1997 DISK/TREND® REPORT

DISK
DRIVE
ARRAYS

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DISK DRIVE ARRAYS

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

Telephone: 650-961-6209
Facsimile: 650-969-2560
E-mail: dtinfo@disktrend.com
Web: www.disktrend.com

FOREWORD

As the disk drive array business continues to evolve in product architecture, disk drive capacities utilized, application requirements and market structure, we have also evolved in our methods of insuring complete coverage and analysis -- up to a point. We've continued to utilize the methods developed in 21 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 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. 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. 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

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INTRODUCTION

The terms used in this business need definitions. 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.

The array business has multiple levels. 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 an array controller board is sold to a system or subsystem manufacturer, we count that sale at the value of the first 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.

Please note individual pricing levels! 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.

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

Worldwide sales revenues for disk drive arrays were $10.8 billion in 1996, a 9.9% increase over the previous year, but lower than previously forecast. Although 1996 unit shipments of 774,732 arrays were very close to last year's DISK/TREND forecast, average unit prices for a few key product groups fell faster than anticipated, holding down the overall revenue growth. 1997 appears to be a stronger year for sales revenue growth, with a 19.2% increase projected, placing the year's total at $12.8 billion. 2000 sales revenues are projected at $17.2 billion, an average annual increase of 10.2% for the 1997-2000 period. Unit shipments in 2000 are forecasted at 1,562,633 arrays, twice the size of the 1996 total.

The utilization of disk drive arrays with mainframe computer systems, open systems and specialized applications continues to expand. Although most disk storage systems for mainframes now have array capability, the trend toward displacement of non-fault tolerant disk subsystems with arrays is still under way. Continuing growth in shipments for disk drive arrays is guaranteed by the opportunity to expand array sales into the portion of the disk storage market still not converted to array subsystems, replacement of earlier arrays with newer models with improved capabilities, and the continuing expansion of the server disk storage market driven by the requirements of new applications.

Captive sales by a broad range of manufacturers of personal computers, midrange computers and supercomputers provide more than 60% of the worldwide disk drive array sales revenues. 1996 captive sales revenues totaled $6.8 billion, and the 2000 captive total is projected to reach $11.6 billion, an average annual increase of 14.2% for the 1997-2000 period. Although captive arrays currently ship in lower quantities than noncaptive arrays, the captive sales revenue totals are boosted by a predominance of complete subsystems, typically at higher unit prices.

Although noncaptive unit shipments are now dominated by large OEM/Integrator sales of array boards and software products at relatively low prices, the PCM/Distributor channel leads in revenues due to greater reliance on higher value complete subsystems. By 2000, however, growing shipments of complete subsystems will give revenue leadership to the OEM/Integrator channel.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

DISK DRIVE ARRAYS

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1996 Revenues		Forecast 1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	3,706.7	6,743.8	4,152.3	7,710.5	4,936.3	8,776.7	5,663.1	10,180.3	6,354.6	11,506.8
PCM/Distributor	1,280.7	2,266.3	1,270.2	2,285.6	1,280.0	2,249.9	1,182.3	2,088.7	1,074.8	1,912.9
OEM/Integrator	649.3	935.5	825.8	1,468.6	1,026.5	1,737.4	1,090.3	1,907.8	1,085.1	1,961.6
TOTAL U.S. REVENUES	5,636.7	9,945.6	6,248.3	11,464.7	7,242.8	12,764.0	7,935.7	14,176.8	8,514.5	15,381.3
Non-U.S. Manufacturers										
Captive	--	90.8	--	111.2	--	114.9	--	115.8	--	113.0
PCM/Distributor	223.4	570.5	293.1	742.3	319.8	777.2	327.7	779.1	322.9	756.2
OEM/Integrator	77.5	152.7	331.0	506.9	458.5	718.2	538.5	841.7	588.3	918.2
TOTAL NON-U.S. REVENUES	300.9	814.0	624.1	1,360.4	778.3	1,610.3	866.2	1,736.6	911.2	1,787.4
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	5,937.6	10,759.6	6,872.4	12,825.1	8,021.1	14,374.3	8,801.9	15,913.4	9,425.7	17,168.7

Marketing channels

Although captive disk drive arrays provided only 38.7% of the worldwide unit shipments of all arrays in 1996, the captive share is projected to increase to 52.1% in 2000. 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 manufacturers of mainframe computers such as IBM, midrange systems such as Digital Equipment, Sun Microsystems, Tandem Computers, Hewlett-Packard and Data General, and personal computers such as Compaq Computer and Dell Computer. Complete subsystems in the Network/Midrange product group are expected to provide leadership in unit shipment growth through 2000. Captive arrays capture an even greater share of total disk drive array sales revenues. Captive arrays of all kinds held 63.5.% of the 1996 worldwide revenue total, and despite the substantial growth projected for noncaptive array manufacturers, sales revenues for the captive sales channel are expected to increase to 67.7% of the overall total in 2000, at $11.6 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.

Total sales revenues for arrays in the PCM/Distributor channel are expected to peak in the 1997-98 period, then decline. The problem is not a decline in shipment volume, but a long-term downward slope in average unit prices. The expected price declines for complete subsystems in the Network/Midrange and Mainframe product groups are the most influential in depressing the total PCM/Distributor sales revenue total, due to the relatively high price levels for complete subsystems. The PCM/Distributor 1996 sales level of $2.8 billion is expected to peak at $3.0 billion, then decline to less than $2.7 billion in 2000.

The United States was about 55% of the worldwide market for all arrays in 1996 and is expected to hold the same share in 2000. However, the product development and sales momentum already attained is expected to make it possible for U.S. companies to hold almost a 90% share of the worldwide disk drive array market through 2000.

TABLE 2

CONSOLIDATED WORLDWIDE REVENUES
DISK DRIVE ARRAYS
MARKET CLASS REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1996 Revenues $M	1996 %	Forecast 1997 $M	1997 %	1998 $M	1998 %	1999 $M	1999 %	2000 $M	2000 %
U.S. Manufacturers										
Captive	6,743.8	62.6%	7,710.5	60.0%	8,776.7	60.9%	10,180.3	63.9%	11,506.8	67.0%
	+8.5%		+14.3%		+13.8%		+16.0%		+13.0%	
PCM/Distributor	2,266.3	21.0%	2,285.6	17.8%	2,249.9	15.6%	2,088.7	13.1%	1,912.9	11.1%
	+1.5%		+.9%		-1.6%		-7.2%		-8.4%	
OEM/Integrator	935.5	8.6%	1,468.6	11.4%	1,737.4	12.0%	1,907.8	11.9%	1,961.6	11.4%
	+62.0%		+57.0%		+18.3%		+9.8%		+2.8%	
Total U.S. Manufacturers	9,945.6	92.2%	11,464.7	89.2%	12,764.0	88.5%	14,176.8	88.9%	15,381.3	89.5%
	+10.2%		+15.3%		+11.3%		+11.1%		+8.5%	
Non-U.S. Manufacturers										
Captive	90.8	.8%	111.2	.8%	114.9	.7%	115.8	.7%	113.0	.6%
	-52.9%		+22.5%		+3.3%		+.8%		-2.4%	
PCM/Distributor	570.5	5.3%	742.3	5.7%	777.2	5.4%	779.1	4.8%	756.2	4.4%
	+30.6%		+30.1%		+4.7%		+.2%		-2.9%	
OEM/Integrator	152.7	1.7%	506.9	4.3%	718.2	5.4%	841.7	5.6%	918.2	5.5%
	+11.5%		+232.0%		+41.7%		+17.2%		+9.1%	
Total Non-U.S. Manufacturers	814.0	7.8%	1,360.4	10.8%	1,610.3	11.5%	1,736.6	11.1%	1,787.4	10.5%
	+6.2%		+67.1%		+18.4%		+7.8%		+2.9%	
Worldwide Recap										
Captive	6,834.6	63.5%	7,821.7	61.0%	8,891.6	61.9%	10,296.1	64.7%	11,619.8	67.7%
	+6.7%		+14.4%		+13.7%		+15.8%		+12.9%	
PCM/Distributor	2,836.8	26.4%	3,027.9	23.6%	3,027.1	21.1%	2,867.8	18.0%	2,669.1	15.5%
	+6.3%		+6.7%		--		-5.3%		-6.9%	
OEM/Integrator	1,088.2	10.1%	1,975.5	15.4%	2,455.6	17.0%	2,749.5	17.3%	2,879.8	16.8%
	+52.3%		+81.5%		+24.3%		+12.0%		+4.7%	
Total All Manufacturers	10,759.6	100.0%	12,825.1	100.0%	14,374.3	100.0%	15,913.4	100.0%	17,168.7	100.0%
	+9.9%		+19.2%		+12.1%		+10.7%		+7.9%	

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

Product groups

The network/midrange product group has a commanding lead in disk drive array sales revenues and unit shipments. 1996 sales revenues for the product group were $6.7 billion, 62.3% of the total for all array product groups, and the 2000 total is forecasted at $14.3 billion. The product group's share of overall array unit shipments is even more impressive, with 723,979 arrays in 1996 for 93.5% of the industry total, and a 2000 projection of 1,486,350 units, 95.2% of the total. Future growth for arrays during this forecast period in network/midrange markets is assured because the network market is still growing rapidly, continual disk drive and array functional improvements stimulate periodic replacement of arrays already installed, and it will require years of additional sales activity to build the array share of the network/midrange storage subsystem to the saturation level.

Underlying the strong showing by network/midrange arrays is a combination of high sales revenues derived from strong shipments of high value complete subsystems in both the captive and PCM/Distributor channels and high unit shipments of array board and software products in both PCM/Distributor and OEM/Integrator channels. 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. Captive revenues contributed 70.7% of the 1996 overall sales revenue total for the product group, and the captive share is expected to be even slightly higher in 2000.

Until 1996, sales revenues for arrays used with mainframe computer systems were increasing 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 $4.3 billion in 1995. However, 1996 sales revenues dropped

7.2%, to $3.9 billion, and are expected to continue declining in subsequent years, despite an expected annual increase in the total amount of disk storage capacity 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 now in the form of disk drive arrays. Future growth in array shipments for mainframe systems will be largely limited to the annual increases in the mainframe market's need for additional disk storage capacity.

The disk drive price per megabyte will decrease much faster in the 1997-2000 period than the mainframe market's increasing appetite for more storage, so the DISK/TREND sales revenue forecast for 2000 indicates a sales revenue decline to less than $2.7 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 1997 worldwide shipment peak of almost 12 thousand mainframe array subsystems is expected to decline to 10.8 thousand in 2000.

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 1996-2000 sales revenue total, despite shipment increases for each product group. 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.

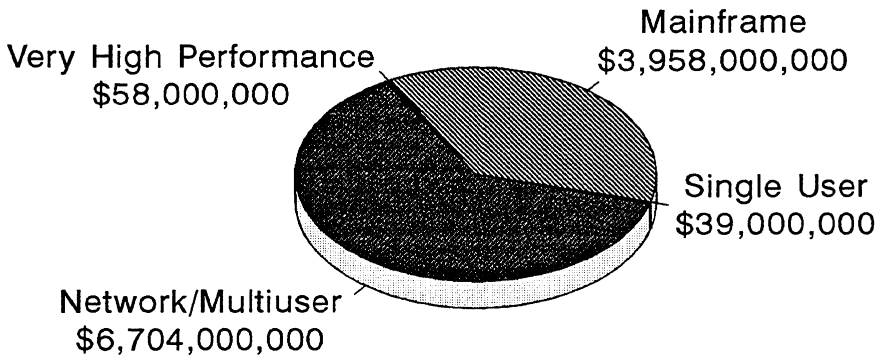
The shipment increases expected for very high performance arrays will be generated primarily by noncaptive sales of specialized subsystems and software products for a variety of specialized applications, including video servers, video editing, medical systems, geophysical exploration data analysis and other imaging systems. 1996 unit shipments of 1,671 very high performance arrays are expected to be two and a half times larger in 2000.

In the single user array product group, 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. The 1997-2000 shipment increase for the group is expected to average 12.8% per year.

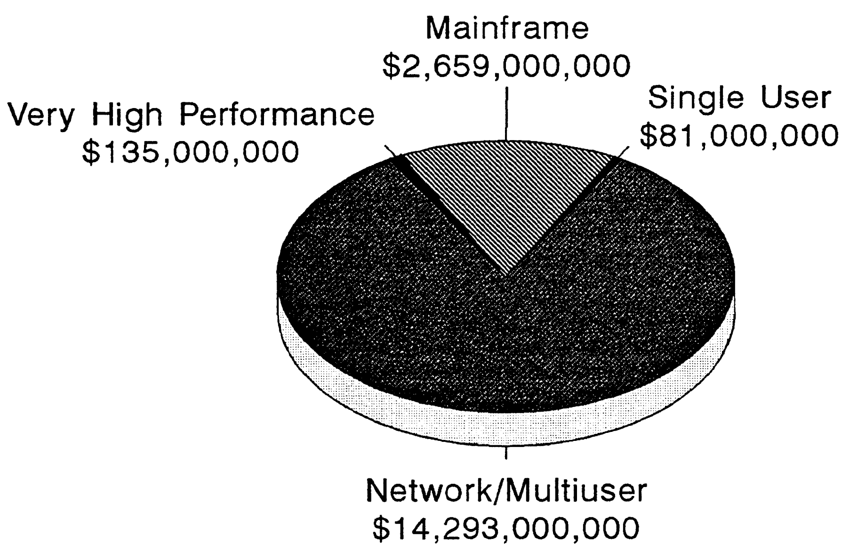
Figure 1

CHANGING PRODUCT MIX

Worldwide Disk Drive Array Revenue



1996



2000

TABLE 3

CONSOLIDATED WORLDWIDE REVENUES
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1996		Forecast							
ALL MANUFACTURERS	Revenues		1997		1998		1999		2000	
	$M	%	$M	%	$M	%	$M	%	$M	%
SINGLE USER SYSTEMS	38.6	.4%	46.7	.4%	58.4	.4%	69.8	.4%	81.4	.5%
	+18.8%		+21.0%		+25.1%		+19.5%		+16.6%	
NETWORKS/MIDRANGE SYSTEMS	6,704.3	62.3%	8,948.6	69.9%	10,891.2	75.9%	12,763.8	80.3%	14,292.7	83.3%
	+23.7%		+33.5%		+21.7%		+17.2%		+12.0%	
MAINFRAMES	3,958.4	36.8%	3,736.5	29.1%	3,310.4	23.0%	2,952.2	18.6%	2,659.3	15.5%
	-7.2%		-5.6%		-11.4%		-10.8%		-9.9%	
VERY HIGH PERFORMANCE	58.3	.5%	93.3	.6%	114.3	.7%	127.6	.7%	135.3	.7%
	-21.3%		+60.0%		+22.5%		+11.6%		+6.0%	
Total Worldwide Revenue	10,759.6	100.0%	12,825.1	100.0%	14,374.3	100.0%	15,913.4	100.0%	17,168.7	100.0%
	+9.9%		+19.2%		+12.1%		+10.7%		+7.9%	

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

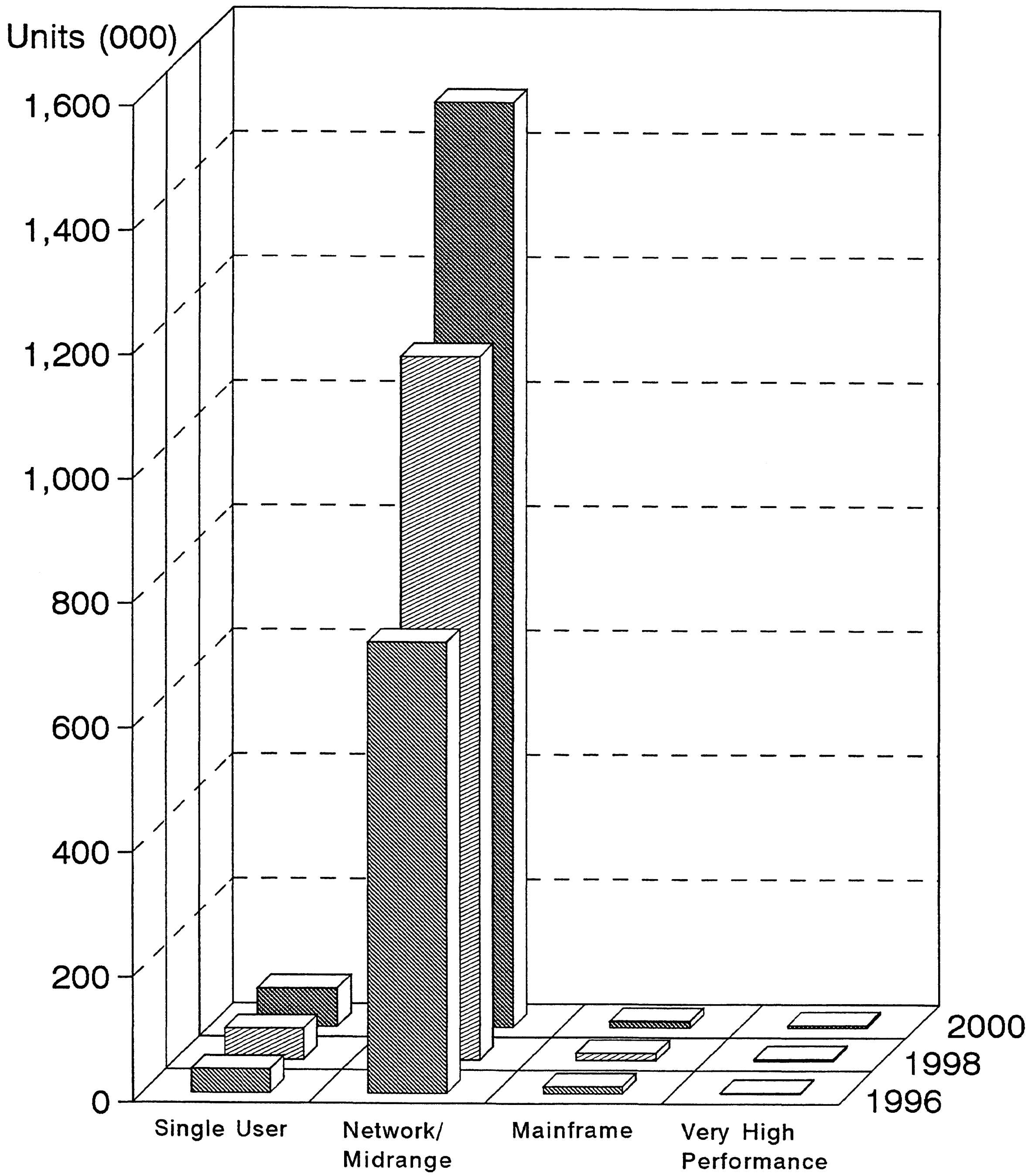


TABLE 4

CONSOLIDATED WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS	------1996-----		------------------------------Forecast------------------------------							
SINGLE UNITS	---Shipments---		------1997-----		------1998-----		------1999-----		------2000-----	
	Units	%	Units	%	Units	%	Units	%	Units	%
SINGLE USER SYSTEMS	37,960	4.9%	46,040	4.7%	50,465	4.2%	55,410	4.0%	61,135	3.9%
	+10.1%		+21.3%		+9.6%		+9.8%		+10.3%	
NETWORKS/MIDRANGE SYSTEMS	723,979	93.5%	925,600	94.0%	1,130,160	94.7%	1,321,200	95.1%	1,486,350	95.2%
	+35.1%		+27.8%		+22.1%		+16.9%		+12.5%	
MAINFRAMES	11,122	1.4%	11,966	1.2%	11,585	1.0%	11,180	.8%	10,765	.7%
	-10.5%		+7.6%		-3.2%		-3.5%		-3.7%	
VERY HIGH PERFORMANCE	1,671	.2%	2,420	.1%	2,975	.1%	3,625	.1%	4,383	.2%
	+20.6%		+44.8%		+22.9%		+21.8%		+20.9%	
Total Worldwide Shipments	774,732	100.0%	986,026	100.0%	1,195,185	100.0%	1,391,415	100.0%	1,562,633	100.0%
	+32.6%		+27.3%		+21.2%		+16.4%		+12.3%	
% U.S. Manufacturers	93.1%		91.8%		91.7%		91.7%		91.6%	

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

Array product mix

In order to organize the DISK/TREND Report on disk drive arrays on a logical basis into types of products, as contrasted with the types of applications for which they are used, shipment and revenue data has been divided into three subgroups. 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.

In 1996, complete subsystems provided almost 45% of total disk drive array unit shipments, and the share held by subsystems is expected to grow to at least 60% of the worldwide total for 2000. Complete subsystems constitute all of the arrays currently shipped for mainframe systems and most of the very high performance systems. Shipments of complete subsystems for network/midrange system applications are currently providing almost half of the shipments for the product group, but the share for complete subsystems is expected to rise to more than 60% in 2000, as users' requirements for fault tolerance move the market to more sophisticated arrays. Complete subsystems currently hold about 25% of the single user systems market, but that share is forecasted to increase to almost 33% of the 2000 total.

A high proportion of the board level array controllers have been utilized during recent years in the network/midrange product group. That group's high share of board shipments is expected to continue, driven by OEM sales to personal computer manufacturers which offer network servers. However, in 1997 the growth rate for network/midrange OEM board shipments is starting to decline in the face of competition from some system manufacturers' internal array board production programs, and are expected to face additional future competition from chip set array controllers, which can be mounted on system motherboards, eliminating the need for a separate array controller board.

Total shipments of software array products continue to maintain positive shipment growth, but their share of the available market is decreasing in total and in each of the DISK/TREND array product groups. After a 1997 peak with 16% of overall array product shipments, software arrays are projected to decline to 14% of the total for 2000. Software arrays tend to be favored by single users and in some specialized midrange system applications in which the usage of processor capacity required for disk array functions is not enough to cause system performance degradation.

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. RAID-1 subsystems and boards have been readily available, have offered high reliability and have been cost-effective compared to the perceived alternatives. As drive capacities increase, falling price per megabyte levels will help to maintain the attractiveness of RAID-1 for many data storage applications.

RAID-3 has been favored for many 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 RAID-3 and RAID-5 arrays.

RAID-5 is expected to assume an ever larger role in the network/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 redundancy, and 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	146
RAID-3 and RAID-0/1/3 combinations	23
RAID-4	5
RAID-5 and RAID-0/1/3/4/5 combinations	617

Figure 3

ARRAY TYPE SUMMARY

Worldwide Shipments in Thousands of Units

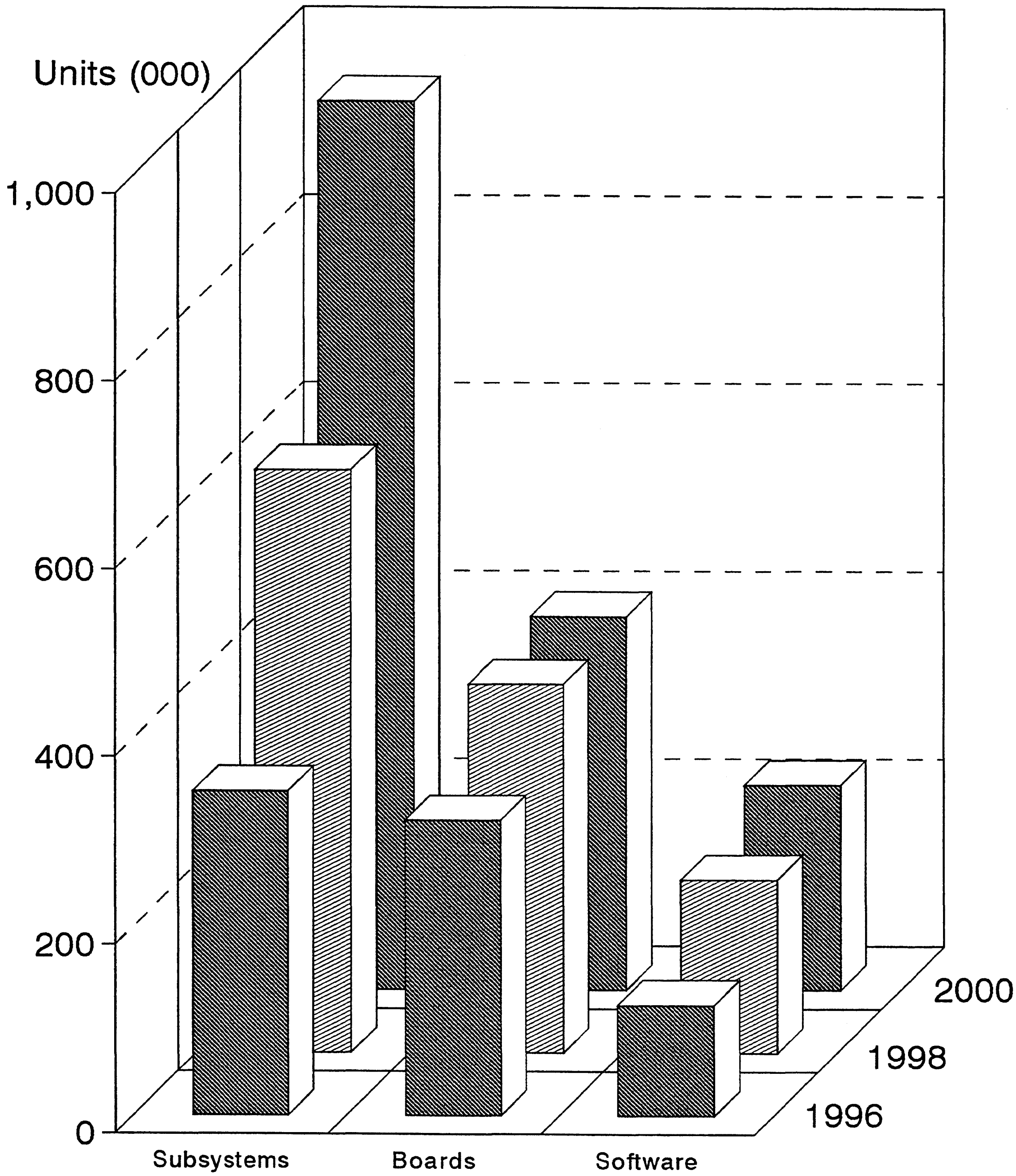


TABLE 5

CONSOLIDATED WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
SUMMARY BY ARRAY TYPE

UNIT SHIPMENTS	------1996-----		------------------------------Forecast-----------------------------							
SINGLE UNITS	---Shipments---		------1997-----		------1998-----		------1999-----		------2000-----	
	Units	%	Units	%	Units	%	Units	%	Units	%
SUBSYSTEMS	344,077	44.4%	464,891	47.1%	619,797	51.9%	783,710	56.3%	946,423	60.6%
	+18.3%		+35.1%		+33.3%		+26.4%		+20.8%	
BOARDS	313,410	40.5%	363,520	36.9%	391,410	32.7%	404,495	29.1%	397,555	25.4%
	+73.0%		+16.0%		+7.7%		+3.3%		-1.7%	
SOFTWARE	117,245	15.1%	157,615	16.0%	183,978	15.4%	203,210	14.6%	218,655	14.0%
	+4.5%		+34.4%		+16.7%		+10.5%		+7.6%	
Total Worldwide Shipments	774,732	100.0%	986,026	100.0%	1,195,185	100.0%	1,391,415	100.0%	1,562,633	100.0%
	+32.6%		+27.3%		+21.2%		+16.4%		+12.3%	

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

Noncaptive market

Except for arrays sold in the mainframe market, continuous growth for both sales revenues and shipments of noncaptive arrays is expected through 2000. 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 begun during the last few years. Noncaptive unit shipments are forecasted to increase from 474,516 in 1996 to 749,283 arrays in 2000.

As a result of a major boost in PCM/Distributor sales of mainframe arrays during 1994-95, total noncaptive array revenues reached over $3.9 billion in 1996, but total revenues are forecasted to peak in 1999 at $5.6 billion and decline slightly in 2000. Mainframe sales dominated DISK/TREND statistics for noncaptive array sales revenues during 1994 and 1995, with the largest impact provided by EMC's spectacular growth in selling heavily cached mirrored disk subsystems in the IBM plug compatible market. However, in 1996 network/midrange sales revenues took the lead in noncaptive markets, with slightly more than half of the noncaptive total.

The worldwide noncaptive shipments of network/midrange arrays in 1996 were 430,794 units, 90.9% of all noncaptive array unit shipments, and the 2000 share of noncaptive shipments is forecasted to change very little, at 90.7%, with 678,995 arrays. 1996 network/midrange noncaptive sales revenue of more than $1.9 billion is expected to double to $4.1 billion in 2000, providing 73.4% of all noncaptive sales. 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 increased at a faster annual rate than complete subsystems until 1997, but shipments of separate array boards are slowing down and are expected to peak after 1999, 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	------1996-----		---------------------------------Forecast-------------------------							
ALL MANUFACTURERS	----Revenues---		------1997-----		------1998-----		------1999-----		------2000-----	
	$M	%	$M	%	$M	%	$M	%	$M	%
SINGLE USER SYSTEMS	38.6	1.0%	46.7	.9%	58.4	1.1%	69.8	1.2%	81.4	1.5%
	+18.8%		+21.0%		+25.1%		+19.5%		+16.6%	
NETWORKS/MIDRANGE SYSTEMS	1,967.3	50.2%	3,147.0	63.0%	3,763.8	68.7%	4,030.4	71.9%	4,069.5	73.4%
	+68.7%		+60.0%		+19.6%		+7.1%		+1.0%	
MAINFRAMES	1,876.9	47.8%	1,728.8	34.6%	1,555.5	28.4%	1,396.5	24.9%	1,268.3	22.9%
	-12.1%		-7.9%		-10.0%		-10.2%		-9.2%	
VERY HIGH PERFORMANCE	42.2	1.0%	80.9	1.5%	105.0	1.8%	120.6	2.0%	129.7	2.2%
	-14.2%		+91.7%		+29.8%		+14.9%		+7.5%	
Total Worldwide Revenues	3,925.0	100.0%	5,003.4	100.0%	5,482.7	100.0%	5,617.3	100.0%	5,548.9	100.0%
	+16.0%		+27.5%		+9.6%		+2.5%		-1.2%	

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

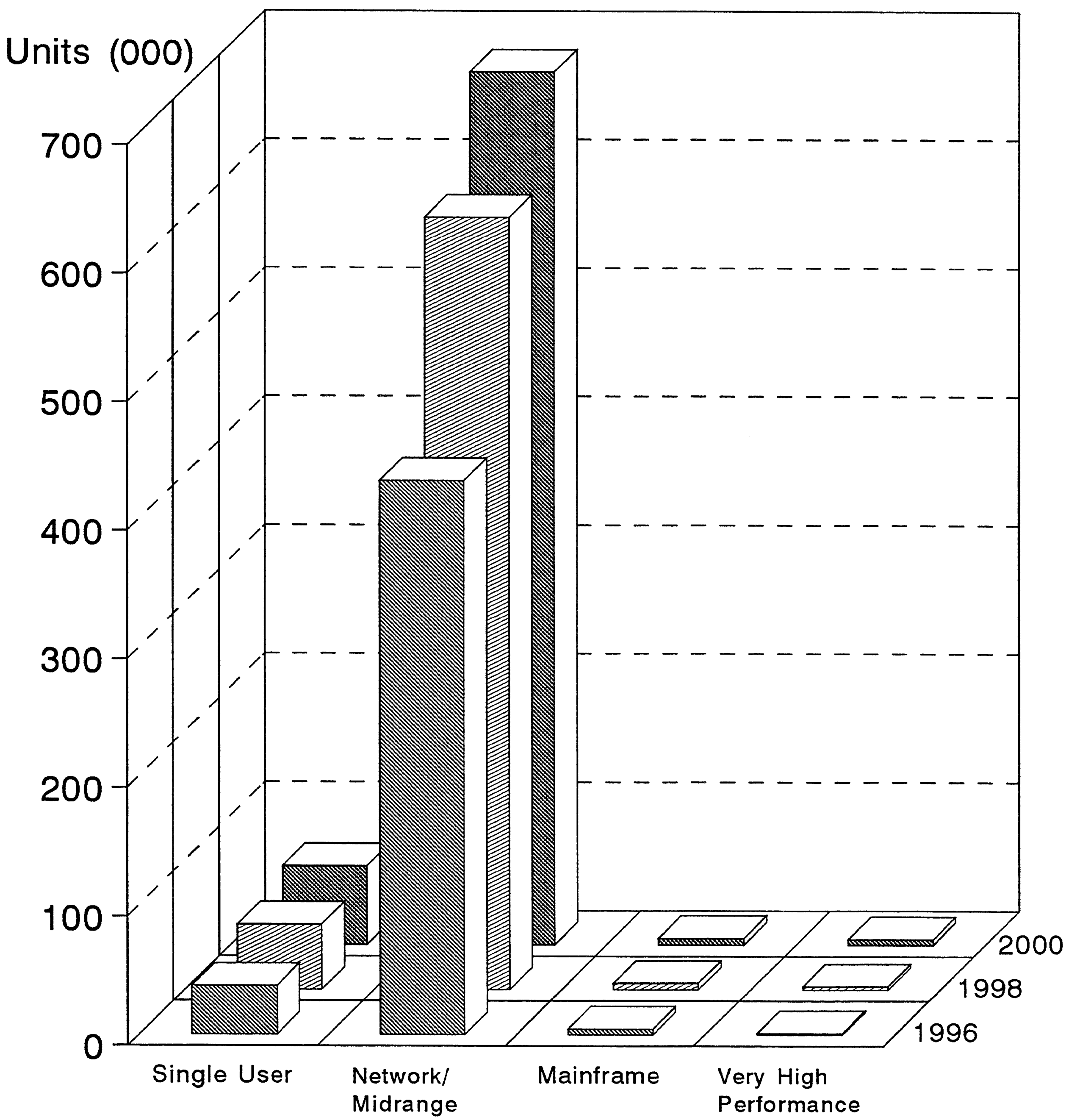


TABLE 7

NONCAPTIVE WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

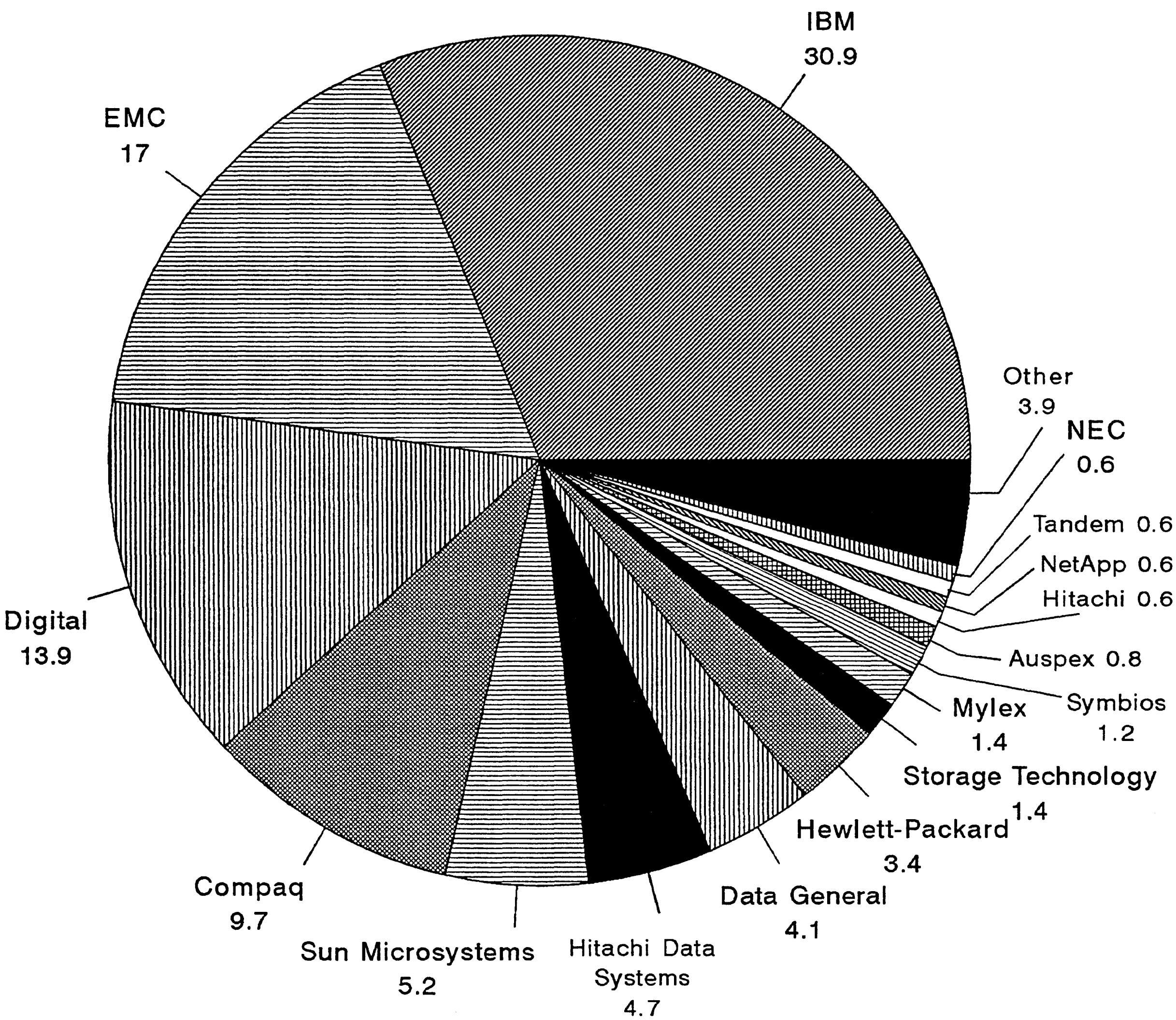
UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS	1996		Forecast							
SINGLE UNITS	Shipments		1997		1998		1999		2000	
	Units	%	Units	%	Units	%	Units	%	Units	%
SINGLE USER SYSTEMS	37,960	8.0%	46,040	8.0%	50,465	7.7%	55,410	7.7%	61,135	8.2%
	+10.1%		+21.3%		+9.6%		+9.8%		+10.3%	
NETWORKS/MIDRANGE SYSTEMS	430,794	90.9%	525,045	90.9%	600,725	91.2%	653,500	91.2%	678,885	90.7%
	+46.4%		+21.9%		+14.4%		+8.8%		+3.9%	
MAINFRAMES	4,467	.9%	4,951	.8%	5,127	.8%	5,140	.7%	5,073	.6%
	-8.4%		+10.8%		+3.6%		+.3%		-1.3%	
VERY HIGH PERFORMANCE	1,295	.2%	2,095	.3%	2,703	.3%	3,400	.4%	4,190	.5%
	+42.3%		+61.8%		+29.0%		+25.8%		+23.2%	
Total Worldwide Shipments	474,516	100.0%	578,131	100.0%	659,020	100.0%	717,450	100.0%	749,283	100.0%
	+41.9%		+21.8%		+14.0%		+8.9%		+4.4%	
% U.S. Manufacturers	89.5%		86.8%		85.7%		84.6%		83.3%	

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

Figure 5

1996 ESTIMATED MARKET SHARES
Worldwide Revenue Percentages of All Disk Arrays



1996 Revenues: $10,759,600,000

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 (116)	Type	Single User Arrays	Network/ Midrange Arrays	Mainframe Arrays	Very High Performance Arrays
1776, Inc.	O,P		SW		
AC Technology	P		SB		
Adaptec	O,P	BD,SW	BD,SW		
Advanced Logic Research	P		SB		
Amdahl	P		SB	SB	
American Digital Systems	O,P		SB		
American Megatrends	O,P		BD		
ANDATACO	O,P		SB		
Antrone Research	O,P		BD		
Apple Computer	C,P		SB		
Applied Digital Systems	P		SB		
APPRO	O,P		SB		
Artecon	P		SB		
ASC Audio Video	P				SW
AST Research	C,P		SB		
ATTO Technology	O,P	SW			
Auspex Systems	C,P		SB		
Aviv	P		SB		
Box Hill Systems	P		SB		
Bytestream Data Systems	O		BD,SW		
Cambex	P		SB	SB	
CharisMac Engineering	O,P	SW	SW		
Ciprico	O,P				SB
CLone Star Software	P		SW		
CMD Technology	O,P		BD,SB		
Compaq Computer	C		BD,SB		
Conley	O,P		SB,SW		
Consensys Computers	O,P		SW		
Corel	O,P		SW		
Cray Research	C				SB
Cubix	P		SB		
CyberStorage Systems	O,P		SB		
Cyranex	O,P	SW	SW		
Dallas Digital	O,P		SB		
Data General	O,P		SB		
Datalink	P		SB		
Dell Computer	C		BD,SB		
Digi-Data	O		BD		
Digital Equipment Corporation	C,O,P		BD,SB,SW		
Direct Connect Systems	P		SB		
Diverse Logistics	O,P		BD		
DPT	O,P		BD,SB		
DTC Data Technology	P	BD			
DynaTek Automation Systems	P		SB		
ECCS	O,P		SB		
Eclipse Technologies	O,P		BD		
EMC	P		SB	SB	
Encore Computer	C,P			SB	
FWB Software	P	SW			
Gain Systems	O,P		SB		

TABLE 8

1996 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL DISK DRIVE ARRAYS
(Value of non-U.S. currencies estimated at average 1996 rates)

	CAPTIVE		PCM/DISTRIBUTOR		OEM/INTEGRATOR		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
Auspex Systems	--	--	91.9	3.2	--	--	91.9	.8
Compaq Computer	1,047.8	15.3	--	--	--	--	1,047.8	9.7
Data General	82.8	1.2	95.9	3.4	257.3	23.6	436.0	4.1
Dell Computer	54.0	.8	--	--	--	--	54.0	.5
Digital Equipment	1,210.9	17.7	224.0	7.9	60.0	5.5	1,494.9	13.9
EMC	--	--	1,423.0	50.2	408.8	37.6	1,831.8	17.0
Hammer Storage Solutions	--	--	31.6	1.1	--	--	31.6	.3
Hewlett-Packard	364.0	5.3	--	--	--	--	364.0	3.4
IBM	3,327.9	48.3	--	--	--	--	3,327.9	30.9
Mylex	--	--	15.9	.6	132.5	12.2	148.4	1.4
Network Appliance	--	--	60.0	2.1	--	--	60.0	.6
Storage Computer	--	--	21.6	.7	8.5	.8	30.1	.3
Storage Technology	--	--	149.4	5.2	--	--	149.4	1.4
Sun Microsystems	556.5	8.1	--	--	--	--	556.5	5.2
Tandem Computer	62.6	.9	--	--	--	--	62.6	.6
Other U.S.	37.3	.6	153.0	5.4	68.4	6.3	258.7	2.3
U.S. Total	6,743.8	98.7	2,266.3	80.0	935.5	86.0	9,945.6	92.4
NON-U.S. MANUFACTURERS								
Hitachi	29.4	.4	16.8	.6	21.6	2.0	67.8	.6
Hitachi Data Systems	--	--	506.4	17.9	--	--	506.4	4.7
NEC	60.4	.9	--	--	--	--	60.4	.6
Symbios Logic	--	--	14.0	.5	111.4	10.2	125.4	1.2
Other Non-U.S.	1.0	--	33.3	1.2	19.7	1.8	54.0	.5
Non-U.S. Total	90.8	1.3	570.5	20.2	152.7	14.0	814.0	7.6
WORLDWIDE TOTAL	6,834.6	100.0	2,836.8	100.0	1,088.2	100.0	10,759.6	100.0

N. American Manuf. (CONTINUED)	Type	Single User Arrays	Network/ Midrange Arrays	Mainframe Arrays	Very High Performance Arrays
GigaTrend	P		SB		
Hammer Storage (StreamLogic)	P	SB	SB		
Hewlett-Packard	C,O		SB		
IBM	C,O,P		BD,SB	SB	
Integrix	P		SB		
Invincible Technologies	C,P		SB		
LAND-5	P		SB		
Legacy Storage Systems	O,P		SB		
Lighthouse Technology	P		SB		
Locom	O,P		SB		
Lomas Data Products	O		BD		
Macro Computer Products	P		SB	SB	
Marner International	C		SB		
MAXSTRAT	O,P				SB
MegaDrive Systems	O,P		SB		SB
Micron Electronics	P		SB		
Micronet Technology	O,P	SB,SW	SB		
MicroPal	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	P		SB		
Network Connection	P		SB		
Network Storage Solutions	P		SW		
Nonstop Networks	P		SW		
nStor Technologies	P		SB		
Optima Technology	P	SB	SB		
PACE Technologies	O,P		SB		
Pacific Micro Data	P		SB		
Pathlight Technology	O,P	BD,SW			
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		
Raidtec	O,P	BD,SB	BD,SB		
Rising Edge Technologies	P		SB		
Seek Systems	P		BD,SB		
Storage Computer	O,P		SB		
Storage Concepts	O,P		SB		SB
Storage Dimensions	P		SB		
StoragePath	O,P		SB		
Storage Technology	P		SB		
StorNet	P		SB		
Stratus Computer	C		SB		
Sun Microsystems	C,P		SB,SW		
Tandem Computers	C		SB		
Tangent Computer	P		SB		
TD Systems	O,P		BD		
Texas Micro	P		SB		
Transitional Technology	P		SB		
Transoft	P		SB		
Unisys	C,P		SB	SB	
Uni Solution	P		SB		
Veritas Software	O,P		SW		
Western Scientific	P		SB		
Winchester Systems	P		SB		

N. American Manuf. (CONTINUED)	Type	Single User Arrays	Network/ Midrange Arrays	Mainframe Arrays	Very High Performance Arrays
World Connections	P		SB		
XIOTech	O,P		SB		
Xistor	P	SB	SB		
ZZYXZ Workstations & Periph.	P		SB		
Asia/Pacific Rim Manufacturers (20)					
Acer	P		SB		
Accord Systems	O,P		SB		
Advanced Technology & Systems	O,P	SB	SB		
Aiwa Core	P		SB		
Amaquest Computer	O,P		BD,SB		
DTC Technology Corp.	O,P	BD	BD		
Enlight	O,P		BD		
Fujitsu	C			SB	
Hitachi	C,O,P		SB	SB	
Hitachi Data Systems	P		SB	SB	
Infortrend	O,P		BD		
Key Technology	O,P	BD			
Maxtronic Int'l. (Arena)	O,P		SB		
NEC	C,P		BD,SB		
Promise Technology	O,P	BD	BD		
Proware Technology	O,P		SB		
Raidar Systems	P		SB		
Sunix	O		BD		
Symbios Logic	O,P		BD,SB		
Tekram Technology	O	BD			
Texa	O,P	SB	SB		
European Manufacturers (13)					
Arco Electronics	P	BD			
ATON Systemes	C,O,P	BD	BD,SB		
Baydel Ltd.	O,P		SB		
Comparex	P		SB	SB	
Dilog SA	O,P		BD		
Eurologic Systems	P		SB		
ICP Vortex	O,P		BD		
Siemens Nixdorf	C		SB		
Solid Computer	P		SB		
SYRED Data Systems	O,P		BD		
TwinCom	O,P		SW		
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, Adaptec or CMD Technology are noncaptive.

PCM/Distributor: Disk drive arrays sold or leased by "plug compatible manufacturers" or distributing organizations 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 nStor 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 MaxStrat for sale to system manufacturers.
* Software produced by 1776 for sale to system manufacturers.
* Array controllers produced by American Megatrends 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 1997 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

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 or network 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. RAID-0 provides high performance and is often favored for video applications where the need for a fast, uninterrupted data stream outweighs the need for fault tolerance.

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 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 was made to classify arrays by their access method rather than by RAID level. While widely used in the industry as standard nomenclature, it does provide a useful alternative view of array categories.

* 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 adopted by RAB and widely 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 pluggable. 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.

The Raid Advisory Board classifies storage subsystems by their data availability characteristics, which are summarized briefly below:

Failure resistant disk system (FRDS): Defines a storage subsystem which includes a disk drive array operating at a RAID-1 level or higher.

Failure tolerant disk system (FTDS): Defines a storage system with redundant components and incorporating automatic failover.

Disaster tolerant (DTDS): Defines a storage subsystem that is failure tolerant and geographically distributed so that a disaster at one site does not make any data unavailable at other sites.

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:

* Can host processor resident software provide adequate array performance, or do you need a hardware based array controller?
* Would a layered array provide better cost/performance benefits than a nonlayered approach?
* Do you require an unbroken data flow, or are short breaks in the data stream acceptable?
* 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:

* Is the cost of replacing or operating without the data stored on a system more than the cost of adding fault tolerance?

* 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?

* What is the total cost of ownership? 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.

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 vs. nonlayered arrays: A nonlayered array controls array configuration at one point in the array structure, and typically operates as a pure RAID-1, 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-3 or RAID-5 with striping, often designated RAID-30 or RAID-50, respectively.

* Host based vs. 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.

* Internal (bus-based) vs. external arrays: When the array controller is physically mounted inside the host computer and attached to an internal bus, it is considered an internal array, as compared to an array controller which is physically separate from the host computer and connected to it via a SCSI, fibre channel or other external bus. The separation may be only a few inches for external controllers mounted in the same cabinet, but may be quite substantial if a fibre channel or other serial link is in use.

* 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 simplifies development and configuration of midrange and large systems), but tend to be too expensive to justify in low end systems. 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 experienced 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 NT. 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 pioneered by Digital Equipment with the StorageWorks series 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 offered by Core International (now Aiwa Computer Systems Division).

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 often incorporates features to indicate failed drives, fans or power supplies and mechanical 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. The enclosures for the associated drives may incorporate fault tolerance and detection features as described above.

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 occurring 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 is beginning 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. Increasing numbers of multifunction chips for implementing advanced parallel and serial interfaces are also appearing, typically including interface drivers, buffers, microprocessors and specific logic functions to implement commonly used commands externally to microprocessor firmware.

Flash memory now has a significant role in 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 3.1 gigabits per square inch density today are expected to offer 10 gigabits per square inch in the year 2000. Already, more than 2 gigabytes of capacity 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/write channels and mechanical elements 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 were introduced in 1997. At the present time, most array producers are using a mix of one inch and half height drives 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 improvements are expected to continue. Though only marginal improvements in seek time are expected in the near term, 7,200 RPM spindle speeds are starting to be displaced by 10,000 RPM drives from Seagate, IBM, Fujitsu and others. 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/write channels to support these new capabilities will be stretched. 15,000 RPM drives are anticipated before the end of 2000, but it is likely that the higher performance drives will sacrifice advances in capacity per spindle in order to obtain better performance. As disk drive disk rotation speeds continue to rise in future product generations, drives will begin to incorporate fluid spindle bearings to control noise and vibration and to improve reliability. The first of these, a 7,200 RPM drive from Seagate, was announced in late 1997.

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.

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, such as the exclusive OR computation available on some Seagate drives.

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 housekeeping events such 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. Ultra SCSI interfaces became available in 1996, but were starting to be displaced in late 1997 by Ultra2 SCSI. Ultra3 SCSI is expected to be available by late 1999. Internal 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 positioned to become the standard high performance interface for host to array controller connection where very fast data transfer or remote array siting is required. SCSI tagged command queuing reduces latency delays and improves 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.

SCSI-2 interfaces between array and drive have been widely displaced by Ultra SCSI, although some low end arrays have been developed that use faster IDE interfaced drives because of their lower cost. 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. Low voltage differential SCSI is still infrequently encountered, but its presence is expected to expand rapidly as Ultra2 SCSI controllers enter service.

Serial interfaces such as the fibre channel interface and IBM's SSA are becoming 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, but these limitations are rapidly disappearing. 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. Graphical user interfaces and network browsers are becoming standard features in array management software.

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 early 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, now marketed by IBM. 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 considered 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, many 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 (now nStor) has received moderate, though not universal, 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.

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 (recently merged with Artecon), 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. Many array companies are planning to offer direct network attached storage to LANs in 1998, probably creating an overcrowded market at the low end. Network attachment of fiber channel interfaced external storage arrays for high end and midrange server connected in a SAN (system area network, server area network, storage area network) is expected to become a major architectural feature of many server installations.

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. 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 is employed, 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 archival or secondary storage in applications requiring 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: A 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 already active drive exceeds a specified threshold.

Exclusive OR (XOR): The logical algorithm used to recover data from an array when a drive has failed. Can be implemented in host processor by software or by firmware on array controller. Some disk drives have XOR logic built in, though only a few array designs take advantage of this capability.

External RAID: Array subsystem with the array controller and drives located externally to the enclosure of the host processor.

Failover: The ability to transfer the function of a failed system element to a redundant system element and continue system operation. Automatic failover requires the ability to detect a failure and substitute the appropriate system element. In the broadest sense, a system element can be anything from a cable to a complete system, as in the case of redundant servers.

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

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). As proposed within ANSI X3T11, it is called FCL (Fibre Channel Loop).

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.

I2O: A layered input/output architecture permitting a high degree of modularity in the design of I/O subsystem software and controller firmware.

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 does 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 <u>average</u> time between data loss for a single array. For an array with redundancy, this <u>average</u> 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 <u>average</u> 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.

SAF-TE: SCSI Accessed Fault Tolerant Enclosure. When implemented, SAF-TE permits monitoring of array enclosure parameters such as power and temperature via a SCSI channel. SAF-TE is supported by several controller and array producers, but has not yet been universally adopted.

SAN: System Area Network. Also called Server Area Network. A form of local area network with a domain limited to servers or server clusters and associated storage subsystems. It is not directly accessible by client systems, but is interfaced to general purpose LANs through gateway systems. The SAN is usually implemented with fibre channel technology. A SAN domain can encompass remote site mirroring.

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 examples of serial interfaces currently in use. Typically used with controllers serving large numbers of attached disk drives or where very high data rates are required, such as in digital video editing or video servers. The P1394 interface appears likely to be widely used in desktop systems.

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

SMART: Self Monitoring Analysis and Reporting Technology. A capability of disk drives to report their state of health back to management and control software.

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. The follow-on Ultra2 SCSI interface doubles the data transfer rate of Ultra SCSI.

Ultra2 SCSI: A follow-on specification to Ultra SCSI, Ultra2 SCSI doubles the specified data transfer rates of Ultra SCSI to 80 megabytes per second. (See Ultra SCSI)

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: 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. While system efficiency tends to increase as the site of the computation moves further from the host processor, few array designs to date have located the XOR function at the drive level.

ARRAYS: SINGLE USER SYSTEMS

ARRAYS: SINGLE USER SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Advanced Technology Systems	AXRS-F430XS
Hammer Storage (StreamLogic)	Pro FTS
Micronet Technology	DataDock
Nippon Texa	Texa RST-540
Optima Technology	4200W, 8200W
Raidtec	FlexArray M
Xistor	xi.raid

Board assembly (no drives)

Adaptec	ARO-1130CA
Arco Electronics	AC Mirror
ATON Systemes	AREKA I-10S
DTC Data Technology	Hard Copy
DTC Technology	8201
Key Technology	MRB1021
Pathlight Technology	ImageNETII
Promise Technology	FastTrak
Raidtec	RUAC MX
Tekram Technology	DC-690

Software arrays

Adaptec (Trillium Research)	Remus Lite 1.4
ATTO Technology	ExpressRAID
CharisMac Engineering	Anubis RAID
Cyranex	EZRAID Lite
FWB Software	RAID ToolKIT
Micronet Technology	DiskWorks
Pathlight Technology	ImageRAID

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. Some of the new single user arrays 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 of 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

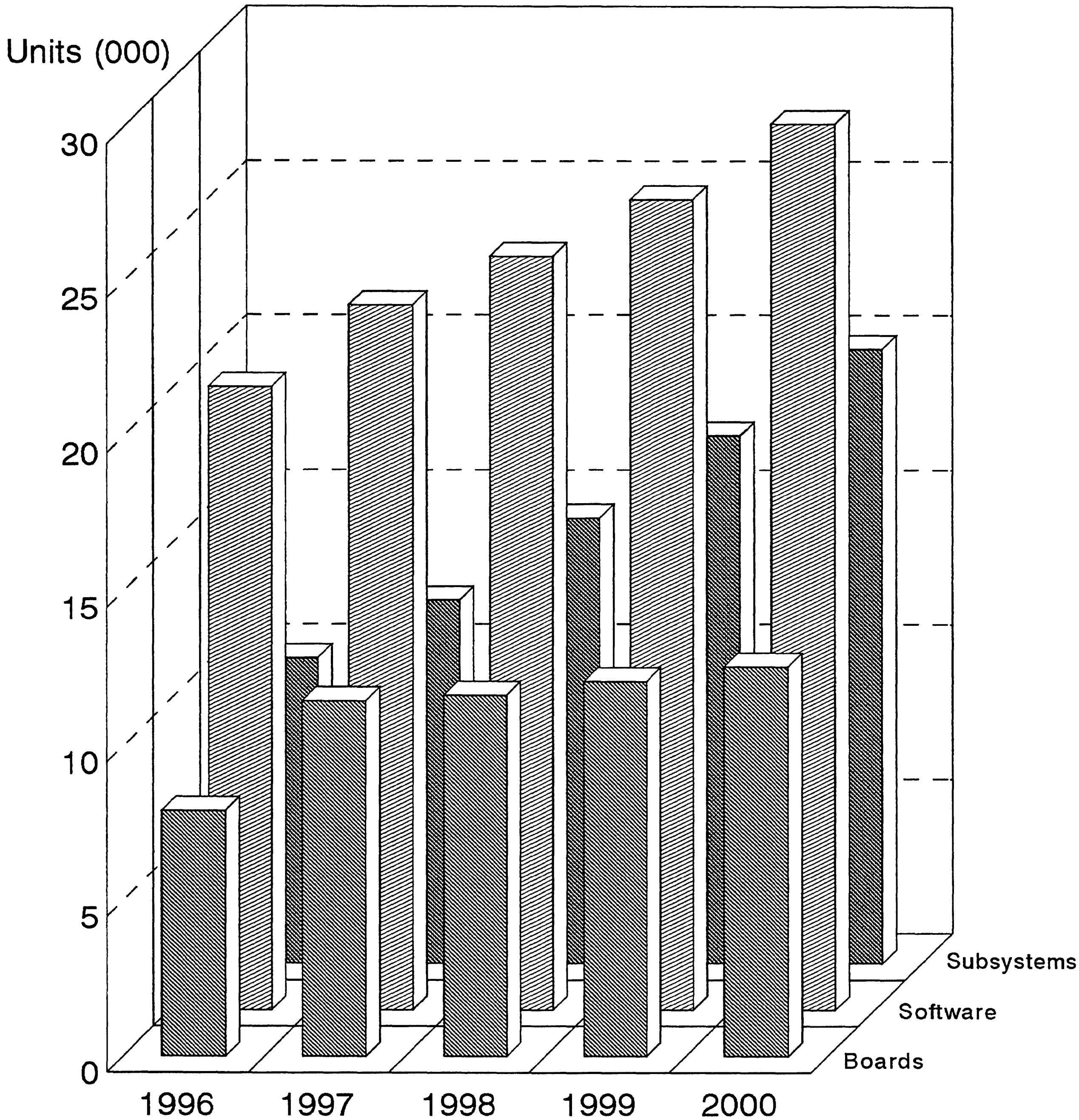
Single user arrays produce the smallest sales revenue total of any DISK/TREND disk drive array product group, but the group continues to grow in both sales revenues and shipments. 1996 sales revenues were up 18.8%, to $38.6 million, and are expected to increase an additional 21% in 1997, to $46.7 million, with most of the increase derived from sales of complete subsystems. 1996 unit shipments increased 10.1%, with 37,960 arrays, and the forecasted 1997 total of 46,040 units represents an increase of 21.3%, with shipment growth expected for all types of arrays.

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. 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 declined due to problems experienced by a leading supplier, boards restarted strong growth and software arrays maintained 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, software arrays do not overload the computer processor, so software products can provide a low cost, high performance array for the serious computer do-it-yourselfer.

Leadership in noncaptive unit shipments was modified by the purchase in mid-1996 of the FWB hardware disk drive array product lines by StreamLogic

Figure 6

Single User System Arrays
Worldwide Shipments by Array Type



and the renaming of the remaining organization as FWB Software. Although the StreamLogic parent company still exists, it now operates under the name Hammer Storage Solutions. FWB Software was the leader in 1996 noncaptive unit shipments with 23.1% of the worldwide total, all software arrays. Second place was held by Nippon Texa with 16.6%, all subsystems.

Marketing trends

It is expected that the single user array product group will grow in both sales revenues and shipments through 2000, but the changing product mix, varying average unit price patterns and the up-and-down fortunes of some of the participating companies may create some confusion. Total sales revenues are expected to increase at an annual average rate of 20.4% during 1997-2000, while unit shipments grow at an annual average of only 9.9%. The product group's sales revenues will get a boost from expanding shipments of complete array subsystems, with about 60% of complete subsystem shipments in the PCM/Distributor channel, at continually increasing average prices. By 2000, complete subsystems are forecasted to produce 90.0% of the product group's sales revenues, while generating only 32.5% of the group's unit shipments.

The relatively low prices for single user array products have produced a completely different pattern of sales and shipments. Software array products lead the product group in unit shipments with almost half of the current total, declining slightly to a forecasted 46.9% in 2000. However, software arrays are expected to generate only 3.8% of the product group's total sales revenues, due to relatively low average unit prices. Board level array products will provide an estimated 10.5% of the product group's 1997's unit shipments, but that share is projected to decline to 5.3% in 2000, even though the unit shipment share for boards is forecasted at 20.6% in 2000. Again, the problem is that the average unit price for boards is only a small percentage of the typical price for complete subsystems.

Although worldwide PCM/Distributor unit shipments are down slightly in 1997, due mostly to the disruptions following the StreamLogic/FWB corporate realignment, continuous future growth for the sales channel is forecasted through 2000, with the projection of 56.6% of shipments of the product group in that year, plus 67.5% of the group's sales revenues. The single user array market remains an add-on market served predominantly 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 are expected to capture 54.9% of the product group's 2000 worldwide sales revenue.

Technical trends

Numerous individual personal computer users have found it prudent and affordable to utilize arrays for a variety of video, graphics, 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.

TABLE 10

SINGLE USER SYSTEMS

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1996 Revenues		Forecast 1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Distributor	11.1	17.8	8.7	15.2	11.2	17.3	14.7	22.7	21.0	32.3
OEM/Integrator	1.8	4.2	2.0	4.7	2.4	5.0	2.4	5.0	2.1	4.4
TOTAL U.S. REVENUES	12.9	22.0	10.7	19.9	13.6	22.3	17.1	27.7	23.1	36.7
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Distributor	.4	11.9	.4	14.1	.5	19.4	2.2	21.6	2.6	22.6
OEM/Integrator	.4	4.7	6.0	12.7	7.6	16.7	9.3	20.5	10.0	22.1
TOTAL NON-U.S. REVENUES	.8	16.6	6.4	26.8	8.1	36.1	11.5	42.1	12.6	44.7
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	13.7	38.6	17.1	46.7	21.7	58.4	28.6	69.8	35.7	81.4

TABLE 11

SINGLE USER SYSTEMS

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1996 Shipments		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Distributor	11,610	16,755	9,380	14,125	10,080	15,175	11,175	16,825	13,020	19,600
OEM/Integrator	5,540	7,105	9,465	11,165	9,712	12,070	9,760	12,810	9,585	13,340
TOTAL U.S. SHIPMENTS	17,150	23,860	18,845	25,290	19,792	27,245	20,935	29,635	22,605	32,940
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Distributor	4,725	11,500	4,325	11,550	4,215	12,640	4,920	13,825	5,330	15,025
OEM/Integrator	725	2,600	4,625	9,200	5,285	10,580	6,015	11,950	6,645	13,170
TOTAL NON-U.S. SHIPMENTS	5,450	14,100	8,950	20,750	9,500	23,220	10,935	25,775	11,975	28,195
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	22,600	37,960	27,795	46,040	29,292	50,465	31,870	55,410	34,580	61,135
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	72	115	100	161	129	212	161	267	195	328

TABLE 12

SINGLE USER SYSTEMS

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1996 Revenues			Forecast 1997			1998			1999			2000		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
PCM/Distributor	14.8	.4	2.6	12.5	.4	2.3	14.5	.4	2.4	19.9	.4	2.4	29.2	.4	2.7
OEM/Integrator	.6	3.4	.2	.8	3.5	.4	.9	3.5	.6	1.1	3.4	.5	.9	3.1	.4
TOTAL U.S. REVENUES	15.4	3.8	2.8	13.3	3.9	2.7	15.4	3.9	3.0	21.0	3.8	2.9	30.1	3.5	3.1
NON-U.S. MANUFACTURERS															
PCM/Distributor	11.3	.6	--	13.5	.6	--	18.6	.8	--	20.9	.7	--	22.0	.6	--
OEM/Integrator	4.6	--	.1	12.2	.4	.1	16.3	.3	.1	20.2	.2	.1	21.8	.2	.1
TOTAL NON-U.S. REVENUES	15.9	.6	.1	25.7	1.0	.1	34.9	1.1	.1	41.1	.9	.1	43.8	.8	.1
WORLDWIDE RECAP															
PCM/Distributor	26.1	1.0	2.6	26.0	1.0	2.3	33.1	1.2	2.4	40.8	1.1	2.4	51.2	1.0	2.7
	+7.0%	+150.0%	--	-.4%	--	-11.5%	+27.3%	+20.0%	+4.3%	+23.3%	-8.3%	--	+25.5%	-9.1%	+12.5%
OEM/Integrator	5.2	3.4	.3	13.0	3.9	.5	17.2	3.8	.7	21.3	3.6	.6	22.7	3.3	.5
	+940.0%	+9.7%	-80.0%	+150.0%	+14.7%	+66.7%	+32.3%	-2.6%	+40.0%	+23.8%	-5.3%	-14.3%	+6.6%	-8.3%	-16.7%
Total Revenues	31.3	4.4	2.9	39.0	4.9	2.8	50.3	5.0	3.1	62.1	4.7	3.0	73.9	4.3	3.2
	+25.7%	+25.7%	-29.3%	+24.6%	+11.4%	-3.4%	+29.0%	+2.0%	+10.7%	+23.5%	-6.0%	-3.2%	+19.0%	-8.5%	+6.7%
ANNUAL SHARE, BY TYPE	81.2%	11.4%	7.4%	83.6%	10.5%	5.9%	86.2%	8.6%	5.2%	89.1%	6.7%	4.2%	90.9%	5.3%	3.8%

TABLE 13

SINGLE USER SYSTEMS

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1996 Shipments			Forecast 1997			Forecast 1998			Forecast 1999			Forecast 2000		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
PCM/Distributor	3,550	115	13,090	2,210	125	11,790	2,540	140	12,495	3,050	155	13,620	3,900	180	15,520
OEM/Integrator	35	1,025	6,045	40	1,125	10,000	55	1,215	10,800	75	1,285	11,450	90	1,350	11,900
TOTAL U.S. SHIPMENTS	3,585	1,140	19,135	2,250	1,250	21,790	2,595	1,355	23,295	3,125	1,440	25,070	3,990	1,530	27,420
NON-U.S. MANUFACTURERS															
PCM/Distributor	4,500	6,700	300	5,000	6,250	300	6,200	6,125	315	7,190	6,310	325	8,125	6,560	340
OEM/Integrator	1,800	100	700	4,500	4,000	700	5,620	4,200	760	6,750	4,365	835	7,760	4,500	910
TOTAL NON-U.S. SHIPMENTS	6,300	6,800	1,000	9,500	10,250	1,000	11,820	10,325	1,075	13,940	10,675	1,160	15,885	11,060	1,250
WORLDWIDE RECAP															
PCM/Distributor	8,050	6,815	13,390	7,210	6,375	12,090	8,740	6,265	12,810	10,240	6,465	13,945	12,025	6,740	15,860
	-34.8%	+129.4%	-9.5%	-10.4%	-6.5%	-9.7%	+21.2%	-1.7%	+6.0%	+17.2%	+3.2%	+8.9%	+17.4%	+4.3%	+13.7%
OEM/Integrator	1,835	1,125	6,745	4,540	5,125	10,700	5,675	5,415	11,560	6,825	5,650	12,285	7,850	5,850	12,810
	--	+25.0%	+96.4%	+147.4%	+355.6%	+58.6%	+25.0%	+5.7%	+8.0%	+20.3%	+4.3%	+6.3%	+15.0%	+3.5%	+4.3%
Total Shipments	9,885	7,940	20,135	11,750	11,500	22,790	14,415	11,680	24,370	17,065	12,115	26,230	19,875	12,590	28,670
	-20.2%	+105.1%	+10.5%	+18.9%	+44.8%	+13.2%	+22.7%	+1.6%	+6.9%	+18.4%	+3.7%	+7.6%	+16.5%	+3.9%	+9.3%
ANNUAL SHARE, BY TYPE	26.0%	20.9%	53.1%	25.5%	25.0%	49.5%	28.6%	23.1%	48.3%	30.8%	21.9%	47.3%	32.5%	20.6%	46.9%

TABLE 14

SINGLE USER SYSTEMS

WORLDWIDE PRICE PER UNIT ($)

ARRAY TYPE	1996	Forecast 1997	1998	1999	2000
Captive					
Subsystems	--	--	--	--	--
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	--	--	--	--	--
PCM/Distributor					
Subsystems	3,239	3,611	3,784	3,972	4,256
Boards	158	166	184	174	166
Software	197	192	188	178	168
PCM/Distributor Average	1,054	1,146	1,317	1,445	1,588
OEM/Integrator					
Subsystems	2,738	2,834	3,026	3,120	2,894
Boards	3,014	742	704	637	569
Software	50	36	53	43	33
OEM/Integrator Average	902	837	954	1,027	998

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

	1996 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
FWB Software	--	--	5,680	5,680	25.1	--	--	8,780	8,780	23.1
Nippon Texa	100	--	--	100	.4	6,300	--	--	6,300	16.6
Transoft	--	--	4,000	4,000	17.7	--	--	4,500	4,500	11.9
Arco Electronics	--	4,000	--	4,000	17.7	--	4,000	--	4,000	10.5
Hammer Storage Sol.	2,340	--	--	2,340	10.4	3,275	--	--	3,275	8.6
Other U.S.	120	460	4,550	5,130	22.7	310	1,140	5,855	7,305	19.2
Other Non-U.S.	--	600	750	1,350	6.0	--	2,800	1,000	3,800	10.1
TOTAL	2,560	5,060	14,980	22,600	100.0	9,885	7,940	20,135	37,960	100.0

ARRAYS: NETWORKS/MIDRANGE SYSTEMS

1997 DISK/TREND REPORT

ARRAYS: NETWORK/MIDRANGE SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

AC Technology	Concorde
Accord Systems	A510
Acer	Altos 19000
Advanced Logic Research	DataStation
Advanced Technology & Systems	AXRC-E9100
Aiwa Core	RAIDstack series
Amaquest Computer	DA-955-42
Amdahl	LVS 4500
American Digital Systems	MasterDisk RAID
ANDATACO	GigaRAID/FT
Apple Computer	AppleRAID
Applied Digital Systems	AD855
APPRO International	APRE-4080H
Artecon	LynxArray
AST Research	Manhattan D
ATON Systemes	Areka VDS
Auspex Systems	NS-7000 series
Aviv	Spitfire, Eclipse
Baydel	MS3-150, DAR5 series
Box Hill Systems	RAID Box 5300
Cambex	Centurion 2000
CMD Technology	CSV-8050, CSV-8150
Compaq Computer	ProLiant, ProSignia series
Comparex	D1200 series
Conley	SR-40, SR-50
Cubix	SafeStor/FT II
CyberStorage Systems	Ultra 205
Dallas Digital	RAIDstor
Data General	CLARiiON series
Datalink	RS 620, RS 660
Dell Computer	PowerEdge series
Digital Equipment	StorageWorks series
Direct Connect Systems	Guardian RAID series
DPT	SmartRAID series
DynaTek Automation Systems	NET91.OF
ECCS	Micro DFT, Synchronix
EMC	Symmetrix
Eurologic Systems	Voyager series
Gain Systems	7000
GigaTrend	Titan series
Hammer Storage(StreamLogic)	SledgeHammer series
Hewlett-Packard	12H AutoRAID
Hitachi	DF350 series
Hitachi Data Systems	57XX series, 6700

Complete subsystems, with disk drives (continued)

IBM	7135, PC Server series
Integrix	RD-10
Invincible Technologies	Ultimate 5 series
LAND-5	DS300
Legacy Storage Systems	SmartARRAY series
Lighthouse Technology	Harbor
Locom	9920
Macro Computer Products	MSR-1100
Marner International	Performance Storage
Maxtronic International	Arena
MegaDrive Systems	MR/5, MR/10, MX/500, Aria
Micron Electronics	VETIX LXI
Micronet Technology	DataDock 7000
MicroPal	EverStor series
Mountaingate Data Systems	Stampede series
MTI Technology	Gladiator series
NEC	RISCserver series
NetFRAME	NF9016
Network Appliance	F230, F630
Network Connection	T.R.A.C Array
Nippon Texa	DAF, DAX series
nStor	CR8, nTera series
Optima Technology	HST series
PACE Technologies	PACE RAID-5
Pacific Micro Data	MAST 4800
Perisol Technology	RAIDsafe Plus
Phoenix International	Phalanx TD
Polywell Computers	SUMA 8000
Precision Computers	Precision RAID
Procom Technology	NetFORCE
RAAC Technologies	ESP200
Raidar Systems	1261
Raidtec	FlexArray series
Rising Edge Technologies	MOR1200 series
Seek Systems	S460
Siemens Nixdorf	PXRC Disk Array
Solid Computer	M20, M30
Storage Computer	OmniRAID series
Storage Concepts	FibreRAID series
Storage Dimensions	RAIDPro series
Storage Technology	9131, 9137
StoragePath	SP series
StorNet	Server RAID
Stratus Computer	D600, D700, D800
Sun Microsystems	SPARCstorage series
Symbios Logic	RM20/DS20, MetaStor series
Tandem Computers	4XXX series, Integrity
Tangent Computer	Enterprise Duo
Texas Micro	SP5500
Transitional Technology	Prism series
Transoft	FC Net Director RAID

Complete subsystems, with disk drives (continued)

Uni Solution	USI RAID
Unisys	ODM 3900, ODR 5900
Western Scientific	CycloneRAID
Winchester Systems	FlashDisk RAID series
XIOtech	Magnitude
Xistor	raid.blitz
Xyratex	N9000, EZiRAID
Zenith Data Systems	Z-RAID option
ZZYXZ Workstations & Peripherals	PowerRAID series

Board assembly (no drives)

Adaptec	AEC-7312A, ARO-1130
Amaquest Computer	DA-150-8
American Megatrends	MegaRAID series
Antrone Research	AccuRAID series
ATON Systemes	Areka E-10F
Bytestream Data Systems	RAID PS
CMD Technology	CRD-5XXX series
Compaq Computer	SMART-2 series
Digi-Data	Model Z9000 series
Digital Equipment	HSZ40, HSZ50
Dilog SA	Windjammer
Diverse Logistics	Windjammer
DPT	SmartCache series
DTC Technology	82XX series
Eclipse Technologies	Mariner 2
IBM	PC ServeRAID series
ICP Vortex	GDT6XXXRP series
Infortrend	IFT-2101UA, IFT-3100UA
Lomas Data Products	LDP Cache series
Mylex	Rome, DAC-960 series
NEC	OP-450-30004
Perceptive Solutions	dataSHADOW, Pathfinder
Promise Technology	iRAID10
Raidtec	Ruac IX, FibreRAID-PCI
Seek Systems	Xcelerator
Sunix	3250
Symbios Logic	SYM1000 series
SYRED Data Systems	Prestige, Regency
TD Systems	Omniserve 2, 3

Software arrays

1776, Inc.	76SC34 series
Adaptec (Trillium Research)	REMUS Lite 1.4
Bytestream Data Systems	RAID IS
CharisMac Engineering	Anubis RAID FC
CLone Star Software	Reflect, Alter Ego
Conley	SoftRAID
Consensys Computers	RAIDZONE

Software arrays (continued)

Corel	Network Manager
Cyranex	EZRAID Pro
Digital Equipment	Volume Shadowing 6.0
NCR	Disk Array Plus
Network Storage Solutions	SPANStor-RAID
Nonstop Networks	No-Stop Network
Sun Microsystems	Online: DiskSuite 4.1
TwinCom	Dual Mirror, Network Mirror
Veritas Software	Volume Manager

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 five years. A very high share of array subsystems shipped until the last few years have been RAID-1 mirrored disk implementations. Many of the leaders in array shipments for networks/midrange systems applications have offered captive disk 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 open systems market available from EMC.

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

1996 overall sales revenues for network/midrange disk drive arrays totaled $6.7 billion, an increase of 23.7% over the previous year, and the 1997 total is forecasted to top $8.9 billion, representing an even stronger growth rate, at 33.5%. The increased growth rate is expected be a short-term phenomenon, resulting from surging demand for relatively high priced complete array subsystems in the enterprise open systems market, with somewhat more restrained growth expected in subsequent years. The 1997 forecasted unit shipment total is roughly at the expected level, with 925,600 arrays, up 27.8%.

Captive arrays continue to dominate sales revenues in this product group, since numerous system manufacturers have found it both strategically important and profitable to offer disk drive arrays with their network and midrange computer systems. 70.7% of the product group's 1996 sales revenues were generated by arrays sold on a captive basis by system manufacturers, a total of $4.7 billion. In contrast, only 40.5% of the product group's total unit shipments were captive arrays. The principal factor which boosted captive revenues to such a high level were very high captive shipments of complete subsystems at typical prices many times higher than the average prices for board and software array products. 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.

PCM/Distributor and OEM/Integrator sales revenues are also dominated by complete array subsystems, due to high average unit prices, although boards and software array products ship in higher quantities.

Complete subsystems also lead in 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 $930.8 million, of which $863.4 million was generated by complete subsystem sales. In contrast, complete subsystems provided only 29.0% of PCM/Distributor unit shipments in 1996, but command average selling prices several times higher than those for boards and software products. Total unit shipments of complete subsystems in the PCM/Distributor channel during 1996 actually declined, due to the disruption in shipments of low priced complete subsystems caused by the difficult merger of StreamLogic and the hardware business of FWB. 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.

OEM/Integrator sales revenues continue to be dominated by complete subsystems, but array board level products have a strong lead in unit shipments. Total board shipments jumped 72.3% in 1996, with 244,795 units. 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. However, a structural change in the OEM/Integrator array board market is under way in 1997, as some system manufacturers, including IBM, turn to internal manufacturing of array boards as their shipments of file servers increases.

In 1996, Mylex increased its lead in noncaptive disk drive array 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 shipped 213,300 boards representing 49.5% of the worldwide noncaptive unit shipment total for 1996. Veritas continued to hold second place with 16.9%, based on shipments of software array products.

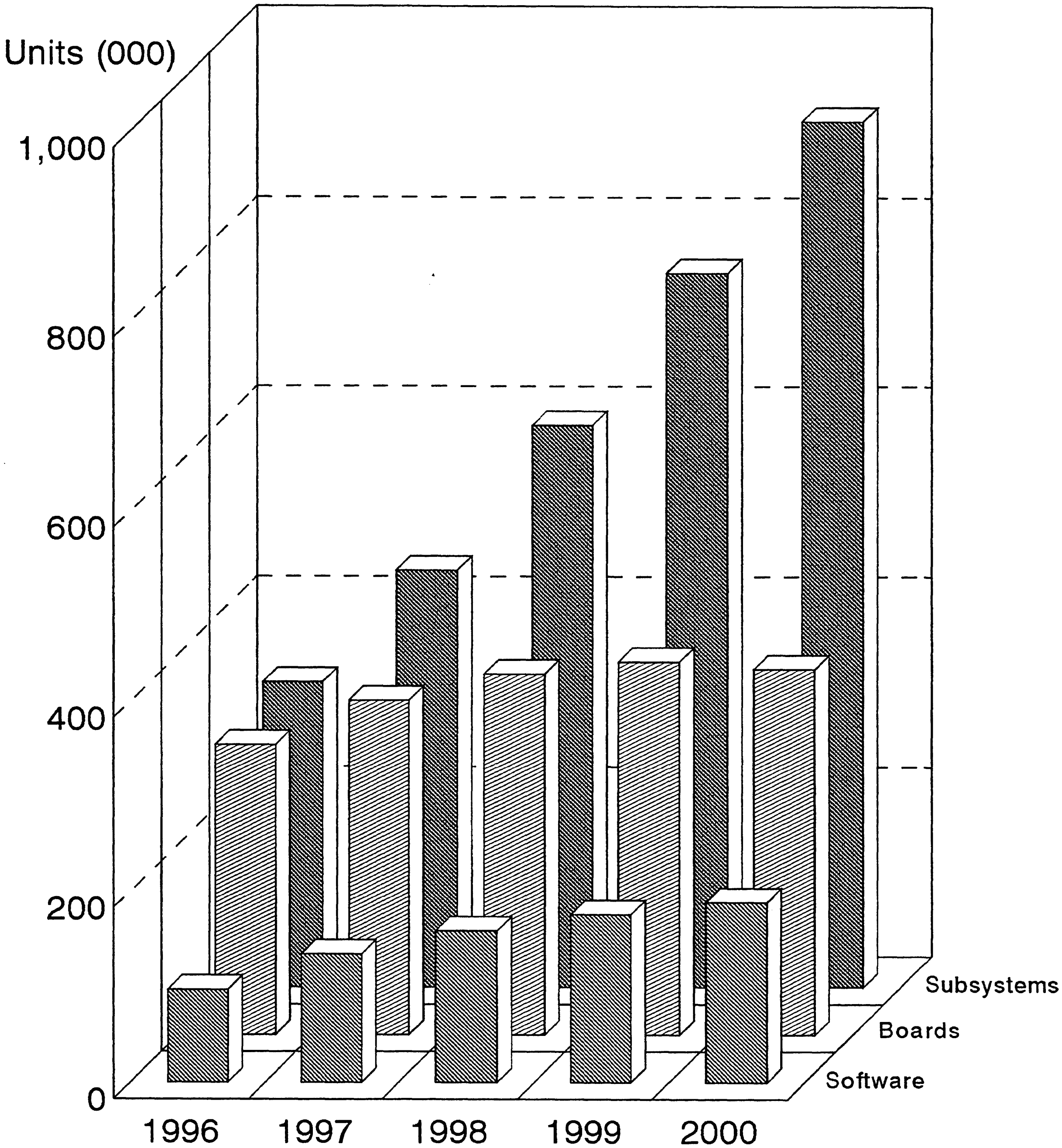
Marketing trends

The network/midrange product group will be subjected to continuous changes during the forecast period of this report. Complete subsystems are clearly destined to hold an increasing share of the product group's sales and

Figure 7

Network/Midrange System Arrays

Worldwide Shipments by Array Type



shipments as more users move to completely assembled storage solutions, with a forecast of 61.4% of the product group's 2000 unit shipments and 97.5% of sales revenues. 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.

The product group's total unit shipments are forecasted at over 1.4 million arrays in 2000, an average annual increase of 17.2% in the 1997-2000 period. Sales revenues are expected to increase at almost the same annual rate, reaching $14.3 billion in 2000.

Leadership in sales revenues for network/midrange arrays will clearly be held by captive arrays during this forecast period, with a 2000 forecast of $10.2 billion, 71.5% of the total for arrays destined for the networks/midrange systems market. PCM/Distributor 2000 sales revenues are projected at $1.3 billion, driven by subsystem sales, which are expected to be 93.6% of the 2000 total for the sales channel. 95.2% of the OEM/Integrator channel 2000 sales revenues are also expected to be derived from complete subsystems, but the picture for unit shipments is quite different. Despite an expected slowdown in board shipments, 54.0% of OEM/Integrator 2000 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 1997-2000 period for each type of array product in each marketing channel. The average unit price increases expected for PCM/Distributor subsystems during 1997 have been caused by a general movement to array subsystems with a higher level of fault tolerance and more disk capacity in open system applications, mostly in larger companies. Future array price declines will be driven by high shipment levels and lower disk drive pricing.

Software array products will continue to be interesting to a significant number of individual 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 12.7% of the 2000 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 1997-2000 period is more complex. Significant new chip set array controller implementations for the networks/midrange market were introduced in 1996, and follow-on card mounted disk drive array chip sets are expected to displace array board sales in gradually increasing quantities in subsequent years. The growth rate for OEM/Integrator board shipments in this product group is expected to start declining, with OEM/Integrator board shipments forecasted to start declining after 1999. 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.

Companies headquartered in the United States dominated sales revenues for the networks/midrange product group in 1996, with 96.0% of the worldwide total. The array market is now spreading throughout the world, but U.S. based companies are expected to retain a 91.7% share of the 2000 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

The typical buyer of a network/midrange disk drive array has a reasonable understanding of the application for which the array is being purchased. However, most buyers cannot be sure of how those requirements will evolve with time, as network architecture and applications undergo continuous changes. As a result, array buyers have become highly sensitive to the need for arrays to be capable of change, as the usage environment changes. Most array manufacturers have become highly sensitive to this requirement and have defined modularity and flexibility as essential array product development objectives.

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. The potential lower cost of direct network attached arrays has stimulated sales growth for the few array manufacturers which have offered production models to date. Further market expansion is expected in both lower cost direct network attach arrays for competitive PC network installations and in fully featured arrays for use with more demanding enterprise system and server area network applications.

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 continue to decline through 2000, 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)									
	1996		Forecast							
	Revenues		1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	2,318.4	4,667.0	2,845.2	5,725.0	3,804.6	7,046.6	4,670.8	8,651.0	5,475.8	10,142.1
PCM/Distributor	520.7	876.2	702.4	1,187.6	763.2	1,296.1	716.5	1,237.0	633.4	1,111.9
OEM/Integrator	623.2	893.9	795.6	1,369.1	990.2	1,621.9	1,054.0	1,791.3	1,050.2	1,850.8
TOTAL U.S. REVENUES	3,462.3	6,437.1	4,343.2	8,281.7	5,558.0	9,964.6	6,441.3	11,679.3	7,159.4	13,104.8
Non-U.S. Manufacturers										
Captive	--	70.0	--	76.6	--	80.8	--	82.4	--	81.1
PCM/Distributor	21.4	54.6	45.7	101.2	76.3	149.5	96.4	186.3	112.8	216.2
OEM/Integrator	77.1	142.6	325.0	489.1	450.9	696.3	529.2	815.8	578.3	890.6
TOTAL NON-U.S. REVENUES	98.5	267.2	370.7	666.9	527.2	926.6	625.6	1,084.5	691.1	1,187.9
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	3,560.8	6,704.3	4,713.9	8,948.6	6,085.2	10,891.2	7,066.9	12,763.8	7,850.5	14,292.7

TABLE 17

NETWORKS/MIDRANGE SYSTEMS

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1996 Shipments		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	152,080	289,435	213,310	396,475	284,175	525,070	358,595	663,120	433,825	802,695
PCM/Distributor	41,793	75,697	49,046	84,559	54,460	94,950	58,230	102,140	58,930	104,105
OEM/Integrator	244,580	320,996	279,956	386,991	304,570	436,945	318,165	468,970	316,890	480,055
TOTAL U.S. SHIPMENTS	438,453	686,128	542,312	868,025	643,205	1,056,965	734,990	1,234,230	809,645	1,386,855
Non-U.S. Manufacturers										
Captive	--	3,750	--	4,080	--	4,365	--	4,580	--	4,770
PCM/Distributor	5,047	17,136	6,805	22,235	9,955	28,890	12,630	34,730	15,240	40,175
OEM/Integrator	8,910	16,965	18,490	31,260	23,940	39,940	29,300	47,660	34,015	54,550
TOTAL NON-U.S. SHIPMENTS	13,957	37,851	25,295	57,575	33,895	73,195	41,930	86,970	49,255	99,495
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	452,410	723,979	567,607	925,600	677,100	1,130,160	776,920	1,321,200	858,900	1,486,350
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	1,176	1,918	1,743	2,844	2,420	3,974	3,197	5,295	4,056	6,781

TABLE 18

NETWORKS/MIDRANGE SYSTEMS

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1996 Revenues			Forecast 1997			Forecast 1998			Forecast 1999			Forecast 2000		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	4,531.9	1.3	133.8	5,569.7	13.7	141.6	6,888.3	13.8	144.5	8,492.7	13.4	144.9	9,985.4	12.9	143.8
PCM/Distributor	818.3	51.2	6.7	1,120.5	59.2	7.9	1,224.8	62.7	8.6	1,171.5	58.2	7.3	1,051.2	53.1	7.6
OEM/Integrator	719.0	164.7	10.2	1,171.8	182.2	15.1	1,464.4	139.1	18.4	1,651.9	120.3	19.1	1,726.0	105.8	19.0
TOTAL U.S. REVENUES	6,069.2	217.2	150.7	7,862.0	255.1	164.6	9,577.5	215.6	171.5	11,316.1	191.9	171.3	12,762.6	171.8	170.4
NON-U.S. MANUFACTURERS															
Captive	70.0	--	--	76.6	--	--	80.8	--	--	82.4	--	--	81.1	--	--
PCM/Distributor	45.1	8.5	1.0	87.5	12.5	1.2	128.9	19.7	.9	163.6	22.0	.7	192.0	23.7	.5
OEM/Integrator	126.9	15.0	.7	474.8	12.6	1.7	685.8	8.8	1.7	808.0	6.3	1.5	884.7	4.5	1.4
TOTAL NON-U.S. REVENUES	242.0	23.5	1.7	638.9	25.1	2.9	895.5	28.5	2.6	1,054.0	28.3	2.2	1,157.8	28.2	1.9
WORLDWIDE RECAP															
Captive	4,601.9	1.3	133.8	5,646.3	13.7	141.6	6,969.1	13.8	144.5	8,575.1	13.4	144.9	10,066.5	12.9	143.8
	+12.1%	-56.7%	-7.1%	+22.7%	+953.8%	+5.8%	+23.4%	+.7%	+2.0%	+23.0%	-2.9%	+.3%	+17.4%	-3.7%	-.8%
PCM/Distributor	863.4	59.7	7.7	1,208.0	71.7	9.1	1,353.7	82.4	9.5	1,335.1	80.2	8.0	1,243.2	76.8	8.1
	+43.0%	+148.8%	-2.5%	+39.9%	+20.1%	+18.2%	+12.1%	+14.9%	+4.4%	-1.4%	-2.7%	-15.8%	-6.9%	-4.2%	+1.3%
OEM/Integrator	845.9	179.7	10.9	1,646.6	194.8	16.8	2,150.2	147.9	20.1	2,459.9	126.6	20.6	2,610.7	110.3	20.4
	+121.2%	+26.2%	+94.6%	+94.7%	+8.4%	+54.1%	+30.6%	-24.1%	+19.6%	+14.4%	-14.4%	+2.5%	+6.1%	-12.9%	-1.0%
Total Revenues	6,311.2	240.7	152.4	8,500.9	280.2	167.5	10,473.0	244.1	174.1	12,370.1	220.2	173.5	13,920.4	200.0	172.3
	+23.9%	+42.1%	-3.2%	+34.7%	+16.4%	+9.9%	+23.2%	-12.9%	+3.9%	+18.1%	-9.8%	-.3%	+12.5%	-9.2%	-.7%
ANNUAL SHARE, BY TYPE	94.2%	3.6%	2.2%	95.1%	3.1%	1.8%	96.3%	2.2%	1.5%	97.0%	1.7%	1.3%	97.5%	1.4%	1.1%

TABLE 19

NETWORKS/MIDRANGE SYSTEMS

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1996 Shipments			Forecast 1997			1998			1999			2000		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	271,485	500	17,450	365,200	12,800	18,475	492,020	13,780	19,270	629,090	14,180	19,850	768,110	14,335	20,250
PCM/Distributor	23,697	47,175	4,825	25,674	53,175	5,710	31,405	56,985	6,560	36,610	58,210	7,320	40,430	55,805	7,870
OEM/Integrator	13,676	233,995	73,325	19,756	258,895	108,340	27,630	278,225	131,090	35,910	286,240	146,820	43,150	278,355	158,550
TOTAL U.S. SHIPMENTS	308,858	281,670	95,600	410,630	324,870	132,525	551,055	348,990	156,920	701,610	358,630	173,990	851,690	348,495	186,670
NON-U.S. MANUFACTURERS															
Captive	3,750	--	--	4,080	--	--	4,365	--	--	4,580	--	--	4,770	--	--
PCM/Distributor	3,216	13,000	920	5,415	15,950	870	8,320	19,780	790	10,910	23,140	680	13,240	26,360	575
OEM/Integrator	5,575	10,800	590	18,930	11,200	1,130	27,430	10,960	1,550	35,130	10,610	1,920	42,130	10,110	2,310
TOTAL NON-U.S. SHIPMENTS	12,541	23,800	1,510	28,425	27,150	2,000	40,115	30,740	2,340	50,620	33,750	2,600	60,140	36,470	2,885
WORLDWIDE RECAP															
Captive	275,235	500	17,450	369,280	12,800	18,475	496,385	13,780	19,270	633,670	14,180	19,850	772,880	14,335	20,250
	+30.7%	-50.0%	-42.3%	+34.2%	--	+5.9%	+34.4%	+7.7%	+4.3%	+27.7%	+2.9%	+3.0%	+22.0%	+1.1%	+2.0%
PCM/Distributor	26,913	60,175	5,745	31,089	69,125	6,580	39,725	76,765	7,350	47,520	81,350	8,000	53,670	82,165	8,445
	-31.2%	+198.8%	-29.3%	+15.5%	+14.9%	+14.5%	+27.8%	+11.1%	+11.7%	+19.6%	+6.0%	+8.8%	+12.9%	+1.0%	+5.6%
OEM/Integrator	19,251	244,795	73,915	38,686	270,095	109,470	55,060	289,185	132,640	71,040	296,850	148,740	85,280	288,465	160,860
	+28.6%	+56.8%	+32.8%	+101.0%	+10.3%	+48.1%	+42.3%	+7.1%	+21.2%	+29.0%	+2.7%	+12.1%	+20.0%	-2.8%	+8.1%
Total Shipments	321,399	305,470	97,110	439,055	352,020	134,525	591,170	379,730	159,260	752,230	392,380	176,590	911,830	384,965	189,555
	+21.4%	+72.3%	+3.3%	+36.6%	+15.2%	+38.5%	+34.6%	+7.9%	+18.4%	+27.2%	+3.3%	+10.9%	+21.2%	-1.9%	+7.3%
ANNUAL SHARE, BY TYPE	44.5%	42.2%	13.3%	47.5%	38.0%	14.5%	52.4%	33.6%	14.0%	57.0%	29.7%	13.3%	61.4%	25.9%	12.7%

TABLE 20

NETWORKS/MIDRANGE SYSTEMS

WORLDWIDE PRICE PER UNIT ($)

ARRAY TYPE	1996	Forecast 1997	1998	1999	2000
Captive					
Subsystems	16,719	15,290	14,039	13,532	13,024
Boards	2,500	1,074	1,000	950	900
Software	7,666	7,666	7,500	7,300	7,100
Captive Average	16,156	14,484	13,462	13,080	12,660
PCM/Distributor					
Subsystems	32,081	38,855	34,078	28,097	23,163
Boards	994	1,036	1,074	985	933
Software	1,345	1,377	1,278	998	969
PCM/Distributor Average	10,028	12,067	11,673	10,399	9,204
OEM/Integrator					
Subsystems	43,937	42,563	39,050	34,626	30,613
Boards	733	721	511	426	382
Software	147	154	151	138	126
OEM/Integrator Average	3,066	4,442	4,860	5,046	5,128

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

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1996 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
Mylex	--	163,900	--	163,900	54.5	--	213,300	--	213,300	49.5
Veritas	--	--	53,275	53,275	17.7	--	--	72,700	72,700	16.9
DPT	480	19,000	--	19,480	6.5	880	38,000	--	38,880	9.0
Data General	10,200	--	--	10,200	3.4	14,600	--	--	14,600	3.4
Symbios Logic	3,735	3,300	--	7,035	2.3	5,315	4,900	--	10,215	2.4
American Megatrends	--	9,700	--	9,700	3.2	--	9,800	--	9,800	2.3
Digital Equipment	5,500	--	--	5,500	1.8	9,500	--	--	9,500	2.2
Infortrend	--	2,100	--	2,100	.7	--	7,000	--	7,000	1.6
Other U.S.	8,293	12,020	4,005	24,318	8.2	12,393	20,070	5,450	37,913	8.8
Other Non-U.S.	1,197	2,600	1,025	4,822	1.7	3,476	11,900	1,510	16,886	3.9
TOTAL	29,405	212,620	58,305	300,330	100.0	46,164	304,970	79,660	430,794	100.0

ARRAYS: MAINFRAME SYSTEMS

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-6592/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 competitive 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, delivered for the first time in October, 1996, again doubled the capacity per disk drive and increased 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 offer up to 284 gigabytes per system, with initial shipments in early 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.

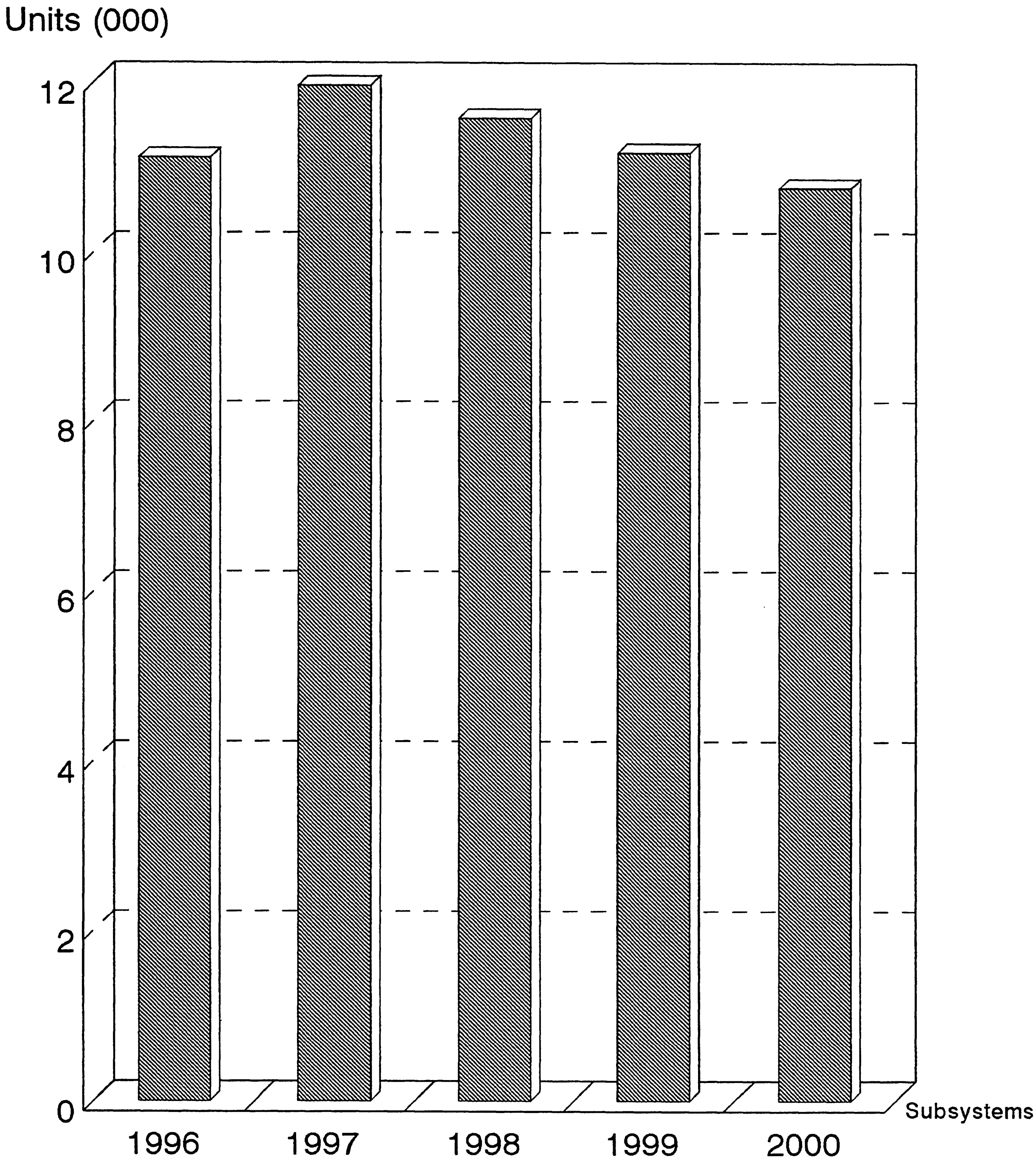
Market status

After a modest annual increase, shipments of mainframe disk drive arrays are expected to top out in 1997, with 11,966 units. 1996 sales revenues declined 7.2% to $3.9 billion, and the 1997 total is forecasted to be down again, at $3.7

Figure 8

Mainframe System Arrays

Worldwide Shipments by Array Type



billion. Disk drive arrays now provide substantially all of the disk storage current shipments for the mainframe computer market, as disk drive array configurations have displaced virtually all of the current nonarray disk subsystem shipments. The market for mainframe disk storage is growing rapidly, but disk drive recording density is increasing even faster, resulting in flat shipments of hardware. However, 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.

During 1996 major changes occurred 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 1996 achieved a total of almost $2 billion, but a significant contribution to reduced PCM/Distributor sales totals for subsequent years was provided by IBM's midyear 1996 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 the period ending in 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 both 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.

EMC has established for itself a commanding presence in the plug compatible mainframe array market and sells some of the same array subsystems to system manufacturers on an OEM basis. In 1996, EMC captured 62.5% of worldwide noncaptive unit shipments, an especially impressive achievement, 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 26.9%. With its mainframe arrays available for only the first half of 1996 on a noncaptive basis, Storage Technology was third with 9.3% of the worldwide total.

Marketing trends

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. 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.

Despite the fact that strong annual increases in the amount of disk storage to be shipped for mainframe computer applications are expected through 2000, the unit shipment and sales revenue totals for the product group are expected to continually decline during the remaining years of the decade. The problem is that disk drive capacities are expected to increase at an even faster rate than the demand for additional mainframe storage. Total unit shipments are projected to decline to 10,765 subsystems in 2000, an average annual decline during the 1997-2000 period of 3.5%. Worldwide sales revenues are forecasted to drop to $2.6 billion in the same period, an average annual decline of 10.7%, due primarily to rapid drops in disk drive price per megabyte.

Noncaptive sales channels are expected to fare better in mainframe array unit shipments than the captive market during the next few years, especially in the case of OEM/Integrator shipments, which are expected to maintain growth through 2000, although starting from a small base. Sales revenues are another picture, however, with declining sales throughout the forecast period for the PCM/Distributor channel, and with sales turning negative for the OEM/Integrator channel by 2000.

Technical trends

Any product development planning for mainframe storage systems must recognize IBM's role in establishing the specific functional environment for proposed products, since 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 plug compatible 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. IBM's statements have implied that 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. In 1997, IBM finally announced the arrival of Seascape -- but, in fact, announced only a few of the pieces to the puzzle. Details of the architecture and most of the products needed to complete the picture are still to come. 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. For the moment, however, it will probably follow familiar paths, with evolution to higher capacity disk drives, faster data rates for drives and interfaces and storage subsystems usable with both mainframe computers and open systems servers.

At the end of 1996, IBM introduced a new mainframe computer family with disk storage embedded in the computer frame, a development which could lead to new competitive challenges to plug compatible storage vendors if IBM's systems evolve further in that direction. The new element is not new technology, but a new way of packaging the disk storage. In the meantime, the immediate question is when IBM's recently announced 18.2 gigabyte 3.5 inch drives and Seagate's 47 gigabyte 5.25 inch drives will be utilized in new mainframe disk storage subsystems -- and the industry probably won't have to wait too long.

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 at approximately one year intervals.

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 disk drive array sales revenues and subsystem unit shipments will continue to decline, 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 22

MAINFRAMES

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1996		Forecast							
	Revenues		1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	1,381.3	2,061.7	1,301.8	1,973.7	1,127.8	1,721.3	989.4	1,522.7	876.5	1,359.4
PCM/Distributor	722.6	1,338.0	509.1	1,015.5	440.6	845.6	376.6	723.8	340.2	654.3
OEM/Integrator	19.7	29.5	21.8	81.2	25.0	96.4	24.3	96.1	23.2	91.1
TOTAL U.S. REVENUES	2,123.6	3,429.2	1,832.7	3,070.4	1,593.4	2,663.3	1,390.3	2,342.6	1,239.9	2,104.8
Non-U.S. Manufacturers										
Captive	--	19.8	--	34.0	--	33.6	--	33.0	--	31.6
PCM/Distributor	201.6	504.0	247.0	627.0	243.0	608.3	229.1	571.2	207.5	517.4
OEM/Integrator	--	5.4	--	5.1	--	5.2	--	5.4	--	5.5
TOTAL NON-U.S. REVENUES	201.6	529.2	247.0	666.1	243.0	647.1	229.1	609.6	207.5	554.5
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	2,325.2	3,958.4	2,079.7	3,736.5	1,836.4	3,310.4	1,619.4	2,952.2	1,447.4	2,659.3

TABLE 23

MAINFRAMES

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1996 Shipments		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	4,385	6,545	4,495	6,815	4,095	6,250	3,785	5,825	3,530	5,475
PCM/Distributor	1,701	3,147	1,494	2,981	1,485	2,850	1,410	2,710	1,370	2,635
OEM/Integrator	60	90	78	290	105	405	120	475	135	530
TOTAL U.S. SHIPMENTS	6,146	9,782	6,067	10,086	5,685	9,505	5,315	9,010	5,035	8,640
Non-U.S. Manufacturers										
Captive	--	110	--	200	--	208	--	215	--	217
PCM/Distributor	480	1,200	650	1,650	735	1,840	770	1,920	750	1,870
OEM/Integrator	--	30	--	30	--	32	--	35	--	38
TOTAL NON-U.S. SHIPMENTS	480	1,340	650	1,880	735	2,080	770	2,170	750	2,125
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	6,626	11,122	6,717	11,966	6,420	11,585	6,085	11,180	5,785	10,765
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	19	31	26	43	32	54	38	66	44	76

TABLE 24

MAINFRAMES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1996 Revenues Subsys.	Forecast --1997-- Subsys.	--1998-- Subsys.	--1999-- Subsys.	--2000-- Subsys.
U.S. MANUFACTURERS					
Captive	2,061.7	1,973.7	1,721.3	1,522.7	1,359.4
PCM/Distributor	1,338.0	1,015.5	845.6	723.8	654.3
OEM/Integrator	29.5	81.2	96.4	96.1	91.1
TOTAL U.S. REVENUES	3,429.2	3,070.4	2,663.3	2,342.6	2,104.8
NON-U.S. MANUFACTURERS					
Captive	19.8	34.0	33.6	33.0	31.6
PCM/Distributor	504.0	627.0	608.3	571.2	517.4
OEM/Integrator	5.4	5.1	5.2	5.4	5.5
TOTAL NON-U.S. REVENUES	529.2	666.1	647.1	609.6	554.5
WORLDWIDE RECAP					
Captive	2,081.5	2,007.7	1,754.9	1,555.7	1,391.0
	-2.2%	-3.5%	-12.6%	-11.4%	-10.6%
PCM/Distributor	1,842.0	1,642.5	1,453.9	1,295.0	1,171.7
	-6.2%	-10.8%	-11.5%	-10.9%	-9.5%
OEM/Integrator	34.9	86.3	101.6	101.5	96.6
	-79.7%	+147.3%	+17.7%	--	-4.8%
Total Revenues	3,958.4	3,736.5	3,310.4	2,952.2	2,659.3
	-7.2%	-5.6%	-11.4%	-10.8%	-9.9%
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 25

MAINFRAMES

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1996 Shipments Subsys.	Forecast --1997-- Subsys.	--1998-- Subsys.	--1999-- Subsys.	--2000-- Subsys.
U.S. MANUFACTURERS					
Captive	6,545	6,815	6,250	5,825	5,475
PCM/Distributor	3,147	2,981	2,850	2,710	2,635
OEM/Integrator	90	290	405	475	530
TOTAL U.S. SHIPMENTS	9,782	10,086	9,505	9,010	8,640
NON-U.S. MANUFACTURERS					
Captive	110	200	208	215	217
PCM/Distributor	1,200	1,650	1,840	1,920	1,870
OEM/Integrator	30	30	32	35	38
TOTAL NON-U.S. SHIPMENTS	1,340	1,880	2,080	2,170	2,125
WORLDWIDE RECAP					
Captive	6,655	7,015	6,458	6,040	5,692
	-11.9%	+5.4%	-7.9%	-6.5%	-5.8%
PCM/Distributor	4,347	4,631	4,690	4,630	4,505
	--	+6.5%	+1.3%	-1.3%	-2.7%
OEM/Integrator	120	320	437	510	568
	-77.4%	+166.7%	+36.6%	+16.7%	+11.4%
Total Shipments	11,122	11,966	11,585	11,180	10,765
	-10.5%	+7.6%	-3.2%	-3.5%	-3.7%
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 26

MAINFRAMES

WORLDWIDE PRICE PER UNIT ($000)

ARRAY TYPE	1996	Forecast 1997	1998	1999	2000
Captive					
Subsystems	312.7	286.1	271.7	257.5	244.3
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	312.7	286.1	271.7	257.5	244.3
PCM/Distributor					
Subsystems	423.7	354.6	310.0	279.7	260.0
Boards	--	--	--	--	--
Software	--	--	--	--	--
PCM/Distributor Average	423.7	354.6	310.0	279.7	260.0
OEM/Integrator					
Subsystems	290.8	269.6	232.3	198.9	170.1
Boards	--	--	--	--	--
Software	--	--	--	--	--
OEM/Integrator Average	290.8	269.6	232.3	198.9	170.1

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 27

MAINFRAMES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1996 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
EMC	1,509	--	--	1,509	67.4	2,794	--	--	2,794	62.5
Hitachi Data Systems	480	--	--	480	21.4	1,200	--	--	1,200	26.9
Storage Technology	240	--	--	240	10.7	415	--	--	415	9.3
Other U.S.	12	--	--	12	.5	28	--	--	28	.6
Other Non-U.S.	--	--	--	--	--	30	--	--	30	.7
TOTAL	2,241	--	--	2,241	100.0	4,467	--	--	4,467	100.0

ARRAYS: VERY HIGH PERFORMANCE SYSTEMS

1997 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	ND-30E, ND-40E, FCN-1
MAXSTRAT	Gen5XL, S-Series XL
MegaDrive Systems	EV-1000
Storage Concepts	C814F

Software arrays

ASC Audio Video	RAIDsoft

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, since 1995 all of the disk drive arrays included in this product group have been complete subsystems, supplemented in 1997 with the addition of software array products by ASC Audio Video.

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.

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

Total sales revenues for very high performance disk drive arrays fell below previous expectations in 1996, as shipments for supercomputer applications softened, but overall 1997 sales are moving upward due to strong shipments for video and high end imaging applications. 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. The PCM/Distributor sales channel is the major beneficiary of this trend.

The product group's sales revenues totaled $58.3 million in 1996, generated by shipments of 1,671 arrays. The 1997 unit shipment total is expected to rise to a total of 2,420 arrays, boosting sales revenues to $93.3 million. 72.1% of the 1997 sales revenues is expected to be generated by the rising sales of very high performance arrays in the PCM/Distributor sales channel for a diverse group of applications, including video servers, video editing systems, multimedia content development, medical imaging systems and geophysical exploration image and data analysis.

The leadership in noncaptive unit shipments continues to be held by Ciprico, with 91.9% of the 1996 worldwide total, composed entirely of subsystems. MAXSTRAT held second place with a product mix of relatively high end arrays, with 5.2% of the unit shipments.

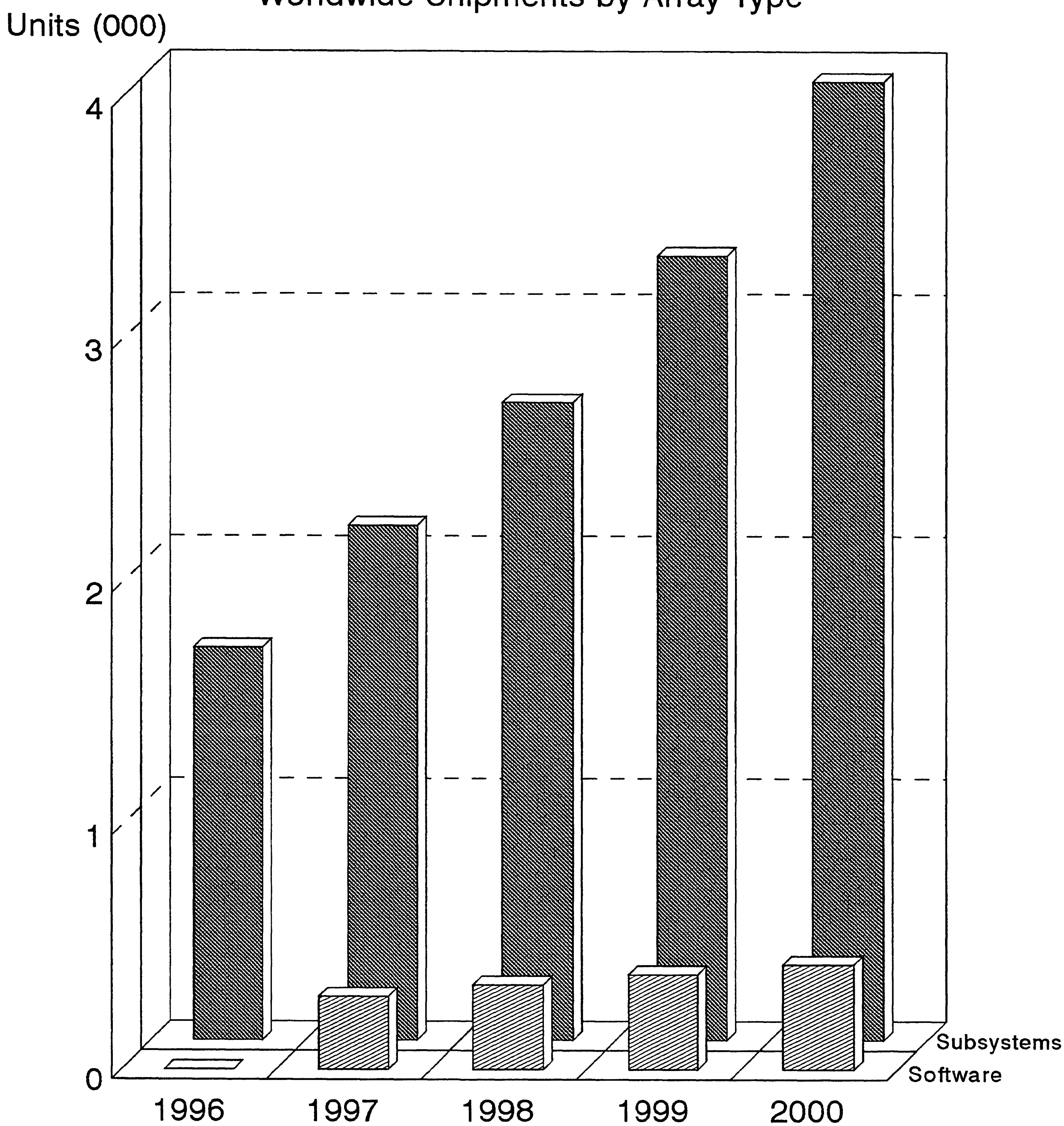
Marketing trends

Once dominated by supercomputer applications, the markets for very high performance disk drive arrays are evolving into the diverse mixture of applications listed above, causing extensive changes in the nature of the array products sold and the marketing channels utilized. Software array products intended for use with very high performance systems have entered the market, sold primarily for video applications in which the primary requirement is very high transfer rates, not a high rate of transactions. However, complete array subsystems are expected to continue to dominate the product group, with over 90% of projected 2000 array unit shipments.

Figure 9

Very High Performance System Arrays

Worldwide Shipments by Array Type



Despite an expected decline in shipments for supercomputer applications, total unit shipments for the product group are forecasted to increase at an average annual rate of 23.1% through 2000, driven by the several specialized markets which currently utilize the majority of the group's products, led by video servers and editing systems. By 2000, total sales revenues of very high performance arrays are expected to reach $124.9 million, with $105.1 million derived from the PCM/Distributor sales channel. Shipments in the PCM/Distributor channel are expected to grow to significantly higher totals than in the OEM/Integrator channel, as independent producers of 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.

The complete subsystems which now provide most of the very high performance group's shipments may face challenges from other product groups during the forecast period. 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.

Technical trends

Most customers for the computer systems which utilize the disk drive arrays in this product group consider higher transfer rates to be the most important improvement which can be made in these storage systems. 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 performance systems through 2000 will not result in sudden performance leaps, but 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, serial interfaces 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 frequently used with arrays 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 28

VERY HIGH PERFORMANCE

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1996		Forecast							
	Revenues		1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	7.0	15.1	5.3	11.8	3.9	8.8	2.9	6.6	2.3	5.3
PCM/Distributor	26.3	34.3	50.0	67.3	65.0	90.9	74.5	105.2	80.2	114.4
OEM/Integrator	4.6	7.9	6.4	13.6	8.9	14.1	9.6	15.4	9.6	15.3
TOTAL U.S. REVENUES	37.9	57.3	61.7	92.7	77.8	113.8	87.0	127.2	92.1	135.0
Non-U.S. Manufacturers										
Captive	--	1.0	--	.6	--	.5	--	.4	--	.3
PCM/Distributor	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. REVENUES	--	1.0	--	.6	--	.5	--	.4	--	.3
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	37.9	58.3	61.7	93.3	77.8	114.3	87.0	127.6	92.1	135.3

TABLE 29

VERY HIGH PERFORMANCE

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1996 Shipments		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	165	358	140	310	115	260	95	215	80	185
PCM/Distributor	887	1,244	1,395	1,925	1,755	2,460	2,170	3,075	2,635	3,770
OEM/Integrator	33	51	100	170	148	243	195	325	257	420
TOTAL U.S. SHIPMENTS	1,085	1,653	1,635	2,405	2,018	2,963	2,460	3,615	2,972	4,375
Non-U.S. Manufacturers										
Captive	--	18	--	15	--	12	--	10	--	8
PCM/Distributor	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	--	18	--	15	--	12	--	10	--	8
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	1,085	1,671	1,635	2,420	2,018	2,975	2,460	3,625	2,972	4,383
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	3	5	5	7	7	10	9	14	12	18

TABLE 30

VERY HIGH PERFORMANCE

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1996 Revenues	Forecast							
		1997		1998		1999		2000	
	Subsys.	Subsys.	Software	Subsys.	Software	Subsys.	Software	Subsys.	Software
U.S. MANUFACTURERS									
Captive	15.1	11.8	--	8.8	--	6.6	--	5.3	--
PCM/Distributor	34.3	56.5	10.8	80.7	10.2	95.6	9.6	105.1	9.3
OEM/Integrator	7.9	12.7	.9	13.1	1.0	14.3	1.1	14.2	1.1
TOTAL U.S. REVENUES	57.3	81.0	11.7	102.6	11.2	116.5	10.7	124.6	10.4
NON-U.S. MANUFACTURERS									
Captive	1.0	.6	--	.5	--	.4	--	.3	--
TOTAL NON-U.S. REVENUES	1.0	.6	--	.5	--	.4	--	.3	--
WORLDWIDE RECAP									
Captive	16.1	12.4	--	9.3	--	7.0	--	5.6	--
	-35.3%	-23.0%	--	-25.0%	--	-24.7%	--	-20.0%	--
PCM/Distributor	34.3	56.5	10.8	80.7	10.2	95.6	9.6	105.1	9.3
	-18.9%	+64.7%	--	+42.8%	-5.6%	+18.5%	-5.9%	+9.9%	-3.1%
OEM/Integrator	7.9	12.7	.9	13.1	1.0	14.3	1.1	14.2	1.1
	+14.5%	+60.8%	--	+3.1%	+11.1%	+9.2%	+10.0%	-.7%	--
Total Revenues	58.3	81.6	11.7	103.1	11.2	116.9	10.7	124.9	10.4
	-21.3%	+40.0%	--	+26.3%	-4.3%	+13.4%	-4.5%	+6.8%	-2.8%
ANNUAL SHARE, BY TYPE	100.0%	87.6%	12.4%	90.3%	9.7%	91.7%	8.3%	92.4%	7.6%

TABLE 31

VERY HIGH PERFORMANCE

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1996 Shipments	Forecast							
		1997		1998		1999		2000	
	Subsys.	Subsys.	Software	Subsys.	Software	Subsys.	Software	Subsys.	Software
U.S. MANUFACTURERS									
Captive	358	310	--	260	--	215	--	185	--
PCM/Distributor	1,244	1,655	270	2,150	310	2,730	345	3,390	380
OEM/Integrator	51	140	30	205	38	280	45	370	50
TOTAL U.S. SHIPMENTS	1,653	2,105	300	2,615	348	3,225	390	3,945	430
NON-U.S. MANUFACTURERS									
Captive	18	15	--	12	--	10	--	8	--
TOTAL NON-U.S. SHIPMENTS	18	15	--	12	--	10	--	8	--
WORLDWIDE RECAP									
Captive	376	325	--	272	--	225	--	193	--
	-20.8%	-13.6%	--	-16.3%	--	-17.3%	--	-14.2%	--
PCM/Distributor	1,244	1,655	270	2,150	310	2,730	345	3,390	380
	+54.5%	+33.0%	--	+29.9%	+14.8%	+27.0%	+11.3%	+24.2%	+10.1%
OEM/Integrator	51	140	30	205	38	280	45	370	50
	-51.4%	+174.5%	--	+46.4%	+26.7%	+36.6%	+18.4%	+32.1%	+11.1%
Total Shipments	1,671	2,120	300	2,627	348	3,235	390	3,953	430
	+20.6%	+26.9%	--	+23.9%	+16.0%	+23.1%	+12.1%	+22.2%	+10.3%
ANNUAL SHARE, BY TYPE	100.0%	87.7%	12.3%	88.4%	11.6%	89.3%	10.7%	90.3%	9.7%

TABLE 32

VERY HIGH PERFORMANCE

WORLDWIDE PRICE PER UNIT ($000)

ARRAY TYPE	1996	Forecast 1997	1998	1999	2000
Captive					
Subsystems	42.5	38.1	34.2	31.2	28.7
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	42.5	38.1	34.2	31.2	28.7
PCM/Distributor					
Subsystems	27.6	34.1	37.5	35.0	31.0
Boards	--	--	--	--	--
Software	--	40.0	33.0	27.8	24.5
PCM/Distributor Average	27.6	34.9	36.9	34.1	30.3
OEM/Integrator					
Subsystems	156.0	90.7	63.7	51.0	38.2
Boards	--	--	--	--	--
Software	--	30.0	26.4	23.8	21.8
OEM/Integrator Average	156.0	80.0	57.8	47.2	36.2

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 33

VERY HIGH PERFORMANCE

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1996 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
Ciprico	840	--	--	840	91.3	1,190	--	--	1,190	91.9
Maxstrat	51	--	--	51	5.5	67	--	--	67	5.2
Other U.S.	29	--	--	29	3.2	38	--	--	38	2.9
Other Non-U.S.	--	--	--	--	--	--	--	--	--	--
TOTAL	920	--	--	920	100.0	1,295	--	--	1,295	100.0

ARRAY SPECIFICATIONS

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, attachment 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.

Host vs. network attach: Implementation is either software or hardware based. The array is noted as network attached if it includes an appropriate controller and is supported transparently as a network attached peripheral device.

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. In most cases, such designations refer to enhanced RAID-5 operation. Combinations of striping and Berkeley RAID levels are indicated as RAID-10, RAID-30, or RAID-50, as appropriate. 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.

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.

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. Caches are read and write capable, unless noted otherwise.

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, then "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, overall system 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.

1997 DISK/TREND product groups for disk drive arrays

Product groups for the 1997 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	ACCORD SYSTEMS
ARRAY MODEL	76SC34	76SC34A	76SC34H	Concorde	A510
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Software -- Software	Software -- Software	Software -- Software	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	PC compatible	PC compatible	PC compatible	Sun, RS/6000, HP, SGI, DEC	SCSI host NetWare, NT, OS/2,UNIX,other
RAID level Configured by:	0/1/10* Host	0/1/10 Host	0/1/10* Host	0/1/3/5/10	3/5 Host
Array capacity (Gbytes) MIN MAX	NA Drive dependent	NA Drive dependent	NA Drive dependent	6 204	3.6 30
Minimum drives per array	2	2	2	3	5
Maximum drives per array	60	56	56	28	5
Concurrent host channels	1	2	1	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI	SCSI-2
Drive interface	SCSI, SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	Ultra SCSI	IDE
Cache size (min, max: MB)	NA	NA	NA	4, 512	--
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	No No No
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	40 40	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	4000, 9100	1200-6400
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
ARRAY SIZE: Inches: H x W x D	N/A	N/A	N/A	Varies	5 x 5.75 x 9
POWER: Power backup	N/A	N/A	N/A	300 watts Cache battery	42 watts
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.	Custom configurations. CMD or ECCS controller.	

MANUFACTURER	ACCORD SYSTEMS	ACER	ACER	ACER	ADAPTEC
ARRAY MODEL	A510-R A510-T	Altos 19000	Altos 900 Altos 900 Pro	Altos 9000 Altos 9000 Pro	AAA-131CA
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Single User
MARKET	OEM, PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Board Host Hardware
Host platform, software environment	SCSI host NetWare, NT, OS/2,UNIX,other	Acer NetWare, VINES, SCO UNIX	Acer NetWare, VINES, SCO UNIX	Acer NetWare, VINES, SCO UNIX	PCI host NT workstation
RAID level Configured by:	3/5 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/10
Array capacity (Gbytes) MIN MAX	7.2 60	2/10/2/2 56/28/45/28	4 8	2/10/2/2 28/14/22/14	Drive dependent Drive dependent
Minimum drives per array	10	2/3	2	2/3	2
Maximum drives per array	10	14	2	7	15
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	PCI	PCI	PCI	PCI
Drive interface	IDE	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	--	4	4	4	16
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	-- -- Yes		-- -- No	No Yes No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10	132 10/20	132 10/20	132 10/20	133 40
DRIVES: Formatted capacity/drive(MB)	1200-6400	2100, 4000	2100, 4000	2100, 4000	Drive dependent
Nominal disk diameter (mm)	95	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
ARRAY SIZE: Inches: H x W x D		24.6 x 14 x 16		23.2 x 7 x 23.2	4.2 x 6.93
POWER: Power backup	84 watts	400 watts UPS optional	200 watts None	350 watts None	
FIRST CUSTOMER SHIPMENT	1996	1996	1996	1996	4Q97
COMMENTS		Complete server 1 or 2 processors. Mylex controll. Array is option	Complete server Needs expansion cab. for RAID-5 Mylex controll. Array is option	Complete server Mylex controll. Array is option	1 Ultra SCSI channel.

MANUFACTURER	ADAPTEC	ADAPTEC	ADAPTEC	ADAPTEC	ADAPTEC
ARRAY MODEL	ARO-1130CA	AAA-131	AAA-132	AAA-133	AEC-4312A
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM	OEM, PCM	OEM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	PCI host NT workstation	PCI host NetWare, NT, OS/2, UNIX	PCI host NetWare, NT, OS/2, UNIX	PCI host NetWare, NT, OS/2, UNIX	SCSI host
RAID level Configured by:	0/1/10	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/3/4/5/10 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	15	15	30	45	30
Concurrent host channels	1	1	1	1	1
Array interface to host	PCI	PCI	PCI	PCI	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	16	1	1	1	8, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes No	No Yes No	No Yes No	No Yes No	Yes Yes No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	133 40	133 40	133 40	133 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
ARRAY SIZE: Inches: H x W x D	3.36 x 7.025	4.2 x 6.93	4.2 x 12.28	4.2 x 12.28	1 x 3.88 x 6.25
POWER: Power backup					16 watts+drives
FIRST CUSTOMER SHIPMENT	3Q97	2Q97	2Q97	2Q97	2Q97
COMMENTS	Requires Adaptec RAID port connector and Ultra SCSI chips on mother board.	1 Ultra SCSI channel.	2 Ultra SCSI channels.	3 Ultra SCSI channels.	OEM design-in kit. AMD 133 MHz processor.

MANUFACTURER	ADAPTEC	ADAPTEC	ADAPTEC	ADAPTEC	ADAPTEC (TRILLIUM RESEARCH)
ARRAY MODEL	AEC-4412B	AEC-7312A	AEC-7412B	ARO-1130	Remus Lite 1.4
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Single User
MARKET	OEM, PCM	OEM	OEM, PCM	OEM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Software -- Software
Host platform, software environment	SCSI host	FC-AL host	FC-AL host	PCI host NetWare, NT, OS/2, UNIX	Power PC, Macintosh System 7, 8
RAID level Configured by:	0/1/3/4/5/10 Panel, Port	0/1/3/4/5/10 Port	0/1/3/4/5/10 Panel, Port	0/1/5/10	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	2	2	2	2
Maximum drives per array	30	30	30	15	15
Concurrent host channels	1	1	1	1	Host dependent
Array interface to host	SCSI	FC-AL	FC-AL	PCI	NuBus,SCSI,PCI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-3
Cache size (min, max: MB)	8, 32	8, 32	8, 32	1	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes No	Yes Yes No	Yes Yes No	No Yes No	N/A N/A N/A
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	100 40	40 40	133 40	Board dependent Drive dependent
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
ARRAY SIZE: Inches: H x W x D	1.61 x 5.75 x 8.625	1 x 3.88 x 6.25	1.61 x 5.75 x 8.625	3.36 x 7.025	N/A
POWER: Power backup	16 watts+drives Battery	16 watts+drives	16 watts+drives Battery	 --	N/A
FIRST CUSTOMER SHIPMENT	4Q97	3Q97	4Q97	4Q96	9/96
COMMENTS		OEM design-in kit. AMD 133 MHz processor.		Requires Adaptec RAID port connector and Ultra SCSI chips on main board.	SCSI manager 4.3 compliant.

MANUFACTURER	ADAPTEC (TRILLIUM RESEARCH)	ADVANCED LOGIC RESEARCH	ADVANCED LOGIC RESEARCH	ADVANCED LOGIC RESEARCH	ADVANCED TECHNOLOGY & SYSTEMS
ARRAY MODEL	Remus 1.4	DataStation Ultra-8	Quick Hot Swap	Revolution Series	AXRA-2500S AXRA-4300S
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Single User
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Software -- Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Host Hardware
Host platform, software environment	Power PC, Macintosh System 7, 8	ALR Novell, NT, OS/2, UNIX	ALR NetWare, UNIX, NT, OS/2, other	ALR/SMP Solaris, UNIX, NT, OS/2	SCSI host Windows, NT, OS/2
RAID level Configured by:	0/1/4/5 Host	0/3/5 Panel	0/3/5 Host	0/3/5 Host	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	16/8/12 72/36/63	3/1.5/2 12/6/8	3 72	2.5 4.3
Minimum drives per array	2	4	2/3	3	2
Maximum drives per array	15	8	6	6	2
Concurrent host channels	Host dependent	1	1	1	1
Array interface to host	NuBus,SCSI,PCI	PCI	PCI	PCI	SCSI-2
Drive interface	SCSI-3	Ultra SCSI	Ultra SCSI	Ultra SCSI	IDE
Cache size (min, max: MB)	--	4, 32	4, 32	4, 32	.256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	N/A N/A N/A	Yes Yes Yes	No Yes No	No Yes Yes	No No No
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Board dependent Drive dependent	132 20/40	132 20/40	132 20/40	10 8.3
DRIVES: Formatted capacity/drive(MB)	Drive dependent	4200, 9100	2100-9100	2100-9100	2500, 4300
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	8	8	
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17	4.17	5.6
ARRAY SIZE: Inches: H x W x D	N/A	17.4 x 6.83 x 19	12.5 x 7.5 x 12.5	Varies	3.2 x 5.74 x 8.05
POWER: Power backup	N/A	300 watts	85 watts None	650 watts	10 watts
FIRST CUSTOMER SHIPMENT	9/96	4/97	12/94	2Q95	1997
COMMENTS	SCSI manager 4.3 compliant.		Option for ALR system.	Complete server AMI controller.	

MANUFACTURER	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS
ARRAY MODEL	AXRB-M1080S	AXRD-M2100NA	AXRD-M2100NS	AXRS-F430XS	AXRC-E4300 AXRR-E4300 AXRS-E4300
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Windows, NT, OS/2	SCSI host Windows, NT, OS/2	SCSI host Windows, NT, OS/2	SCSI host Various	SCSI host Various
RAID level Configured by:	1 Preset	0/1 Host	0/1 Host	5 Preset	0/5 Host
Array capacity (Gbytes) MIN MAX	 1.08	 4.32/2.16	 4.32/2.16	8.6 21.5	 21.4
Minimum drives per array	2	2	2	3	2
Maximum drives per array	2	2	2	6	6
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	IDE	SCSI-2	SCSI-2	SCSI-2
Drive interface	IDE	IDE	IDE	SCSI-2	IDE
Cache size (min, max: MB)	.256	.256	.256	2	12
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No	No No No	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 8.3	8.3 8.3	10 8.3	10 10	20 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	2160	2160	4300	4300
Nominal disk diameter (mm)	84	65	65	95	95
Average positioning time (msec)				8.5	10
Average rotational delay (msec)	6.6			5.6	5.56
ARRAY SIZE: Inches: H x W x D	1.625 x 4 x 5.8	1 x 4 x 5.75	1 x 4 x 5.75	12.2 x 7.1 x 15.75	19.7 x 8.27 x 20.1
POWER: Power backup	15 watts			 Cache battery	250 watts
FIRST CUSTOMER SHIPMENT	1997	1997	1997	1997	1997
COMMENTS					AXRC and AXRR are rack mounted and expandable.

MANUFACTURER	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	AIWA CORE	AIWA CORE
ARRAY MODEL	AXRC-E9100 AXRR-E9100 AXRS-E9100	AXRS-D1080S AXRS-D1085S	AXRS-E2100	COREarray 20000	LightningArray
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host NetWare, UNIX, OS/2, DOS, NT	SCSI host NetWare, NT, OS/2, UNIX, DOS
RAID level Configured by:	0/5 Host	0/1/5 Panel	0/5 Host	3/5 Host, Port	3/5 Host, Port
Array capacity (Gbytes) MIN MAX	 45.2	1.08/2.16 3.24/5.4	 10.7	2 20	3 45
Minimum drives per array	2	2	2	3	3
Maximum drives per array	6	6	6	6	6
Concurrent host channels	1	1	1	1	2
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	IDE	IDE	IDE	SCSI-2	SCSI-2
Cache size (min, max: MB)	12	2, 8	12	2	8, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No No No	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 20	10 8.3	20 20	10 10	20 10
DRIVES: Formatted capacity/drive(MB)	9100	1080	2100	1000,2000,4000	1000-9000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	10	9	10	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	5.6	5.56	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	19.7 x 8.27 x 20.1	11.6 x 7.1 x 15.75	19.7 x 8.27 x 20.1	8 x 13.7 x 18	8 x 13.7 x 18
POWER: Power backup	250 watts	200 watts Cache battery	250 watts	240 VA None	240 VA None
FIRST CUSTOMER SHIPMENT	1997	10/94	1997	3Q94	4Q95
COMMENTS	AXRC and AXRR are rack mounted and expandable.				Single ended SCSI. Rack mount option.

MANUFACTURER	AIWA CORE	AIWA CORE	AIWA CORE	AIWA CORE	AIWA CORE
ARRAY MODEL	MicroArray III	MicroArray	RAIDstack	RAIDstack/PCI	RAIDstack/SCSI
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host NT, Win., DOS, OS/2, UNIX	SCSI host NetWare, UNIX, OS/2, DOS, NT	SCSI host NetWare	PCI host NetWare, NT	SCSI host NetWare, NT, OS/2, UNIX
RAID level Configured by:	1/3/5 Host, Port	3/5 Host, Port	3/5 Host	0/1/3/5/10 Host	0/1/3/5/10 Host, Port
Array capacity (Gbytes) MIN MAX	5.1/10.2	4.2 8.4	3 189	2 189	2 189
Minimum drives per array	3	3	3	2	2
Maximum drives per array	3	5	8	8	8
Concurrent host channels	1	1	1	1	1
Array interface to host	Ultra SCSI	SCSI-2	SCSI-2	PCI	SCSI-2
Drive interface	IDE	IDE	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4	2	Host dependent	8, 128	8, 128
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)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	40 16.6	10 16.6	20 20	132 20	20 20
DRIVES: Formatted capacity/drive(MB)	5100	1250, 2150	1000-9000	1000-9000	1000-9000
Nominal disk diameter (mm)	95	65	95	95	95
Average positioning time (msec)	10	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6	Drive dependent	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	3.25 x 5.75 x 9.325	3.25 x 5.75 x 8	20.1 x 14.25 x 12	20.1 x 14.25 x 12	20.6 x 14.2 x 12.25
POWER: Power backup	46 watts None	55 watts max. None	185 watts None	185 watts None	185 watts None
FIRST CUSTOMER SHIPMENT	4Q97	3Q94	4Q95	4Q95	1Q96
COMMENTS			Expandable up to 24 external drives.	Expandable up to 24 external drives.	Expandable up to 24 drives.

MANUFACTURER	AMAQUEST COMPUTER	AMAQUEST COMPUTER	AMAQUEST COMPUTER	AMAQUEST COMPUTER	AMAQUEST COMPUTER
ARRAY MODEL	CTL-9500	CTL-9600	DA-150-8	DA-155-12	DA-950-8
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 Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	SCSI host Various	PCI DOS, NT, UNIX, NetWare	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1/3/5 Port	0/1/3/5 Preset	0/1/3/5 Panel, Port	0/1/3/5 Panel, Port	0/1/3/5 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	2/3	2/3	2/3	2/3	2/3
Maximum drives per array	45	30	45	30	7
Concurrent host channels	1	1	1	1	1
Array interface to host	Ultra SCSI	PCI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	4, 64	4, 32	4, 64	4, 64	4, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	Option -- Yes	Option -- Yes	Option -- Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	132 40	40 40	40 40	40 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	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
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup	 Cache battery		600 watts Cache battery	500 watts Cache battery	600 watts Cache battery
FIRST CUSTOMER SHIPMENT	2Q97	1997	2Q97	3Q97	2Q97
COMMENTS	486 DX2-66 processor. Purchased controller.	486 DX2-66 processor. Purchased controller.	486 DX2-66 processor. Purchased controller. Rack mount.	486 DX2-66 processor. Purchased controller. Rack mount.	486 DX2-66 processor. Purchased controller.

MANUFACTURER	AMAQUEST COMPUTER	AMAQUEST COMPUTER	AMAQUEST COMPUTER	AMAQUEST COMPUTER	AMDAHL
ARRAY MODEL	DA-951-14	DA-955-42	FT-830 TW-8XXX	PM-730 PM-7200B	LVS 4100
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 Attachment Implementation	Board Host Hardware	Board Host Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	Ethernet NT	Ethernet Various	SCSI host Windows NT
RAID level Configured by:	0/1/3/5 Panel, Port	0/1/3/5 Panel, Port	0/1/3/5 Panel, Port	0/1/3/5 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	12.9 91
Minimum drives per array	2/3	2/3	2/3	2/3	3
Maximum drives per array	14	42	45	15	10
Concurrent host channels	1	1	1	1	1
Array interface to host	Ultra SCSI	Ultra SCSI	Ultra SCSI	PCI	SCSI-2
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	4, 32	4, 32	4, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option -- Yes	Option -- Yes	Yes 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)	40 40	40 40	40 40	132 40	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4300, 9100
Nominal disk diameter (mm)	95	95	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	4.17
ARRAY SIZE: Inches: H x W x D				25 x 9 x 25.2	18.97 x 6.94 x 21
POWER: Power backup	500 watts Cache battery	1200 watts Cache battery	400 watts	300 watts	250 watts Cache battery
FIRST CUSTOMER SHIPMENT	3Q97	3Q97	1997	1997	2/97
COMMENTS	486 DX2-66 processor. Purchased controller.	486 DX2-66 processor. Purchased controller.	Fault tolerant server. Purchased controller.	Server. Purchased controller.	Rack mount option.

MANUFACTURER	AMDAHL	AMDAHL	AMERICAN DIGITAL SYSTEMS	AMERICAN DIGITAL SYSTEMS	AMERICAN MEGATRENDS
ARRAY MODEL	LVS 4500	Spectris	MasterDisk RAID	MasterDisk RPS	Express MegaRAID
DISK/TREND GROUP	Net/Midrange	Mainframe	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware
Host platform, software environment	Solaris, AIX, HP-UX, NT, NCRSVR4	IBM S/390 MVS/ESA, M/ESA, UTS	SCSI host Various	SCSI host Various	PCI host UNIX, NT, DOS, NetWare, other
RAID level Configured by:	0/1/3/5/10 Host	3 Preset	0/1/3/5 Port, Panel	0/1/3/5 Port, Panel	0/1/3/5/10/50
Array capacity (Gbytes) MIN MAX	20 819*	45.4 726.4	Drive dependent Drive dependent	1.05 63.7	Drive dependent Drive dependent
Minimum drives per array	5	5	2	1	2
Maximum drives per array	90	80	28	7	30
Concurrent host channels	2-16	4, 8, 12, 16	3	7	1
Array interface to host	Ult.SCSI, FC-AL	ESCON, OEMI	Ultra SCSI, DEC	Ultra SCSI, DEC	PCI
Drive interface	Ultra SCSI	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	32, 256	512, 3072	32	0, 256	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes-optional Yes Yes	Yes-optional Yes Yes	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40/100 40	20 10	40 40	40 40	132 40
DRIVES: Formatted capacity/drive(MB)	4300, 9100	2825	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	95	Drive dependent
Average positioning time (msec)	Drive dependent	10.5	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	5.6	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	72.9 x 26 x 45	70.9 x 86.8(max)x 29.5	5.25 x 19 x 25	5.25 x 19 x 25	--
POWER: Power backup	 Dual power	1.15 KVA Cache battery	26 watts+drives None	12 watts+drives None	
FIRST CUSTOMER SHIPMENT	4/96	12/95	3Q93	1/95	1Q98
COMMENTS	*Expandable to multi-TB. 486 DX2-66 processor.		Mylex, CMD controllers.	Mylex, CMD controllers.	For RAID on motherboard.

MANUFACTURER	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS
ARRAY MODEL	Express Plus MegaRAID	MR 418 MegaRAID	MR 431 MegaRAID	MR 432 MegaRAID FC	MR 438 MegaRAID LVDS
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 Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	PCI host UNIX, NT, DOS, NetWare, other	PC compatible NetWare, DOS,NT Wind.,OS/2,UNIX	PCI host UNIX, NT, DOS, NetWare, other	PCI host UNIX, NT, DOS, NetWare, other	PCI host UNIX, NT, DOS, NetWare, other
RAID level Configured by:	0/1/3/5/10/50	0/1/3/5/10* Host	0/1/3/5/10/50*	0/1/3/5/10*	0/1/3/5/10*
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	30	45	30		45
Concurrent host channels	1	1	1	1	1
Array interface to host	PCI	PCI	PCI	PCI	PCI
Drive interface	Ultra SCSI	SCSI-2	Ultra SCSI	FC-AL	SCSI-LVDS
Cache size (min, max: MB)		4, 128	4, 128	8, 256	8, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	132 20	132 40	132 100	132 80
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
ARRAY SIZE: Inches: H x W x D	--	4.2 x .5 x 12.3	4.2 x 12.3	4.2 x 12.3	4.2 x 12.3
POWER: Power backup		12 watts Battery option	Cache battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	1Q98	8/95	4Q97	4Q97	1Q98
COMMENTS	For RAID on motherboard.	Uses Intel 960. *Also RAID 30 and RAID 50 modes. Flash Firmware.	*RAID 30 supported. I20 support. Intel i960 RP.	*RAID 30 and 50 supported.	*RAID 30 and 50 supported. I20 support.

MANUFACTURER	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS	ANDATACO	ANDATACO	ANDATACO
ARRAY MODEL	MRU 428 MegaRAID Ultra	MRU 434 MegaRAID Ultra GT	GigaRAID/FT+	GigaRAID/FT	GigaRAID/HA
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 Attachment Implementation	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	PC compatible NetWare, DOS,NT Wind.,OS/2,UNIX	PC compatible NetWare, DOS,NT Wind.,OS/2,UNIX	SCSI host UNIX, NT	SCSI host UNIX, NT	SCSI host UNIX, NT
RAID level Configured by:	0/1/3/5/10* Host	0/1/3/5/10* Host	0/1/3/5/10 Host,Panel,Port	0/1/3/5/10 Host,Panel,Port	0/1/5* Host,Panel,Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	4 80	4 80	35.2 264
Minimum drives per array	2	2	2	2	4
Maximum drives per array	45	45	20	10	30
Concurrent host channels	1	1	1, 2	1, 2	2
Array interface to host	PCI	PCI	SCSI-2	SCSI-2	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	SCSI-2	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	4, 128	4, 256	8, 64	8, 64	128
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	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	132 40	10/20 10/20	10/20 10/20	40 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	2050-9100	2050-9100	4500-9100
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	4.17	4.17	4.17/3.0
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	4.2 x .5 x 12.3	4.2 x .5 x 12.3	24.8 x 14 x 30	24.8 x 10.5 x 30	7 x 19 x 25.6
POWER: Power backup	12 watts Battery option	12 watts Battery option	880 watts Battery	880 watts Battery	Dual 400 watts Cache battery
FIRST CUSTOMER SHIPMENT	3/96	2Q97	1996	1996	7/97
COMMENTS	Uses Intel 960. *Also RAID 30 and RAID 50 modes. Flash Firmware.	Uses Intel 960. *Also RAID 30 and RAID 50 modes. Flash Firmware.	Based on CLARiiON array.	Based on CLARiiON array.	Mirrored cache. *Includes "Data Base Raid",with parity protect. for individual disks.

MANUFACTURER	ANDATACO	ANDATACO	ANDATACO	ANTRONE RESEARCH	ANTRONE RESEARCH
ARRAY MODEL	GigaRAID/SA	GigaRAID/SX	RAIDTower II	AR-600I AccuRAID	AR-600UW AccuRAID
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	SCSI host UNIX, NT	SCSI host UNIX, NT	RS6000, HP, Sun NetWare, NT, AS/400	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1/3/5/10 Host, Port	0/1/3/5/10	0/1/5	0/1/5 Host, Panel	0/1/5 Host, Panel
Array capacity (Gbytes) MIN MAX		4.2 127.4	 112	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	4	2/3	2/3
Maximum drives per array	14	14	28	6	6
Concurrent host channels	1	1	1, 2	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	EIDE	EIDE, ATA-4
Cache size (min, max: MB)	8, 64	4, 64	--, 64	8, 128	8, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option (1/97) Yes Yes	Option Yes Yes	Yes 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)	 10/20 10/20	 20 20	 20 40	 10 16.6	 40 33.3
DRIVES: Formatted capacity/drive(MB)	2050-9100	2100-9100		Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95, 130	95	95	95
Average positioning time (msec)	4.17	8		Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	4.17		Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	22.43 x 17.2 x 25.53	Configuration dependent		16 x 7.5 x 18.5	24.75 x 8.25 x 17.75
POWER: Power backup	250 watts Cache battery	300 watts		.72 KVA	.72 KVA
FIRST CUSTOMER SHIPMENT	4Q96	2Q97		1996	1997
COMMENTS	Mylex controller. Rack mount available.	Rack mount option. 25 MHz i960 processor.			

MANUFACTURER	APPLE COMPUTER	APPLIED DIGITAL SYSTEMS	APPLIED DIGITAL SYSTEMS	APPLIED DIGITAL SYSTEMS	APPLIED DIGITAL SYSTEMS
ARRAY MODEL	AppleRAID	AD410	AD595	AD850	AD855
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Apple servers	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1 Host	0/1/3/5	0/1/3/5	0/1/3/5	3/5
Array capacity (Gbytes) MIN MAX	2 4-8	 8	 25	 36	 86
Minimum drives per array	2				
Maximum drives per array	4	5	8	5	24
Concurrent host channels	1	1	1	1	1
Array interface to host	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.5, 1	4, 128	4, 128	4, 128	4, 128
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)	None	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	20 20	20 20	20 20	20 20
DRIVES: Formatted capacity/drive(MB)	4000-9100	2100-4300	9100	2100-4300	2100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	11	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6/8.3	Drive dependent	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	N/A				
POWER: Power backup	N/A	 Cache battery	 Cache battery	 Cache battery	 Cache battery
FIRST CUSTOMER SHIPMENT	4Q94	1997	1997	1997	1997
COMMENTS	Sold only with Apple servers.	Purchased controller.	Purchased controller.	Purchased controller.	Purchased controller.

MANUFACTURER	APPRO INTERNATIONAL	ARCO ELECTRONICS	ARCO ELECTRONICS	ARCO ELECTRONICS	ARCO ELECTRONICS
ARRAY MODEL	APRE-4080H Topaz	AC Mirror	DupliDisk	DupliDisk-PCI	DupliDisk-Bay
DISK/TREND GROUP	Net/Midrange	Single User	Single User	Single User	Single User
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	APPRO Various	PC compatible DOS, OS/2, NetWare, Windows	PC compatible DOS, OS/2, UNIX, NetWare, Windows	PC compatible DOS, OS/2, UNIX, NetWare, Windows	PC compatible DOS, OS/2, UNIX, NetWare, Windows
RAID level Configured by:	0/1/3/5 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	2	2	2	2	2
Maximum drives per array	8	4	4	4	4
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	PC AT	ISA	PCI	EIDE
Drive interface	SCSI-2	IDE	EIDE	EIDE	EIDE
Cache size (min, max: MB)		--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	No No No	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 20	1.4 Drive dependent	Host dependent Drive dependent	Host dependent Drive dependent	Host dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	65	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
ARRAY SIZE: Inches: H x W x D	7 x 19 x 18.5	3.5 x 11.5	3.5 x 7.35	3.5 x 7.35	1 x 4 x 5.75
POWER: Power backup		6 watts+ drives None	6 watts+drives None	6 watts+drives	6 watts+drives
FIRST CUSTOMER SHIPMENT	1997	2Q95	8/96	4Q97	4Q97
COMMENTS	Industrial packaging. Various custom configurations.				

MANUFACTURER	ARCO ELECTRONICS	ARTECON	ARTECON	ARTECON	ARTECON
ARRAY MODEL	DupliDisk-IDE	7000 FastfilePro	9000 FastfilePro	LR-2030 LynxStak	LR-3000 LynxArray
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	PC compatible DOS, OS/2, UNIX, NetWare, Windows	SCSI host UNIX, NT	SCSI host UNIX, NT	SCSI host Mac, Sun, DEC, HP, IBM, SGI, PC	SCSI host Mac, Sun, DEC, HP, IBM, SGI, PC
RAID level Configured by:	1 Preset	0/1/5/10 Host, Port	0/1/5/10 Host, Port	0/1/3/5/10 Host, Panel	0/1/3/5/10 Host, Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	8 1000	8 2300	27 324	27 324
Minimum drives per array	2	3	3	2	3
Maximum drives per array	4	90	135	18	18
Concurrent host channels	1			2, 2	2
Array interface to host	EIDE	PCI, Ethernet	PCI, FC, E'net	Ultra SCSI	Ultra SCSI
Drive interface	EIDE	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	--	8, 128	8, 128	16, 64	16, 24
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	Option Yes Yes	Option Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	132 20/40	100/132 10/20	40 40	40 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	8800, 17400	8800, 17400	8800, 17400	8800, 17400
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
ARRAY SIZE: Inches: H x W x D	3.5 x 7.35				
POWER: Power backup	6 watts+drives	 Battery	 Battery	40 watts None	660 watts --
FIRST CUSTOMER SHIPMENT	4Q97	1994	1997	1996	1997
COMMENTS		Complete server	Complete server	Infortrend controller.	Infortrend controller.

MANUFACTURER	ARTECON	ARTECON	ASC AUDIO VIDEO	AST RESEARCH	AST RESEARCH
ARRAY MODEL	LR-5000 LynxArray	LR-7000 LynxRAID LynxTower	RAIDsoft	Manhattan D	Premium HS
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Very High Perf.	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Software Host Software	Subsystem Host Hardware	Subsystem Network Hardware
Host platform, software environment	SCSI host Mac, Sun, DEC, HP, IBM, SGI,PC	SCSI host Mac, Sun, DEC, HP, IBM, SGI,PC	VR300	Manhattan UNIX, NT, OS/2, NetWare	Manhattan UNIX, NT, OS/2, NetWare
RAID level Configured by:	0/1/3/5/10 Host, Panel	0/1/3/5/10 Panel, Port	4 Host	0/1/3/5/10 Host	0/1/3/5/10* Host
Array capacity (Gbytes) MIN MAX	63 774	387 1548	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	7	7	10	2/3	2/3
Maximum drives per array	43	86	50	6	12
Concurrent host channels	5	5	1	1	1
Array interface to host	Ultra SCSI	Ultra SCSI	FC-AL	PCI	PCI
Drive interface	Ultra SCSI	Ultra SCSI	FC-AL	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	128	256	--	4, 64	4, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	-- -- --	No No Option	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	40 40	100 100	132 20/40	132 20/40
DRIVES: Formatted capacity/drive(MB)	8800, 17400	8800, 17400	Drive dependent	2100-9100	4550-9100
Nominal disk diameter (mm)	95	95	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	8
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	3
ARRAY SIZE: Inches: H x W x D			-- --	24.9 x 8.5 x 20.5	24.9 x 17 x 20.5
POWER: Power backup	660 watts Battery	660 watts Battery	-- --	275 watts None	330 watts None
FIRST CUSTOMER SHIPMENT	1997	1996	5/97	1997	4Q97
COMMENTS	Infortrend controller.	Infortrend controller.	For use with ASC video servers.	DPT or AMI controller options.	*AMI controller Also supports RAID-30, RAID-50. Complete server

MANUFACTURER	ATON SYSTEMES	ATON SYSTEMES	ATON SYSTEMES	ATON SYSTEMES	ATTO TECHNOLOGY
ARRAY MODEL	Areka I-10S	Areka E-10F	Areka P-10F	Areka VDS	ExpressRAID
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Single User
MARKET	Captive,OEM,PCM	OEM, PCM	OEM, PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware	Software -- Software
Host platform, software environment	PC: ISA DOS, Windows, Windows NT	PC: EISA, DOS, Windows, Windows NT	PC: PCI DOS, Windows, Windows NT,UNIX	Various DOS, Windows, Windows NT	PC compatible Various
RAID level Configured by:	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Preset	0/1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	10 280	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7	7	7	35	4
Concurrent host channels	1	1	1	1	1
Array interface to host	ISA	EISA	PCI	SCSI-2	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	0	0	0	0, 64	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	No Yes Yes	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	6 5	33 10	133 10	20 10	133 40/80
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
ARRAY SIZE: Inches: H x W x D	--	--	--	16.9 x 8.7 x 16.5	--
POWER: Power backup	10 watts --	14 watts --	10 watts --	.45 KVA None	--
FIRST CUSTOMER SHIPMENT	1993	1993	1995	1994	1Q97
COMMENTS					Requires ATTO PCI host adapter.

MANUFACTURER	AUSPEX SYSTEMS	AUSPEX SYSTEMS	AUSPEX SYSTEMS	AUSPEX SYSTEMS	AVIV
ARRAY MODEL	NS 7000/150 NS 7000/151 NS 7000/152	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 I
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	Captive, PCM	Captive, PCM	Captive, PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Host Hardware
Host platform, software environment	NFS (Sun)	NFS (Sun)	NFS (Sun)	NFS (Sun)	SCSI host UNIX, NetWare, Windows NT
RAID level Configured by:	0/1/5/10	0/1/5/10	0/1/5/10	0/1/5/10	0/1/0+1/3/5
Array capacity (Gbytes) MIN MAX	9 382	9 382	9 546	9 1911	6.3 180.6
Minimum drives per array	2	2	2	2	3
Maximum drives per array	42	42	60	210	42
Concurrent host channels	1	1	1-3	1-5	2
Array interface to host	VME	VME	VME	VME	SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI
Cache size (min, max: MB)	64, 512*	64, 512*	64, 1290***	64, 1290**	32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No Yes*	No No Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	 10	 10	 10	 10	20 10
DRIVES: Formatted capacity/drive(MB)	9100	9100	9100	9100	4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8-9	8-9	8-9	8-9	8-10
Average rotational delay (msec)	4.17	4.17	4.17	4.17	4.7-5.6
ARRAY SIZE: Inches: H x W x D	28.5 x 16 x 32.5**	28.5 x 16 x 32.5**	77 x 24 x 39.5**	77 x 24 x 39.5*	
POWER: Power backup	.36-.96 KVA Cache battery	 Cache battery	 Cache battery	 Cache battery	 Cache BBU
FIRST CUSTOMER SHIPMENT	3Q94	3Q94	2Q95	3Q96	1/95
COMMENTS	*Can share system cache. **Expandable. Complete server	*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.

MANUFACTURER	AVIV	AVIV	BAYDEL LTD.	BAYDEL LTD.	BAYDEL LTD.
ARRAY MODEL	Eclipse II	Spitfire	MS3-150 Media Server	MS3-90 Media Server	O/ESR DAR3-xxx
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host UNIX, NetWare, Windows NT	SCSI host UNIX, NetWare, Windows NT	SCSI host UNIX, NT, other	SCSI host UNIX, NT, other	SCSI host UNIX, NT, other
RAID level Configured by:	0/1/0+1/3/5	0/1/0+1/3/5	3 Preset	3 Preset	3 Preset
Array capacity (Gbytes) MIN MAX	12.9 655	12.9 127	156	93	Drive dependent Drive dependent
Minimum drives per array	3	3	20 + 5 parity	12 + parity	4 + parity
Maximum drives per array	72	14			30
Concurrent host channels	2	1	5 (5x2 option)	3 (3x2 option)	1 (2 optional)
Array interface to host	SCSI	SCSI	SCSI,SCSI-2,Ult	SCSI,SCSI-2,Ult	SCSI,SCSI-2,Ult
Drive interface	SCSI	SCSI			
Cache size (min, max: MB)	128	16, 32	80, 640	48, 384	16, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No Yes Yes	Yes Yes Yes	Yes Yes Yes	Option Yes Option
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 20	20 10	10/20/40 10	10/20/40 10	10/20/40 10
DRIVES: Formatted capacity/drive(MB)	4300, 9100	4300, 9100	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	130	130	95
Average positioning time (msec)	8-10	8-10	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.7-5.6	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D			10.5 x 19 x 27	10.5 x 19 x 27	6.9 x 16.85 x 26.5
POWER: Power backup	Cache BBU	Cache BBU	1750 watts Battery option	1050 watts Battery option	240 watts Battery option
FIRST CUSTOMER SHIPMENT	4/97	1/96	1996	1996	1992
COMMENTS	Pedestal or rack.	Pedestal.			Rack, pedestal and tabletop options.

MANUFACTURER	BAYDEL LTD.	BOX HILL SYSTEMS	BOX HILL SYSTEMS	BYTESTREAM DATA SYSTEMS	BYTESTREAM DATA SYSTEMS
ARRAY MODEL	O/ESR DAR5-xxx	Fibre Box	RAID Box 5300 Turbo+	RAID IS	RAID PS
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	PCM	PCM	OEM	OEM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Software -- Software	Board Host Hardware
Host platform, software environment	SCSI host UNIX, NT, other	PC, Sun NT, Solaris	Sun, HP, other UNIX, Windows NT	PCI host Various	PCI host Various
RAID level Configured by:	3 Preset	0/1/5/10 Port	0/1/4/5 RS232 Port	0/1/5/10 Host	0/1/5/10 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	36 72	2 2700	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	4 + parity	2	2	2	2
Maximum drives per array	30	8	120	45	45
Concurrent host channels	1 (2 optional)	1, 2	4	1, 2	1, 2
Array interface to host	SCSI,SCSI-2,Ult	PCI, SBUS	SCSI-2	PCI	PCI
Drive interface		FC-AL	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	16, 128	--	32, 512	--	4, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Option	N/A 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)	10/20/40 10	132 100/200*	40 40	132 Drive dependent	132 20/40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	9000	2000-23000	Drive dependent	Drive dependent
Nominal disk diameter (mm)	130	95	95, 130	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
ARRAY SIZE: Inches: H x W x D	10.4 x 16.85 x 27.8	7 x 17 x 21	Varies		4.2 x 9.5
POWER: Power backup	576 watts Battery option	300 watts	450 watts UPS	--	10 watts
FIRST CUSTOMER SHIPMENT	1993	1997	1996	1997	1997
COMMENTS	Rack, pedestal and tabletop options.	Expandable to 125 drives. Dual AC. *Dual ported.	Internal UPS.	Supports I20.	I20 compliant.

MANUFACTURER	CAMBEX	CAMBEX	CAMBEX	CHARISMAC ENGINEERING	CHARISMAC ENGINEERING
ARRAY MODEL	Cascade XE	Centurion 2000	Cascade 3X	Anubis RAID	Anubis RAID FC
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Mainframe	Single User	Net/Midrange
MARKET	PCM	PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Software Host Software	Software Host Software
Host platform, software environment	IBM,Sun,HP,NCR, Sequent, Novell NT,MVS,VM,ESA	IBM, Sun, HP, NCR, Sequent, Novell, NT	IBM MVS, VM	Macintosh System 7, 8	Macintosh System 7, 8
RAID level Configured by:	0/1 Host	0/1/3/5/10 Host, Port	0/1 Host	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	51 576	17/17 100/576	68 544/272	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	6	5/5	8	2	2
Maximum drives per array	64	30/160	64	10	8*
Concurrent host channels	4	2, 16	4	1	1
Array interface to host	Parallel, ESCON	SCSI-2	ESCON, Parallel	NuBus,SCSI, PCI	PCI
Drive interface	SCSI	Ultra SCSI	SCSI-2	Ult. SCSI, SSA	FC-AL
Cache size (min, max: MB)	32, 4096	16, 2048	8, 256	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Option Yes Yes	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	4.5 17	40 20	4.5 10	Host dependent Drive dependent	Host dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	4300, 9000	4300, 9000	8500	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	130	Drive dependent	Drive dependent
Average positioning time (msec)	9	9		Drive dependent	Drive dependent
Average rotational delay (msec)	4	4	5.6	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	70 x 40 x 30	70 x 40 x 30	70.5 x 44 x 32	--	--
POWER: Power backup	1500 watts	1500 watts	1.6 KVA	-- --	-- --
FIRST CUSTOMER SHIPMENT	4/95	8/96	8/95	11/94	4Q97
COMMENTS				Supports StreamLogic, ATTO, other.	Supports any FC controller. *Expandable to 127 drives.

MANUFACTURER	CIPRICO	CIPRICO	CIPRICO	CLONE STAR SOFTWARE	CLONE STAR SOFTWARE
ARRAY MODEL	6500 Series Spectra 6500	6900 Series Spectra 6900	7000 Series Spectra 7000 Halo 7000	ALTER EGO	REFLECT
DISK/TREND GROUP	Very High Perf.	Very High Perf.	Very High Perf.	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Software Host Software	Software Host Software
Host platform, software environment	Various	Various	PCI, SGI Various	PC compatible MS-DOS	PC compatible MS-DOS, NetWare
RAID level Configured by:	3 Preset	3 Preset	3 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	9	5 or 9	9	2	2
Maximum drives per array	9	9	9	2	2
Concurrent host channels	1	1	1	1	1
Array interface to host	Ultra SCSI	Ultra SCSI	FC-AL	N/A	N/A
Drive interface	IDE	Ultra SCSI	SCSI-2	N/A	N/A
Cache size (min, max: MB)	N/A	N/A	N/A	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No Yes	No Yes Yes	NA NA NA	NA NA NA
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	40 40	100	N/A N/A	N/A N/A
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
ARRAY SIZE: Inches: H x W x D	7 x 17 x 22	7 x 17 x 22	7 x 17 x 22	N/A	N/A
POWER: Power backup	300 watts --	300 watts --	300 watts --	N/A N/A	N/A N/A
FIRST CUSTOMER SHIPMENT	9/96	6/95	9/96	1989	1988
COMMENTS					

MANUFACTURER	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY
ARRAY MODEL	CRD-5400	CRD-5440	CRD-5500	CRD-5640	CSV-8050 TRIDENT
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 Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host	DEC VMS, OSF
RAID level Configured by:	0/1/4/5/10 Panel	0/1/4/5/10 Panel, Port	0/1/4/5/10 Panel	0/1/4/5/10 Panel	0/1 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	
Maximum drives per array	14	45	120	30	42
Concurrent host channels	1	1, 3	1, 4	1, 2	1
Array interface to host	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI	CI, FDDI
Drive interface	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	4, 256	128	128, 512	32, 256	0, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	No -- --	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)	10/20 10/20	20/40 20/40	20/40 20/40	20/40 20/40	10 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
ARRAY SIZE: Inches: H x W x D	1.7 x 5.75 x 8.25	1.7 x 5.75 x 8.6	3.25 x 5.75 x 8.1		5.2 x 19 x 24.5
POWER: Power backup	75 watts	15 watts Cache battery	40 watts	15 watts	100 watts Battery
FIRST CUSTOMER SHIPMENT	2Q95		2Q95	4Q97	4Q94
COMMENTS				Hot swap controller. Mirrored cache.	FDDI requires CSV-8160 option

MANUFACTURER	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	CSV-8150 TRIDENT	ORD-5640	UltraDaytona RAIDArray	ProLiant 2500	ProLiant 5000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	OEM	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	DEC VMS, OSF	SCSI host Various	SCSI host Various	Compaq NT, NetWare, OS/2, SCO UNIX	Compaq NT, NetWare, OS/2, SCO UNIX
RAID level Configured by:	0/1 Port, Panel	0/1/4/5 Panel, Port	0/1/4/5/10 Panel, Port	0/1/4/5 Host	0/1/4/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	4 301*	4 361*
Minimum drives per array		2	4	2	2
Maximum drives per array	42	30	13	7/14*	7/14*
Concurrent host channels	1, 2	1, 2	16, 128	1	1
Array interface to host	CI, DSSI, FDDI	Ultra SCSI	Ultra SCSI	EISA, PCI	EISA, PCI
Drive interface	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI-3	Ultra SCSI-3
Cache size (min, max: MB)	0, 256	128		16 ECC	16 ECC
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes (option) Yes Yes	No -- --	No Yes Yes	With duplexing No Yes	With duplexing No 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 20/40	20/40 20/40	33/133 20/40	33/133 20/40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	2100-9100	2100-9100
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	9.5	9.5
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	4.7	4.7
ARRAY SIZE: Inches: H x W x D	5.2 x 19 x 24.5	1.6 x 1.6 x 8.55	1 x 3.75 x 6.25	25.8 x 8.75 x 22.4	25.8 x 8.75 x 22.4
POWER: Power backup	100 watts Battery	15 watts	15 watts	445 watts Cache battery	445 watts Cache battery
FIRST CUSTOMER SHIPMENT	4Q94	3Q97	2Q97	1997	1997
COMMENTS	FDDI requires CSV-8160 option		Includes GUI software.	*With optional storage subsystem.	*With optional storage subsystem.

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	ProLiant 6000	ProLiant 6500	ProLiant 7000	ProLiant 800	ProLiant 850R
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host 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	Compaq NT, NetWare, OS/2, SCO UNIX
RAID level Configured by:	0/1/4/5 Host	0/1/4/5 Host	0/1/4/5 Host	0/1/4/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	4 109.2/937.3*	4 63.7/746.4*	4 109.2/746.4*	4 240*	4 27.3/127
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7/14*	7/14*	7/14*	7/14*	7
Concurrent host channels	1	1	1	1	1
Array interface to host	EISA, PCI	EISA, PCI	EISA, PCI	ISA, PCI	EISA, PCI
Drive interface	Ultra SCSI-3	Ultra SCSI-3	Ultra SCSI-3	Ultra SCSI-3	Ultra SCSI-3
Cache size (min, max: MB)	16 ECC	16 ECC	16 ECC	16 ECC	6 ECC
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	With duplexing Yes Yes	With duplexing Yes Yes	With duplexing Yes Yes	With duplexing No Yes	With duplexing No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33/133 40/80	33/133 40/80	33/133 40/80	33/133 20/40	33/133 40
DRIVES: Formatted capacity/drive(MB)	2100-9100	2100-9100	2100-9100	2100-9100	2100-9100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5	9.5	9.5	9.5	9.5
Average rotational delay (msec)	4.7	4.7	4.7	4.7	4.7
ARRAY SIZE: Inches: H x W x D	24.25 x 22.8 x 17.25	12 x 19 x 24.5	12 x 19 x 24.5	21.9 x 8.96 x 17.25	5.1 x 17.7 x 15.8
POWER: Power backup	750 watts Cache battery	750 watts Cache battery	750 watts Cache battery	240 watts Cache battery	200 watts Cache battery
FIRST CUSTOMER SHIPMENT	1997	3Q97	3Q97	1997	2Q97
COMMENTS	*With external storage subsystem.	*With external storage subsystem.	*With external storage subsystem.	*With optional storage subsystem.	Read cache only

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAREX	COMPAREX
ARRAY MODEL	ProSignia 200	SMART 2-DH	SMART 2-SL	D1200 Cabinet OpenLine	D1200 MiniTower OpenLine
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware	Subsystem Host 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	SCSI host DEC, Sun, NT, RS/6000,NetWare	SCSI host DEC, Sun, NT, RS/6000,NetWare
RAID level Configured by:	0/1/4/5 Host	0/1/4/5 Host	0/1/5 Host	0/1/5 Port	0/1/5 Port
Array capacity (Gbytes) MIN MAX	4 150*	Drive dependent Drive dependent	Drive dependent Drive dependent	4.1/16.6 33.3/139.4	4.1/16.6 17.4/34.8
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7/14*	14	7	20*	5*
Concurrent host channels	1	1	1	2	1
Array interface to host	ISA, PCI	EISA, PCI	EISA, PCI	SCSI-2/3,AS/400	SCSI-2/3,AS/400
Drive interface	Ultra SCSI-3	Ultra SCSI-3	Ultra SCSI-3	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	16 ECC	16 ECC	6 ECC	16, 512	16, 512
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	With duplexing No Yes	With duplexing -- --	With duplexing -- --	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)	33/133 20/40	33/133 40/80	33/133 40	10/20 40	10/20 40
DRIVES: Formatted capacity/drive(MB)	2100-9100	2100-9100	2100-9100	4100, 8700	4100, 8700
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5	9.5	9.5	9.5	9.5
Average rotational delay (msec)	4.7	4.7	4.7	4.17	4.17
ARRAY SIZE: Inches: H x W x D	21.9 x 8.96 x 17.25	3.9 x 13.75 x .6	3.9 x 12.25 x .6	8.5 x 19.1 x 27.9	16.1 x 9 x 18.3
POWER: Power backup	200 watts Cache battery	13.5watts+drves Cache battery	None	.4 KVA Battery	.3 KVA Battery
FIRST CUSTOMER SHIPMENT	1997	3Q97	2Q97	2Q97	2Q97
COMMENTS	*With optional storage subsystem.	Read ahead cache. Online reconfiguration Removable cache	Read cache only.	*Plus hot spares.	*Plus hot spares.

MANUFACTURER	COMPAREX	COMPAREX	CONLEY	CONLEY	CONLEY
ARRAY MODEL	D1200 RackMount OpenLine	TETRAGON 2000	SoftRAID	SR-40	SR-50
DISK/TREND GROUP	Net/Midrange	Mainframe	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	OEM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Software -- Software	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host DEC, Sun, NT, RS/6000,NetWare	HDS/IBM mainframe MVS, VS, VSE	Macintosh,Power PC, Quadra	Sun, Mac, HP, RS/6000, NT	Sun, Mac, HP, RS/6000, NT
RAID level Configured by:	0/1/5 Port	5 Preset	0/1	0/1/3/5/10 Host	0/1/3/5/10 Host
Array capacity (Gbytes) MIN MAX	4.1/16.6 69.7/139.7	45 1600	Drive dependent Drive dependent	20 216	20 650
Minimum drives per array	2	7	2	3	3
Maximum drives per array	10*/20*	224*	12	42	72
Concurrent host channels	2	8, 16	1	2	7
Array interface to host	SCSI-2/3,AS/400	IBM, SCSI-2	--	SCSI	Ult. SCSI,FC-AL
Drive interface	Ultra SCSI	SCSI-2	--	SCSI	Ultra SCSI
Cache size (min, max: MB)	16, 512	256, 8192	--	32	256-1028
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	NA NA NA	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)	10/20 40	17 20	Drive dependent Drive dependent	20-40 20-40	40-100
DRIVES: Formatted capacity/drive(MB)	4100, 8700	4360, 9200	Drive dependent	4000-9000	4000-9000
Nominal disk diameter (mm)	95	95	Drive dependent	95, 140	95, 140
Average positioning time (msec)	9.5	11.5/12.5	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.7	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	27.6 x 11.8 x 23.6	70.5 x 51.2 x 31.5	N/A	28 x 9 x 22	28 x 9 x 22
POWER: Power backup	.8 KVA Battery	2.2 KVA Battery	N/A	350 watts	350 watts
FIRST CUSTOMER SHIPMENT	2Q97	5/95	11/93	8/94	6/97
COMMENTS	*Plus hot spares.	*Plus hot spares.			

MANUFACTURER	CONSENSYS COMPUTERS	COREL	CRAY RESEARCH	CRAY RESEARCH	CRAY RESEARCH
ARRAY MODEL	RAIDZONE	Network Manager	FCN-1	ND-30E	ND-40E
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Very High Perf.	Very High Perf.	Very High Perf.
MARKET	OEM, PCM	OEM, PCM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Software Host Software	Software -- Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	PC compatible Windows NT Server	PC compatible NetWare 3.1X, Windows 3	Cray Unicos	Cray Unicos	Cray Unicos
RAID level Configured by:	0/1/5/10 Host	4/5 Host	3 Host	1/5 Console	1/5 Console
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	38 1520	64 127	200 800
Minimum drives per array	2	3	5	8	24
Maximum drives per array	20	16	200	16	96
Concurrent host channels	1	1		2	4
Array interface to host	PCI	SCSI-2	Proprietary	IPI-3 (HIPPI)	IPI-3 (HIPPI)
Drive interface	IDE, Ultra ATA	SCSI-2	FC-AL	SCSI	SCSI
Cache size (min, max: MB)	--	--	--	20	20
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	-- -- --	Yes Yes No	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)	132 33	10/20 10/20	160 8-12	Up to 40	Up to 190 7-11
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	9500	4300	9100
Nominal disk diameter (mm)	95	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	8 RD/9.5 WR	8 RD/9 WR	8 RD/9.5 WR
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	4.875 x 4 x 5.75	-- --		22.75 x 19 x 24.6	36.5 x 29.5 x 72
POWER: Power backup	77 watts	-- --	 None		Up to 4.85 KVA Int. UPS
FIRST CUSTOMER SHIPMENT	1/98	1Q94*	4/97	12/96	11/96
COMMENTS	Windows 95 support in 1998	*Shipped as Corel RAID in 3Q93.			

MANUFACTURER	CUBIX	CYBERSTORAGE SYSTEMS	CYBERSTORAGE SYSTEMS	CYBERSTORAGE SYSTEMS	CYBERSTORAGE SYSTEMS
ARRAY MODEL	SafeStor/FT II	10000	2001	Ultra 2010	Ultra 205
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Cubix, other OS/2, NetWare, NT	SCSI, FC host	SCSI host	SCSI host	SCSI host
RAID level Configured by:	0/1/5 Host	0/1/0+1/3/5 On board GUI	0/1/0+1/4/5+ Host GUI panel	0/1/0+1/3/5 RS-232	0/1/0+1/3/5 RS-232
Array capacity (Gbytes) MIN MAX	 25.2	72 2760	20 252	 1300	6 345
Minimum drives per array	2/3	8	5		
Maximum drives per array	12	120	28		20
Concurrent host channels	1-6	2, 4	1-4	4	1
Array interface to host	*	Ult.SCSI,FC,PCI	SCSI-2	Ultra SCSI	Ultra SCSI
Drive interface	SCSI-2	Ult.SCSI, FC-AL	SCSI-2	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	*	8, 1024	8-512	--, 512	--, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	Optional Yes Yes	Yes (option) Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual*	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	 20	40/80/100/132 40/80/100	20 20	40 40	40 40
DRIVES: Formatted capacity/drive(MB)	1100-4200	9100-23000	4000, 9000	2000-23000	2000-23000
Nominal disk diameter (mm)	95	95, 130	95, 130	95, 130	95, 130
Average positioning time (msec)	8.5-9	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17-5.56	Drive dependent	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	8.75 x 19 x 18	8.25 x 19 x 20	19 x 15.75 x 30	23.5 x (tower) 9.75 x 20.75	23.5 x (tower) 9.75 x 20.75
POWER: Power backup	153 watts None	350-400	300 watts		
FIRST CUSTOMER SHIPMENT	3Q95	12/97	4Q96		
COMMENTS	Purchased controller. *Controller dependent. Dual AC.		CMD controller.		

MANUFACTURER	CYBERSTORAGE SYSTEMS	CYRANEX	CYRANEX	CYRANEX	DALLAS DIGITAL
ARRAY MODEL	Ultra Wide PCI	EZRAID Lite Version 2.01	EZRAID for Windows	EZRAID Pro Version 2.01	RAIDstor
DISK/TREND GROUP	Net/Midrange	Single User	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Software Host Software	Software Host Software	Software Host Software	Subsystem Host Hardware
Host platform, software environment	SCSI host	PC compatible OS/2	PC compatible Windows 95, Windows 98	PC compatible OS/2	SCSI host Various
RAID level Configured by:	0/1/0+1/3/5 On board GUI	0/1 Host	1 Host	0/1/4/5 Host	0/1/3/5 Panel, Port
Array capacity (Gbytes) MIN MAX	6 184	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	3 112
Minimum drives per array		2	2	2	2
Maximum drives per array		2	Varies	7 per control.	24
Concurrent host channels	1	1	1	1	3
Array interface to host	PCI	Various	Various	Various	SCSI-2
Drive interface		Various	Various	Various	SCSI-2
Cache size (min, max: MB)	--, 32	--	1, 16*	.03-2*	32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	 Yes Yes	-- -- --	-- -- --	-- -- --	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	None	None	Auto	Auto
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	 132 40	 Host dependent Drive dependent	 Host dependent Drive dependent	 Host dependent Drive dependent	 20 20
DRIVES: Formatted capacity/drive(MB)	2000-23000	Drive dependent	Drive dependent	Drive dependent	2100, 4300
Nominal disk diameter (mm)	95, 130	Drive dependent	Drive dependent	Drive dependent	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	9
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4.17
ARRAY SIZE: Inches: H x W x D	23.5 x (tower) 9.75 x 20.75	--	--	--	10.5 x 19 x 17*
POWER: Power backup		-- -	-- --	-- --	 UPS option
FIRST CUSTOMER SHIPMENT		1994	4Q97	11/94	4/94
COMMENTS			Runs in RAID-1 or snapshot mirror mode. *Option.	*In driver.	*Customized configuration.

MANUFACTURER	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL
ARRAY MODEL	100 CLARiiON	1100 1110 CLARiiON	1300 CLARiiON	1900T CLARiiON	2800 2810 CLARiiON
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Open Systems NetWare, NT, UNIX	Open Systems NetWare, NT, UNIX	Open Systems NetWare, NT, UNIX	Telco Sun, DG, AViiON IBM RS/6000, NT	Open Systems NetWare, NT, UNIX
RAID level Configured by:	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, 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	12.6 124.6	12.6 178	21 178	21 178	12.6 356
Minimum drives per array	3	3	5	5	3
Maximum drives per array	7	10	10	10	20
Concurrent host channels	1	1, 2	2	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)	8, 32	8, 64	16, 128	8, 256	32, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No 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)	20 20	20/40 20	20/40 20	20/40 50	20/40 50
DRIVES: Formatted capacity/drive(MB)	4200,8800,17800	4200,8800,17800	4200,8800,17800	4200,8800,17800	4200,8800,17800
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	7.8-11.2	8.5-9.4	8.5-9.4	8-9.5	8.5-9.4
Average rotational delay (msec)	5.6/4.17	4.17	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	19.5 x 7 x 19	24.8 x 10.5 x 30	24.8 x 10.5 x 30	22.75 x 17.5 x 13.25	24.8 x 14 x 30
POWER: Power backup	300 watts Battery	575 watts Battery	575 watts Battery	600 watts DC pwr.,Battery	880 watts Battery
FIRST CUSTOMER SHIPMENT	6/95	1/94	3/94	3/97	6/92
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.	Designed for Telco applications, with Telco rack design.	Concurrent RAID levels, mirrored cache, GUI management tool.

MANUFACTURER	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL
ARRAY MODEL	2900 CLARiiON	3100 3110 CLARiiON	3200 CLARiiON	3400 CLARiiON	3500 CLARiiON
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Open Systems NetWare, NT, UNIX	Open Systems NetWare, NT, UNIX	Open Systems NetWare, NT, UNIX	Open Systems NetWare, NT, UNIX	Open Systems NetWare, NT, UNIX
RAID level Configured by:	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, 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	21 356	12.6 534	21 534	12.6 534	21 534
Minimum drives per array	5	3	5	3	
Maximum drives per array	20	30	30	30	30
Concurrent host channels	2	1, 2	2	1, 2	2
Array interface to host	SCSI-2	SCSI-2	SCSI-2	Fibre Channel	Fibre Channel
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	64, 256	32, 128	64, 256	32, 128	64, 256
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)	20/40 50	20/40 50	20/40 50	100/200 50	100/200 50
DRIVES: Formatted capacity/drive(MB)	4200,8800,17800	4200,8800,17800	4200,8800,17800	4200,8800,17800	4200,8800,17800
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8.5-9.4	8.5-9.4	8.5-9.4	8.5-9.4	8.5-9.4
Average rotational delay (msec)	4.17	4.17	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	24.8 x 14 x 30	18.4 x 19 x 30	18.4 x 19 x 30	18.4 x 19 x 30	18.4 x 19 x 30
POWER: Power backup	880 watts Battery	1150 watts Battery option	1150 watts Battery option	1150 watts Battery option	1150 watts Battery option
FIRST CUSTOMER SHIPMENT	3/94	11/96	11/96	11/96	11/96
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.	Concurrent RAID levels, mirrored cache, GUI management tool.

MANUFACTURER	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATALINK	DATALINK
ARRAY MODEL	FC5000 CLARiiON	FC5500 CLARiiON	VF2000 CLARiiON	RS 620	RS 660
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 Attachment Implementation	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Open Systems	Open Systems NetWare, NT, UNIX	Video	SCSI host UNIX, Novell, NT	SCSI host UNIX, Novell, NT
RAID level Configured by:	S/W dependent Host	0/1/3/5/10 Host, Port	3 Preset	0/1/5/10 Port	0/1/5/10 Port
Array capacity (Gbytes) MIN MAX	26.2 1000+	25.2 1000+	21 176	4 127	4 870
Minimum drives per array	3	3	5	3	3
Maximum drives per array	120	120	20	14	96
Concurrent host channels	1, 2	1, 2	1, 2	1, 1	1
Array interface to host	FC-AL	FC	SCSI-2	SCSI-2	SCSI-2
Drive interface	FC-AL	FC-AL	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	32, 1536	16, 64	16, 16	32, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	N/A Yes Yes	Yes Yes Yes	Yes Yes Yes	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	--	Auto	None	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 100	200 200	20/40 50	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	8820	8820	4200, 8800	2000,4000,9000	2000,4000,9000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8-9.5	8-9.5	8.5-9.4	8	8
Average rotational delay (msec)	4.17	4.17	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	6 x 17.5 x 24	11.25 x 17.5 x 27.2	24.8 x 14 x 30	21 x 10 x 21	34 x 19 x 21
POWER: Power backup	400 watts	760 watts Battery/UPS	880 watts	.75 KVA AC Battery (cache)	1.5 KVA AC Battery (cache)
FIRST CUSTOMER SHIPMENT	6/97	6/97	10/96	--	--
COMMENTS	Mirrored cache, GUI management tool, RAID status depends on software.	Concurrent RAID levels, mirrored cache, GUI management tool, dual AC.	RAID-3 optimized for high bandwidth.	DEC StorageWorks.	DEC StorageWorks.

MANUFACTURER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER
ARRAY MODEL	2200 PowerEdge	4200 PowerEdge	4200 PERC PowerEdge	6100 PERC	PERC
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware
Host platform, software environment	Dell NetWare, NT	Dell NetWare, NT	Dell NetWare, NT	Dell NetWare, NT	Dell NetWare, NT
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 54.6	4 54.6	4 146	4 342	Drive dependent Drive dependent
Minimum drives per array	2	2	2		2
Maximum drives per array	6	6	16		16
Concurrent host channels	1	1	1		1
Array interface to host	PCI	PCI	PCI		PCI
Drive interface	SCSI-2	Ultra SCSI	Ultra SCSI		Ultra SCSI
Cache size (min, max: MB)	4, 32	4, 32 ECC	4, 32 ECC	4, 64 ECC	4, 32 ECC
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Duplex No No	Duplex Yes Option	Duplex Yes Option	Duplex Yes Option	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	132 40	132 40	132 40	132 40
DRIVES: Formatted capacity/drive(MB)	2100-9100**	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
ARRAY SIZE: Inches: H x W x D	Varies	Varies	Varies	Varies	
POWER: Power backup	Host dependent Cache battery	Host dependent Cache battery	Host dependent Cache battery	700 watts Cache battery	Host dependent Cache battery
FIRST CUSTOMER SHIPMENT	1997	4Q96	4Q96	1997	1996
COMMENTS	AMI controller. *Also RAID 30 and RAID 50 modes. **18000 in 1H98	AMI controller. *Also RAID 30 and RAID 50 modes. **18000 in 1H98	AMI controller. *Also RAID 30 and RAID 50 modes. **18000 in 1H98	AMI controller. *Also RAID 30 and RAID 50 modes. **18000 in 1H98	AMI controller. *Also RAID 30 and RAID 50 modes. For Dell systems.

MANUFACTURER	DIGI-DATA	DIGI-DATA	DIGI-DATA	DIGI-DATA	DIGI-DATA
ARRAY MODEL	Model Z9000	Model Z9100	Model Z9150	Model Z9200	Model Z9250
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM	OEM	OEM	OEM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host 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	3 Preset	3/5 Port	3 Preset	3/5 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	5	5	5	5	5
Maximum drives per array	35	75	90	90	90
Concurrent host channels	1	1, 2	1, 2	1, 2	1, 2
Array interface to host	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra2 SCSI	Ultra2 SCSI
Drive interface	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)	4, 128	8, 256	8, 256	8, 256	8, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	Yes No No	Yes No No	Yes No No	Yes No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	40 40	40 40	80 80	80 80
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
ARRAY SIZE: Inches: H x W x D	3.25 x 5.75 x 8	3.25 x 5.75 x 8	3.25 x 5.75 x 8	3.25 x 5.75 x 8	3.25 x 5.75 x 8
POWER: Power backup	26 watts+drives None	26 watts+drives None	25 watts+drives None	25 watts+drives None	25 watts+drives None
FIRST CUSTOMER SHIPMENT	3/94	7/97	4Q97	4Q97	4Q97
COMMENTS			Hardware upgrade to Z9100.		

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	RAID Array 230 StorageWorks	RAID Array 310 StorageWorks	RAID Array 450 StorageWorks	ESA 10000 High Capacity	ESA 10000 General Business
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Digital UNIX, OVMS, NT	Digital, IBM, HP Sun, Intel, UNIX NT, OVMS, NetW.	Digital, Open Systems, NetW., UNIX, NT, Sun	Digital, IBM, HP Sun, Intel UNIX, OVMS, NT	Digital, IBM, HP Sun, Intel UNIX, OVMS, NT
RAID level Configured by:	0/1/5 Host	0/1/3/5/0+1 Preset	0/1/3/5/0+1	0/1/3/5/0+1	0/1/3/5/0+1
Array capacity (Gbytes) MIN MAX	2.1 191	2.1 127	2.1 218	2.1 655	2.1 431
Minimum drives per array	1	1	1	1	1
Maximum drives per array	21	14	42	72	48
Concurrent host channels	1	1	1	1	1
Array interface to host	PCI	SCSI-2	SCSI-2	Ultra, SCSI	Ultra, SCSI
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	Ultra, SCSI	Ultra, SCSI
Cache size (min, max: MB)	4, 8	16	32, 128	256	256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	Option 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)	30 40	20 20	20 10	40 40	40 40
DRIVES: Formatted capacity/drive(MB)	2100,4300,9100	2100,4300,9100	2100,4300,9100	2100,4300,9100	2100,4300,9100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8	8	Drive dependent	8	8
Average rotational delay (msec)	4.2	4.2	Drive dependent	4.2	4.2
ARRAY SIZE: Inches: H x W x D	22.2 x 8.2 x 17	21.4 x 9.6 x 20.6	33 x 18.75 x 19	66.9 x 23.6 x 35.4	66.9 x 23.6 x 35.4
POWER: Power backup	150 watts Battery option	204 watts Battery	204 watts Battery	110-240 V Single phase	110-240 V Single phase
FIRST CUSTOMER SHIPMENT	6/97	5/96	11/96	9/97	9/97
COMMENTS			Uses Digital HSZ50 controller.		

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	ESA 10000 High Bandwith	ESA Model C	ESA Model M	ESA Model L	HA2400C/SC-4600
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	Captive, PCM	Captive, PCM	Captive, PCM	OEM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Digital, IBM, HP Sun, Intel UNIX, OVMS, NT	VAX, Alpha, Open Systems	VAX, Alpha, Open Systems	VAX, Alpha, Open Systems	SCSI host Various
RAID level Configured by:	0/1/3/5/0+1	0/1/3/5/0+1	0/1/3/5/0+1	0/1/3/5/0+1	0/1/3/5/0+1 Host
Array capacity (Gbytes) MIN MAX	2.1 437	155 21612	155 2457	155 2293	6.3 218.4
Minimum drives per array	1	36	36	36	3
Maximum drives per array	48	2375	270	252	24
Concurrent host channels	1	1, 66	2, 15	3, 21	1
Array interface to host	Ultra, SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	Ultra, SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	512	250-16896	512-3840	786-5376	32
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)	40 40	20/Port 20	20/Port 20	20/Port 20	20 20
DRIVES: Formatted capacity/drive(MB)	2100,4300,9100	4300, 9100	4300, 9100	4300, 9100	2100,4300,9100
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
ARRAY SIZE: Inches: H x W x D	66.9 x 23.6 x 35.4	67 x 31 x 34.5	67 x 31 x 34.5	67 x 31 x 34.5	34 x 19 x 21
POWER: Power backup	110-240 V Single phase	Battery	Battery	Battery	Battery
FIRST CUSTOMER SHIPMENT	9/97	3Q96	3Q96	3Q96	4Q94
COMMENTS		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	HA2450/SC-5650	HA720W/SC-4200	HS211	HS221	HS241
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM, PCM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	Alpha, Open VMS	Alpha, Open VMS	Alpha, Open VMS
RAID level Configured by:	0/1/3/5/10 Host	0/1/3/5/0+1	0/1/3/5	0/1/3/5	0/1/3/5
Array capacity (Gbytes) MIN MAX	6.3 218.4	6.3 60	6.3 382	6.3 328	6.3 655
Minimum drives per array	3	3	3	3	3
Maximum drives per array	72	14	42	36	72
Concurrent host channels	1	1	1	2	2
Array interface to host	Ultra SCSI	SCSI-2	FDDI	FDDI	FDDI
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	64, 128	4, 16	32	64	128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	 Yes Yes	No 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)	40 40	20 20	12 10	24 10	24 10
DRIVES: Formatted capacity/drive(MB)	2100,4300,9100	Drive dependent	2100,4300,9100	2100,4300,9100	2100,4300,9100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8	Drive dependent	8	8	8
Average rotational delay (msec)	4.2	Drive dependent	4.2	4.2	4.2
ARRAY SIZE: Inches: H x W x D	34 x 19 x 21		67 x 31 x 34.5	67 x 31 x 34.5	67 x 31 x 34.5
POWER: Power backup	Battery	Cache battery			
FIRST CUSTOMER SHIPMENT	7/97	4Q94	4Q95	4Q95	4Q95
COMMENTS					

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	HSD10	HSD30	HSD50	HSJ30 StorageWorks	HSJ40 StorageWorks
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host 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	0/1/3/5	0/1/3/5	0/1/3/5	0/1/3/5
Array capacity (Gbytes) MIN MAX	2.1 63.7	2.1 191	2.1 382	2.1 164	2.1 328
Minimum drives per array	1	1	1	1	1
Maximum drives per array	7	21	42	18	36
Concurrent host channels	1	1	1	1, 8	1, 8
Array interface to host	DSSI	DSSI	DSSI	CI	CI
Drive interface	SCSI-2	SCSI	SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	16, 32	16, 32	64, 128	0, 32	16, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)		--	--		
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	3 10	3.2 10	3.4 10	6.7 10	6.7 10
DRIVES: Formatted capacity/drive(MB)	2100,4300,9100	2100,4300,9100	2100,4300,9100	2100,4300,9100	2100,4300,9100
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
ARRAY SIZE: Inches: H x W x D				Various configurations	Various configurations
POWER: Power backup				1300-3140 watts	1300-3140 watts
FIRST CUSTOMER SHIPMENT	1/94	1/94	3Q96	1Q94	3Q93
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	VAX, Alpha, VMS	VAX, Alpha, VMS	VAX, Alpha, VMS	Digital, IBM, HP Sun, Intel, UNIX, OVMS, NT	Digital, IBM, HP Sun, Intel, UNIX, OVMS, NT
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 MAX	2.1 328	4.2 328/655	8.4 655/1310	2.1 382	2.1 382
Minimum drives per array	1	2	2	1	1
Maximum drives per array	36	36/72	72/144	42	42
Concurrent host channels	1, 8	1, 8	1, 8	1	1
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
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes (option) Yes Yes	Yes (option) Yes Yes
Spare drive (None/Auto/Manual)				Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	12.7 10	25.4 10	50.8 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	2100,4300,9100	2100,4300,9100	2100,4300,9100	2100,4300,9100	2100,4300,9100
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
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	HSZ70	QL-OMHA-AA QL-2YFA-AA QL-OMGAA-3B StorageWorks	RA 7000	SWXNA-AA,AB SWXNA-FA,FB	SWXNA-BA,BB SWXNA-GA,GB
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	Captive	Captive, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Software -- Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Digital,IBM,HP Sun, Intel, UNIX, OVMS, NT	Open VMX VAX	Digital,IBM,HP Sun, Intel UNIX, OVMS, NT	UNIX, Windows NT	UNIX, Windows NT
RAID level Configured by:	0/1/3/5/10	0/1/5 Host	0/1/3/5	0/1/3/5	0/1/3/5
Array capacity (Gbytes) MIN MAX	2.1 655	-- --	2.1 655	6.3 328	6.3 655
Minimum drives per array	1	--	1	3	3
Maximum drives per array	72	7 + parity	72	36	72
Concurrent host channels	1	--	1	1, 2	1, 2
Array interface to host	Ultra SCSI	Varies	Ultra, SCSI	FDDI, CDDI	FDDI, CDDI
Drive interface	Ultra SCSI	Varies	Ultra, SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	64, 128	--	64, 128	2, 32	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes (option) Yes Yes	-- -- --	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)	40 40	-- --	40 40	12 10	12 10
DRIVES: Formatted capacity/drive(MB)	2100,4300,9100	2100,4300,9100	2100,4300,9100	2100,4300,9100	2100,4300,9100
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
ARRAY SIZE: Inches: H x W x D		--	35.25 x 19 x 21.25	67 x 31 x 34.5	67 x 31 x 34.5
POWER: Power backup		-- --	110-240 V Single phase		
FIRST CUSTOMER SHIPMENT	9/97	12/93	9/97	2Q96	2Q96
COMMENTS					

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DILOG SA	DILOG SA	DILOG SA	DIRECT CONNECT SYSTEMS
ARRAY MODEL	Volume Shadowing, Version 6.0	2XFR	Ultra-Windjammer	Windjammer	Guardian Enterprise Array
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Software -- Software	Board Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	VAX, Alpha	SCSI host Various	SCSI host Various	SCSI host Various	DEC, Sun, AT&T UNIX, OS/2, NetWare
RAID level Configured by:	1	0/1 Port	0/1 Panel, Port	0/1 Panel, Port	0/1/3/5/10 Host, 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	2	5
Maximum drives per array	130 x 3	2	14	14	35
Concurrent host channels	1, 130	1	1	1	1, 2
Array interface to host	DSSI, SCSI, CI	Ultra SCSI	Ultra SCSI-2	SCSI-2	SCSI-2
Drive interface	DSSI, SCSI, CI	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	N/A	4, 16	8, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	No No No	No N/A N/A	No N/A N/A	Yes Yes Yes
Spare drive (None/Auto/Manual)	--	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Drive dependent Drive dependent	40 40	40 20	20 10	20 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	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
ARRAY SIZE: Inches: H x W x D	--	1.625 x 4 x 5.9	1.625 x 5 x 7	1.625 x 5 x 8	67 x 31 x 34.5
POWER: Power backup	-- --	6.2 watts None	8 watts+ drives None	8 watts+ drives None	880 watts Battery
FIRST CUSTOMER SHIPMENT	1990	4Q97	8/96	1/94	1994
COMMENTS			Byte striping in RAID 0.	Byte striping in RAID 0.	

MANUFACTURER	DIRECT CONNECT SYSTEMS	DIRECT CONNECT SYSTEMS	DIVERSE LOGISTICS	DIVERSE LOGISTICS	DIVERSE LOGISTICS
ARRAY MODEL	Server 24 Guardian RAID	Server 7 Guardian RAID	2XFR	Ultra-Windjammer	Windjammer
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	DEC, Sun, AT&T UNIX, OS/2, NetWare	DEC, Sun, AT&T UNIX, OS/2, NetWare	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1/3/5 Panel, Port	0/1/3/5 Panel, Port	0/1 Port	0/1 Panel, Port	0/1 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	3	3	2	2	2
Maximum drives per array	24	7	2	14	14
Concurrent host channels	1, 3	1	1	1	1
Array interface to host	SCSI-2	SCSI-2	Ultra SCSI	Ultra SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	Ultra SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	32	16, 32	--	N/A	4, 16
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes	No No No	No N/A N/A	No N/A N/A
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10	10/20 10	40 40	40 20	20 10
DRIVES: Formatted capacity/drive(MB)	4500-9100	4500-9100	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
ARRAY SIZE: Inches: H x W x D		22.25 x 7.5 x 23	1.625 x 4 x 5.9	1.625 x 5 x 7	1.625 x 5 x 8
POWER: Power backup	400 watts None	170 watts Cache battery	6.2 watts None	8 watts+ drives None	8 watts+ drives None
FIRST CUSTOMER SHIPMENT	1995	1995	4Q97	8/96	1/94
COMMENTS	DEC StorageWorks.	DEC StorageWorks.		Byte striping in RAID 0.	Byte striping in RAID 0.

MANUFACTURER	DPT	DPT	DPT	DPT	DPT
ARRAY MODEL	DM4000 SmartCache III Disk Array Module	DM401X SmartCache Plus Disk Array Module	DPT-RS3/UR DPT-RS3W/UR*	EISATWR SmartRAID Subsystem	PCITWR SmartRAID Subsystem
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 Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware	Subsystem Host 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	PC compatible NetWare, OS/2, NT, 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	7	7	6	6
Concurrent host channels	1	1	1	2	2
Array interface to host	PCI, EISA, ISA	EISA, ISA	PCI	EISA	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2,Ult.SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	1, 64	1, 16	4, 64	1, 64	1, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No No	Yes No No	Yes No No	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)	132/33/10 10	33/10 10	132 20/40*	33 10	132 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	1100,2100,4300	1100,2100,4300
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
ARRAY SIZE: Inches: H x W x D	Adapter dependent	Adapter dependent	9.4 x 7.6 x 11.7	21.4 x 9.6 x 20.6	21.4 x 9.6 x 20.6
POWER: Power backup	10 watts+drives None	10 watts+drives None	11 watts+drives	164 watts None	164 watts None
FIRST CUSTOMER SHIPMENT	3Q93	3Q93	1/97	3Q94	3Q94
COMMENTS	SmartCache Plus SCSI controller option. CM4000 cache module is prerequisite.	SmartCache Plus SCSI controller option. CM401X cache module is prerequisite.	Includes card, 4 MB SIMM, 3-bay tower w/o drives. *Ultra SCSI.		

MANUFACTURER	DPT	DPT	DPT	DPT	DPT
ARRAY MODEL	PM2044UWR PM2044UWRH	PM2144UWR PM2144UWRH	PM3222 SmartRAID Controller	PM3224 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 Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host 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 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			37*	37*	15, 45*
Concurrent host channels	1	1	1	1	1
Array interface to host	PCI	PCI	EISA	PCI	EISA
Drive interface	SCSI-3	SCSI-3	SCSI-2	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	1, 64	1, 64	1, 64	1, 64	1, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No No	Yes No No	Yes No No	Yes No No	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 10/20/40	132 10/20/40	33 10	132 10/20	33 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
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup	11 watts+drives None	11 watts+drives None	12 watts+drives None	11 watts+drives None	12 watts+drives
FIRST CUSTOMER SHIPMENT			3Q94	3Q94	6/96
COMMENTS	Array kit.	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	*With SX4030. ECC cache option.

MANUFACTURER	DPT	DPT	DPT	DPT	DPT
ARRAY MODEL	PM3332UW/2	PM3332UW/3	PM3334UDW	PM3334UW	PM3334UW-AIX
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 Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	PC compatible	PC compatible	PCI host Various	PCI host Various	PCI host AIX 4.1 and up
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	30	45	15, 45*	15, 45*	15, 45*
Concurrent host channels	2	3	1	1	1
Array interface to host	EISA	EISA	PCI	PCI	PCI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-3
Cache size (min, max: MB)	4, 64	4, 64	16, 64	16, 64	16, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No No	Yes No No	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	32 40	32 40	132 40	132 40	132 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
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup	12 watts+drives	12 watts+drives	12 watts+drives None	12 watts+drives	12 watts+drives
FIRST CUSTOMER SHIPMENT	6/96	6/96	11/96	6/96	
COMMENTS			Differential Ultra SCSI. *With SX4030.	*With SX4030. ECC cache option. -MAC for Macintosh.	*With SX4030. Voltage and internal temp. monitor. 68040 processor

MANUFACTURER	DPT	DPT	DPT	DPT	DTC TECHNOLOGY
ARRAY MODEL	PM3334UW/2	PM3334UW/3	RC4040 SmartCache IV RAID/Caching	RC4041	8201
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Single User
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	PC compatible	PC compatible	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	0/1 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	30	45	7	7	7
Concurrent host channels	2	3	1	1	1
Array interface to host	PCI	PCI	PCI, EISA, ISA	--	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	SCSI-3	--	Ultra SCSI
Cache size (min, max: MB)	4, 64	4, 64	1, 64	16, 32	4, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No No	Yes No No	Yes No No	-- -- --	No -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	132 40	132/33/10 10/20	33/132 40	20 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
ARRAY SIZE: Inches: H x W x D			Adapter dependent		
POWER: Power backup	12 watts+drives	12 watts+drives	10 watts None	12 watts+drives	
FIRST CUSTOMER SHIPMENT	6/96	6/96	2/96	6/96	1996
COMMENTS	68040 processor	68040 processor	SmartCache IV SCSI adapter option.	Requires DPT PM2X44 adapter. Uses DPT DIMMS.	

MANUFACTURER	DTC TECHNOLOGY	DTC TECHNOLOGY	DTC TECHNOLOGY	DTC DATA TECHNOLOGY CORPORATION	DYNATEK AUTOMATION SYSTEMS
ARRAY MODEL	8230	8235	8260	HardCopy	NET109.0F
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Network Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	PC compatible DOS, Windows, NT, OS/2, other	Networked host NT, NetWare, OS/2, UNIX
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host	1 Preset	0/1/4/5/10 Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	 109.2
Minimum drives per array	2	2	2	2	14
Maximum drives per array	35	14	1	4	14
Concurrent host channels	1	1	14	1	1
Array interface to host	Ultra SCSI	Ultra SCSI	PCI	ISA	Ethernet 10BT
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	EIDE	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	4, 32	--	4, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	No -- --	No -- --	No No No	No Yes Per drive
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Auto
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	 40 40	 40 40	 132 40	 Host dependent Drive dependent	 1.2 10/20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	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	10
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4.17
ARRAY SIZE: Inches: H x W x D				4.5 x 7.645 x 45	20.94 x 35.7 x 12.48
POWER: Power backup				5.5watts+drives None	
FIRST CUSTOMER SHIPMENT	1997	1996	1997	2/96	1/97
COMMENTS					

MANUFACTURER	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS
ARRAY MODEL	NET18.0F	NET36.0F	NET63.0F	NET72.0F	NET91.0F
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware
Host platform, software environment	Networked host NT, NetWare, OS/2, UNIX	Networked host NT, NetWare, OS/2, UNIX	Networked host NT, NetWare, OS/2, UNIX	Networked host NT, NetWare, OS/2, UNIX	Networked host NT, NetWare, OS/2, UNIX
RAID level Configured by:	0/1/4/5/10 Port	0/1/4/5/10 Port	0/1/4/5/10 Port	0/1/4/5/10 Port	0/1/4/5/10 Port
Array capacity (Gbytes) MIN MAX	 18.2	 36.4	 63.7	 72.8	 91.0
Minimum drives per array	3	5	8	10	12
Maximum drives per array	3	5	8	10	12
Concurrent host channels	1	1	1	1	1
Array interface to host	Ethernet 10BT	Ethernet 10BT	Ethernet 10BT	Ethernet 10BT	Ethernet 10BT
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	4, 64	4, 64	4, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Per drive	No Yes Per drive	No Yes Per drive	No Yes Per drive	No Yes Per drive
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	1.2 10/20	1.2 10/20	1.2 10/20	1.2 10/20	1.2 10/20
DRIVES: Formatted capacity/drive(MB)	9100	9100	9100	9100	9100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	10	10	10	10	10
Average rotational delay (msec)	4.17	4.17	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	17.85 x 10.47 x 12.48	17.85 x 10.47 x 12.48	17.85 x 10.47 x 12.48	20.94 x 35.7 x 12.48	20.94 x 35.7 x 12.48
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	1/97	1/97	1/97	1/97	1/97
COMMENTS					

MANUFACTURER	ECCS	ECCS	ECCS	ECCS	ECLIPSE TECHNOLOGIES
ARRAY MODEL	Micro DFT-1R	Raven UX 410	Synchronection	Synchronix	Mariner 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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Host Hardware	Board Host Hardware
Host platform, software environment	NCR, HP, Sun, RS/6000,NetWare Windows NT	Sun	SCSI host	NCR,HP,Sun,SCI, RS/6000,NetWare Windows NT,UNIX	SCSI host Various
RAID level Configured by:	1/10 Preset	1/10 Preset	0/1/3/5/10 Port	0/1/3/5/10 Host, Port	0/1/3/4/5/10 Host, Port
Array capacity (Gbytes) MIN MAX	4.2 33.6	4.2 18.2	10.2 546	10.2 270	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	87	4	60	30	35
Concurrent host channels	1-4	3	12	2	1
Array interface to host	SCSI-2	SCSI	SCSI,FDDI,Ether	SCSI-2,Ult.SCSI	SCSI-2
Drive interface	SCSI-2	Ultra SCSI	SCSI-2,Ult.SCSI	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	None		16, 224	16-224	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	20 20	100 40	40 40	20 10
DRIVES: Formatted capacity/drive(MB)	2100-4200	4200-23000	2100-9100	2100-9100	Drive dependent
Nominal disk diameter (mm)	95	95, 130	95	95	95
Average positioning time (msec)	8	Varies	8	8	Drive dependent
Average rotational delay (msec)	4.17	Varies	4.17	4.17	Drive dependent
ARRAY SIZE: Inches: H x W x D	5.88 x 17 x 16	5.25 x 17 x 22	Varies	7-17.5 x 17.5 x 24	7.5 x 19 x 20
POWER: Power backup	300 watts None		500 watts	350-1050 watts UPS option	180 watts None
FIRST CUSTOMER SHIPMENT	10/94	11/96	3/97	12/94	1/95
COMMENTS	ECCS controller		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	3100-9 Symmetrix	3130-4 Symmetrix	3200-9 Symmetrix	3240-4	3330-9M Symmetrix
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Open Systems UNIX, PC	Open Systems AS/400	Open Systems UNIX, PC	Open Systems AS/400	Open Systems UNIX, PC, AS/400
RAID level Configured by:	0/1/"S"	0/1/"S" Preset	0/1/"S"	0/1/"S" Preset	1 Preset
Array capacity (Gbytes) MIN MAX	70/35/52 140/70/104	67/33/50 134/67/100	140/70/104 279/140/209	134/67/100 402/201/302	36 144
Minimum drives per array	8	16	16	32	8
Maximum drives per array	16	32	32	96	32
Concurrent host channels	8, 16	4, 8	8, 16	4, 16	8-16
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2, FC-AL
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	512, 2048	512, 2048	512, 4096	512, 4096	--, 2048
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)		20 20		20 20	20/100 20
DRIVES: Formatted capacity/drive(MB)	8730	4192	8730	4192	9100
Nominal disk diameter (mm)	130	95	130	95	95
Average positioning time (msec)	12	12	12	12	8 RD/9 WR
Average rotational delay (msec)	5.6	5.6	5.6	5.6	2.99
ARRAY SIZE: Inches: H x W x D	46 x 21 x 36	46 x 21 x 36	73.6 x 24.3 x 36.4	73.6 x 24.3 x 36.4	46 x 21 x 36
POWER: Power backup	1.39-1.63 KVA Battery	1.36-1.63 KVA Battery	1.96-2.65 KVA Battery	2.0-2.61 KVA Battery	1.17-1.76 KVA Battery
FIRST CUSTOMER SHIPMENT	6/95		6/95		2/97
COMMENTS					

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	3330-9S Symmetrix	3430-9M Symmetrix	3430-9S Symmetrix	3500-9 Symmetrix	3700-23M Symmetrix
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Open Systems UNIX, PC, AS/400	Open Systems UNIX, PC, AS/400	Open Systems UNIX, PC, AS/400	Open Systems UNIX, PC	Open Systems UNIX, PC, AS/400
RAID level Configured by:	0/1/"S" Preset	1 Preset	0/1/"S" Preset	0/1/"S"	1 Preset
Array capacity (Gbytes) MIN MAX	72/36/54 289/144/217	54 434	108/54/81 868/434/651	279/140/209 1118/559/836	184 1477*
Minimum drives per array	8	12	12	32	16
Maximum drives per array	32	96	96	128	128
Concurrent host channels	8-16	8-16	8-16	8, 32	8-32
Array interface to host	SCSI-2, FC-AL	SCSI-2, FC-AL	SCSI-2, FC-AL	SCSI-2	SCSI-2, FC-AL
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--, 2048	--, 4096	--, 4096	1024, 4096	--, 4096
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)	20/100 20	20/100 20	20/100 20		20/100 20
DRIVES: Formatted capacity/drive(MB)	9100	9100	9100	8730	23400
Nominal disk diameter (mm)	95	95	95	130	130
Average positioning time (msec)	8 RD/9 WR	8 RD/9 WR	8 RD/9 WR	12	13 RD/14 WR
Average rotational delay (msec)	2.99	2.99	2.99	5.6	5.6
ARRAY SIZE: Inches: H x W x D	46 x 21 x 36	73.6 x 24.3 x 36.4	73.6 x 24.3 x 36.4	74.9 x 68.7 x 36.4	74.9 x 68.7 x 36.4
POWER: Power backup	1.17-1.76 KVA Battery	1.49-3.28 Battery	1.49-3.28 Battery	4.61-8.81 KVA Battery	3.98-8.81 KVA Battery
FIRST CUSTOMER SHIPMENT	2/97	2/97	2/97	6/95	2/97
COMMENTS					*2954 GB when used with remote site mirror.

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	5100-9 Symmetrix	5100-9M Symmetrix	5100-9S Symmetrix	5200-3 Symmetrix	5200-9 Symmetrix
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.	IBM mainframes All OS and VAR Open Systems	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.
RAID level Configured by:	0/1/"S" Preset	1 Preset	0/1/"S" Preset	0/1 Preset	0/1/"S" Preset
Array capacity (Gbytes) MIN MAX	68/34/51 136/68/102	34 68	68/34/51 136/68/102	45 90	68/68/51 272/136/204
Minimum drives per array	8	8	8	16	8
Maximum drives per array	16	16	16	32	32
Concurrent host channels	4, 8	4, 8	4, 8	4, 16	4, 16
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, 2048	512, 2048	768, 2048	512, 4096	512, 4096
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)	3/4.5/10/17 Drive dependent	3/4.5/10/17 Drive dependent	3/4.5/10/17 Drive dependent	3/4.5/10/17 Drive dependent	3/4.5/10/17 Drive dependent
DRIVES: Formatted capacity/drive(MB)	8530	8530	8530	2830	8530
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
ARRAY SIZE: Inches: H x W x D	42 x 21 x 36	42 x 21 x 36	42 x 21 x 36	73.62 x 24.25 x 36.4	73.6 x 24.3 x 36.4
POWER: Power backup	1.39-1.63 KVA Battery	1.39-1.63 KVA Battery	1.39-1.63 KVA Battery	1.96-2.65 KVA Battery	1.62-2.65 KVA Battery
FIRST CUSTOMER SHIPMENT	4/95	4/95	4/95	5/94	5/95
COMMENTS				Unisys/Bull version available.	

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	5200-9M Symmetrix	5200-9S Symmetrix	5230-4 Symmetrix	5230-4M Symmetrix	5230-4S Symmetrix
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.	Mainfrm/Opn Sys Mainframe OS & Var. Open Syst.
RAID level Configured by:	 Preset	0/1/"S" Preset	0/1/"S" Preset	1 Preset	0/1/"S" Preset
Array capacity (Gbytes) MIN MAX	68 136	68/68/51 272/136/204	45/22/34 363/181/272	67 201	83/67/62 402/201/302
Minimum drives per array	16	8	20	32	20
Maximum drives per array	32	16	96	96	96
Concurrent host channels	4, 16	4, 16	4, 16	4, 16	4, 16
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	1024, 4096	512, 4096	512, 4096	1024, 4096
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)	3/4.5/10/17 Drive dependent	3/4.5/10/17 Drive dependent	3/4.5/10/17 Drive dependent	3/4.5/10/17 Drive dependent	3/4.5/10/17 Drive dependent
DRIVES: Formatted capacity/drive(MB)	8530	8530	4192	4192	4192
Nominal disk diameter (mm)	130	130	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
ARRAY SIZE: Inches: H x W x D	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	73.6 x 24.3 x 36.4
POWER: Power backup	1.96-2.65 KVA Battery	1.62-2.65 KVA Battery	2.0-2.61 KVA Battery	2.43-3.83 KVA Battery	2.17-3.83 KVA Battery
FIRST CUSTOMER SHIPMENT	5/94	5/95	4/95	4/95	4/95
COMMENTS	Unisys/Bull version available.				

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	5330-9M Symmetrix	5330-9S Symmetrix	5430-9M Symmetrix	5430-9S Symmetrix	5500-2 Symmetrix
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.	IBM mainframes All OS
RAID level Configured by:	1 Preset	0/1/"S" Preset	1 Preset	0/1/"S" Preset	0/1 Preset
Array capacity (Gbytes) MIN MAX	72 144	72/--/54 289/144/217	108 434	108/--/81 868/434/651	90/45 242/121
Minimum drives per array	16	8	24	12	48
Maximum drives per array	32	32	96	96	128
Concurrent host channels	8-16	8-16	8-16	8-16	8, 16
Array interface to host	BMX,ESC,SCSI/FC	BMX,ESC,SCSI/FC	BMX,ESC,SCSI/FC	BMX,ESC,SCSI,FC	BMX,ESCON,SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--, 2048	--, 2048	--, 4096	--, 4096	1792, 4096
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)	3/4.5/10/17/100 20	3/4.5/10/17/100 20	3/4.5/10/17/100 20	3/4.5/10/17/100 20	3/4.5/10/17 Drive dependent
DRIVES: Formatted capacity/drive(MB)	9100	9100	9100	9100	1890
Nominal disk diameter (mm)	95	95	95	95	130
Average positioning time (msec)	8 RD/9 WR	8 RD/9 WR	8 RD/9 WR	8 RD/9 WR	Drive dependent
Average rotational delay (msec)	2.99	2.99	2.99	2.99	Drive dependent
ARRAY SIZE: Inches: H x W x D	46 x 21 x 36	46 x 21 x 36	73.6 x 24.3 x 36.4	73.6 x 24.3 x 36.4	74.9 x 68.7 x 36.4
POWER: Power backup	1.37-1.76 KVA Battery	1.17-1.76 KVA Battery	1.57-3.28 KVA Battery	1.49-3.28 KVA Battery	5.36-8.81 KVA Battery
FIRST CUSTOMER SHIPMENT	2/97	2/97	2/97	2/97	11/92
COMMENTS					Unisys/Bull version available.

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	5500-3 Symmetrix	5500-9 Symmetrix	5500-9M Symmetrix	5500-9S Symmetrix	5700-23M Symmetrix
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	IBM mainframes All OS	Mainfrm/Opn Sys Mainframe OS & Var. Open Syst.	Mainfrm/Opn Sys Mainframe OS & Var. Open Syst.	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys.	Mainfrm/Opn Sys Mainframe OS & Var. Open Sys
RAID level Configured by:	0/1 Preset	0/1/"S" Preset	1 Preset	0/1/"S" Preset	1 Preset
Array capacity (Gbytes) MIN MAX	136/68 363/181	136/136/102 1088/544/816	136 544	136/136/102 1088/544/816	184 1477*
Minimum drives per array	48	16	32	16	16
Maximum drives per array	128	128	128	128	128
Concurrent host channels	8, 16	8, 16	8, 16	8, 16	4-32
Array interface to host	BMX,ESCON,SCSI	BMX,ESCON,SCSI	BMX,ESCON,SCSI	BMX,ESCON,SCSI	BMX/ESC/SCSI/FC
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1792, 4096	1024, 4096	1024, 4096	1024, 4096	--, 4096
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)	3/4.5/10/17 Drive dependent	3/4.5/10/17 Drive dependent	3/4.5/10/17 Drive dependent	3/4.5/10/17 Drive dependent	3/4.5/10/17/100 20
DRIVES: Formatted capacity/drive(MB)	2830	8530	8530	8530	23400
Nominal disk diameter (mm)	130	130	130	130	130
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	13 RD/14 WR
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	5.6
ARRAY SIZE: Inches: H x W x D	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	74.9 x 68.7 x 36.4
POWER: Power backup	5.36-8.81 KVA Battery	3.98-8.81 KVA Battery	4.67-8.81 KVA Battery	3.98-8.81 KVA Battery	3.98-8.81 KVA Battery
FIRST CUSTOMER SHIPMENT	1Q93	5/95	5/94	5/95	2/97
COMMENTS	Unisys/Bull version available.		Unisys/Bull version available.		*2954 GB when used with remote site mirror.

MANUFACTURER	ENCORE COMPUTER	ENLIGHT	ENLIGHT	ENLIGHT	EUROLOGIC SYSTEMS LIMITED
ARRAY MODEL	Infinity SP30 Infinity SP40	EN-8800	EN-8850	EN-8900	Voyager 1000
DISK/TREND GROUP	Mainframe	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	IBM mainframes (3990), Encore, other	SCSI host NT, OS/2, UNIX	SCSI host NT, OS/2, UNIX	SCSI host NT, OS/2, UNIX	PCI host NT, NetWare, other
RAID level Configured by:	0/1/5	0/1/5 Panel, Port	0/1/5 Panel, Port	0/1/5 Panel, Port	0/1/3/5 Panel, Port
Array capacity (Gbytes) MIN MAX	48 324*	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	 126
Minimum drives per array	12	2	2	2	2/3
Maximum drives per array	108*	42	7	4	14
Concurrent host channels	4-32	1, 2	1, 2	1, 2	1
Array interface to host	IBM, SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI	PCI
Drive interface	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	512, 4096	2, 64	2, 64	2, 64	8, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No -- --	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)	4.5** 10	40 40	40 40	40 40	132 20/40
DRIVES: Formatted capacity/drive(MB)	4200, 9100	Drive dependent	Drive dependent	Drive dependent	1000-9000
Nominal disk diameter (mm)	95	Drive dependent	95	130	95
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
ARRAY SIZE: Inches: H x W x D	79 x 41 x 39	1.69 x 5.79 x 8.54	1.69 x 5.79 x 8.54	1.69 x 5.79 x 8.54	14 x 15.1 x 20.4
POWER: Power backup	 UPS	21 watts None	250 watts None	250 watts None	200-400 watts
FIRST CUSTOMER SHIPMENT	4Q94	1997	1997	1997	1Q97
COMMENTS	Redundant cache Dual AC. *324 with expan cab., 1.3TB max **Per IBM block mux channel.	AMD 5X86-133 processor. Controller only	AMD 5X86-133 processor. Controller and enclosure.		CMD controller.

MANUFACTURER	EUROLOGIC SYSTEMS LIMITED	EUROLOGIC SYSTEMS LIMITED	FUJITSU	FUJITSU	FWB SOFTWARE
ARRAY MODEL	Voyager 3000	Voyager 5000	F6492	F6493 F1710	RAID ToolKit Version 2.06
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Mainframe	Mainframe	Single User
MARKET	PCM	PCM	Captive	Captive	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Software -- Software
Host platform, software environment	SCSI host	SCSI host	Fujitsu M series	Fujitsu M series, VP series	Macintosh, Quadra, Power Mac 8100
RAID level Configured by:	0/1/3/5 Panel, Port	0/1/4/5/10 Panel, Port	3 Host	3 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	 117	 378	5.04 90.72	5.04 181.44	Drive dependent
Minimum drives per array	2/3	2/3	5	5	2
Maximum drives per array	13	42	32	16	15
Concurrent host channels	1	1, 3	2-8	4-16 (F1710)	1
Array interface to host	Ultra SCSI	Ultra SCSI-2	Proprietary,OEM	Proprietary,OEM	SCSI, NuBus
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 32	8, 256	512, 2048	256, 3072	Drive dependent
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20/40 20/40	10/20/40 10/20	20 20	20 20	Drive dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	1000-9000	1000-9000	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	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
ARRAY SIZE: Inches: H x W x D	14 x 15.1 x 20.4	31.5 x 23.6 x 46.5	71 x 33.5 x 30	71 x 22 x 30	--
POWER: Power backup	200-400 watts	720-1320 watts Cache battery	1.0-2.0 KVA	1.0-2.9 KVA	-- None
FIRST CUSTOMER SHIPMENT	1Q97	1Q97		3Q95	1996
COMMENTS	CMD controller.	CMD controller.	Sold in Japan.	Sold in Japan. Up to 4 F6493 can be attached to F1710A controller.	

MANUFACTURER	GAIN SYSTEMS	GIGATREND	GIGATREND	HAMMERSTORAGE (STREAMLOGIC)	HAMMERSTORAGE (STREAMLOGIC)
ARRAY MODEL	7000	TITAN ES 834	TITAN ES 867	Pro FTS SledgeHammer	Pro 2 UWD SledgeHammer
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Net/Midrange
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Software
Host platform, software environment	IBM compatible NetWare, UNIX	SCSI host NetWare, NT, UNIX	SCSI host NetWare, NT, UNIX	Macintosh	Macintosh NT
RAID level Configured by:	0/1/5/10	0/1/3/5 Host,Panel,Port	0/1/3/5 Host,Panel,Port	0/1/5 Host	0/1
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	 34.4	 72.8	12 68	4.1 17.4
Minimum drives per array	2	2	2	3	2
Maximum drives per array	8	7	7	8	2
Concurrent host channels	1	1	1	1	1, 2
Array interface to host	PCI	Ultra SCSI	Ultra SCSI	SCSI	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	16	64, 128	64, 128	8, 128	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes	Option Yes Yes	No Yes Yes	-- No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto (RAID-1)
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	40 40	40 40	20 20/40	27 17
DRIVES: Formatted capacity/drive(MB)	Drive dependent	4300	9100	4100, 8700	4100, 8700
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	7.9	7.9	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	4.17	4.17	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	32 x 22 x 10			7 x 19 x 21.5	10.25 x 7 x 14.5
POWER: Power backup	600 watts None				
FIRST CUSTOMER SHIPMENT	1997	1997	1997	6/96	1997
COMMENTS	AMI controller. Custom configurations available.	i960 processor. Rack mount option. Mylex controller.	i960 processor. Rack mount option. Mylex controller.	Desktop and rack options.	

MANUFACTURER	HAMMERSTORAGE (STREAMLOGIC)	HAMMERSTORAGE (STREAMLOGIC)	HAMMERSTORAGE (STREAMLOGIC)	HAMMERSTORAGE (STREAMLOGIC)	HAMMERSTORAGE (STREAMLOGIC)
ARRAY MODEL	Pro 4 UWD SledgeHammer	Pro 8 UWD SledgeHammer	Pro FTP SledgeHammer	UN SledgeHammer	UW SledgeHammer
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type / Attachment / Implementation	Subsystem / Host / Software	Subsystem / Host / Software	Subsystem / Host / Hardware	Subsystem / Host / Software	Subsystem / Host / Software
Host platform, software environment	Macintosh NT	Macintosh NT	Macintosh	Macintosh NT	Macintosh NT
RAID level / Configured by:	0/1	0/1	0/1/5/10 / Host	0/1	0/1
Array capacity (Gbytes) MIN / MAX	4.1 / 34.8	4.1 / 69.6	12 / 72	4.1 / 17.4	4.1 / 17.4
Minimum drives per array	2	2	3	2	2
Maximum drives per array	4	8	8	2	4
Concurrent host channels	1, 2	1, 2	1	1	1
Array interface to host	Ultra SCSI	Ultra SCSI	SCSI	Ultra SCSI	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)			8, 128		
Redundancy: Controller (Yes/No) / Fan (Yes/No) / Power supply (Yes/No)	-- / No / No	-- / No / No	No / Yes / Yes	-- / No / No	-- / No / No
Spare drive (None/Auto/Manual)	Auto (RAID-1)	Auto (RAID-1)	Auto	Auto (RAID-1)	Auto (RAID-1)
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) / drive (MB/Sec)	60 / 17	66 / 17	20 / 20/40	40 / 11	40 / 13
DRIVES: Formatted capacity/drive(MB)	4100, 8700	4100, 8700	4100, 8700	4100, 8700	4100, 8700
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
ARRAY SIZE: Inches: H x W x D	14.5 x 7 x 14.5	7 x 19 x 21.5	7 x 19 x 21.5		
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	1997	1997		1997	1997
COMMENTS			Desktop and rack options.		

MANUFACTURER	HAMMERSTORAGE (STREAMLOGIC)	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HITACHI
ARRAY MODEL	UWD SledgeHammer	12H AutoRAID	A3515A AutoRAID (Deskside)	A3516A/A2 AutoRAID (Rack Mount)	DF-300-RK A-6531-RK
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	Captive, OEM	Captive	Captive	Captive,OEM,PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Macintosh NT	SCSI host UNIX	SCSI host Various	SCSI host Various	SCSI host UNIX, NT, NetWare
RAID level Configured by:	0/1	0/1/5	0/1/5 Host, Panel	0/1/5 Host, Panel	0/1/5 Panel, Port
Array capacity (Gbytes) MIN MAX	4.1 34.8	18 109	3 18.5	3 18.5	4.1/2/8.2 41.6/16.6/33.3
Minimum drives per array	2	2	2	2	1/2/5
Maximum drives per array	4	12	12	12	10/8/10
Concurrent host channels	1, 2	1, 2	1, 2	1, 2	1, 2
Array interface to host	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)					8, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- Yes Yes	Yes Yes Option	Yes Yes Option	Yes Yes Option	Option Yes Option
Spare drive (None/Auto/Manual)	Auto (RAID-1)	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 13	20 20	20 20	20 20	10/20 10
DRIVES: Formatted capacity/drive(MB)	4100, 8700	4300, 9100	2100	2100	2068-4162
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	9	9	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17	4.17	Drive dependent
ARRAY SIZE: Inches: H x W x D		18 x 17.8 x 12.5	18 x 17.8 x 12.5	18 x 17.8 x 12.5	8.5 x 19.1 x 27.9
POWER: Power backup			660 watts Battery	660 watts Battery	400 watts Cache battery
FIRST CUSTOMER SHIPMENT	1997	6/97	1996	1996	2Q95
COMMENTS		Rack version holds up to 6 arrays.		Rack holds up to 6 arrays.	Rack mount type

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
ARRAY MODEL	DF-300-CK A-6531-CK	DF-300-DK A-6531-DK	DF-300-MK A-6531-MK	DF-300-RKH A-6531-RKH	DF-300-RKWH A-6531-RKWH
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host UNIX, NT, NetWare	SCSI host UNIX, NT, NetWare	SCSI host UNIX, NT, NetWare	SCSI host UNIX, NT, NetWare	SCSI host UNIX, NetWare, NT
RAID level Configured by:	0/1/5 Panel, Port	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	4.1/2/8.2 174.2/69.7/139	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 87.1/34.8/69.7	4.1/2/8.2 174.2/69.7/139
Minimum drives per array	1/2/5	1/2/5	1/2/5	1/2/5	1/2/5
Maximum drives per array	20/16/20	5/4/5	5/4/5	10/8/10	20/16/20
Concurrent host channels	1, 2	1	1, 2	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)	8, 128	4, 64	8, 128	8, 128	8, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Option	No No Option	Option Yes Option	Option Yes Option	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	None	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)	2068,4162,8712	2068-4162	2068,4162,8712	2068,4162,8712	2068-8712
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
ARRAY SIZE: Inches: H x W x D	27.6 x 11.8 x 23.6	13.8 x 5.9 x 15	16.1 x 9.1 x 18.3	10.4 x 19.1 x 25.8	17.3 x 18.9 x 24.9
POWER: Power backup	800 watts Cache battery	240 watts Cache battery	300 watts Cache battery	500 watts Cache battery	900 watts Cache battery
FIRST CUSTOMER SHIPMENT	2Q95	2Q95	2Q95	4Q95	4Q96
COMMENTS				Rack mount type	Rack mount type

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
ARRAY MODEL	DF350-MK A-6533-MK	DF350-CK A-6533-CK	DF350-DK A-6533-DK	DF350-RKH A-6533-RKH	DF350-RKWH A-6533-RKWH
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host UNIX, NetWare, NT	SCSI host UNIX, NetWare, NT	SCSI host UNIX, NetWare, NT	SCSI host UNIX, NetWare, NT	SCSI host UNIX, NetWare, NT
RAID level Configured by:	0/1/5 Panel, Port	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	4.1/2/8.2 43.5/17.4/34.8	4.1/2/8.2 174.2/69.7/139	4.1/2/8.2 20.8/8.3/16.6	4.1/2/8.2 17.1/34.8/69.7	4.1/2/8.2 174.2/69.7/139
Minimum drives per array	2/2/5	2/2/5	2/2/5	2/2/5	2/2/5
Maximum drives per array	5/4/5	20/16/20	5/4/5	10/8/10	20/16/20
Concurrent host channels	1, 2	1, 2	1	1, 2	1, 2
Array interface to host	Ult. SCSI,FC-AL	Ult. SCSI,FC-AL	Ult. SCSI,FC-AL	Ult. SCSI,FC-AL	Ult. SCSI,FC-AL
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	16, 1024	16, 1024	16, 16	16, 1024	16, 1024
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Option	Option Yes Option	No No Yes	Option Yes Option	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	None	Auto	Auto
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	20/40/100 20	20/40/100 20	20/40/100 20	20/40/100 20	20/40/100 20
DRIVES: Formatted capacity/drive(MB)	2068,4162,8712	2068,4162,8712	2068, 4162	2068,4162,8712	2068,4162,8712
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
ARRAY SIZE: Inches: H x W x D	16.1 x 9.1 x 18.3	27.6 x 11.8 x 23.6	13.8 x 5.9 x 15	10.4 x 19.1 x 25.8	17.4 x 18.9 x 24.9
POWER: Power backup	300 watts Cache battery	800 watts Cache battery	240 watts Cache battery	500 watts Cache battery	900 watts Cache battery
FIRST CUSTOMER SHIPMENT	1Q97	1Q97	1Q97	1Q97	1Q97
COMMENTS					

MANUFACTURER	HITACHI	HITACHI	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS
ARRAY MODEL	HT-2460-111	A-6592/A-6595 H-6592/H-6595	5730E Mini-Tower	5742E 5744E Rack-Mount	5750E Tower
DISK/TREND GROUP	Net/Midrange	Mainframe	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	Captive, PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Ethernet	IBM, Hitachi mainframe, MVS, VSVM, VSE, UNIX	AS/400, SCSI	AS/400, SCSI	AS/400, SCSI
RAID level Configured by:	5 Host,Panel,Port	1/5 Preset	0/1/5 Port	0/1/5 Port	0/1/5 Port
Array capacity (Gbytes) MIN MAX	8 33	22.7/408 723.7/1634	4.1 43.2	4.1 174	4.1 174
Minimum drives per array	5	7*	2	2	2
Maximum drives per array	20	224*	5	10/20	20
Concurrent host channels	1	8, 16	1	2	2
Array interface to host	Ethernet	IBM,Hitac.,SCSI	SCSI-2/3,AS/400	SCSI-2/3,AS/400	SCSI-2/3,AS/400
Drive interface	SCSI-2	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	64, 128	256, 8192	8, 256	8, 256	8, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes No	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	None	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	10	17/20 20	10-20 40	10-20 40	10-20 40
DRIVES: Formatted capacity/drive(MB)	2068	4360, 9230	4100, 8700	4100, 8700	4100, 8700
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	11.5	9.5	9.5	9.5
Average rotational delay (msec)	Drive dependent	4.7	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	27.6 x 15.2 x 23.6	--	16.1 x 9 x 18.3	8.5 x 19.1 x 27.9	27.6 x 11.8 x 23.6
POWER: Power backup	1000 watts Cache battery	7 KVA Battery	.3 KVA Battery	.4 KVA Battery	.8 KVA Battery
FIRST CUSTOMER SHIPMENT	1Q96	3Q95	2Q97	2Q97	2Q97
COMMENTS		*Host spares.			

MANUFACTURER	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	IBM	IBM
ARRAY MODEL	6700 Array Subsystem	7700 Array Subsystem	7750 Array Subsystem	32H3811 SSA RAID Adapter for PC	3527
DISK/TREND GROUP	Net/Midrange	Mainframe	Mainframe	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	Captive	Captive, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	Mainframe, Sun, RS/6000, HP	Mainframe, Sun, RS/6000, HP	HDS/IBM mainframe MVS, VS, VSE	PC Server OS/2, NetWare, NT	PC OS/2, NT, NetWare
RAID level Configured by:	5 Preset	1/5 Preset	5 Preset	0/1/5 Host	0/1/5*
Array capacity (Gbytes) MIN MAX	45 1600	45 1600	22.7 90.86	Drive dependent Drive dependent	4.4 22.5
Minimum drives per array	7*	7*	7	--	2
Maximum drives per array	224*	224*	28	96	5
Concurrent host channels	4, 16	4, 8	4, 8	1	2, 2
Array interface to host	IBM, SCSI-2	IBM, SCSI-2	IBM	PCI	SSA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SSA	SSA
Cache size (min, max: MB)	256, 8192	256, 8192	256, 2560		
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	N/A N/A N/A	Yes No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Option
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	17/20 12.5	17/20 12.5	17 12.5	132 80	40 7-9/20
DRIVES: Formatted capacity/drive(MB)	9200	9200	4360	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	Drive dependent	95
Average positioning time (msec)	12.5	12.5	11.5	Drive dependent	Drive dependent
Average rotational delay (msec)	4.7	4.7	4.7	Drive dependent	4.7
ARRAY SIZE: Inches: H x W x D	70.5 x 51.2 x 31.5	70.5 x 51.2 x 31.5	70.5 x 29.5 x 31.5	.85 x 5 x 13.4	16 x 7.75 x 19
POWER: Power backup	2.2 KVA Battery	2.2 KVA Battery	2.39 KVA Battery	16 watts N/A	378 watts (max)
FIRST CUSTOMER SHIPMENT	3Q97	4Q96	7/96	10/96	10/96
COMMENTS	*Plus 1-10 hot spares.	*Plus 1-10 hot spares.			*RAID status depends on adapter used.

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	4011 SSA RAID Adapter	6217 (RS/6000) SSA RAID Adapter	6218 (RS/6000) SSA RAID Adapter for PCI	7131-405	7133-20 7133-600
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	Captive	Captive	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Compaq, HP NT	RS/6000 AIX 4.1.5	PCI host AIX 4.1.5	RS/6000 AIX	RS/6000, PC, AIX, OS/2, NT, NetWare
RAID level Configured by:	0/1/5 Host	5 Host	5 Host	0/1/5*	0/1/5*
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	4.4 45.5	8.8 145.6
Minimum drives per array	2	--	--	2	4
Maximum drives per array	96	96	96	5	16
Concurrent host channels	1	1	1	2, 2	8, 8
Array interface to host	PCI	MCA	PCI	SSA	SSA
Drive interface	SSA	SSA	SSA	SSA	SSA
Cache size (min, max: MB)				Adapter: 0, 8	Adapter: 0, 8
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	N/A N/A N/A	N/A N/A N/A	Yes(2 adapters) No No	Yes(2 adapters) Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Option	Option
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	132 80	 80	132 80	40 7-9/20	140 7-9/20
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	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	4.7	4.7
ARRAY SIZE: Inches: H x W x D	5 x .85 x 13.4	4.2 x 12.3	4.8 x 13.1	16 x 7.75 x 19	24 x 8.3 x 32.3
POWER: Power backup		16.2 watts N/A	19.9 watts N/A	378 watts (max)	532 watts (max)
FIRST CUSTOMER SHIPMENT	8/97	11/96	3/97	3Q95	3Q95
COMMENTS	2 SSA loops.			*RAID status depends on adapter used.	Model 20 drawer Model 600 tower *RAID status depends on adapter used.

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	7135-210 RAIDiant	7137-413 7137-513	7137-414 7137-514	7137-415 7137-515	8640-ESS PC Server 330
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive, PCM	Captive, PCM	Captive, PCM	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware
Host platform, software environment	RS/6000 AIX 6000	RS/6000 AIX, HP UNIX, Sun, NCR	RS/6000, HP, Sun, NCR AIX, UNIX	RS/6000, HP, Sun, NCR	PC Server 330 OS/2,NT,NetWare UNIXWare, SCO
RAID level Configured by:	0/1/3/5 Host	0/5 Panel	0/5 Panel	0/5 Panel	0/1/5 Host
Array capacity (Gbytes) MIN MAX	22.5/11.2/18/18 135/67/108/108	6.45/4.30 17.2/15.05	12.92/8.61 34.44/30.14	26.56/17.7 70.83/61.98	Drive dependent Drive dependent
Minimum drives per array	5	3	3	3	1
Maximum drives per array	30	8	8	8	6
Concurrent host channels	1, 2	1	1	1	1
Array interface to host	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	16*	1, 4	1, 4	4	4
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes (option) Yes Yes	No No Yes	No No Yes	No No Yes	No No No
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	40 10	40 10	40 10	40 40
DRIVES: Formatted capacity/drive(MB)	4500	2151	4306	8854	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	Drive dependent
Average positioning time (msec)	8.3	7.8	8	6.9	Drive dependent
Average rotational delay (msec)	4.17	4.17	4.17	4.17	Drive dependent
ARRAY SIZE: Inches: H x W x D	10.5 x 17.4 x 26.2	24 x 12.2x32.3 (413)	24 x 12.2x32.3 (414)	24 x 12.2x32.3 (415)	24.5 x 7.5 x 18.6
POWER: Power backup	650 watts None	308 watts None	308 watts None	.35 KVA None	350 watts
FIRST CUSTOMER SHIPMENT	3Q93	4Q94	4Q94	11/96	1/97
COMMENTS	For RS/6000. *Dual 16 MB with optional dual controller	Dual AC feed. Mirrored write cache. -413 is tower. -513 is rack mount.	Dual AC feed. Mirrored write cache. -414 is tower. -514 is rack mount.	Dual AC feed. Mirrored write cache. -415 is tower. -515 is rack mount.	Complete server

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	8640-P Series PC Server 330	8641-EDx PC Server 520	8641-EZx 8641-MZx PC Server 520	8642-2ZS PC Server 720	8642-4ZS PC Server 720
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware
Host platform, software environment	PC Server 330 OS/2, NT, UNIX, NetWare, SCO	PC Server 520 OS/2,NT,NetWare UNIXWare, SCO	PC Server 520 OS/2, NT, UNIX, NetWare	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	2	1	1	1	1
Maximum drives per array	6	12	12	12	12
Concurrent host channels	1	1	1	1	1
Array interface to host	PCI	PCI	PCI	MC	MC
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 8	4	4	4	4
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)	132 40	132 20	132 20	80 20	80 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	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
ARRAY SIZE: Inches: H x W x D	24.5 x 7.5 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	350 watts Battery option	434 watts UPS option	434 watts UPS option	690 watts UPS	690 watts UPS
FIRST CUSTOMER SHIPMENT	9/97			7/95	7/95
COMMENTS	Complete server Dynamic reconfiguration	Complete server	Complete server	Complete server	Complete server

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	8650-5MO 8650-6MM PC Server 704	9337-540/545	9337-580/585	9337-590/595	96H9835 SSA RAID Cluster Adapter
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware
Host platform, software environment	PC Server 704 OS/2, NetWare, NT, SCO	AS/400, SCSI host OS/400, UNIX	AS/400, SCSI host OS/400, UNIX	AS/400, SCSI host OS/400, UNIX	PC Server NT
RAID level Configured by:	0/1/5 Host	0/5 Host, Panel	0/5 Host, Panel	0/5 Host, Panel	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	7.86/5.9 15.73/13.76	16.77/12.88 33.55/29.35	34.36/25.77 68.71/60.12	Drive dependent Drive dependent
Minimum drives per array	1	4	4	4	2
Maximum drives per array	12	8	8	8	44*
Concurrent host channels	1	1	1	1	1
Array interface to host	PCI	Ultra SCSI	Ultra SCSI	Ultra SCSI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SSA
Cache size (min, max: MB)	4	4 MB NV Write	4 MB NV Write	4 MB (NV Write)	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Option	No No Yes	No No Yes	No No Yes	Yes (duplexed) -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto*
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	132 20	20/40 10	20/40 10	20/40 10	132 80
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1967	4194	8590	2200,4500,9100
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	7.8	8	7.8	Drive dependent
Average rotational delay (msec)	Drive dependent	4.17	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	27.4 x 18 x 24.8	7 x 19 x 26.2(Rack)	7 x 19 x 26.2(Rack)	7 x 19 x 28.2(Rack)	.85 x 5 x 13.4
POWER: Power backup	420 watts	365 watts None	365 watts None	365 watts None	24 watts* None
FIRST CUSTOMER SHIPMENT	5/97	6/96	6/96	2/97	3Q97
COMMENTS	Complete server Duplexed RAID-1 on motherboard via software on 5650-5MO.	Dual AC feed. -540 is rack mount. -545 is tower.	Dual AC feed. -580 is rack mount. -585 is tower.	Dual AC feed. -590 is rack mount. -595 is tower.	Requires adapter pair for RAID-1. *Per pair.

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	PC ServeRAID SCSI Adapter	PC ServeRAID II	9393-001 RAMAC Virtual Array Storage	9393-002 RAMAC Virtual Array Storage	9393-T42 RAMAC Virtual Array 2 Turbo
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Mainframe	Mainframe	Mainframe
MARKET	Captive	Captive, OEM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	PC Server OS/2, NetWare, NT, SCO	PC Server* OS/2, NetWare, NT, SCO, UNIX	System/390 MVS, VM, VSE	System/390 MVS, VM, VSE	System/390 MVS, VM, VSE
RAID level Configured by:	0/1/5 Host	0/1/5 Host	"6" Preset	"6" Preset	"6" Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	180* 720*	160* 840*	160* 840*
Minimum drives per array	1	2	32	14	14
Maximum drives per array	45	45	256	60	60
Concurrent host channels	1		12	4	4
Array interface to host	PCI	PCI	ESCON, Parallel	ESCON, Parallel	ESCON, Parallel
Drive interface	Ultra SCSI	Ultra SCSI	SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	4	4, 8	1024, 3072**	1024, 3072**	1024, 3072**
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No N/A N/A	No No No	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)	40 40	132 40	18 10	18 20	18 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	1450	4550	4550
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent		7.5	7.5
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	N/A	5 x .85 x 13.4	72.6 x 126 (max) x 32	72.6 x 47.5 x 32	72.6 x 47.5 x 32
POWER: Power backup	N/A N/A	 Battery option	12.7 KVA (max)	5.39 KVA (max.) Cache battery	4.9 KVA (max) Cache battery
FIRST CUSTOMER SHIPMENT	8/96	9/97	8/96	11/96	4/97
COMMENTS		Dynamic reconfiguration *Also Netfinity 7000.	*Assumes 3.3X data compress. **Effect cap. assumes 2:1 compression. (STC Iceberg).	*Assumes 3.6X data compress. **Effect cap. assumes 2:1 compression. (STC Iceberg).	*Assumes 3.6X data compress. **Effect cap. assumes 2:1 compression. (STC Iceberg).

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	9393-T82 RAMAC Virtual Array 2 Turbo	9396-001,002 RAMAC Scalable Array Storage	9396-200,"2XY" RAMAC Scalable Array Storage 2	Multiprise 2000 (Internal Disk)	RAMAC 1 Array DASD
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host 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	System/390 MVS, VM, VSE, TPF
RAID level Configured by:	"6" Preset	5 Preset	5 Preset	1 Preset	5* Preset
Array capacity (Gbytes) MIN MAX	160* 840*	278 1,394.1	304 1368	17.8 (3390 fmt) 284.8(3390 fmt)	11.3 181.4(2X racks)
Minimum drives per array	14	36	40	4	8 (2X drawers)
Maximum drives per array	60	180	180	64	128 (2X racks)
Concurrent host channels	8	16	16	N/A	**
Array interface to host	ESCON, Parallel	ESCON, Parallel	ESCON, Parallel	N/A	ESCON, Parallel
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1024, 3072**	1024, 4096	1024, 4096	32, 1024	256, 4096
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	Manual	Manual	None	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	18 20	18 20	18 20	N/A 20	18 20
DRIVES: Formatted capacity/drive(MB)	4550	9110	9110	9100	2048
Nominal disk diameter (mm)	95	140	95	95	95
Average positioning time (msec)	7.5	11	8.5	8.5 RD	9.2 RD/10.7 WR
Average rotational delay (msec)	4.17	5.6	4.17	4.17	5.6
ARRAY SIZE: Inches: H x W x D	72.6 x 47.5 x 32	72.4 x 142.1(max)x35.2	72.4 x 101.7 x 35.2	N/A	62.2 x 29.5 x 38.5
POWER: Power backup	4.9 KVA (max) Cache battery	14.9 KVA (max.) Cache battery	11.4 KVA Cache battery	N/A N/A	3.7 KVA (max.) Battery
FIRST CUSTOMER SHIPMENT	8/97	11/96	4/97	1Q97	9/94
COMMENTS	*Assumes 3.6X data compress. **Effect cap. assumes 2:1 compression. (STC Iceberg).	Compatible with 3380, 3390. (STC Kodiak).	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.

MANUFACTURER	IBM	IBM	IBM	IBM	ICP VORTEX
ARRAY MODEL	RAMAC 1 Array Subsystem	RAMAC 2 Array DASD	RAMAC 2 Array Subsystem	RAMAC 3 Array	GDT3000A
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware
Host platform, software environment	System/390 MVS, VM, VSE, TPF	System/390 MVS, VM, VSE, TPF	System/390 MVS, VM, VSE, TPF	System/390 MVS, VM, VSE, TPF	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.
RAID level Configured by:	5 Preset	5* Preset	5 Preset	5* Preset	0/1
Array capacity (Gbytes) MIN MAX	11.3 90.8	22.7 181.4	22.7 181.4	45.4 726 (2X racks)	Drive dependent Drive dependent
Minimum drives per array	8 (2X drawers)	8 (2X drawers)	8 (2X drawers)	8 (2X drawers)	2
Maximum drives per array	64 (1 rack)	64 (1 rack)	64 (1 rack)	128 (2X racks)	35
Concurrent host channels	4, 8	**	4, 8	**	2-5
Array interface to host	ESCON, Parallel	ESCON, Parallel	ESCON, Parallel	ESCON, Parallel	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	256, 2048	256, 4096	256, 2048	256, 8192	4, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	No No No
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	18 20	33 10
DRIVES: Formatted capacity/drive(MB)	2048	4512	4512	9100	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	Drive dependent
Average positioning time (msec)	9.2 RD/10.7 WR	8 RD/9.5 WR	8 RD/9.5 WR	8.5 RD	Drive dependent
Average rotational delay (msec)	5.6	4.17	4.17	4.17	Drive dependent
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	62.2 x 29.5 x 38.5	
POWER: Power backup	3.3 KVA (max.) Battery	3.3 KVA (max.) Battery	3.3 KVA (max.) Battery	3.2 KVA (max.) Battery	
FIRST CUSTOMER SHIPMENT	10/94	10/95	10/95	10/96	1992
COMMENTS	Compat.w/3380-K 3390 or 9340. Attaches directly to system.	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.	Upgradable to RAID-4/5.

MANUFACTURER	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX
ARRAY MODEL	GDT3000B	GDT3010A	GDT3020A	GDT3050A	GDT6111RP
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 Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host 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	7
Concurrent host channels	1	1	2-5	5	1
Array interface to host	EISA	EISA	EISA	EISA	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	1, 64	4, 64	4, 128	4, 128	4, 64
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 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
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	1993	1993	1993	1993	4/97
COMMENTS	Array operation requires upgrade to basic board.				Upgradable to RAID-4/5/10.

MANUFACTURER	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX
ARRAY MODEL	GDT6117RP	GDT6121RP	GDT6127RP	GDT6511RP	GDT6517RP
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 Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host 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	0/1	0/1	0/1/4/5/10	0/1/4/5/10
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	14	7	7
Concurrent host channels	1	2	2	1	1
Array interface to host	PCI	PCI	PCI	PCI	PCI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	4, 64	4, 64	4, 64	4, 64	4, 64
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 40	132 20	132 40	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
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	4/97	4/97	4/97	4/97	4/97
COMMENTS	Upgradable to RAID-4/5/10.	Upgradable to RAID-4/5/10.	Upgradable to RAID-4/5/10.		

MANUFACTURER	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX	INFORTREND
ARRAY MODEL	GDT6521RP	GDT6527RP	GDT6537RP	GDT6557RP	IFT-2101UA* IFT-2101UB
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 Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host 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.	SCSI host DOS, NT, OS/2, UNIX, NetWare
RAID level Configured by:	0/1/4/5/10	0/1/4/5/10	0/1/4/5/10	0/1/4/5/10	0/1/3/5 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	14	14	21	35	15*/30
Concurrent host channels	2	2	3	5	1
Array interface to host	PCI	PCI	PCI	PCI	PCI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	4, 64	4, 64	4, 64	4, 64	4, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/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 20	132 40	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
ARRAY SIZE: Inches: H x W x D					4.2 x 6.88
POWER: Power backup					10 watts Battery option
FIRST CUSTOMER SHIPMENT	4/97	4/97	4/97	4/97	8/96
COMMENTS					Flash memory firmware. *Single output channel.

MANUFACTURER	INFORTREND	INFORTREND	INFORTREND	INTEGRIX	INTEGRIX
ARRAY MODEL	IFT-3100UA IFT-3100UB*	IFT-3101U	IFT-3102UA IFT-3102UB*	RD-10	RD-10/25
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 Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	Sun SPARC UNIX	Sun SPARC UNIX
RAID level Configured by:	0/1/3/5 Panel, Port	0/1/3/5 Port, Panel	0/1/3/5 Port, Panel	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	6.3 12.6	6.3 25.2
Minimum drives per array	2	2	2	2	2
Maximum drives per array	90	30	75	6	6
Concurrent host channels	1, 2	1, 2	1, 5	2	2
Array interface to host	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-2	SCSI-2
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 128	4, 64	4, 128	8, 128	16, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes -- --	Yes -- --	Yes -- --	No Yes No	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	40 40	40 40	20 20	70 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	1000-2100	2100-9100
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
ARRAY SIZE: Inches: H x W x D	1.6 x 5.7 x 8.4	1.61 x 4.01 x 6.26	1.6 x 5.7 x 8.4	3.1 x 16.4 x 16.1	3.1 x 16.4 x 16.1
POWER: Power backup	6.5 watts Option	6.5 watts None	7.5 watts Battery option	175 watts Battery	175 watts Battery
FIRST CUSTOMER SHIPMENT	7/97	8/96	8/96	1Q96	1997
COMMENTS	Flash memory firmware. Mirrored cache. *3.25" high.	Flash memory firmware.	Flash memory firmware. *3.25" high.	33 MHz RISC processor.	

MANUFACTURER	INTEGRIX	INTEGRIX	INTEGRIX	INVINCIBLE TECHNOLOGIES	INVINCIBLE TECHNOLOGIES
ARRAY MODEL	RD-10U	RD-15	RD-20	LIFELINE Information Server	Ultimate-5 700
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	Captive	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Host Hardware
Host platform, software environment	Sun SPARC UNIX	Sun SPARC UNIX	Sun SPARC UNIX	LIFELINE, NT, UNIX, SPARC	DEC, Sun, NT, RS/6000, H-P
RAID level Configured by:	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port	0/1/5/10 Host	0/1/3/5/10 Host, Panel
Array capacity (Gbytes) MIN MAX	12.6 25.2	4 54	 100	20 1000	6 61
Minimum drives per array	2	2	2	5	3
Maximum drives per array	6	6	6	120	7
Concurrent host channels	2	2	2	N/A	1
Array interface to host	Ultra SCSI	Ultra SCSI	FC-AL	PCI	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	16, 128	8, 128	16, 128	8, 256	8, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes No	No Yes No	No 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)	 40 20	 40 20	 100 20	 133 10	 20 10
DRIVES: Formatted capacity/drive(MB)	2100-9100	9100	2100-9100	4200, 8800	4200, 8800
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	8	8
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	4.16	4.16
ARRAY SIZE: Inches: H x W x D	3.1 x 16.4 x 16.1	3.1 x 16.4 x 16.1			19 x 7 x 19
POWER: Power backup	175 watts Battery	175 watts Battery	175 watts Battery		300 watts Battery
FIRST CUSTOMER SHIPMENT	1997	4Q97	1998	6/97	5/96
COMMENTS		Rack mount.	Rack mount.	Server, rack or pedestal.	Rack or tower.

MANUFACTURER	INVINCIBLE TECHNOLOGIES	INVINCIBLE TECHNOLOGIES	INVINCIBLE TECHNOLOGIES	KEY TECHNOLOGY	KEY TECHNOLOGY
ARRAY MODEL	Ultimate-5 1000	Ultimate-5 2050	Ultimate-5 3050	MRB1020	MRB1021
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Single User
MARKET	PCM	PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	DEC, Sun, NT, RS/6000, H-P	DEC, Sun, NT, RS/6000, H-P	DEC, Sun, NT, RS/6000, H-P	PC compat. host Various	PC compat. host Various
RAID level Configured by:	0/1/3/5/10 Host, Panel	0/1/3/5/10 Host, Panel	0/1/3/5/10 Host, Panel	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	6 88	6 176	8 264	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	5	5	5	2	2
Maximum drives per array	10	20	30	2	2
Concurrent host channels	2	2	2	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2, FC-AL	PCI	ISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	EIDE	EIDE
Cache size (min, max: MB)	8, 256	8, 256	8, 256	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	No -- --	No -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20/100 10	132 16.7 PIO Mode 4	4 16.7 PIO Mode 4
DRIVES: Formatted capacity/drive(MB)	4200, 8800	4200, 8800	4200, 8800	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	8	8	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	4.16	4.16	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	24 x 10.5 x 30	24.8 x 14 x 30	24.8 x 14 x 30		
POWER: Power backup	575 watts UPS	880 watts UPS	880 watts UPS		
FIRST CUSTOMER SHIPMENT	5/96	5/96	1/97	1997	1997
COMMENTS	Rack or pedestal.	Rack or pedestal.	Rack or pedestal.		

MANUFACTURER	LAND-5	LAND-5	LEGACY STORAGE SYSTEMS	LEGACY STORAGE SYSTEMS	LEGACY STORAGE SYSTEMS
ARRAY MODEL	DS300	DS350 PolaRAID	SmartARRAY/XE	SmartARRAY/RM	SmartARRAY/SE
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	Misc. networks NetWare, NT, OS/2, UNIX	Misc. networks NetWare, NT, OS/2, UNIX	SCSI host NetWare, NT, OS/2, UNIX
RAID level Configured by:	0/1/3/5/"7"/10 Host	0/1/3/5/"7"/10 Host	0/1/3/5/10	0/1/3/5/10	0/1/3/5/10
Array capacity (Gbytes) MIN MAX	4 76	4 800	2 48	2 32	2
Minimum drives per array	2	2	2	3	3
Maximum drives per array	18	270	13	8	9
Concurrent host channels	1, 2	1, 2	1, 6	1, 4	1, 2
Array interface to host	Ultra SCSI	Ultra SCSI	EISA,ISA,SCSI,P	EISA,ISA,SCSI,P	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	64, 128	64, 128	0, 32 EDO	32 EDO	0, 32 EDO
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes (option) Yes Yes	Yes (option) 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)	40 40	40 40	40 40	40 40	40 40
DRIVES: Formatted capacity/drive(MB)	2000, 4000	2000, 4000	1000-9100	1000-9100	1000-9100
Nominal disk diameter (mm)	95	95	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
ARRAY SIZE: Inches: H x W x D	10.5 x 28 x 17	10.5 x 28 x 17	29.4 x 8.4 x 20.6	10.5 x 19 x 22	21.4 x 8.4 x 20.6
POWER: Power backup	400 watts	400 watts	250-750 watts	200-250 watts	.69 KVA
FIRST CUSTOMER SHIPMENT	1995	4Q97	12/93	2/95	1997
COMMENTS	Dual AC power.	Dual AC power.	RAID-3/5 optional. Dual AC power.	RAID-3/5 optional. Rack mount. Dual AC power.	Dual AC power.

MANUFACTURER	LIGHTHOUSE TECHNOLOGY	LOCOM	LOMAS DATA	LOMAS DATA	MACRO COMPUTER PRODUCTS
ARRAY MODEL	Harbor	9920	LDP CACHE IV	LDP CACHE VI	MSR-1100
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	OEM	OEM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host UNIX	* Various	PC compatible NetWare, UNIX, DOS, OS/2	PC compatible NetWare, UNIX, DOS, OS/2	SCSI host Various
RAID level Configured by:	0/1/3/5/10 Panel	0/1/3/5* *	1 Preset	0/1/5/10 Host	3/5
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	3	2	2	2	2
Maximum drives per array	35	16	4		10
Concurrent host channels	1, 4	1	1	1	1
Array interface to host	Ultra SCSI	*	ISA	PCI	SCSI-2
Drive interface	Ultra SCSI	SSA	SCSI, SCSI-2	SCSI, SCSI-2	EIDE
Cache size (min, max: MB)	16, 128	*	2, 16	4, 128	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	* Yes Yes	No -- --	No -- --	No No Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual-foregrnd	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	* 80	6 10	132 40	20 13
DRIVES: Formatted capacity/drive(MB)	2000-9000	2200-9100	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	95
Average positioning time (msec)	Drive dependent	7.2	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	4.17	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	Varies		4.7 x 13.4		
POWER: Power backup	Cache battery	*	9 watts None	9 watts None	
FIRST CUSTOMER SHIPMENT	1996	1996	4Q93		1/97
COMMENTS	CMD controller.	*Determined by user specified controller or software.			Purchased controller.

MANUFACTURER	MACRO COMPUTER PRODUCTS	MARNER INTERNATIONAL	MAXSTRAT	MAXSTRAT	MAXSTRAT
ARRAY MODEL	Macro-RAID 7 8000 Series	Performance Storage	Gen5 L	Gen5 XL	S-Series L
DISK/TREND GROUP	Mainframe	Net/Midrange	Very High Perf.	Very High Perf.	Very High Perf.
MARKET	PCM	Captive	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Unisys A, V Other SCSI UNIX	Sun SPARC Solaris	Cray, IBM, SGI, Sun, Convex UNIX	Cray, IBM, SGI, Sun, Convex UNIX	Multi-SCSI host UNIX, NT
RAID level Configured by:	"7" Preset	0/1/5	0/1/3/5 Host, Panel	0/1/3/5 Host, Panel	0/1/5/10 Host, Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	18.2/9.1/22 82/36/65	64 128	200 800	64 128
Minimum drives per array	3	2	8	24	8
Maximum drives per array	48	9	16	96	16
Concurrent host channels	1, 12	1-5	1-2	1-4	2-4
Array interface to host	Ult. SCSI,FC-AL	SCSI	HIPPI	HIPPI	Ult.SCSI, FC-AL
Drive interface	SCSI-2	SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	4, 256	--, 32	8	48	8
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes No	No Yes No	Yes Yes Yes	No Yes No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20/40/100 10	20 20	100 40	100 40	20/40/133 40
DRIVES: Formatted capacity/drive(MB)	4300-9100	9100	9100	9100	9100
Nominal disk diameter (mm)	95, 130	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	8	8	8
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	Varies with configuration	19 x 8.75 x 16	22.5 x 19 x 24.75	72 x 29.5 x 36.5	22.5 x 19 x 24.6
POWER: Power backup	1.3 KVA None		.9-1.2 KVA None	3.3-4.8 KVA Integral UPS	.9-1.2 KVA None
FIRST CUSTOMER SHIPMENT	9/96	1997	3/95	12/94	5/96
COMMENTS	Storage Computer controller. Nonvolatile memory option.	Infortrend controller.			SCSI, FC-AL and Ultra-SCSI network ports.

MANUFACTURER	MAXSTRAT	MAXTRONIC INTERNATIONAL	MEGADRIVE SYSTEMS	MEGADRIVE SYSTEMS	MEGADRIVE SYSTEMS
ARRAY MODEL	S-Series XL	Arena	Aria	Enterprise Ultra E-2	Enterprise Ultra E-8
DISK/TREND GROUP	Very High Perf.	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Software	Subsystem Host Software	Subsystem Host Software
Host platform, software environment	Multi-SCSI host UNIX, NT	SCSI host Various	FC-AL host SGI, Sun, PC, Mac, RS/6000	SCSI host SGI, Sun, PC, Mac, RS/6000	SCSI host SGI, Sun, PC, Mac, RS/6000
RAID level Configured by:	0/1/5/10 Host, Panel	0/1/5 Panel, Port	0/1/5/10 Host	0/1 Preset	0/1/5/10 Host
Array capacity (Gbytes) MIN MAX	200 800	4.3 20.6	9 72	2 23	4 92
Minimum drives per array	24	2/3	1	1	2
Maximum drives per array	96	6	8*	2	8
Concurrent host channels	2-8	1	2	1	1
Array interface to host	Ult.SCSI, FC-AL	Ultra SCSI	FC-AL, other	Ultra SCSI	Ultra SCSI
Drive interface	Ultra SCSI	EIDE	FC-AL, other	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	48	8, 128	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No Yes Yes	-- Yes Yes	-- -- --	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	None	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20/40/133 40	40 16.7	100-200 100-200	40 40	40 40
DRIVES: Formatted capacity/drive(MB)	9100	4300	9090	Drive dependent	9090-23000
Nominal disk diameter (mm)	95	95	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
ARRAY SIZE: Inches: H x W x D	72 x 29.5 x 38.5	13.8 x 6.9 x 12.2	17.3 x 7 x 14	6.5 x 7 x 11	17.3 x 7 x 14
POWER: Power backup	4.85 KVA Integral UPS	250 watts	235 watts UPS	70 watts None	200 watts None
FIRST CUSTOMER SHIPMENT	5/96	7/97	3Q96	3Q96	3Q96
COMMENTS	SCSI, FC-AL and Ultra-SCSI network ports.	486DX2 processor.	*Expand. to 126 devices/loop. Requires array software. Expand. to 144 GB tower.	Expandable to 46 GB.	Expandable rack & tower. Hardware RAID option. Drives & DLT & DAT support.

MANUFACTURER	MEGADRIVE SYSTEMS	MEGADRIVE SYSTEMS	MEGADRIVE SYSTEMS	MEGADRIVE SYSTEMS	MEGADRIVE SYSTEMS
ARRAY MODEL	EV-200	MK/5	MR/10	MR/5	MX/500
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host SGI, Sun, PC, Mac, RS/6000	SCSI host SGI, Sun, PC, Mac, RS/6000	SCSI host SGI, Sun, PC, Mac, RS/6000	SCSI host SGI, Sun, PC, Mac, RS/6000	SCSI host SGI, Sun, PC, Mac, RS/6000
RAID level Configured by:	0/1/3/5/10 Host	0/3/5 Host	0/3/5 Host	0/3/5 Host	0/3/5 Panel, Port
Array capacity (Gbytes) MIN MAX	4 184	12 45	12 91	12 45	69 345
Minimum drives per array	2	3	3	3	3
Maximum drives per array	15	5	10	5	15
Concurrent host channels	1	1	1	1	1
Array interface to host	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4. 64	0, 128	0, 128	0, 128	8, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	40-80 40-81	10/20 10/20	10/20 10/20	10/20 10/20	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	4000-23000	2100-9100	2100-9100	2100-9100	23000
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
ARRAY SIZE: Inches: H x W x D	17.3 x 7 x 14	17 x 7 x 18	15.5 x 20.5 x 19	17 x 7 x 18	14 x 19 x 21
POWER: Power backup	235 watts UPS	200 watts None	200 watts None	200 watts None	400 watts None
FIRST CUSTOMER SHIPMENT	4Q97	4Q93	4Q92	4Q92	1Q95
COMMENTS	Numerous options. Local & remote configurations.	Modified purchased controller. Rack mount. i960 RISC processor.	Modified purchased controller. i960 RISC processor.	Modified purchased controller. i960 RISC processor.	i960 processor.

MANUFACTURER	MEGADRIVE SYSTEMS	MICRON ELECTRONICS	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY
ARRAY MODEL	EV-1000	VETIX LXI VETIX MXI	DataDock	DiskWorks	DVA Series
DISK/TREND GROUP	Very High Perf.	Net/Midrange	Single User	Single User	Single User
MARKET	OEM, PCM	PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Software	Software -- Software	Subsystem Host Software
Host platform, software environment	SCSI,FC-AL host SGI, Sun, PC, Mac, RS/6000	Micron NT, NetWare	SCSI host Apple, NT	Apple Power Macintosh	Macintosh
RAID level Configured by:	0/1/3/5/10 Host	0/1/5/10 Host	0/1 Host	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	45 920	4.3 12.5	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	5	2	2	2	2
Maximum drives per array	70	6	3	6	6
Concurrent host channels	1, 2	1, 2	1, 2	1, 6	1, 2
Array interface to host	FC-AL, Ult.SCSI	PCI	Ultra SCSI	--	Ultra SCSI
Drive interface	FC-AL, Ult.SCSI	Ultra SCSI	Ultra SCSI	--	Ultra SCSI
Cache size (min, max: MB)	0, 128	4, 32	.5, 2	--	.5, 1
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Option Yes Yes	No No No	-- -- --	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Manual	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40-100 40-100	132 40	40 40	Drive dependent Drive dependent	40 40
DRIVES: Formatted capacity/drive(MB)	4000-23000	4300	4300-9100	Drive dependent	4300-9100
Nominal disk diameter (mm)	Drive dependent	95	95	Drive dependent	95
Average positioning time (msec)	Drive dependent	8	9	Drive dependent	9
Average rotational delay (msec)	Drive dependent	4.17	5.6	Drive dependent	5.6
ARRAY SIZE: Inches: H x W x D	Scalable rack		8.25 x 12.25	--	6.5 x 18 x 18
POWER: Power backup	UPS & mirrored cache battery	300 watts	100 watts None	--	45 watts None
FIRST CUSTOMER SHIPMENT	2Q97	1997	2Q95	3Q96	2Q95
COMMENTS	Mirrored cache. Expandable to 1.8 TB. Scalable throughput to 1 GB+/second.	Complete server Mylex controller.	Expandable. Rack mount option. Software array.	Includes drive management features. Requires SCSI controller.	

MANUFACTURER	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICROPAL	MICROPAL	MICROPAL
ARRAY MODEL	Advantage RAID	DataDock 7000	EverStor 2000	EverStor 2011 EverStor 2012	EverStor 2021 EverStor 2022
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host NetWare, NT, OS/2,UNIX,other	SCSI host NetWare, NT, OS/2,UNIX,other	SCSI host NetWare, NT, OS/2,UNIX,other
RAID level Configured by:	0/1/5 Panel	0/1/3/5/10 Port	3/5	3/5	3/5
Array capacity (Gbytes) MIN MAX	 Drive dependent	Drive dependent Drive dependent	7.5 30	10.5 60	10.5 60
Minimum drives per array	2	2	5	5	5
Maximum drives per array	6	7	5	10	10
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	IDE	Ultra SCSI	IDE	IDE	IDE
Cache size (min, max: MB)	2	8, 128			
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No Yes Yes	No No No	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 13.3	10/20 20/40			
DRIVES: Formatted capacity/drive(MB)	4000-8000	4300-9100	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	11	8	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5	4.17/3	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D		18 x 8.75 x 21.5	5 x 5.75 x 9	15.75 x 7 x 18.75	7 x 19 x 17.75
POWER: Power backup	 None	300 watts Cache battery	42 watts Cache battery	84 watts Cache battery	84 watts Cache battery
FIRST CUSTOMER SHIPMENT	3Q97	3Q96	1997	1997	1997
COMMENTS		Expandable. Rack mount option.	Accord controller.	Accord controller.	Accord controller.

MANUFACTURER	MOUNTAINGATE DATA SYSTEMS	MOUNTAINGATE DATA SYSTEMS	MOUNTAINGATE DATA SYSTEMS	MTI TECHNOLOGY	MTI TECHNOLOGY
ARRAY MODEL	CentraVision	Stampede 2	Stampede Ultra Array	3200 Gladiator	6200 Gladiator
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	PCI host Various	SCSI host Various	SCSI host Various	SCSI host UNIX, Windows NT	SCSI host UNIX, Windows NT
RAID level Configured by:	0/1 Host	0/1/3/5/10 Panel, Port	0/1/3/5/10 Panel, Port	0/1/5/0+1 Host	5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	36.4 145.6	34.3 145.6
Minimum drives per array	2	2	2	4	8
Maximum drives per array	8	8	8	16	16
Concurrent host channels	1	1	1	1 or 2	1 or 2
Array interface to host	PCI	SCSI-2	SCSI-2	Ultra SCSI	Ultra SCSI
Drive interface	FC-AL	Ultra SCSI	Ultra SCSI	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	--	16, 32	16, 32	32, 64	32 to 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 100	10/20 20/40	20 20/40	40 20	40 40
DRIVES: Formatted capacity/drive(MB)	4200-23000	4200-23000	4200-23000	9100	4290, 9100
Nominal disk diameter (mm)	95, 130	95, 130	95, 130	90	90
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	8	8
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	4.17	4.17
ARRAY SIZE: Inches: H x W x D	19 x 8.75 x 21	20.5 x 7 x 19	21 x 10 x 20.5	8.75 x 19 x 22 rack	10.5 x 19 x 25
POWER: Power backup	.48 KVA None	300 watts None	300 watts None	165 watts Cache BBU std.	540 watts Cache BBU std.
FIRST CUSTOMER SHIPMENT	1997	2Q97	1996	6/97	7/97
COMMENTS	Anubis RAID software. Rack mount option.	Redundant AC power option. Purchased controller. Rack mount.	Redundant AC power option. Purchased controller. Rack mount.		

MANUFACTURER	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY
ARRAY MODEL	8300	9300	9500	ESS 3100 Gladiator	ESS 3200 Gladiator
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Windows NT	SCSI host UNIX, Windows NT	SCSI host UNIX, Windows NT	SCSI host UNIX, Windows NT	SCSI host UNIX, Windows NT
RAID level Configured by:	0/1/0+1/5 Host	0/1/5/0+1 Host	0/1/5/0+1 Host	0/1/5/0+1	0/1/5/0+1
Array capacity (Gbytes) MIN MAX	4.3 72.8	4.3 145.6	18.2 72.8	137.3 582.4	137.3 582.4
Minimum drives per array	2	2	2	32	32
Maximum drives per array	8	16	8	64	64
Concurrent host channels	2	1 or 2	1 or 2	4 to 16	4 to 16
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 8	16, 64	16, 64	256, 4096	256, 4096
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Option Yes Yes	No 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)	20 20	20 20	20 20	20 20	40 20
DRIVES: Formatted capacity/drive(MB)	2150,4350,9100	2150,4350,9100	9100	4290, 9100	4290, 9100
Nominal disk diameter (mm)	90	90	130	90	90
Average positioning time (msec)	8	8	11	8	8
Average rotational delay (msec)	4.17	4.17	5.56	4.17	4.17
ARRAY SIZE: Inches: H x W x D	5.25 x 19 x 22 rack	8.75 x 19 x 22 rack	22 x 22 x 18	77 x 25 x 31	77 x 25 x 31
POWER: Power backup	150 watts Battery opt.	165 watts Cache BBU std.	350 watts Cache BBU opt.	710 watts Cache BBU std.	710 watts Cache BBU std.
FIRST CUSTOMER SHIPMENT	10/96	3/96	6/95	4/97	7/97
COMMENTS		Dual host option, redundant controller option.	Dual host option.		

MANUFACTURER	MTI TECHNOLOGY	MYLEX	MYLEX	MYLEX	MYLEX
ARRAY MODEL	Stingray III StorageWare	DAC960PD-Ultra	DAC960PG	DAC960PJ	DAC960SF
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	OEM	OEM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	DEC VMS	PC compatible NetWare, OS/2, NT, UNIX	PCI host NetWare, OS/2, NT, UNIX	PCI host NetWare, OS/2, NT, UNIX	FC-AL host Various
RAID level Configured by:	0/3/5	0/1/5/10 Host	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	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	Drive dependent	45	15/30/45	45	90
Concurrent host channels	1, 2	1	1	1	2
Array interface to host	CI, FDDI	PCI	PCI	PCI	FC-AL
Drive interface	SCSI-2	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	16, 128	4, 32	4, 128	4, 128	32, 1024
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Option Option	No -- --	No -- --	No -- --	Yes -- --
Spare drive (None/Auto/Manual)	None	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	8 10	132 40	132 40	132 40	100 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
ARRAY SIZE: Inches: H x W x D	7 x 19 x 26	4.5 x 13	4.5 x 13		5.5 x 8
POWER: Power backup	122 watts None	20 watts Cache battery	17 watts Battery*	 Cache battery*	3 watts
FIRST CUSTOMER SHIPMENT		6/96	1/97	1Q98	4Q97
COMMENTS			*Option. I2O, SMART, SAFE-TE compliant. Online reconfig and expansion.	*Option. I2O, SMART, SAFE-TE compliant. Online reconfig and expansion.	Active/active failover. Dual loop. Mirrored cache.

MANUFACTURER	MYLEX	MYLEX	MYLEX	MYLEX	MYLEX
ARRAY MODEL	DAC960SU	DAC960SUI-X	DAC960SX	DAC960SXI	RAIDPlus
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM	OEM	OEM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	PCI host NT, Windows 95, DOS
RAID level Configured by:	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, Panel	0/1/10 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	14/35*	14/35*	30/75**	30/75**	8
Concurrent host channels	1, 2*	1, 2*	1, 2*	1, 2**	1
Array interface to host	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	PCI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	4, 128	4, 128	16, 256	16, 256	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	No -- --	Yes* -- --	Yes* -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	40 40	40 40	40 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
ARRAY SIZE: Inches: H x W x D	5.5 x 8	3.25 x 5.75 x 8.5	5.70 x 8	3.250 x 5.75 x 8	4.5 x 7
POWER: Power backup	20 watts Cache battery	20 watts Cache battery	22 watts Cache battery	22 watts Cache battery	3 watts
FIRST CUSTOMER SHIPMENT	8/96	9/96	3/97	3/97	3Q97
COMMENTS	*With DBI960S upgrade.	*With DBI960S upgrade.	*Active-Active failover. **With DBI960SX daughter board. 33 MHz i960 mirrored cache.	*Active-Active failover. **With DBI960SX daughter board. 33 MHz i960 mirrored cache.	RAID upgrade to existing host has adapter products.

MANUFACTURER	MYLEX	NCR	NEC	NEC	NEC
ARRAY MODEL	Rome	Disk Array Plus	AJ2550	DS1000	DS1000V
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	Captive,OEM,PCM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Chip Set	Software Host Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Various	NCR UNIX	PC, NEC, EWS NetWare, NT, DOS	SCSI host	UNIX
RAID level Configured by:	0/1/3/5/10 Host	0/1/3/4/5/10/53 Host	1/5	1/3/5	3
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	5 12.5	 216	 144
Minimum drives per array	2	N/A	3	2	5
Maximum drives per array	15/30/45	N/A	6	30	20
Concurrent host channels	1	1-4	1	1	1
Array interface to host	PCI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	Ultra SCSI	SCSI-2	IDE	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 128	--	2	8, 128	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	N/A N/A N/A	-- -- --	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	Host dependent Drive dependent	10 13.3	20 20	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	2500	2000-9000	4000-9000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Varies	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Varies	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D		N/A	12 x 15 x 33.7	13.8 x 19 x 30	12.09 x 19 x 26.38
POWER: Power backup		N/A	--	650 watts Battery	650 watts
FIRST CUSTOMER SHIPMENT	2Q97	6/92	1/97	3/97	12/96
COMMENTS	120, SMART, SAFE-TE compliant. Online reconfig and expansion.	Online tuning. Single volume. Can span multiple drives and adapters.			

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
ARRAY MODEL	Express/II LT	OP-450-30004 OP-450-30005 OP-450-31001	OP-450-30001 OP-450-30002 OP-450-30003	OP-450-5103 SCSI Mirroring Module	RISCserver
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	Captive	Captive	Captive	Captive, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	NEC Various	NEC Express Various	NEC Express, EISA PCs	EISA PC	NEC RISCserver Various
RAID level Configured by:	0/1/3/5 Host	0/1/5	0/1/5	1 Preset	0/1/3/5
Array capacity (Gbytes) MIN MAX	1.1/.54/1.1/1.1 9.6/4.1/8.2/8.2	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	1.1 16
Minimum drives per array	2/3	2	2	2	2
Maximum drives per array	7	7	7	6	8
Concurrent host channels	1	1	1	1	1
Array interface to host	EISA	EISA	EISA	EISA	
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	4, 64	4, 16	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	-- -- --	-- -- --	-- -- --	
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	--	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	33 10	33 10	
DRIVES: Formatted capacity/drive(MB)	540, 1370	540-2000	540-2000	Drive dependent	540-2000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)		Drive dependent	Drive dependent	Drive dependent	
Average rotational delay (msec)		Drive dependent	Drive dependent	Drive dependent	
ARRAY SIZE: Inches: H x W x D	24.4 x 8.5 x 23.2	-- --	-- --	EISA standard	23.25 x 7.25 x 23.25
POWER: Power backup	400 watts None	--	--	-- --	350 watts
FIRST CUSTOMER SHIPMENT	1994	1/94	12/93	6/92	
COMMENTS	Complete server			Requires EISA SCSI host adapter OP-450-6301.	

MANUFACTURER	NEC	NEC	NETFRAME	NETFRAME	NETWORK APPLIANCE CORPORATION
ARRAY MODEL	RISCserver 2200	RISCserver 4200	NF9008	NF9016	F210
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem* Network Hardware
Host platform, software environment	RISCserver 2200 Windows NT, NTAS	RISCserver 4200 Windows NT, NTAS	NetFRAME NetWare, NT	NetFRAME NetWare, NT	F210 NFS, CIFS, HTTP
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host	4 Preset
Array capacity (Gbytes) MIN MAX	2/1/- 42/21/30	4	8.4/4.2/8.4 131/61/104	8.4/4.2/8.4 131/61/104	 51.6
Minimum drives per array	2	2	2/3	2/3	2
Maximum drives per array	21	21	8*	15*	7/14**
Concurrent host channels	1	1	1	1	1
Array interface to host	EISA	PCI	PCI	PCI	PCI
Drive interface	SCSI-2	SCSI-2	Ultra SCSI	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	4, 128		2, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)			Option Yes Yes	No Yes Yes	No Yes Option
Spare drive (None/Auto/Manual)			Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	133 10	132 20/40	132 20/40	132 20
DRIVES: Formatted capacity/drive(MB)	1000, 2000	2000, 4000	4200-8700	4200-8700	4300, 9000
Nominal disk diameter (mm)	95, 130	95, 130	95	95	95
Average positioning time (msec)			8	8	8
Average rotational delay (msec)	4.2	4.2	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	23.25 x 7.25 x 23.25	23.25 x 7.25 x 23.25			8.75 x 17.25 x 22
POWER: Power backup	300 watts None	-- --			.633 KVA Battery
FIRST CUSTOMER SHIPMENT		4Q95			2Q97
COMMENTS	Complete server	Complete server	Complete server AMI controller. *Expandable.	Complete server DEC controller. Rack mount. *Expandable.	*Includes NFS server and network interfaces to FDDI, ATM, Ethernet. **W/4 GB drive.

MANUFACTURER	NETWORK APPLIANCE CORPORATION	NETWORK APPLIANCE CORPORATION	NETWORK APPLIANCE CORPORATION	NETWORK CONNECTION	NETWORK STORAGE SOLUTIONS
ARRAY MODEL	F230	F520	F630	T.R.A.C. Array	SPANStor-RAID
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem* Network Hardware	Subsystem* Network Hardware	Subsystem* Network Hardware	Subsystem Network Hardware	Software -- Software
Host platform, software environment	F230 NFS, CIFS, HTTP	F520 NFS, CIFS, HTTP	F630 NFS, CIFS, HTTP	T.R.A.C. DOS, OS/2, UNIX NetWare, other	PCI host NT, UNIX
RAID level Configured by:	4 Preset	4 Preset	4 Preset	0/1/4/5 Host	0/1/5
Array capacity (Gbytes) MIN MAX	 111.8	 232.2	8.6 438.6	Drive dependent Drive dependent	4 20
Minimum drives per array	2	2	2	2	2
Maximum drives per array	14	28	52	54	7
Concurrent host channels	1	1	2, 4	1	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	2, 32	2, 32	4, 128	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Option	No Yes Option	No Yes Option	No Yes Yes	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 20	132 20	132 20	132 10/20	Host dependent Host dependent
DRIVES: Formatted capacity/drive(MB)	4300, 9000	4300, 9000	4300, 9000	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
ARRAY SIZE: Inches: H x W x D	8.75 x 17.25 x 22	8.75 x 17.25 x 22	8.75 x 17.25 x 22	84 x 24 x 36	11.75 x 10 x 11
POWER: Power backup	.633 KVA Battery	.633 KVA Battery	.675 KVA Battery	250 watts None	
FIRST CUSTOMER SHIPMENT	2Q97	2Q97	2Q97	1996	1996
COMMENTS	*Includes NFS server and network interfaces to FDDI, ATM, Ethernet.	*Includes NFS server and network interfaces to FDDI, ATM, Ethernet.	*Includes NFS server and network interfaces to FDDI, ATM, Ethernet.	Complete server Purchased controller.	

MANUFACTURER	NONSTOP NETWORKS	NSTOR	NSTOR	NSTOR	NSTOR
ARRAY MODEL	No-Stop Network	CR8e-340T	CR8e-390T	nTera-360	nTera-720
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Software -- Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	PC compatible DOS, Windows, NetWare	SCSI NetWare, NT, UNIX, OS/2	SCSI host NetWare, NT, UNIX, OS/2	SCSI host NetWare, NT, UNIX, OS/2	SCSI host NetWare, NT, UNIX, OS/2
RAID level Configured by:	1 Preset	0/1/3/5/10/50* Host	0/1/3/5/10/50* Host	0/1/3/5/10/50* Host	0/1/3/5/10/50* Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	12 32	27 72	27 360	27 720
Minimum drives per array	2	3	3	3	3
Maximum drives per array	20	8	8	40	80
Concurrent host channels	1	3	3	3	3
Array interface to host	--	Ultra SCSI, PCI	Ultra SCSI, PCI	Ultra SCSI, PCI	Ultra SCSI, PCI
Drive interface	--	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	--	4, 128	4, 128	4, 128	4, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	Option Yes Yes	Option Yes Yes	Option 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)	Drive dependent Drive dependent	40/132 40	40/132 40	40/132 40	40/132 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	4200	9100	4200, 9100	4200, 9100
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	8	8	8	8
Average rotational delay (msec)	Drive dependent	3.0/4.17	3.0/4.17	3.0/4.17	3.0/4.17
ARRAY SIZE: Inches: H x W x D	--	17.5 x 7 x 19.125	17.5 x 7 x 19.125	72	47
POWER: Power backup	-- --	150 watts None	150 watts None	-- None	-- None
FIRST CUSTOMER SHIPMENT	1990	1Q97	1Q97	1Q98	1Q98
COMMENTS	Mirrored drives can be in different hosts	Supports SAF-TE specification. Dynam. reconfig Optional rack mount. *Also RAID-30.	Supports SAF-TE specification. Dynam. reconfig Optional rack mount. *Also RAID-30.	Supports SAF-TE specification. Dynamic reconfiguration *Also RAID-30.	Supports SAF-TE specification. Dynamic reconfiguration *Also RAID-30.

MANUFACTURER	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY
ARRAY MODEL	18000W DisKovery	4200W DisKovery	46W Concorde	8200W DisKovery	HST/10 HST/10 DAT DiskArray
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Software	Subsystem Host Software	Subsystem Host Software	Subsystem Host Software	Subsystem Host Hardware
Host platform, software environment	Macintosh	Macintosh	Macintosh	Macintosh	Macintosh, PC
RAID level Configured by:	0/1 Host	0/1 Host	0/1 Host	0/1 Host	0/1/3/5/10 Panel
Array capacity (Gbytes) MIN MAX	17.4 17.4	4.2 4.2	 44.3	8.6 8.6	 110
Minimum drives per array	2	2	2	2	3
Maximum drives per array	2	2	2	2	10
Concurrent host channels	1	1	1	1	1, 2
Array interface to host	PCI	PCI	PCI	PCI	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	--	--	--	--	4, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No	No No No	No Yes Yes
Spare drive (None/Auto/Manual)	None	None	None	None	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	132 40	40 40	132 40	40 40
DRIVES: Formatted capacity/drive(MB)	9000	2100	2300	4100	2100-22100
Nominal disk diameter (mm)	95	95	130	95	95, 130
Average positioning time (msec)	9	8.5	13.2	8.5	8.5
Average rotational delay (msec)	4.17	4.17	5.6	4.17	4.17
ARRAY SIZE: Inches: H x W x D	5.75 x 11.42 x 10.21	5.75 x 11.42 x 10.21	9.37 x 11.42 x 10.21	5.75 x 11.42 x 10.21	23.5 x 9.75 x 20.25
POWER: Power backup	20 watts	15 watts	35 watts	15 watts	300 watts
FIRST CUSTOMER SHIPMENT	9/94	9/94	1997	9/94	4Q94
COMMENTS	Software array.	Software array.	Software array.	Software array.	DAT tape is option.

MANUFACTURER	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	PACE TECHNOLOGIES	PACIFIC MICRO DATA	PACIFIC MICRO DATA
ARRAY MODEL	HST/20 HST/20 DAT DiskArray	HST/30 HST/30 DAT DiskArray	Pace RAID-5	MAST 2400	MAST 4800
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Macintosh, PC	Macintosh, PC	Pace Various	Various	Various
RAID level Configured by:	0/1/3/5/10 Panel	0/1/3/5/10 Panel	0/3/5 Host	0/1/4/5/10 E'net Port	0/1/4/5/10 E'net Port
Array capacity (Gbytes) MIN MAX	 221	 331	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	3	5	2/3	2/3
Maximum drives per array	20	30	20	24	48
Concurrent host channels	1, 2	1, 2	1	1, 3	1, 3
Array interface to host	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	4, 32	4, 32	0, 128	8, 512	8, 512
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	Yes Yes Yes (per drive)	Yes Yes Yes (per drive)
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	40 40	20 10	40 40	40 40
DRIVES: Formatted capacity/drive(MB)	2100-22100	2100-22100	Drive dependent	4300-9100	4300-9100
Nominal disk diameter (mm)	95	95, 130	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	8	8	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.17	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	23.5 x 9.25 x 20.25	23.5 x 9.25 x 20.25	Varies	Varies	Varies
POWER: Power backup	300 watts	300 watts	20 watts+drives None	Varies	Varies
FIRST CUSTOMER SHIPMENT	4Q94	4Q94	1/93	1997	1997
COMMENTS	DAT tape is option.	DAT tape is option.	Digi-Data controller.	Purchased controller.	Purchased controller.

MANUFACTURER	PACIFIC MICRO DATA	PATHLIGHT TECHNOLOGY	PATHLIGHT TECHNOLOGY	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS
ARRAY MODEL	MAST 800	ImageNETII	ImageRAID	1200SX Ultima	2100/2700 PATHFINDER
DISK/TREND GROUP	Net/Midrange	Single User	Single User	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Network Software	Software Host Software	Board Host Software	Board Host Hardware
Host platform, software environment	Various	Apple Power Mac Mac OS	Apple Power Mac Mac OS	PC compatible Various	PC compatible Various
RAID level Configured by:	0/1/4/5/10 E'net Port	0/1 Host	0/1 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	2/3	2	2	2	2
Maximum drives per array	8	126	126	4	4
Concurrent host channels	1	1	1	1	1
Array interface to host	Ultra SCSI	PCI	PCI	ISA, EISA	ISA, PCI
Drive interface	Ultra SCSI	SSA	SSA	SCSI-2	EIDE, SCSI-2
Cache size (min, max: MB)	8, 512			4, 16	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes (per drive)	-- -- --	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto	Manual	None	Manual, Auto*	Manual, Auto*
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	132 80	132 40	12.5/33 10/20	4/132 10
DRIVES: Formatted capacity/drive(MB)	4300-9100	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
ARRAY SIZE: Inches: H x W x D	Varies	--	--		4 x 14
POWER: Power backup	Varies	7 watts	--		N/A N/A
FIRST CUSTOMER SHIPMENT	1997	1997	1997	2Q95	4Q94
COMMENTS	Purchased controller.	Requires ImageRAID software.	Requires Pathlight PCI-SSA adapter.	Requires PSI software for RAID-1. *RAID-5 mode.	Requires PSI software for RAID-1. 2700 has PCI interface. *RAID-5 mode.

MANUFACTURER	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS	PERISOL TECHNOLOGY
ARRAY MODEL	2401	dataSHADOW	PCI 2000A Intellicache	PCI 22201	RAIDSafe
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 Attachment Implementation	Board Host Hardware	Board Host Software	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	PC compatible Various	PC compatible UNIX, Linux, OS/2, DOS	PC compatible Various	PC compatible Various	SCSI host Various
RAID level Configured by:	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	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	1 12
Minimum drives per array	2	2	2	2	2
Maximum drives per array	8	24	8	4	5
Concurrent host channels	1	1	1	1	1
Array interface to host	ISA, EISA	VESA, ISA, PCI	PCI	PCI	SCSI-2
Drive interface	EIDE	SCSI	SCSI-3	EIDE	SCSI-2
Cache size (min, max: MB)	--	1, 16	4, 128	--	2
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	N/A N/A N/A	-- -- --	-- -- --	No No Yes
Spare drive (None/Auto/Manual)	Manual, Auto*	Manual, Auto*	Manual, Auto*	Manual, Auto*	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	Host dependent 2-5	132 10/20	132 Drive dependent	10 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	65
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	9-11
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	5.6
ARRAY SIZE: Inches: H x W x D	4.5 x 7.4	N/A	4 x 6.945	4 x 5 x 5	3.25 x 5.75 x 8
POWER: Power backup	 None	N/A None	N/A None	N/A --	 Cache battery
FIRST CUSTOMER SHIPMENT	3Q96	1Q90	3Q97	2Q97	1995
COMMENTS	Audible alarm. *RAID-5 mode.	*RAID-5 mode.	Audible alarm. *RAID-5 mode.	Audible alarm. *RAID-5 mode	Purchased controller.

MANUFACTURER	PERISOL TECHNOLOGY	PHOENIX INTERNATIONAL	PHOENIX INTERNATIONAL	PHOENIX INTERNATIONAL	PHOENIX INTERNATIONAL
ARRAY MODEL	RAIDSafe Plus	PDR 5400	PDR 5500	Phalanx D	Phalanx T
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host UNIX, OSF/1, VMS,NT, other	SCSI host UNIX, other	SCSI host UNIX, other	SCSI host UNIX, other	SCSI host UNIX, other
RAID level Configured by:	0/1/4/5/10 Panel, Port	1/3/5/10 Panel, Port	1/3/5/10 Panel, Port	0/3/5 Port, Panel	0/3/5 Port, Panel
Array capacity (Gbytes) MIN MAX	2 432	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	56	6	6	10	16
Concurrent host channels	1, 4	1	4	1, 4	1, 4
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, 512	8, 256	16, 512	8, 512	8, 512
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option 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	10/20 10/20	10/20 10/20	10/20 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)	95	Drive dependent	Drive dependent	95	95
Average positioning time (msec)	8-9	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6/4.17	Drive dependent	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	22.25 x 7.5 x 23	12 x 10 x 15	12 x 10 x 15	12 x 10 x 15	21 x 11 x 23
POWER: Power backup	300 watts Cache battery	120 watts Cache battery	120 watts	120 watts Cache battery	300 watts Cache battery
FIRST CUSTOMER SHIPMENT	3Q93			2/96	2/96
COMMENTS	CMD controller.	CMD controller.	CMD controller.	CMD controller. Dual AC.	CMD controller. Dual AC. Rack mount. Customized versions available.

MANUFACTURER	PHOENIX INTERNATIONAL	PHOENIX INTERNATIONAL	PHOENIX INTERNATIONAL	PHOENIX INTERNATIONAL	POLYWELL COMPUTERS
ARRAY MODEL	PRMR 5400	PRMR 5500	PTR 5400	PTR 5500	SUMA 8000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host UNIX, other	SCSI host UNIX, other	SCSI host UNIX, other	SCSI host UNIX, other	PCI host NetWare, OS/2, SCO UNIX, NT
RAID level Configured by:	1/3/5/10 Panel, Port	1/3/5/10 Panel, Port	1/3/5/10 Panel, Port	1/3/5/10 Panel, Port	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	12	9	12	9	8
Concurrent host channels	1	4	1	4	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2, SCSI-3
Cache size (min, max: MB)	8, 256	16, 512	8, 256	16, 512	4, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes	Option Yes Yes	Option 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)	10/20 10/20	10/20 10/20	10/20 10/20	10/20 10/20	133 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	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
ARRAY SIZE: Inches: H x W x D	7 x 10 x 20	7 x 10 x 20	21 x 11 x 23	21 x 11 x 23	29 x 10 x 22
POWER: Power backup	300 watts	300 watts	300 watts	300 watts	750 watts UPS option
FIRST CUSTOMER SHIPMENT					1996
COMMENTS	CMD controller.	CMD controller.	CMD controller.	CMD controller.	Purchased controller. Rack mount option.

MANUFACTURER	PRECISION COMPUTERS	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROMISE TECHNOLOGY	PROMISE TECHNOLOGY
ARRAY MODEL	Precision RAID	Millenium LANForce	NetFORCE	FastTrak	iRAID10
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Net/Midrange
MARKET	OEM, PCM	PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	NetWare, UNIX, DOS OS/2	SCSI host Various	Ethernet NT, UNIX	PCI host NetWare, NT, DOS, other	SCSI host Various
RAID level Configured by:	0/1/4/5/10 Host	0/1/4/5/10 Host, Port	0/1/4/5/10	0/1/10 Host, Port	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	8	8	2	3
Maximum drives per array	5	56	56	4	10
Concurrent host channels	1		1	1	1
Array interface to host	Ultra SCSI	Ultra SCSI	Ethernet, FDDI	PCI	SCSI-2
Drive interface	SCSI-2	Ultra SCSI	Ultra SCSI	EIDE	EIDE
Cache size (min, max: MB)	4, 32	32, 512	32, 512		--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Option	No Yes Per drive	No Yes Per drive	No No No	No Yes Yes
Spare drive (None/Auto/Manual)	Auto		Auto	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	40 40	1.2/12 40	132 16.6/33	20 16.6/33
DRIVES: Formatted capacity/drive(MB)	2100-9100	4300-18000	4300-18000	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	Drive dependent	95
Average positioning time (msec)	8-9	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	Drive dependent	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	33.75 x 10.83 x 23.75	17.85 x 10.47 x 12.48	17.85 x 10.47 x 12.48	3 x 4.75 x .5	15.75 x 7.1 x 19.7
POWER: Power backup	225 watts None	Cache battery	UPS option		.5VA
FIRST CUSTOMER SHIPMENT	2Q96	7/97	1Q98	4Q97	4Q97
COMMENTS	Mylex controller.	Monitoring via Ethernet. Rack mount option. Adaptec controller.		25 MB/s sustained rate in RAID-0/10 modes.	

MANUFACTURER	PROMISE TECHNOLOGY	PROWARE TECHNOLOGY	PROWARE TECHNOLOGY	RAAC TECHNOLOGIES	RAIDAR SYSTEMS
ARRAY MODEL	iRAID5	5000I	5000S	ESP200	1261 Ultra
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 Attachment Implementation	Board Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	PC compatible Various	Macintosh System 7.5
RAID level Configured by:	3/5 Host, Port	0/1/5 Panel, Port	0/1/5 Panel, Port	0/1 Preset	0/1/3/5/6/10
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	 48	 420	Drive dependent Drive dependent	4 48
Minimum drives per array	3	2	2	2	2
Maximum drives per array	5	12	105	4	12
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	Ultra SCSI	Ultra SCSI	EISA, ISA	Ultra SCSI
Drive interface	EIDE	EIDE	Ultra SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	2, 128	2, 128	4, 32	1
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	Option Yes Yes	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	 20 16.6/33	 40 16.6	 40 40	 33 10	 40 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	8
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4.17
ARRAY SIZE: Inches: H x W x D	5 x 5.75 x 8.9	20.7 x 8.46 x 20.5	20.7 x 8.46 x 20.5	10.5 x 19 x 17	7.1 x 8.3 x 15.7
POWER: Power backup	38 watts	.88 KVA	.88 KVA	375 watts None	250 watts None
FIRST CUSTOMER SHIPMENT	4Q97	1996	1996	2Q94	1997
COMMENTS		Antrone controller. Rack mount option.	Antrone controller. Rack mount option.	DPT controller. Ruggedized.	

MANUFACTURER	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC
ARRAY MODEL	FlexArray M	RUAC MX	FibreArray	FibreRAID-PCI	FibreRAID-HI
DISK/TREND GROUP	Single User	Single User	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Host Hardware	Subsystem Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	Various DOS, UNIX, OS/2 NetWare, Syst.7	SCSI host	FC-AL host Various	PCI host NT, NetWare, UNIX	FC-AL host Various
RAID level Configured by:	0/1 Panel	0/1 Panel	0/1/3/5/10 Host, Port	0/1/3/5/6/10 Host, Port	0/1/3/5/10 Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	6	6
Minimum drives per array	2	2	3	3	3
Maximum drives per array	4	14	112	126	112
Concurrent host channels	1	1	1	1	1, 2
Array interface to host	SCSI, SCSI-2	SCSI, SCSI-2	FC-AL*	FC-AL, PCI	FC-AL
Drive interface	SCSI-2	SCSI-2	FC-AL	FC-AL	FC-AL
Cache size (min, max: MB)	--	--	8, 128	8, 128	8, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	-- -- --	Yes* Yes Yes	Yes (option) -- --	Yes (option) Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	100 100	132 100	100 100
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	2100-9100	2100, 23000	2100-9000
Nominal disk diameter (mm)	95	Drive dependent	95	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	8	Drive dependent	8
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17	Drive dependent	4.17
ARRAY SIZE: Inches: H x W x D	6.5 x 9.25 x 12.75	1.625 x 5.75 x 8.12	17.4 x 8.7 x 20.6	4.5 x 13.25	19 x 8.7 x 10.6
POWER: Power backup	150 watts	7.5 watts	300 watts Cache battery*	15 watts	300 watts Cache battery
FIRST CUSTOMER SHIPMENT	3Q96	3Q94	1Q97	1Q97	2Q97
COMMENTS	3 SCSI channels including host.	3 SCSI channels including host.	Dynamic reconfiguration *Options. Rack mount option.	Dynamic reconfiguration	Dynamic reconfiguration option. Rack mount option.

MANUFACTURER	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC
ARRAY MODEL	FlexArray RX	FlexArray FX	FlexArray TFX	FlexArray IX	RUAC FX
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	Various DOS, UNIX, OS/2 NetWare, Syst.7	Various DOS, UNIX, OS/2 Netware, Syst.7	SCSI host Various
RAID level Configured by:	0/1/3/5/10 Panel	0/1/3/5/10 Panel, Port	0/1/3/5 Panel, Port	0/1/3/5 Panel	0/1/3/5/10 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	2
Maximum drives per array	5	6	75	6	75
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI, SCSI-2	SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No -- --
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10/20	20 20	20 20	10 10	20 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
ARRAY SIZE: Inches: H x W x D	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	3.8 x 16.6 x 13
POWER: Power backup	300 watts	300 watts	300 watts	300 watts	140 watts
FIRST CUSTOMER SHIPMENT	3Q94	3Q94	4Q96	1Q93	3Q94
COMMENTS	Requires RUAC controller.	RUAC II controller. Remote diag. and monitoring.	6 SCSI channels including host.	6 SCSI channels including host.	6 SCSI channels including host.

MANUFACTURER	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC
ARRAY MODEL	RUAC II	RUAC IX	UltraRAID TA FlexArray	UltraRAID TB FlexArray	UltraRAID TC FlexArray
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	SCSI host Various	SCSI host DOS, UNIX, OS/2 Netware, Syst.7	PCI host NetWare,NT,UNIX Win. 95, OS/2	PCI host NetWare,NT,UNIX Win. 95, OS/2	PCI host NetWare,NT,UNIX Win. 95, OS/2
RAID level Configured by:	0/1/3/5/10 Panel, Port	0/1/3/5 Panel	0/1/3/5 Panel, Port	0/1/3/5 Panel, Port	0/1/3/5 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	2
Maximum drives per array	75	35	7	7	7
Concurrent host channels	1	1	1, 2	1, 2	1
Array interface to host	SCSI, SCSI-2	SCSI, SCSI-2	PCI	PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	--	--	8, 32	8, 32	8, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	No Yes Yes	No Yes Yes	No 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)	20 20	10 10	132 20/40	132 20/40	132 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	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
ARRAY SIZE: Inches: H x W x D	8.5 x 10.5	3.8 x 16.6 x 13	19 x 8.7 x 20.6	19 x 8.7 x 20.6	19 x 8.7 x 20.6
POWER: Power backup	140 watts	140 watts	10 watts+drives	10 watts+drives	10 watts+drives
FIRST CUSTOMER SHIPMENT	3Q94	1Q94			
COMMENTS	6 channels including host. Remote monitor. Beeper notification. Differential.	6 SCSI channels including host.	Rack mount option. Expandable to 14 drives. 2 channel.	Rack mount option. Expandable to 14 drives. 2 channel.	Rack mount option. Expandable to 14 drives. 2 channel.

MANUFACTURER	RISING EDGE TECHNOLOGIES	RISING EDGE TECHNOLOGIES	RISING EDGE TECHNOLOGIES	SEEK SYSTEMS	SEEK SYSTEMS
ARRAY MODEL	MOR1200i	MOR1200S	MOR1200XHA	Adaptive RAID	Commander
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Various	Local Area Net Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	0/3/5 Host	0/3/5 Host	0/3/5 Host	1/5 Host	1/5 Host
Array capacity (Gbytes) MIN MAX	 5.7	 5.7	 36.4	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	5	5	5	2	4
Maximum drives per array	5	5	35	64	16
Concurrent host channels	1	1	1	1	1, 2
Array interface to host	SCSI-2	Ethernet	SCSI-2	Ultra SCSI	Ultra SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	4, 128	4, 128	4, 128	32, 1000	256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- Option	No -- Option	Option Yes Yes	No -- --	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	 20 20	 1.2 20	 20 20	 40 40	 40 40
DRIVES: Formatted capacity/drive(MB)	1300	1300	1300	Drive dependent	Drive dependent
Nominal disk diameter (mm)	130	130	130	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
ARRAY SIZE: Inches: H x W x D	17 x 7 x 17	17 x 7 x 17	17 x 7 x 17	3.38 x 5.25 x 10.3	29 x 22 x 22
POWER: Power backup	250 watts --	250 watts UPS option	 UPS option	20 watts Cache battery	.65 KVA UPS
FIRST CUSTOMER SHIPMENT	5/97	5/97	9/97	1/97	3Q97
COMMENTS	Optical LIM-DOW drive array. Many options.	Optical LIM-DOW drive array. Many options.	Optical LIM-DOW drive array. Many options.	Can be used as solid state disk.	Rack mount option.

MANUFACTURER	SEEK SYSTEMS	SEEK SYSTEMS	SEEK SYSTEMS	SEEK SYSTEMS	SIEMENS NIXDORF
ARRAY MODEL	Escort	S460	Sentry	Xcelerator	PXRC Disk Array
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host UNIX, NetWare
RAID level Configured by:	1/5 Host	0/1/4/5/10 Panel, Port	1/5 Host	1/3/5 Port	0/1/3/5/10
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	5 100	4 84
Minimum drives per array	4	7	6	5	4
Maximum drives per array	4	56	6	60	24
Concurrent host channels	1, 2	1, 4	1, 2	1, 4	1, 2
Array interface to host	Ultra SCSI	SCSI-2	SCSI-2	SCSI-3	SCSI-2
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-3	SCSI-2
Cache size (min, max: MB)	64	8, 512	128	32, 1000	32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Option Yes Yes (option)	No Yes Yes	Yes Yes Yes (option)	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	10/20 10/20	40 40	10/20 10/20	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	2100, 9100	Drive dependent	Drive dependent	4200
Nominal disk diameter (mm)	95	95	95	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
ARRAY SIZE: Inches: H x W x D	16.5 x 10.25 x 14.5	Varies	25.87 x 9.36 x 21		33.9 x 18.9 x 19.9
POWER: Power backup	.28 KVA UPS	300 watts Cache battery	.42-.7 KVA UPS	45 watts Cache battery	378 watts
FIRST CUSTOMER SHIPMENT	3Q97	1996	3Q97	12/94	11/96
COMMENTS	Rack mount option.	CMD controller. UPS option.	Rack mount option.	Can be used as solid state disk.	

MANUFACTURER	SOLID COMPUTER	SOLID COMPUTER	SOLID COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER
ARRAY MODEL	M20	M30	M7	Series: 70 Desktop Server	Series: 71 Storage Server
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Sun, RS/6000, DG AViiON NetWare, UNIX	Sun,RS/6000,SGI H-P,Apple,PowPC NetWare, UNIX	Sun, RS/6000 DG AViiON NetWare, UNIX	All SCSI	All SCSI
RAID level Configured by:	0/1/3/5/10 Port	0/1/3/5/10 Port	0/1/3/5/10 Port	7	7
Array capacity (Gbytes) MIN MAX	21 176	12 264	12 62	54 138	54 575
Minimum drives per array	5	3	3	6	6
Maximum drives per array	20	30	7	12	27
Concurrent host channels	1	1, 2	1	1, 2	1, 4
Array interface to host	SCSI-2, PCI	SCSI-2, FC-AL	SCSI-2	SCSI,UI.SCSI,FC	SCSI,UI.SCSI,FC
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI	SCSI
Cache size (min, max: MB)	4, 64	32, 256	4, 128	16, 128	16, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes 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 20	20/40/100 20	20 20	10/20 Drive dependent	10/20 Drive dependent
DRIVES: Formatted capacity/drive(MB)	4200, 8800	4200, 8800	4200, 8800	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	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
ARRAY SIZE: Inches: H x W x D	24.8 x 14 x 30	18.4 x 19 x 30	7 x 17.5 x 16.5	15.3 x 17.75 x 18.5	14 x 17 x 28.5
POWER: Power backup	880 watts	1150 watts	300 watts	8A @ 120VAC 4A @ 220VAC	12A @ 120VAC 6A @ 220VAC
FIRST CUSTOMER SHIPMENT	1997	1997	1997	2Q92	2Q92
COMMENTS	CLARiiON array.	CLARiiON array.	CLARiiON array.		

MANUFACTURER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE CONCEPTS	STORAGE CONCEPTS
ARRAY MODEL	Series: 72 OmniRAID Server	Series: 73 OmniRAID Superserver	Series: 74 OmniRAID Superserver/ES	Concept 812SW	807 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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	All SCSI	All SCSI	All SCSI	SCSI host Proprietary	PC, SGI NT, IRIX, OS-9 Solaris, other
RAID level Configured by:	3/5/7	0/1/3/5/7	0/1/3/5/7	0/3 Port	0/3 Host, Port
Array capacity (Gbytes) MIN MAX	54 1 TB	54 4 TB	54 16 TB	16 72	16 36
Minimum drives per array	6	6	12	4	4
Maximum drives per array	48	48	48	10	5
Concurrent host channels	1, 12	1, 12	1, 12	1	1, 2
Array interface to host	SCSI,Ul.SCSI,FC	SCSI,Ul.SCSI,FC	SCSI,Ul.SCSI,FC	SCSI-2	Fibre Channel
Drive interface	SCSI	SCSI	SCSI	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	16, 128	64, 256	256, 1 GB	2	4, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Yes Yes Yes	Yes Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40/100 Drive dependent	40/100 Drive dependent	40/100 Drive dependent	20+ 20	50 (sustained) 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	4000, 9100	4300, 9100
Nominal disk diameter (mm)	95, 130	95, 130	95, 130	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	8	8
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	4.17	4.17/3.0
ARRAY SIZE: Inches: H x W x D.	62 x 24 x 36	78 x 24 x 36	78 x 48 x 36	5.25 x 19 x 21	5.25 x 19 x 21
POWER: Power backup	24A @ 120VAC 12A @ 220VAC	24A @ 120VAC 12A @ 220VAC	48A @ 120VAC 24A @ 220VAC	250 watts Dual power supp	
FIRST CUSTOMER SHIPMENT	1Q97	2Q96	3Q97	3/95	4/97
COMMENTS	Size for R1 model.	Size for C2 model.	Size for C3 model.	Real time control engine. i960 processor.	Dual ported. Network attach option.

MANUFACTURER	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE DIMENSIONS
ARRAY MODEL	C814F FibreRAID	C823F FibreRAID	Videoplex	VideoStar	MiniFlex
DISK/TREND GROUP	Very High Perf.	Very High Perf.	Very High Perf.	Very High Perf.	Net/Midrange
MARKET	PCM	PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	PC, SGI UNIX, NT, OS-9, VXWorks, Irix	SCSI host UNIX, NT, OS-9, VXWorks	Intel Pentium, DEC Alpha, Sun Win., NT, UNIX	Intel Pentium, DEC Alpha, Sun	PC compatible NetWare, NT, Solaris, AIX
RAID level Configured by:	0/3	0/3	3/5 Port	3/5 Port	0/1 Host
Array capacity (Gbytes) MIN MAX	32 144	92 184	18 660	18 660	4.3 18.2
Minimum drives per array	9	4	3	3	2
Maximum drives per array	9	9	36	36	2
Concurrent host channels	1, 2	1, 2	1	1	1
Array interface to host	Fibre Channel	Fibre Channel	SCSI,NTSC,PAL	SCSI,NTSC,PAL	SCSI-2
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64			--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes			No No No
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	--
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 (sustained) 40	80 (sustained) 40	 40	 40	20 20
DRIVES: Formatted capacity/drive(MB)	4000, 9100	23000, 46000*	9100, 23000	9100, 23000	4300, 9100
Nominal disk diameter (mm)	95	130	95, 130	95, 130	95
Average positioning time (msec)	8	11	Drive dependent	Drive dependent	8.5
Average rotational delay (msec)		5.5	Drive dependent	Drive dependent	4.17
ARRAY SIZE: Inches: H x W x D	5.25 x 19 x 21	26 x 19 x 21			7.2 x 6.7 x 12
POWER: Power backup	300 None	350 watts None			65 watts Optional UPS
FIRST CUSTOMER SHIPMENT	4/96	4Q97	4/96	4Q96	2/95
COMMENTS	Real time control engine. i960 processor. Network attach option.	Real time control engine. *Future option.	For MPEG-1 video server.	For MPEG-2 video server.	

MANUFACTURER	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS
ARRAY MODEL	RAIDPro LC	RAIDPro VL	RAIDPro XL	SuperFlex 4500	SuperFlex 5000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	PCI host NetWare, NT	PCI host NT, NetWare	PCI host NT, NetWare	SCSI host NetWare, NT, Solaris	SCSI host Solaris, NT NetWare
RAID level Configured by:	0/1/3/5/10 Host	0/1/3/5/10 Host	0/1/3/5/10 Host	0/1/3/5/10 Host	0/1/3/5/10 Host
Array capacity (Gbytes) MIN MAX	12.9 54.6	12.9 54.6	12.9 109.2	12.9 127.4	12.9 63.7
Minimum drives per array	3	3	3	3	3
Maximum drives per array	6	6	12	14	7
Concurrent host channels	1	1	1	1	1
Array interface to host	PCI	PCI	PCI	SCSI-2	SCSI-2
Drive interface	SCSI-2	Ultra SCSI	Ultra SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	64	16, 64	32, 64	16, 32	16, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	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)	132 20	132 40	132 40	20 20	20 20
DRIVES: Formatted capacity/drive(MB)	4300	4300, 9100	4300, 9100	4300, 9100	4300, 9100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8.5	8.5/9	9	8.5	8
Average rotational delay (msec)	5.56	5.54/4.17	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	5.25 x 8.75 x 14	5.25 x 8.75 x 14	5.25 x 8.75 x 14	6.9 x 17.4 x 19.5	6.9 x 17.4 x 19.5
POWER: Power backup	 Battery	200 watts Battery option	200 watts Battery option	250 watts	250 watts Battery
FIRST CUSTOMER SHIPMENT	4Q97	2Q97	3Q97	9/94	7/96
COMMENTS	SAFE-TE compliant. Dynamic reconfiguration	SAF-TE compliant. Dynamic reconfiguration	SAF-TE compliant. Expands to 12 drives. Dynamic reconfiguration	Dual AC input. *Upgradable to dual redundant controller.	Dual AC input. Dual redundant controller.

MANUFACTURER	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE TECHNOLOGY	STORAGE TECHNOLOGY
ARRAY MODEL	SuperFlex 5500	SuperFlex 5200	SuperFlex 3000 DGR Ultra	9131	9133
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host NetWare, NT, Solaris	SCSI host NetWare, NT	PCI host NetWare, NT	RS/6000, Sun, NT, UNIX	RS/6000, Sun, PC, UNIX, DEC
RAID level Configured by:	0/1/3/5/10 Host	0/1/3/5/10 Host	0/1/3/5/10 Host	0/1/1+0/3/5 Service func.	0/1/1+0/3/5 Service func.
Array capacity (Gbytes) MIN MAX	12.9 127.4	12.9 127.4	12.9 191.1	21 704	21 528
Minimum drives per array	3	3	3	5	5
Maximum drives per array	14	14	21	80	60
Concurrent host channels	2	1	1	2	2
Array interface to host	Ultra SCSI	SCSI-2	PCI	IBM, SCSI-2	SCSI-2
Drive interface	Ultra SCSI	SCSI-2	Ultra SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	32, 128	16, 32	16, 128	8, 128	8, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	No 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)	40 40	10/20 10/20	132 40	20 20	20/40 10
DRIVES: Formatted capacity/drive(MB)	4300, 9100	4300, 9100	4300, 9100	3500,4000,8800	4200, 8800
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8.5	8.5/9	8.5	7.8-11.2	7.5-9.5
Average rotational delay (msec)	4.17	4.17	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	6.9 x 17.4 x 19.5	13.76 x 17.38 x 19.5	6.9 x 17.4 x 19.5	72 x 29 x 30	24.8 x 10.5 x 30
POWER: Power backup	250 watts Battery	300 watts Battery	250 watts Battery	880 watts Battery	575 watts
FIRST CUSTOMER SHIPMENT	12/97	2Q97	3Q97	1995	1996
COMMENTS	Dual AC input. Dual active controllers.	Dual AC input. Dual redundant controller.	Dual AC input. Dynamic reconfiguration		

MANUFACTURER	STORAGE TECHNOLOGY	STORAGE TECHNOLOGY	STORAGEPATH	STORAGEPATH	STORAGEPATH
ARRAY MODEL	9135	9137	SP-18BTHT	SP-5BT	SP-9BR
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	RS/6000, Sun, PC, UNIX, DEC	RS/6000, Sun, PC, UNIX, DEC	SCSI host UNIX, VMS, NT, NetWare, DOS	SCSI host Various	SCSI host UNIX, VMS, NT, NetWare, DOS
RAID level Configured by:	0/1/1+0/3/5 Service func.	0/1/1+0/3/5 Service func.	0/3/5 Host	0/1/3/4/5	0/3/5 Host
Array capacity (Gbytes) MIN MAX	126 370	21 729	2.5 45	 16	2.5 28.7
Minimum drives per array	3	5	2	5	2
Maximum drives per array	42	90	15	5	7
Concurrent host channels	1	2	1	1	1
Array interface to host	SCSI-2	SCSI-2, FC-AL	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2, FC-AL	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 32	8, 64	0, 32	8, 512	--, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	No Per drive Yes	No No No	No Per drive Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20/40/100 10	20 10	10 10	20 10
DRIVES: Formatted capacity/drive(MB)	4200, 8800	4200, 8800	Drive dependent	4000	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	7.8-11.2	7.5-9.5	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.17	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	19.5 x 7 x 19	24.8 x 14 x 30	20 x 24 x 24	12.2 x 10.6 x 19.9	8.75 x 19 x 21
POWER: Power backup	300 watts	1000 watts	300 watts	200 watts	300 watts
FIRST CUSTOMER SHIPMENT	1996	1997	4Q94	4Q94	4Q94
COMMENTS			Purchased controller.	Purchased controller.	Rack mount. Purchased controller.

MANUFACTURER	STORAGEPATH	STORAGEPATH	STORNET	STRATUS COMPUTER	STRATUS COMPUTER
ARRAY MODEL	SP-9BT	SP-9BTHT	Server RAID	D600 (K121)	D700 (K460)
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	OEM, PCM	PCM	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Various	SCSI host UNIX, VMS, NT, NetWare, DOS	Sun UNIX	Stratus VOS/FTX	Stratus VOS/FTX
RAID level Configured by:	0/1/3/4/5	0/3/5 Host	0/1 Host	1 Preset	1 Preset
Array capacity (Gbytes) MIN MAX	 28	2.5 28.7	Drive dependent Drive dependent	1.46 Varies by syst.	2 Varies by syst.
Minimum drives per array	7	2	2	2	2
Maximum drives per array	7	7	10	Varies by syst.	Varies by syst.
Concurrent host channels	1	1	1	2, 10	2, Varies
Array interface to host	SCSI-2	SCSI-2	SCSI-2	Proprietary	Proprietary
Drive interface	SCSI-2	SCSI-1/2	SCSI-2	SCSI	SCSI-2
Cache size (min, max: MB)	8, 512	0, 32	--	.256	.256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	No Per drive Yes	No -- Per drive	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 20	5 Drive dependent	20 Drive dependent
DRIVES: Formatted capacity/drive(MB)	4000	Drive dependent	Drive dependent	Varies	Varies
Nominal disk diameter (mm)	95	95	Drive dependent	Varies	Varies
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
ARRAY SIZE: Inches: H x W x D		20 x 11.5 x 24	Varies	Varies	Varies
POWER: Power backup	300 watts	300 watts	Configuration dependent	Drive dependent Battery	Drive dependent Battery
FIRST CUSTOMER SHIPMENT	4Q94	4Q94	1997	3/91	1Q95
COMMENTS	Purchased controller.	Purchased controller.	Many configurations.		

MANUFACTURER	STRATUS COMPUTER	SUN MICROSYSTEMS	SUN MICROSYSTEMS	SUN MICROSYSTEMS	SUN MICROSYSTEMS
ARRAY MODEL	D800	A5000	Online: DiskSuite 4.1	RSM Array 2000	SPARCstorage Model 112
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive, PCM	Captive	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Software	Software Host Software	Subsystem Host Hardware	Subsystem Host Software
Host platform, software environment	Stratus VOS/FTX HP UX	SPARC servers Solaris	Sun SPARC Solaris	SPARC servers UNIX, HP-UX, NT	SPARC servers Solaris
RAID level Configured by:	1 Preset	0/1/5/10 Host	0/1/5 Host	0/1/3/5/10 Host	0/1/5/10 Host
Array capacity (Gbytes) MIN MAX	2 9	45.5 127.8	Drive dependent Drive dependent	 318	12.6 63
Minimum drives per array	2	5	2	15	6
Maximum drives per array	52	14	128	35	30
Concurrent host channels	2, 4	4	--	2	1, 2
Array interface to host	SCSI-2	FC-AL	--	Ultra SCSI	S-bus/Fibre
Drive interface	SCSI-2	FC-AL	--	SCSI-2	SCSI-2
Cache size (min, max: MB)	8		--	128, 256	16
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Option -- --	Yes Yes Yes	No Yes No
Spare drive (None/Auto/Manual)	None	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 Drive dependent	100 100	Drive dependent Drive dependent	40 20	25/50 duplexed 20
DRIVES: Formatted capacity/drive(MB)	Varies	9100	Drive dependent	4200, 9100	2100
Nominal disk diameter (mm)	95	95	Drive dependent	95	95
Average positioning time (msec)	10	8	Drive dependent	9	9
Average rotational delay (msec)	4.17	4.17	Drive dependent	4.17	4.17
ARRAY SIZE: Inches: H x W x D	Varies	8.9 x 9.5 x 24.6	--	48 x 30 x 39	8.94 x 21.06 x 19.46
POWER: Power backup	Drive dependent UPS		-- --	4200 watts max.	.65 KVA Cache battery
FIRST CUSTOMER SHIPMENT	2Q96	3Q97	9/91	2/97	2Q94
COMMENTS		Expandable to 509 gigabytes.			

MANUFACTURER	SUN MICROSYSTEMS	SUN MICROSYSTEMS	SUN MICROSYSTEMS	SUNIX	SUNIX
ARRAY MODEL	SPARCstorage Model 114	SPARCstorage Model 214RSM	SPARCstorage Model 219RSM	3250	2220
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, PCM	Captive, PCM	Captive, PCM	OEM	OEM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Software	Subsystem Host Software	Subsystem Host Software	Board Host Hardware	Board Host Hardware
Host platform, software environment	SPARC servers Solaris	SPARC servers Solaris	SPARC servers UNIX, HP-UX, NT	PCI host DOS, Wind. NT, NetWare, other	PCI host DOS, Wind. NT, NetWare, other
RAID level Configured by:	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	25.2 126	75.6 176.4	163.8 382	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	6	18	18	2	2
Maximum drives per array	30	42	42	4	14
Concurrent host channels	2	1, 2	2	1	1
Array interface to host	S-bus/Fibre	S-bus/Fibre	S-bus/Fibre	PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	EIDE	SCSI-2
Cache size (min, max: MB)	16	16	16	128	128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes No	No Yes No	No Yes Yes	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	25/50 duplexed 20	25/50	 20	133 11.3 PIO Mode 3	133 10
DRIVES: Formatted capacity/drive(MB)	4200	4200	9100	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	Drive dependent	Drive dependent
Average positioning time (msec)	9	9	9	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.17	4.17	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	8.94 x 21.06 x 19.46	19" Rack		.5 x 4.25 x 7.87	.5 x 4.25 x 7.87
POWER: Power backup		4.8 KVA Cache battery		4 watts None	4 watts None
FIRST CUSTOMER SHIPMENT		2Q96		1997	1997
COMMENTS		Rack mount.			

MANUFACTURER	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC
ARRAY MODEL	Data Center Scaleable Storage MetaStor	Department Scaleable Storage MetaStor	FS60	RM20/DS20	SH6000 MetaStor
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	OEM	OEM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware
Host platform, software environment	SCSI,FC-AL host UNIX, NT, DOS	SCSI,FC-AL host UNIX, NT, DOS	SCSI,FC-AL host UNIX, NT, DOS, NetWare, other	SCSI,FC-AL host UNIX, NT, DOS, NetWare, other	Intel, SPARC NFS, SMB
RAID level Configured by:	0/1/3/5 Host, Port	0/1/3/5 Host, Port	0/1/3/5 Host, Port	0/1/3/5 Host, Port	5 Panel,Web brows
Array capacity (Gbytes) MIN MAX	126 910	42 455	Drive dependent Drive dependent	Drive dependent Drive dependent	42 637
Minimum drives per array	30	10	5	5	10
Maximum drives per array	100	50	60	30	70
Concurrent host channels	8	4	2	2	4
Array interface to host	Ultra2, FC-AL	Ultra2, FC-AL	Ult.SCSI, FC-AL	Ult.SCSI,FC-AL	E'net, various
Drive interface	Ultra, FC-AL	Ultra, FC-AL	Ultra SCSI	Ultra SCSI	Ult.SCSI, FC-AL
Cache size (min, max: MB)	64, 128	64, 128	8, 128	8, 128	64, 2048
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	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)	40/80/100 40/100	40/80/100 40/100	40/100 40	40/100 40	2600 40/100
DRIVES: Formatted capacity/drive(MB)	4200, 9100	4200, 9100	4000, 9000	4200, 9100	4200, 9100
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	95
Average positioning time (msec)	7.5/8.25	7.5/8.25	Drive dependent	Drive dependent	7.5/8.3
Average rotational delay (msec)	2.99/4.17	2.99/4.17	Drive dependent	Drive dependent	2.99/4.17
ARRAY SIZE: Inches: H x W x D	72 x 22 x 36	20.75 x 41 x 26.2	56 x 22 x 36	14 x 19 x 30/ 22.5 x 15 x 32	72 x 22 x 36
POWER: Power backup	Cache battery	Cache battery	Cache battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	4Q97	4Q97	1995	3Q95	4Q97
COMMENTS			Uses up to 3 RM20.	Series 3-3622 or -3703 controller.	

MANUFACTURER	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC
ARRAY MODEL	SH6400 MetaStor	SH850 MetaStor	SYM1000-3621 SYM1000-3702	SYM1000-4566	SYM1000-4766
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	OEM	OEM	OEM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Network Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	Intel/SPARC NFS, SMB	Intel/SPARC NFS, SMB	SCSI,FC-AL host UNIX, NT, DOS, NetWare, other	SCSI host UNIX, NT, DOS, NetWare, other	FC-AL host UNIX, NT, DOS, NetWare, other
RAID level Configured by:	5 Panel,Web brows	5 Panel,Web brows	0/1/3/5 Host, Port	0/1/3/5 Host, Port	0/1/3/5 Host, Port
Array capacity (Gbytes) MIN MAX	42 546	12.6 182	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	10	3	N/A	N/A	N/A
Maximum drives per array	60	20	N/A	N/A	N/A
Concurrent host channels	8	2	2	4	2
Array interface to host	E'net, various	E'net, various	Ult.SCSI, FC-AL	Ultra2 SCSI	FC-AL
Drive interface	Ult.SCSI,FC-AL	Ult.SCSI,FC-AL	Ultra SCSI	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)	256, 2048	64, 2048	8, 128	16, 256	16, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No 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)	5000 40/100	850 40/100	40/100 40	80 80	100 80
DRIVES: Formatted capacity/drive(MB)	4200, 9100	4200, 9100	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	7.5/8.3	7.5/8.3	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	2.99/4.17	2.99/4.17	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	72 x 22 x 36	20.75 x 14.5 x 26.2	7 x 18.5 x 26	7 x 18.5 x 26	7 x 18.5 x 26
POWER: Power backup	Cache battery	Cache battery	Cache battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	4Q97	1Q98	1Q97	3Q98	2Q98
COMMENTS			Controller unit in modular packaging.	Controller unit in modular packaging.	Controller unit in modular packaging.

MANUFACTURER	SYMBIOS LOGIC	SYMBIOS LOGIC	SYRED DATA SYSTEMS	SYRED DATA SYSTEMS	SYRED DATA SYSTEMS
ARRAY MODEL	SYM2000-3240	Workgroup Scaleable Storage MetaStor	Cruiser	Prestige	Prestige Plus
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	SCSI host UNIX, NT, DOS, NetWare, other	SCSI host UNIX, NT, DOS,	PCI host UNIX, Windows, NetWare	SCSI host DEC VMS,Solaris NetWare,NT,oth.	SCSI host DEC VMS,Solaris NetWare,NT,oth.
RAID level Configured by:	0/1/3/5 Host, Port	0/1/3/5 Host, Port	0/1/3/4/5/10	0/1/5/10 Panel, Port	0/1/4/5/10 Panel, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	12.6 91	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	3	2	2	2
Maximum drives per array	10	10	45	14	45
Concurrent host channels	1	2	1	1	1
Array interface to host	Ultra SCSI	Ultra SCSI	PCI	SCSI-2	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	8, 64	16, 64	4, 64	4, 32	16, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	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)	40 40	40 40	132 20/40	10 10	20/40 20/40
DRIVES: Formatted capacity/drive(MB)	4200,9100,18200	4200, 9100	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	7.5/8.25	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	2.99/4.17	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	5.25 x 17.5 x 25	20.75 x 6 x 26.2			
POWER: Power backup	 Cache battery	 Cache battery	12 watts	11 watts+drive None	11 watts+drive None
FIRST CUSTOMER SHIPMENT	3Q97	4Q97	2Q97	1993	1996
COMMENTS					

MANUFACTURER	SYRED DATA SYSTEMS	SYRED DATA SYSTEMS	TANDEM COMPUTERS	TANDEM COMPUTERS	TANDEM COMPUTERS
ARRAY MODEL	Regency	SuperPrestige	4518	4570	4580
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	OEM, PCM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host DEC VMS,Solaris NetWare,NT,oth.	SCSI host DEC VMS,Solaris NetWare,NT,oth.	Tandem NonStop Himalaya	Tandem NonStop Himalaya	Tandem NonStop Himalaya
RAID level Configured by:	0/1/3/4/5/10 Panel, Port	0/1/3/4/5/10 Panel, Port	1 Host	1 Host	1 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	18 72	4.2 16.8	8.8 35.2
Minimum drives per array	2	2	2	2	2
Maximum drives per array	105	30	8	8	8
Concurrent host channels	1	1, 2	2	2	2
Array interface to host	Ult.SCSI, FC-AL	Ultra SCSI	SCSI	SCSI over fiber	SCSI over fiber
Drive interface	Ultra SCSI	Ultra SCSI	SCSI	SCSI	SCSI
Cache size (min, max: MB)	2, 128	2, 128	1, 128	1, 128	1, 128
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	Yes	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20/40/60 20/40	20/40 20/40	20 10	5 10	5 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	18200	4200	8800
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	9	10	10
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D			7 x 19 x 12	7 x 19 x 28	7 x 19 x 28
POWER: Power backup	30 watts+drive None	12 watts None	400 watts Dual AC	400 watts Dual AC	400 watts Dual AC
FIRST CUSTOMER SHIPMENT	1997	1Q97	12/97	3/95	3Q96
COMMENTS					

MANUFACTURER	TANDEM COMPUTERS	TANDEM COMPUTERS	TANDEM COMPUTERS	TANDEM COMPUTERS	TANGENT COMPUTER
ARRAY MODEL	4590	4604	4608	INTEGRITY NR RAID	Enterprise Duo Enterprise Quad
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Software
Host platform, software environment	Tandem NonStop Himalaya	Tandem NonStop Himalaya	Tandem NonStop Himalaya	Tandem NonStop UNIX	Tangent NetWare, UNIX, OS/2, NT, Other
RAID level Configured by:	1 Host	1	1	0/1/3/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	18 72	4.2 16.8	8.8 35.2	12.2 167.5	27/9/18 109/55/82
Minimum drives per array	2	2	2	4	3
Maximum drives per array	8	8	8	48	12
Concurrent host channels	2	2	2	1, 2	1
Array interface to host	SCSI	SCSI	SCSI	SCSI-2	PCI
Drive interface	SCSI	SCSI	SCSI	SCSI-2	Ultra
Cache size (min, max: MB)	1, 128	1, 128	1, 128	16, 64	16
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)	Yes	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	5 10	5 10	5 10	20 10	132 40
DRIVES: Formatted capacity/drive(MB)	18200	4200	8800	4300	9100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9	10	10	9	8
Average rotational delay (msec)	4.17	4.17	4.17	4.17	4.17
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	450 watts None
FIRST CUSTOMER SHIPMENT	1/98	10/96	10/96	4/95	4/97
COMMENTS				EMC controller.	Tower or rack mount. Complete server

MANUFACTURER	TD SYSTEMS	TD SYSTEMS	TD SYSTEMS	TD SYSTEMS	TEKRAM TECHNOLOGY
ARRAY MODEL	OMNISERVE 2	OMNISERVE 3	SCSI-STOR MX	SCSI-STOR DR	DC-690 DC-890
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Single User
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	All SCSI hosts Various	All SCSI hosts Various	SCSI host	SCSI host	PC compatible DOS, UNIX, NT, NetWare, other
RAID level Configured by:	1 Preset	1 Preset	1 RS232	1 RS232	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	14	28	16	16	4
Concurrent host channels	1, 2	1, 2	1	2	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	IDE
Cache size (min, max: MB)	--	--	--	--	.256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	Option -- Yes	-- -- --
Spare drive (None/Auto/Manual)	Manual	Manual	None	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Up to 10 10	Up to 20 20	20 20	20 20	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	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
ARRAY SIZE: Inches: H x W x D	1.625 x 5.75 x 8.25	3.25 x 5.75 x 8.25	3.25 x 5.75 x 8.25	3.25 x 5.75 x 8.25	
POWER: Power backup	10-20 watts --	10-20 watts --			2.5 watts
FIRST CUSTOMER SHIPMENT	1/93	1Q94	1996	1996	1995
COMMENTS	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.			

MANUFACTURER	TEXA	TEXA	TEXA	TEXA	TEXA
ARRAY MODEL	RST-05S RST-10W RST-20W	RST-1000W RST-2000W RST-4000W	RST-10WU RST-20WU	RST-540 RST-1000	RST-F4GU RST-F8GU
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Single User
MARKET	OEM	OEM, PCM	OEM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host 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	0/3/5 Host, Panel	0/3/5 Host, Panel	0/3/5 Host, Panel	0/3/5 Host, Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	1/2/4 1.5/3/6	Drive dependent Drive dependent	.5/1 .8/1.5	4/8 6/12
Minimum drives per array	3	3	3	3	3
Maximum drives per array	3	3	3	3	3
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-3	SCSI-3	Ultra SCSI	SCSI-2	Ultra SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.5, 2	1	1, 2	.5	2
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)	15/12/12 10	15/12/12 10	22/15/15 10	9/8/8 10	22/15/15 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	540,1000,2000	Drive dependent	270, 540	2000, 4000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	12/9/9	Drive dependent	12	9/9
Average rotational delay (msec)	Drive dependent	6.6/5.5/5.5	Drive dependent	6.6/6.6	4.2
ARRAY SIZE: Inches: H x W x D	9.3 x 6.7 x 9.5	9.3 x 6.7 x 9.5	9.3 x 6.7 x 9.5	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	100 watts None	100 watts None	100 watts None
FIRST CUSTOMER SHIPMENT	10/94	9/94	3/97	9/94	3/97
COMMENTS	SyQuest drive may be used.				

MANUFACTURER	TEXA	TEXA	TEXA	TEXA	TEXA
ARRAY MODEL	RST-LP10	RST-N05S RST-N10W RST-N20W	RST-NL05 RST-NL10 RST-NL20	RST-NP10	RST-PM2000
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host 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:	0/1/3/5 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	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	2 3
Minimum drives per array	1	1	1	1	1
Maximum drives per array	3	3	3	3	3
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-3	SCSI-3	SCSI-3	SCSI-3	SCSI-2
Drive interface	IDE	SCSI-2	SCSI-2	SCSI-2	IDE
Cache size (min, max: MB)	.5, 1	.5, 2	.5, 2	.5, 1	.5
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)	15/12/12 14	15/12/12 10	15/12/12 10	15/12/12 10	9/8/8 14
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	540,1000,2000	1000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	12.5
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	6.7
ARRAY SIZE: Inches: H x W x D	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	7 x 5.1 x 10.8
POWER: Power backup	70 watts None	80 watts None	70 watts None	70 watts None	80 watts None
FIRST CUSTOMER SHIPMENT	11/95	11/95	11/95	11/95	4/96
COMMENTS	Mounts in 5.25" drive bay.	Mounts in 5.25" drive bay.			

MANUFACTURER	TRANSITIONAL TECHNOLOGY	TRANSITIONAL TECHNOLOGY	TRANSITIONAL TECHNOLOGY	TRANSOFT	TWINCOM
ARRAY MODEL	Prism P2400	Prism P4800	Prism P800	FC Net Director RAID	Dual Mirror
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Host Software	Software -- Software
Host platform, software environment	SCSI host	SCSI host	SCSI host	Server Network NT, SGI, Apple	Various Most UNIX versions
RAID level Configured by:	0/1/4/5/10 Host	0/1/4/5/10 Host	0/1/4/5/10 Host	0/1	1 Preset
Array capacity (Gbytes) MIN MAX	 216	 378	 72	86 --	Drive dependent Drive dependent
Minimum drives per array	2	2	2	4	2
Maximum drives per array	24	40	8	--	32
Concurrent host channels	1	1	1	--	1, 2
Array interface to host	Ultra SCSI	Ultra SCSI	Ultra SCSI	FC-AL	Host dependent
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	FC-AL	Drive dependent
Cache size (min, max: MB)	8, 516	8, 516	8, 516	--	Host dependent
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	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)	40 40	40 40	40 40	100 100	Host dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	9100	9100	9100	9100	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	Drive dependent
Average positioning time (msec)	8	8	8	8	Drive dependent
Average rotational delay (msec)	4.17	4.17	4.17	3.0/4.17	Drive dependent
ARRAY SIZE: Inches: H x W x D				Varies	--
POWER: Power backup				 None	-- --
FIRST CUSTOMER SHIPMENT	1997	1997	1997	4Q96	1986
COMMENTS	Network attached server Purchased controller.	Network attached server Purchased controller.	Network attached server Purchased controller.	Sold only as part of system area network.	

MANUFACTURER	TEXA	TEXA	TEXA	TEXA	TEXAS MICRO
ARRAY MODEL	DAF-8000 DAF-16000 DAF-36000	DAV-xx	DAX-xx	RST-X	SP5500
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host 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 Configured by:	0/3/5 Host, Panel	0/3/5 Host, Panel	0/3/5 Host, Panel	0/3/5 Host, Panel	0/1/5 Host
Array capacity (Gbytes) MIN MAX	8 45	4 81	4 81	4 81	Drive dependent Drive dependent
Minimum drives per array	5	3	3	3	2
Maximum drives per array	5	9	9	9	6
Concurrent host channels	1	2, 2	2, 2	1	1, 2
Array interface to host	SCSI-3	Ultra SCSI, FC	SCSI-3, Ultra	Ultra SCSI	PCI
Drive interface	SCSI-2	Ultra SCSI	SCSI-2	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	1, 4	4, 32	4, 64	4, 32	4, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No Yes Yes	No Yes Yes	No No No	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	16/14/14 10	39/38/38 20	35/32/32 10	38/32/32 20	132 10/20
DRIVES: Formatted capacity/drive(MB)	2000,4000,9000	2000, 9000	2000, 9000	2000, 9000	1000-9100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9	9	9	Drive dependent	Drive dependent
Average rotational delay (msec)	5.5/4.2	4.2	5.5/4.2	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	23.3 x 10.6 x 16.2	6.9 x 16.9 x 13.8	23.3 x 12.6 x 19.8	15 x 5.75 x 10.7	12.5 x 19 x 19.25
POWER: Power backup	250 watts None	350 watts None	350 watts None	200 watts None	400
FIRST CUSTOMER SHIPMENT	3/94	7/96	1/96	1/97	3Q96
COMMENTS				Scalable configuration. Mounts in 5.25" drive bay.	Mylex controller. Software array available.

MANUFACTURER	TWINCOM	UNI SOLUTION	UNISYS	UNISYS	UNISYS
ARRAY MODEL	Network Mirror	USI RAID	GPS ELS AQUANTA	HR/6 QR/6 DR/6** AQUANTA	HS/6 AQUANTA
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Software -- Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Various Most UNIX versions	SCSI host UNIX, Open VMS, Solaris, other	Unisys NetWare, UNIX NT	Unisys NetWare, UNIX NT	Unisys NetWare, UNIX NT
RAID level Configured by:	1 Preset	0/1/4/5/10 Panel	0/1/5	0/1/3/5	0/1/3/5/10/50
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	4 509	2.1 18.2*/50	2.1 327.6	2.1 327.6
Minimum drives per array	2	2	2	2	2
Maximum drives per array	32	56	3*/7	45*	45*
Concurrent host channels	1, 4	1-4	1	1	1
Array interface to host	Host dependent	SCSI-2	PCI	PCI	PCI
Drive interface	Drive dependent	SCSI-2	SCSI-2	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	Host dependent	32, 512			
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	Option Yes Yes	No No No	No HR6, QR6 HR6, QR6	No No Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	10/20 10/20	132 20	132 40	132 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	2100-9100	2100-9100	2100-9100	4300-9100
Nominal disk diameter (mm)	Drive dependent	95	95	95, 130	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
ARRAY SIZE: Inches: H x W x D	--	Varies	19.3 x 8.3 x 16.2	13.8 x 19 x 28.2	25.75 x 12.75 x 23
POWER: Power backup	-- --	240 watts Cache battery	200*/320 watts	1000/575 watts	575 watts
FIRST CUSTOMER SHIPMENT	1992	1/94	2Q97	2Q97	2Q97
COMMENTS	Mirrors over a network.	CMD controller. Custom configurations.	*For ELS. Server.	*With external drawer. **RAID-0/1/5. Server.	*With external drawer.

MANUFACTURER	UNISYS	UNISYS	UNISYS	UNISYS	UNISYS
ARRAY MODEL	ODM 3900	ODR 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 Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Software	Subsystem Host 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, 2	1, 2
Array interface to host	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)	4, 128	16, 224	16, 224	--	16, 224
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Option	Yes Yes Yes	Option Yes Yes	-- Yes Yes	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	100 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	9.5	12.2
Average rotational delay (msec)	4.17/5.54	4.17	4.17	4.17	4.17
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	.4 KVA None	746 watts UPS option
FIRST CUSTOMER SHIPMENT	3Q96	3Q96	1995	1996	9/96
COMMENTS		Mirrored cache.			

MANUFACTURER	UNISYS	UNISYS	UNISYS	UNISYS	VERITAS SOFTWARE
ARRAY MODEL	USP 5100	USP 5500	USR 3000	USS 5100	Veritas Volume Manager
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Net/Midrange
MARKET	Captive	Captive	Captive	Captive	OEM, PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Software	Subsystem Host Software	Subsystem Host Software	Subsystem Host 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	Solaris, HPUX, NT, UNIXWare
RAID level Configured by:	0/1 Host, Port	0/1/5 Host, Port	0/1 Host	0/1 Host, Port	0/1/5 Host
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	Host dependent
Concurrent host channels	2-4	8	1, 2	2	Host dependent
Array interface to host	BMCFIPS61	BMCFIPS61	SCSI-2	SCSI-2	Various
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI, ESDI, IDE
Cache size (min, max: MB)	256, 4096	1792, 4096	--	512, 2048	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	NA Option Option	Yes Yes Yes	Yes -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	4.5 10	4.5 20	10 10	10 10	Drive dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	4210	2841	4200	3960	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	Drive dependent
Average positioning time (msec)	Drive dependent	11	12.17		Drive dependent
Average rotational delay (msec)	Drive dependent	5.6	4.17		Drive dependent
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	1991
COMMENTS	EMC controller. Dual AC power.	EMC controller. Dual AC power.	Software based array. Optional dual AC power.	EMC controller. Dual AC power.	Can mirror logical disks. Driver,control. independent. Bundled w/ Solaris,NTS.0.

MANUFACTURER	WESTERN SCIENTIFIC	WESTERN SCIENTIFIC	WESTERN SCIENTIFIC	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS
ARRAY MODEL	CycloneRAID	TempestRAID	Ultra-35 CycloneRAID	FlashDisk RAID Database Accelerator	FlashDisk RAID Departmental
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host UNIX, NetWare, NT, other	SCSI host UNIX, NetWare, NT, other	SCSI host UNIX, NetWare, NT, other	SCSI host Any O/S	SCSI host Any O/S
RAID level Configured by:	0/3/5	0/1/4/5/10 Host	3 Preset	5 RS-232	0/1/3/5/0+1 RS-232
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	17.2 245	17.2 Drive dependent	9.1 109.2	9.1 109.2
Minimum drives per array	5	5	5	2	2
Maximum drives per array	35	28	70	12	12
Concurrent host channels	1	1	1	4	1, 4
Array interface to host	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI	SCSI
Cache size (min, max: MB)	32, 128	32	32, 128	128, 512	64, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	No Yes Yes	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)	10/20 10/20	40 40	40 40	160 (combined) 40	40 40
DRIVES: Formatted capacity/drive(MB)	2100-9100	4300-9100	4300-23200	2150-9100	4550-9100
Nominal disk diameter (mm)	95, 130	95	95, 130	95	95
Average positioning time (msec)	8	8	Drive dependent	7.5-9	7.5-9
Average rotational delay (msec)	4.17	4.17	3.0-5.56	3.0-4.17	3.0-4.17
ARRAY SIZE: Inches: H x W x D	Configuration dependent	Configuration dependent	Configuration dependent	19 x 7 x 25	19 x 7 x 25
POWER: Power backup	300 watts	300 watts	300 watts	 Battery, UPS	 Battery, UPS
FIRST CUSTOMER SHIPMENT	4Q96	4Q97	4Q97	12/96	10/95
COMMENTS	Purchased controller. Multiple configurations.		Expandable to 1.3 terabytes.		

MANUFACTURER	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	WORLD CONNECTIONS
ARRAY MODEL	FlashDisk RAID Enterprise	FlashDisk PCI	FlashDisk Auto Failover	FlashDisk RAID Workgroup	AV Vault
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Software
Host platform, software environment	SCSI host Any O/S	SCSI host Any O/S	SCSI host Any O/S	SCSI host Any O/S	PCI host
RAID level Configured by:	0/1/3/5/0+1 RS-232	0/1/3/5/0+1 RS-232	0/1/3/5/0+1 RS-232	0/1/3/5/0+1 RS-232	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	9.1 728	9.1 109.2	18.2 72.8	9.1 100.1	Drive dependent Drive dependent
Minimum drives per array	2	2	4	2	2/3
Maximum drives per array	80	12	8	11	20
Concurrent host channels	1, 4	1	2	1	1
Array interface to host	Ultra SCSI	PCI	SCSI	SCSI	PCI
Drive interface	SCSI	SCSI-2/3	SCSI	SCSI	Ultra SCSI
Cache size (min, max: MB)	64, 640	32, 128	64, 256	32, 64	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No Yes Yes	Yes Yes Yes	Yes Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto (option)
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40		40 20/40	40 40	132 40
DRIVES: Formatted capacity/drive(MB)	4550-9100	4550-9100	4550-9100	4550-9100	9100-18000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	7.5-9	7.5-9	7.5-9	9	8
Average rotational delay (msec)	3.0-4.17	3.0-4.17	3.0-4.17	4.17	4.17
ARRAY SIZE: Inches: H x W x D	31 x 60 x 82	19 x 7 x 25	19 x 7 x 25	12.125 x 10.25 x 14.5	Varies
POWER: Power backup	Battery, UPS	Battery, UPS	Battery, UPS	Battery, UPS	None
FIRST CUSTOMER SHIPMENT	3/95	3/97	9/97	12/95	1997
COMMENTS					Various configurations.

MANUFACTURER	WORLD CONNECTIONS	WORLD CONNECTIONS	XIOTECH	XISTOR	XISTOR
ARRAY MODEL	Data Vault	DC3400W	Magnitude	xi.raid	raid.blitz
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Net/Midrange
MARKET	PCM	PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Software	Subsystem Host Hardware
Host platform, software environment	PCI host	Macintosh System 7	PCI host NT	PCI host Various	PCI host Various
RAID level Configured by:	0/1/3/4/5/10 Host	0/1/4/5 Host	0/1/5/10 Port	0/1 Host	0/1/5/10 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	4.2/2.1/2.1/2.1 15/7.5/ /	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2/3	2/3	2	2	2
Maximum drives per array	32	7	18	4	6
Concurrent host channels	1, 2	1	1, 8	1	1
Array interface to host	PCI	SCSI-2	PCI	PCI	PCI
Drive interface	Ultra SCSI	SCSI-2	Ultra SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option -- --	No Yes Yes	No Yes Yes	No No No	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto (option)	Auto (option)	Auto	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	20 20	132 80	132 40	132 40
DRIVES: Formatted capacity/drive(MB)	9100-18000	2100	Drive dependent	4000-9000	4000-9000
Nominal disk diameter (mm)	95	95	Drive dependent	95	95
Average positioning time (msec)	8	8	Drive dependent	8 RD/9 WR	8 RD/9 WR
Average rotational delay (msec)	4.17	4.17	Drive dependent	3	3
ARRAY SIZE: Inches: H x W x D	Varies	Varies	60 x 17.4 x 25		
POWER: Power backup	None	None	1.2 KVA Option		
FIRST CUSTOMER SHIPMENT	1997	1Q94	4Q97	1997	1997
COMMENTS	Various configurations. Purchased controller.	Remus software. ATTO controller	Expandable to 64 drives. Fiber link from host adapter to array adapter.		Software RAID option.

MANUFACTURER	XYRATEX	XYRATEX	XYRATEX	XYRATEX	XYRATEX
ARRAY MODEL	EZiRAID	N3000	N9000	R9000	S9000
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 Attachment Implementation	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Host Hardware	Subsystem Host Software
Host platform, software environment	PCI host Windows, NT, DOS Network	SCSI host NFS, Netware, NT	SCSI host NFS, NetWare, NT	SCSI host NT, NetWare, UNIX	SSA/PCI NT, NetWare
RAID level Configured by:	0/1/3/5 Host	0	0/1/3/5 Port	0/1/3/5 Host, Port	0/1 Host
Array capacity (Gbytes) MIN MAX	12 25	4 27	12 25	8 120	4 72 per tower
Minimum drives per array	3	1	3	2	2
Maximum drives per array	6	3	6	14	8 per tower
Concurrent host channels	1	1	1	1	127
Array interface to host	PCI	SCSI-2	SCSI-2	SCSI-2	SSA, PCI
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SSA
Cache size (min, max: MB)	16	32	32	8, 32	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)	Auto	None	Auto	Auto	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	133 40	10 10	10 10	20/20 20/20	40/40 40/40
DRIVES: Formatted capacity/drive(MB)	4300	4300, 9100	4300	4300, 9100	4300, 9100
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
ARRAY SIZE: Inches: H x W x D	11 x 8 x 11	11 x 8 x 11	19 x 8 x 15.2	19 x 8 x 15.2	19 x 8 x 15.2
POWER: Power backup	85 watts	110 watts	2x300 watts UPS	2x300 watts UPS	2x300 watts
FIRST CUSTOMER SHIPMENT	4/97	11/96	11/96	6/96	6/96
COMMENTS		Direct network attached.	Direct network attached.		

MANUFACTURER	ZENITH DATA SYSTEMS	ZZYZX WORKSTATIONS & PERIPHERALS	ZZYZX WORKSTATIONS & PERIPHERALS		
ARRAY MODEL	Z-RAID Option	PowerRAID LT	PowerRAID II		
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange		
MARKET	PCM	PCM	PCM		
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware		
Host platform, software environment	PC compatible NetWare, NT, UNIX, other	Sun, HP, SGI, other	Sun, HP, SGI, other		
RAID level Configured by:	0/1/5 Host	0/1/4/5/10 Host,Panel,Port	0/1/4/5/10 Host,Panel,Port		
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent		
Minimum drives per array	4	2	2		
Maximum drives per array	8	5*	5*		
Concurrent host channels	1	1-3	1-3		
Array interface to host	PCI	SCSI-2	SCSI-2		
Drive interface	SCSI-2	SCSI-2	SCSI-2		
Cache size (min, max: MB)	4, 64	32	64, 512		
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	Option Yes Yes	Option Yes Yes		
Spare drive (None/Auto/Manual)	Auto	Auto	Auto		
ARRAY PERFORMANCE: Transfer rate: host (MB/Sec) drive (MB/Sec)	132 10	20 20	20 20		
DRIVES: Formatted capacity/drive(MB)	500-4000	Drive dependent	Drive dependent		
Nominal disk diameter (mm)	95	95	95		
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent		
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent		
ARRAY SIZE: Inches: H x W x D	Varies				
POWER: Power backup	20 watts+drives None	75 watts+drives Cache battery	75 watts+drives Cache battery		
FIRST CUSTOMER SHIPMENT	1Q94	1997	1997		
COMMENTS	Mylex controller.	CMD CRD-5400 controller. *Expandable to 14 drives.	CMD CRD-5500 controller. *Expandable to 35 drives.		

MANUFACTURER PROFILES

MANUFACTURER PROFILES

All manufacturers now producing disk drive arrays, or those which are expected to enter the market, are listed in this section. "1996 total net sales" covers the fiscal year ending in 1996 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, 1996, 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 1996 is used, as cited by the Federal Reserve Bulletin.

Country	Currency	Currency units/U.S. dollar
Canada	Canadian dollar	1.36
France	French franc	5.12
Germany	Deutschmark	1.50
Japan	Yen	108.8
Taiwan	Taiwan dollar	27.5
United Kingdom	Pound	.64

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
1165 Herndon Parkway, Suite 150
Herndon, VA 20170

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 and ECCS controller lines in its array storage subsystems. Many of the firm's sales are to government agencies.

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

1997 total net sales: $933,868,000 (FY ending 3/31/97)   Net income: $107,561,000

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, which now operates as the Adaptec Trillium Research Center. Adaptec now offers both bus based and external array controllers directed at entry level to medium range servers.

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)
418-B 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. Arrays were discontinued in 1997, although the firm is still an active supplier of enclosures, power supplies and other components usable in array subsystems.

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 a purchased controller. RAID modes 0, 1, and 5 are included. The firm was purchased by Gateway in 1997.

AMDAHL CORPORATION (Subsidiary of Fujitsu, Ltd.)
1250 East Arques Avenue
Sunnyvale, CA 94088

1996 total net sales: $1,631,549,000 Net income: ($326,682,000)

Since the early days of the company, Amdahl has marketed mainframe computer systems and disk storage subsystems manufactured by Fujitsu, which acquired control of Amdahl (now a wholly owned subsidiary) in September, 1997. 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 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.

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 large OEM accounts and has become a major

OEM supplier of array controllers. AMI's most recent array controllers, introduced in 1996, support dynamic reconfiguration of an array. Support for clustered processors was added late in 1996.

ANDATACO-IPL SYSTEMS, INC.
10140 Mesa Rim Road
San Diego, CA 92121

1996 total net sales: $17,100,000 Net income: ($2,100,000)

ANDATACO, a system integrator and storage subsystem producer that concentrates on Sun, Hewlett-Packard, Silicon Graphics and certain UNIX-based IBM and DEC platforms, merged with IPL Systems in mid-1997. The headquarters of the merged combination is in California, with IPL's Massachusetts location taking on the major responsibility for R&D. The ANDATACO array products include array subsystems based on controllers from a variety of sources. RAID-0, RAID-1, RAID-3, RAID-5, and RAID-10 are supported, with array capacities up to 264 gigabytes available in a variety of configurations.

IPL's primary market focus was tape and disk drive subsystems, plus memory upgrades, sold into the IBM AS/400 market. Founded in 1973, IPL distributed AS/400 data storage products through large independent distributors in the U.S. and Europe, later supplemented by newer RAID-0/1/5 arrays using high capacity gigabyte 3.5" drives aimed at the RS-6000 and open systems market.

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

Antrone offers arrays incorporating a SCSI to IDE or SCSI to SCSI controller and physical space for up to 8 drives. The subsystem includes multiple fans and power supplies. The array was introduced in late 1995, with updated versions introduced in 1996 and 1997.

APPLE COMPUTER
20525 Mariani Avenue
Cupertino, CA 95014

1997 total net sales: $7,081,000,000 Net income: ($1,045,000,000)
(FY ending 9/26/97)

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 planned hardware array support for its line of servers in 1996 based upon third party controllers, but this effort was discontinued in 1997.

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. Several array subsystems are available based upon a variety of controllers, and much of the firm's array production is done on a customized basis. ADS also resells the CMD Daytona array.

APPRO INTERNATIONAL
446 South Abbot Street
Milpitas, CA 95035

Founded in 1991, APPRO is a manufacturer of industrial computer system components, notably rack mounted modules. The product line includes rack mounted disk drive arrays using purchased controllers. APPRO products are typically custom configured for individual customers.

ARTECON
6305 El Camino Real
Carlsbad, CA 92009

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. In mid-1997, Artecon announced the acquisition of Falcon Systems, a move that improved Artecon's sales and support presence and also gave the firm an entry in the network attached storage market.

ASC AUDIO VIDEO CORPORATION
3816 Burbank Boulevard
Burbank, CA 91505

ASC produces video servers and other equipment for the broadcast industry, including a fibre channel based model with a software based array operating in RAID-4 mode. The firm is in the process of being acquired by Leitch, a Canadian based producer of equipment for the broadcast industry.

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

1996 total net sales: $2,103,643,000 Net income: ($417,715,000)

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. 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 for its Manhattan series and later servers.

ATTO TECHNOLOGY
40 Hazelwood Drive
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. The software was upgraded and combined with a utilities package in 1997, and is now marketed as ExpressRAID.

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

1997 total net sales: $202,486,000 Net income: $13,420,000
(FY ending 6/30/97)

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, RAID-5 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 1.9 terabytes 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, manufactured 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, but Austin ceased operations in May of 1997.

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-0, RAID-3 and RAID-5 operating modes.

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

BayStor was 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 for use with IDE disk drives, but was not able to establish adequate sales momentum and is now inactive.

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

1996 total net sales: $50,027,000 Net income: $826,000

Box Hill, which went public in 1997, was founded in 1987 as a producer of storage subsystems for the UNIX based systems market, notably for Sun systems sold within the financial community. About 36% of revenue is derived from sales of arrays. Current array products include a RAID-5 configuration designed around a purchased controller and a newer design incorporating fibre channel interfaces and Seagate XOR drives to provide array functionality. The company has broadened its marketing focus to include the telecommunications industry in recent years.

BYTESTREAM DATA SYSTEMS
124 Acton Street
Maynard, MA 01754

Founded in 1996, Bytestream is focused on high performance I2O compliant RAID controllers and software. Both cards and host based software are included in the product line.

CAMBEX CORPORATION
360 Second Avenue
Waltham, MA 02154

1996 total net sales: $22,917,000 Net income: ($8,632,000)

Cambex was founded in 1968 to supply add-in semiconductor memory systems for the IBM mainframe market. 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. The firm has been under financial stress in recent years, and filed for Chapter 11 bankruptcy in October, 1997.

CHARISMAC ENGINEERING
10000 Hillview Road
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 integrators in the United States.

CIPRICO, INC.
2800 Campus Drive
Plymouth, MN 55441

1997 total net sales: $36,390,000 (FY ending 9/30/97) Net income: $4,249,000

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

1996 total net sales: $18,109,000,000 Net income: $1,313,000,000

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 plans to include its arrays in a variety of storage products for use with servers and server networks. 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 integrated a line of disk drive arrays, mostly based upon the Digi-Data controller, which are made to customer specifications, but has decided to concentrate on resales of arrays and has discontnued its own array subsystem.

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
2101 West Cypress Creek Road
Fort Lauderdale, FL 33309

1997 total net sales: $108,367,000 (FY ending 6/30/97)   Net income: $4,061,000

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 have been included in Concurrent's systems in recent years, while an earlier hardware implementation was discontinued. In 1997 Concurrent acquired the real-time systems business of Harris Computer Systems, moved to that organization's Florida headquarters, and closed the previous Concurrent facility in Oceanport, New Jersey.

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-0, RAID-1 and combined RAID-0/1 modes. Conley has licensed its array technology to several other firms, including Apple Computer, Micronet, and others.

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 introduced new array products in 1997 with the intention of addressing the Windows NT based systems market.

CORE INTERNATIONAL (See AIWA CO., LTD.)

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. Some configurations are 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. 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 RAID-3 disk array channel adapter for IPI-2 8" parallel transfer drives, has been replaced 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.

CYBERSTORAGE SYSTEMS, INC. (Formerly Clovis, Inc.)
Millyard Technology Park
75 Pine Street Extension
Nashua, NH 03060

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.

CYRANEX CORPORATION (Formerly Pro Engineering)
333 Preston Street
Ottawa, Ontario K1S 5N4
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. The firm resells disk drive arrays as well as integrating its own arrays.

DATA GENERAL CORPORATION
4400 Computer Drive
Westboro, MA 01580

1997 total net sales: $1,533,200,000 (FY ending 9/27/97) Net income: $55,900,000

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 has prospered on the strength of the AViiON line of RISC servers and workstations using UNIX, plus the CLARiiON data storage products. 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.

DATA STORAGE MARKETING
5718 Central Avenue
Boulder, CO 80303

Data Storage Marketing, founded in 1987, was a storage subsystems integrator and distributor that made heavy use of telemarketing to sell its products. The firm's disk drive arrays were based upon CMD controllers, Seagate drives and a variety of array enclosures. In July, 1997 Data Storage Marketing was acquired by Comstor, a subsidiary of GE Capital IT Solutions, and a distributor and integrator of computer industry products.

DELL COMPUTER CORPORATION
1 Dell Way
Round Rock, TX 78682

1997 total net sales: $7,759,000,000 (FY ending 2/2/97) Net income: $518,000,000

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 offered RAID-0 and RAID-1 capabilities, later 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. Dell has begun to aggressively market server class systems, which is significantly increasing the volume of Dell's array shipments in 1997.

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, and later models provide Ultra SCSI and Ultra2 SCSI interfaces and up to 256 megabytes of cache.

DIGITAL EQUIPMENT CORPORATION
146 Main Street
Maynard, MA 01754

1997 total net sales: $13,046,832,000 (FY ending 6/28/97) Net income: $140,875,000

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. 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 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.

DTC DATA TECHNOLOGY CORPORATION (Photonics 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 introduced in February, 1996 a mirroring controller that operates with EIDE drives. It plugs into a PC compatible ISA bus computer. Other array controllers subsequently introduced incorporate purchased controllers.

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 has offered several array products using purchased controllers 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. In late 1996, the firm began revamping its array product line and became a CLARiiON distributor. The firm began offering direct network attached arrays in 1997.

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

1996 total net sales: $22,600,000 Net income: ($769,000)

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
547 Oakmead Parkway
Sunnyvale, CA 94086

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. Unable to develop a high level of shipments, the firm is de-emphasizing the hardware products and returning to its roots as an engineering consulting organization.

EMC CORPORATION
171 South Street
Hopkinton, MA 01748

1996 total net sales: $2,273,652,000 Net income: $386,229,000

Established in 1979, EMC became a born-again growth company in the 1990's, based on rapid market growth since 1990 for its Symmetrix family of cached disk storage systems offering mirrored disk capability for IBM and other mainframe computers, supplemented in recent years by models designed for the open systems 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 company agreed to sell its storage related business activities to Sun Microsystems in mid-1997, which may also help sales.

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, was a distributor and integrator of storage subsystems and UNIX based systems, with ten sales and distribution locations in the U.S. Falcon customized array configurations using a variety of purchased controllers and drives and has marketed network attached array systems. The firm was acquired by Artecon in mid-1997.

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. After several years of producing array subsystems for OEM and distribution markets, Formation has phased out the activity.

FWB SOFTWARE, LLC
2750 El Camino Real
Redwood City, CA 94061

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 (7.5%) 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
4357 Park Drive, Suite E
Norcross, GA 30093

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. AMI controllers are used.

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 manufactured array boards offering RAID-0/1 and RAID modes 0, 1 and 5, operating with EIDE drives, but Gainbery ceased operations as of November, 1997.

GIGATREND
2234 Rutherford Road
Carlsbad, CA 9208

GigaTrend is an integrator of storage subsystems, including tape backup systems, optical jukeboxes and disk drive arrays, introduced in 1997. The arrays are based upon Mylex controllers and Quantum disk drives, and contain DLT tape drives for array backup.

HAMMER STORAGE SOLUTIONS (StreamLogic)
7015 Gateway Boulevard
Newark, CA 94560

This company was born as a product line within Micropolis, was then spun off as StreamLogic, and is now in the process of acquiring a new identity, as StreamLogic wrestles with Chapter 11 bankruptcy. After several years of developing disk drive arrays for a variety of markets, Micropolis sold its disk drive operations to Singapore Technologies in early 1996, and renamed the remaining array operation StreamLogic. StreamLogic subsequently acquired FWB's hardware products, broadening its product line and improving access to the Apple systems market, an FWB specialty. Despite restructuring, the firm has had financial problems, filing for Chapter 11 status in mid-1997.

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

1996 total net sales: $38,420,000,000 (FY ending 10/31/96) Net income: $2,586,000,000

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.

INTEGRIX, INC.
2001 Corporate Center Drive
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. Rack mounted arrays and servers are also available. The company specializes in Sun compatible products.

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504

1996 total net sales: $75,947,000,000 Net income: $5,429,000,000

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. During the last two years IBM has moved to internally designed controllers for personal computer arrays, in addition to internally developed controllers for the array file servers used with AS/400 and open systems applications.

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 was 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 product line included servers incorporating optional disk drive arrays, fabricated using purchased controllers. IPC Peripherals, a related company, supplies other data storage products, including CD-ROM drives. IPC closed this location in May, 1997.

LAND-5 CORPORATION
9747 Business Park Avenue
San Diego, CA 92131

LAND-5, founded in 1994 as a research and development organization, now develops and manufactures storage and communications systems for WAN and LAN environments, including complete servers, tape backup systems, and host independent disk drive arrays. Both parity and nonparity RAID configurations are implemented. The company has positioned itself as a specialist in thermal cooling of components to provide its customers with low component failure rates. Bell Microproducts' Quadrus contract manufacturing unit has been announced as a contract manufacturer for LAND-5 arrays and servers.

LEGACY STORAGE SYSTEMS, 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. However, later in 1996 the rights to the Legacy name, plus array and CD-ROM related products were spun off from Tecmar, recreating Legacy, which 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.

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. Lighthouse also remarkets Eurologic arrays.

LOCOM CORPORATION
2368 Walsh Avenue
Santa Clara, CA 95051

Locom was founded in 1977 as a manufacturer of add-on products for IBM mainframes. The firm later included smaller systems and midrange computers in the range of systems supported, and also added support for Unisys equipment. The company provides semicustomized storage subsystems employing purchased SSA controllers, both RAID and non-RAID, bundled with an enclosure containing disk drives.

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.

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. The firm also integrates arrays using purchased controllers and EIDE drives, as well as reselling Symbios Logic MetaStor storage subsystems. While the company does most of its business in the Unisys mainframe add-on market, the arrays are 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 for introduction probably in 1998.

MAXSTRAT
801 Buckeye Court
Milpitas, CA 95035

Founded as Maximum Strategy in September, 1986, the company 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.

MAXSTRAT emphasizes 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 supports ATM and FCS attachment, but dispenses with the IPI interface in favor of SCSI-2. The market focus of the company is on providing storage subsystems for very high performance UNIX based systems, and developing strength in video server and geological survey markets. During the last year, the company decided that the firm's nickname, "MaxStrat", was too good to ignore and adopted it as the company name.

MEDEA CORPORATION
31826 Village Center Road, Suite C
Westlake Village, CA 91361

Medea was founded in September, 1996 by veterans of Micropolis. The company has developed a RAID-0 array that attaches to the EIDE port of an IBM compatible PC, permitting it to be used for video editing. The company is targeting the low end video editing market as its primary area of operations. VideoRAID, Medea's first product was introduced at the 1997 NAB conference, with first shipments in mid-1997.

MEGADRIVE SYSTEMS
9201 Oakdale Avenue
Chatsworth, CA 91311

MegaDrive Systems was founded in 1988 to provide high performance data storage solutions. MegaDrive's original strategy was 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. More recently, the firm has been making heavy use of fibre channel technology and repositioning itself as a storage solutions provider to the entertainment and content provider industries.

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 Enterprise array, first shipped in early 1995, offered RAID levels 0, 1, 5, and 10 with either 3.5" or 5.25" drives. This series has had several upgrades since. 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. MegaDrive arrays announced in 1996 and 1997 incorporate FC-AL interfaces as well as UltraSCSI support.

MICRON ELECTRONICS, INC.
900 East Karcher Road
Nampa, ID 83687-3045

1997 total net sales: $1,955,783,000 (FY ending 8/28/97) Net income: $87,262,000

Micron Electronics was formed in April, 1995 as the result of a merger of Micron Computer, Micron Custom Manufacturing Services and ZEOS International. The company makes desktop, notebook and server computer and continues its custom contract manufacturing operations as well. Arrays are available as options on its server class systems, fabricated with Mylex controllers.

In August, 1997, Micron acquired NetFRAME, a supplier of midrange clustered servers, which also offers a line of arrays based on Digital's StorageWorks.

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.

MICROPAL CORPORATION
12015 Mora Drive
Santa Fe Springs, CA 90670

Founded in 1996, MicroPal is an integrator of data storage subsystems. The firm's disk drive arrays are based on controllers manufactured by Accord Systems, with which the company has a close relationship.

MICROTECH INTERNATIONAL
158 Commerce Street
East Haven, CT 06512

Microtech, a distributor and integrator of products for the Apple Macintosh market, offered mirroring software bundled with a controller interfacing SCSI drives to achieve an array configuration. In 1997, the firm elected to change its emphasis to concentrate on the PC card market and digital camera applications for its product line. The array product has been discontinued, though other storage products remain as active offerings.

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

Morton was a network and communications system integrator. Array products were typically rack mounted, and using either array software or a Digi-Data controller. The arrays attached to PC compatible systems, and supported RAID-5 (software versions) or RAID-0/1/5 (hardware controller). The arrays were available in 6 or 12 gigabyte capacities. The firm has become inactive.

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

1997 total net sales: $153,727,000 (FY ending 4/5/97) Net income: $5,704,000

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

1996 total net sales: $173,123,000 Net income: $17,250,000

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 a leading supplier of array controller boards and a major factor in array controllers for personal computer file servers. In February of 1996, Mylex acquired BusLogic, a manufacturer of host bus adapters. A new business unit, Network Power and Light, was formed in 1996 to take Mylex into the direct network attached storage subsystem market.

Depending upon the model, Mylex controllers attach to a host internal or external 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. Fibre channel capability is being added.

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.

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 1994, NCR became AT&T Global Information Solutions. In 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 Symbios Logic. A software array, 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

1996 total net sales: $74,349,000 Net income: ($27,984,000)

NetFRAME, acquired by Micron Electronics in August, 1997, 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.

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 and other purchased controllers.

NETWORK APPLIANCE INC.
2770 San Tomas Expressway
Santa Clara, CA 95051

1997 total net sales: $93,333,000 (FY ending 4/25/97) Net income: $250,000

Founded in April, 1992, Network Appliance manufactures and sells high performance network attached 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. Current products support UNIX, Windows and Web based networks.

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.

NETWORK STORAGE SOLUTIONS, INC. (Formerly Symmetrix Technology)
600 Herndon Parkway
Herndon, VA 22070

Founded in 1989 as Symmetrical Technologies, the company produces a direct network attached storage server that incorporates a disk drive array.

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 mostly 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 for the CR8 line. All use purchased controllers. In early 1997, nStor purchased Parity Systems, a California based integrator of array subsystems.

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 was a subsystem integrator producing an array based upon a purchased array controller. RAID modes 0, 3 and 5 were provided, as was a RAID-3 only subsystem. The arrays attached to Sun, H-P, IBM and other UNIX based systems, and were available in rack, desktop or tower configurations. Some models were equipped with dual AC power feeds and battery backup for the cache. Parity was purchased by nStor in early 1997.

PATHLIGHT TECHNOLOGY, INC.
767 Warren Road
Ithaca, NY 14850

Pathlight is one of the few producers of controllers supporting SSA. Video editing and other video related applications are significant users of the firm's PCI to SSA controllers. Pathlight also supplies a RAID-1/0 software package for use with the Apple Power Macintosh.

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 servers. 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.

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.

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.

RIDGE TECHNOLOGIES
2199 Zanker Road
San Jose, CA 95131

Founded in mid-1997 by former Apple and Sun managers, Ridge is developing RAID and fibre channel based storage subsystems for the Windows NT server market. Adaptec is an investor in the firm, as well as a strategic partner. Ridge expects to deliver its first product in mid-1998.

RISING EDGE TECHNOLOGIES
1110 Eldon Street, Suite 301
Herndon, VA 20170

Founded in 1994 as a custom storage systems supplier, Rising Edge now offers an array that is built around optical disk drives employing direct overwrite technology. A removable rigid disk cartridge drive version is also available. RAID modes 0/3/5 are supported by a controller designed and manufactured by the company. A typical media "unit" contains 5 disks in a set, electronically labeled to avoid mismatches of members of sets. Rack or tower mounting is available.

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.

SEEK SYSTEMS, INC.
11715 North Creek Parkway South, Suite 110
Bothell, WA 980113

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.

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-0 and RAID-1 capability and in 1993 added RAID-3 and RAID-5 capabilities using a purchased array controller. The firm currently remarkets CLARiiON arrays.

SEQUOIA SYSTEMS, INC. (See Texas Micro)
400 Nickerson Road
Marlborough, MA 01752

Sequoia was founded in 1981 as a manufacturer of fault tolerant on-line transaction processing systems. The company's strategy was 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 were originally mirrored, later supplemented with purchased array controllers. 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, and adopted the Texas Micro name. The merged company subsequently sold off the Sequoia Enterprise Systems business unit in October, 1996, to General Automation.

SIGMA ENTERPRISES
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 operated as the Interactive Solutions division within Sigma. The array activity was subsequently spun off into a new organization, Sigma Enterprises, which is currently inactive, although the arrays, now made by a Taiwanese producer, continue to be available through MicroPal and a few other companies.

STORAGE COMPUTER CORPORATION
11 Riverside Street
Nashua, NH 03062

1996 total net sales: $31,011,429 Net income: $5,073,177

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 its orientation to high performance, the company is emphasizing arrays for the video-on-demand market. Storage products introduced in the 1995-1996 period 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

1996 total net sales: $72,300,000 Net income: $1,200,000

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 by its managers and an investment group. The firm went public in March, 1997. 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 several 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, and expansion of sales/marketing capability is a major corporate goal.

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 TECHNOLOGY CORPORATION
2270 South 88th Street
Louisville, CO 80027

1996 total net sales: $2,039,550,000 Net income: $180,327,000

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 eight sales locations. Arrays are offered in both custom and standard configurations, with the standard configurations based upon array software, SCSI controllers and 3.5" disk drives. The company also remarkets arrays from Hitachi Data Systems.

STRATUS COMPUTER, INC.
55 Fairbanks Boulevard
Marlboro, MA 01752

1996 total net sales: $609,300,000 Net income: $43,500,000

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 (See Hammer Storage Solutions)

SUN MICROSYSTEMS, INC.
2550 Garcia Avenue
Mountain View, CA 94043

1997 total net sales: $8,598,346,000 (FY ending 6/30/97) Net income: $762,421,000

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. The firm began incorporating arrays from Symbios Logic into its high end enterprise systems in early 1997. A second generation of fibre based arrays was also introduced in 1997.

TANDEM COMPUTERS INC.
19333 Vallco Parkway
Cupertino, CA 95014

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.

In 1997, Tandem was acquired by Compaq, which found Tandem attractive for its Fortune 100 marketing and support capabilities as well as its high availability systems product lines.

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
100 Bearfoot Road
Northborough, MA 01532

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.

TEXAS MICRO, INC.
5959 Corporate Drive
Houston, TX 77036

1997 total net sales: $64,992,000 (FY ending 6/30/97) Net income: ($2,774,000)

Founded in 1981 as a systems integrator serving the oil industry, Texas Microsystems retained its industrial customer orientation, providing Intel based fault tolerant systems for a variety of manufacturing, communications, resource extraction 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, which moved the corporate headquarters to Houston and operated the combined organizations under the Texas Micro name. The Sequoia Enterprise Systems business unit was sold to General Automation in October, 1996.

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, later scaled back to a more conservative 500 drive total. Thinking Machines achieved fame with its supercomputers, but not fortune. During the last two years the company has transitioned from high performance hardware to software intended for computer cluster technology and scalable data mining applications.

TOTAL TEC SYSTEMS INC.
2 Gourmet Lane
Edison, NJ 08837

Total Tec is a distributor and integrator of storage products, networking products and complete customized systems, catering primarily to the DEC market but also to other UNIX platform markets. The firm's customized array products employ purchased DEC 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 TECHNOLOGY CORPORATION
425 East Cota Street
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. In 1997, the firm began integrating storage subsystems using array controllers purchased from third parties, but is now focussed upon software based arrays and for the video production and imaging markets.

TRICORD SYSTEMS, INC.
3750 Annapolis Lane
Plymouth, MN 55447

1996 total net sales: $51,269,000 Net income: ($15,204,000)

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 was designed for field upgradability and included 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.

In February, 1997, Tricord indicated it would exit the server market, concentrating on software products for distributed data access and management. Server production is expected to end in 1997.

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, 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 its Remus array software under the Adaptec name as well as its own.

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 several government organizations.

UNISYS CORPORATION
P.O. Box 500
Blue Bell, PA 19424

1996 total net sales: $6,370,500,000 Net income: $49,700,000

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-0 and RAID-1 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. In 1997, Unisys introduced the Aquanta line of small and midrange servers, which also incorporate disk arrays.

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 sold through dealers and VARs, gradually developing an OEM base as well. Unitrol's array also operated with disk drives employing removable cartridges, allowing creation of instant backups as file contents change. It was also possible to logically partition the disks and mirror only selected partitions. The firm also offered IDE drive controllers configured to allow duplexing with mirroring software. The firm has been acquired by another Canadian company and is currently inactive.

VERITAS SOFTWARE CORPORATION
1600 Plymouth Street
Mountain View, CA 94043

1996 total net sales: $36,090,000 Net income: $9,767,000

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 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.

WORLD CONNECTIONS
7800 Glenroy Road
Minneapolis, MN 55439

Founded in 1987 as Direct Connections, the firm offered customized storage subsystems for the Apple Macintosh aftermarket, including a software based RAID-0/RAID-1 array, and customized hardware and software based array subsystems. In the summer of 1997, the company changed its identity, becoming World Connections, and expanding its scope of activity to include storage subsystems for a variety of platforms.

XIOTECH CORPORATION
6509 Flying Cloud Drive, Suite 200
Eden Prairie, MN 55344-3379

XIOtech, founded in 1995, entered the array market in late 1997 with a high performance array aimed at the clustered server market segment. Initial support will be for Windows NT environments, with UNIX and NetWare support to be added in 1998. The firm plans to emphasize its OEM sales channel.

XISTOR
1790 Skyline Boulevard
Reno, NV 89509

Xistor is an integrator of storage subsystems. The firm's disk drive arrays include the software based xi-raid and blitz-raid. The latter can be equipped with optional hardware controllers.

ZITEL CORPORATION
630 Alder Drive
Milpitas, CA 95035

1997 total net sales: $17,966,000 (FY ending 9/30/97) Net income: ($17,501,000)

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.

ZZYZX WORKSTATIONS AND PERIPHERALS
5893 Oberlin Drive
San Diego, CA 92121

Zzyzx ("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 CMD controllers. The arrays are available with selected Seagate drives.

Asia/Pacific Rim Manufacturers

(All companies are in Japan unless otherwise noted.)

ACCORD SYSTEMS, INC.
5F, 279 Chuang Ching Road
Taipei
Taiwan

Accord is manufacturing arrays based upon a controller design obtained from Allodyne (later Sigma), a U.S. firm. Integration and distribution in the U.S. is handled by MicroPal, a closely related company. Accord markets the controller and array subsystems in Asia.

ACER INC.
347 Wu Lin Fung Chen Road
Lung Tan Hsiang
Taoyuan
Taiwan

1996 total net sales: $2,094,792,000 (FY ending 12/96)   Net income: $111,398,000

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 internal 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

1997 total net sales: $3,127,873,000 (FY ending 3/97)   Net income: $58,831,000

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, 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.

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 preceded 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 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.

AMAQUEST COMPUTER CORPORATION
8F, No. 79 Hsin Tai Wu Road, Section 1
Hsi-Chih, Taipei Hsien
Taiwan

Amaquest is a supplier of data storage subsystems and fault tolerant servers. The company uses locally procured controllers in its line of arrays and array-based servers, which are intended for use in Windows NT and other commonly encountered software environments.

DTC TECHNOLOGY CORPORATION
2F, 542-2 Chung Cheng Road
Hsin-Tien City
Taipei-Hsien
Taiwan

DTC has been producing a controller with RAID-0 and RAID-1 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-0 and RAID-1 operation as well.

ENLIGHT CORPORATION
11 Ting Hu Road, Ta-Kang
Kweishan, Taoyuan
Taiwan

Enlight was founded in 1982 as a manufacturer of kitchen hardware and electronic components. Computer cases and other hardware is now a major product line, and overall sales are above the $100 million level. An array controller supporting RAID-0, RAID-1, and RAID-5 was introduced in mid-1997.

FUJITSU LTD.
1-6-1, Marunouchi 2-chome
Chiyoda-ku, Tokyo 100

1997 total net sales: $41,399,835,000 (FY ending 3/97)   Net income: $424,223,000

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 manufactures over 90% of its rigid drives outside Japan, with additional plants in Thailand and the Philippines. Fujitsu, which had a 44% ownership position in Amdahl, acquired a 97% ownership position in September, 1997, and now operates Amdahl as a wholly owned subsidiary.

Starting in 1990, Fujitsu offered a RAID-3 array, with all shipments so far limited to Japan. In 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 shipments of Spectris in late 1995.

HITACHI DATA SYSTEMS
750 Central Expressway
Santa Clara, CA 95056 U.S.A.

Hitachi Data Systems is owned by two other companies: Hitachi, Ltd., which has an 84% share, and EDS, which holds a 16% share. The firm concentrates upon mainframe data storage subsystems. 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 also added a new series of 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

1997 total net sales: $78,351,000,000 (FY ending 3/97) Net income: $812,006,000

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.

KEY TECHNOLOGY CORPORATION
56 Park Avenue II
Science Based Industrial Park
Hsinchu
Taiwan

Key Technology manufactures an internal IDE array controller providing RAID-0 and RAID-1 capability. Firmware is kept in flash memory and can be updated.

MAXTRONIC INTERNATIONAL COMPANY, LTD.
6F, No.4, Alley 16, Lane 235, Pao Chiao Road
Hsien Tien, Taipei Hsien
Taiwan

MaxTronic manufactures the Arena brand array subsystems, incorporating a controller and up to 6 IDE drives, addressed in pairs. RAID modes 0, 1, and 5 are supported. The array was introduced at the 1997 COMPUTEX exhibition and first shipped in mid-1997.

NEC CORPORATION
5-7-1, Shiba
Minato-ku, Tokyo 108

1997 total net sales: $45,505,000,000 (FY ending 3/97) Net income: $1,114,000,000

NEC has defined its product area as communications and computers, with computer products currently accounting for about 49% of the firm's total revenues. Current disk drive production involves fixed disk drives for both captive and OEM markets. 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, including a line of small servers incorporating optional arrays.

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.

PROMISE TECHNOLOGY
7F, 93 Nan Kang Road, Section 3
Taipei
Taiwan

Promise was founded in 1987 as a producer of computer add-in boards and controllers for computer peripherals. The firm produces an IDE array controller supporting RAID-0 and RAID-1. About two thirds of the firm's sales are in the U.S. market.

PROWARE TECHNOLOGY CORPORATION
4F, No. 5, Lane 235, PaoChao Road
Hsien Tien, Taipei Hsien
Taiwan

Proware, founded in 1996, is a system integrator providing data storage subsystems, including a family of host independent, SCSI-interfaced disk drive arrays built around a purchased controller. The company first introduced its disk drive arrays in 1996.

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 specialized 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 customized disk drive arrays are built around Digital Equipment's StorageWorks and a variety of array controllers.

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 first displayed at COMPUTEX in 1994 and mother boards supporting the Adaptec RAIDPort controller.

European Manufacturers

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 can also attach to two external drives, instead of drives mounted on the board. Updated versions of the arrays are scheduled for shipment in late 1997.

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 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 mainframe plug compatible drive 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 disk drive subsystems for mainframe and open systems markets 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 0 and 1. Distributed Logic markets storage subsystems in Europe, Africa and the Middle East, while Diverse Logistics covers the Americas.

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.

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.

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.

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 is currently marketing a midrange RAID-0/1/3/5 array.

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, and operations both in Europe and the U.S. offers a family of RAID controllers for SCSI, PCI and FC AL open systems markets. The firm also offers an enclosure for use with its controller.

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, marketed under the ICP Vortex name, 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.

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

1997 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 1997 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1997 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.

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.

   <u>Installing AutoImport V3.xx</u>: 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 ---->			N/A
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	1997 Rigid Report	1997 Removable Report	1997 Optical Report	1997 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	--
22	MASKA	MASKA	--	MASKA
23	--	MASKA	MASKA	MASKA
24	--	MASKC	MASKA	--
25	MASKD	MASKC	--	--
26	MASKI	MASKA	--	--
27	--	MASKA	MASKD	--
28	MASKA	MASKA	--	MASKA
29	MASKA	MASKH	MASKA	MASKA
30	--	MASKD	MASKA	--
31	--	--	--	--
32	MASKD	MASKA	--	--
33	MASKI	MASKA	MASKD	--
34	--	--	--	
35	MASKA	--	MASKA	
36	MASKA	MASKI	MASKA	
37	--	MASKD	--	
38	--	--	--	
39	MASKD	MASKA	MASKE	
40	MASKI	MASKA	MASKD	
41	--	--	--	
42	MASKA	--	MASKA	
43	MASKA	MASKD	MASKA	
44	--	--	--	
45	--	MASKA	--	
46	MASKD	MASKA	MASKA	
47	MASKI	--	MASKA	

Cross-reference (continued)

Table Number	1997 Rigid Report	1997 Removable Report	1997 Optical Report	1997 Array Report
48	--	--	--	
49	MASKA	MASKD	--	
50	MASKA	--	MASKE	
51	--	MASKA	MASKA	
52	--	MASKA	MASKA	
53	MASKD	--	--	
54	MASKI	--	--	
55	--	MASKE	MASKE	
56	MASKA	MASKE	MASKA	
57	MASKA	MASKD	MASKA	
58	--	--	--	
59	--		--	
60	MASKD		MASKE	
61	MASKI		MASKA	
62	--		MASKA	
63	MASKA		--	
64	MASKA		--	
65	--		MASKE	
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: AT4.97A VT12.97V OT14.97O RT19.97R

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 key-strokes 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: AT10.97A

   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: AS197 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: **650-961-6209** 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.