant share of the overall disk drive array market on its own systems. Sun is expected to expand and upgrade its array capabilities with products to be introduced in late 1996 and the first half of 1997.

TANDEM COMPUTERS INC.
19333 Vallco Parkway
Cupertino, CA 95014

1996 total net sales: $1,899,943,000 (FY ending 9/30/96) Net income: ($5,425,000)

Since its start in 1974, Tandem has become the largest manufacturer of fault tolerant on-line transaction processing systems, and has expanded its product coverage to include fault tolerant UNIX software based systems and large network systems. In 1992, the company also introduced systems using RISC processors and for the first time offered data storage systems using large capacity 5.25" disk drives. Tandem's target customers are mainly large companies and government installations with mission critical applications requiring computer systems with high standards of availability.

In 1990, Tandem acquired Array Technology Corporation, which produced array subsystems, including the Storage Technology Alpine array marketed in

the IBM AS/400 market. Tandem did not use Array Technology RAID subsystems with its own OLTP systems, and continues to primarily employ the mirrored disk implementations which have been its storage mainstay for many years. In early 1994, most of the assets of Array Technology, which had been reduced to only a development facility, were sold to EMC. An array based upon EMC controllers was added to the Tandem product line in 1995. The Tandem 4500/4600 series of RAID-1 disk drive subsystems has been upgraded several times during the 1990's, adding higher capacity disk drives as they become available.

TANGENT COMPUTER, INC.
197 Airport Boulevard
Burlingame, CA 94010

Tangent is a system manufacturer that produces servers working under OS/2 and UNIX, and servers for Novell networks. Its product line includes a six drive array option operating in RAID-5 mode and several server models operating with RAID levels 0, 1, and 10.

TD SYSTEMS
24 Payton Street
Lowell, MA 01853

TD Systems manufactures and sells RAID-1 and dual path RAID-1 controllers to selected VARs and system integrators. The array works with SCSI hosts and drives. Multiple host computers are supported. The controllers are packaged in a standard 5.25" drive full height or half height form factor.

TECMAR TECHNOLOGIES, INC.
(Subsidiary of LEGACY STORAGE SYSTEMS INTERNATIONAL, INC.)
43 Riviera Drive
Markham, Ontario L3R 5J6
Canada

Legacy Storage Systems was the name adopted in June, 1991, for the firm which resulted from the merger of two earlier Canadian companies. In March, 1996, Legacy acquired Rexon Incorporated, a manufacturer of tape backup systems and subsystems, renaming the reorganized companies for Tecmar, Rexon's distribution arm because of the broad recognition of the Tecmar name. Tecmar now offers tape and disk drive subsystems and disk drive arrays, including RAID-0/1/3/5/10 arrays based on purchased controllers. These arrays also include tape drive options, and are offered for a variety of PC, NetWare and UNIX network applications.

TEXAS MICROSYSTEMS, INC.
5959 Corporate Drive
Houston, TX 77036

Founded in 1981 as a systems integrator serving the oil industry, Texas Microsystems has retained its industrial customer orientation, providing fault tolerant systems for a variety of manufacturing and government organizations. The fault tolerant systems employ purchased controllers with modified microcode. The firm sells extensively through manufacturers representatives. In 1995, Texas Microsystems became a wholly owned subsidiary of Sequoia Systems.

THINKING MACHINES CORPORATION
14 Crosby Drive
Bedford, MA 01730

Thinking Machines was established in 1983 to design and manufacture parallel processing supercomputers. The company's pioneering "DataVault" disk drive array using a Hamming Code error correcting scheme became known as RAID-2 when the U.C. Berkeley RAID nomenclature system was published in 1987. Unfortunately, RAID-2 was not as efficient in utilizing available disk drive resources as later array configurations, and the DataVault is no longer in production. It was superseded in 1992 by the CM-5 Scalable Disk Array, a RAID-3 array architecture originally with the theoretical ability to attach 3,072 3.5" drives, since scaled back to a more conservative 500 drive total.

TOTAL TEC SYSTEMS INC.
2 Gourmet Lane
Edison, NJ 08837

Total Tec is a distributor and integrator of storage products, networking products and complete systems, catering primarily to the DEC market but also to other UNIX platform markets. The firm's array products employ purchased controllers and operate in RAID-3 or RAID-5 mode.

TRANSITIONAL TECHNOLOGY, INC.
5401 East La Palma Avenue
Anaheim, CA 92807

TTi started in 1987 as a storage solutions provider, and continues to offer a variety of storage products, including tape storage subsystems and an NFS file server incorporating a RAID-5 disk drive array and a log structured file system. The server attaches to both 10 megabit and 100 megabit Ethernets.

TRANSOFT CORPORATION
31 Parker Way
Santa Barbara, CA 93101

Transoft was founded in 1986 as the result of a merger between two software companies, Mibek and Apolyonics. The company integrates software based array controllers with other mechanical and electrical subassemblies, shipping most of its output to VARs and OEMs serving the Macintosh market. The firm markets in the U.S., Europe and Asia, notably Taiwan.

TRICORD SYSTEMS, INC.
3750 Annapolis Lane
Plymouth, MN 55447

1995 total net sales: $60,181,000 Net income: ($37,153,000)

Tricord started in 1987 with venture capital funding to develop and manufacture network superservers for the enterprise computing market. Additional investment was received from Kubota, and Tricord has licensed Kubota Computer to manufacture and sell Tricord products in the Japanese domestic market. The PowerFrame server series is designed for field upgradability and includes duplexing for most components to achieve a high level of fault tolerance. In the past Tricord has resold Ciprico RAID-3 arrays, but in June, 1992, added its own RAID-0/1 capability for Tricord file servers, supplemented in April, 1993, with an optional RAID-0/1/4/5/10 array board. The servers were upgraded with third party controllers, custom configured for Tricord, in 1994 and 1995.

TRILLIUM RESEARCH, INC.
220 Locust Street
Hudson, WI 54106

In May of 1993, Trillium announced its RAID-0/1/4/5 Remus array software package, which is used by many system integrators with storage subsystems for the Apple Macintosh. The software package operates with a number of widely available SCSI controllers, including ATTO, BusLogic, FWB, Seraph and others. An array configuration and status reporting utility is included. In mid-1995, Trillium was acquired by Adaptec. The firm now operates as a wholly owned subsidiary, selling Remus array software under its own well recognized name..

ULTRASTOR CORPORATION
13766 Alton Parkway, Suite 144
Irvine, CA 92718

UltraStor Corporation was founded in 1989 to develop and market a family of "ULTRA" high performance disk controllers aimed at rapidly growing disk intensive systems such as multiuser, networking, CAD/graphics and desktop publish-

ing. The company's family of disk controllers and adapters supported the popular SCSI devices, IDE interface drives, as well as higher performance ESDI interface disk drives.

In October, 1991, the company introduced its first RAID product, the Model ULTRA 124F, an EISA/SCSI Array Controller for the OEM and systems integrator markets supporting RAID levels 0, 1, 4 and 5, followed by later models with expanded capabilities. UltraStor was initially successful with its array controllers, capturing many system integrators and some OEMs as customers. Despite its good start, UltraStor was unable to fund its growth and after acquisition discussions in 1993 with GigaTrend, filed for Chapter 11 bankruptcy. The company rebuilt its engineering team, updated its product line, and resumed shipments in 1994, but was unsuccessful in its restart and ceased operations in 1995.

UNI SOLUTION, INC.
5005 Riverway, Suite 330
Houston, TX 77056

Uni Solution was founded in 1992 as a supplier of UNIX based systems. The firm began integrating disk drive arrays into its systems in 1993, and is currently emphasizing its storage integration activities. Most customers are in the U.S., and most of these are end users, including government organizations.

UNISYS CORPORATION
P.O. Box 500
Blue Bell, PA 19424

1995 total net sales: $6,202,300,000 Net income: ($624,600,000)

With roots deep in the history of the computer business, Unisys is a manufacturer of mainframes, minicomputers, and networking equipment. The existing company was formed from the merger of Burroughs and Sperry-Univac in 1986. With the decline of its mainframe market in recent years, Unisys has been focussing on networking, software and services. Financial services, airlines, travel and telecommunications are areas of Unisys market strength. The company offers RAID-1 and RAID-0 arrays on its network and mainframe systems, many using Veritas array software. A hardware based array for network servers offers RAID levels 0, 1, 3, and 5. A subsystem with RAID-1 capability purchased from EMC is offered with some Unisys mainframe systems.

UNITROL DATA PROTECTION SYSTEMS INC.
1177 West Hastings Street, Suite 2108
Vancouver, British Columbia V6E 2K3 Canada

Unitrol offers a software implementation of a RAID-1 array. The software operates on any IBM compatible PC running DOS or Windows. The firm sells

through dealers and VARs, but is gradually developing an OEM base as well. Unitrol's array can also operate with disk drives employing removable cartridges, allowing creation of instant backups as file contents change. It is also possible to logically partition the disks and mirror only selected partitions. The firm also offers IDE drive controllers configured to allow duplexing with mirroring software.

VERITAS SOFTWARE CORPORATION
1600 Plymouth Street
Mountain View, CA 94043

1995 total net sales: $24,087,000 Net income: $9,874,000

An offshoot of Tolerant Systems, a UNIX based systems manufacturer, Veritas was established in 1988. The company has developed storage management software add-ons to the UNIX operating system, including a module permitting disks to operate in mirrored and striped modes. RAID-5 was added in 1995. At present, the Veritas modules operate with UNIX SVR4, SCO UNIX and Sun Solaris. The company has licensed the use of its technology to system manufacturers that include UNIX SVR4 with their systems. The SCO UNIX and Solaris versions are sold through distribution, with an increasing emphasis upon the Solaris based marketplace. Veritas has had a long-standing joint development program with UNIX System Laboratories (recently acquired by Novell), and similar relationships with IBM relating to nonarray software products. The firm is also working on joint developments with a number of other firms, including Oracle and a number of array producers. In 1996, Veritas announced that it had engaged in a strategic alliance with Microsoft to port Volume Manager to Windows NT 5.0, creating a potentially very large market for Veritas products.

WESTERN SCIENTIFIC, INC.
4631 Viewridge Avenue
San Diego, CA 92123

WSI is an integrator, supplying complete computer systems, mass storage subsystems and networking products for UNIX based systems. The firm has concentrated its array program into one product line supplying from 21 to 315 gigabytes of storage in various configurations. The storage subsystem is built around a purchased array controller.

WINCHESTER SYSTEMS, INC.
400 West Cummings Park
Woburn, MA 01801

Winchester Systems has been marketing its add-on storage subsystems since 1981. Early products were mostly disk drive subsystems, but DAT tape subsystems have been a larger part of the company's business in recent years.

The company's Flashdisk array subsystem series has been offered since mid-1992, with a series of enhancements. In addition to the company's long-standing PCM/Distribution activities, the firm is now selling selected array products on an OEM basis, notably to Sequoia Systems.

ZITEL CORPORATION
630 Alder Drive
Milpitas, CA 95035

1995 total net sales: $23,714,000 (FY ending 9/30/95) Net income: $8,526,000)

Zitel, which began operation in 1979, is best known as a manufacturer of large solid state memory add-ons for Unisys mainframes and minicomputers, especially those used in on-line transaction processing. Zitel has also developed products for a number of OEM customers, including IBM. In 1991, the firm began selling a memory subsystem incorporating both solid state memory used as a large, fast cache and a high performance disk drive.

While Zitel does not market array products at present, it has done so in the past, beginning with a RAID-2 array sold to Ford Aerospace in 1988, and has undertaken custom array development projects for outside firms, including IBM. Zitel currently enjoys significant licensing revenue from IBM as a result of development activities during the gestation period of IBM's RAMAC mainframe array. The company remains interested in high performance arrays and may reenter the market in the future, possibly in conjunction with a selected strategic partner.

ZZYXZ WORKSTATIONS AND PERIPHERALS
5893 Oberlin Drive
San Diego, CA 92121

ZZYXZ ("Z-Zix", as it's pronounced) is a system integrator. The firm introduced an array based system in the second half of 1993. Array functionality is based upon a CMD controller. The ZRS-3000 series is packaged with 3.5" drives. The similar ZRS-5000 has 5.25" disk drives.

Asia/Pacific Rim Manufacturers

(All companies are in Japan unless otherwise noted.)

ACER INC.
347 Wu Lin Fung Chen Road
Lung Tan Hsiang
Taoyuan
Taiwan

1995 total net sales: $2,360,023,000 (FY ending 12/95)

Net income: $208,985,000

Founded in 1981, Acer is known for its personal computers and related products. The firm is now one of Taiwan's largest companies. Acer's U.S. subsidiary, Acer America, is located in San Jose, at the facilities of Altos, which Acer acquired.

While Acer has had an internal development program focussed on RAID-0/1, its server class products equipped with an array option currently use controllers purchased from third parties that offer RAID levels 0, 1 and 5. All of Acer's array sales are for subsystems attached to Acer computers. The majority of Acer's array sales have been to customers outside the U.S., a pattern that is expected to continue.

ADVANCED TECHNOLOGY AND SYSTEMS CO., LTD.
1, Kirihara-cho
Fujisawa-shi, Kanagawa-ken 252

Marketing under the AXRD/AXRS brand name, AT&S is a joint partnership with IBM participation. The firm is located at IBM's Fujisawa facility, marketing external rigid and optical disk drives, memory cards, and storage subsystems. Hardware based array subsystems are offered with RAID levels 0, 1, and 5 available.

AIWA CO., LTD.
2-11, Ikenohata 1-chome
Taito-ku, Tokyo 110

1996 total net sales: $3,159,904,000 (FY ending 3/96)

Net income: $56,550,000

Best known for its entertainment products, Aiwa is an increasing presence in the data storage business as well, offering tape drives and libraries, fax modems, CD-ROM drives and other products. Aiwa acquired Core International, now operating as part of Aiwa Computer Systems Division, and is responsible for sales of disk drive array products through its various national sales organizations.

DTC TECHNOLOGY CORPORATION
2F, 542-2 Chung Cheng Road
Hsin-Tien City
Taipei-Hsien
Taiwan

DTC has been producing a controller with RAID-1 and RAID-0 capability since 1992, and in late 1993 announced an EISA bus controller capable of providing RAID-0/1/4/5 capability. Both controllers support combined RAID-1 and RAID-0 operation as well.

FUJITSU LTD.
1-6-1, Marunouchi 2-chome
Chiyoda-ku, Tokyo 100

1996 total net sales: $40,053,248,000 (FY ending 3/96) Net income: $670,927,000

Fujitsu derives about 70% of its sales from the computer industry and is known as the leading manufacturer of computers for the Japanese domestic market. Fujitsu is also a major exporter to the worldwide computer market. Since 1982, the company has been among the leaders in worldwide disk drive revenues, and skillfully managed a transition from older removable disk drives to a product line consisting mainly of fixed disk drives in all capacity ranges and in several disk diameters. Fujitsu is manufacturing some of its high performance drives at a major facility near Portland, Oregon, which is now in full operation, with additional plants in Thailand and the Philippines. Intellistor, located in Longmont, Colorado, is a Fujitsu subsidiary which has developed small diameter disk drives and disk drive arrays. Fujitsu also has a 44% ownership position in Amdahl.

Since 1990, Fujitsu has been offering a RAID-3 array originally developed by Intellistor. All shipments of the array have so far been limited to Japan. In the 1994, the firm began shipping RAID-3 arrays using Baydel controllers, a product line since discontinued. Fujitsu and Amdahl cooperated in development of the Spectris array intended for mainframe applications, with production by Fujitsu. Amdahl started PCM shipments of Spectris in late 1995, and Fujitsu is expected to add an equivalent captive array to its product line.

HITACHI DATA SYSTEMS
750 Central Expressway
Santa Clara, CA 95056 U.S.A.

HDS introduced the 7600 disk storage subsystem for mainframe applications using unique Hitachi 6.5" disk drives, in June of 1993. The RAID-1 7600 was effectively replaced by the 7700 RAID-5 subsystem in mid-1995, and supplemented by the versatile 7750 RAID-5 subsystem in mid-1996. HDS has also

added a new series modular midrange RAID-0/1/5 subsystems for AS-400 and open systems applications, with first shipments in late 1995.

HITACHI, LTD.
4-6 Kanda-Surugadai
Chiyoda-ku, Tokyo 101

1996 total net sales: $86,515,548,000 (FY ending 3/96) Net income: $1,509,798,000

Hitachi remains Japan's largest manufacturer of electrical and electronic equipment and a major manufacturer of computer systems. The firm currently makes a wide range of Winchester technology fixed disk drives for both captive and noncaptive markets. In addition to significant OEM sales of smaller capacity fixed disk drives, Hitachi also sells IBM compatible mainframe storage subsystems through Hitachi Data Systems (formerly National Advanced Systems, before acquisition by Hitachi), and in 1983 started selling plug compatible drives for distribution in the European PCM market through BASF, and currently through Comparex.

Hitachi began shipping a progression of midrange arrays under the Hitachi label in late 1992, utilizing various RAID-3, RAID-4 and RAID-5 configurations. In addition to producing the midrange and mainframe arrays currently marketed by Hitachi Data Systems and Comparex, Hitachi sells comparable products through its own organization to both captive and PCM/Distributor channels.

INFORTREND, INC.
32-3 Dong Men Street
Baan Chyau, Taipei
Taiwan

Infortrend produces an array controller offering RAID-0, RAID-1, RAID-3, and RAID-5. The controllers have PCI, EISA or SCSI-2 drive ports, and are intended for use on IBM PC compatible platforms. The firm is marketing the controllers on an OEM basis, and has achieved some success with system integrators in the U.S. and in Taiwan.

NEC CORPORATION
5-7-1, Shiba
Minato-ku, Tokyo 108

1996 total net sales: $46,828,456,000 (FY ending 3/96) Net income: $821,789,000

NEC has defined its product area as communications and computers, with computer products currently accounting for about 49% of the firm's total reve-

nues. Current disk drive production involves fixed disk drives, from large to small configurations, for both captive and OEM markets. Fixed disk drives include 3.5", 2.5" and 1.8" disk diameters. NEC was the first of the major Japanese drive producers to produce small form factor rigid disk drives offshore, with the establishment of a factory in the Philippines. Since 1992, NEC has shipped a SCSI controller board with mirroring capability in the personal computer market, and in following years has added a variety of board and subsystem array products.

NIPPON TEXA CO., LTD.
824-1 Saedo Tsuzuki-ku
Yokohama 224

Nippon Texa is a subsystem integrator and reseller addressing the Japanese market. A variety of storage subsystems are offered for the Macintosh and PC compatible markets. Disk drive arrays capable of RAID-0, RAID-3, and RAID-5 operation have been shipped since early 1994. The company is emphasizing small arrays for single user systems and wishes to develop an international market for them.

RAIDAR SYSTEMS PTY. LTD.
Suite 5, 7 Lloyds Avenue
Carlingford NSW 2118
Australia

Founded in 1995, Raidar offers disk drive array systems for the Apple Macintosh family of computers. Up to 12 SCSI drives with SCA connectors can be attached. RAID modes 1,3,4,5,6 and 10 are supported.

SUNIX CO., LTD.
76, Pao Kao Road
Hsin Tsin, Taipei
Taiwan

Sunix, established in 1986, is a manufacturer of controller cards. The product line includes a mirroring controller based upon ITRI technology. Up to 8 IDE drives can be attached.

SYMBIOS LOGIC (Subsidiary of Hyundai Electronics)
3718 North Rock Road
Wichita, KS 67226 U.S.A.

Symbios Logic started as NCR's Peripheral Products Division. When NCR was purchased by AT&T, the organization then became a part of the AT&T Microelectronic Products Division, which was primarily concerned with special-

ized chips. In late 1994, Hyundai Electronics initiated the purchase of MPD from AT&T, and MPD became Symbios Logic, a wholly owned subsidiary of Hyundai Electronics.

Symbios Logic produces array controllers which it uses in its own arrays and also sells on an OEM basis to other array producers. In 1991, a specialized array chip set, produced by the Microelectronics Division, was introduced, which is used internally and also sold to OEMs. The chip set and controllers were upgraded in 1993 to use more powerful processors. A third series of upgraded array controllers using faster microprocessors appeared in 1995. In recent years the firm has emphasized its subsystem level products, and while not abandoning its board level business, is giving it less weight. Updated graphically oriented array management software was introduced in 1996.

SYSTEX CORPORATION
51 Section 2 Chung Ching South Road
Taipei
Taiwan

Systex, founded in 1976 as a system integrator, today has revenues exceeding $100 million and is a significant supplier of information systems to the banking, financial and retail industries. The firm's disk drive arrays are built around Digital Equipment's StorageWorks and a variety of array controllers.

TEAC CORPORATION
3-7-3 Naka-cho
Musashino, Tokyo 180

1996 total net sales: $1,204,313,000 (FY ending 3/96) Net income: $17,806,000

TEAC marketed in Japan an array with RAID-3 and RAID-5 capability, utilizing Allodyne controllers. The half inch high 3.5" disk drives produced by TEAC to the Kalok (now JTS) design were used, with up to five drives packaged in the form factor of a full height 5.25" disk drive. Marketing began in 1994, but the program was discontinued in 1995.

TEKRAM TECHNOLOGY CO., LTD.
5, Lane 768, Pateh Road Section 4
Taipei
Taiwan

Tekram, founded in 1990, is a producer of controller cards. The firm's announced products include a mirroring disk controller displayed at COMPUTEX in 1994.

European Manufacturers

ADVANCED TELECOMMUNICATIONS MODULES LTD.
Mount Pleasant House
2, Mount Pleasant
Huntingdon Road
Cambridge CB3 0BL
United Kingdom

ATML was founded in 1993 as a spin-off from Olivetti's research laboratory in Cambridge, and has a minority investment by Olivetti. The firm's objective is to develop and market a wide variety of products for use with asynchronous transfer mode networks. The first array product offered is a high performance RAID-3 subsystem designed to interface directly to ATM networks.

ARCO ELECTRONICS INC. (Subsidiary of ARCO Electronic Control Ltd., Israel)
2750 North 29th Avenue, Suite 316
Hollywood, FL 33020

ARCO was founded in 1987 and is a supplier of LAN controllers and storage subsystems for personal computers. The firm is a subsidiary of ARCO Electronic Control, an Israeli company specializing in industrial electronics and timers. In late 1992, ARCO began shipping a RAID-1 array including a board with two mirrored 2.5" drives mounted on the board. The board, which has a Micro Channel interface, can also attach to two external drives, instead of drives mounted on the board. An ISA bus version was added in 1995.

ATON SYSTEMES
Batiment Euclide
9, Rue Olof Palme
94000 Creteil
France

ATON, founded in 1992, produces the AREKA brand array subsystems and array controllers. All sales are currently in Europe, through a network of distributors. The company's disk drive arrays operate in RAID modes 0, 1, 5 and combined RAID-1/0, with array controllers available with either an EISA or ISA bus host interface. SCSI-2 and PCI interfaced versions became available in 1994 and 1995, respectively.

BAYDEL LTD.
Brook Way
Leatherhead
Surrey KT22 7NA
United Kingdom

RAID-3 array controllers and subsystems are among the products of Baydel. Controllers are supplied on an OEM or PCM basis to firms in the U.S. and in Europe, while most complete subsystems are sold in Europe. Most European sales are through distributors in the U.K., Germany and Switzerland. The array attaches to a host SCSI port, and includes a cache ranging from 4 to 64 megabytes in capacity.

The firm was founded in 1972 by engineers from IBM's Hursley research establishment, and initially designed and fabricated peripheral equipment for the IBM and DEC systems market. Add-on products for the PC market became part of the product line in 1988. Controllers supporting mirroring and caching were first developed in 1979, and the first RAID-3 units were shipped in 1991.

COMPAREX INFORMATIONSSYSTEME GMBH
Subsidiary of BASF
Gottlieb-Daimler-Strasse 10
D-6800 Mannheim
Germany

Comparex became operational at the beginning of January, 1987, as a joint venture operation comprising the former BASF and Siemens PCM businesses, marketing systems and peripherals made by Fujitsu and Hitachi, with a concentration in recent years on Hitachi products. In late 1991, the owners announced BASF's assumption of complete ownership. In late 1992, Comparex and Hitachi Data Systems announced an agreement under which Comparex would control distribution of Hitachi mainframes and peripherals in Germany and Eastern Europe, and HDS would handle distribution in most of the rest of Europe and in the Middle East. Recent disk drive activities have involved PCM 3390 equivalent drives, including subsystems with RAID-1 and RAID-5 capability, produced by Hitachi.

DISTRIBUTED LOGIC (DILOG) SA
16 Route de Boudry
CH2016 Cortaillod
Switzerland

Dilog is the parent company of Diverse Logistics, a wholly owned subsidiary, located in California. The two firms share a common controller design and

manufacturing for boards offering RAID levels 1 and 0. Distributed Logic markets storage subsystems in Europe, Africa and the Middle East, while Diverse Logistics covers the Americas.

EUROLOGIC SYSTEMS LTD.
49 Bracken Road
Sandyford Industrial Estate
Dublin 18
Ireland

Eurologic is a system integrator producing storage subsystems with RAID-0/3/5 capability based upon a CMD controller. The subsystems are equipped with redundant power supplies and fans, and dual AC power feed is offered as an option. Host interfaces for SCSI-2 and the DEC DSSI and CI bus are available.

FUTURE COMPUTERS LTD.
14 Imperial Way
Croydon Airport Industrial Estate
Croydon, Surrey CR0 4RR
United Kingdom

Future Computers is a subsidiary of Baydel established to market array subsystems in the European market. The RAID-3 subsystems use the Baydel controller and are available in 3 drive or 5 drive configurations.

GROUPE BULL
121, avenue de Malakoff
75116 Paris
France

Groupe Bull is the parent organization of an intricate grouping of companies active in the computer industry. Included are Compagnie des Machines Bull, the successor to a long line of French computer organizations, and now the parent company for all Bull computer programs. Also included are the organizations previously known in the United States as Honeywell Information Systems and, until 1996, Zenith Data Systems.

Computer operations, except for personal computers, are the responsibility of Bull Systems Products, which early in 1993 announced deals with Data General to resell the DG CLARiiON RAID-0/1/3/5 array subsystems for UNIX applications and with EMC to resell the Symmetrix 4800 RAID-1 subsystems for main-

frame applications. Zenith Data Systems had been reselling Integra RAID-5 software arrays for personal computer applications, but later switched to a hardware based design using Mylex controllers. In February, 1996, Zenith Data Systems ownership was transferred to Packard Bell Electronics, with Groupe Bull retaining a minority interest.

HI-DATA LTD.
61 Reading Road, Unit 8
Pangbourne, Berkshire RG8 7HY
United Kingdom

Hi-Data manufactures and sells array controllers and subsystems capable of operating at RAID level 3 and in hybrid RAID-3/RAID-5 modes which Hi-Data calls RAID-53 and RAID-35. Redundant fans and power supplies are provided in the Hi-Data subsystems. A second array controller can be provided as an option to provide controller redundancy. Hot sparing and hot swapping are also supported. In a program to expand distribution beyond Europe, Hi-Data has opened a sales and support office in Woburn, MA, and has been promoting its presence in the market through participation in small exhibitions and other public relations activities.

ICL
Lovelace Road
Bracknell
Berkshire RG12 8SN
United Kingdom

ICL added disk drive arrays to its product line in 1993 with a software based array offering RAID-0 and RAID-1, plus a hardware based array with RAID modes 0, 1 and 5. In 1994, a more powerful array was added using a combined RAID-3 and RAID-5 mode of operation. Purchased controllers are used.

MEMOREX TELEX CORPORATION (Subsidiary of Memorex Telex N.V.)
4343 S. 118th East Avenue
Tulsa, OK 74146

The pioneer magnetic media and plug compatible disk drive producer originally known as Memorex Corporation was acquired by Burroughs in late 1981, and Burroughs placed all disk drive development and manufacturing responsibility for the entire company in the Memorex organization. In late 1986, however, Burroughs sold the disk drive sales and service operations of Memorex to a group of Memorex executives, retaining only the rigid disk development and

manufacturing operations. Telex was acquired by Memorex in early 1988 and the firm adopted its new name. Plug compatible disk drive subsystems now sold and serviced by Memorex Telex use various purchased drive mechanisms. Memorex, headquartered in Europe, includes PCM marketing operations, the Memorex Communications Division, and the flexible media operations. During the 1990's the firm has endured weak financial performance, and since 1991 has gone through multiple bankruptcies. In 1992 Memorex Telex introduced a RAID-1 subsystem in the AS/400 add-on market, using an array manufactured by Formation, and in 1994 announced a program to resell Data General CLARiiON array subsystems in the AS/400, RS/6000, Sun workstation and Novell network markets.

SIEMENS NIXDORF INFORMATIONSSYSTEME AG
Otto-Hahn-Ring 6
D-81739 Munich
Germany

Siemens AG produced rigid disk drives for many years in Munich, but never achieved a market position with which the firm's management was satisfied, and withdrew from disk drive manufacturing in 1990. A year later, the firm sold its share of Comparex, the joint venture company established by Siemens and BASF to market mainframe storage products, to its partner, BASF. The subsequent merger of the Nixdorf organization with Siemens' computer operations resulted in the current Siemens Nixdorf organization, a major participant in the European computer and peripherals market. Siemens Nixdorf has announced a family of midrange RAID-0/1/3/5 arrays for late 1996 availability, using SSA disk drives, and intended for a variety of open systems applications.

SOLID COMPUTER GMBH
Bruckmannring 32
D-8042 Oberschlessheim
Germany

Solid Computer is a system integrator and manufacturer offering SPARC workstation clones and a variety of controller cards for Sun and other systems. Also in the product line are solid state disk drives, optical disk drive subsystems, tape subsystems and servers. The firm has an array subsystem capable of operating at RAID levels 0, 1, 3, and 5, which began shipping in late 1992, incorporating the Data General CLARiiON array. While most sales have been in Europe, a U.S. subsidiary located in Norcross, GA, Solid Computer Corporation, is beginning to develop U.S. markets.

SYRED DATA SYSTEMS (Formerly Dynatex RAID Systems)
32 Rue Planchat
75020 Paris
France

Founded in 1989 as Dynatex RAID Systems, the company, now with a new identity, offers RAID controllers in a 5.25" drive form factor. The firm also offers an enclosure for use with its controller. Controllers are available for both SCSI and EIDE drives.

TWINCOM INTERNATIONAL
Slotlaan 15
4902 AD Oosterhout
The Netherlands

TwinCom is offering mirroring software for UNIX systems in Europe and in U.S. markets. The software can operate RAID-1 arrays locally or over a network. Sales are made through distribution and on an OEM basis. A U.S. marketing and support office is located in Shreveport, LA.

TwinCom's product is derived from mirroring software developed 12 years ago for a Dutch pharmaceutical company. It was ported to UNIX in 1983, and first became generally available in 1986 as a system drive mirroring product. Support for multiple pairs became available in 1989 and for networks in 1992.

VORTEX COMPUTERSYSTEME GMBH
Falterstrasse 51-53
74223 Flein
Germany

Vortex was founded in 1985 and is privately held. The firm's product line consists of SCSI and disk array controllers. RAID levels 0, 1, 4, and 5 are provided via firmware installed in the controller. EISA and PCI bus array controllers, all manufactured in Germany by Vortex, are available, and are resold by a network of system integrators and distributors.

XYRATEX (Havant International Ltd.)
P.O. Box 6, Langstone Road
Havant, Hampshire PO9 1SA
United Kingdom

Xyratex was created in December, 1994, as the result of a management buyout of IBM's Havant facilities, at that time a division of IBM. Xyratex, at that time a brand name, became the trading name of the new company. Products include disk drives, flexible circuits, storage subsystems, test systems and networking equipment, some produced under contract for a number of clients,

including IBM. Xyratex also develops and sells specialized software products. Although "new", the company is of significant size, occupying about 600,000 square feet of space and employing about 2,000 people. The firm manufactured over two million small disk drives in 1994.

Xyratex announced its own line of disk drive array subsystems supporting RAID levels 0, 1, 3, and 5 at CeBIT in 1995. The initial products offered conventional SCSI drive interfaces, but Xyratex later added an SSA interfaced version.

ZENITH DATA SYSTEMS (Subsidiary of Packard Bell)
2150 East Lake Cook Road
Buffalo Grove, IL 60089

Zenith entered the array market by remarketing a version of Integra's OASYS array software, beginning in 1992, on its EISA bus based servers. The company later dropped software solutions in favor of hardware implementations, using Mylex controllers with its array subsystems. In February, 1996, Groupe Bull's ownership of Zenith Data Systems was transferred to Packard Bell Electronics, with Groupe Bull retaining a minority ownership.

DISK/TREND ON DISK

1996 DISK/TREND REPORT

DISK/TREND ON DISK

Introduction

DISK/TREND ON DISK is a licensed set of floppy disks available for separate purchase that contain the statistical tables and specification tables from the annual DISK/TREND Reports. The disk files have been prepared in a format usable on IBM or IBM-compatible computers running under the MS-DOS or PC-DOS operating system. A system with a hard disk is highly recommended, but a system with two floppy disks can be used if necessary. All DISK/TREND ON DISK files contain data only -- manipulation of data is the user's responsibility. Because some of the files can be very large, system memory of 640K or more is recommended.

Two types of diskette files are supplied for each DISK/TREND disk drive report. The first type contains the statistical tables in ASCII format. File names are keyed to the table numbers in the report for easy identification. The second type contains the specification section in a Lotus 1-2-3 data base format. Multiple disks of each type are provided where the files are too numerous or too large to fit on a single floppy disk. The color of the label of the floppy disk is similar to the color used on the cover of the corresponding report for ease in identification.

Because the statistical tables are provided in ASCII format, they can be used with any spreadsheet program that can import ASCII text files. However, the specification tables have been prepared specifically in Lotus 1-2-3 format to allow them to be searchable using Lotus 1-2-3 data base commands. If you are using a spreadsheet program other than Lotus 1-2-3 that can translate Lotus WK1 formatted files to its own format, it may be able to import the specification tables without difficulty.

A file translation program, AutoImport, is available from DISK/TREND to assist in converting the data supplied to the formats of several popular spreadsheet programs. One copy of AutoImport is provided automatically at no extra charge to DISK/TREND subscribers who have purchased an original copy of DISK/TREND ON DISK but is provided only in the first year DISK/TREND ON DISK is purchased. Updates to AutoImport may be provided in following years at DISK/TREND's discretion. Extra copies of AutoImport may be purchased at any

time. If you have not purchased DISK/TREND ON DISK, but would find AutoImport useful with other file translation tasks, it may be purchased independently from DISK/TREND or White Crane Systems, Inc.

IMPORTANT NOTE: Since July, 1994, White Crane has shipped version 3.13 or higher of AutoImport. Instructions in this section are written to work with these later versions. If you have an older version of AutoImport, refer to instructions in previous DISK/TREND reports. You must have AutoImport 3.13 or higher to use DISK/TREND ON DISK with these instructions.

The authors of this manual assume that you are familiar with personal computers, Lotus 1-2-3 or other spreadsheets, and MS-DOS, and do not cover their operation in this manual. This manual deals specifically with how to load and use the files supplied on the floppy disks.

Note: Please read the license on the following page.

DISK/TREND ON DISK

Information License

DISK/TREND supplies diskettes containing selected information from the 1996 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1996 DISK/TREND Report volume.

YOU MAY:

1. Install and use the information on a single computer system, provided that you or the organization by which you are employed has purchased at least one copy of the DISK/TREND report volume associated with the information.

2. Make backup copies of the information for your own use. Such backup copies may be used only on the computer on which the information is installed. You must reproduce the copyright notice on any copies.

3. Reproduce the information, but not the associated programs or documentation, contained in the Product for use within internal documents distributed within the organization by which you are employed.

YOU MAY NOT:

1. Install, or allow the use of, the information on more than a single computer system.

2. Transfer the information through or within a computer network.

3. Distribute the information or any portion thereof in any form outside the organization by which you are employed or modify the information for purposes of distribution.

4. Transfer this license to another party.

AUTOIMPORT

Use of AutoImport is subject to license terms and conditions of White Crane Systems, Inc., 8255 Overview Court, Suite 100, Roswell, GA 30076

Trademarks

IBM, Lotus and Lotus 1-2-3 are trademarks of International Business Machines Corporation.
MS-DOS is a trademark of Microsoft Corporation.
AutoImport is a trademark of White Crane Systems, Inc.

1996 DISK/TREND REPORT

Getting started

The first thing you should do is to make working copies of the original DISK/TREND diskettes. Place the originals in a safe location and use only the working copies for day-to-day operations. This procedure will help to protect your data from inadvertent destruction or loss due to a malfunction of the computer or its operator. We also recommend that you place a write protect tab on the working copies (after you create them) for the same reason. Use the hard disk or another floppy disk copy for day-to-day manipulations of the files.

The statistical tables are provided in ASCII text format. This allows you to use any word processor to edit the file prior to importing it into Lotus 1-2-3. Appropriate editing removes any material you don't wish to work with and allows you to add figures or text to the data tables. You may also embed the data in internal documents or reports you are preparing for use within your company.

To convert the statistical tables to a spreadsheet you may use the AutoImport utility software, which is probably quicker and easier than the typical text file import and conversion procedure provided with spreadsheet programs. One copy of AutoImport is provided automatically at no extra charge to each DISK/TREND subscriber who has purchased an original copy of DISK/TREND ON DISK and is provided in the first year DISK/TREND ON DISK is purchased. Updates to AutoImport may be provided in following years at DISK/TREND's discretion. Extra copies of AutoImport may be purchased at any time.

DISK/TREND ON DISK is normally shipped on 1.44 megabyte 3.5" floppy disks, but is also available on 1.2 megabyte 5.25" disks if requested.

STATISTICAL TABLES

Loading and Installation

1. Place the floppy disk marked "Tables" in a floppy disk drive able to read your size disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the Lotus 1-2-3 system disk in drive A. Use the DOS 'DIR' command to examine the file directory on the "Tables" disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

   TYPE A:READ.ME (Use the appropriate drive letter if not A)

   If you wish to print the instructions, turn on your printer and type:

   TYPE A:READ.ME>PRN

2. Do this step if you have a hard disk. Log into the hard disk directory in which Lotus 1-2-3 normally stores worksheet files. Using the DOS 'COPY' command, copy all the statistical table files to the hard disk. This can be done in one step using the copy command as follows:

   COPY A:?T*.*

   Several utility files should also be copied. The command is:

   COPY A:*.PRN (if you are using the Lotus 1-2-3 data parsing commands)
   COPY A:MASK?2.MSK (if you are using AutoImport version 2.xx)
   COPY A:MASK?3.MSK (if you are using AutoImport version 3.xx)

   The utility files named FORMLIN?.PRN are specifically for usage with Lotus 1-2-3 data parsing if you prefer not to use AutoImport for file translation.

   Installing AutoImport V3.xx: If you have a hard disk, create a directory named AIMP (You could use other names if you prefer). Now place AutoImport disk 1 in drive A and type: COPY A:*.* and then ENTER. Follow any instructions appearing on the screen until installation is complete. To make AutoImport accessible from any directory, place C:\AIMP in your AUTOEXEC.BAT file's 'PATH' statement. See your MS-DOS instruction manual for information about this step.

   If you are using a floppy-only system, copy the AutoImport disks and use only the copies in following steps. In a floppy-only system, AutoImport disk 1 should be in drive A when AutoImport is in use for file translation.

3. If you are using AutoImport (highly recommended) for translation of files to spreadsheet format, do the translation at this point. See the following section on using AutoImport for details.

4. Now you are ready to start your spreadsheet. If you are using a two floppy system, place the DISK/TREND disk in drive B and the spreadsheet system disk in drive A. If you are using a rigid disk system, place a copy of the spreadsheet system disk in floppy drive A if required by the security provisions of your spreadsheet program. Now start your spreadsheet as usual. After obtaining the blank spreadsheet image on the screen, use the appropriate file retrieval command to select a file. For Lotus 1-2-3:

   /FR<filename>

   The file names are in the format XTYY.WK1, where: X= Type of data

   R (Rigid disk drive data)
   O (Optical disk drive data)
   A (Disk drive array data)
   V (Removable drive data)

   YY= Table number, as shown in the appropriate report volume

   Examples:
   File RT10.WK1 is Rigid Disk Drive Report Table 10
   File OT1.WK1 is Optical Disk Drive Report Table 1
   File AT3.WK1 is Disk Drive Array Report Table 3
   File VT2.WK1 is Removable Drive Report Table 2

   The file selected will be loaded as a worksheet. If this is the first time the file has been loaded, you may want to create your own formulas linking the cells of the spreadsheet. See your spreadsheet reference manual for details on numerical manipulations and graphics.

If you don't use AutoImport

If you don't use AutoImport but still want to translate ASCII files to your spreadsheet format, you will have to use spreadsheet tools such as the Lotus 1-2-3 Data Parse commands. They allow the user to convert a table which has been imported in the form of a block of text to a form in which the individual numbers and labels can be manipulated as spreadsheet elements or used to prepare graphics. Let's take Lotus 1-2-3 as an example. Before proceeding, it would be useful to read the Lotus reference manual on this subject if you are not a regular user of the Data Parse commands.

The trickiest and most time-consuming part of using the Data Parse commands is setting up the format line. Several utility files have been provided on the tables disk to make this process easier. These are used with various table formats encountered in the DISK/TREND Report on arrays and correspond with the precomputed masks provided for use with AutoImport:

o FORMLINA.PRN	Used with Table 1, and the Revenue and Unit Shipment tables found in the product group sections of all DISK/TREND reports.
o FORMLINB.PRN	Used with Table 2.
o FORMLINF.PRN	Used with Tables 3 through 7.
o FORMLIND.PRN	Used with Table 21 and application tables.
o FORMLINE.PRN	Used with Drive Height, Drive Capacity and Track Density tables in Removable Data Storage Report.

There are no FORMLIN format files for disk diameter tables or market share tables, as these are variable in format. You will have to construct the format line directly, but after you have seen how it is done for the other tables, this should not be too big a job.

After you have used spreadsheet tools to translate a file, you will understand why we recommend AutoImport for this function.

Using AutoImport

Using AutoImport is a two-step process. Step one is creation of a translation mask for each format used in files to be converted. The typical DISK/TREND Report uses 5 to 7 standard mask designs (which have been precomputed and included on your Statistical Tables disk) plus additional masks that are dependent upon table content, as some table types have variable numbers of columns. To create your own masks for such tables, see the instructions below.

Step two is the translation process. Once the mask has been created, it can be used with any table matching the mask format. See the tables below which relate table types to specific masks.

MASK TABLE

Mask File Name	Rigid Report	Removable Report	Optical Report	Array Report
MASKA	<-------- Table 1--------->		Tables 1,2	Table 1
	<-------------- Product Group Revenue ---------->			
	<-------------- Product Group Shipment ---------->			
MASKB	<-------- Table 2 -------->		Tables 3,4	Table 2
MASKC	Tables 3,4,6,9, 10,11	Tables 3 to 6, 11,12,24,25	Tables 5 to 12	Tables 3 to 7
MASKD	<-- All Product Group Application Tables ---->			Table 21
MASKE	N/A	Drive height, Drive capacity	Write-Once/ Erasable Analysis	N/A
MASKH	Tables 7,8	Table 30	N/A	N/A
MASKI	<----- Product Group -----> Price/Megabyte		N/A	N/A

N/A = Not applicable to this report

* Variable format depending upon number of disk diameters in the product group.

TABLE NUMBER TO MASK CROSS-REFERENCE

Table Number	1996 Rigid Report	1996 Removable Report	1996 Optical Report	1996 Array Report
1	MASKA	MASKA	MASKA	MASKA
2	MASKB	MASKB	MASKA	MASKB
3	MASKC	MASKC	MASKB	MASKC
4	MASKC	MASKC	MASKB	MASKC
5	MASKC	MASKC	MASKC	MASKC
6	MASKC	MASKC	MASKC	MASKC
7	MASKH	--	MASKC	MASKC
8	MASKH	--	MASKC	--
9	MASKC	MASKA	MASKC	--
10	MASKC	MASKA	MASKC	MASKA
11	MASKC	MASKC	MASKC	MASKA
12	--	MASKC	MASKC	--
13	--	--	--	--
14	MASKA	MASKI	--	--
15	MASKA	--	--	--
16	--	MASKI	--	MASKA
17	--	--	MASKA	MASKA
18	MASKD	MASKI	MASKA	--
19	MASKI	--	--	--
20	--	MASKI	--	--
21	MASKA	--	MASKD	MASKD
22	MASKA	MASKA	--	--
23	--	MASKA	MASKA	MASKA
24	--	MASKC	MASKA	MASKA
25	MASKD	MASKC	--	--
26	MASKI	MASKA	--	--
27	--	MASKA	MASKD	--
28	MASKA	MASKA	--	--
29	MASKA	MASKA	MASKA	MASKA
30	--	MASKH	MASKA	MASKA
31	--	MASKD	--	--
32	MASKD	--	--	--
33	MASKI	MASKA	MASKD	--
34	--	MASKA	--	--
35	MASKA	--	MASKA	
36	MASKA	--	MASKA	
37	--	MASKI	--	
38	--	MASKD	--	
39	MASKD	--	MASKE	
40	MASKI	MASKA	MASKD	
41	--	MASKA	--	
42	MASKA	--	MASKA	
43	MASKA	--	MASKA	
44	--	MASKD	--	
45	--	--	--	
46	MASKD	MASKA	MASKA	
47	MASKI	MASKA	MASKA	

Cross-reference (continued)

Table Number	1996 Rigid Report	1996 Removable Report	1996 Optical Report	1996 Array Report
48	--	--	--	
49	MASKA	--	--	
50	MASKA	MASKD	MASKE	
51	--	--	MASKA	
52	--	MASKA	MASKA	
53	MASKD	MASKA	--	
54	MASKI	--	--	
55	--	--	MASKE	
56	MASKA	MASKE	MASKA	
57	MASKA	MASKE	MASKA	
58	--	MASKD	--	
59	--	--	--	
60	MASKD		MASKE	
61	MASKI			
62	--			
63	MASKA			
64	MASKA			
65	--			
66	--			
67	MASKD			
68	MASKI			
69	--			
70	MASKA			
71	MASKA			
72	--			
73	--			
74	--			
75	MASKD			
76	MASKI			
77	--			

-- indicates that the format of this table is variable. Create a mask using AutoImport if a spreadsheet is needed.

Translation using precomputed masks

1. First, copy the files you wish to translate to the AIMP directory from the DISK/TREND ON DISK floppy disk. Go to the AIMP directory, insert the floppy disk in drive A and type the following commands:

   COPY A:?T*.*
   COPY A:MASK?2.MSK (if you are using AutoImport version 2.xx)
   COPY A:MASK?3.MSK (if you are using AutoImport version 3.xx)

   These commands copy the data files and mask files you need.

   If you are using a two floppy disk system, copy the files you want to translate to a second floppy disk along with the mask files. Make sure that no more than half of the floppy disk is filled, because you will need space for the converted files.

2. Now start AutoImport by typing AI, then the ENTER key. When the opening screen appears, select the "File" menu bar item using the mouse or just type /F. (The AutoImport menu system works just like the menus in Lotus 1-2-3.)

3. When the next screen appears (File Selection menu), use the arrow keys or the mouse to select the Mask name option, then select the name of the mask you want from the displayed list. If a standard mask is being used, see the mask table above to choose the mask file name to enter. If you used a mask previously, the system defaults to the last mask named.

4. Select Input file name option on the File Selection Menu.

   Enter the name of the file, <u>including the extension</u>, which will be of the form yy? where yy is the year of the report and ? is the report type as above.

   Examples: AT4.96A VT12.96V OT14.96O RT19.96R

5. Select the Output file option on the File Selection menu.

   Enter the name of the file. The file name form recommended is ?Tnn, where ? is the type of report (A, R, V, or O), T is just that, and nn is the DISK/TREND Report table number matching the file being translated. You should not enter the file name extension as the system adds it automatically for you.

   Examples: AT4 VT12 OT14 RT20

6. The default spreadsheet type to which translation is made is Lotus 1-2-3 version 2.x. If you wish to translate to a different spreadsheet format you may choose it by selecting Format from the File Selection menu and then selecting your preference from the menu of choices displayed.

7. You are ready to translate. Select "CONVERT" button using the mouse (or arrow keys and ENTER). If you are asked "Do you want to load input file *.* named in mask", answer "NO". You will see the file being translated scroll by as the translation proceeds.

8. If you want to do more translations, repeat from step 3.

9. When you are done translating, leave AutoImport by typing /Q or use the mouse to select "Quit" on the menu bar to return to the AutoImport main menu to leave AutoImport and return to DOS. It will save you some keystrokes if you copy your new spreadsheet files to your spreadsheet directory. If you are using a two floppy system, just remove the AutoImport disk from drive A and substitute your spreadsheet disk.

Mask Generation

1. Start AutoImport as above. When the opening screen appears, select "File" using the mouse or type /F.

2. Name the input file you will use as the template to create the mask. The file name will be of the form ?Tnn.yy?, where ? is the type of report (R, V, O, or A), nn is the table number and yy is the report year.

   Example: AT10.96A

   To name the file, select Input file from the File selection menu. Type the desired file name and press 'Enter'. The contents of the file will now appear on the screen.

3. Next define the header lines. These are lines that are translated to the spreadsheet as a single cell of text. Place the cursor at the top of the header area, normally at the left top of the report table. Now select "Lines" from the menu bar, then select "Header" from the pop-up window that opens. Using the down arrow key, expand the highlighted area until it extends to just above the first row of numerical data. Press 'ENTER'. If there are any footnotes at the bottom, the lines in which they appear can be treated the same way by locating the header at the left margin of the first footnote line, selecting "Lines" and "Headings" again, and extending the highlight area over the note and pressing 'ENTER'.

4. Next, locate the longest left margin label (excluding the header lines) in the table. Position the cursor so that it is at the left margin of the line containing the longest label. Select "Column" from the menu bar, then "Auto Define". This step actually creates the mask. Check to be sure all figures have been delineated properly. If not, see below.

   In a few cases, the automatic feature may be confused by a table layout and all values will not be picked for conversion. In these unusual cases, you may be able to get the overlooked values included by repeating this step on another line.

   Another unusual case can occur in which the right-hand part of a label is somehow included in a value occurring in the next column to the right. Deal with this rare case as follows:

   o Place cursor in left margin of offending line. Select "Column", then "Width & move". Select the column you wish to adjust with mouse (or arrows & ENTER), and then use arrow keys to move right column margin clear of the column of values. You can also shift the entire column by depressing the CONTROL key and using the appropriate arrow key (or drag with the mouse).

5. Save the mask in a mask file. Select "File", then "Mask", then the Save Mask button, or type /FMS (File:Mask:Save). Fill in the name of the mask file when asked.

   Example: MYMASK.MSK, or just MYMASK

6. Save the output file. Type /FO (File:Output). Now enter the file name.

   Example: AT10. You don't need to enter the file extender.

7. To make more masks, repeat from step 2. To quit the mask function, type /QY (quit).

Other AutoImport Functions

AutoImport can do much more than the functions described above, which are those concerned with a basic understanding of how to create spreadsheets from DISK/TREND ON DISK files. See the separate AutoImport manual provided for details of these other functions.

SPECIFICATION TABLES

Loading

1. Place the floppy disk marked "Specifications" in a floppy disk drive able to read your size disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the spreadsheet system disk in drive A. Use the DOS "DIR" command to examine the file directory on the "Tables" disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

   TYPE A:READ.ME (Use the appropriate drive letter if not A)

   If you wish to print the instructions, turn on your printer and type:

   TYPE A:READ.ME>PRN

2. Do this step if you have a hard disk. Log into the hard disk directory in which your spreadsheet normally stores worksheet files. Using the DOS "COPY" command, copy all the specification table files to the hard disk. This can be done in one step using the copy command as follows:

   COPY A:?S*.*

3. Now you are ready to start Lotus 1-2-3 or other spreadsheet. If you are using a two floppy system, place the DISK/TREND disk in drive B and the Lotus spreadsheet system disk in drive A. If you are using a rigid disk system, place the spreadsheet system disk in floppy drive A. If your spreadsheet is not Lotus 1-2-3, you will have to translate the data from Lotus 1-2-3 to your format. Almost all spreadsheet packages of recent vintage are able to do this translation. After translation, if needed, start your spreadsheet as usual. After obtaining the blank spreadsheet image on the screen, use the spreadsheet File Retrieve command to select a file. The equivalent Lotus 1-2-3 command is:

   /FR<filename>

   The file names are in the format XSYZZ.WK1 or XSYZZ.WKS, depending upon which version of Lotus 1-2-3 you are using. X,Y, and Z are:

   X= O (Optical disk drive data)
   R (Rigid disk drive data)
   A (Disk drive array data)
   V (Removable data storage data)

Y= Table number. Usually, there is only one table, but if the specification file is so large as to need multiple disks to hold it, there may be several.

ZZ= Year of report.

Example: AS196 Disk drive array specification table

Note that the specification tables load directly as a data base. You can use the data base functions of Lotus 1-2-3 to sort, count or otherwise manipulate the data for purposes of special analysis. Other spreadsheets may have similar capabilities.

Using the specification data base

Introduction: If you have not used the Lotus 1-2-3 /DATA QUERY commands, it will be helpful for you to review the sections of the Lotus 1-2-3 reference manual that pertain to their use before proceeding further.

The specification data base fits into a worksheet format of 25 to 30 columns, depending upon whether rigid, optical or floppy drives are involved, and a row count of up to 500 rows. Each row represents a specific record, and is equivalent to a single column in the Specifications section of the DISK/TREND report. Each column represents a specific specification parameter, and is equivalent to one row of the DISK/TREND report.

The data base has been set up for data extraction using Lotus 1-2-3 commands. The Input, Output and Criterion ranges have been predefined, but you, the user, will have to decide how you want the extracted data manipulated and place the appropriate Lotus functions, such as @COUNT, in the appropriate cells. Some rows between the bottom of the input range and the top of the output range have been left empty so that you can do this easily. When the data base is first loaded, you will see the top of the input range, showing the first column (manufacturer name) for the first several manufacturers. Use the arrow keys to find other manufacturers or specific product specifications. If you are not using Lotus 1-2-3, use the equivalent procedure for your spreadsheet.

Operating tips

Expanding the input or output ranges: The predefined output range is of a nominal size, and a search with broad parameters may result in overflowing the output range. In such a case, merely extend the output range (add more rows) using the Lotus 1-2-3 /DQEO command. Similarly, it is possible to extend the input range to add more products, but be sure you move the output range so that there is no overlap.

Memory overflow: If you should receive a memory overflow message while manipulating the specification data, it is usually because:

- o There are other "pop-up" programs resident in the memory of your computer. These should be removed.
- o You have selected too large an output range. Use a smaller output range or delete some of the columns that contain data not relevant to your analysis. If you delete data, be sure that if you save your spreadsheet you use a different file name, otherwise you will overwrite the original file with the modified spreadsheet.
- o If you receive a memory overflow message while loading the data base, the data base is too large for your computer's available memory. You probably will have to remove other resident programs and reload Lotus 1-2-3 and the data base. If your computer doesn't have at least 640K memory, you will probably get this message.

Saving time

The specification data base is large and takes significant time to recompute or perform other operations. If you are interested in drives that belong to only a few product groups, it will probably save you time in the long run if you extract only those groups you are interested in into a new worksheet and use that for the analysis. Use spreadsheet FILE EXTRACT and FILE COMBINE commands for this purpose.

Another way to save time is to use the SORT capabilities of your spreadsheet to organize the data the way you find it most useful. The most commonly done sorts are by manufacturer name and by DISK/TREND product group, but it would also be possible to sort by average seek time, price, and so on.

Make sure that when you save a worksheet using the FILE SAVE command

that you save it in a new file name. If you save it in the file name from which it was loaded, the original copy will be overwritten. If a file is overwritten unintentionally, it can take a long time to recreate.

If you are interested in only a subset of product groups, use the FILE EXTRACT and FILE COMBINE commands to move these records to another file and then use the second file for analysis. The smaller file will take less time to process.

Technical support

Just about all of your questions regarding the use of DISK/TREND ON DISK should be answered in this manual or in the Lotus 1-2-3 reference manual. However, if you need to contact us to resolve any points of confusion, report errors, or otherwise receive comfort:

Call us at: **415-961-6209** or
E-mail us at: **dtinfo@disktrend.com**

Ask for Technical Support for DISK/TREND ON DISK

In order to make this process efficient, if you call--

1. Tell us what is on the diskette label.

2. Have your computer up and displaying the data or operation that is the subject of your call.

3. Have this manual and the Lotus 1-2-3 reference manual handy.

If you have questions about AutoImport as it is used with DISK/TREND ON DISK, contact DISK/TREND at the number above. Questions about other functions of AutoImport should be referred to White Crane Systems.

Apple Macintosh compatibility: While DISK/TREND ON DISK has been prepared for use on IBM PC compatible computers, users have reported that they are able to translate files into Macintosh format using Apple Computer software. The specific software reported used is Apple File Exchange.

Special data

The specification data base contains one category of information not present in the hard copy report. This is the country code field, representing the continental region in which the headquarters of the drive producer is located. A key is located at the top of the adjacent column to the right.

In order to make it easier to do sorting or extraction analysis on the data, the contents of certain fields have been modified and are not exactly the same as in the printed report tables. Some affected fields have been converted to purely numeric fields as described below. Where multiple values existed, the value representing the highest level of performance or capability has been retained.

Comments and asterisks in the affected fields have been eliminated. A '0' means that no data was available. Asterisks are retained in the comment field so that you will have an indication that one or more characteristics of the drive was referenced to a comment. Check the printed report table for details.

The affected fields are:

Group:	Numeric conversion: Now you can extract a range of groups.
Host_chans: (Number of host channels)	Numeric conversion: You can sort or extract on a value or range of values for number of host channels.

A country code field has been added in the last column of the data base.
The code explanation is:

1 = U.S. manufacturer
2 = Asian manufacturer
3 = European manufacturer.
4 = South American or other manufacturer

Codes are based upon the location of the manufacturer's headquarters.

First ship date has been modified so that the last two characters will always represent the year of shipment. An entry of ??94 in the criterion field for the First Ship Date column will cause all products first shipped in 1994 to be extracted.