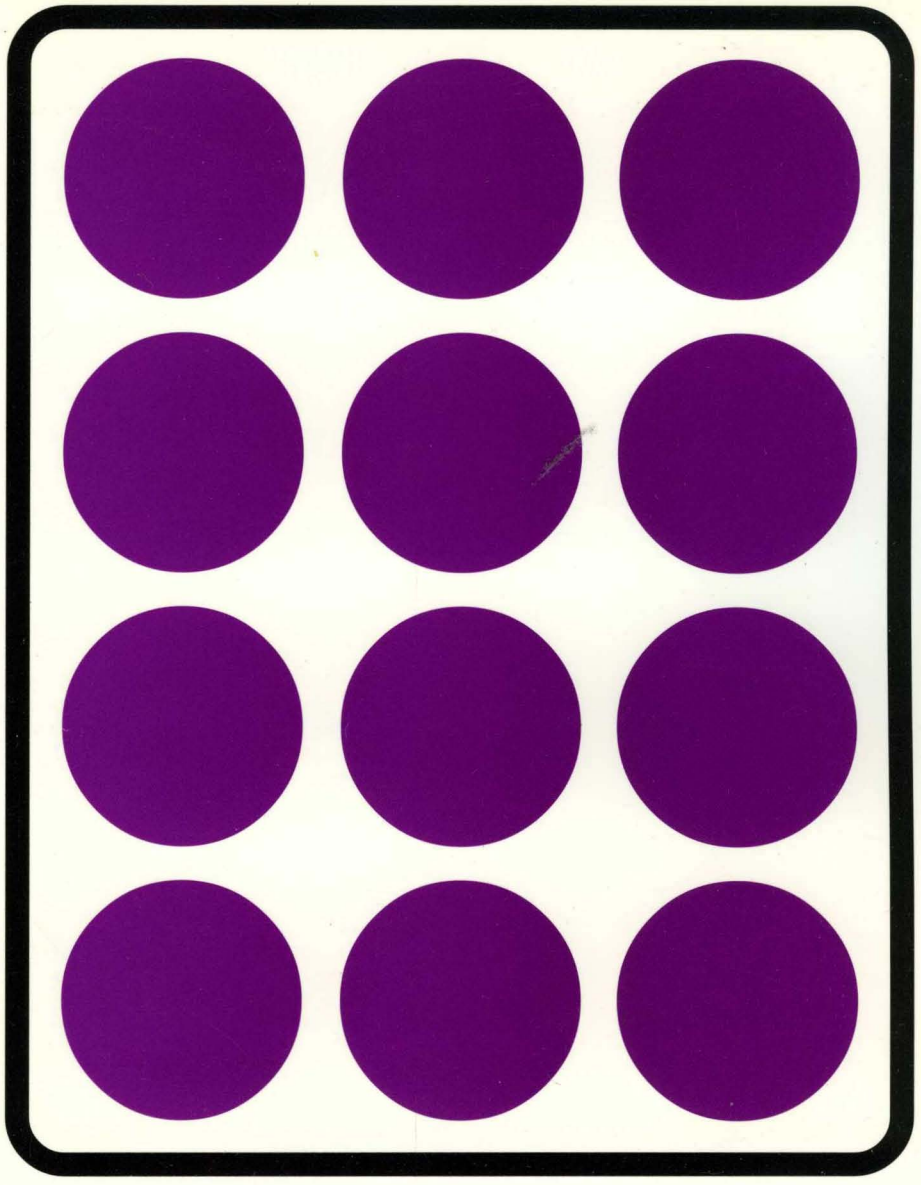
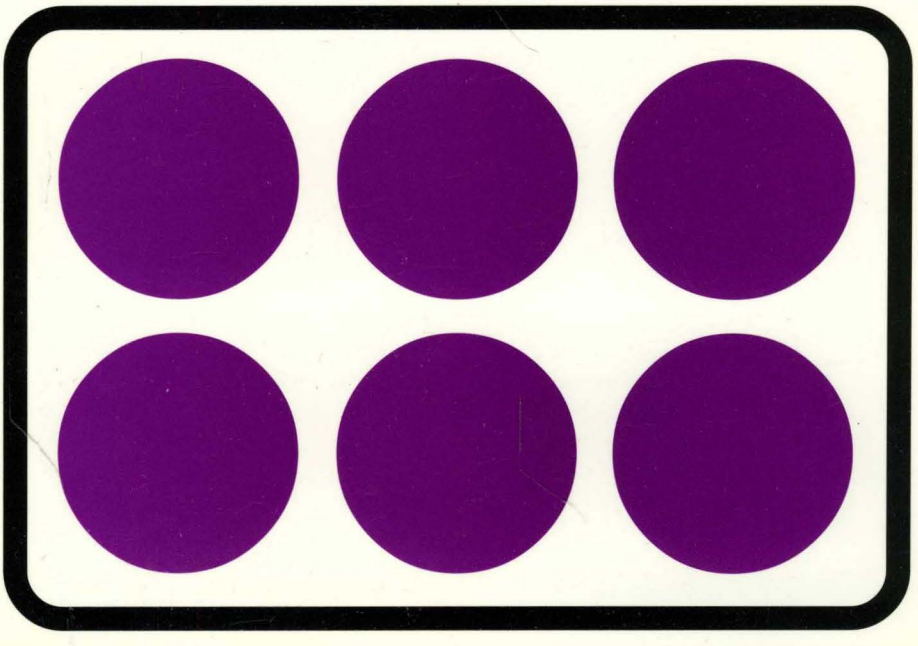


1999 DISK/TREND® REPORT



DISK DRIVE ARRAYS

1999 DISK/TREND® REPORT

DISK DRIVE ARRAYS

November, 1999

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FOREWORD

The disk drive array business is expected to reach almost $20 billion in sales revenue by the 2002 horizon of this report. This business has followed the usual pattern of high technology growth industries: Numerous firms crowd into the market, the market grows while products are improved and applications diversify, producers with skilled managements respond to changing user requirements, the number of participating companies declines. It would be premature to say that the disk drive array business is nearing maturity, but it's reached the point where the remaining participants must be good managers as well as good engineers.

To make sense out of this continually evolving market, we've continued to utilize the methods developed in 23 years of the DISK/TREND Report -- analysis of all aspects of the industry by direct contact with participants active in all phases of the business. We cover all known companies originating basic disk drive array products because it's our desire to make the report as complete as possible, both in identifying all companies which are originating array products and in describing the size and nature of the industry. 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!

Your comments are welcome, and we are always willing to help you at any time by providing additional information on the industry which we may have available.

James N. Porter

Robert H. Katzive

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

INTRODUCTION

It's important to note how prices are recorded! 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, 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, distributor and OEM/Integrator array sales revenues, which is important in interpreting DISK/TREND revenue statistics.

Please note how we count disk drive arrays 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.

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.

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, usage instructions are included on the disks and are also available on the DISK/TREND Web site.

SUMMARY: DISK DRIVE ARRAYS

Industry size

Although there are still many disk storage subsystems without RAID capability in use (known as JBOD, "just a bunch of disks" to most array producers), a high percentage of disk drive subsystems shipped in recent years have been disk drive arrays. Continuing growth 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.

Worldwide disk drive array sales revenues topped $12.5 billion in 1998, and the 2002 total is projected to reach $19.8 billion, an average annual increase during the 1999-2002 period of 12.1%. Arrays sold as complete subsystems dominated 1998 sales revenues with 94.5% of the overall total and are expected to increase to 96.2% in 2002. The market share of complete subsystem shipments is also forecasted to increase modestly during the same period, from 41.3% to 43.4%. Although the worldwide totals for sales revenues and shipments of disk drive arrays are both increasing, significant changes are underway in portions of the complete subsystem array product lines, resulting in lower average unit prices. Because disk drive capacities continue to increase so rapidly, array buyers have frequently found it possible to reduce the number of disk drives purchased per array, especially in the class of arrays used with PC networks, reducing the typical selling price.

Although captive arrays ship in lower quantities than noncaptive arrays, the captive sales revenue totals are boosted by a predominance of complete subsystems, typically at higher prices. As a result, captive array sales revenues held 60.3% of the 1998 total, with a decline to 53.1% projected for 2002. Noncaptive unit shipments are dominated by large OEM/Integrator sales of array boards and software products at relatively low prices, with the result that no significant increase in the sales channel's share of the total is expected. However, due to greater reliance on higher value complete subsystems and an expanding market, the distributor channel's share of total sales revenue is forecasted to increase from 1998's 25.5% to 33.8% in 2002.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

DISK DRIVE ARRAYS

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1998		Forecast							
	Revenues		1999		2000		2001		2002	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	3,339.5	7,300.4	3,778.8	8,016.6	3,604.7	8,821.3	3,969.4	9,593.8	4,328.9	10,298.4
Distributor	1,508.5	2,550.7	2,318.5	3,757.4	3,016.2	4,809.9	3,531.9	5,678.3	3,870.6	6,137.0
OEM/Integrator	953.4	1,693.5	999.3	1,677.0	1,439.6	2,012.8	1,607.5	2,256.1	1,705.6	2,407.4
TOTAL U.S. REVENUES	5,801.4	11,544.6	7,096.6	13,451.0	8,060.5	15,644.0	9,108.8	17,528.2	9,905.1	18,842.8
Non-U.S. Manufacturers										
Captive	--	280.3	--	266.8	--	267.4	12.6	258.0	21.1	246.3
Distributor	254.4	660.3	243.5	641.8	232.8	635.0	220.5	608.8	202.4	562.4
OEM/Integrator	7.2	91.4	29.0	122.6	53.7	157.0	66.6	177.2	75.9	192.8
TOTAL NON-U.S. REVENUES	261.6	1,032.0	272.5	1,031.2	286.5	1,059.4	299.7	1,044.0	299.4	1,001.5
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	6,063.0	12,576.6	7,369.1	14,482.2	8,347.0	16,703.4	9,408.5	18,572.2	10,204.5	19,844.3

Marketing channels

Captive disk drive arrays provided 38.5% of 1998's total shipments of all types of arrays, and the captive total is forecasted to decline only slightly by 2002, to 36.9%. Captive arrays capture an even greater share of overall sales revenues, with 60.3% in 1998 for a total of almost $7.6 billion. In 2002, the captive share will decline slightly to 53.1%, but sales revenues are projected to reach $10.5 billion. 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 and Hitachi, midrange systems such as Sun Microsystems and Hewlett-Packard, and personal computers such as Compaq Computer and Dell Computer.

Although captive array manufacturers hold the leadership in both sales revenue and shipments, the young array industry has seen enthusiastic missionary selling campaigns sponsored by the numerous noncaptive, independent manufacturers of controllers and other data storage peripherals which have entered the disk drive array business, with a full range of complete subsystems, boards and software products.

The outlook for distributor sales revenues and shipments through 2002 is stronger than previously expected, in view of the continuing movement in the open system market to more efficient storage architectures, such as storage area networks, and the rapid, flexible response to these changes by manufacturers of noncaptive arrays. Average prices will certainly decline, but the distributor share of worldwide total array sales revenues is expected to climb from 25.5% in 1998 to 33.8% in 2002, at $6.7 billion. Growth in the Network/Midrange product group will dominate this increase in sales revenue, as open systems markets increase in size and industry importance. Although OEM/Integrator sales revenues will continue to see modest overall growth, performance in individual product groups will vary, with continuous price declines for most types of arrays, and the share of sales revenues held by the OEM sales channel is expected to be flat.

U.S. based manufacturers have achieved dominance in product development and sales momentum, and are expected to maintain their lead, increasing their lead in total sales revenues from 91.6% in 1998 to 94.8% in 2002.

TABLE 2

CONSOLIDATED WORLDWIDE REVENUES
DISK DRIVE ARRAYS
MARKET CLASS REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1998 Revenues $M	1998 Revenues %	1999 Forecast $M	1999 Forecast %	2000 Forecast $M	2000 Forecast %	2001 Forecast $M	2001 Forecast %	2002 Forecast $M	2002 Forecast %
U.S. Manufacturers										
Captive	7,300.4 +1.3%	58.0%	8,016.6 +9.8%	55.3%	8,821.3 +10.0%	52.8%	9,593.8 +8.8%	51.5%	10,298.4 +7.3%	51.8%
Distributor	2,550.7 +13.6%	20.2%	3,757.4 +47.3%	25.9%	4,809.9 +28.0%	28.7%	5,678.3 +18.1%	30.5%	6,137.0 +8.1%	30.9%
OEM/Integrator	1,693.5 +59.7%	13.4%	1,677.0 -1.0%	11.5%	2,012.8 +20.0%	12.0%	2,256.1 +12.1%	12.1%	2,407.4 +6.7%	12.1%
Total U.S. Manufacturers	11,544.6 +9.8%	91.6%	13,451.0 +16.5%	92.7%	15,644.0 +16.3%	93.5%	17,528.2 +12.0%	94.1%	18,842.8 +7.5%	94.8%
Non-U.S. Manufacturers										
Captive	280.3 +46.0%	2.2%	266.8 -4.8%	1.8%	267.4 +.2%	1.6%	258.0 -3.5%	1.3%	246.3 -4.5%	1.2%
Distributor	660.3 +9.5%	5.2%	641.8 -2.8%	4.4%	635.0 -1.1%	3.8%	608.8 -4.1%	3.2%	562.4 -7.6%	2.8%
OEM/Integrator	91.4 -59.5%	1.0%	122.6 +34.1%	1.1%	157.0 +28.1%	1.1%	177.2 +12.9%	1.4%	192.8 +8.8%	1.2%
Total Non-U.S. Manufacturers	1,032.0 +1.1%	8.4%	1,031.2 --	7.3%	1,059.4 +2.7%	6.5%	1,044.0 -1.5%	5.9%	1,001.5 -4.1%	5.2%
Worldwide Recap										
Captive	7,580.7 +2.5%	60.3%	8,283.4 +9.3%	57.2%	9,088.7 +9.7%	54.4%	9,851.8 +8.4%	53.0%	10,544.7 +7.0%	53.1%
Distributor	3,211.0 +12.7%	25.5%	4,399.2 +37.0%	30.4%	5,444.9 +23.8%	32.6%	6,287.1 +15.5%	33.9%	6,699.4 +6.6%	33.8%
OEM/Integrator	1,784.9 +38.8%	14.2%	1,799.6 +.8%	12.4%	2,169.8 +20.6%	13.0%	2,433.3 +12.1%	13.1%	2,600.2 +6.9%	13.1%
Total All Manufacturers	12,576.6 +9.1%	100.0%	14,482.2 +15.2%	100.0%	16,703.4 +15.3%	100.0%	18,572.2 +11.2%	100.0%	19,844.3 +6.8%	100.0%

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

Product groups

Sales revenue for the network/midrange product group represents the majority of 1998 revenue, accounting for $9.2 billion, or 73.3% of the total for all array product groups, and is forecasted at $17.3 billion, 87.4% of the overall total in 2002. The product group retains its commanding lead in array unit shipments, over 1.3 million arrays in 1998, 93.3% of the industry total. The 2002 projection for the product group is almost 2.2 million units, 93.2% of the total. Future growth for arrays in network/midrange markets during this forecast period remains assured: The network market is still growing rapidly and continual disk drive and array functional improvements stimulate periodic replacement of arrays already installed. Years of increasing sales will occur before the annual growth of the network/midrange array product group is at saturation level.

Contributing to the eminent position of network/midrange arrays is the combination of high revenues from strong shipments of high value complete subsystems in both the captive and distributor channels, plus high shipments of array board and software products in both 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, provided a large initial sales thrust for the product group. Captive revenues contributed 67% of the 1998 overall sales revenue total for the product group, and the captive share is expected to remain above 55% or higher through 2002. Sales through distributors are projected to grow from 16.8% to 31.2% of the product group total in the same period.

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 $1.8 billion in 1994, and $4.3 billion in 1995. However, sales revenues began declining in 1996, dropping in

1998 to slightly over $3.2 billion, and are expected to continue to drop in subsequent years, despite an expected annual increase in the total amount of disk capacity purchased for mainframe applications. Almost all disk storage now used with mainframes is in the form of disk drive arrays, so 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 mainframe market's increasing appetite for more storage will not be able to overcome the even more rapid decline in the price per megabyte for disk drives during the 1999-2002 time period, with the result that total mainframe array sales revenues are projected to drop to under $2.4 billion in 2002. 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 12 thousand mainframe array subsystems is expected to decline to under 8.9 thousand in 2002.

Despite shipment increases for both product groups, the revenue contribution of single user arrays and specialized high performance arrays to the industry's total sales revenues will be much smaller, with neither product group expected to produce as much as 1% of the overall sales revenue total in the 1998-2002 period. Although significant to the participating companies in each product group, the revenue totals in both groups will remain modest -- but for different reasons in each product group.

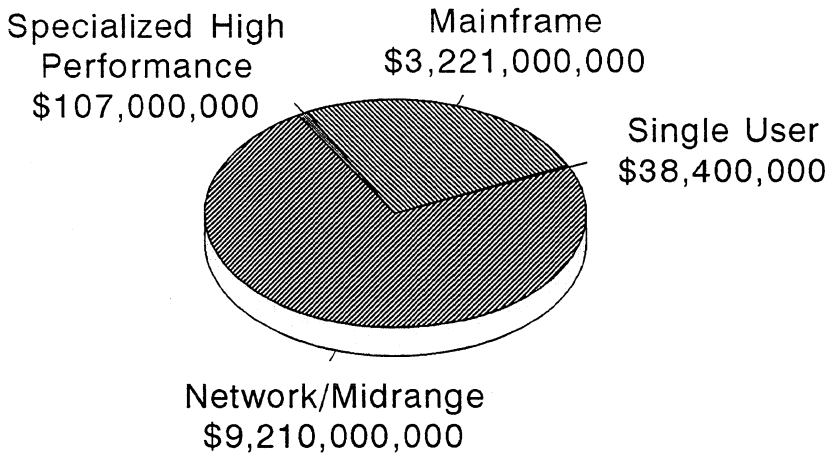
The slight shipment increases expected for specialized high performance arrays will be generated primarily by noncaptive sales of complete subsystems and software products for a variety of specialized applications, including video servers, video editing, medical systems, geophysical exploration data analysis and other imaging systems.

In the single user array product group, distributor sales will continue to predominate, concentrated in a narrow segment of the Macintosh, Wintel PC and UNIX/Linux workstation markets -- 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 1999-2002 shipment average annual growth rate for the group is projected at 16.5% per year.

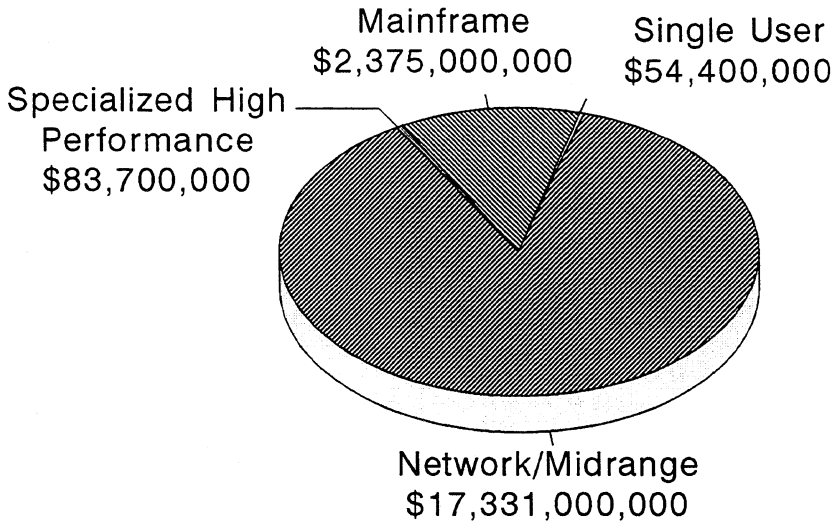
Figure 1

CHANGING PRODUCT MIX

Worldwide Disk Drive Array Revenue



1998



2002

TABLE 3

CONSOLIDATED WORLDWIDE REVENUES
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	------1998-----		----------Forecast----------							
ALL MANUFACTURERS	----Revenues---		------1999-----		------2000-----		------2001-----		------2002-----	
	$M	%	$M	%	$M	%	$M	%	$M	%
SINGLE USER SYSTEMS	38.4	.3%	46.1	.3%	53.3	.3%	54.9	.3%	54.4	.3%
	+17.4%		+20.1%		+15.6%		+3.0%		-.9%	
NETWORK/MIDRANGE SYSTEMS	9,210.4	73.3%	11,333.7	78.4%	13,670.8	81.9%	15,792.5	85.1%	17,331.2	87.4%
	+17.4%		+23.1%		+20.6%		+15.5%		+9.7%	
MAINFRAME SYSTEMS	3,221.0	25.6%	3,013.3	20.8%	2,891.8	17.3%	2,639.0	14.2%	2,375.0	12.0%
	-9.4%		-6.4%		-4.0%		-8.7%		-10.0%	
SPECIALIZED HIGH PERFORMANCE SYSTEMS	106.8	.8%	89.1	.5%	87.5	.5%	85.8	.4%	83.7	.3%
	+9.9%		-16.6%		-1.8%		-1.9%		-2.4%	
Total Worldwide Revenue	12,576.6	100.0%	14,482.2	100.0%	16,703.4	100.0%	18,572.2	100.0%	19,844.3	100.0%
	+9.1%		+15.2%		+15.3%		+11.2%		+6.8%	

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

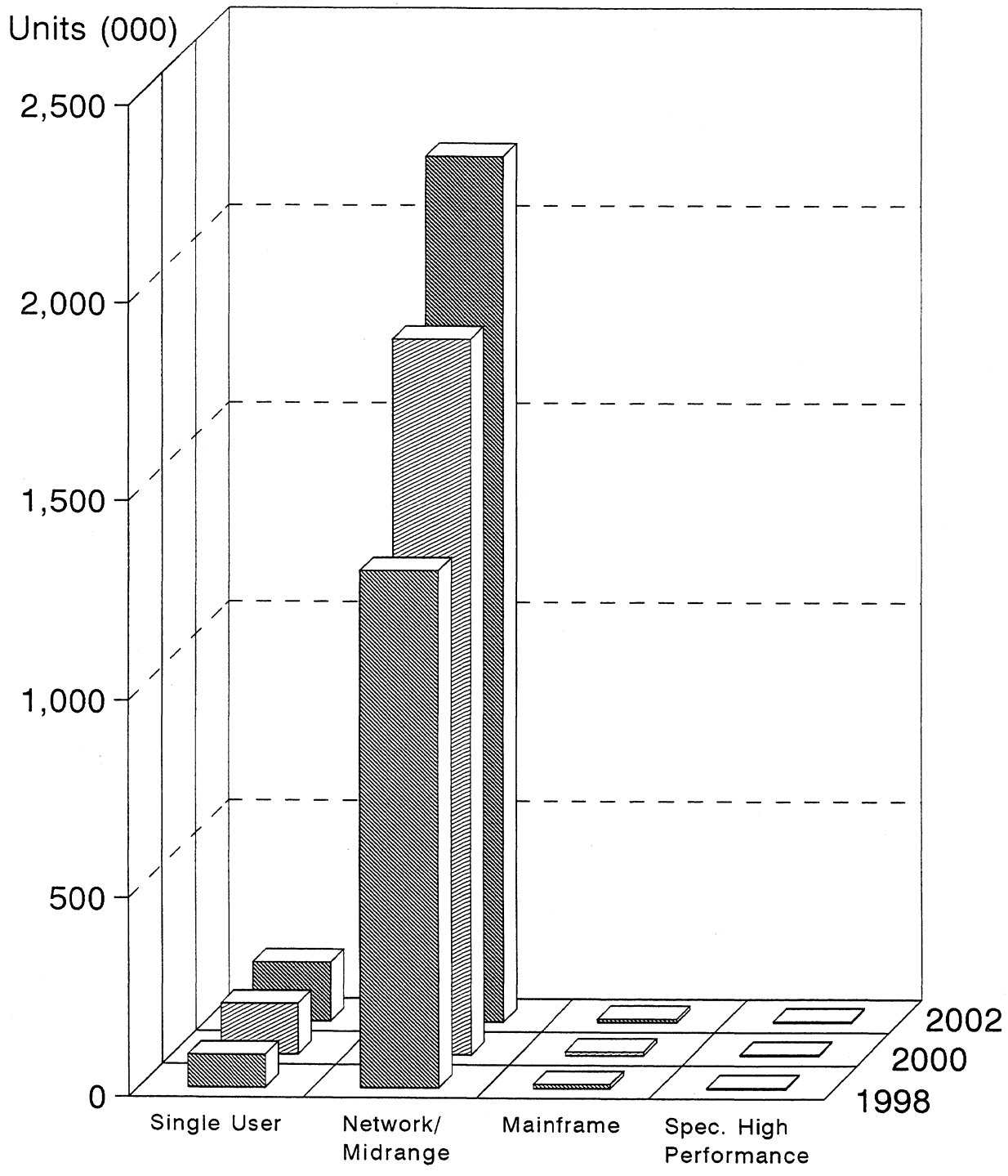


TABLE 4

CONSOLIDATED WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS	1998		Forecast							
SINGLE UNITS	Shipments		1999		2000		2001		2002	
	Units	%	Units	%	Units	%	Units	%	Units	%
SINGLE USER SYSTEMS	81,950	5.9%	108,950	6.5%	127,230	6.5%	139,120	6.4%	148,920	6.4%
	+71.2%		+32.9%		+16.8%		+9.3%		+7.0%	
NETWORK/MIDRANGE SYSTEMS	1,302,033	93.3%	1,563,780	92.9%	1,802,800	92.9%	2,009,450	93.1%	2,182,200	93.2%
	+28.2%		+20.1%		+15.3%		+11.5%		+8.6%	
MAINFRAME SYSTEMS	10,490	.8%	10,015	.6%	9,635	.5%	9,290	.4%	8,875	.4%
	-12.7%		-4.5%		-3.8%		-3.6%		-4.5%	
SPECIALIZED HIGH PERFORMANCE SYSTEMS	2,728	--	2,787	--	2,957	.1%	3,131	.1%	3,290	--
	-4.2%		+2.2%		+6.1%		+5.9%		+5.1%	
Total Worldwide Shipments	1,397,201	100.0%	1,685,532	100.0%	1,942,622	100.0%	2,160,991	100.0%	2,343,285	100.0%
	+29.6%		+20.6%		+15.3%		+11.2%		+8.4%	
% U.S. Manufacturers	94.5%		93.6%		93.1%		92.9%		92.8%	

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

Array product mix

The disk drive array is a complex combination of products, made even more complicated by the fact that arrays are sold in various levels of completeness. Within the DISK/TREND product groups, which are divided by major application areas, the data is also organized by product 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.

Complete subsystems provided 41.3% of 1998 total disk drive array unit shipments, and the share held by subsystems is expected to grow to 43.4% of the worldwide total for 2002. Complete subsystems constitute all of the arrays currently shipped for mainframe systems and more than 90% of the specialized high performance systems. Complete subsystems for network/midrange system applications currently provide over 40% of the product group's shipments, and their share is expected to remain in the 40-50% range through 2002, as users' requirements for fault tolerance continue to move the market to more sophisticated arrays. Complete subsystems held about 14% of the 1998 single user systems market, but that share is forecasted to decrease to about 10% in 2002.

A high proportion of the board level array controllers have been consumed during recent years by 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, the growth rate for network/midrange OEM board shipments started to decline in 1997 as a consequence of competition from system manufacturers' internal array board production programs, and is expected to further soften as chip set array controllers (which can be mounted on system motherboards, eliminating the need for a separate array controller board) receive increasing acceptance.

Total shipments of software array products continue to maintain positive shipment growth, but their share of the overall array market is declining, following the market withdrawal of some participating firms and declining prices for array

controllers. 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.

The individual RAID level of each disk drive array shipped is not included in DISK/TREND statistics, 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 was originally 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 is starting to be displaced by 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 continue its dominant role in the network/midrange and mainframe array markets, with the availability of appropriate subsystems becoming widespread and declining unit prices, made possible by 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 large total disk capacities 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	137
RAID-3 and RAID-0/1/3 combinations	33
RAID-4	4
RAID-5 and RAID-0/1/3/4/5 combinations	596

Figure 3

ARRAY TYPE SUMMARY

Worldwide Shipments in Thousands of Units

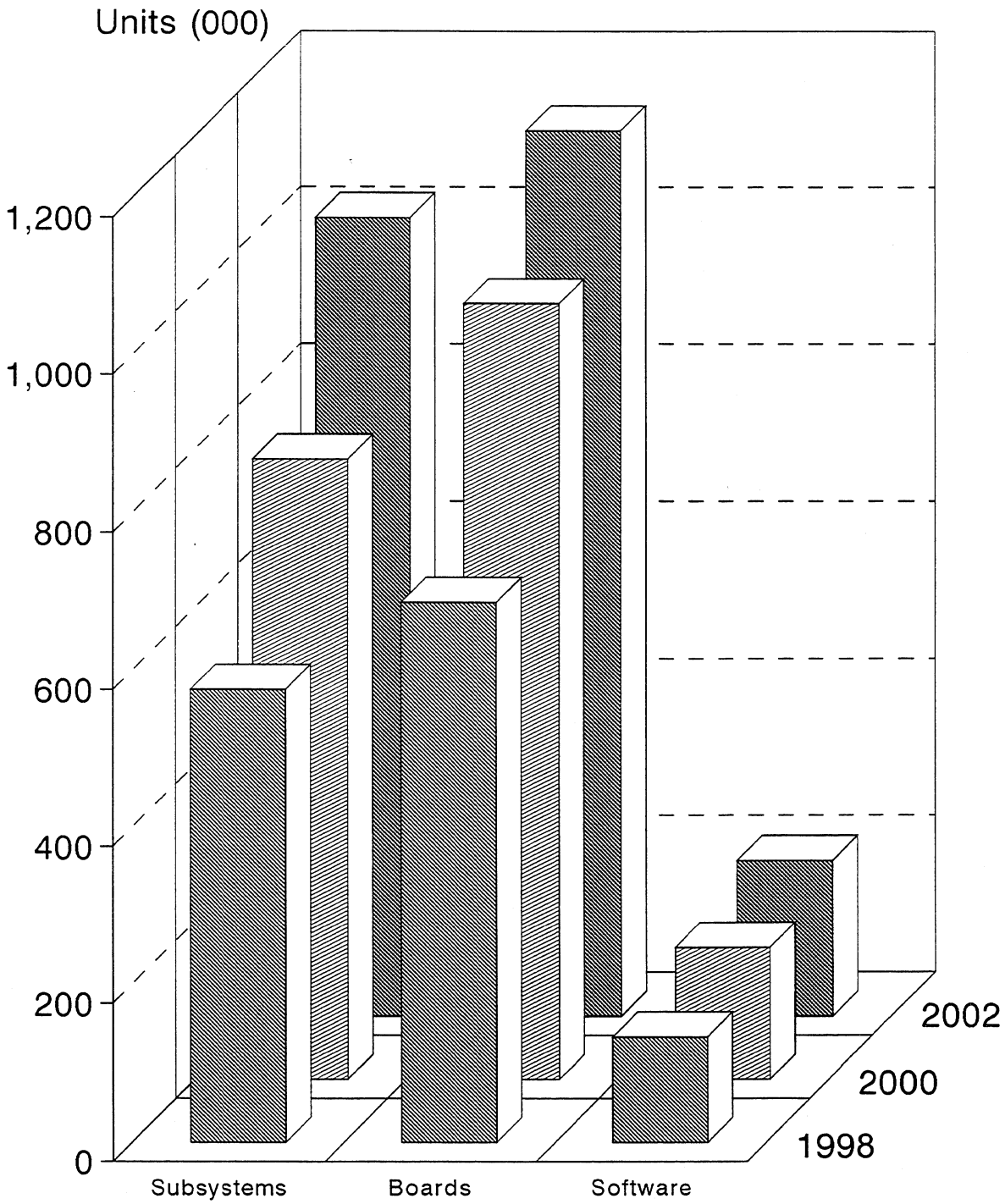


TABLE 5

CONSOLIDATED WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
SUMMARY BY ARRAY TYPE

UNIT SHIPMENTS	1998		Forecast							
SINGLE UNITS	Shipments		1999		2000		2001		2002	
	Units	%	Units	%	Units	%	Units	%	Units	%
SUBSYSTEMS	576,371	41.3%	677,600	40.2%	788,262	40.6%	902,528	41.8%	1,016,400	43.4%
	+13.4%		+17.6%		+16.3%		+14.5%		+12.6%	
BOARDS	687,327	49.2%	858,010	50.9%	986,950	50.8%	1,073,670	49.7%	1,128,660	48.2%
	+44.7%		+24.8%		+15.0%		+8.8%		+5.1%	
SOFTWARE	133,503	9.6%	149,922	8.9%	167,410	8.6%	184,793	8.6%	198,225	8.5%
	+40.5%		+12.3%		+11.7%		+10.4%		+7.3%	
Total Worldwide Shipments	1,397,201	100.0%	1,685,532	100.0%	1,942,622	100.0%	2,160,991	100.0%	2,343,285	100.0%
	+29.6%		+20.6%		+15.3%		+11.2%		+8.4%	

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

Noncaptive market

The total noncaptive array market is projected to grow through 2002, despite the small declines in noncaptive mainframe array shipments forecasted after 1998 as a consequence of expanding disk drive capacities and declining mainframe shipments. The more mature captive disk drive array shipments of many system manufacturers are expected to grow more slowly than the noncaptive array product lines addressing yet unsaturated markets. Numerous new array programs by independent manufacturers, but continuing declines in the number of independent producers, are anticipated. 1998 total noncaptive unit shipments of 859,771 units are forecasted to increase to 1,479,350 units in 2002.

Noncaptive array sales revenues expanded 20.8% in 1998, reaching nearly $5 billion. While a major boost in noncaptive sales of mainframe arrays during 1994-95 drove earlier growth, growth leadership has shifted to the network/midrange systems product group. Sales revenue growth is expected in all categories except mainframe systems, which will exhibit declines for 1999 and after. Changes in the supercomputer disk storage equipment market will depress the revenues for specialized high performance systems in 1999. Total noncaptive revenue is projected to rise to nearly $9.3 billion in 2002.

Network/midrange array shipments again dominated the worldwide noncaptive total in 1998, accounting for 89.7% (769,833 units) of total 1998 unit shipments, and the share for network/midrange shipments is forecasted to change very little in 2002, at 89.4%, or 1,322,000 arrays. 1998 network/midrange noncaptive sales revenue of over $3.0 billion is expected to grow to more than $7.7 billion in 2002, providing 83.3% of all noncaptive sales. Captive subsystem sales are expected to continue to surpass sales of noncaptive subsystems from the independent array suppliers, despite their active deployment of attractive new product features and innovative sales programs.

The product groups for single user arrays and specialized high performance arrays remain a small portion of the total noncaptive market for disk drive arrays, and their share of the total array market is not expected to grow significantly though 2002. Each of these product groups has a relatively small number of established applications and participants, and has no identified storage applications likely to generate more aggressive short term growth patterns.

TABLE 6

NONCAPTIVE WORLDWIDE REVENUES
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1998		Forecast							
ALL MANUFACTURERS	Revenues		1999		2000		2001		2002	
	$M	%	$M	%	$M	%	$M	%	$M	%
SINGLE USER SYSTEMS	38.4	.8%	46.1	.7%	53.3	.7%	54.9	.6%	54.4	.6%
	+17.4%		+20.1%		+15.6%		+3.0%		-.9%	
NETWORK/MIDRANGE SYSTEMS	3,041.7	61.0%	4,362.3	70.5%	5,797.2	76.2%	7,015.5	80.6%	7,743.0	83.3%
	+34.3%		+43.4%		+32.9%		+21.0%		+10.4%	
MAINFRAME SYSTEMS	1,834.0	36.7%	1,719.6	27.8%	1,691.3	22.2%	1,574.7	18.0%	1,425.8	15.4%
	+4.2%		-6.2%		-1.6%		-6.9%		-9.5%	
SPECIALIZED HIGH PERFORMANCE SYSTEMS	81.8	1.5%	70.8	1.0%	72.9	.9%	75.3	.8%	76.4	.7%
	+7.9%		-13.4%		+3.0%		+3.3%		+1.5%	
Total Worldwide Revenues	4,995.9	100.0%	6,198.8	100.0%	7,614.7	100.0%	8,720.4	100.0%	9,299.6	100.0%
	+20.8%		+24.1%		+22.8%		+14.5%		+6.6%	

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

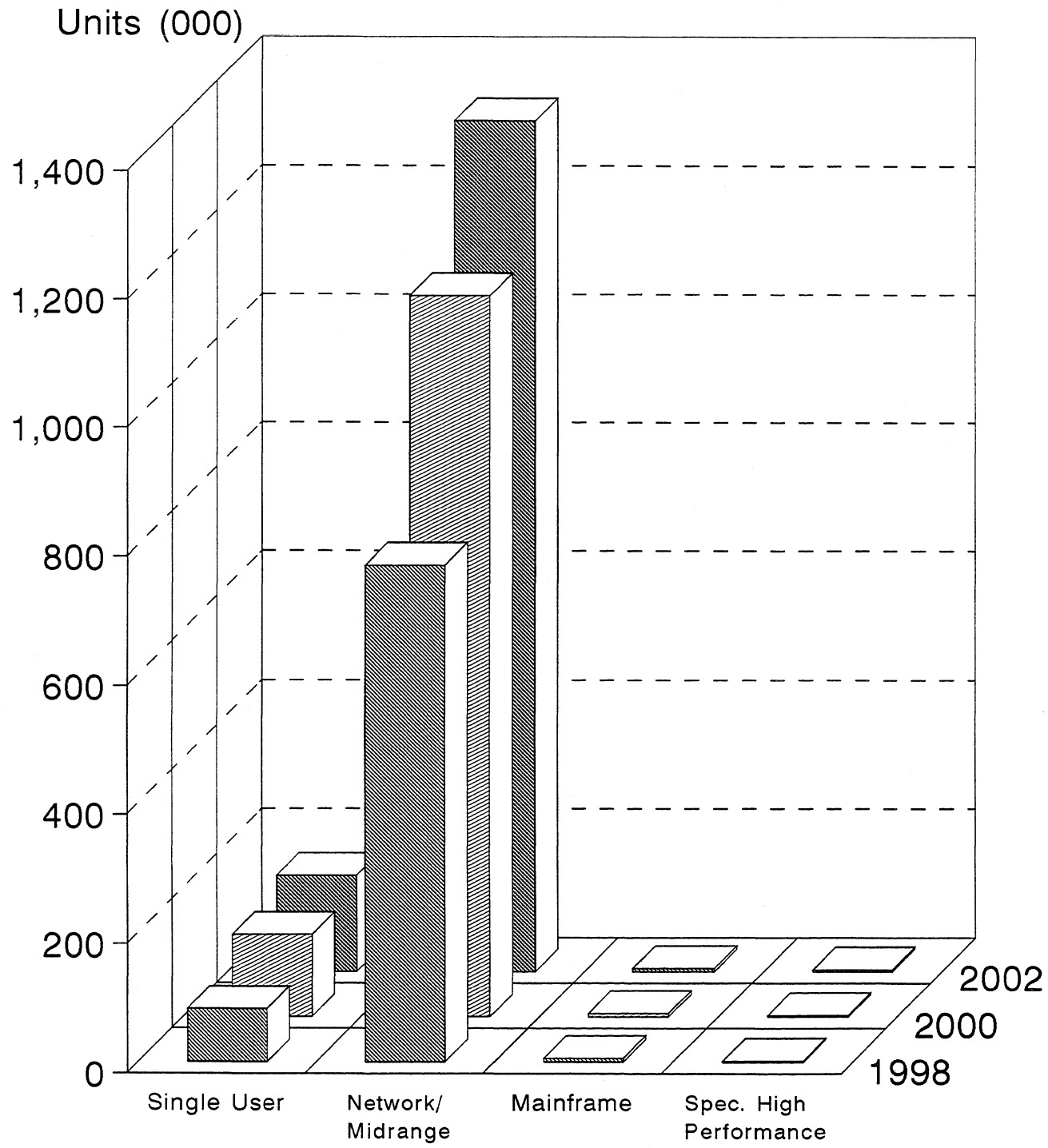


TABLE 7

NONCAPTIVE WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

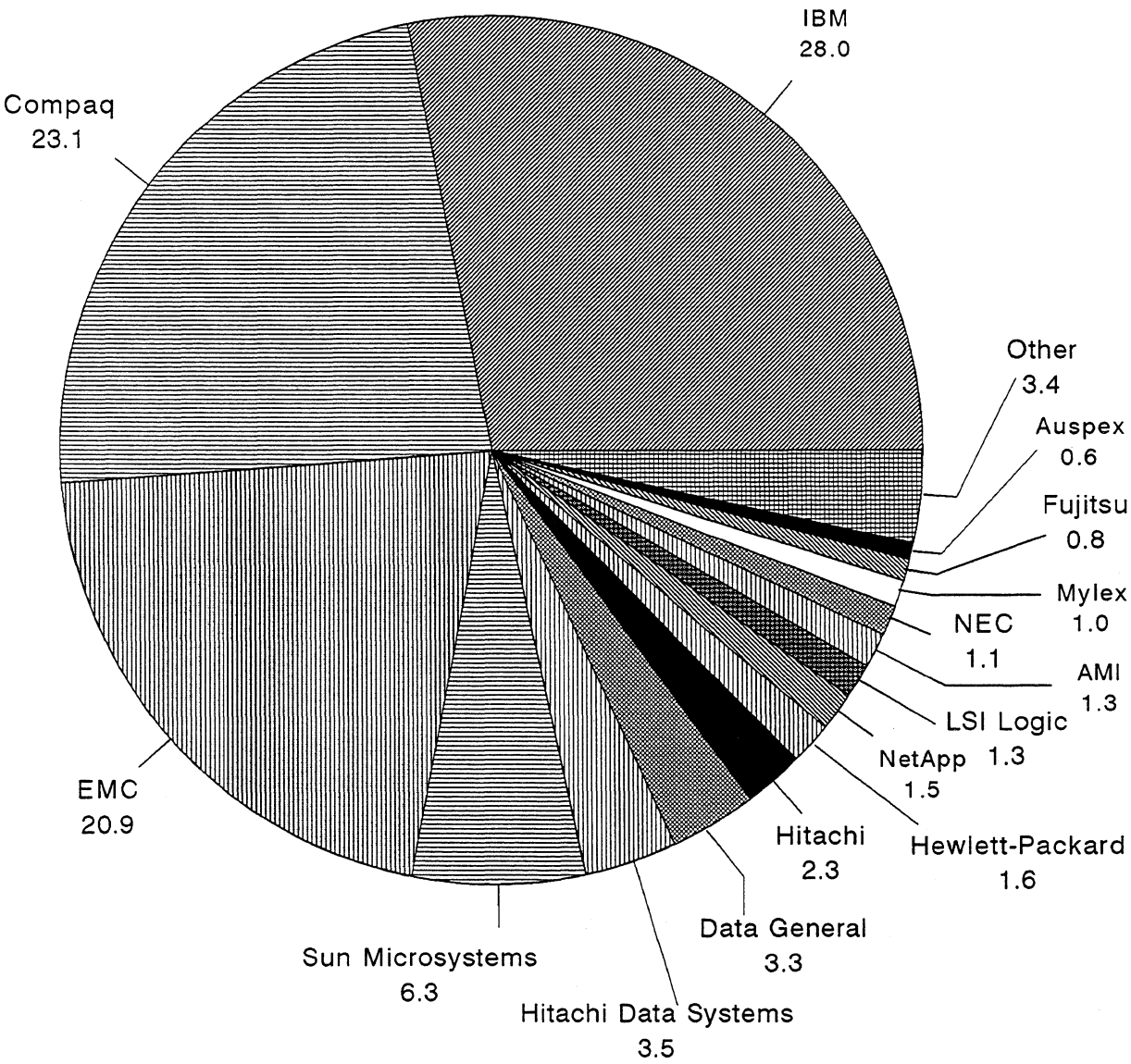
UNIT SHIPMENTS	1998		Forecast							
SINGLE UNITS	Shipments		1999		2000		2001		2002	
	Units	%	Units	%	Units	%	Units	%	Units	%
SINGLE USER SYSTEMS	81,950	9.5%	108,950	10.1%	127,230	10.1%	139,120	10.0%	148,920	10.1%
	+71.2%		+32.9%		+16.8%		+9.3%		+7.0%	
NETWORK/MIDRANGE SYSTEMS	769,833	89.7%	960,180	89.3%	1,120,200	89.4%	1,241,950	89.5%	1,322,100	89.4%
	+41.3%		+24.7%		+16.7%		+10.9%		+6.5%	
MAINFRAME SYSTEMS	5,930	.7%	5,590	.5%	5,485	.4%	5,425	.4%	5,305	.4%
	+12.9%		-5.7%		-1.9%		-1.1%		-2.2%	
SPECIALIZED HIGH PERFORMANCE SYSTEMS	2,058	.1%	2,242	.1%	2,510	.1%	2,778	.1%	3,025	.1%
	-8.7%		+8.9%		+12.0%		+10.7%		+8.9%	
Total Worldwide Shipments	859,771	100.0%	1,076,962	100.0%	1,255,425	100.0%	1,389,273	100.0%	1,479,350	100.0%
	+43.2%		+25.3%		+16.6%		+10.7%		+6.5%	
% U.S. Manufacturers	91.5%		90.5%		89.7%		89.4%		89.0%	

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

Figure 5

1998 ESTIMATED MARKET SHARES

Worldwide Revenue Percentages of All Disk Arrays



1998 Revenues: $12,576,600,000

TABLE 8

1998 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL DISK DRIVE ARRAYS
(Value of non-U.S. currencies estimated at average 1998 rates)

	CAPTIVE		DISTRIBUTOR		OEM/INTEGRATOR		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
American Megatrends	--	--	35.1	1.1	131.4	7.4	166.5	1.3
Auspex Systems	--	--	77.1	2.4	--	--	77.1	.6
Ciprico	--	--	30.6	1.0	--	--	30.6	.2
CMD	--	--	25.0	.8	8.3	.5	33.3	.3
Compaq Computer	2,812.9	37.1	80.0	2.5	20.0	1.1	2,912.9	23.2
Data General	39.8	.5	83.6	2.6	291.9	16.4	415.3	3.3
Distributed Processing Tech.	--	--	27.3	.9	12.2	.7	39.5	.3
EMC	--	--	1,769.6	55.1	861.5	48.3	2,631.1	20.9
Hewlett-Packard	144.1	1.9	60.0	1.9	--	--	204.1	1.6
IBM	3,517.2	46.4	--	--	--	--	3,517.2	28.0
LSI Logic	--	--	2.6	.1	160.0	9.0	162.6	1.3
Mylex	--	--	50.4	1.6	78.1	4.4	128.5	1.0
Network Appliance	--	--	192.0	6.0	--	--	192.0	1.5
Sun Microsystems	750.3	9.9	23.8	.7	9.8	.5	783.9	6.2
Veritas Software	--	--	9.0	.3	36.0	2.0	45.0	.4
Other U.S.	36.1	.4	84.6	2.6	84.3	4.7	205.0	1.7
U.S. Total	7,300.4	96.3	2,550.7	79.4	1,693.5	94.9	11,544.6	91.8
NON-U.S. MANUFACTURERS								
Fujitsu	.4	--	94.3	2.9	--	--	94.7	.8
Hitachi	140.0	1.8	74.5	2.3	70.5	3.9	285.0	2.3
Hitachi Data Systems	--	--	444.1	13.8	--	--	444.1	3.5
NEC	139.9	1.8	--	--	1.7	.1	141.6	1.1
Other Non-U.S.	--	--	47.4	1.5	19.2	1.1	66.6	.5
Non-U.S. Total	280.3	3.7	660.3	20.6	91.4	5.1	1,032.0	8.2
WORLDWIDE TOTAL	7,580.7	100.0	3,211.0	100.0	1,784.9	100.0	12,576.6	100.0

TABLE 9

CURRENT PRODUCT LINES
MANUFACTURERS OF DISK DRIVE ARRAYS

Codes: C = Captive
O = OEM/Integrator
D = Distributor
SB = Subsystems
BD = Boards
SW = Software

		DISK/TREND PRODUCT GROUP			
N. American Manufacturers (83)	Type	Single User Arrays	Network/ Midrange Arrays	Mainframe Arrays	Spec. High Performance Arrays
3Ware	O,D		BD		
Adaptec (Includes Trillium)	O,D	BD,SW	BD,SW		
Amdahl	D		SB	SB	
American Megatrends	O,D	BD	BD		
Apple Computer	C,D		SB		
Applied Digital Systems	D		SB		
ATTO Technology	O,D	SW			
Auspex Systems	C,D		SB		
Aviv	D		SB		
Cambex	D		SB	SB	
Chaparral Network Storage	O,D		BD		
CharisMac Engineering	O,D	SW	SW		
Ciprico	O,D				SB
CLone Star Software	D		SW		
CMD Technology	O,D		BD		
Commercial Data Servers	D			SB	
Compaq Computer	O,C,D		SB,BD		
Connex	D		SB		
Consensys Computers	O,D		SW		
Corel	O,D		SW		
CyberStorage Systems	O,D		SB		
Cyranex	O,D	SW	SW		
DataDirect Networks	O,D		SB		SB
Data General	O,D		SB		
Dell Computer	C		BD,SB		
Digi-Data	O,D		BD		
Diverse Logistics	O,D		BD		
Dot Hill	D		SB		
DPT	O,D		BD		
ECCS	O,D		SB		
EMC	O,D		SB	SB	
FWB Software	D	SW			
Hammer Storage Solutions	D	SB	SB		
Hewlett-Packard	C,D		SB		
IBM	C,O,D		BD,SB	SB	
Integrix	D		SB		
LAND-5	O,D		SB		
Legacy Storage Systems	O,D		SB		
Leitch Technology (ASC)	D				SW
Lighthouse Technology	D		SB		
Locom	O,D		SB		
LSI Logic	O,D		BD,SB		
Macro Computer Products	D		SB	SB	
Marner International	C		SB		
Maxtor	O,D		SB,SW		
Micron Electronics	O,D		SB		
Micronet Technology	O,D	SB,SW	SB		
MountainGate Data Systems	D		SB		
MTI Technology	D		SB		
Mylex	O,D		BD		
Network Appliance	D		SB		
Network Storage Solutions	D		SW,SB		
nStor	O,D		SW,SB		

N. American Manuf. (CONTINUED)	Type	Single User Arrays	Network/ Midrange Arrays	Mainframe Arrays	Spec. High Performance Arrays
Optima Technology	D	SB,SW	SB		
Pacific Micro Data	D		SB		
Perceptive Solutions	O,D		BD		
Phoenix International	D		SB		
Polywell Computers	D	SB	SB		
Procom Technology	D		SB		
Quantum	D		SB		
Raidion Systems (PTG)	D		SB		
Raidtec	O,D	BD,SB	BD,SB		
Rising Edge Technologies	D		SB		
Rock Solid Systems	D	BD			
Seek Systems	D		SB		
Silicon Graphics (SGI)	C				SB
SMS Data Products Group	D		SB		
SoftRAID	O,D		SW		
Storage Computer	O,D		SB		
Storage Concepts	O,D		SB		SB
StoragePath	O,D		SB		
Storage Technology	D		SB	SB	
Stratus Computer	C		SB		
Sun Microsystems	C,D		SB	SB	
TD Systems	O,D		BD		
Transitional Technology	D		SB		
TrueSAN Networks	O,D		SB		
Unisys	C		SB		
Veritas Software	O,D		SW		
Winchester Systems	D		SB		
XIOTech	O,D		SB		
Xistor	D	SB			
ZZYZX Peripherals	D		SB		
Asia/Pacific Rim Manufacturers (19)					
ACard Technology	O,D	BD	BD		
Acer	D		SB		
Accordance Systems	O,D	BD			
Advanced Technology & Systems	D	SB	SB		
Amaquest Computer	O,D		BD,SB		
Dataworld	O,D		BD		
Enlight	O,D		BD		
Fujitsu	C		SB	SB	
Hitachi	C,O,D		SB	SB	
Hitachi Data Systems	D		SB	SB	
Infortrend	O,D		BD		
Maxtronic International	O,D	BD	SB,BD		
NEC	O,C		SB	SB	SB
OneofUs	O		BD		
Promise Technology	O,D	BD	BD		
Proware Technology	O,D	BD	SB,BD		
Raidar Systems	D		SB		
Raidell Computer	O,D		BD		
Texa	O,D	SB	SB		
European Manufacturers (13)					
Arco Computer Products	D	BD			
Axis Communications	O,D		BD		
Baydel Ltd.	O,D		SB		
Comparex	D		SB	SB	
Dilog SA	O,D		BD		
Eurologic Systems	D		SB		
ICP Vortex	O,D		BD		
Nexsan Technologies	O,D		SB		
Nlynx Systems	D		SB		
Sagitta	O,D		SB		
SYRED Data Systems	O,D		BD		
TwinCom	O,D	SW	SW		
Xyratex	O		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, OS/2, UNIX, LINUX, 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, Hewlett-Packard 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.

Specialized 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.

Market classification

Market class is used here, arbitrarily, to differentiate captive, 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 distributor or OEM/Integrator market classes are classified accordingly.

Example:

- Arrays sold by 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 distributor shipments are included in the noncaptive sales channel.

Examples:

- Shipments by the CLARiiON unit of Data General (recently acquired by EMC) are noncaptive, except for arrays sold with computer systems made by the parent company or other subsidiaries.
- Shipments made by American Megatrends, Adaptec or CMD Technology are noncaptive.

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 DPT 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 LSI Logic for sale to system manufacturers.
- Software produced by Twincom 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 CharisMac 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, 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 1999 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

1999 DISK/TREND REPORT

ARRAY SYSTEM CONSIDERATIONS

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

ARRAY CHARACTERISTICS AND CLASSIFICATION

What is an array? A disk drive array is an assembly of disk drives and hardware controllers operated by array management software. The array presents itself to its host system environment as if it were a single physical disk drive. The storage devices that are members of the array can be any type of random access, nonvolatile 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 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 that 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 responding to an I/O request provides 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 that 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 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, although RAID-4 remains in use in a few proprietary subsystems designed to minimize the write penalty.

- RAID-5: Data in a RAID-5 array is striped across the drives in the array, but parity data is also distributed among all of the drives, eliminating some of the write bottleneck. Writes are still slow because of the need to read data from all drives to recompute parity when writing (sometimes called the read-modify-write process). Concurrent I/O transactions can be processed. Data can be recovered in the event of a single drive failure. RAID-5 is efficient for long data records, but is also reasonably efficient for short ones if the array design includes features to improve write performance, or if the application requires a high proportion of reads. It is a good

choice for achieving high data availability, with acceptable performance provided that the data block size is small. RAID-5 carries only a modest cost per megabyte penalty compared to a nonarray approach.

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

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

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.

STORAGE SUBSYSTEM ARCHITECTURE ISSUES

Increasingly, the disk drive array is an element in a storage subsystem that is, in turn, an element in a network of interacting servers, specialized servers and client systems/users. Arrays may be attached to a general purpose host computer (Host attached) which is in turn attached to a network, or may be included in a storage subsystem designed to be connected to a network without the intervention of a host computer (Network attached). Domains of networked servers, isolated from client network segments through gateways, are receiving increas-

ing attention as the next major step in enterprise system architecture. Mainframe systems have been networked in this manner for some time. While identified by a variety of names, the industry seems to be settling on "Storage Area Network" (SAN) as the preferred acronym. The SAN may also be called "Server Area Network", "System Area Network", or "Enterprise Storage Network", depending upon the manufacturer supporting it, but the basic concept remains much the same.

A SAN is a network domain incorporating high performance servers (some specialized for storage), whose nodes are interconnected by a high speed network fabric (Fibre channel, Escon, SSA) , communicating with client systems via gateways to LANs or WANs. Theoretically, either host attached or network attached arrays could be included in a SAN. The implementation issues are complex, considering that the servers involved will be manufactured by multiple vendors, and run under various operating systems. They may employ a variety of network architectures, be local or remote, use a variety of file system organizations, protocols, access policy and security protocols, management tools, and may serve an entire enterprise or a fraction thereof. A few firms have announced open system (heterogeneous) SANs. While these early systems can link diverse equipment, universal interoperation of storage management capabilities and applications will probably not be available for several years, although subsets and partial implementations, many using single vendor or vendor alliance (homogeneous) solutions, are becoming available. It is altogether too early to determine what the final form of the SAN will be, but it is likely that there will be several successful architectures, each optimum for a given range of performance, size, data availability and fault tolerance, scalability and other criteria. Switched fiber optic networks are gaining favor as enterprise level solutions, although FC-AL implementations seem likely to remain relevant for smaller installations.

Network attached storage (NAS), storage subsystems that attach directly to a SAN or other network segment, can fit within the overall SAN architecture or be used on LAN segments outside the domain of a SAN. NAS is generally easy to install and maintain, offers support for heterogeneous hosts, and permits sharing of storage resources, but its effectiveness may be limited by network bandwidth capabilities and the volume of network traffic on the network segment to which it is attached. Entry level NAS subsystems may have prices in the $1,000 range, but offer little fault tolerance. NAS servers may incorporate specific types of storage, such as CD-ROM drives, as well as rigid disk drives.

SAN implementation is so complex that system vendors are now beginning to offer complete SAN design and implementation services, removing the need to deal with SAN complexities by the ultimate using organizations, and, as a result, removing one of the barriers to SAN market actualization. (And, not incidentally, creating a captive customer.) From an array-centric point of view, the array is isolated from the SAN or other network by its associated processor, and is not impacted directly by network design. The array is impacted to the extent that the appropriate capacity, fault tolerance and performance characteristics must be chosen to serve the needs of host systems/servers attached to the SAN. The real challenge is to enable the server software to be flexible enough to handle all of the conditions it may encounter in an arbitrary SAN configuration.

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 executing array software cause other host activities to degrade? 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?
- If operating with a SAN, do you need to support FC-AL or switched FC protocols? Interoperability may be easier to achieve in a switched environment than in a network loop if equipment from many different suppliers must communicate.

- 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, and 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 usually 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, mirrored cache, even redundant processors and power feeds, will be required. Any element whose failure can make the system nonfault toler-

ant 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.

The array may be required to operate as an element in a network comprised of systems and storage subsystems using various operating systems, file structures and management tools. Insuring compatibility and manageability in this context is a non-trivial consideration.

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?

The most important cost of all may be the cost to the organization using the array if the stored data is not available during 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 with 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. Others use software capable of reporting the failure (or impending failure) of an array component over a network to a system administrator, or employ a combination of techniques. Since removing the wrong drive when making an array repair will make data unavailable, the array design should provide protections against this kind of inadvertent error. Fault detection systems help to insure the correct replacement parts are used.

It is sometimes 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 user 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.

Larger arrays, or arrays containing high performance drives, can generate substantial heat. Array enclosures must provide sufficient cooling, as must the physical facility in which the array is located.

TECHNICAL REVIEW

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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. Storage system architecture increasingly emphasizes data integrity and availability, even when multiple system components fail or degrade. While improvements in device integrity contribute to this end and are welcome, elimination of single points of failure in a system or subsystem is the desired end goal, and the array is a major implementation tool. 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.

- 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 and Compaq 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. Thinner drives and higher aerial density contribute to increases in overall data density--more gigabytes per cubic inch--highly desired by IT managers concerned with minimizing floor space needs.

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. Some canisters also provide shock isolation and a standardized interface permitting exchange of drives between systems.

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 has become of serious concern to some producers of board level controllers.

Semiconductors: Specialized semiconductors for use in disk drive arrays became available from NCR in 1991, and several firms now produce families of chips for storage applications, 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. Flash is also used in disk drives to permit upgrades of the drive microcode. The ability of flash memory to be updated will make it easy to perform field upgrades of arrays and drives as new software versions are released.

The decreasing cost per megabit of semiconductor memory encourages the use of larger cache memory on array controllers and disk drives. Array controllers for even small systems may contain several megabytes of cache, and cache sizes exceeding 100 megabytes are increasingly common.

Disk drives: The trend to higher areal density will continue. The 3.5" server drives that offer 7 gigabits per square inch density in 1999 are expected to achieve over 20 gigabits per square inch by 2001. Already, 10 gigabytes of capacity is available in a single platter desktop 3.5" drive. 36 gigabyte and 50 gigabyte 3.5" server drives were announced in 1998, and these capacities have been expanded to over 72 gigabytes as of the end of 1999. 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, servos and mechanical elements to advance performance as fast as areal density is improving.

The 3.5" disk drive in the one inch high form factor has become the mainstay product for array producers because of its packaging efficiencies. Availability of inch high 3.5" drives with 4.5 gigabytes capacity from multiple manufacturers was first achieved in 1996, and 18 gigabyte low profile drives were introduced in 1998. 36 gigabyte low profile drives were announced in 1999. At the present time, many 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. Accordingly, 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 being supplemented by 10,000 RPM where performance is critical. 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. However, more recently introduced 10,000 RPM drives in the 3.5" form factor generate a much lower heat load due to their adoption of 3 inch diameter media. 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. A 12,000 RPM drive (with 2.5" media to reduce heat generation) is available from Hitachi. 15,000 RPM drives are anticipated, but it is likely that the highest 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 climbed steadily through 200,000 hours and 500,000 hours to the 1,000,000 hour MTBF drives announced by IBM in 1993, and at least 1,000,000 hours MTBF is now expected for server class drives.

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. As drive intelligence increases, some drives may become capable of being attached directly to a network, although the challenges in obtaining reliable operation in a variety of network environments is formidable.

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.

The majority of array host interfaces currently use Ultra SCSI (40 MB/sec.) or Ultra2 SCSI (80 MB/sec.), many in the fast and/or wide configuration. Ultra SCSI interfaces became available in 1996, and began to be displaced in late 1997 by Ultra2 SCSI, which is faster and can support up to 15 devices per SCSI channel. The 12 meter maximum SCSI bus length, while improved, is still a limitation for array builders. The use of Ultra 160 SCSI (160 MB/sec.) interfaces began ramping up in the latter half of 1999. Internal arrays for PC based systems typically connect to 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). However, fibre channel is positioned to become the standard high performance interface for host to array controller connection, if 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. The SCSI-3 command set (which is associated with the Ultra 160 SCSI interface) was implemented in some array controllers even before Ultra 160 SCSI drives were available to support advanced commands and high data transfer rates as drives became available. The ability to queue commands at the controller and at the drive provides a significant improvement in array performance.

Some low end arrays have been developed that use faster IDE interfaced drives because of their lower cost. Using DMA, newer IDE drives can achieve data transfer rates of 33 or 66 megabytes per second, making small IDE based arrays performance competitive with small SCSI based arrays. 100 megabyte per second data transfer rates are expected in 2000. However, the IDE/EIDE command set does not support recovery from error conditions as well as the SCSI command set.

Serial interfaces such as the fibre channel interface are becoming more widely used. FC-AL (fibre channel arbitrated loop) is frequently designed into a system as the host to storage channel, but its use on the drive side of the array controller is still limited, though growing as FC-AL interfaced drives become available from multiple sources. While FC-AL or switched fiber channel has displaced IBM's SSA in most array producer's plans, SSA lives on within IBM as well as certain segments of the video systems market. Currently, FC-AL provides 100 megabytes per second transfer rates per channel. Faster designs may appear as early as 2000, but may be premature, given the industry's desire to fully assimilate the current technology before moving on. IEEE 1394 has received some attention, but seems an unlikely contender in servers targeted to transaction

oriented environments. It may achieve some use in servers for video related applications.

Concerns about the power required by serial interface solutions, the slow rate of development and ramp up of critical components, and software incompatibilities between network nodes have limited the rate of acceptance, especially in desktop and small server class equipment, but these limitations are rapidly disappearing. Interoperability in SAN environments is a more pressing challenge.

Drives configured to plug into parallel SCSI bus backplanes use 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 make extensive use of backplane interconnection.

Some arrays use separate RS-232 ports to communicate with a remote computer that 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 non-obvious; 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 NS7000/700 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 recently introduced array controllers do 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, marketed for several years 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. The data will be 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 an-

nouncement inspired other 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.

  A related issue is how to define the hardware and software interfaces to all the critical components of an array whose status must be controlled or monitored. These include fans, power supplies, indicators, controls, etc. The SAF-TE and SES specifications have received moderate, though not universal, industry acceptance. SMART (Self-Monitoring Analysis and Reporting Technology), a standard for including diagnostic capabilities in disk drive controllers is widely implemented. SMART support is increasingly provided by array controllers and array management software. Many disk drives also include internal temperature sensing and reporting capabilities. The ability of SMART-capable drives to accurately predict failures is marginal (especially in desktop class drives), but improving. More effective advance failure diagnosis and reporting is highly desired by system manufacturers.

- 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 standards issues have been addressed in 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. SNIA, the Storage Networking Industry Association, is addressing issues concerning interoperability in SAN architectures, as well as other groups (typically containing a mix of switch, controller, software and storage subsystem makers) addressing the interoperability problem, including:

- Open Standards Fabric Initiative.

- FibreAlliance Group (Sponsored by EMC).

- Celestra Consortium (Sponsored by Legato).
- Jiro (Sponsored by Sun Microsystems).

Companies may have membership in several of these groups.

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 that when the component is removed, power is removed before the ground connection and 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 has been extended to other elements of the system, such as controllers, that might be present in multiples and need to be exchanged without shutting down a system.

SAN attachment: Array controllers can be interfaced to a SAN through the appropriate bus adapter, but the software required to attach to switched SANs differs from that required for FC-AL. Array makers need to work closely with switch and server makers to assure compatibility. Fiber switch manufacturers actively supporting SAN development include Brocade, Gadzooks, Ancor, Vixel, McData and others. A key issue to be resolved is how to manage the file system in an environment including multiple operating systems contending for access to the same storage subsystems. As a result, most SANs implemented to date tend to be homogenous with respect to the operating systems and protocols supported. And many prospective purchasers of SANs are experimenting with smaller configurations to gain real-world experience before committing to enterprise wide SAN systems.

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, 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. Several companies now offer direct network attached storage with array capability, probably creating an overcrowded market at the low end. Low end solutions are usually RAID-0/1, though some RAID-5 configurations have appeared. Some of these products are expected to also receive host software support as redundant network attached storage servers.

Network attachment of fiber channel interfaced external storage arrays for high end and midrange servers 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. FC-AL is currently being used in most instances of host to server connection, but over the next few years, switched fiber connection is expected to become the most common implementation in SAN environments.

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 the 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, such as the models offered by Rising Edge Technologies. 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 fixed drive optical technology developed by Quinta (acquired by Seagate) and others may possibly appear in very high capacity drives in the future.

The most probable uses of optical (removable) 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. Fixed drives employing optical technologies will be used in arrays emphasizing minimum cost per megabyte.

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 (active) 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. Switched fibre channel is used for the SAN connection fabric between server and storage subsystem.

Fire Wire: See P1394.

HBA: Host Bus Adapter

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 (and drives) located inside the enclosure of the host processor. The array controller typically plugs into an I/O bus slot, such as a PCI slot. Some of the drives may be located externally in larger configurations.

IPI: Intelligent Peripheral Interface. An older high performance interface that 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.

LUN: An acronym for **L**ogical **U**nit **N**umber. A LUN maps a block of storage into a single addressable block emulating a physical disk drive. A LUN may include a single drive, a portion of a drive, several drives or portions thereof.

LUN Mapping: A procedure to avoid conflicts between operating systems residing on multiple servers that commonly access a storage subsystem. LUN masking, LUN blocking or LUN partitioning are related techniques with the same goal. LUN mapping and its logical cousins may be implemented as host software, firmware in an array controller or host bus adapter. The same effect can be achieved by limiting access to devices through a properly controlled Fibre Channel switch, a technique called LUN zoning.

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 mirrored mode are defined as a RAID-1 configuration.

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

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

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

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

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

NAS (Network attached storage): A storage subsystem with an internal controller that allows it to connect directly to a network, supplying storage services to remote host or client systems. May be used to provide general file services or, with appropriate protocols, specific database services.

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 32 bit 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. The more recent 64 bit PCI bus transfers data at 264 megabytes per second.

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. RAB also classifies arrays according to their feature sets within a RAB defined EDAP (Extended Data Availability and Protection) set of criteria.

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: Storage Area Network. Also called System Area Network or Server Area Network. A form of high bandwidth local area network with a domain limited to heterogeneous 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 connecting host and storage subsystem. 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 synchronous burst transfer rate for SCSI and SCSI-2 is 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 operate at up to 40 megabytes per second, while Ultra2 SCSI operates at 80 megabytes per second. The SCSI 160/m variant of SCSI 3 operates at 160 megabytes per second. 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.

SNIA: Storage Networking Industry Association. An organization established to coordinate and develop standards for storage network functions and protocols, especially those related to SANs.

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. Originated by IBM, which is currently the only source for SSA disk drives.

Storage Area Network: See SAN

Storage networking: The technique(s) of interconnecting multiple elements of storage subsystems and processing systems to each other, including the administration and control of the resulting configurations.

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)

Ultra3 SCSI: A further upgrade of Ultra2 SCSI that enables inclusion of several additional features, including operation at 160 megabytes/second.

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 the 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

1999 DISK/TREND REPORT

ARRAYS: SINGLE USER SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Advanced Technology & Systems	AXRA-M4300A
Hammer Storage Solutions	SLPro 4FC
Micronet Technology	DataDock
Optima Technology	8200W, 18000W
Polywell Computers	Poly 800B9
Raidtec	FlexArray M
Texa	Texa RST-NPU10

Board assembly (no drives)

Acard Technology	ARS2010
Accordance Systems	ARAID99-300
Adaptec	ARO-1130CA2
American Megatrends	Express 100
Arco Computer Products	DupliDisk
DTC Data Technology	HardCopy
Maxtronic International	Arena M2
Promise Technology	FastTrak66 Pro
Proware Technology	DataPlum
Raidtec	RUAC MX
Rock Solid Systems	RS955

Software arrays

Adaptec (Trillium Research)	Remus Lite 1.4
ATTO Technology	ExpressMirror
CharisMac Engineering	CharisMac RAID+
Cyranex	EZRAID Lite
FWB Software	Hard Disk Toolkit
Micronet Technology	ExpressRAID
Optima Technology	DiskArray
Twincom	Infinity

All disk drive arrays used primarily with single personal computers or workstations are included in this product group. Most of these arrays are designed for the very price sensitive personal computer markets, and use disk mirroring, or RAID-1, usually in conjunction with RAID-0. Some of the new single user arrays support IDE drives. The first shipments in the product group occurred in 1990, with early software and board level arrays. Although individual arrays offering RAID-3 or RAID-5 capability are included among the above complete subsys-

tems, board and software arrays, they remain the exception, and in some cases are intended for high-end workstations used for graphics and prepress applications.

The majority of array products offered for single user computer systems are designed for the Macintosh market. 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

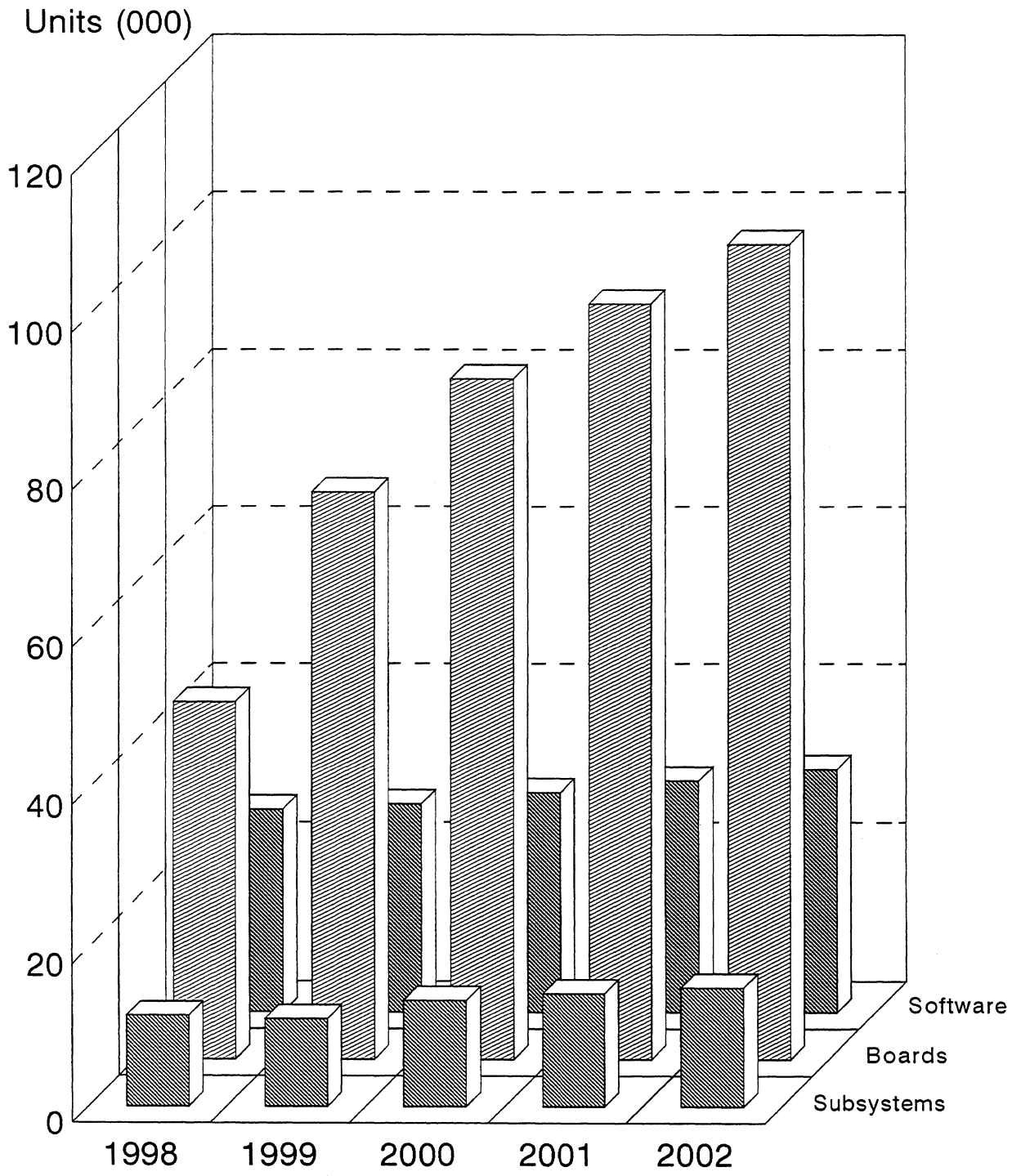
During the 1998/99 period, shipments of disk drive arrays for single user systems have increased rapidly, with the largest portion of the increase driven by sales of board assemblies. Shipments of low priced boards jumped 176.1% in 1998, with a further increase of 59.3% forecasted for 1999. The 1998 average unit price for boards in this product group was only $255, and typical prices for complete subsystems and software array products are lower than in any other product group. As a result, single user arrays continue to produce the smallest sales revenue total of any DISK/TREND array product group, with sales revenue for single user arrays reaching $38.4 million in 1998, and $46.1 million forecasted for 1999, up 20.1%. Driven by rapid growth in array board products, worldwide unit shipments increased 71.2% in 1998 to 81,950, with further growth expected in 1999, reaching 108,950 units, up 32.9%.

The price sensitive markets for single user disk drive arrays are currently undergoing rapid growth due to revitalized Macintosh shipments and the expanding demands of many Wintel personal computer users for more reliable disk storage. 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 1997, shipments of complete subsystems were surpassed by shipments of boards, a pattern that is now accelerating. Software array shipments were also passed up by boards in 1998, but software arrays also continued to grow in shipments, as the result of Apple's turnaround and increasing interest in the SOHO market. With most single user applications, software arrays do not over-

Figure 6

Single User System Arrays

Worldwide Shipments by Array Type



load the computer processor, so software products can provide a low cost, high performance array for the serious computer do-it-yourselfer or small business operator.

Promise Technology became the shipment leader of single user arrays in 1998, with 23.2% of the worldwide total, all boards. All sales in this product group were noncaptive. Adaptec held 17.7% of the total for second place, with Texa and Arco Computer Products tied for third position, each with 10.6%.

Marketing trends

Continued growth in unit shipments is expected for the single user array product group through 2002, but falling average prices are forecasted to limit sales revenue growth, with revenue peaking in 2001. Total sales revenues are expected to peak in 2001 at $54.9 million, declining slightly in 2002, to $54.4 million. Unit shipments are forecasted to reach 148,920 in 2002, an average annual increase during the 2000/2002 period of 11.0%.

Although single user complete subsystem arrays command prices many times higher than boards and software products, the projected 2002 average price for complete subsystems is drastically lower than for the other DISK/TREND product groups included in this report, at only $2,086. In 2002, complete subsystems are forecasted to produce 57.8% of the product group's sales revenues, while generating only 10.1% of the group's unit shipments. Boards, with 69.4% of unit shipments, will produce only 36.9% of 2002 revenues. Again, the problem is that the average unit price for boards is only a small percentage of the typical price for complete subsystems. Whereas software array products led 1997 unit shipments with over 43% of the total, they are expected to generate only 5.3% of the product group's 2002 sales revenues, due to relatively low average prices and strong growth of board product shipments.

Distributor and OEM/Integrator sales channels tend to follow different patterns in the U.S. and non-U.S. markets for single user arrays. U.S. shipments of complete subsystems are small, with the highest volume in boards and software, and with OEM shipments in the lead. Non-U.S. array manufacturers dominate complete subsystem shipments, predominately through the distributor channel, and they also lead in board shipments, with distributor sales also in the lead.

Array manufacturers headquartered in the U.S. have led in development of the growth markets for single user arrays, but hardware oriented non-U.S. manufacturers have expanded their participation in the group, and non-U.S. firms are expected to capture the majority of the product group's worldwide sales revenue during the forecast period.

Technical trends

The storage demands of many video, graphics, multimedia and complex business applications have motivated numerous personal computer users to utilize disk drive arrays. 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. 3.5" disk 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.

Array logic embedded in hardware 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, more flexibility in modifying array configurations and faster I/O rates for EIDE and SCSI family drives. 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, personal computer 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. The largest shipment increases will be produced by boards, due to low prices and improved performance capabilities.

TABLE 10

SINGLE USER SYSTEMS

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1998 Revenues		Forecast 1999		2000		2001		2002	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Distributor	2.5	4.3	2.5	4.3	2.6	4.1	2.6	4.3	2.4	4.2
OEM/Integrator	4.1	7.9	5.8	13.2	7.0	14.2	7.4	14.7	7.4	14.4
TOTAL U.S. REVENUES	6.6	12.2	8.3	17.5	9.6	18.3	10.0	19.0	9.8	18.6
Non-U.S. Manufacturers										
Distributor	1.9	22.0	1.9	25.5	3.1	30.9	3.3	31.6	3.1	31.5
OEM/Integrator	.8	4.2	.7	3.1	1.0	4.1	1.0	4.3	1.0	4.3
TOTAL NON-U.S. REVENUES	2.7	26.2	2.6	28.6	4.1	35.0	4.3	35.9	4.1	35.8
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	9.3	38.4	10.9	46.1	13.7	53.3	14.3	54.9	13.9	54.4

TABLE 11

SINGLE USER SYSTEMS

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1998		Forecast							
	Shipments		1999		2000		2001		2002	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Distributor	11,900	16,000	12,300	16,100	12,955	17,210	13,210	18,380	13,405	19,610
OEM/Integrator	17,110	26,450	21,960	39,550	24,920	43,200	26,605	46,150	28,010	48,700
TOTAL U.S. SHIPMENTS	29,010	42,450	34,260	55,650	37,875	60,410	39,815	64,530	41,415	68,310
Non-U.S. Manufacturers										
Distributor	15,200	23,400	19,200	33,800	24,230	44,440	25,895	50,040	26,330	54,350
OEM/Integrator	9,400	16,100	12,300	19,500	13,425	22,380	14,290	24,550	14,615	26,260
TOTAL NON-U.S. SHIPMENTS	24,600	39,500	31,500	53,300	37,655	66,820	40,185	74,590	40,945	80,610
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	53,610	81,950	65,760	108,950	75,530	127,230	80,000	139,120	82,360	148,920
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	151	245	217	354	292	481	372	620	455	769

TABLE 12

SINGLE USER SYSTEMS

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1998 Revenues			Forecast											
	1999			2000			2001			2002					
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Distributor	1.2	1.9	1.2	1.4	1.6	1.3	1.4	1.3	1.4	1.5	1.3	1.5	1.5	1.2	1.5
OEM/Integrator	--	6.7	1.2	--	12.0	1.2	--	12.7	1.5	--	13.2	1.5	--	13.1	1.3
TOTAL U.S. REVENUES	1.2	8.6	2.4	1.4	13.6	2.5	1.4	14.0	2.9	1.5	14.5	3.0	1.5	14.3	2.8
NON-U.S. MANUFACTURERS															
Distributor	20.0	2.0	--	23.2	2.3	--	26.5	4.4	--	26.5	5.1	--	26.3	5.2	--
OEM/Integrator	3.2	.9	.1	2.2	.8	.1	3.1	.9	.1	3.4	.8	.1	3.6	.6	.1
TOTAL NON-U.S. REVENUES	23.2	2.9	.1	25.4	3.1	.1	29.6	5.3	.1	29.9	5.9	.1	29.9	5.8	.1
WORLDWIDE RECAP															
Distributor	21.2	3.9	1.2	24.6	3.9	1.3	27.9	5.7	1.4	28.0	6.4	1.5	27.8	6.4	1.5
	-7.4%	+387.5%	-53.8%	+16.0%	--	+8.3%	+13.4%	+46.2%	+7.7%	+.4%	+12.3%	+7.1%	-.7%	--	--
OEM/Integrator	3.2	7.6	1.3	2.2	12.8	1.3	3.1	13.6	1.6	3.4	14.0	1.6	3.6	13.7	1.4
	+18.5%	+123.5%	+333.3%	-31.2%	+68.4%	--	+40.9%	+6.3%	+23.1%	+9.7%	+2.9%	--	+5.9%	-2.1%	-12.5%
Total Revenues	24.4	11.5	2.5	26.8	16.7	2.6	31.0	19.3	3.0	31.4	20.4	3.1	31.4	20.1	2.9
	-4.7%	+173.8%	-13.8%	+9.8%	+45.2%	+4.0%	+15.7%	+15.6%	+15.4%	+1.3%	+5.7%	+3.3%	--	-1.5%	-6.5%
ANNUAL SHARE, BY TYPE	63.6%	29.9%	6.5%	58.2%	36.2%	5.6%	58.3%	36.2%	5.5%	57.3%	37.2%	5.5%	57.8%	36.9%	5.3%

TABLE 13

SINGLE USER SYSTEMS

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1998 Shipments			Forecast											
	1999			2000			2001			2002					
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Distributor	700	4,100	11,200	800	3,400	11,900	860	3,550	12,800	910	3,620	13,850	950	3,710	14,950
OEM/Integrator	--	13,200	13,250	--	26,300	13,250	--	29,500	13,700	--	32,100	14,050	--	34,400	14,300
TOTAL U.S. SHIPMENTS	700	17,300	24,450	800	29,700	25,150	860	33,050	26,500	910	35,720	27,900	950	38,110	29,250
NON-U.S. MANUFACTURERS															
Distributor	7,300	15,800	300	8,300	25,200	300	9,800	34,300	340	10,200	39,450	390	10,500	43,400	450
OEM/Integrator	3,500	11,900	700	2,000	16,800	700	2,800	18,800	780	3,200	20,500	850	3,600	21,750	910
TOTAL NON-U.S. SHIPMENTS	10,800	27,700	1,000	10,300	42,000	1,000	12,600	53,100	1,120	13,400	59,950	1,240	14,100	65,150	1,360
WORLDWIDE RECAP															
Distributor	8,000 -8.9%	19,900 +765.2%	11,500 -27.2%	9,100 +13.8%	28,600 +43.7%	12,200 +6.1%	10,660 +17.1%	37,850 +32.3%	13,140 +7.7%	11,110 +4.2%	43,070 +13.8%	14,240 +8.4%	11,450 +3.1%	47,110 +9.4%	15,400 +8.1%
OEM/Integrator	3,500 +66.7%	25,100 +79.3%	13,950 +184.7%	2,000 -42.9%	43,100 +71.7%	13,950 --	2,800 +40.0%	48,300 +12.1%	14,480 +3.8%	3,200 +14.3%	52,600 +8.9%	14,900 +2.9%	3,600 +12.5%	56,150 +6.7%	15,210 +2.1%
Total Shipments	11,500 +5.7%	45,000 +176.1%	25,450 +23.0%	11,100 -3.5%	71,700 +59.3%	26,150 +2.8%	13,460 +21.3%	86,150 +20.2%	27,620 +5.6%	14,310 +6.3%	95,670 +11.1%	29,140 +5.5%	15,050 +5.2%	103,260 +7.9%	30,610 +5.0%
ANNUAL SHARE, BY TYPE	14.0%	55.0%	31.0%	10.2%	65.9%	23.9%	10.6%	67.8%	21.6%	10.3%	68.9%	20.8%	10.1%	69.4%	20.5%

TABLE 14

SINGLE USER SYSTEMS

WORLDWIDE PRICE PER UNIT ($)

ARRAY TYPE	1998	Forecast 1999	2000	2001	2002
Distributor					
Subsystems	2,655	2,693	2,617	2,522	2,426
Boards	199	141	151	147	135
Software	107	110	110	110	100
Distributor Average	671	599	569	525	483
OEM/Integrator					
Subsystems	900	1,100	1,100	1,050	1,000
Boards	296	295	282	265	244
Software	94	97	109	99	90
OEM/Integrator Average	279	275	278	266	249

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

	1998 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
Promise Technology	--	16,000	--	16,000	29.8	--	19,000	--	19,000	23.2
Adaptec	--	6,500	--	6,500	12.1	--	14,500	--	14,500	17.7
Texa	--	--	--	--	--	8,700	--	--	8,700	10.6
Arco	--	7,900	--	7,900	14.7	--	8,700	--	8,700	10.6
Other U.S.	400	1,400	20,710	22,510	42.0	700	2,800	24,450	27,950	34.1
Other Non-U.S.	--	--	700	700	1.4	2,100	--	1,000	3,100	3.8
TOTAL	400	31,800	21,410	53,610	100.0	11,500	45,000	25,450	81,950	100.0

ARRAYS: NETWORKS/MIDRANGE SYSTEMS

1999 DISK/TREND REPORT

ARRAYS: NETWORK/MIDRANGE SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Acer	Altos 9100B
Advanced Technology & Systems	AXRC-G16000SD
Amaquest Computer	FT830
Amdahl	LVS 4800
Apple Computer	AppleRAID
Applied Digital Systems	AD855
Auspex Systems	AS200, NS-8000 series
Aviv	Spitfire, Eclipse
Baydel	DAR5 series
Cambex	2000 FJ
Compaq Computer	ProLiant series, RA 4000
Comparex	D1400 series
CyberStorage Systems	Ultra 1600
DataDirect Networks	EV-200, EV-800
Data General	CLARiiON series
Dell Computer	PowerEdge series
Dot Hill	SANnet series, Fibre Box
ECCS	Synchronix series
EMC	Symmetrix 3000 series
Eurologic Systems	Voyager series
Fujitsu	F6495E2
Hammer Storage Solutions	SLPro series
Hewlett-Packard	A3700 series, HD Server 4000
Hitachi	DF350 series
Hitachi Data Systems	5800 series
IBM	7133, Netfinity series
Integrix	R2000
LAND-5	DS 2000
Legacy Storage Systems	UDSS DiskARRAY
Lighthouse Technology	Harbor
Locom	9920
LSI Logic	MetaStor series, S-Class series
Macro Computer Products	MSR-1100
Marner International	Performance Storage
Maxtor	MaxAttach
Maxtronic International	Arena Silver
Micron Electronics	NF6201
Micronet Technology	DataDock 7000
Mountaingate Data Systems	CentraVision
MTI Technology	Gladiator series, Vivant series
NEC	DS1000 series
Network Appliance	F720, F760
Network Storage Solutions	SPANStor-GT
Nexsan Technologies	XRAID series

Complete subsystems, with disk drives (continued)

Nlynx Systems	e-RAID
nStor	CR8e series
Optima Technology	GigaBank
Pacific Micro Data	MAST 9500
Phoenix International	Phalanx series
Polywell Computers	Poly SUMA 8000
Procom Technology	NetFORCE series
Proware Technology	5000I
Quantum	Snap! Server
Raidar Systems	1261 Ultra
Raidion Systems (PTG)	RAIDION series
Raidtec	FlexArray series
Rising Edge Technologies	MOR1200 series
Sagitta	EZiRAID, Salient Series
Seek Systems	Escort, Sentry
SMS Data Products Group	S850F
Storage Computer	OmniRAID series
Storage Concepts	Concept 812SW
Storage Technology	9145, 9153
StoragePath	SP series
Stratus Computer	D600
Sun Microsystems	StorEdge series
Texa	DAF, DAX series
Transitional Technology	Prism series
Unisys	OSM 3000, OSR 5000
Winchester Systems	FlashDisk RAID series
XIOtech	Magnitude series
Xyratex	SR-1200 series
ZZYZX Workstations & Peripherals	PowerRAID series

Board assembly (no drives)

3Ware	DiskSwitch series
Acard Technology	AEC6850
Adaptec	AAC-364, ARO-1130U2
Amaquest Computer	CTL-9600, DA-951
American Megatrends	MegaRAID series
Axis Communications	NAS 100
Chaparral Network Storage	G5312, G7313
CMD Technology	CRD-5XXX series
Compaq Computer	Smart Array series, HSZ70
Dataworld	DA 3500
Dell Computer	PERC
Digi-Data	Z9000 series
Dilog SA	Windjammer
Diverse Logistics	Windjammer
DPT	RAIDstation series
Enlight	EN-8900
IBM	ServeRAID series
ICP Vortex	GDT6XXXRD series
Infortrend	IFT-2101UA, IFT-3102U2

Board assembly (continued)

LSI Logic	SYM1000 series
Maxtronic International	Arena P3
Mylex	Rome, DAC 960 series
Oneofus	FC4400, FC2200
Perceptive Solutions	dataSHADOW, 2700
Promise Technology	SuperTrak Pro
Proware Technology	5960S
Raidell Computer	IM-7500
Raidtec	Ruac II, FibreRAID-PCI
SYRED Data Systems	RegencyPlus, Supra
TD Systems	Omniserve 3, 4

Software arrays

Adaptec (Trillium Research)	Remus 1.4
CharisMac Engineering	RAID NT
CLone Star Software	REFLECT
Consensys Computers	RAIDZONE
Corel	CorelSCSI
Cyranex	EZRAID Pro
Maxtor	ReflectIt
Network Storage Solutions	SPANStor series
SoftRAID	FireRAID
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 disk drive 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. Extensive merger and acquisition activities have changed the list of network/midrange system array manufacturers during the last few years, with examples such the company now named Dot Hill, which includes firms previously known as Box Hill, Artecon, Storage Dimensions and Falcon. Although Mylex has been acquired by IBM, it is being operated as a separate subsidiary, and is shown separately above. EMC has completed the acquisition of Data General, but CLARiiON is also shown separately, since it has not yet been integrated into the EMC product line.

A 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 companies which have had leadership positions in array shipments for networks/midrange systems applications have offered captive disk subsystems with RAID-1 capability as part of midrange computer product lines.

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

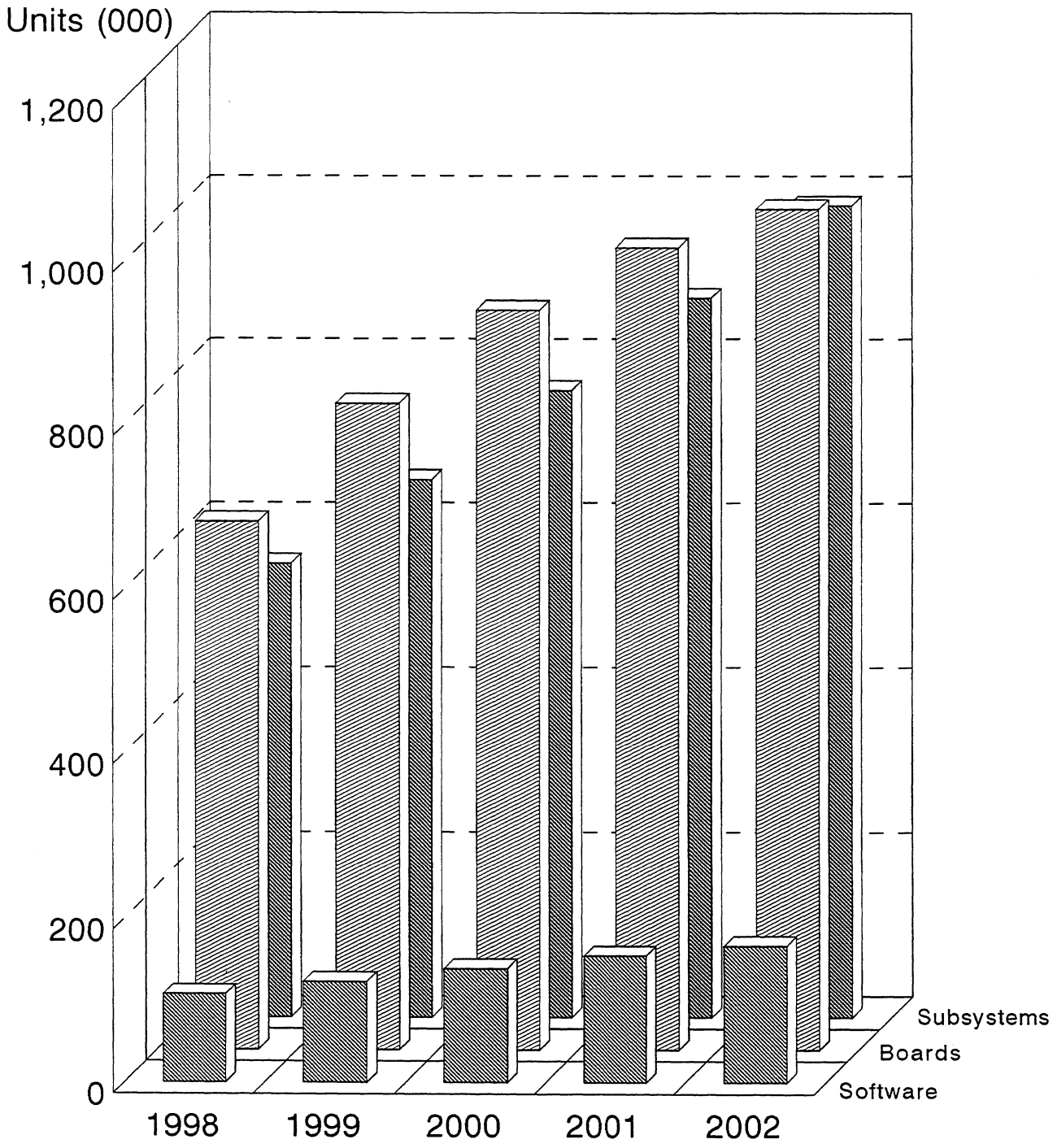
With estimated 1999 sales revenues of $11.3 billion and shipments of over 1.5 million units, the network/midrange systems array product group continues to dominate the worldwide disk drive array business. Although array board products are shipped in larger quantities, much of the product group's high growth in sales revenues has resulted from surging demand for relatively high priced complete array subsystems in the enterprise open systems market. Total shipments topped a million units for the first time in 1997, growing to 1.3 million units in 1998, up 28.2%, with 1999's shipments expected to increase another 20.1%. Sales revenues increased 17.4% in 1998, at $9.2 billion, and the growth for 1999 is estimated at 23.1%.

Captive sales revenues continue to provide two thirds of the total sales revenues for this product group, and most of that total consists of complete array subsystems sold on a captive basis by the numerous system manufacturers which have found it strategically important and profitable to offer disk drive arrays

Figure 7

Network/Midrange System Arrays

Worldwide Shipments by Array Type



with their network and midrange computer systems. Compaq Computer, IBM, Data General (recently acquired by EMC), Hewlett-Packard, Dell Computer, Hitachi and Sun Microsystems have all found it profitable to develop strong disk storage programs, with disk drive arrays in key roles. 66.9% of the product group's 1998 sales revenues were generated by disk drive arrays sold on a captive basis by system manufacturers, a total of $6.2 billion. In contrast, only 40.9% of the product group's 1998 total unit shipments were captive arrays. The principal factor which boosted captive sales 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.

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. 1998 overall distributor sales revenues were $1.6 billion and OEM/Integrator revenues reached $1.5 billion, but there continues to be competitive juggling between the two noncaptive sales channels. Sales revenues for both channels are dominated by sales of complete subsystems, with both channels benefiting from revenue growth in 1998. However, OEM unit shipments of complete subsystems declined slightly in 1998, in the face of product mix transition problems and strong competition from distributor and captive array manufacturers. Despite leadership in sales revenues by complete subsystems, board level array products continue to sell in larger quantities, although at drastically lower prices. Total board shipments were up 40.4% in 1998, with another increase of 22.4% forecasted for 1999, to 786,310 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.

American Megatrends advanced to first place in 1998 shipments of noncaptive disk drive array shipments in the networks/midrange systems product group with 33.5% of the worldwide total, representing 258,000 boards. Mylex (acquired by IBM in 1999), shipped 203,500 boards, and fell to second position with 26.4%. Veritas Software stayed in third place with 8.4%, all software products.

Marketing trends

The network/midrange product group is growing in sales revenues and shipments at a somewhat faster rate than previously expected, and the outlook during the next few years continues to be strong. The product group's total unit shipments are forecasted at almost 2.2 million arrays in 2002, an average annual increase of 11.8% in the 1999-2002 period. Sales revenues are expected to increase at an even stronger annual rate, as the result of a gradually increasing share of the product mix for more costly complete subsystems, reaching $17.3 billion in 2002.

As both storage area networks and network attached storage continue to gain acceptance in the enterprise open systems market, complete subsystems are clearly destined to hold an increasing share of the product group's sales and shipments as more users move to completely assembled storage solutions. Complete subsystems are forecasted to advance from 41.9% of 1999 overall array shipments to 45.4% of the 2002 total, while sales revenues move from 93.9% to 95.9% during the same period. It is clear that a very high percentage of computer networks will be equipped with file servers utilizing disk drive arrays by the end of this decade. Average selling prices per unit are expected to decline continually during the 1999-2002 period for most types of array products. Future array price declines will be driven by high shipment levels and lower disk drive pricing.

Several conflicting trends will influence the sales outlook for array boards and board assemblies in the 1999-2002 period. Significant new chip set array controller implementations for the network/midrange market have been introduced in recent years, and follow-on card mounted disk drive array chip sets are expected to displace array board sales in gradually increasing quantities in subsequent years. Although unit shipments are forecasted to continue increasing through 2002, the growth rate for OEM/Integrator board shipments in this product group is expected to continue declining through 2002. 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 many of these innovations will be implemented first in board-level array products.

While shipments of software array products are expected to increase during this forecast period, declining prices are forecasted to keep sales revenues declining through 2002. 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 unit shipments of software array products are expected to increase, their share of the network/midrange product group's overall total shipments are expected to decline. 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.

Technical trends

Most buyers of disk drive arrays have become highly sensitive to the need for arrays to be capable of change, as the usage environment changes. Most array manufacturers have responded to this requirement and have defined modularity and scalability as essential disk drive array development objectives. Hewlett-Packard's 1995 introduction of AutoRAID, which used a new method to map host block addresses to disk drive addresses, was the first commercial implementation of many of the array improvements expected by the industry, including dynamic data migration between RAID modes, the ability to expand disk 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 have moved toward increased versatility and modularity in new array designs.

Rapid increases in disk drive recording density have dramatically lowered disk price per megabyte in recent years, with an inevitable impact on 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, but market impact has been minimized by rapid changes in controller interface standards.

Operating systems that include array functions are not included in the DISK/TREND Report shipment and revenue totals. Limited array capabilities were included in some operating systems for minicomputers and mainframes by Digital Equipment and IBM, and more recently by Microsoft in Windows NT. 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. However, their impact on the market for hardware based arrays and separate software array packages has been modest.

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 2002, due to competition from array chip sets mounted on system motherboards.

TABLE 16

NETWORK/MIDRANGE SYSTEMS

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1998 Revenues		Forecast 1999		2000		2001		2002	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	2,698.9	6,068.0	3,152.9	6,849.1	3,029.2	7,738.3	3,462.8	8,638.8	3,878.6	9,449.7
Distributor	913.8	1,474.0	1,631.1	2,646.8	2,405.9	3,729.7	2,985.6	4,696.7	3,381.7	5,258.2
OEM/Integrator	871.2	1,470.5	964.8	1,594.9	1,403.4	1,925.7	1,569.5	2,165.2	1,666.3	2,315.4
TOTAL U.S. REVENUES	4,483.9	9,012.5	5,748.8	11,090.8	6,838.5	13,393.7	8,017.9	15,500.7	8,926.6	17,023.3
Non-U.S. Manufacturers										
Captive	--	100.7	--	122.3	--	135.3	12.6	138.2	21.1	138.5
Distributor	22.9	76.5	28.3	90.5	28.3	101.2	30.2	108.6	33.3	116.8
OEM/Integrator	6.4	20.7	9.4	30.1	12.7	40.6	14.4	45.0	17.2	52.6
TOTAL NON-U.S. REVENUES	29.3	197.9	37.7	242.9	41.0	277.1	57.2	291.8	71.6	307.9
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	4,513.2	9,210.4	5,786.5	11,333.7	6,879.5	13,670.8	8,075.1	15,792.5	8,998.2	17,331.2

TABLE 17

NETWORK/MIDRANGE SYSTEMS

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1998 Shipments		Forecast 1999		2000		2001		2002	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	188,370	529,700	236,950	600,100	270,600	678,500	310,900	763,100	356,300	855,500
Distributor	119,204	215,039	167,487	291,685	197,300	346,500	223,300	388,300	237,400	413,800
OEM/Integrator	298,587	524,252	348,932	622,655	406,500	714,500	455,100	784,400	483,000	830,000
TOTAL U.S. SHIPMENTS	606,161	1,268,991	753,369	1,514,440	874,400	1,739,500	989,300	1,935,800	1,076,700	2,099,300
Non-U.S. Manufacturers										
Captive	--	2,500	--	3,500	--	4,100	400	4,400	700	4,600
Distributor	4,404	15,525	7,940	22,560	10,400	28,600	12,300	32,900	13,500	35,600
OEM/Integrator	6,081	15,017	9,460	23,280	12,800	30,600	15,800	36,350	19,300	42,700
TOTAL NON-U.S. SHIPMENTS	10,485	33,042	17,400	49,340	23,200	63,300	28,500	73,650	33,500	82,900
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	616,646	1,302,033	770,769	1,563,780	897,600	1,802,800	1,017,800	2,009,450	1,110,200	2,182,200
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	2,431	4,235	3,202	5,799	4,100	7,602	5,117	9,611	6,228	11,794

TABLE 18

NETWORK/MIDRANGE SYSTEMS

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1998 Revenues			Forecast											
				1999			2000			2001			2002		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	5,984.8	20.2	63.0	6,797.8	21.3	30.0	7,697.1	23.2	18.0	8,601.0	25.0	12.8	9,413.3	26.7	9.7
Distributor	1,312.9	150.1	11.0	2,456.2	177.3	13.3	3,481.8	231.0	16.9	4,440.0	241.4	15.3	4,998.4	244.9	14.9
OEM/Integrator	1,077.7	355.7	37.1	1,173.0	367.9	54.0	1,526.4	336.8	62.5	1,778.3	321.3	65.6	1,939.2	316.3	59.9
TOTAL U.S. REVENUES	8,375.4	526.0	111.1	10,427.0	566.5	97.3	12,705.3	591.0	97.4	14,819.3	587.7	93.7	16,350.9	587.9	84.5
NON-U.S. MANUFACTURERS															
Captive	100.7	--	--	122.3	--	--	135.3	--	--	138.2	--	--	138.5	--	--
Distributor	62.3	12.6	1.6	70.1	18.8	1.6	79.6	19.7	1.9	85.3	21.3	2.0	93.0	21.9	1.9
OEM/Integrator	6.7	11.4	2.6	11.2	16.3	2.6	16.5	22.5	1.6	20.3	23.4	1.3	25.0	26.5	1.1
TOTAL NON-U.S. REVENUES	169.7	24.0	4.2	203.6	35.1	4.2	231.4	42.2	3.5	243.8	44.7	3.3	256.5	48.4	3.0
WORLDWIDE RECAP															
Captive	6,085.5	20.2	63.0	6,920.1	21.3	30.0	7,832.4	23.2	18.0	8,739.2	25.0	12.8	9,551.8	26.7	9.7
	+11.3%	+8.0%	-30.7%	+13.7%	+5.4%	-52.4%	+13.2%	+8.9%	-40.0%	+11.6%	+7.8%	-28.9%	+9.3%	+6.8%	-24.2%
Distributor	1,375.2	162.7	12.6	2,526.3	196.1	14.9	3,561.4	250.7	18.8	4,525.3	262.7	17.3	5,091.4	266.8	16.8
	+46.7%	+66.4%	-53.0%	+83.7%	+20.5%	+18.3%	+41.0%	+27.8%	+26.2%	+27.1%	+4.8%	-8.0%	+12.5%	+1.6%	-2.9%
OEM/Integrator	1,084.4	367.1	39.7	1,184.2	384.2	56.6	1,542.9	359.3	64.1	1,798.6	344.7	66.9	1,964.2	342.8	61.0
	+18.0%	+40.4%	+74.1%	+9.2%	+4.7%	+42.6%	+30.3%	-6.5%	+13.3%	+16.6%	-4.1%	+4.4%	+9.2%	-.6%	-8.8%
Total Revenues	8,545.1	550.0	115.3	10,630.6	601.6	101.5	12,936.7	633.2	100.9	15,063.1	632.4	97.0	16,607.4	636.3	87.5
	+16.6%	+45.5%	-17.9%	+24.4%	+9.4%	-12.0%	+21.7%	+5.3%	-.6%	+16.4%	--	-3.9%	+10.3%	+.6%	-9.8%
ANNUAL SHARE, BY TYPE	92.9%	6.0%	1.1%	93.9%	5.3%	.8%	94.7%	4.6%	.7%	95.5%	4.0%	.5%	95.9%	3.7%	.4%

TABLE 19

NETWORK/MIDRANGE SYSTEMS

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1998 Shipments			Forecast 1999			2000			2001			2002		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	501,500	19,200	9,000	573,600	21,500	5,000	651,200	23,900	3,400	734,500	26,000	2,600	825,000	28,400	2,100
Distributor	21,404	178,835	14,800	39,285	237,900	14,500	56,800	275,000	14,700	75,000	298,000	15,300	88,000	310,000	15,800
OEM/Integrator	23,112	419,940	81,200	32,855	489,100	100,700	44,500	552,000	118,000	55,400	595,000	134,000	64,000	620,000	146,000
TOTAL U.S. SHIPMENTS	546,016	617,975	105,000	645,740	748,500	120,200	752,500	850,900	136,100	864,900	919,000	151,900	977,000	958,400	163,900
NON-U.S. MANUFACTURERS															
Captive	2,500	--	--	3,500	--	--	4,100	--	--	4,400	--	--	4,600	--	--
Distributor	2,990	11,435	1,100	3,630	17,430	1,500	4,400	22,400	1,800	4,900	26,000	2,000	5,500	28,000	2,100
OEM/Integrator	400	12,917	1,700	1,100	20,380	1,800	1,500	27,500	1,600	1,900	33,000	1,450	2,400	39,000	1,300
TOTAL NON-U.S. SHIPMENTS	5,890	24,352	2,800	8,230	37,810	3,300	10,000	49,900	3,400	11,200	59,000	3,450	12,500	67,000	3,400
WORLDWIDE RECAP															
Captive	504,000 +14.2%	19,200 +10.8%	9,000 -24.4%	577,100 +14.5%	21,500 +12.0%	5,000 -44.4%	655,300 +13.6%	23,900 +11.2%	3,400 -32.0%	738,900 +12.8%	26,000 +8.8%	2,600 -23.5%	829,600 +12.3%	28,400 +9.2%	2,100 -19.2%
Distributor	24,394 +40.6%	190,270 +95.8%	15,900 +78.1%	42,915 +75.9%	255,330 +34.2%	16,000 +.6%	61,200 +42.6%	297,400 +16.5%	16,500 +3.1%	79,900 +30.6%	324,000 +8.9%	17,300 +4.8%	93,500 +17.0%	338,000 +4.3%	17,900 +3.5%
OEM/Integrator	23,512 -1.8%	432,857 +25.7%	82,900 +55.6%	33,955 +44.4%	509,480 +17.7%	102,500 +23.6%	46,000 +35.5%	579,500 +13.7%	119,600 +16.7%	57,300 +24.6%	628,000 +8.4%	135,450 +13.3%	66,400 +15.9%	659,000 +4.9%	147,300 +8.7%
Total Shipments	551,906 +14.3%	642,327 +40.0%	107,800 +45.5%	653,970 +18.5%	786,310 +22.4%	123,500 +14.6%	762,500 +16.6%	900,800 +14.6%	139,500 +13.0%	876,100 +14.9%	978,000 +8.6%	155,350 +11.4%	989,500 +12.9%	1,025,400 +4.8%	167,300 +7.7%
ANNUAL SHARE, BY TYPE	42.5%	49.3%	8.2%	41.9%	50.3%	7.8%	42.4%	50.0%	7.6%	43.7%	48.7%	7.6%	45.4%	47.0%	7.6%

TABLE 20

NETWORK/MIDRANGE SYSTEMS

WORLDWIDE PRICE PER UNIT ($)

ARRAY TYPE		Forecast			
	1998	1999	2000	2001	2002
Captive					
Subsystems	12,074	11,991	11,952	11,827	11,513
Boards	1,050	990	970	960	940
Software	7,000	6,000	5,300	4,900	4,600
Captive Average	11,590	11,549	11,534	11,435	11,147
Distributor					
Subsystems	56,372	58,866	58,194	56,636	54,452
Boards	855	768	843	810	789
Software	787	932	1,139	997	937
Distributor Average	6,724	8,710	10,213	11,408	11,960
OEM/Integrator					
Subsystems	46,122	34,873	33,540	31,390	29,580
Boards	848	754	619	548	520
Software	479	550	536	494	413
OEM/Integrator Average	2,765	2,515	2,638	2,693	2,713

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

NETWORK/MIDRANGE SYSTEMS

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1998 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
American Megatrends	--	156,000	--	156,000	36.4	--	258,000	--	258,000	33.5
Mylex	--	74,000	--	74,000	17.3	--	203,500	--	203,500	26.4
Veritas Software	--	--	48,200	48,200	11.3	--	--	64,500	64,500	8.4
DPT	800	31,000	--	31,800	7.4	1,500	55,000	--	56,500	7.3
Adaptec	--	18,900	--	18,900	4.4	--	42,100	--	42,100	5.5
Softraid	--	--	21,000	21,000	4.9	--	--	24,000	24,000	3.1
LSI Logic	4,540	17,900	--	22,440	5.2	4,540	17,900	--	22,440	2.9
Data General	13,700	--	--	13,700	3.2	18,300	--	--	18,300	2.4
Infortrend	--	6,600	--	6,600	1.5	--	16,500	--	16,500	2.1
Other U.S.	12,306	12,995	6,450	31,751	7.5	20,176	22,275	7,500	49,951	6.6
Other Non-U.S.	730	1,455	1,700	3,885	.9	3,390	7,852	2,800	14,042	1.8
TOTAL	32,076	318,850	77,350	428,276	100.0	47,906	623,127	98,800	769,833	100.0

ARRAYS: MAINFRAME SYSTEMS

1999 DISK/TREND REPORT

ARRAYS: MAINFRAME SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Amdahl	Spectris series
Cambex	Cascade 3X
Commercial Data Servers	CDS2000
Comparex	TETRAGON 2100
EMC	Symmetrix series
Fujitsu	F6495
Hitachi	A-6593/A-6596
Hitachi Data Systems	7700E
IBM	2105 ESS, Multiprise 3000

Each of the disk drive arrays included in this product group are intended primarily for use with mainframe computer systems, or are physically integrated into the same housing as the mainframe computer. 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 disk drive array offered in the mainframe market was a pioneering RAID-3 subsystem introduced by Control Data Systems in 1989, which is 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 1994, under the recycled RAMAC brand name. The RAMAC 1 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 2, which started shipments in October, 1995, but the 3990-6 could still handle only 180 gigabytes, limiting each controller to only one RAMAC 2 frame of 64 drives. RAMAC 3, 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.

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. In 1999, IBM is still selling the STK Iceberg series, but the agreement is being phased out, and STK is reentering the mainframe array market with similar products.

In 1997 IBM introduced a new variable in the mainframe disk array contest with the Multiprise 2000, a small mainframe family with RAID-1 disk storage incorporated in the same cabinet with the computer. The Multiprise 3000, using RAID-5 disk storage, followed in 1999. Obviously, IBM's plug compatible competitors find it difficult to compete against built-in disk arrays, and the company's future development of this product feature will continue to provide an interesting competitive challenge.

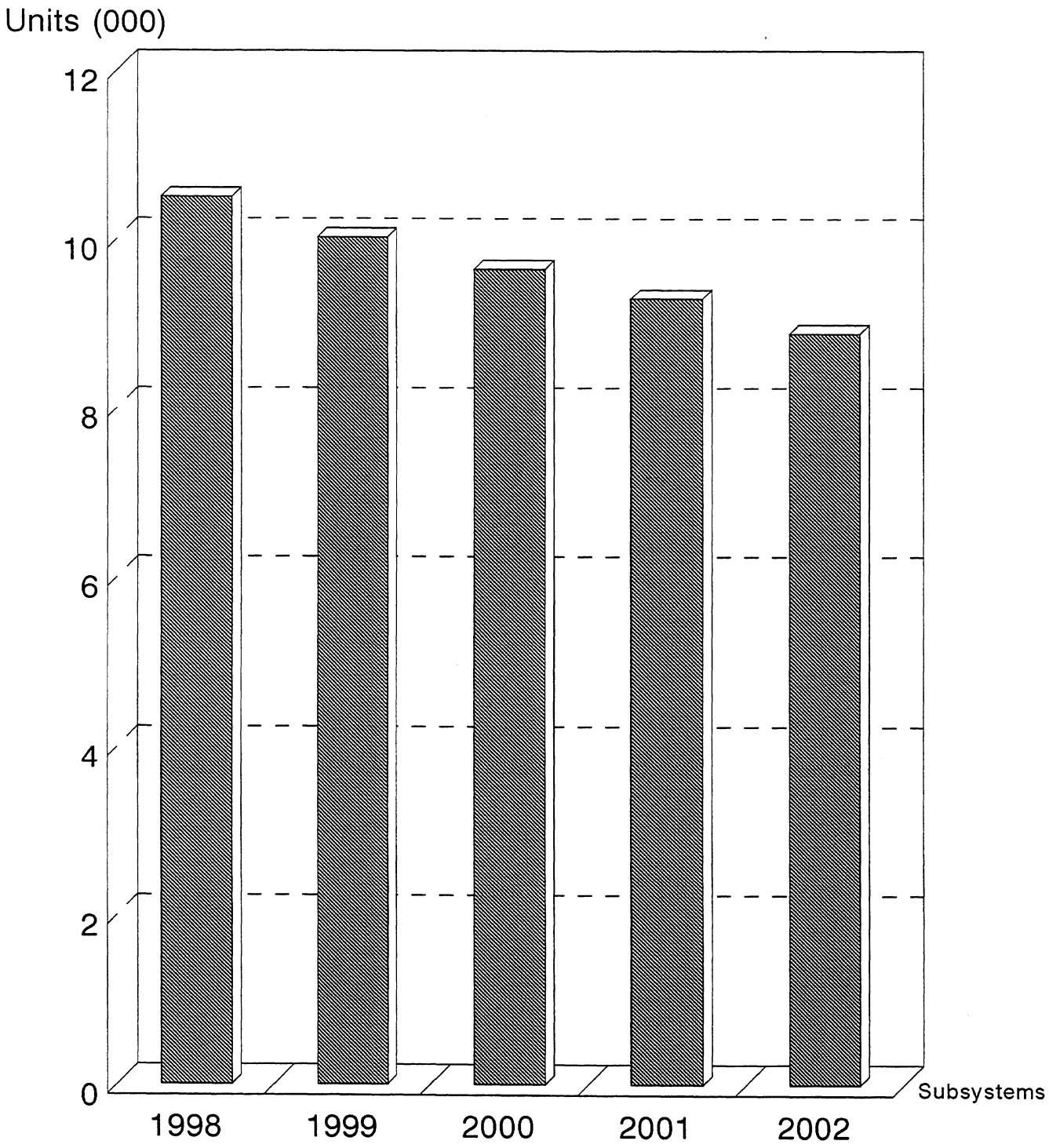
Market status

Despite predictions by many observers that the market for mainframe storage was destined to drop drastically by the end of this decade, the market has followed a different pattern. Although the number of disk drive array units has started to decline, the rapid increase in the capacity of disk drives used in mainframe arrays has resulted in an increase in the total new array capacity in-

Figure 8

Mainframe System Arrays

Worldwide Shipments by Array Type



stalled each year. Unfortunately for array subsystem manufacturers, sales revenues have peaked, following the pattern for unit shipments.

The product group's sales revenues were down again in 1998, at $3.2 billion, a decline of 9.4%, and the DISK/TREND forecast for 1999 reflects a slight decline of 3.0%, to $3.1 billion. Mainframe array unit shipments for 1998 were also down, although the percentage difference is not meaningful, due to a change in the way DISK/TREND shipment statistics count mainframe array units shipped by some manufacturers. 1998 shipments totaled 10,490 array units, and 9,915 units are expected in 1999, down 5.5%. 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. It should be noted that while many disk storage subsystems shipped to date have the capability to operate in either RAID-1 or RAID-5 modes 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.

The competitive structure of the mainframe storage market was changed during the 1990's as the result of the development of cost-effective array subsystems using small disk drives by independent manufacturers, combined with IBM's late response. 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 noncaptive sales levels achieved in this product group, supplemented by Storage Technology's Iceberg starting in 1994, and Hitachi's sales of mainframe subsystems. Array sales by independent manufacturers direct to users or through resellers are included in the DISK/TREND statistics for the "Distributor" sales channel, with almost $1.6 billion in 1998 sales, and forecasted to increase slightly to almost $1.7 billion in 1999.

Changing business relationships between manufacturers participating in this product group have been responsible for several revisions in the statistics for individual sales channels. When IBM took over sales for some STK products in 1996, DISK/TREND statistics credited those shipments to IBM, but that's changing in 1999, as STK again assumes sales responsibility. DISK/TREND shipment data credited Storage Technology, and the distribution sales channel, for sales of the company's mainframe arrays through the period ending in June, 1996, but

IBM's sales of the same products starting in July, 1996, were considered IBM captive sales, with Storage Technology acting as a contract manufacturer. EMC's loss of OEM sales to Hewlett-Packard, and H-P's switch to Hitachi arrays, has caused U.S. OEM shipments to drop while non-U.S. shipments increase.

In 1998, EMC retained its leadership in noncaptive mainframe disk drive array shipments, with 54.6% of the worldwide total. EMC's sales leadership is an impressive achievement, since the company's average sale price continues to be significantly higher than its competitors. Hitachi noncaptive mainframe disk drive arrays, including those resold by Hitachi Data Systems, Comparex and Olivetti, placed second with 38.5%.

Marketing trends

During the next few years covered by this forecast, the overall demand for mainframe disk storage is expected to continue increasing, driven by growth in traditional applications, and enhanced by data warehousing, worldwide networking and other new applications. Although much of the work previously accomplished by mainframe systems is now being assigned to "client/server" networks, the current market for new mainframe systems is strong and new disk drive capacity consumed by this market, as measured in terabytes shipped, is higher than in recent years.

However, the incessant annual boosts in disk drive areal density are expected to provide more disk capacity than the market demands, with the result that further declines in both array unit shipments and sales revenues are forecasted through 2002. Total unit shipments are projected to decline to 8,875 subsystems in 2002, a modest average annual decline during the 1998-2001 period of 3.6%. Worldwide sales revenues are forecasted to drop somewhat faster during the same period, an average annual decline of 8.7%, due to rapid drops in disk drive average price per megabyte combined with declining shipments.

Noncaptive sales channels are expected to fare somewhat better in mainframe array unit shipments and sales revenues than the captive market during the next few years, especially in the case of OEM/Integrator shipments, which are expected to maintain growth through 2002, although starting from a small base.

Technical trends

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. 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. 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. IBM has announced a few of the pieces to the puzzle each year, but many details of the architecture and most of the products needed to complete the picture are still to come. IBM finally offered a major part of the storage requirement with the 1999 announcement of a new model of the 2105 Enterprise Storage Server, offering a RAID-5 capacity of up to 11.2 terabytes.

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 the Multiprise 2000 mainframe computer family with disk storage embedded in the computer frame, followed by the Multiprise 3000 in 1999, establishing a potential pattern 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.

Forecasting assumptions

1. IBM will continue to phase into new storage architecture for mainframe computers and open systems during this forecast period, and will continue to introduce new disk drive array storage subsystems optimized for mainframe usage at approximately one year intervals.

2. Manufacturers of plug compatible mainframe arrays will maintain aggressive product development and market introduction schedules, utilizing continually improved array architectures and higher disk drive capacities.

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

MAINFRAME SYSTEMS

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1998		Forecast							
	Revenues		1999		2000		2001		2002	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	628.9	1,209.0	614.3	1,151.4	566.3	1,070.2	500.2	945.7	446.0	842.2
Distributor	550.5	1,009.0	648.0	1,049.0	569.1	1,016.4	503.7	915.3	445.9	811.7
OEM/Integrator	66.3	196.7	20.3	55.4	21.1	59.7	22.1	62.9	23.0	64.1
TOTAL U.S. REVENUES	1,245.7	2,414.7	1,282.6	2,255.8	1,156.5	2,146.3	1,026.0	1,923.9	914.9	1,718.0
Non-U.S. Manufacturers										
Captive	--	178.0	--	142.3	--	130.3	--	118.6	--	107.0
Distributor	229.6	561.8	213.3	525.8	201.4	502.9	187.0	468.6	166.0	414.1
OEM/Integrator	--	66.5	18.9	89.4	40.0	112.3	51.2	127.9	57.7	135.9
TOTAL NON-U.S. REVENUES	229.6	806.3	232.2	757.5	241.4	745.5	238.2	715.1	223.7	657.0
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,475.3	3,221.0	1,514.8	3,013.3	1,397.9	2,891.8	1,264.2	2,639.0	1,138.6	2,375.0

TABLE 23

MAINFRAME SYSTEMS

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1998 Shipments		Forecast 1999		2000		2001		2002	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	1,935	3,720	1,950	3,655	1,815	3,430	1,690	3,195	1,565	2,955
Distributor	1,525	2,795	1,600	2,590	1,355	2,420	1,285	2,335	1,225	2,230
OEM/Integrator	150	445	55	150	60	170	65	185	70	195
TOTAL U.S. SHIPMENTS	3,610	6,960	3,605	6,395	3,230	6,020	3,040	5,715	2,860	5,380
Non-U.S. Manufacturers										
Captive	--	840	--	770	--	720	--	670	--	615
Distributor	915	2,340	915	2,330	895	2,235	850	2,130	810	2,020
OEM/Integrator	--	350	110	520	235	660	310	775	365	860
TOTAL NON-U.S. SHIPMENTS	915	3,530	1,025	3,620	1,130	3,615	1,160	3,575	1,175	3,495
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	4,525	10,490	4,630	10,015	4,360	9,635	4,200	9,290	4,035	8,875
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	30	53	35	63	39	73	43	82	47	91

TABLE 24

MAINFRAME SYSTEMS

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1998 Revenues Subsys.	Forecast 1999 Subsys.	2000 Subsys.	2001 Subsys.	2002 Subsys.
U.S. MANUFACTURERS					
Captive	1,209.0	1,151.4	1,070.2	945.7	842.2
Distributor	1,009.0	1,049.0	1,016.4	915.3	811.7
OEM/Integrator	196.7	55.4	59.7	62.9	64.1
TOTAL U.S. REVENUES	2,414.7	2,255.8	2,146.3	1,923.9	1,718.0
NON-U.S. MANUFACTURERS					
Captive	178.0	142.3	130.3	118.6	107.0
Distributor	561.8	525.8	502.9	468.6	414.1
OEM/Integrator	66.5	89.4	112.3	127.9	135.9
TOTAL NON-U.S. REVENUES	806.3	757.5	745.5	715.1	657.0
WORLDWIDE RECAP					
Captive	1,387.0 -22.8%	1,293.7 -6.7%	1,200.5 -7.2%	1,064.3 -11.3%	949.2 -10.8%
Distributor	1,570.8 -7.7%	1,574.8 +.3%	1,519.3 -3.5%	1,383.9 -8.9%	1,225.8 -11.4%
OEM/Integrator	263.2 +352.2%	144.8 -45.0%	172.0 +18.8%	190.8 +10.9%	200.0 +4.8%
Total Revenues	3,221.0 -9.4%	3,013.3 -6.4%	2,891.8 -4.0%	2,639.0 -8.7%	2,375.0 -10.0%
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 25

MAINFRAME SYSTEMS

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1998 Shipments Subsys.	Forecast 1999 Subsys.	2000 Subsys.	2001 Subsys.	2002 Subsys.
U.S. MANUFACTURERS					
Captive	3,720	3,655	3,430	3,195	2,955
Distributor	2,795	2,590	2,420	2,335	2,230
OEM/Integrator	445	150	170	185	195
TOTAL U.S. SHIPMENTS	6,960	6,395	6,020	5,715	5,380
NON-U.S. MANUFACTURERS					
Captive	840	770	720	670	615
Distributor	2,340	2,330	2,235	2,130	2,020
OEM/Integrator	350	520	660	775	860
TOTAL NON-U.S. SHIPMENTS	3,530	3,620	3,615	3,575	3,495
WORLDWIDE RECAP					
Captive	4,560 -32.5%	4,425 -3.0%	4,150 -6.2%	3,865 -6.9%	3,570 -7.6%
Distributor	5,135 +5.3%	4,920 -4.2%	4,655 -5.4%	4,465 -4.1%	4,250 -4.8%
OEM/Integrator	795 +111.4%	670 -15.7%	830 +23.9%	960 +15.7%	1,055 +9.9%
Total Shipments	10,490 -12.7%	10,015 -4.5%	9,635 -3.8%	9,290 -3.6%	8,875 -4.5%
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 26

MAINFRAME SYSTEMS

WORLDWIDE PRICE PER UNIT ($)

ARRAY TYPE	1998	Forecast 1999	2000	2001	2002
Captive					
Subsystems	304,166	292,344	289,272	275,371	265,878
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	304,166	292,344	289,272	275,371	265,878
Distributor					
Subsystems	305,903	320,071	326,374	309,948	288,428
Boards	--	--	--	--	--
Software	--	--	--	--	--
Distributor Average	305,903	320,071	326,374	309,948	288,428
OEM/Integrator					
Subsystems	331,056	216,104	207,072	198,723	189,606
Boards	--	--	--	--	--
Software	--	--	--	--	--
OEM/Integrator Average	331,056	216,104	207,072	198,723	189,606

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

MAINFRAME SYSTEMS

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1998 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
EMC	1,675	--	--	1,675	64.7	3,240	--	--	3,240	54.6
Hitachi	685	--	--	685	26.4	2,280	--	--	2,280	38.5
Other U.S.	--	--	--	--	--	--	--	--	--	--
Other Non-U.S.	230	--	--	230	8.9	410	--	--	410	6.9
TOTAL	2,590	--	--	2,590	100.0	5,930	--	--	5,930	100.0

ARRAYS: SPECIALIZED HIGH PERFORMANCE SYSTEMS

1999 DISK/TREND REPORT

ARRAYS:
SPECIALIZED HIGH PERFORMANCE SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Ciprico	6500, 7000 series, SANITY
DataDirect Networks	EV-1000, EV-5000
SGI	Cray FCN-2
Storage Concepts	C814F, Express

Software arrays

Leitch Technology (ASC)	RAIDsoft

Although arrays in this product group, previously known as "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.

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, in recent years, the applications have diversified, with continuing growth in video, engineering, geophysical exploration and medical systems markets.

In addition to arrays for supercomputer applications, independent manufacturers offer RAID-3 and RAID-5 subsystems, which are sold on a noncaptive basis to manufacturers of specialized 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 specialized high performance arrays into a separate product group in future years.

Market status

Unit shipments for specialized high performance arrays were down slightly in 1998, as expected, due largely to the cyclical nature of the show business markets for some of the equipment in this product group. Equipment sold for video post production and movie special effects created a large portion of the product group's shipment growth in recent years, but a wave of popularity for human actors occurred in 1998, softening the market for specialized high performance arrays. The product group's sales revenue total actually increased 11.1% in 1998, to $108 million due to subsystem upgrades. In 1999, the situation is changing again, with overall unit shipments forecasted to be flat, and sales revenues dropping 17.5%, to $89.1 million. Demand in most application areas is growing in 1999, but the market with supercomputers is softening, reducing the forecast for array subsystems with very high average unit prices and lowering the expected overall sales revenue total.

Demand remains strong in a diverse group of applications, including video servers, multimedia content development, medical equipment, various imaging systems, and geophysical exploration image and data analysis. These applications are providing growth for both distributor and OEM shipments in 1999, offsetting the expected decline in supercomputer arrays, sold through captive sales channels.

Ciprico continued to lead in noncaptive unit shipments in 1998, with 54.3% of the worldwide total, composed entirely of subsystems. Storage Concepts held second place, with 22.4%.

Marketing trends

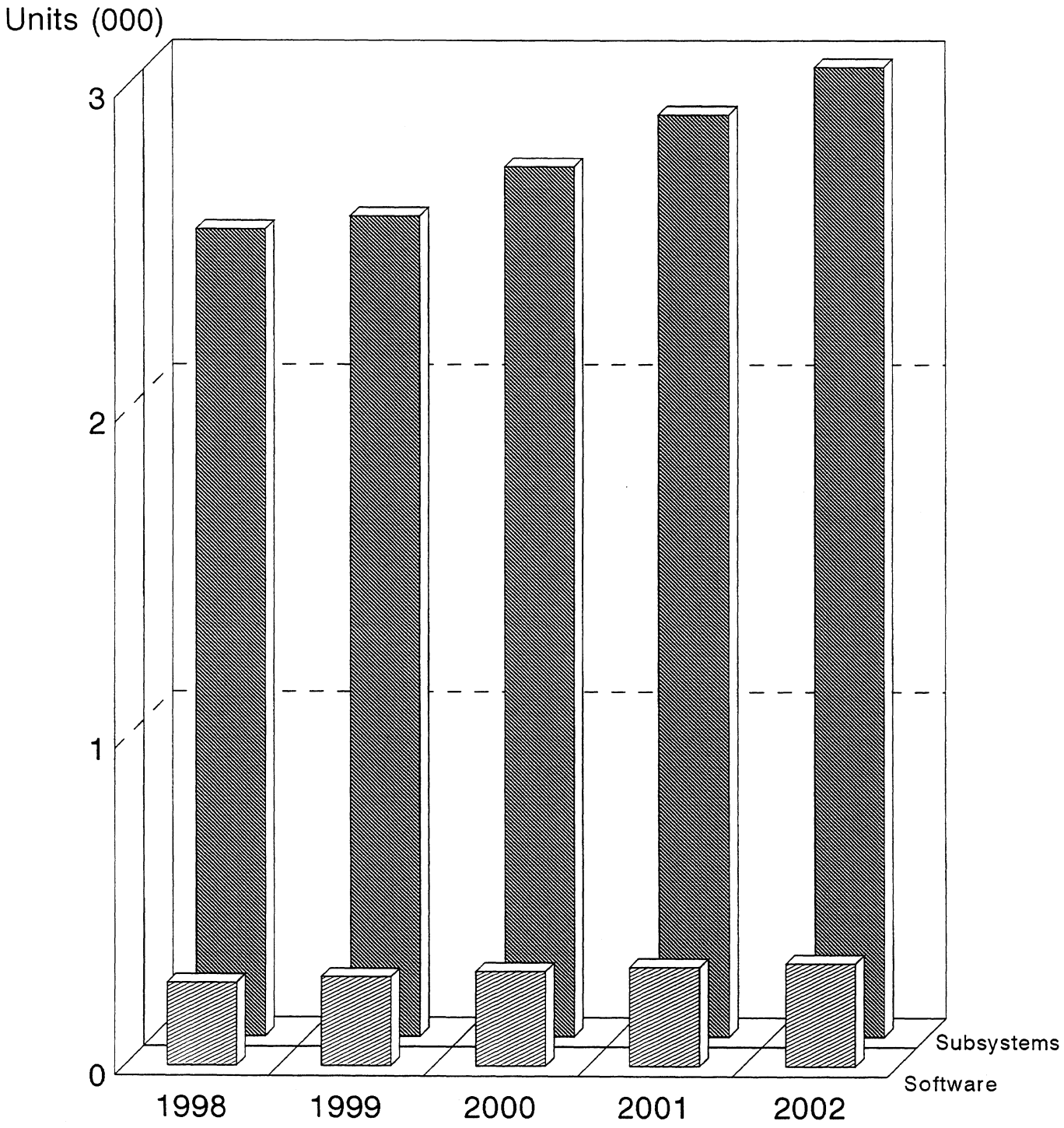
Total annual shipments are forecasted to increase an average of 5.7% per year during the 2000-2002 period, reaching almost 3.3 thousand units in 2002. It will be a different picture for sales revenues, as the total is impacted by declining shipments of captive arrays for the supercomputer market. The sales revenue total for 2002 is projected at $83.7 million, an average annual 2000-2002 decline of 2.0%.

The changing nature of the supercomputer market is forecasted to reduce shipments of specialized high performance arrays for that application, but the

Figure 9

Specialized High Performance System Arrays

Worldwide Shipments by Array Type



sales opportunities 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 2002 array unit shipments.

The distributor channel continues to generate shipments at significantly higher totals than the OEM/Integrator channel, as independent producers of array subsystems explore specialized array markets. In many applications, independent storage subsystem companies have been able to develop specialized array markets more cost-effectively than major system manufacturers, which are frequently slow to devote the resources required to establish a strong position in smaller markets with unique functional requirements.

The complete subsystems which now provide most of the specialized 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 cause some of the specialized subsystems in this product group to be displaced, but there is still uncertainty as to the timetables for general availability, product features and actual suitability for specific high performance applications.

Technical trends

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 appropriately designed RAID-5 arrays cannot provide the higher transfer rates needed by very high performance systems.

In all segments of the disk drive array business, the objectives of product development programs usually target higher performance, increased versatility and lower cost. 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. It is believed that most of the improvements in arrays used with very high performance systems through 2001 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.

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

SPECIALIZED HIGH PERFORMANCE SYSTEMS

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1998		Forecast							
	Revenues		1999		2000		2001		2002	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	11.7	23.4	11.6	16.1	9.2	12.8	6.4	9.3	4.3	6.5
Distributor	41.7	63.4	36.9	57.3	38.6	59.7	40.0	62.0	40.6	62.9
OEM/Integrator	11.8	18.4	8.4	13.5	8.1	13.2	8.5	13.3	8.9	13.5
TOTAL U.S. REVENUES	65.2	105.2	56.9	86.9	55.9	85.7	54.9	84.6	53.8	82.9
Non-U.S. Manufacturers										
Captive	--	1.6	--	2.2	--	1.8	--	1.2	--	.8
TOTAL NON-U.S. REVENUES	--	1.6	--	2.2	--	1.8	--	1.2	--	.8
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	65.2	106.8	56.9	89.1	55.9	87.5	54.9	85.8	53.8	83.7

TABLE 29

SPECIALIZED HIGH PERFORMANCE SYSTEMS

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1998 Shipments		Forecast 1999		2000		2001		2002	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	325	650	375	520	305	425	230	335	165	250
Distributor	1,035	1,605	1,095	1,725	1,250	1,935	1,385	2,145	1,510	2,340
OEM/Integrator	265	453	312	517	353	575	404	633	450	685
TOTAL U.S. SHIPMENTS	1,625	2,708	1,782	2,762	1,908	2,935	2,019	3,113	2,125	3,275
Non-U.S. Manufacturers										
Captive	--	20	--	25	--	22	--	18	--	15
TOTAL NON-U.S. SHIPMENTS	--	20	--	25	--	22	--	18	--	15
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	1,625	2,728	1,782	2,787	1,908	2,957	2,019	3,131	2,125	3,290
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	7	10	8	13	10	16	12	19	14	22

TABLE 30

SPECIALIZED HIGH PERFORMANCE SYSTEMS

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1998 Revenues		Forecast 1999		2000		2001		2002	
	Subsys.	Software	Subsys.	Software	Subsys.	Software	Subsys.	Software	Subsys.	Software
U.S. MANUFACTURERS										
Captive	23.4	--	16.1	--	12.8	--	9.3	--	6.5	--
Distributor	55.7	7.7	49.8	7.5	52.2	7.5	54.7	7.3	55.9	7.0
OEM/Integrator	17.5	.9	12.6	.9	12.3	.9	12.4	.9	12.8	.7
TOTAL U.S. REVENUES	96.6	8.6	78.5	8.4	77.3	8.4	76.4	8.2	75.2	7.7
NON-U.S. MANUFACTURERS										
Captive	1.6	--	2.2	--	1.8	--	1.2	--	.8	--
TOTAL NON-U.S. REVENUES	1.6	--	2.2	--	1.8	--	1.2	--	.8	--
WORLDWIDE RECAP										
Captive	25.0	--	18.3	--	14.6	--	10.5	--	7.3	--
	+16.8%	--	-26.8%	--	-20.2%	--	-28.1%	--	-30.5%	--
Distributor	55.7	7.7	49.8	7.5	52.2	7.5	54.7	7.3	55.9	7.0
	+11.4%	-1.3%	-10.6%	-2.6%	+4.8%	--	+4.8%	-2.7%	+2.2%	-4.1%
OEM/Integrator	17.5	.9	12.6	.9	12.3	.9	12.4	.9	12.8	.7
	+1.2%	+28.6%	-28.0%	--	-2.4%	--	+.8%	--	+3.2%	-22.2%
Total Revenues	98.2	8.6	80.7	8.4	79.1	8.4	77.6	8.2	76.0	7.7
	+10.7%	+1.2%	-17.8%	-2.3%	-2.0%	--	-1.9%	-2.4%	-2.1%	-6.1%
ANNUAL SHARE, BY TYPE	92.0%	8.0%	90.7%	9.3%	90.5%	9.5%	90.5%	9.5%	90.9%	9.1%

TABLE 31

SPECIALIZED HIGH PERFORMANCE SYSTEMS

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1998 Shipments		Forecast							
			1999		2000		2001		2002	
	Subsys.	Software	Subsys.	Software	Subsys.	Software	Subsys.	Software	Subsys.	Software
U.S. MANUFACTURERS										
Captive	650	--	520	--	425	--	335	--	250	--
Distributor	1,385	220	1,490	235	1,685	250	1,885	260	2,070	270
OEM/Integrator	420	33	480	37	535	40	590	43	640	45
TOTAL U.S. SHIPMENTS	2,455	253	2,490	272	2,645	290	2,810	303	2,960	315
NON-U.S. MANUFACTURERS										
Captive	20	--	25	--	22	--	18	--	15	--
TOTAL NON-U.S. SHIPMENTS	20	--	25	--	22	--	18	--	15	--
WORLDWIDE RECAP										
Captive	670	--	545	--	447	--	353	--	265	--
	+13.2%	--	-18.7%	--	-18.0%	--	-21.0%	--	-24.9%	--
Distributor	1,385	220	1,490	235	1,685	250	1,885	260	2,070	270
	-17.3%	+2.3%	+7.6%	+6.8%	+13.1%	+6.4%	+11.9%	+4.0%	+9.8%	+3.8%
OEM/Integrator	420	33	480	37	535	40	590	43	640	45
	+23.5%	+32.0%	+14.3%	+12.1%	+11.5%	+8.1%	+10.3%	+7.5%	+8.5%	+4.7%
Total Shipments	2,475	253	2,515	272	2,667	290	2,828	303	2,975	315
	-5.1%	+5.4%	+1.6%	+7.5%	+6.0%	+6.6%	+6.0%	+4.5%	+5.2%	+4.0%
ANNUAL SHARE, BY TYPE	90.8%	9.2%	90.3%	9.7%	90.3%	9.7%	90.4%	9.6%	90.5%	9.5%

TABLE 32

SPECIALIZED HIGH PERFORMANCE SYSTEMS

WORLDWIDE PRICE PER UNIT ($)

ARRAY TYPE		Forecast			
	1998	1999	2000	2001	2002
Captive					
Subsystems	37,283	33,614	32,460	30,039	27,471
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	37,283	33,614	32,460	30,039	27,471
Distributor					
Subsystems	40,209	33,422	31,000	29,000	27,000
Boards	--	--	--	--	--
Software	35,000	32,000	30,000	28,000	26,000
Distributor Average	39,495	33,228	30,870	28,878	26,884
OEM/Integrator					
Subsystems	41,666	26,083	23,000	21,000	20,000
Boards	--	--	--	--	--
Software	26,000	23,000	21,000	19,000	17,000
OEM/Integrator Average	40,525	25,862	22,860	20,864	19,802

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

SPECIALIZED HIGH PERFORMANCE SYSTEMS

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1998 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
Ciprico	770	--	--	770	59.2	1,150	--	--	1,150	55.8
Storage Concepts	210	--	--	210	16.2	415	--	--	415	20.2
Other U.S.	165	--	155	320	24.6	240	--	253	493	24.0
Other Non-U.S.	--	--	--	--	--	--	--	--	--	--
TOTAL	1,145	--	155	1,300	100.0	1,805	--	253	2,058	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 plug compatible vendors, but which are manufactured by other firms. Not listed in some cases are captive arrays that 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. If a variety of drives are used, array capacity is shown as "Drive dependent".

Drives per array

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

Concurrent host channels

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

Drive channels

The number of standard bus ports available to which drives may be connected. These may be parallel, such as SCSI, or serial, such as FC-AL.

Array interface to host and drives

Interfaces that 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 redundant 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 and form factor are given. If a range of values is specified, the lowest and highest are given. An example for drive capacity, in megabytes: 9,100 – 36,400. Where manufacturers support a wide variety of drives, the drive parameters are given as "Drive dependent".

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.

1999 DISK/TREND product groups for disk drive arrays

Product groups used in the 1999 DISK/TREND Report on disk drive arrays include:

Single user systems

Networks/midrange systems

Mainframe systems

Specialized high performance systems

MANUFACTURER	3WARE	3WARE	3WARE	ACARD TECHNOLOGY	ACARD TECHNOLOGY
ARRAY MODEL	DiskSwitch 2S	DiskSwitch 4S	DiskSwitch 8S	ARS2010	AEC6820U
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Net/Midrange
MARKET	DIST, OEM	DIST, OEM	DIST, OEM	DIST, OEM	DIST, 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 & 98, Linux, Novell	PCI host NT & 98, Linux, Novell	PCI host NT & 98, Linux, Novell	SCSI host WIN,NT,Linux, NetWare,other	SCSI host WIN,NT,Linux, NetWare,other
RAID level Configured by:	0/1 Host	0/1/5 Host	0/1/5 Host	1 Preset	0/1 Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	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	2	4	8	2	14
Concurrent host channels	1	1	1	1	1
Drive channels	2	4	8	1	2
Array interface to host/net	PCI	PCI	PCI	Ultra SCSI	PCI
Drive interface	IDE	IDE	IDE	IDE/ATAPI	Ultra SCSI
Cache size (min, max: MB)	--	--	--		
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	No No No	-- -- --
Spare drive (None/Auto/Manual)	None	Auto	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 Drive dependent	132 Drive dependent	132 Drive dependent	40 33 UDMA	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	95	Drive dependent
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup	5 watts	5 watts	5 watts		
FIRST CUSTOMER SHIPMENT	4Q99	4Q99	1Q00	1998	1998
COMMENTS					

MANUFACTURER	ACARD TECHNOLOGY	ACCORDANCE SYSTEMS	ACER	ACER	ACER
ARRAY MODEL	AEC6850	ARAID99-300	Altos 1100E	Altos 330	Altos 500
DISK/TREND GROUP	Net/Midrange	Single User	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST, OEM	DIST, OEM	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware
Host platform, software environment	PCI host	IDE/ATAPI host Various	Acer NetWare, VINES, SCO UNIX	Acer NetWare, VINES, SCO UNIX	Acer NetWare, VINES, SCO UNIX
RAID level Configured by:	0/1/3/5/10/50	1 Preset	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host
RAB EDAP Classification	--	--		--	--
Array capacity (Gbytes) MIN MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	2/3	2	2/3
Maximum drives per array	75	2	7	7	7
Concurrent host channels	1	1	1	1	1
Drive channels	5	2	1, 2	1	1, 2
Array interface to host/net	PCI			PCI	PCI
Drive interface	Ultra SCSI	IDE/ATAPI	Ultra2 SCSI	Ultra SCSI	Ultra2 SCSI
Cache size (min, max: MB)	128	--	4, 128	4, 128	4, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	No No No	-- -- Yes	-- -- No	-- -- No
Spare drive (None/Auto/Manual)	Auto	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	33 33	132 80	132 40	132 80
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
ARRAY SIZE: Inches: H x W x D		3.5 x 5.75 x 8.2	17 x 8.5 x 19.5	16.25 x 7.75 x 19.25	17 x 8.5 x 19.5
POWER: Power backup	25 watts+drives	10 watts+drives None	300 watts	200 watts	250 watts
FIRST CUSTOMER SHIPMENT	3Q99	2Q99	1999	1999	1999
COMMENTS			Complete server Mylex controll. Array is option	Complete server Mylex controll. Array is option	Complete server Mylex controll. Array is option

MANUFACTURER	ACER	ADAPTEC	ADAPTEC	ADAPTEC	ADAPTEC
ARRAY MODEL	Altos 9100B	AAA-131CA2	ARO-1130CA2	AAA-131U2	AAA-132SA
DISK/TREND GROUP	Net/Midrange	Single User	Single User	Net/Midrange	Net/Midrange
MARKET	DIST	OEM	OEM	OEM, DIST	OEM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	Acer NetWare, VINES, SCO UNIX	PCI host NT workstation	PCI host NT workstation	PCI host NT,NetWare,UNIX	PCI host NetWare, NT
RAID level Configured by:	0/1/5/10 Host	0/1/10 Host	0/1/10 Host	0/1/5/10 Host	0/1/5/10 Host/Remote
RAB EDAP Classification	--				--
Array capacity (Gbytes) MIN MAX	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	15	15	15	30
Concurrent host channels	1	1	1	1	1
Drive channels	1, 2	1	1-2	1	2
Array interface to host/net	PCI	PCI	PCI	PCI	PCI
Drive interface	Ultra SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra SCSI
Cache size (min, max: MB)	4, 128	16-64	16-64	16, 64	2
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- Yes	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	133 80	133 80	132 80	133 40
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
ARRAY SIZE: Inches: H x W x D	7 x 23.2 x 23.2	4.2 x 6.93	3.36 x 7.025	.75 x 4.2 x 6.93	4.2 x 12.28
POWER: Power backup	400 watts				
FIRST CUSTOMER SHIPMENT	1999	9/98	6/98		2Q97
COMMENTS	Complete server Mylex controll. Array is option	1 Ultra2 SCSI channel.	Requires Adaptec RAID port connector and Ultra2 SCSI chips on mother board.	1 Ultra2 SCSI channel.	2 Ultra SCSI channels.

MANUFACTURER	ADAPTEC	ADAPTEC	ADAPTEC	ADAPTEC (TRILLIUM RESEARCH)	ADAPTEC (TRILLIUM RESEARCH)
ARRAY MODEL	AAA-133U2	AAC-364	ARO-1130U2	Remus Lite 1.4	Remus 1.4
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Net/Midrange
MARKET	OEM, DIST	OEM	OEM, DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Software -- Software	Software -- Software
Host platform, software environment	PCI host NT,NetWare,UNIX	PCI host NetWare, NT		Power PC, Macintosh System 7, 8	Power PC, Macintosh System 7, 8
RAID level Configured by:	0/1/5/10 Host	0/1/5/10	0/1/5/10 Host	0/1 Host	0/1/4/5 Host
RAB EDAP Classification		--		--	--
Array capacity (Gbytes) MIN MAX	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	45	60	15	15	15
Concurrent host channels	1	1	1	Host dependent	Host dependent
Drive channels	3	4	1-2	Board dependent	Board dependent
Array interface to host/net	PCI	PCI-64 bit	PCI	NuBus,SCSI,PCI	NuBus,SCSI,PCI
Drive interface	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	SCSI-3	SCSI-3
Cache size (min, max: MB)	16, 64	16, 128	2, 64	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No	N/A N/A N/A	N/A N/A N/A
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 80	266 80	132 80	Board dependent Drive dependent	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
ARRAY SIZE: Inches: H x W x D	.75 x 4.2 x 12.28		.75 x 4.2 x 6.875	N/A	N/A
POWER: Power backup		Cache battery		N/A	N/A
FIRST CUSTOMER SHIPMENT		1/99		9/96	9/96
COMMENTS	3 Ultra2 SCSI channels.	Supports SAFTE and S.M.A.R.T. 233 MHz processor.	Requires Adaptec RAID port connector and Ultra2 SCSI chips on mother board.	SCSI manager 4.3 compliant.	SCSI manager 4.3 compliant.

MANUFACTURER	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS
ARRAY MODEL	AXRA-M4300S AXRA-M8400S	AXRA-M4300A AXRA-M8400A	AXRB-M2100NS AXRB-M4000NS	AXRB-M2100NA AXRB-M4000NA	AXRD-M2100NA AXRD-M4100NA
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Single User
MARKET	DIST	DIST	DIST	DIST	DIST
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 Windows, NT, OS/2	SCSI host Windows, NT, OS/2
RAID level Configured by:	1 Preset	1 Preset	1 Preset	1 Preset	0/1 Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	4.3 8.4	4.3 8.4	2.1 4.0	2.1 4.0	 4.32/2.16
Minimum drives per array	2	2	2	2	2
Maximum drives per array	2	2	2	2	2
Concurrent host channels	1	1	1	1	1
Drive channels	2	2	2	2	2
Array interface to host/net	SCSI-2	SCSI-2	SCSI-2	SCSI-2	IDE
Drive interface	IDE	IDE	IDE	IDE	IDE
Cache size (min, max: MB)	.256	.256	.256	.256	.256
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)	10 8.3	8.3 8.3	10 8.3	8.3 8.3	8.3 8.3
DRIVES: Formatted capacity/drive(MB)	2160, 4300	2160,4300	2160, 4000	2160, 4000	2160
Nominal disk diameter (mm)	95	95	65	65	65
ARRAY SIZE: Inches: H x W x D	3.2 x 5.74 x 8.05	3.2 x 5.74 x 8.0	1.625 x 4 x 5.8	1.625 x 4 x 5.8	.9 x 4 x 5.75
POWER: Power backup	10 watts	10 watts	15 watts	15 watts	
FIRST CUSTOMER SHIPMENT	1997	1997	1997	1997	1997
COMMENTS					

MANUFACTURER	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS
ARRAY MODEL	AXRD-M2100NS AXRD-M4300NS	AXRC-G16000SD	AXRC-G25000SD	AXRR-G16000xx AXRS-G16000xx AXRS-G16003xx	AXRR-G25000xx AXRR-G25003xx
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	DIST
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 Windows, NT, OS/2	SCSI host Windows, NT, OS/2
RAID level Configured by:	0/1 Host	0/1/5 Preset	0/1/5 Preset	0/1/5 Preset	0/1/5 Preset
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	4.32/2.16	84 588	84.0 875.0	33.7 84.3	50.0 125.0
Minimum drives per array	2	6	6	3	3
Maximum drives per array	2	42	42	6	6
Concurrent host channels	1				
Drive channels	2				
Array interface to host/net	SCSI-2	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI
Drive interface	IDE		IDE	IDE	IDE
Cache size (min, max: MB)	.256	24	24	24	24
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No 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)	10 8.3	40	40 33.3	40 33.3	40 33.3
DRIVES: Formatted capacity/drive(MB)	2160	16800	25000	16800	25000
Nominal disk diameter (mm)	65	95	95	95	95
ARRAY SIZE: Inches: H x W x D	.9 x 4 x 5.75	42.6 x 22.4 x 31.5	42.6 x 22.4 x 31.5	12.2 x 7.1 x 16.9*	12.2 x 7.1 x 16.9*
POWER: Power backup		1000 watts UPS option	1000 watts UPS option	150 watts UPS option	150 watts UPS option
FIRST CUSTOMER SHIPMENT	1997				
COMMENTS				*Desktop model.	*Desktop model.

MANUFACTURER	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS
ARRAY MODEL	AXRR-G4300xx AXRR-G4303xx AXRS-G4300xx AXRS-G4303xx	AXRR-G8400xx AXRS-G8400xx AXRS-G8403xx	AXRS-J092S AXRS-J093S AXRS-J094S	AXRS-J182S AXRS-J183S AXRS-J184S	AXRS-M4300S AXRS-M8400S
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	DIST
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 Mac, NT, UNIX NetWare, Linux	SCSI host Mac, NT, UNIX NetWare, Linux	SCSI host Windows, NT, OS/2
RAID level Configured by:	0/1/5 Preset	0/1/5 Preset	0/1/5 Preset	0/1/5 Preset	0/1 Preset
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	8.5 21.3	16.8 42.1	9.1 27.3	18.2 54.0	4.3 16.8
Minimum drives per array	3	3	2	2	2
Maximum drives per array	6	6	4	4	2
Concurrent host channels					1
Drive channels					2
Array interface to host/net	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	SCSI-2
Drive interface	IDE	IDE	Ultra2 SCSI	Ultra2 SCSI	IDE
Cache size (min, max: MB)	24	24	16	16	.256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes	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)	40 33.3	40 33.3	40 40	40 40	10 8.3
DRIVES: Formatted capacity/drive(MB)	4300	8400	9100	18200	4300,8400
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	12.2 x 7.1 x 16.9*	12.2 x 7.1 x 16.9*	10.6 x 6.7 x 10.6	10.6 x 6.7 x 10.6	7.1 x 4.0 x 12.2
POWER: Power backup	150 watts UPS option	150 watts UPS option	90 watts	90 watts	100 watts
FIRST CUSTOMER SHIPMENT					
COMMENTS	*Desktop model.	*Desktop model.			

MANUFACTURER	AMAQUEST COMPUTER	AMAQUEST COMPUTER	AMAQUEST COMPUTER	AMAQUEST COMPUTER	AMAQUEST COMPUTER
ARRAY MODEL	CTL-9500	CTL-9600	DA-950	DA-951	DA-955-42
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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
RAB EDAP Classification	--	--	--	--	--
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	7	12	42
Concurrent host channels	1	1	1	1	1
Drive channels	3, 6	2			
Array interface to host/net	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, 128	4, 64	4, 64	4, 64	4, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option -- --	Option -- --	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
ARRAY SIZE: Inches: H x W x D			17.5 x 8.75 x 21.5	26.75 x 9.75 x 25.5	
POWER: Power backup	Cache battery		300 watts Cache battery	500 watts Cache battery	1200 watts Cache battery
FIRST CUSTOMER SHIPMENT	2Q97	1997	2Q97	3Q97	3Q97
COMMENTS	486 DX2-66 processor. Purchased controller.	486 DX2-66 processor. Purchased controller.	486 DX2-66 processor. Purchased controller.	486 DX2-66 processor. Purchased controller.	486 DX2-66 processor. Purchased controller.

MANUFACTURER	AMAQUEST COMPUTER	AMAQUEST COMPUTER	AMAQUEST COMPUTER	AMAQUEST COMPUTER	AMAQUEST COMPUTER
ARRAY MODEL	FT-830 TW-8XXX	Gemina II	Personal Mainframe	PM-730 PM-7200B	RM-DA150
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Board Host Hardware	Board Host Hardware	Subsystem Network Hardware	Board Host Hardware
Host platform, software environment	Ethernet NT	NT cluster	NT	Ethernet Various	SCSI host Various
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 Panel, Port
RAB EDAP Classification	--			--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent	Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2/3	2	2	2/3	2/3
Maximum drives per array	45	5	5	15	45
Concurrent host channels	1	1	1	1	1
Drive channels		3, 6	2		
Array interface to host/net	Ultra SCSI	Ultra SCSI	PCI	PCI	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	4, 32	4, 64	4, 64	4, 32	4, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Option Option Yes	No Yes Yes	No Yes 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	40 40	132 40	132 40	40 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95	95	Drive dependent	95
ARRAY SIZE: Inches: H x W x D		26.75 x 12.5 x 25.5	26.75 x 9.75 x 25.5	25 x 9 x 25.2	
POWER: Power backup	400 watts	900 watts	600 watts	300 watts	300 watts Cache battery
FIRST CUSTOMER SHIPMENT	1997	1998	1998	1997	2Q97
COMMENTS	Fault tolerant server. Purchased controller.	Complete server	Complete server	Server. Purchased controller.	486 DX2-66 processor. Purchased controller. Rack mount.

MANUFACTURER	AMDAHL	AMDAHL	AMDAHL	AMDAHL	AMDAHL
ARRAY MODEL	LVS 4600	LVS 4800	Gold Spectris	Platinum Spectris	Platinum/400
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Mainframe	Mainframe	Mainframe
MARKET	DIST	DIST	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	FC host Solaris, AIX, HP-UX, NT	FC host Solaris, AIX, HP-UX, NT	IBM S/390 MVS/ESA, M/ESA, UTS	S/390, Open Sys Various	System/390
RAID level Configured by:	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port	3 Preset	1 Preset	1 Preset
RAB EDAP Classification	FTDS+	FTDS+	FTDS+	FTDS+	
Array capacity (Gbytes) MIN MAX	36 2505	55 3006	45.4 726.4	100 1403	102.2 2960
Minimum drives per array	4	6	5	5	6
Maximum drives per array	50	60	80	80	174
Concurrent host channels	2	2	4, 16	4, 16	4, 16
Drive channels	4, 10	6	2, 4	2, 4	4, 16
Array interface to host/net	FC-AL	FC-AL	ESCON, OEMI	ESCON, OEMI	ESCON,SCSI,FC
Drive interface	Ultra SCSI	Ultra2 SCSI	SCSI-2	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	64, 128	256, 512	512, 3072	1024, 12288	1024, 12288
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 40	100 80	18 10	18 15	18 80
DRIVES: Formatted capacity/drive(MB)	9100-50100	9100-50100	2825	8510, 16700	9100-36400
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	73.5 x 25.5 x 44.5	72.3 x 26 x 45	70.9 x 21.7 x 29.5	70.9 x 21.7 x 31.0	70.9 x 21.7 x 31.0
POWER: Power backup	436-572 watts Cache battery	436-572 watts Cache battery	2.1 KVA Battery	1.73 KVA Battery	Battery
FIRST CUSTOMER SHIPMENT	3Q98	2Q99	5/97	2/98	9/99
COMMENTS		Dual AC power. Mirrored cache.			

MANUFACTURER	AMDAHL	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS
ARRAY MODEL	Silver Spectris	Express 100 466WS MegaRAID	Enterprise 1200 MRU 428 MegaRAID Ultra	Enterprise 1300 MRU 434 MegaRAID	Enterprise 1500 MegaRAID
DISK/TREND GROUP	Mainframe	Single User	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	IBM S/390 MVS/ESA, M/ESA, UTS	PC compatible NT, NW	PC compatible NetWare, DOS,NT Wind.,OS/2,UNIX	PC compatible NetWare, DOS,NT Wind.,OS/2,UNIX	PCI host NW, NT, Linux OS/2, other
RAID level Configured by:	3 Preset	0/1/5	0/1/3/5/10* Host	0/1/3/5/10* Host	0/1/3/5/10/50 Host
RAB EDAP Classification	FTDS+	--	--	--	--
Array capacity (Gbytes) MIN MAX	58.3 688	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	60	15	45	45	60
Concurrent host channels	4, 16	1	1	1	1
Drive channels	2, 4	1, 1	1, 3	1, 3	4, 6
Array interface to host/net	ESCON, OEMI	32 bit PCI	PCI	PCI	64 bit PCI
Drive interface	SCSI-2	Ultra2 LVD	Ultra SCSI	Ultra SCSI	Ultra2 LVD*
Cache size (min, max: MB)	512, 3072	16, 64	4, 128	4, 256	16, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No	-- -- --	-- -- --	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	18 10	132 80	132 40	132 40	264 80/160
DRIVES: Formatted capacity/drive(MB)	36400	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	70.9 x 21.7 x 29.5	4.2 x 6.5	4.2 x .5 x 12.3	4.2 x .5 x 12.3	4.2 x 12.3
POWER: Power backup	2.1 KVA Battery		12 watts Battery option	12 watts Battery option	BBU on-board
FIRST CUSTOMER SHIPMENT	12/97	2/99	3/96	2Q97	8/99
COMMENTS		RAID for workstation.	Uses Intel 960. *Also RAID 30 and RAID 50 modes. Flash Firmware.	Uses Intel 960. *Also RAID 30 and RAID 50 modes. Flash Firmware.	Uses Intel i960 RN. *160M option.

MANUFACTURER	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS	AMERICAN MEGATRENDS
ARRAY MODEL	Explorer 500 MegaRAID	Express 000 MR762 MegaRAID	Express 200 MR466 MegaRAID	Express 300 MegaRAID	Enterprise 1400 MR 438 MegaRAID
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Board FC Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	Fibre host Various	PCI host UNIX, NT, DOS, NetWare, other	PCI host UNIX, NT, DOS, NetWare, other	PC compatible NW, NT, Linux OS/2, other	PCI host UNIX, NT, DOS, NetWare, other
RAID level Configured by:	0/1/3/5/10/50 Host,Panel,Port	0/1/3/5/10/50	0/1/3/5/10/50	0/1/3/5/10/50 Host	0/1/3/5/10/30*
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	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	15	15	45
Concurrent host channels	2, 2	1	1	1	1
Drive channels	2, 2	1, 2	1	1, 1	1, 3
Array interface to host/net	FC-AL	PCI	PCI	32 bit PCI	PCI
Drive interface	Ultra2 LVD	Ultra SCSI	Ultra2 SCSI	Ultra2 LVD	Ultra2 LVDS
Cache size (min, max: MB)	16, 128			16, 128	8, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No	-- -- --	-- -- --	No	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 80	132 40/80	132 80	132 80	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
ARRAY SIZE: Inches: H x W x D	1.625 x 4 x 5.75	4.2 x 5.5	4.2 x 6.5	4.2 x 7.2	4.2 x 12.3
POWER: Power backup	BBU on-board				Cache battery
FIRST CUSTOMER SHIPMENT	8/99	1Q98	1Q98	7/99	1Q98
COMMENTS	i960RN based.	For RAID on motherboard.		Uses Intel i960 RM.	I20 support. *Also RAID 50 mode.

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, DIST	DIST	DIST	DIST	DIST
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
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	2 4-8	86	36	25	8
Minimum drives per array	2				
Maximum drives per array	4	24	5	8	5
Concurrent host channels	1	1	1	1	1
Drive channels	2	1, 2	1, 2	1, 2	1, 2
Array interface to host/net	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
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	ARCO COMPUTER PRODUCTS	ARCO COMPUTER PRODUCTS	ARCO COMPUTER PRODUCTS	ARCO COMPUTER PRODUCTS	ARCO COMPUTER PRODUCTS
ARRAY MODEL	DupliDisk RAIDcase	DupliDisk POS	DupliDisk Multibus	DupliDisk-ISA	DupliDisk-PCI
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Single User
MARKET	DIST	DIST	DIST	DIST	DIST
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 DOS, OS/2,UNIX, Windows, other	PC compatible DOS, OS/2,UNIX, Windows, other	PC compatible DOS, OS/2,UNIX, Windows, other	PC compatible DOS, OS/2,UNIX, NetWare,Windows	PC compatible DOS, OS/2,UNIX, NetWare,Windows
RAID level Configured by:	1 Preset	1 Preset	1 Preset	1 Preset	1 Preset
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	4	4	4	4	4
Concurrent host channels	2	2	2	1	2
Drive channels	2	2	2	2	2
Array interface to host/net	EIDE	EIDE	EIDE	EIDE, UIDE	EIDE, UIDE
Drive interface	EIDE	EIDE	EIDE	EIDE	EIDE
Cache size (min, max: MB)	--	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes No	No Yes No	No Yes 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)	Host dependent Drive dependent	Host dependent 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)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	2.2 x 3.12	2.2 x 3.12	2.2 x 3.12	3.84 x 6.32	4.0 x 4.72
POWER: Power backup	6 watts+drives	6 watts+drives	6 watts+drives	6 watts+drives None	6 watts+drives
FIRST CUSTOMER SHIPMENT	9/99	5/99	9/99	8/96	4Q97
COMMENTS					

MANUFACTURER	ARCO COMPUTER PRODUCTS	ARCO COMPUTER PRODUCTS	ARCO COMPUTER PRODUCTS	ATTO TECHNOLOGY	AUSPEX SYSTEMS
ARRAY MODEL	DupliDisk-Bay	DupliDisk-No-Slot	DupliDisk-Direct	ExpressMirror ExpressRAID	AS100 4Front
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Net/Midrange
MARKET	DIST	DIST	DIST	OEM, DIST	Captive, DIST
ARRAY CONFIGURATION: Type	Board	Board	Board	Software	Subsystem
Attachment	Host	Host	Host	--	Network
Implementation	Hardware	Hardware	Hardware	Software	Hardware
Host platform, software environment	PC compatible DOS, OS/2,UNIX, NetWare,Windows	PC compatible DOS, OS/2,UNIX, NetWare,Windows	PC compatible DOS, OS/2,UNIX, Windows, other	Macintosh Various	Auspex NT, UNIX
RAID level	1	1	1	0/1	0/1
Configured by:	Preset	Preset	Preset	Preset	Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	Drive dependent	36
MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	109
Minimum drives per array	2	2	2	2	2
Maximum drives per array	4	4	4	4	7
Concurrent host channels	2	2	2	1	1
Drive channels	2	2	2	1	
Array interface to host/net	EIDE, UIDE	EIDE, UIDE	EIDE	PCI	Ethernet
Drive interface	EIDE	EIDE	EIDE	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	--	--	--	--	
Redundancy: Controller (Yes/No)	No	No	No	--	No
Fan (Yes/No)	No	No	No	--	Yes
Power supply (Yes/No)	No	No	No	--	Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	None	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	Host dependent	Host dependent	Host dependent	133	1.2/12
drive (MB/Sec)	Drive dependent	Drive dependent	Drive dependent	40	40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	9100-18200
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	95
ARRAY SIZE: Inches: H x W x D	1 x 4 x 5.75	3.95 x 5.74	2.2 x 3.12	--	
POWER: Power backup	6 watts+drives	6 watts+drives	6 watts+drives	--	
FIRST CUSTOMER SHIPMENT	1/98	1/98	2/98	1Q97	1Q99
COMMENTS				Requires ATTO PCI host adapter.	

MANUFACTURER	AUSPEX SYSTEMS	AUSPEX SYSTEMS	AUSPEX SYSTEMS	AUSPEX SYSTEMS	AUSPEX SYSTEMS
ARRAY MODEL	AS200 4Front	NS 7000/250 NS 7000/251 NS 7000/252	NS 7000/700 NS 7000/710 NS 7000/720	NS 7000/800	NS 8000/350
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, DIST	Captive, DIST	Captive, DIST	Captive, DIST	Captive, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware
Host platform, software environment	Auspex NT, UNIX	NFS (Sun)	NFS (Sun)	NFS (Sun)	NFS (Sun)
RAID level Configured by:	0/1/5 Host	0/1/5/10	0/1/5/10	0/1/5/10	0/1/5/10
RAB EDAP Classification	--	--	--		
Array capacity (Gbytes) MIN MAX	36 291	9 382	9 1911	9.1 2050*	9.1 724*
Minimum drives per array	2	2	2	2	2
Maximum drives per array	12	42	210	203*	40*
Concurrent host channels	2	1	1-5	3, 12	6, 12
Drive channels		6	6		6
Array interface to host/net	Ethernet	VME	VME	E'net,FDDI,ATM	E'net,FDDI,ATM
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)		64, 512*	64, 1290**	32, 384	64, 384
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No No No	No No Yes	No No Yes	No No Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual		
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	1.2/12 40	10	10	20	20
DRIVES: Formatted capacity/drive(MB)	9100-18200	9100	9100	9100	9100-18000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D		28.5 x 16 x 32.5**	77 x 24 x 39.5*		
POWER: Power backup		Cache battery	Cache battery	1200 watts Cache battery	1000 watts Cache battery
FIRST CUSTOMER SHIPMENT	1Q99	3Q94	3Q96	3Q98	3Q98
COMMENTS		*Can share system cache. **Expandable. Complete server	*Expandable. **Can share system cache. Complete server	Complete server HIPPI option. *With expansion cabinet.	Complete server *With expansion cabinet.

MANUFACTURER	AUSPEX SYSTEMS	AUSPEX SYSTEMS	AVIV	AVIV	AXIS COMMUNICATIONS
ARRAY MODEL	NS 8000/850	NS2000 4Front	Eclipse II	Spitfire	NAS 100
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, DIST	Captive, DIST	DIST	DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Board Network Hardware
Host platform, software environment	NFS (Sun)	Auspex UNIX, NT	SCSI host UNIX, NetWare, Windows NT	SCSI host UNIX, NetWare, Windows NT	Ethernet NT, NetWare, UNIX, TCP/IP
RAID level Configured by:	0/1/5/10	0/1/5/7 Host	0/1/3/5/10	0/1/3/5/10	0/1/5* Port
RAB EDAP Classification		--	--	--	--
Array capacity (Gbytes) MIN MAX	9.1 5100*	54 9000	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent
Minimum drives per array	2	3	3	3	2
Maximum drives per array	203*	252	72	14	14
Concurrent host channels	6, 15	--, 36	2	1	1
Drive channels	6	9	6	2	1
Array interface to host/net	E`net,FDDI,ATM	Ethernet, FDDI	SCSI, FC-AL	SCSI	Ethernet
Drive interface	SCSI-2	Ultra SCSI	SCSI	SCSI	Ultra SCSI
Cache size (min, max: MB)	64, 384	3000 RD, 576 WR	128	16, 32	32, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	Yes Yes Yes	Yes Yes Yes	No Yes Yes	No No No
Spare drive (None/Auto/Manual)		Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20	1.2/12* 40	40 40	40 40	1.2/12 40
DRIVES: Formatted capacity/drive(MB)	9100-18000	18200-36400	9100-18400	9100-18400	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	77 x 24 x 39.5	Configuration dependent			1.7 x 5.9 x 8.2
POWER: Power backup	1200 watts Cache battery	Cache battery	Cache BBU	Cache BBU	10 watts None
FIRST CUSTOMER SHIPMENT	3Q98	3/99	4/97	1/96	4Q99
COMMENTS	Complete server *With expansion cabinet.	*Per channel Also supports FDDI, Gb Ethernet.	Pedestal or rack.	Pedestal.	*RAID 5 requires additional controller.

MANUFACTURER	BAYDEL LTD.	BAYDEL LTD.	CAMBEX	CAMBEX	CAMBEX
ARRAY MODEL	O/ESR DAR3-xxx	O/ESR DAR5-xxx	2000 FJ Centurion	2000 FM Centurion	2000 SA Centurion
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	DIST	DIST	DIST
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 UNIX, NT, other	SCSI host UNIX, NT, other	IBM, Sun, HP, NCR, Sequent, Novell, NT	IBM, Sun, HP, NCR, Sequent, Novell, NT	IBM, Sun, HP, NT
RAID level Configured by:	3 Preset	3 Preset	0/1/5 Host, Port	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port
RAB EDAP Classification	--	--			--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	21 1900	21 3600	 1900
Minimum drives per array	4 + parity	4 + parity			
Maximum drives per array	30	30	12	100	12
Concurrent host channels	1 (2 optional)	1 (2 optional)			1, 4
Drive channels	5	5			
Array interface to host/net	SCSI,SCSI-2,Ult	SCSI,SCSI-2,Ult	FC-AL	FC-AL,Ult.SCSI	SSA
Drive interface			FC-AL	Ultra SCSI	SSA
Cache size (min, max: MB)	16, 128	16, 128	16, 2048	16, 512	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Option	Option Yes Option	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20/40 10	10/20/40 10	100 100	100 40	40 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	4300-18200	4300-18200	9100, 18200
Nominal disk diameter (mm)	95	130	95	95	95
ARRAY SIZE: Inches: H x W x D	6.9 x 16.85 x 26.5	10.4 x 16.85 x 27.8	7.0 x 17.5 x 23	12.1 x 18.9 x 24	7.0 x 17.5 x 23
POWER: Power backup	240 watts Battery option	576 watts Battery option	Battery	Battery	
FIRST CUSTOMER SHIPMENT	1992	1993	7/98	7/98	11/98
COMMENTS	Rack, pedestal and tabletop options.	Rack, pedestal and tabletop options.			

MANUFACTURER	CAMBEX	CHAPARRAL NETWORK STORAGE	CHAPARRAL NETWORK STORAGE	CHAPARRAL NETWORK STORAGE	CHAPARRAL NETWORK STORAGE
ARRAY MODEL	Cascade 3X	G5312	G7313	K5412	K7413
DISK/TREND GROUP	Mainframe	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	IBM MVS, VM	SCSI host	FC-AL host	SCSI host	FC-AL host
RAID level Configured by:	0/1 Host	0/1/3/4/5/10 RS-232	0/1/3/4/5/10 RS-232	0/1/3/4/5/10 RS-232	0/1/3/4/5/10 RS-232
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	68 544/272	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	8	2	2	2	2
Maximum drives per array	64	30	45	45	45
Concurrent host channels	4	1	1	1	1
Drive channels	4	2	3	2	3
Array interface to host/net	ESCON, Parallel	Ultra2 SCSI	FC-AL	Ultra2 SCSI	FC-AL
Drive interface	SCSI-2	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)	8, 256	--, 128	--, 128	--, 128	--, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	-- -- --	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	4.5 20	80 80	100 80	80 80	100 80
DRIVES: Formatted capacity/drive(MB)	8500	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	130	Drive dependent	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	70.5 x 44 x 32	.75 x 4.25 x 9.0	.75 x 4.25 x 9.0	1.625 x 5.75 x 8.625	1.625 x 5.75 x 8.625
POWER: Power backup	1.6 KVA	Battery	Battery	Battery	Battery
FIRST CUSTOMER SHIPMENT	8/95	9/98	9/98	4/99	4/99
COMMENTS					

MANUFACTURER	CHARISMAC ENGINEERING	CHARISMAC ENGINEERING	CIPRICO	CIPRICO	CIPRICO
ARRAY MODEL	CharisMAC RAID+ v 2.0	RAID NT	6500 Series Spectra 6500	6900 Series Spectra 6900	7000 Series Spectra 7000 Halo 7000
DISK/TREND GROUP	Single User	Net/Midrange	Spec High Perf.	Spec High Perf.	Spec High Perf.
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type	Software	Software	Subsystem	Subsystem	Subsystem
Attachment	Host	Host	Host	Host	Host
Implementation	Software	Software	Hardware	Hardware	Hardware
Host platform, software environment	Macintosh Mac OS	SCSI/PCI host NT	Various	Various	PCI, SGI Various
RAID level	0/1	0/1	3	3	3
Configured by:	Host	Host	Preset	Preset	Preset
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	9	5 or 9	9
Maximum drives per array	10	10	9	9	9
Concurrent host channels	1	1	1	1	1
Drive channels	1	1	9	9	9
Array interface to host/net	NuBus,SCSI, PCI	Ult.SCSI, PCI	Ultra SCSI	Ultra SCSI	FC-AL
Drive interface	Ult.SCSI,SSA,FC	Ult.SCSI,SSA,FC	IDE	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	--	--	N/A	N/A	N/A
Redundancy: Controller (Yes/No)	--	--	No	No	No
Fan (Yes/No)	--	--	No	No	Yes
Power supply (Yes/No)	--	--	No	Yes	Yes
Spare drive (None/Auto/Manual)	None	None	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	Host dependent	Host dependent	40	40	100
drive (MB/Sec)	Drive dependent	Drive dependent	40	40	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
ARRAY SIZE: Inches: H x W x D	--	--	7 x 17 x 22	7 x 17 x 22	7 x 17 x 22
POWER:	--	--	300 watts	300 watts	300 watts
Power backup	--	--	--	--	--
FIRST CUSTOMER SHIPMENT	5/98	4Q99	9/96	6/95	9/96
COMMENTS	Supports HFS+, Extended Format.				

MANUFACTURER	CIPRICO	CIPRICO	CIPRICO	CLONE STAR SOFTWARE	CMD TECHNOLOGY
ARRAY MODEL	FibreSTORE	RaidiaNT	SANITY	REFLECT	CRA-7280 Titan
DISK/TREND GROUP	Spec High Perf.	Spec High Perf.	Spec High Perf.	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Software Host Software	Board Host Hardware
Host platform, software environment	Various	Intel, DEC, NT 4.0	NT, IRIX	PC compatible MS-DOS, NetWare	Fibre host
RAID level Configured by:	3 Preset	3 Preset	3 Preset	1 Preset	
RAB EDAP Classification	--	--	--	--	FTAC+
Array capacity (Gbytes) MIN MAX	288 1870	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent
Minimum drives per array	4	9	9	2	2
Maximum drives per array	100	9	9	2	112
Concurrent host channels		1	1	1	2
Drive channels	1, 16	9	9	--	8
Array interface to host/net	FC-AL	FC-AL	FC-AL	N/A	FC-AL
Drive interface	FC-AL	SCSI-2	SCSI-2	N/A	Ultra2 SCSI
Cache size (min, max: MB)		N/A	N/A	--	1000 max.
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	No Yes Yes	No Yes Yes	NA NA NA	Option Yes Yes
Spare drive (None/Auto/Manual)	Option	Manual	Manual	None	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 100	100 20	100 20	N/A N/A	100 80
DRIVES: Formatted capacity/drive(MB)	36400	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	Drive dependent	95
ARRAY SIZE: Inches: H x W x D	7 x 17 x 24	7 x 17 x 22	7 x 17 x 22	N/A	5.25 x 19 x 20.27
POWER: Power backup	300 watts --	300 watts --	300 watts --	N/A N/A	350 watts
FIRST CUSTOMER SHIPMENT	1/99	3Q98	4Q98	1988	3Q99
COMMENTS		Includes PCI host adapter.	Access from LAN Work Stations.		SAF-TE and SES compliant.

MANUFACTURER	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY
ARRAY MODEL	CRD-5330	CRD-5400	CRD-5440	CRD-5500	CRD-5640
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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 NetWare, NT, UNIX, other	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host
RAID level Configured by:	0/1/4/5/10 Port	0/1/4/5/10 Panel	0/1/4/5/10 Panel, Port	0/1/4/5/10 Panel, Port	0/1/4/5/10 Port
RAB EDAP Classification	--	--	--	--	--
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	14	45	120	30
Concurrent host channels	1	1	1-2	1-4	2
Drive channels	2	2	2-3	1-8	2
Array interface to host/net	Ultra SCSI	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI
Drive interface	Ultra SCSI	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	16, 128	4, 256	128	128, 512	32, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	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	20 20	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	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	1 x 3.75 x 6.25	1.7 x 5.75 x 8.25	1.7 x 5.75 x 8.6	3.25 x 5.75 x 8.1	2.25 x 5.75 x 9.25
POWER: Power backup	27 watts	75 watts	15 watts Cache battery	40 watts	15 watts
FIRST CUSTOMER SHIPMENT	3Q97	2Q95		2Q95	4Q97
COMMENTS	32 bit RISC processor.				Hot swap controller. Mirrored cache.

MANUFACTURER	CMD TECHNOLOGY	COMMERCIAL DATA SERVERS	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	CRD-5640-104	CDS2000	221 Smart Array	3100ES Smart Array	3200 Smart Array
DISK/TREND GROUP	Net/Midrange	Mainframe	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	DIST	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	SCSI host Various	CDS OS/390, VM/ESA, VSE/ESA	Compaq NT, NetWare, UNIX,OS/2,other	Compaq NT, NetWare, UNIX,OS/2,other	Compaq NT, NetWare, UNIX, OS/2
RAID level Configured by:	0/1/4/5/10	0/4/5 Panel	0/1/4/5/10	0/1/4/5 Host	0/1/4/5 Host
RAB EDAP Classification	FTAC	--	--		
Array capacity (Gbytes) MIN MAX	Drive dependent	 200	Drive dependent Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2		2	2	2
Maximum drives per array	42	22	14	18	28
Concurrent host channels	1-2	2	1	1	1
Drive channels	2-3	5	1	3	2
Array interface to host/net	Ultra SCSI	FC-AL	PCI	PCI	PCI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra2 SCSI	Ultra SCSI	Ultra2 SCSI
Cache size (min, max: MB)	32, 256*	64	6	64	64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes -- --	No Yes Yes	No No No	Duplexing -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	100 40	133 80	133 40	133 80
DRIVES: Formatted capacity/drive(MB)	Drive dependent	9100-18200	4300-18200	4300-18200	4300-36400
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
ARRAY SIZE: Inches: H x W x D	3.25 x 5.75 x 9.25	49.1 x 22.1 x 32.5			
POWER: Power backup	17 watts	 UPS, battery		Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	1Q99	1997	2/99	6/98	9/98
COMMENTS	*Mirrored.	S/390 system with integrated array.		For ProLiant 6000/7000 only. Cable-less.	

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	4200 Smart Array	4250 Smart Array	4260	RA 3000 RA 3000 RM	RA 7000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive	Captive, OEM	Captive, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Compaq NT,NetWare,OS/2 UNIX, other	Compaq NT, NetWare, OS/2, SCO UNIX	Tandem NonStop Himalaya	Digital,UNIX, NT, Open VMS	Digital,IBM,HP Sun, Intel UNIX, OVMS, NT
RAID level Configured by:	0/1/4/5/10	0/1/4/5 Host	1 Host	0/1/4/5/10	0/1/3/5
RAB EDAP Classification	--		--		--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	 382		 127.4	2.1 655
Minimum drives per array	2	2	2		1
Maximum drives per array	56	21	8	14	72
Concurrent host channels	1	1	2	2	1
Drive channels	4	3		2	6
Array interface to host/net	PCI-64 bit	64 Bit PCI	SCSI-2	Ultra SCSI	Ult.SCSI, FC-AL
Drive interface	Ultra2 SCSI	Ultra2 SCSI	SCSI-2	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	64	64	1, 128	16	64, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	With duplexing -- --	Yes Yes Yes	Option 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)	266 80	266 40	20 20	40 40	40/90 40
DRIVES: Formatted capacity/drive(MB)	4300-18200	4300-18200	4300	2100-18200	4300,9100,18000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D				22.2 x 10.0 x 19.5	35.25 x 19 x 21.25
POWER: Power backup	Cache battery	Cache battery	400 watts Dual AC	204 watts UPS	110-240 V Single phase
FIRST CUSTOMER SHIPMENT	8/99	4/99	1999		9/97
COMMENTS	64 bit RISC processor.			RM is rack mount. Purchased controller.	

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	4518	4580	4590	4609	4636
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 Software	Subsystem Host Hardware	Subsystem Host Software	Subsystem Host Software	Subsystem Host Software
Host platform, software environment	Tandem NonStop Himalaya	Tandem NonStop Himalaya	Tandem NonStop Himalaya	Tandem NonStop Himalaya	Tandem NonStop Himalaya
RAID level Configured by:	1 Host	1 Host	1 Host	1 Host	1 Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	18 72	8.8 35.2	18 72		
Minimum drives per array	2	2	2	2	2
Maximum drives per array	8	8	8	8	8
Concurrent host channels	2	2	2	2	2
Drive channels	--	--	--		
Array interface to host/net	SCSI	SCSI over fiber	SCSI	SCSI-2	SCSI-2
Drive interface	SCSI	SCSI	SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	1, 128	1, 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	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Yes	Auto	Yes	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	5 10	5 10	20 20	20 20
DRIVES: Formatted capacity/drive(MB)	18200	8800	18200	8800	36000
Nominal disk diameter (mm)	95	95	95	95	95
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	400 watts Dual AC	400 watts Dual AC	400 watts Dual AC	400 watts Dual AC	400 watts Dual AC
FIRST CUSTOMER SHIPMENT	12/97	3Q96	1/98	1999	1999
COMMENTS					

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	ESA 10000 High Capacity	ESA 10000 General Business	ESA 10000 High Bandwith	ESA 12000	ESA 12000(SCSI)
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, DIST	Captive, DIST	Captive, DIST	Captive, DIST	Captive, DIST
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	Digital, IBM, HP Sun, Intel UNIX, OVMS, NT	Digital, IBM, HP Sun, Intel UNIX, OVMS, NT	Compaq, IBM, HP UNIX, Open VMS AIX, other	UNIX, Open VMS AIX, other
RAID level Configured by:	0/1/3/5/10	0/1/3/5/10	0/1/3/5/10	0/1/3/5/10	0/1/3/5/10 Port, Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	2.1 655	2.1 431	2.1 437	Drive dependent	
Minimum drives per array	1	1	1	6	24
Maximum drives per array	72	48	48	144	48-72
Concurrent host channels	1	1	1	2	2
Drive channels	6	6	6	6	6
Array interface to host/net	Ult.SCSI, FC-AL	Ult.SCSI, FC-AL	Ult.SCSI, FC-AL	FC-AL	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	256	256	512	256-512	256-512
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)	40/90 40	40/90 40	40/90 40	100 40	40 40
DRIVES: Formatted capacity/drive(MB)	4300,9100,18000	4300,9100,18000	4300,9100,18000	4000-18000	9100-18200
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	66.9 x 23.6 x 35.4	66.9 x 23.6 x 35.4	66.9 x 23.6 x 35.4	78.75 x 23.62 x 36.1	78.75 x 23.62 x 36.1
POWER: Power backup	360 watts Battery	360 watts Battery	360 watts Battery	2.2 KVA Cache battery	2.2 KVA Cache battery
FIRST CUSTOMER SHIPMENT	9/97	9/97	9/97	1Q99	1Q99
COMMENTS	I/O intensive applications.	Mixed applications.	Bandwidth applications.	PCI HBA. Uses HSG80 controller. Rack mount.	HSZ80 controller.

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	HSG80	HSJ50	HSJ52	HSJ54	HSZ70
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, DIST	Captive	Captive	Captive	Captive, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware
Host platform, software environment	Digital, IBM, HP Sun, Intel UNIX, NT, OVMS	VAX, Alpha, VMS	VAX, Alpha, VMS	VAX, Alpha, VMS	Digital, IBM, HP Sun, Intel, UNIX, OVMS, NT
RAID level Configured by:	0/1/3/5/10	0/1/3/5	0/1/3/5	0/1/3/5	0/1/3/5/10
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent	2.1 328	4.2 328/655	8.4 655/1310	2.1 655
Minimum drives per array	2	1	2	2	1
Maximum drives per array	72	36	36/72	72/144	72
Concurrent host channels	1, 2	1, 8	1, 8	1, 8	1
Drive channels	6	6	12	24	6
Array interface to host/net	FC-AL	CI	CI	CI	Ultra SCSI
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	64, 512	32, 128	64, 256	512	64, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes (option) Yes Yes
Spare drive (None/Auto/Manual)	Auto				Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 40	12.7 10	25.4 10	50.8 10	40 40
DRIVES: Formatted capacity/drive(MB)	2100-18200	2100,4300,9100	2100,4300,9100	2100,4300,9100	2100-18200
Nominal disk diameter (mm)	95	95	95	95	95
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	
FIRST CUSTOMER SHIPMENT	2/98	3Q96	3Q96	3Q96	9/97
COMMENTS	Requires software kit. For RA 8000.		Dual HSJ50.	Dual HSJ52.	

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	KZPAC RA 230+	ProLiant 1200	ProLiant 1600	RA 4000	RA 8000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, DIST	Captive	Captive	Captive, OEM	Captive, OEM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Digital UNIX, OVMS, NT	Compaq NT, NetWare, OS/2,UNIX,other	Compaq NT, NetWare, OS/2,UNIX,other	Fibre host NT, NetWare UNIX, OS/2	Various
RAID level Configured by:	0/1/5/10	0/1/4/5 Host	0/1/4/5 Host	0/1/4/5/10	0/1/3/5/10
RAB EDAP Classification	--			--	
Array capacity (Gbytes) MIN MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	2	4	6
Maximum drives per array	7, 21	3	5	48	72
Concurrent host channels	1	1	1	2	2
Drive channels	1, 3	2	2	4	6
Array interface to host/net	PCI	EISA, PCI	EISA, PCI	FC-AL	FC-AL*
Drive interface	Ultra SCSI	Ultra SCSI-3	Ultra SCSI-3	Ultra2 SCSI	Ultra SCSI
Cache size (min, max: MB)	4, 8	16	16	64	64-512
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	With duplexing No Option	With duplexing No Option	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	33/133 40	33/133 40	100 80	100 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	4300-18200	4300-18200	9100-18200	4000-18000
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup	Cache battery	280 watts Cache battery	325 watts Cache battery	350 watts Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	1998	1998	1998	8/99	1Q99
COMMENTS		External storage option.	Rack option. External storage option.		*Ultra SCSI option. PCI HBA. Uses HSG80 controller.

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	RA4000	SMART-2DH SMART-2/E	SMART-2SL	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	Captive	Captive	OEM, DIST	OEM, DIST
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, UNIX, OS/2	Compaq NT, NetWare, OS/2, SCO UNIX	Compaq NT, NetWare, OS/2, SCO UNIX	UNIX, Windows NT	UNIX, Windows NT
RAID level Configured by:	0/1/4/5 Host	0/1/4/5 Host	0/1/5/4 Host	0/1/3/5	0/1/3/5
RAB EDAP Classification		--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	6.3 328	6.3 655, 1300*
Minimum drives per array	2	2	2	3	3
Maximum drives per array	12	7	7	36	72, 144*
Concurrent host channels	1	1	1	1, 2	1, 2
Drive channels	2	2	2	6	12
Array interface to host/net	FC-AL	EISA*, PCI	PCI	FDDI, CDDI	FDDI, CDDI
Drive interface	Ultra SCSI	Ultra SCSI-3**	Ultra SCSI-3	SCSI-2	SCSI-2
Cache size (min, max: MB)	32, 64	16 ECC	6 ECC	2, 32	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	-- -- --	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)	100 40	33/133 40	33/133 40	12 10	12 10
DRIVES: Formatted capacity/drive(MB)	2100-18200	4300-18200	4300-18200	2100,4300,9100	2100,4300,9100
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D		3.9 x 13.75 x .6	3.9 x 12.25 x .6	67 x 31 x 34.5	67 x 31 x 34.5
POWER: Power backup	350 watts Cache battery	13.5 watts+drvs Cache battery	None	800 watts	800 watts
FIRST CUSTOMER SHIPMENT	1Q98	3Q97	2Q97	2Q96	2Q96
COMMENTS		Read ahead cache. Online reconfiguration *-2/E model. **SMART-2DH.	Read cache only.	Alpha processor	*With expander. Alpha processor

MANUFACTURER	COMPAREX	COMPAREX	COMPAREX	COMPAREX	CONNEX (WESTERN DIGITAL)
ARRAY MODEL	D1400 Cabinet	D1400 RackMount	D1400-L RackMount	TETRAGON 2100	N3000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Mainframe	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware
Host platform, software environment	Open Systems UNIX, NT	Open Systems UNIX, NT	Open Systems UNIX, NT	Mainframe UNIX, NT	Various NT, UNIX
RAID level Configured by:	0/1/5/10 Port	0/1/5/10 Port	0/1/5/10 Port	1/5	5 Panel
RAB EDAP Classification	--	--	--	DTDS+	--
Array capacity (Gbytes) MIN MAX	18 358	18 536	35.7 360	18.5 6025	 90
Minimum drives per array	2	2	2	4	3
Maximum drives per array	20	30	10	232*	6
Concurrent host channels	4, 8	4, 8	4	4, 32	1, 2
Drive channels	6 Dual port	6 Dual port	1, 2	8, 32 Dual port	1
Array interface to host/net	Ultra2 SCSI, FC	Ultra2 SCSI, FC	Ultra2 SCSI, FC	IBM,FC-AL,SCSI	Ethernet
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-2	Ultra2 SCSI
Cache size (min, max: MB)	32, 2048	32, 4096	32, 512	256, 16384	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Option 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)	40/80/100 40	40/80/100 40	40/80/100 40	17, 20, 40, 100 20	 80
DRIVES: Formatted capacity/drive(MB)	17880-35760	17880-35760	17880-35760	6100-36925	18200
Nominal disk diameter (mm)	95	95	95	65, 95	95
ARRAY SIZE: Inches: H x W x D	28.0 x 15.0 x 28.6	27.6 x 19.1 x 28.0	10.3 x 19.0 x 27.8	70.5 x 51.2 x 31.5	17.9 x 8.1 x 20.5
POWER: Power backup	Battery	Battery	Battery	4.4 KVA Battery	220 watts max. UPS
FIRST CUSTOMER SHIPMENT	10/98	10/98	9/99	3/98	1/2000
COMMENTS				*Plus hot spares.	

MANUFACTURER	CONSENSYS COMPUTERS	COREL	CYBERSTORAGE SYSTEMS	CYBERSTORAGE SYSTEMS	CYBERSTORAGE SYSTEMS
ARRAY MODEL	RAIDZONE	CorelSCSI Network Manager	CyberBorg	CyberFibre	Media Server
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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, Linux	PC compatible NetWare 3.1X, Windows 3	SCSI/FC-AL host	FC-AL host	SCSI host, FC
RAID level Configured by:	0/1/5/10 Host	4/5 Host	0/1/5/53/10 On board GUI	0/1/3/5/10	3 On board GUI
RAB EDAP Classification	--	--		--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	72 34560	72 17280	27 34560
Minimum drives per array	2	3	8	8	3
Maximum drives per array	15	16	250	500	250
Concurrent host channels	1	1	2-6	1, 4	1, 6
Drive channels		Cont. dependent	6-12, 4-8	1, 8	1, 12
Array interface to host/net	PCI	SCSI-2	Ultra2 SCSI, FC	FC-AL	Ultra2 SCSI, FC
Drive interface	IDE, Ultra ATA	SCSI-2	Ultra2 SCSI, FC	FC-AL	Ultra2 SCSI, FC
Cache size (min, max: MB)	--	--	256-4000	128, 256	64, 4000
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	-- -- --	No 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)	132 33	10/20 10/20	80-100 80-100	100 100	80-100 80-100
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	9100-36400	9100-36400	9100-36400
Nominal disk diameter (mm)	95	Drive dependent	95	95	95
ARRAY SIZE: Inches: H x W x D	4.875 x 4 x 5.75	-- --	12.25 x 19 x 20.25	12.25 x 19 x 20.75	12.25 x 19 x 20.25
POWER: Power backup	77 watts	-- --	Battery	Battery	Battery
FIRST CUSTOMER SHIPMENT	1/98	1Q94*	1999	1999	1998
COMMENTS	Rack mount option.	*Shipped as Corel RAID in 3Q93.	NAS/SAN option.		

MANUFACTURER	CYBERSTORAGE SYSTEMS	CYBERSTORAGE SYSTEMS	CYBERSTORAGE SYSTEMS	CYRANEX	CYRANEX
ARRAY MODEL	Ultra 1600	Ultra 1600 PCI	Ultra 308	EZRAID Lite Version 2.11	EZRAID for Windows
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Software Host Software	Software Host Software
Host platform, software environment	SCSI host	SCSI host	SCSI/FC-AL host	PC compatible OS/2	PC compatible Windows 95, Windows 98
RAID level Configured by:	0/1/3/5/10	0/1/5/10 On board GUI	0/1/3/5/10	0/1 Host	1 Host
RAB EDAP Classification	--		--	--	--
Array capacity (Gbytes) MIN MAX	27 900	27 900	72 3600	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	3	4	2	2
Maximum drives per array	14	14	120	2	Varies
Concurrent host channels	1, 2	1	1, 4	1	1
Drive channels	2, 3	1-3	2, 6	1	1
Array interface to host/net	Ultra2 SCSI	PCI	Ultra2 SCSI, FC	Various	Various
Drive interface	Ultra2 SCSI	Ultra2 SCSI, FC	Ultra2 SCSI	Various	Various
Cache size (min, max: MB)	32, 128	32-128	64, 256	--	1, 16*
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	No Yes Yes	Option Yes Yes	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	80 80	132/264 80-100	80-100 80	Host dependent Drive dependent	Host dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	9100-4800	9100-48000	9100-48000	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D			12.25 x 19 x 20.75	--	--
POWER: Power backup	Battery	Battery	Battery	-- -	-- --
FIRST CUSTOMER SHIPMENT	1998	1999	1998	1994	4Q97
COMMENTS					Runs in RAID-1 or snapshot mirror mode. *Option.

MANUFACTURER	CYRANEX	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL
ARRAY MODEL	EZRAID Pro Version 2.11	1100 1110 CLARiiON	1300 CLARiiON	1400 1410 CLARiiON	1500 CLARiiON
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type	Software	Subsystem	Subsystem	Subsystem	Subsystem
Attachment	Host	Host	Host	Host	Host
Implementation	Software	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible OS/2	Open Systems NetWare, NT, UNIX	Open Systems NetWare, NT, UNIX	Open Systems NetWare, NT, UNIX	Open Systems NetWare, NT, UNIX
RAID level	0/1/4/5	0/1/3/5/10	0/1/3/5/10	0/1/3/5/10	0/1/3/5/10
Configured by:	Host	Host, Port	Host, Port	Host, Port	Host, Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN	Drive dependent	12.6	21	12.6	21
MAX	Drive dependent	178	178	178	178
Minimum drives per array	2	3	5	3	5
Maximum drives per array	7 per control.	10	10	10	10
Concurrent host channels	1	1, 2	2	1, 2	2
Drive channels	1	2	2	2	2
Array interface to host/net	Various	SCSI-2	SCSI-2	Ultra SCSI	Ultra SCSI
Drive interface	Various	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.03-2*	8, 64	16, 128	32, 128	64, 256
Redundancy: Controller (Yes/No)	--	Yes	Yes	Yes	Yes
Fan (Yes/No)	--	Yes	Yes	Yes	Yes
Power supply (Yes/No)	--	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	Host dependent	20/40	20/40	40/80	40/80
drive (MB/Sec)	Drive dependent	20	20	20	20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	4200,8800,17800	4200,8800,17800	4200,8800,17800	4200,8800,17800
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
ARRAY SIZE: Inches: H x W x D	--	24.8 x 10.5 x 30	24.8 x 10.5 x 30	24.8 x 10.5 x 30	24.8 x 10.5 x 30
POWER:	--	575 watts	575 watts	575 watts	575 watts
Power backup	--	Battery	Battery	Battery	Battery
FIRST CUSTOMER SHIPMENT	11/94	1/94	3/94	4/98	4/98
COMMENTS	*In driver.	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	DATA GENERAL	DATA GENERAL
ARRAY MODEL	2800 2810 CLARiiON	2900 CLARiiON	3100 3110 CLARiiON	3200 CLARiiON	3400 CLARiiON
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	12.6 356	21 356	12.6 534	21 534	12.6 534
Minimum drives per array	3	5	3	5	3
Maximum drives per array	20	20	30	30	30
Concurrent host channels	1, 2	2	1, 2	2	1, 2
Drive channels	5	5	5	5	5
Array interface to host/net	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)	32, 128	64, 256	32, 128	64, 256	32, 128
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	20/40 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
ARRAY SIZE: Inches: H x W x D	24.8 x 14 x 30	24.8 x 14 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	880 watts Battery	1150 watts Battery option	1150 watts Battery option	1150 watts Battery option
FIRST CUSTOMER SHIPMENT	6/92	3/94	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	DATA GENERAL	DATA GENERAL
ARRAY MODEL	3500 CLARiiON	FC5000 CLARiiON	FC5300 CLARiiON	FC5500 CLARiiON	FC5700 CLARiiON
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Software	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	S/W dependent Host	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	21 534	26.2 2100	26.2 1100	26.2 1800	26.2 1800
Minimum drives per array	3	3	3	3	3
Maximum drives per array	30	120	30	120	120
Concurrent host channels	2	1, 2	1, 2	1, 2	1, 2
Drive channels	5	5	2	5	
Array interface to host/net	FC-AL	FC-AL	FC AL	FC-AL	FC-AL
Drive interface	SCSI-2	FC-AL	FC AL	FC-AL	FC-AL
Cache size (min, max: MB)	64, 256	--	512	32, 1536	512
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	N/A 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)	100/200 50	200 200	100 100	200 200	100 100
DRIVES: Formatted capacity/drive(MB)	4200,8800,17800	8820-36400	8820-36400	8820-36400	8820-36400
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	18.4 x 19 x 30	6 x 17.5 x 24	26.8 x 20.6 x 29.4	11.25 x 17.5 x 27.2	26.8 x 20.6 x 29.4*
POWER: Power backup	1150 watts Battery option	400 watts	392 watts	760 watts Battery/UPS	392-4310 watts
FIRST CUSTOMER SHIPMENT	11/96	6/97	9/99	6/97	12/98
COMMENTS	Concurrent RAID levels, mirrored cache, GUI management tool.	Mirrored cache, GUI management tool, RAID status depends on software.		Concurrent RAID levels, mirrored cache, GUI management tool, dual AC.	*Rack mount available.

MANUFACTURER	DATA GENERAL	DATADIRECT NETWORKS	DATADIRECT NETWORKS	DATADIRECT NETWORKS	DATADIRECT NETWORKS
ARRAY MODEL	FC5703 CLARiiON	Aria	Enterprise LVD E-2	Enterprise LVD E-8	EV-200
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Software	Subsystem Host Software	Subsystem Host Software	Subsystem Host Hardware
Host platform, software environment	Open Systems NetWare, NT, UNIX	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	SCSI host SGI, Sun, PC, Mac, RS/6000
RAID level Configured by:	0/1/3/5/10 Host, Port	0/1/5/10 Host	0/1 Preset	0/1/5/10 Host	0/1/3/5/10 Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	26.2 540	9 144	9 400	9 400	9 750
Minimum drives per array	3	1	1	1	2
Maximum drives per array	30	8*	2	8	15
Concurrent host channels	1, 2	2	1	1	1
Drive channels			1	1	2
Array interface to host/net	FC-AL	FC-AL, other	Ultra SCSI	Ultra2 SCSI	Ultra SCSI
Drive interface	FC-AL	FC-AL, other	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	512	--	--	--	4, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	-- Yes Yes	-- -- --	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Manual	None	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 100	100-200 100-200	40 40	40-80 40	40-80 40-81
DRIVES: Formatted capacity/drive(MB)	8820-36400	9090-50000	9090-50000	9090-50000	9090-50000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	Rack: 11.25 x 17.5 x 27.2	17.3 x 7 x 14	6.5 x 7 x 11	17.3 x 7 x 14	17.3 x 7 x 14
POWER: Power backup	392-1180 watts	235 watts UPS	70 watts None	200 watts None	235 watts UPS
FIRST CUSTOMER SHIPMENT	12/98	3Q96	3Q96	3Q96	4Q97
COMMENTS	FC5603 is single controller version.	*Expand. to 126 devices/loop. Requires array software. Expand. to 144 GB tower.	Expandable to 100 GB.	Expandable rack & tower. Hardware RAID option. Upgradeable to SAN.	Numerous options. Local & remote configurations.

MANUFACTURER	DATADIRECT NETWORKS	DATADIRECT NETWORKS	DATADIRECT NETWORKS	DATAWORLD	DATAWORLD
ARRAY MODEL	EV-800	EV-1000	EV-5000	DA-2500 ESCORT	DA-300 ESCORT
DISK/TREND GROUP	Net/Midrange	Spec High Perf.	Spec High Perf.	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	DIST, OEM	DIST, OEM
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,FC-AL host SGI,Sun,RS/6000 Windows,NT,Mac	SCSI,FC-AL host SGI, Sun, PC, Mac, RS/6000	FC-AL host SGI, Sun, PC, Mac, RS/6000	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1/3/4/5/10 Host, RS-232	0/1/3/5/10 Host	0/1/3/5/10 RS-232	0/1/3/5/10 Panel, Port	0/1/3/5/10 Panel, Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	27 1200	45 920	36 4200	Drive dependent	Drive dependent
Minimum drives per array	3	5	4	2	2
Maximum drives per array	24	70	84	120	3
Concurrent host channels	1	1, 2	1, 2	1-3	1
Drive channels	3	5	6	3-6	3
Array interface to host/net	FC-AL, Ultra2	FC-AL, Ult.SCSI	FC-AL	Ultra2 SCSI	Ultra2 SCSI
Drive interface	Ultra2 SCSI	FC-AL, Ult.SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)	4-128	0, 128	16, 1024	8, 128	8, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes	No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	80-100 80-160	40-100 40-100	40-200 80-480	40/80 40/80	40/80 40/80
DRIVES: Formatted capacity/drive(MB)	9090-50000	9090-50000	9100-50000	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	17.3 x 7 x 18.3	Scalable rack	Scalable rack		
POWER: Power backup	235 watts UPS	UPS & mirrored cache battery	UPS & mirrored cache battery	300 watts Cache battery	100 watts
FIRST CUSTOMER SHIPMENT	4Q99	2Q97	7/98	1999	1999
COMMENTS	SAN enabled local & remote configurations.	Mirrored cache. Expandable to 1.8 TB. Scalable throughput to 1 GB+/second.	Mirrored cache. Fully redundant system. Scalable to 35 GB/second. Throughput.	Purchased controller.	Purchased controller.

MANUFACTURER	DATAWORLD	DATAWORLD	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER
ARRAY MODEL	DA-3500 ESCORT	DA-6000 ESCORT	2200 PowerEdge	4200 PowerEdge	4200 PERC PowerEdge
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST, OEM	DIST, 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	SCSI host Various	SCSI host Various	Dell NetWare, NT	Dell NetWare, NT	Dell NetWare, NT
RAID level Configured by:	0/1/3/5/10 Panel, Port	0/1/3/5/10 Panel, Port	0/1/5/10* Host	0/1/5/10* Host	0/1/5/10* Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent	Drive dependent	4 54.6	4 54.6	4 146
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7	120	6	6	16
Concurrent host channels	1	1-3	1	1	1
Drive channels	3	3-6		2	2
Array interface to host/net	Ultra2 SCSI	Ultra2 SCSI	PCI	PCI	PCI
Drive interface	Ultra2 SCSI	Ultra2 SCSI	SCSI-2	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	8, 128	8, 128	4, 32	4, 32 ECC	4, 32 ECC
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes	Duplex No No	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)	40/80 40/80	40/80 40/80	132 40	132 40	132 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	2100-9100**	2100-9100**	2100-9100**
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D			Varies	Varies	Varies
POWER: Power backup	300 watts Cache battery		Host dependent Cache battery	Host dependent Cache battery	Host dependent Cache battery
FIRST CUSTOMER SHIPMENT	1998	1999	1997	4Q96	4Q96
COMMENTS	Purchased controller.	Rack mount. Purchased controller.	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

MANUFACTURER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER
ARRAY MODEL	6100 PERC	PERC	PERC2	PERC2/SC	PowerEdge 1300
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	Board Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	Dell NetWare, NT	Dell NetWare, NT	Dell NT	Dell NT	Dell NT
RAID level Configured by:	0/1/5/10* Host	0/1/5/10* Host	0/1/5/10 Host	0/1/5 Host	0/1/5 Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	4 342	Drive dependent Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array		2	2	2	2
Maximum drives per array		16	60	15	8
Concurrent host channels		1	1	1	1
Drive channels			4	1	1
Array interface to host/net		PCI	PCI-64 bit	PCI	PCI
Drive interface		Ultra SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)	4, 64 ECC	4, 32 ECC	16, 128		
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Duplex Yes Option	-- -- --	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 40	264 80	132 80	132 80
DRIVES: Formatted capacity/drive(MB)	2100-9100**	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	Drive dependent	95	95	95
ARRAY SIZE: Inches: H x W x D	Varies				
POWER: Power backup	700 watts Cache battery	Host dependent Cache battery	Cache battery		
FIRST CUSTOMER SHIPMENT	1997	1996	1Q99	1Q99	1Q99
COMMENTS	AMI controller. *Also RAID 30 and RAID 50 modes. **18000 in 1H98	AMI controller. *Also RAID 30 and RAID 50 modes. For Dell systems.	Adaptec controller.	Adaptec controller.	Uses PERC2/SC controller.

MANUFACTURER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER
ARRAY MODEL	PowerEdge 4300	PowerEdge 4350	PowerEdge 6300	PowerEdge 6350	PowerEdge 2300
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	Dell NT	Dell NT	Dell NT	Dell NT	Dell NT
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host
RAB EDAP Classification	--	--	--	--	--
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
Maximum drives per array					60
Concurrent host channels	1	1	1	1	1
Drive channels	1, 4	1, 4	1, 4	1, 4	1, 4
Array interface to host/net	PCI	PCI	PCI	PCI	PCI
Drive interface	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)			64, 512	64, 512	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)					No No No
Spare drive (None/Auto/Manual)	Auto				Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 80	132 80	132 80	132 80	132 80
DRIVES: Formatted capacity/drive(MB)	18000-36000	18000-36000	18000-36000	18000-36000	18000-36000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup					
FIRST CUSTOMER SHIPMENT					
COMMENTS	Uses PERC2/SC or PERC2 controller.	Uses PERC2/SC or PERC2 controller.	Uses PERC2/SC or PERC2 controller.	Uses PERC2/SC or PERC2 controller.	Uses PERC2/SC or PERC2 controller.

MANUFACTURER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER	DELL COMPUTER
ARRAY MODEL	PowerVault 720N	PowerVault 740N	PowerVault 760N	PowerVault 650F PowerVault 651F	PowerVault 200S PowerVault 201S
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	Dell	Dell	Dell	Dell	Dell
RAID level Configured by:				1/5	0/1/5
RAB EDAP Classification	--				
Array capacity (Gbytes) MIN MAX	450	1000	1400	2000	288 2300
Minimum drives per array					8
Maximum drives per array	30	60	80		64
Concurrent host channels				2	
Drive channels					
Array interface to host/net	Ethernet*	Ethernet*	Ethernet*	FC-AL	Ultra2 SCSI
Drive interface	FC-AL	FC-AL	FC-AL	FC-AL	Ultra2 SCSI
Cache size (min, max: MB)	8	32	32		
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)	1.2/12 100	1.2/12 100	1.2/12 100	100 100	80 80
DRIVES: Formatted capacity/drive(MB)				9000-18000	9000-36000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D					5.25 x 17.55 x 17
POWER: Power backup					460 watts
FIRST CUSTOMER SHIPMENT	6/99	6/99	6/99		
COMMENTS	Network Applications array. *FDDI, ATM optional.	Network Applications array. *FDDI, ATM optional.	Network Applications array. *FDDI, ATM optional.	Clariion array.	Eurologic array. Dell controller Rack mount.

MANUFACTURER	DIGI-DATA	DIGI-DATA	DIGI-DATA	DIGI-DATA	DIGI-DATA
ARRAY MODEL	Z-9100	Z-9102	Z-9150	Z-9152	Z-9200
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM, DIST	OEM	OEM, DIST	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:	3 Preset	3 Preset	3/5 Port	3, 5 Port	3 Preset
RAB EDAP Classification	--		--		--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent	Drive dependent Drive dependent	Drive dependent	Drive dependent Drive dependent
Minimum drives per array	5	3	5	3	5
Maximum drives per array	75	90	90	90	90
Concurrent host channels	1, 2	2	1, 2	2	1, 2
Drive channels	1, 5	6	1, 5	6	1, 5
Array interface to host/net	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra2 SCSI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra2 SCSI
Cache size (min, max: MB)	8, 256	8, 256	8, 256	8, 256	8, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No No	Option No No	Yes No No	Option 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)	40 40	40/80 40	40 40	40/80 40	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
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	25 watts+drives None	25 watts+drives None	25 watts+drives None	25 watts+drives None
FIRST CUSTOMER SHIPMENT	7/97	8/98	4Q97	8/98	4Q97
COMMENTS			Hardware upgrade to Z9100.		

MANUFACTURER	DIGI-DATA	DIGI-DATA	DIGI-DATA	DIGI-DATA	DIGI-DATA
ARRAY MODEL	Z-9250	Z-9500 Z-9500 Plus	Z-9502 Z-9502 Plus	Z-9550 Z-9550 Plus	Z-9552 Z-9552 Plus
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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:	3/5 Port	3 Preset	3 Preset	3, 5 Port	3, 5 Port
RAB EDAP Classification	--				
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	5	3	3	3	3
Maximum drives per array	90	90	90	90	90
Concurrent host channels	1	2	1, 2	2	1, 2
Drive channels	1, 5	6	6	6	6
Array interface to host/net	Ultra2 SCSI	FC-AL	FC-AL	FC-AL	FC-AL
Drive interface	Ultra2 SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	8, 256	8, 256	8, 256	8, 256	8, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No No	Option No No	Option No No	Option No No	Option No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	80 80	100 40	100 40	100 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
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	25 watts+drives None	25 watts+drives None	25 watts+drives None	25 watts+drives None	25 watts+drives None
FIRST CUSTOMER SHIPMENT	4Q97	8/98	8/98	8/98	8/98
COMMENTS		Plus supports LUN masking + Switched Fibre.	Plus supports LUN masking + Switched Fibre.	Plus supports LUN masking + Switched Fibre.	Plus supports LUN masking + Switched Fibre.

MANUFACTURER	DILOG SA	DILOG SA	DILOG SA	DIVERSE LOGISTICS	DIVERSE LOGISTICS
ARRAY MODEL	2XFR	Ultra-Windjammer	Windjammer	2XFR+	3XFR
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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:	0/1 Port	0/1 Panel, Port	0/1 Panel, Port	0/1 Port	0/1/3 Port
RAB EDAP Classification	--	--	--	--	--
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	3
Maximum drives per array	2	14	14	8	12
Concurrent host channels	1	1	1	1	1
Drive channels	2	2	2	2	3
Array interface to host/net	Ultra SCSI	Ultra 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)	--	N/A	4, 16	N/A	N/A
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No N/A N/A	No N/A N/A	No No No	No N/A N/A
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Manual	
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	40 20	20 10	40 40	40 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
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	1.625 x 4 x 5.9	1.625 x 4 x 5.9
POWER: Power backup	6.2 watts None	8 watts+ drives None	8 watts+ drives None	6.2 watts None	6.2 watts None
FIRST CUSTOMER SHIPMENT	4Q97	8/96	1/94	4Q97	3Q98
COMMENTS		Byte striping in RAID 0.	Byte striping in RAID 0.	Block striping in RAID 0.	Block striping in RAID 0/3.

MANUFACTURER	DIVERSE LOGISTICS	DIVERSE LOGISTICS	DOT HILL	DOT HILL	DOT HILL
ARRAY MODEL	Ultra-Windjammer	Windjammer	Fibre Box	LR-400 Series LynxArray II	LR-500 Series LynxArray II
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Network Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	PC, Sun NT,Solaris,IRIX HP-UX, ALPHA	FC-AL host NT, Solaris	FC-AL host NT, Solaris
RAID level Configured by:	0/1 Panel, Port	0/1 Panel, Port	0/1/5/0+1 Port	0/1/3/5/10	0/1/3/5/10 Panel, Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	18 400	18 2650	18 2150
Minimum drives per array	2	2	2	2	2
Maximum drives per array	14	14	8	53	43
Concurrent host channels	1	1	1, 2	2	2
Drive channels	2	2	2,8 per chassis	6	5
Array interface to host/net	Ultra SCSI-2	SCSI-2	FC-AL	FC-AL, PCI	FC-AL, PCI
Drive interface	SCSI-2	SCSI-2	FC-AL	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	N/A	4, 16	N/A	128, 256	128, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No N/A N/A	No N/A N/A	N/A Yes Yes	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 20	20 10	100 100/200*	100 40	100 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	9000-50000	9000-50000	9000-50000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
ARRAY SIZE: Inches: H x W x D	1.625 x 5 x 7	1.625 x 5 x 8	7 x 17 x 21	7 x 19 x 22	7 x 19 x 22
POWER: Power backup	8 watts+ drives None	8 watts+ drives None	300 watts	300 watts UPS, Battery	300 watts UPS, Battery
FIRST CUSTOMER SHIPMENT	8/96	1/94	1997	1998	1998
COMMENTS	Byte striping in RAID 0.	Byte striping in RAID 0.	Expandable to 125 drives. Dual AC. *Dual ported.		

MANUFACTURER	DOT HILL	DOT HILL	DOT HILL	DOT HILL	DOT HILL
ARRAY MODEL	RAID Box 5300 Turbo+	SANnet 100 Data Center	SANnet 2100	SANnet 3100	SANnet 4100
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware
Host platform, software environment	UNIX, Windows NT	SCSI, FC host NT, Solaris, Linux, etc.	SCSI host NT, Solaris, Linux	SCSI host NT, Solaris, Linux	FC-AL host NT, Solaris, Linux
RAID level Configured by:	0/1/4/5 RS232 Port	0/1/3/5/10 Panel, Port	0/1/5/10 Panel, Port	0/1/3/5/10 Panel, Port	0/1/3/5/10 Panel, Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	2 2700	72 5000	18 1000	18 2500	18 2500
Minimum drives per array	2	2	1	2	2
Maximum drives per array	120	100	20	50	50
Concurrent host channels	4	4	2	2	2
Drive channels		10	2	5	5
Array interface to host/net	SCSI-2	Ultra2 SCSI, FC	Ultra SCSI 160m	Ultra2 SCSI	FC-AL
Drive interface	Ultra SCSI	Ultra2 SCSI	Ultra SCSI 160m	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)	32, 512	256, 512	--	64, 256	64, 256
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)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	80/100 80	160 160	80 80	100 80
DRIVES: Formatted capacity/drive(MB)	2000-23000	9000-50000	9100-36400	9100-50010	9100-50010
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	Varies	56 x 19 x 22	5.25 x 19.0 x 17.0	7.0 x 19.0 x 17.0	7.0 x 19.0 x 17.0
POWER: Power backup	450 watts UPS	6000 watts	Battery	Battery	Battery
FIRST CUSTOMER SHIPMENT	1996	4Q99	4Q99	4Q99	4Q99
COMMENTS	Internal UPS.				

MANUFACTURER	DOT HILL	DOT HILL	DOT HILL	DPT	DPT
ARRAY MODEL	SANnet 50 Data Center	SANnet 6008	Turbo HS	DPT-RS3/UR DPT-RS3W/UR*	PM1554U2
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Network Software	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	SCSI, FC host NT, Solaris, Linux, etc.	FC-AL host NT, Solaris, Linux	All UNIX NT	PC compatible	PC compatible NetW.,VINES,NT, OS/2,UNIX,other
RAID level Configured by:	0/1/3/5/10 Panel, Port	0/1/5 Panel	0/1/0+1/4/5 RS232 Port	0/1/5 Host	0/1/5/10/50
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	36 2500	400 6250	18 1400	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	8	2	2	2
Maximum drives per array	50	125	28	7	15-45*
Concurrent host channels	2	2	2	1	1
Drive channels	5	2	2	1, 3*	1-3*
Array interface to host/net	Ultra2 SCSI, FC	FC-AL	SCSI	PCI	PCI
Drive interface	Ultra2 SCSI	FC-AL	SCSI	Ultra SCSI	Ultra2 SCSI
Cache size (min, max: MB)	128, 256		32, 256	4, 64	4, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	N/A Yes Yes	Yes Yes Yes	Yes No No	
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	80/100 80	100 100	40/80	132 40	132 80
DRIVES: Formatted capacity/drive(MB)	9000-50000	9100-50010	9000-50000	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	28 x 19 x 22	7 x 12 x 22	17 x 7.63 x 20	9.4 x 7.6 x 11.7	
POWER: Power backup	3000 watts	UPS, Battery	300 watts	11 watts+drives	6 watts+drives None
FIRST CUSTOMER SHIPMENT	4Q99	4Q99	1998	1/97	
COMMENTS			Dual hot-swappable controllers. Dual AC entry power cords.	Includes card, 4 MB SIMM, 3-bay tower w/o drives. *3 channel.	RAID requires RA4050 module. *With expander. Fiber option.

MANUFACTURER	DPT	DPT	DPT	DPT	DPT
ARRAY MODEL	PM2554U2	PM2654U2-R-16M	PM3754U2-16M	PM3755F-16M	PM3755U2B-16M
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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 Various	PCI host Various	PCI host Various	PCI host Various	PCI host Various
RAID level Configured by:	0, 1 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10/50 Host	0/1/5/10 Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	15, 45*	15, 45*	15, 45*	126, 252*	15, 45*
Concurrent host channels	1	1	1	1	1
Drive channels	1-3	1, 3*	1-3*	1-2*	1-3*
Array interface to host/net	PCI	PCI	PCI	PCI-64 bit	PCI-64 bit
Drive interface	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	FC-AL	Ultra2 SCSI
Cache size (min, max: MB)	16, 64	16, 64	16, 256	16, 256	16, 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 80	132 80	132 80	264 100	264 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
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup	6 watts+drives None	9 watts+drives Cache battery	6 watts+drives None	7.5 watts+drvs	9 watts+drives Cache battery
FIRST CUSTOMER SHIPMENT		2/99	2/99		
COMMENTS	*With SX4052U2 expander. FC-AL port option. i960 RD.	*With SX4052U2 expander. FC-AL port option. i960 RD.	*With SX4052U2 expander. FC-AL port option.	*With SX4055F expander.	*With SX4052U2 expander. FC-AL port option. Battery option.

MANUFACTURER	DPT	DPT	DPT	DPT	DPT
ARRAY MODEL	RA4050 SmartRAID V RAID 5 Module	RS/14UWSE RAIDstation-14	RS/7F	RS/7U2	RS/7UW RAIDstation-7
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	DPT2654U2 DPT2554U2	SCSI host	SCSI host		SCSI host
RAID level Configured by:	5/50 Host	0/1/5/10/50	0/1/5/10/50		0/1/5/10/50
RAB EDAP Classification					
Array capacity (Gbytes) MIN MAX	Drive dependent	Drive dependent	Drive dependent		Drive dependent
Minimum drives per array	--	2	2	2	2
Maximum drives per array	--	14	7	15	7
Concurrent host channels	--	1	2	1	1
Drive channels	--	1	1	1-2	1
Array interface to host/net	--	Ultra SCSI	PCI	Ultra2 SCSI	Ultra SCSI
Drive interface	--	Ultra SCSI	FC-AL	Ultra2 SCSI	Ultra SCSI
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
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	--	40 40	132 100	80 80	40 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95	95	Drive dependent	95
ARRAY SIZE: Inches: H x W x D		20.5 x 13.8 x 14	20.5 x 8.7 x 14	20.5 x 8.7 x 14	20.5 x 8.7 x 14
POWER: Power backup		360 watts	200 watts	260 watts None	180 watts
FIRST CUSTOMER SHIPMENT	2/99	1998	5/98	2Q99	1998
COMMENTS	Add-on adaptor provides RAID 5/50.		Requires controller.	Rack option. SES + SAF-TE support. Requires controller.	

MANUFACTURER	DTC DATA TECHNOLOGY CORPORATION	ECCS	ECCS	ECCS	EMC
ARRAY MODEL	HardCopy	Raven Series	Synchronection2	Synchronix 2000	3330-18 Symmetrix
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	PC compatible DOS, Windows, NT, OS/2, other	Sun	SCSI host UNIX, NT	NCR,HP,Sun,SCI, RS/6000,NetWare Windows NT,UNIX	Open Systems Mainframe OS & Var. Open Sys.
RAID level Configured by:	1 Preset	1/10 Preset	0/1/3/5/10 Port	0/1/3/5/10 Host, Port	1 Preset
RAB EDAP Classification	--	--	--	--	DTDS+
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	4.2 18.2	24000	543	35/71* 286/572*
Minimum drives per array	2	2		2	4
Maximum drives per array	4	4		30	32
Concurrent host channels	1	3		2	4, 16
Drive channels	2	5		5	8
Array interface to host/net	ISA	SCSI	Ultra SCSI	Ult. SCSI,FC-AL	ESC,SCSI,FC-AL
Drive interface	EIDE	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	--		512	32, 512	1024, 8192
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	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)	Host dependent Drive dependent	20 20		40/100 40	100 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	4200-23000	9100-50000	9100-50000	18100
Nominal disk diameter (mm)	Drive dependent	95, 130	95	95	95
ARRAY SIZE: Inches: H x W x D	4.5 x 7.645 x 45	5.25 x 17 x 22			46 x 21 x 36
POWER: Power backup	5.5watts+drives None			350-1050 watts UPS option	.484-1.547 KVA Battery
FIRST CUSTOMER SHIPMENT	2/96	11/96	3/99	1Q99	1/98
COMMENTS				Dual AC feed. NEBS compliant. i960 processor. Mirrored cache. ECCS controller	*When used with remote data facility.

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	3330-18S Symmetrix	3430-18 Symmetrix	3430-18S Symmetrix	3700-18 Symmetrix	3700-18S Symmetrix
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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 Mainframe OS & Var. Open Sys.	Open Systems Mainframe OS & Var. Open Sys.	Open Systems Mainframe OS & Var. Open Sys.	Open Systems Mainframe OS & Var. Open Sys.	Open Systems Mainframe OS & Var. Open Sys.
RAID level Configured by:	0/1/"S" Preset	1 Preset	0/1/"S" Preset	1 Preset	0/1/"S" Preset
RAB EDAP Classification	FTDS+	DTDS+	FTDS+	DTDS+	FTDS+
Array capacity (Gbytes) MIN MAX	54 651	71/143* 859/1718*	54 1303	143/286* 1145/2291*	54 1737
Minimum drives per array	4	8	4	16	4
Maximum drives per array	32	96	96	128	128
Concurrent host channels	4-16	4, 24	4-24	4, 32	8-32
Drive channels	8		16	16	16
Array interface to host/net	SCSI, ESCON, FC	ESCON, SCSI, FC	SCSI-2,ESCON,FC	ESCON, SCSI, FC	ESCON, SCSI, FC
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1024, 8192	1024, 16384	1024, 16384	1024, 16384	1024, 16384
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 20	100 20	100 20	100 20	100 20
DRIVES: Formatted capacity/drive(MB)	18100	18100	18100	18100	18100
Nominal disk diameter (mm)	95	95	95	95	95
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	.591-1.230 KVA Battery	1.22-3.58 KVA Battery	1.38-3.39 KVA Battery	2.46-5.48 KVA Battery	3.10-7.43 KVA Battery
FIRST CUSTOMER SHIPMENT	1/98	1/98	1/98	4/98	4/98
COMMENTS		*When used with remote data facility.		*When used with remote data facility.	

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	3700-47 Symmetrix	3630-18 Symmetrix	3630-36 Symmetrix	3830-18 Symmetrix	3830-36 Symmetrix
DISK/TREND GROUP	Net/Midrange	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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 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 Sys.
RAID level Configured by:	1 Preset	1 Preset	1 Preset	1 Preset	1 Preset
RAB EDAP Classification	DTDS+	DTDS+	DTDS+	DTDS+	DTDS+
Array capacity (Gbytes) MIN MAX	369/739* 2958/5917*	35/71* 286/572*	71/143* 572/1145*	71/143* 859/1718*	143/286* 1718/3436*
Minimum drives per array	16	4	4	8	8
Maximum drives per array	128	32	32	96	96
Concurrent host channels	8, 32	4, 16	4, 16	4, 24	4, 24
Drive channels	16	2, 4	2, 4	2, 6	2, 6
Array interface to host/net	ESCON, SCSI, FC	ESCON,SCSI,FC	ESCON,SCSI,FC	ESCON,SCSI,FC	ESCON,SCSI,FC
Drive interface	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	1024, 16384	1024, 16384	1024, 16384	1024, 16384	1024, 16384
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 20	40,100 40	40,100 40	40,100 40	40,100 40
DRIVES: Formatted capacity/drive(MB)	46820	18200	36400	18200	36400
Nominal disk diameter (mm)	130	95	95	95	95
ARRAY SIZE: Inches: H x W x D	74.9 x 68.7 x 36.4	46.0 x 21.0 x 36.0	46.0 x 21.0 x 36.0	73.6 x 24.3 x 63.4	73.6 x 24.3 x 63.4
POWER: Power backup	3.05-7.05 KVA Battery	0.8-1.59 KVA Battery	0.8-1.59 KVA Battery	1.24-3.71 KVA Battery	1.24-3.71 KVA Battery
FIRST CUSTOMER SHIPMENT	4/98	3/99	3/99	3/99	3/99
COMMENTS	*When used with remote data facility.	*When used with remote data facility.	*When used with remote data facility.	*When used with remote data facility.	*When used with remote data facility.

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	3930-18 Symmetrix	3930-36 Symmetrix	5330-18 Symmetrix	5330-18S Symmetrix	5430-18 Symmetrix
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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 Sys.
RAID level Configured by:	1 Preset	1 Preset	1 Preset	0/1/"S" Preset	1 Preset
RAB EDAP Classification	DTDS+	DTDS+	DTDS+	FTDS+	DTDS+
Array capacity (Gbytes) MIN MAX	286/572* 2291/4582*	572/1145* 6873/13746*	35/71* 286/572*	53 644	71/143* 859/1718*
Minimum drives per array	32	32	4	4	8
Maximum drives per array	256	384	32	32	96
Concurrent host channels	4, 32	4, 32	4, 16	4-16	4, 24
Drive channels	4, 8	4, 8	8	8	16
Array interface to host/net	ESCON,SCSI,FC	ESCON,SCSI,FC	BMX,ESC,SCSI,FC	BMX,ESC,SCSI/FC	BMX,ESC,SCSI,FC
Drive interface	Ultra SCSI	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1024, 16384	1024, 16384	1024, 6384	1024, 6384	1024, 16384
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)	40,100 40	40,100 40	100 20	100 20	100 20
DRIVES: Formatted capacity/drive(MB)	18200	36400	17900	17900	17900
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	74.9 x 68.7 x 36.4	74.9 x 68.7 x 36.4	46 x 21 x 36	46 x 21 x 36	73.6 x 24.3 x 36.4
POWER: Power backup	3.39-9.68 KVA Battery	3.39-9.68 KVA Battery	.848-1.547 KVA Battery	.591-1.230 KVA Battery	1.22-3.58 KVA Battery
FIRST CUSTOMER SHIPMENT	3/99	3/99	1/98	1/98	1/98
COMMENTS	*When used with remote data facility.	*When used with remote data facility.	*When used with remote data facility.		*When used with remote data facility.

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	5430-18S Symmetrix	5630-18 Symmetrix	5630-36 Symmetrix	5700-18 Symmetrix	5700-18S Symmetrix
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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 Sys
RAID level Configured by:	0/1/"S" Preset	1 Preset	1 Preset	1 Preset	0/1/"S" Preset
RAB EDAP Classification	FTDS+	DTDS+	DTDS+	DTDS+	FTDS+
Array capacity (Gbytes) MIN MAX	53 1288	35/71* 286/572*	71/143* 572/1145*	143/286* 1145/2291*	53 1718
Minimum drives per array	4	4	4	16	4
Maximum drives per array	96	32	32	128	128
Concurrent host channels	4, 24	4, 16	4, 16	8, 32	8-32
Drive channels	16	2, 4	2, 4	16	16
Array interface to host/net	BMX,ESC,SCSI,FC	BMX,ESC,SCSI,FC	BMX,ESC,SCSI,FC	BMX,ESC,SCSI,FC	BMX/ESC/SCSI/FC
Drive interface	SCSI-2	Ultra SCSI	Ultra SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	1024, 16384	1024, 16384	1024, 16384	1024, 16384	1024, 16384
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 20	40,100 40	40,100 40	100 20	100 20
DRIVES: Formatted capacity/drive(MB)	17900	18200	36400	17900	17900
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	73.6 x 24.3 x 36.4	46.0 x 21.0 x 36.0	46.0 x 21.0 x 36.0	74.9 x 68.7 x 36.4	74.9 x 68.7 x 36.4
POWER: Power backup	1.38-3.39 KVA Battery	0.8-1.59 KVA Battery	0.8-1.59 KVA Battery	2.46-5.48 KVA Battery	3.1-7.43 KVA Battery
FIRST CUSTOMER SHIPMENT	1/98	3/99	3/99	4/98	4/98
COMMENTS		*When used with remote data facility.	*When used with remote data facility.	*When used with remote data facility.	

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	5700-47 Symmetrix	5830-18 Symmetrix	5830-36 Symmetrix	5930-18 Symmetrix	5930-36 Symmetrix
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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 Sys.
RAID level Configured by:	1 Preset	1 Preset	1 Preset	1 Preset	1 Preset
RAB EDAP Classification	DTDS+	DTDS+	DTDS+	DTDS+	DTDS+
Array capacity (Gbytes) MIN MAX	369/739* 2958/5917*	71/143* 859/1718*	143/286* 1718/3436*	286/572* 2291/4582*	572/1145* 6873/13746*
Minimum drives per array	16	8	8	32	32
Maximum drives per array	128	96	96	256	384
Concurrent host channels	8, 32	4, 24	4, 24	4, 32	4, 32
Drive channels	16	2, 6	2, 6	4, 8	4, 8
Array interface to host/net	BMX,ESC,SCSI,FC	ESCON,SCSI,FC	ESCON,SCSI,FC	ESCON,SCSI,FC	BMX,ESC,SCSI,FC
Drive interface	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	1024, 16384	1024, 16384	1024, 16384	1024, 16384	1024, 16384
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 20	40,100 40	40,100 40	40,100 40	40,100 40
DRIVES: Formatted capacity/drive(MB)	46230	18200	36400	18200	36400
Nominal disk diameter (mm)	130	95	95	95	95
ARRAY SIZE: Inches: H x W x D	74.9 x 68.7 x 36.4	73.6 x 24.3 x 63.4	73.6 x 24.3 x 63.4	74.9 x 68.7 x 36.4	74.9 x 68.7 x 36.4
POWER: Power backup	3.05-7.05 KVA Battery	1.24-3.71 KVA Battery	1.24-3.71 KVA Battery	3.39-9.68 KVA Battery	3.39-9.68 KVA Battery
FIRST CUSTOMER SHIPMENT	4/98	3/99	3/99	3/99	3/99
COMMENTS	*When used with remote data facility.	*When used with remote data facility.	*When used with remote data facility.	*When used with remote data facility.	*When used with remote data facility.

MANUFACTURER	ENLIGHT	ENLIGHT	ENLIGHT	EUROLOGIC SYSTEMS	EUROLOGIC SYSTEMS
ARRAY MODEL	EN-8800	EN-8850	EN-8900	Voyager 3000	Voyager 3110
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	DIST	DIST
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 NT, OS/2, UNIX	SCSI host NT, OS/2, UNIX	SCSI host NT, OS/2, UNIX	SCSI host	SCSI host
RAID level Configured by:	0/1/5 Panel, Port	0/1/5 Panel, Port	0/1/5 Panel, Port	0/1/3/5 Panel, Port	0/1/3/4/5/10 Panel, Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	18 234	 648
Minimum drives per array	2	2	2	2/3	
Maximum drives per array	42	7	4	13	18
Concurrent host channels	1, 2	1, 2	1, 2	1	1
Drive channels	2	2	2	2	1
Array interface to host/net	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra2 SCSI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra2 SCSI
Cache size (min, max: MB)	2, 64	2, 64	2, 64	8, 32	16, 128
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)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	40 40	40 40	20/40 20/40	80 80
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	9000-18000	9100-36400
Nominal disk diameter (mm)	Drive dependent	95	130	95	95
ARRAY SIZE: Inches: H x W x D	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	5 x 20 x 5
POWER: Power backup	21 watts None	250 watts None	250 watts None	200-400 watts	 Battery
FIRST CUSTOMER SHIPMENT	1997	1997	1997	1Q97	6/99
COMMENTS	AMD 5X86-133 processor. Controller only	AMD 5X86-133 processor. Controller and enclosure.	AMD 5X86-133 processor. Controller and enclosure.	Infortrend controller.	

MANUFACTURER	EUROLOGIC SYSTEMS	EUROLOGIC SYSTEMS	EUROLOGIC SYSTEMS	EUROLOGIC SYSTEMS	FUJITSU
ARRAY MODEL	Voyager 3120	Voyager 5000	Voyager 5110	Voyager 5120	F6403A1/2/3 Rack-Mount
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	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	FC-AL host	SCSI host	SCSI host	FC-AL host	Fujitsu, other NT, Solaris
RAID level Configured by:	0/1/3/4/5/10 Panel, Port	0/1/4/5/10 Panel, Port	0/1/3/4/5/10 Panel, Port	0/1/3/4/5/10 Panel, Port	0/1/3/5/10 Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	 1080	18 756			27 720
Minimum drives per array		2/3			4
Maximum drives per array	30	42	60	60	44
Concurrent host channels	1	1, 3	1, 2	1, 2	2
Drive channels	1	7	5	5	6
Array interface to host/net	FC-AL	Ultra SCSI	Ultra2 SCSI	FC-AL	Ultra SCSI, FC
Drive interface	Ultra2 SCSI	Ultra SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra SCSI
Cache size (min, max: MB)	16, 128	8, 256	32, 256	32, 256	64, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Yes 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)	100 80	10/20/40 10/20	80 80	100 80	40, 100 40
DRIVES: Formatted capacity/drive(MB)	9100-36400	9000-18000	9100-36400	9100-36400	9000-18000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	5 x 20 x 5	31.5 x 23.6 x 46.5	31.5 x 23.6 x 78	31.5 x 23.6 x 78	70.9 x 27.4 x 36.4
POWER: Power backup	Battery	720-1320 watts Cache battery	Battery	Battery	Battery
FIRST CUSTOMER SHIPMENT	6/99	1Q97			1999
COMMENTS		CMD controller.			

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
ARRAY MODEL	F6403B1 Cabinet	F6403C1 Tower	F6494E2	F6495E2	F6496L
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	Fujitsu, other NT, Solaris	Fujitsu, other NT, Solaris	Fujitsu, other Various	Fujitsu, other Various	Fujitsu, other Various
RAID level Configured by:	0/1/3/5/10 Host	0/1/3/5/10 Host	1	1	1
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	27 270	18 72	5.04 357.2	5.04 714.4	20.1 714.4
Minimum drives per array	4	3	2	2	2
Maximum drives per array	17	9	20	40	20
Concurrent host channels	2	2	2, 8	4, 16	2, 8
Drive channels	6	2	2, 8	4, 16	2, 8
Array interface to host/net	Ultra SCSI, FC	Ultra SCSI	Various	Various	Various
Drive interface	Ultra SCSI	Ultra SCSI	SCSI 2	SCSI 2	Ultra SCSI
Cache size (min, max: MB)	64	64	512-2000	1000, 12000	512-2000
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option 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)	40, 100 40	40 40	17 Prop. 20	17 Prop. 20	17 Prop. 40
DRIVES: Formatted capacity/drive(MB)	9000-18000	9000	9000, 18000	9000, 18000	36000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	27.6 x 22.0 x 31.5	21.6 x 8.7 x 24.4	70.9 x 29.5 x 29.5	70.9 x 48.4 x 29.5	70.9 x 29.5 x 29.5
POWER: Power backup	Battery	Battery	2 KVA max.	1.4-6.7 KVA	2 KVA max.
FIRST CUSTOMER SHIPMENT	1999	1999	2Q99	2Q99	2Q99
COMMENTS					

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
ARRAY MODEL	F6497L	F6492	F6493 F1710	F6494	F6495
DISK/TREND GROUP	Net/Midrange	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	Fujitsu, other Various	Fujitsu M series	Fujitsu M series, VP series	Fujitsu MXVP Solaris, NT, IBM AIX, HP-UX	Fujitsu MXTD Solaris, NT, IBM AIX, HP-UX
RAID level Configured by:	1	3 Host	3 Host	1 --	1 --
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	20.1 2857.7	5.04 90.72	5.04 181.44	8.51 357.42	17.02 725.76
Minimum drives per array	2	4	4	4	8
Maximum drives per array	40	32	256	64	256
Concurrent host channels	4, 16	2-8	4-16 (F1710)	2-8	4-16
Drive channels	4, 16	2-4	2-16	2-4	4-16
Array interface to host/net	Various	Proprietary	Proprietary	Prop., SCSI2	Prop., SCSI-2
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1000-12000	512, 2048	256, 12288	512, 2048	1024, 12288
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)	17 Prop. 40	17 20	17 20	17 (prop.) 20 (SCSI-2)	17 (prop.) 20 (SCSI-2)
DRIVES: Formatted capacity/drive(MB)	36000	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	70.9 x 48.4 x 29.5	71 x 33.5 x 30	71 x 22 x 30	71 x 30 x 30	71 x 48 x 30
POWER: Power backup	1.4-6.7 KVA	1.0-2.0 KVA	1.0-2.9 KVA	Max. 2.05 KVA	1.4-6.7 KVA
FIRST CUSTOMER SHIPMENT	2Q99		3Q95	1Q98	3Q97
COMMENTS		Sold in Japan.	Sold in Japan. Up to 4 F6493 can be attached to F1710A controller.	Sold in Japan.	Sold in Japan.

MANUFACTURER	FUJITSU	FUJITSU	FWB SOFTWARE	HAMMER STORAGE SOLUTIONS	HAMMER STORAGE SOLUTIONS
ARRAY MODEL	F6496	F6497	Hard Disk ToolKit v3	SLPro 2 FC SledgeHammer	SLPro 2 U2 SledgeHammer
DISK/TREND GROUP	Mainframe	Mainframe	Single User	Single User	Single User
MARKET	Captive	Captive	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Software -- Software	Subsystem Host Software	Subsystem Host Software
Host platform, software environment	Fujitsu MXTD Solaris, NT, IBM AIX, HP-UX	Fujitsu MXTD Sun Solaris for SPARC	Macintosh	SGI, Macintosh NT	SGI, Macintosh NT
RAID level Configured by:	1 --	1 --	0/1 Host	0/1	0/1
RAB EDAP Classification	--	--	--		
Array capacity (Gbytes) MIN MAX	40.3 357.2	80.6 714.4	Drive dependent	8.7 100	8.7 100
Minimum drives per array	32	64	2	2	2
Maximum drives per array	128	256	15	2	2
Concurrent host channels	2-8	4-16	1	1	1
Drive channels	2-4	4-16	1	1	1
Array interface to host/net	Prop., SCSI-2	Prop., SCSI-2	SCSI,NuBus,PCI	FC-AL	Ultra2 SCSI
Drive interface	SCSI-2	SCSI-2	Various	FC-AL	Ultra2 SCSI
Cache size (min, max: MB)	512, 2048	1024, 3072	Drive dependent		
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	No No No	-- No No	-- No No
Spare drive (None/Auto/Manual)	Auto	Auto	None	Auto (RAID-1)	Auto (RAID-1)
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	17 (prop.) 20 (SCSI-2)	17 (prop.) 20 (SCSI-2)	Drive dependent Drive dependent	100 100	80 80
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	8700-50000	8700-50000
Nominal disk diameter (mm)	95	95	Drive dependent	95	95
ARRAY SIZE: Inches: H x W x D	71 x 30 x 30	71 x 48 x 30	--	7 x 19 x 21.5	7 x 19 x 21.5
POWER: Power backup	Max. 1.8 KVA	Max. 3.5 KVA	-- None	100 watts	100 watts
FIRST CUSTOMER SHIPMENT	1998	1999	4Q98	10/99	10/98
COMMENTS	Sold in Japan.	Sold in Japan.			

MANUFACTURER	HAMMER STORAGE SOLUTIONS	HAMMER STORAGE SOLUTIONS	HAMMER STORAGE SOLUTIONS	HAMMER STORAGE SOLUTIONS	HAMMER STORAGE SOLUTIONS
ARRAY MODEL	SLPro 4 FC SledgeHammer	SLPro 4 U2 SledgeHammer	SLPro 12 FC SledgeHammer	SLPro 12 FC FT SledgeHammer	SLPro 12 LVD FT SledgeHammer
DISK/TREND GROUP	Single User	Single User	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Software	Subsystem Host Software	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SGI, Macintosh NT	SGI, Macintosh NT	SGI, Macintosh NT	FC-AL host SGI, Mac, NT	SGI, Mac, NT
RAID level Configured by:	0/1	0/1	0/1 Host	0/1/3/5/10	0/1/3/5/10
RAB EDAP Classification				--	--
Array capacity (Gbytes) MIN MAX	18 200	18 200	8.7 600	600	600
Minimum drives per array	2	2	2		
Maximum drives per array	4	4	12	12	12
Concurrent host channels	1, 2	1, 2	1, 2	2	2
Drive channels	1, 2	1, 2	1, 2	1	1
Array interface to host/net	FC-AL	Ultra2 SCSI	FC-AL	FC-AL	Ultra2 SCSI
Drive interface	FC-AL	Ultra2 SCSI	FC-AL	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)				128 max.	128 max.
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- No No	-- No No	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto (RAID-1)	Auto (RAID-1)	Auto (RAID-1)	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 100	80 80	100 100	100 100	80 80
DRIVES: Formatted capacity/drive(MB)	8700-50000	8700-50000	9000-36400	9100-50000	9100-50000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	14 x 19 x 21.5	14 x 19 x 21.5	7 x 17.5 x 23	7 x 17.5 x 23	7 x 17.5 x 23
POWER: Power backup	200 watts	200 watts	450 watts	1.1 KVA	1.1 KVA
FIRST CUSTOMER SHIPMENT	10/99	10/98	5/98	12/98	12/98
COMMENTS			Desktop or rack options.	Desktop, tower, rack.	Desktop, tower, rack.

MANUFACTURER	HAMMER STORAGE SOLUTIONS	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
ARRAY MODEL	SLPro12-FC-FCFT	A3700A/AZ SureStore E 12H (Rack Mount)	A3700AD SureStore E 12H (Deskside)	J3290A HD Server 4000	J3291A HD Server 4000
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	Captive	Captive	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Network Hardware
Host platform, software environment	SGI, Macintosh NT	SCSI host Various	SCSI host Various	Windows, NT	Windows, NT
RAID level Configured by:	0/1/3/5	0/1/5 Host, Panel	0/1/5 Host, Panel	5 Preset	5 Preset
RAB EDAP Classification		--		--	--
Array capacity (Gbytes) MIN MAX	432*	36.4 436.8	36.4 436.8	18 18	18 18
Minimum drives per array	2	4	4	3	3
Maximum drives per array	9	12	12	3	3
Concurrent host channels	1, 2	1, 2	1, 2	1	1
Drive channels	1, 2	1	1	2	2
Array interface to host/net	FC-AL	SCSI-2, FC-AL	SCSI-2, FC-AL	Ethernet	Ethernet
Drive interface	FC-AL	SCSI-2	SCSI-2	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	128 max.	96	96	32	32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes	Option Yes Yes	No No Yes	No No Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 100	20, 100 20	20, 100 20	1.2/12 40	1.2/12 40
DRIVES: Formatted capacity/drive(MB)	9100-50000	9100-36400	9100-36400	9000	9000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	7 x 17.5 x 23	22.8 x 16.7 x 12.2	22.8 x 16.7 x 12.2	16.7 x 8.5 x 17.5	16.7 x 8.5 x 17.5
POWER: Power backup	.62 KVA	660 watts Battery	660 watts Battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	10/99	3Q97	3Q97	4Q99	4Q99
COMMENTS	Rack mount. Expandable to 7 TB.	Rack version holds up to 6 arrays. Formerly AutoRAID.	Formerly AutoRAID.		

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HITACHI	HITACHI
ARRAY MODEL	J3292A HD Server 4000	J3293A HD Server 4000	Transoft FC Net Director RAID	DF350-MK A-6533-MK	DF350-CK A-6533-CK
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	CAPT,OEM,DIST	CAPT,OEM,DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Windows, NT	Windows, NT	Server Network NT, SGI, Apple	SCSI host UNIX, NetWare, NT	SCSI host UNIX, NetWare, NT
RAID level Configured by:	5 Preset	5 Preset	0/1	0/1/5/10 Panel, Port	0/1/5/10 Panel, Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	45 45	90 90	86 --	8.3/4.1/8.3/8.3 89/35/71/35	8.3/4.1/8.3/8.3 357/143/286/143
Minimum drives per array	6	6	4	2/2/3/4	2/2/3/4
Maximum drives per array	6	6	--	5/4/5/4	20/16/20/16
Concurrent host channels	1	1	--	1, 2	1, 2
Drive channels	2	2	--	5	5
Array interface to host/net	Ethernet	Ethernet	FC-AL	Ultra SCSI	Ultra SCSI
Drive interface	Ultra SCSI	Ultra SCSI	FC-AL	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	32	32	--	64, 1024	64, 1024
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	No No Yes	-- Yes Yes	Option Yes Option	Option Yes Option
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto (option)	Auto (option)
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	1.2/12 40	1.2/12 40	100 100	40 20	40 20
DRIVES: Formatted capacity/drive(MB)	9000	18000	9100	4162,8712,17887	4162,8712,17887
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	16.7 x 8.5 x 17.5	16.7 x 8.5 x 17.5	Varies	16.1 x 9.1 x 18.3	27.6 x 11.8 x 23.6
POWER: Power backup	Cache battery	Cache battery	None	300 watts Cache battery	800 watts Cache battery
FIRST CUSTOMER SHIPMENT	4Q99	4Q99	4Q96	1Q97	1Q97
COMMENTS			Sold only as part of system area network.		

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
ARRAY MODEL	DF350-DK A-6533-DK	DF350-DKH A-6533-DKH	DF350-RKH A-6533-RKH	DF350-RKWH A-6533-RKWH	DF350F-CK A-6534-CK
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	CAPT,OEM,DIST	CAPT, OEM, DIST	CAPT,OEM,DIST	CAPT,OEM,DIST	CAPT, OEM, DIST
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	FC-AL host UNIX, NT
RAID level Configured by:	0/1/5/10 Panel, Port	0/1/5/10 Panel, Port	0/1/5/10 Panel, Port	0/1/5/10 Panel, Port	0/1/5/10
RAB EDAP Classification	--		--	--	
Array capacity (Gbytes) MIN MAX	8.3/4.1/8.3/8.3 20/8/16/8	8.3/4.1/8.3/8.3 89/35/71/35	8.3/4.1/8.3/8.3 178/71/143/71	8.3/4.1/8.3/8.3 357/143/286/143	8.3/4.1/8.3/8.3 357/143/286/143
Minimum drives per array	2/2/3/4	2/2/3/4	2/2/3/4	2/2/3/4	2/2/3/4
Maximum drives per array	5/4/5/4	5/4/5/4	10/8/10/8	20/16/20/16	20/16/20/16
Concurrent host channels	1	1	1, 2	1, 2	1, 2
Drive channels	5	5	5	5	5
Array interface to host/net	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	FC-AL
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	16, 16	64, 256	64, 1024	64, 1024	64, 1024
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	No No Option	Option Yes Option	Option Yes Yes	Option Yes Option
Spare drive (None/Auto/Manual)	None	Auto (option)	Auto (option)	Auto (option)	Auto (option)
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 20	40 20	40 20	40 20	100 20
DRIVES: Formatted capacity/drive(MB)	4162	4162,8712,17887	4162,8712,17887	4162,8712,17887	4162,8712,17887
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	13.8 x 5.9 x 15.7	17.1 x 6.7 x 16.5	10.4 x 19.1 x 25.8	17.4 x 18.9 x 24.9	27.6 x 11.8 x 23.6
POWER: Power backup	240 watts Cache battery	300 watts Cache battery	500 watts Cache battery	900 watts Cache battery	900 watts Cache battery
FIRST CUSTOMER SHIPMENT	1Q97	2Q98	1Q97	1Q97	2Q98
COMMENTS			Rack mount type.	Rack mount type.	

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
ARRAY MODEL	DF350F-MK A-6534-MK	DF350F-RKH A-6534-RKH	DF350F-RKWH A-6534-RKWH	DF400-CK A-6541-CK	DF400-RK A-6541-RK
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	CAPT, OEM, DIST	CAPT, OEM, DIST	CAPT, OEM, DIST	CAPT, OEM, DIST	CAPT, OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	FC-AL host UNIX, NT	FC-AL host UNIX, NT	FC-AL host UNIX, NT	SCSI,FC-AL host UNIX, NT	SCSI,FC-AL host UNIX, NT
RAID level Configured by:	0/1/5/10	0/1/5/10	0/1/5/10	0/1/5/10 Panel, Port	0/1/5/10 Panel, Port
RAB EDAP Classification				--	--
Array capacity (Gbytes) MIN MAX	8.3/4.1/8.3/8.3 89/35/71/35	8.3/4.1/8.3/8.3 178/71/143/71	8.3/4.1/8.3/8.3 357/143/286/143	4.1/16.6/8.3 143/286/143	4.1/16.6/8.3 214/429/214
Minimum drives per array	2/2/3/4	2/2/3/4	2/2/3/4	5/2/5/4	5/2/5/4
Maximum drives per array	5/4/5/4	10/8/10/8	20/16/20/16	20/16/20/16	30/24/30/24
Concurrent host channels	1, 2	1, 2	1, 2	1, 8	1, 16
Drive channels	5	5	5	6	6
Array interface to host/net	FC-AL	FC-AL	FC-AL	Ult2 SCSI,FC-AL	Ult2 SCSI,FC-AL
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	64, 1024	64, 1024	64, 1024	32, 1024	32, 2048
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Option	Option Yes Option	Option Yes Yes	Option Yes Option	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto (option)	Auto (option)	Auto (option)	Auto (option)	Auto (option)
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 20	100 20	100 20	80, 100 40	80, 100 40
DRIVES: Formatted capacity/drive(MB)	4162,8712,17887	4162,8712,17887	4162,8712,17887	4162/8712/17887	4162/8712/17887
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	16.1 x 9.1 x 18.3	10.4 x 19.1 x 25.8	17.4 x 18.9 x 24.9	27.6 x 14.8 x 28.1	27.6 x 18.9 x 27.8
POWER: Power backup	400 watts Cache battery	500 watts Cache battery	900 watts Cache battery	1000 watts Cache battery	1200 watts Cache battery
FIRST CUSTOMER SHIPMENT	2Q98	2Q98	2Q98	3Q98	3Q98
COMMENTS		Rack mount type.	Rack mount type.		Rack mount type.

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
ARRAY MODEL	DF400-RKY A-6541-RKY	VB8240-200 VB8240-210	VB8240-420	VB8450-100 VB8450-110 VB8450-111	VB8450-100R VB8450-110R VB8450-111R
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	CAPT, OEM, DIST	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	SCSI,FC-AL host UNIX, NT	PCI host Windows NT	PCI host Windows NT	PCI host Windows NT	PCI host Windows NT
RAID level Configured by:	0/1/5/10 Panel, Port	0/1/3/5/7/10	0/1/3/5/7/10	0/1/3/5/7/10	0/1/3/5/7/10
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	4.1/16.6/8.3 214/429/214	18 45	9 45	9 108	9 108
Minimum drives per array	5/2/5/4	3	1	1	1
Maximum drives per array	30/24/30/24	5	5	6	6
Concurrent host channels	1, 16	1	1	1	1
Drive channels	6	1	1	1	1
Array interface to host/net	Ult2 SCSI,FC-AL	PCI	PCI	PCI	PCI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	32, 2048	4, 4	4, 4	8, 8	8, 8
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	No No No	No No No	No No Yes	No No Yes
Spare drive (None/Auto/Manual)	Auto (option)	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	80, 100 40	132 40	132 40	132 40	132 40
DRIVES: Formatted capacity/drive(MB)	4162/8712/17887	9100	9100	9100/18200	9100/18200
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	17.3 x 29.1 x 27.8	7.6 x 3.3 x 7.1	7.6 x 3.3 x 7.1	7.8 x 5.4 x 10.5	5.5 x 7.4 x 10.1
POWER: Power backup	1200 watts Cache battery	Max. 150 watts	Max. 150 watts	Max. 511 watts	Max. 463 watts
FIRST CUSTOMER SHIPMENT	3Q98	9/98	4/99	2/99	2/99
COMMENTS	Rack mount type.	Mylex controller.	Mylex controller.	Mylex controller.	Mylex controller.

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
ARRAY MODEL	VB8450-220	VB8450-220R	VB8460-100	VB8460-200 VB8460-110 VB8460-111 VB8460-112	VB8460-220
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	PCI host Windows NT	PCI host Windows NT	PCI host Windows NT	PCI host Windows NT	PCI host Windows NT
RAID level Configured by:	0/1/3/5/7/10	0/1/3/5/7/10	0/1/3/5/7/10	0/1/3/5/7/10	0/1/3/5/7/10
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	9 108	9 108	18 216	36 216	9 216
Minimum drives per array	1	1	3	5	1
Maximum drives per array	6	6	12	12	12
Concurrent host channels	1	1	1	1	1
Drive channels	1	1	2	2	2
Array interface to host/net	PCI	PCI	PCI	PCI	PCI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	8, 8	8, 8	4, 4	4, 4	32, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	No No Yes	No No Yes	No No Yes	No No Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 80	132 80	132 40	132 40	266 80
DRIVES: Formatted capacity/drive(MB)	9100/18200	9100/18200	9100/18200	9100/18200	9100/18200
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	7.8 x 5.4 x 10.5	5.5 x 7.4 x 10.1	11.0 x 6.7 x 11.0	11.0 x 6.7 x 11.0	11.0 x 6.7 x 11.0
POWER: Power backup	Max. 511 watts	Max. 463 watts	Max. 848 watts	Max. 848 watts	Max. 848 watts
FIRST CUSTOMER SHIPMENT	6/99	6/99	9/98	9/98	5/99
COMMENTS	Mylex controller.	Mylex controller.	Mylex controller.	Mylex controller.	Mylex controller.

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI DATA SYSTEMS
ARRAY MODEL	VB8460-300	VB8880-100R VB8880-111R VB8880-112R	VB8880-221R VB8880-222R	A-6593/A-6596 H-6593/H-6596	5840 Rack Mount
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Mainframe	Net/Midrange
MARKET	Captive	Captive	Captive	Captive, DIST	DIST
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 Windows NT	PCI host Windows NT	PCI host Windows NT	Mainfrm,Opn Sys VOS3, MVS, MSP UNIX, NT	Open Systems UNIX, NT
RAID level Configured by:	0/1/3/5/7/10	0/1/3/5/7/10	0/1/3/5/7/10	1/5 Preset	0/1/5/10 Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	72 216	9 108	9 108	17.5 5925.7	35.7 360
Minimum drives per array	5	1	1	4	2
Maximum drives per array	12	6	6	232	10
Concurrent host channels	1	1	1	32	4
Drive channels	2	1	1	1-32	1, 2
Array interface to host/net	PCI	PCI	PCI	Prop., SCSI, FC	Ultra2 SCSI, FC
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-2	Ultra SCSI
Cache size (min, max: MB)	4, 4	4, 4	32, 32	256, 16384	32, 512
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	No No Yes	No No Yes	Yes Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto (option)	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	132 40	266 80	17/20/40/100 20	80/100 40
DRIVES: Formatted capacity/drive(MB)	9100/18200	9100/18200	9100/18200	9230-36930	17800-35760
Nominal disk diameter (mm)	95	95	95	95, 65	95
ARRAY SIZE: Inches: H x W x D	11.0 x 6.7 x 11.0	11.7 x 7.4 x 9.9	11.7 x 7.4 x 9.9	--	10.3 x 19.0 x 27.8
POWER: Power backup	Max. 848 watts	Max. 977 watts	Max. 977 watts	13 KVA (max.) Cache battery	Battery
FIRST CUSTOMER SHIPMENT	9/98	1/99	5/99	1Q98	9/99
COMMENTS	Mylex controller.	Mylex controller.	Mylex controller.		

MANUFACTURER	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	IBM	IBM
ARRAY MODEL	5846 Rack Mount	5860 Cabinet	7700E Array Subsystem	01K7207 ServeRAID-3H Netfinity	01K7296 FC Failsafe
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Mainframe	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Board	Board
Attachment	Host	Host	Host	Host	Host
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Open Systems UNIX, NT	Open Systems UNIX, NT	Mainframe UNIX, NT	IBM PCI host	IBM PCI host
RAID level	0/1/5/10	0/1/5/10	1/5	0/1/5	0/1/3/5
Configured by:	Port	Port			Host
RAB EDAP Classification	--	--	DTDS+	--	--
Array capacity (Gbytes) MIN	35.7	35.7	18.45	Drive dependent	Drive dependent
MAX	1080	720	6025	Drive dependent	Drive dependent
Minimum drives per array	2	2	4	2	
Maximum drives per array	30	20	232	45	15/channel
Concurrent host channels	8	4	4, 32	1	
Drive channels	1, 6	1, 4	8, 32 Dual port	3	6
Array interface to host/net	Ultra2 SCSI, FC	Ultra2 SCSI, FC	IBM, FC, SCSI	PCI	FC-AL, PCI
Drive interface	Ultra SCSI	Ultra SCSI	SCSI-2	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)	32, 4096	32, 2048	256, 16384	32	128
Redundancy: Controller (Yes/No)	Option	Option	Yes	--	Yes
Fan (Yes/No)	Yes	Yes	Yes	--	Yes
Power supply (Yes/No)	Yes	Yes	Yes	--	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	80/100	80/100	17, 20, 40, 100	132/264	100
drive (MB/Sec)	40	40	20	80	80
DRIVES: Formatted capacity/drive(MB)	17800-35760	17800-35760	6100-35870	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	65, 95	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	27.6 x 19.0 x 27.8	27.6 x 14.8 x 28.1	70.5 x 51.2 x 31.5		
POWER: Power backup	Battery	Battery	4.4 KVA Battery	Battery option	Battery
FIRST CUSTOMER SHIPMENT	9/99	9/99	3/98	9/98	9/98
COMMENTS				40 MHz RISC processor.	Mounted in 35261RU unit, as redundant controller.

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	01K7364 ServeRAID-3L Netfinity	2102	2108-S20 SAN Data Gateway	2494 (RS/6000) SCSI RAID Adapter	2748 (AS/400) PCI RAID Disk Unit Controller
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	DIST	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Subsystem Network Hardware	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	IBM PCI host	FC-AL host NT, UNIX	SCSI host	PCI host OS/2, NT, AIX, NetWare, UNIX	AS/400e
RAID level Configured by:	0/1/5	0/1/3/5/10	1	0/1/5 Host	1/5 Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	36.4 2200	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	4	--		4
Maximum drives per array	15	10	64	45	15
Concurrent host channels	1	2	1	3	1
Drive channels	1	6	2	3	3
Array interface to host/net	PCI	FC-AL	Ultra SCSI	PCI	PCI
Drive interface	Ultra2 SCSI	Ultra2 SCSI	SSA	Ultra SCSI	Ultra2 SCSI
Cache size (min, max: MB)	4	256, 512		32	26
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	Yes Yes Yes	N/A N/A N/A	N/A N/A N/A	N/A N/A N/A
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 80	100 80	40 80	80 40	132 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	9100-36400	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D		6.9 x 17.5 x 25.0	3.0 x 4.25 x 11.0	4.2 x 5.0 x 12.3	
POWER: Power backup	Battery option	2.8 KVA Cache battery	60 watts		
FIRST CUSTOMER SHIPMENT	9/98	3/99	5/99	4/99	8/99
COMMENTS	25 MHz RISC processor.	Complete server. Expandable to 60 drives.			

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	35261RU Fibre Channel RAID Controller	37L6086 ServeRAID-3HB Netfinity	4040 SerialRAID/X Adapter	6219 (RS/6000) SSA RAID Adapter	6225 (RS/6000) Advanced Serial RAID Adapter
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	DIST	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	IBM PCI host	IBM PCI host	PCI host NT, NetWare	RS/6000 AIX 4.1.5	PCI host AIX
RAID level Configured by:	0/1/3/5 Host	0/1/5	0/1/5/10	5 Host	0/5 Host
RAB EDAP Classification	--	--	--	--	--
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	4	--	4
Maximum drives per array	15/channel	45	96	96	96
Concurrent host channels		3	1	2	2
Drive channels	6	1	1	2	2
Array interface to host/net	FC-AL, PCI	PCI	PCI	MCA	PCI
Drive interface	Ultra2 SCSI	Ultra2 SCSI	SSA	SSA	SSA
Cache size (min, max: MB)	128	32	32	0, 4	32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	N/A N/A N/A	Option N/A N/A	N/A N/A N/A	N/A N/A N/A
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 80	132/264 80	160 160	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
ARRAY SIZE: Inches: H x W x D	6.88 x 17.5 x 24.9		4.2 x 5.0 x 12.3	4.2 x 5.0 x 12.3	4.2 x 5.0 x 12.3
POWER: Power backup	Battery	Battery option		16.2 watts N/A	
FIRST CUSTOMER SHIPMENT	9/98	7/99	3/99	11/96	4/99
COMMENTS	166 MHz Pent. processor.				

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	7133-D40 Rack Mount	7133-T40 Tower	76H3584 ServeRAID II	8640-21Y PC Server 330	8660 Netfinity 5500 Server
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	Captive, OEM	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Board Host Hardware	Subsystem Network Hardware	Subsystem Host Hardware
Host platform, software environment	RS/6000, PC AIX, OS/2, NT NetWare, UNIX	RS/6000, PC AIX, OS/2, NT NetWare, UNIX	PC Server* OS/2, NetWare, NT, SCO, UNIX	PC Server 330 OS/2, NT, UNIX, NetWare, SCO	PCI host NT, NetWare
RAID level Configured by:	0/1/5* Panel	0/1/5* Panel	0/1/5 Host	0/1/5 Host	0/1/5 Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	36 582	36 582	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	4	4	2	2	2
Maximum drives per array	16	16	45	6	6
Concurrent host channels	8, 8	8, 8		1	2
Drive channels	8, 8	8, 8	3(15 drvs.each)	2	2
Array interface to host/net	SSA	SSA	PCI	PCI	PCI
Drive interface	SSA	SSA	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)			4, 8	4, 8	4, 8
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	No No No	No No No	-- Yes Option
Spare drive (None/Auto/Manual)	Option	Option	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	80 80	80 80	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)	95	95	Drive dependent	95	95
ARRAY SIZE: Inches: H x W x D	6.7 x 17.5 x 29.0	24.0 x 8.3 x 33.9	5 x .85 x 13.4	24.5 x 7.5 x 18.6	20.9 x 19.0 x 27.6
POWER: Power backup	.483 KVA	.483 KVA	Battery option	350 watts Battery option	
FIRST CUSTOMER SHIPMENT	11/98	11/98	9/97	6/98	6/98
COMMENTS	*RAID status depends on adapter used.	*RAID status depends on adapter used.	Dynamic reconfiguration *Also Netfinity	Complete server Dynamic reconfiguration	Integrated ServeRAID II array controller.

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	8661 Netfinity 5500 M10 Server	8662 Netfinity 5500 M20 Server	8680 Netfinity 7000 M10 Server	2105-E10 Enterprise Storage Server	2105-E20 Enterprise Storage Server
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	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	PCI host NT, NetWare	PCI host NT, NetWare	PCI host NT, NetWare	S/390,SCSI host MVS,VM,VSE,NT, AS/400, UNIX	S/390,SCSI host MVS,VM,VSE,NT, AS/400, UNIX
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5* Host	5	5
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	420 1680	420 11210
Minimum drives per array	2	2	2	16	16
Maximum drives per array	6	6	6	64	384*
Concurrent host channels	2	2	2	2, 32	2, 32
Drive channels	2	2	2	4, 8	4, 8
Array interface to host/net	PCI	PCI	PCI	ESCON, SCSI-3	ESCON, SCSI-3
Drive interface	Ultra SCSI	Ultra SCSI	SCSI,FC,SSA*	SSA-160	SSA-160
Cache size (min, max: MB)	4, 8	4, 8		6144	6144
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- Yes Option	-- 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)	100 40	100 40	100 40	40 160	40 160
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	9100-36400	9100-36400
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	20.9 x 19.0 x 27.6	20.9 x 19.0 x 27.6	21.9 x 19.0 x 28.3	75.3 x 54.4 x 35.8	75.3 x 54.4 x 35.8
POWER: Power backup	400 watts	500 watts	400 watts	3.5 KVA	5 KVA
FIRST CUSTOMER SHIPMENT	10/98	3/99	3/99	9/99	9/99
COMMENTS	Integrated ServeRAID II array controller.	Integrated ServeRAID II array controller.	*RAID status depends on adapter used.		*256 drives in expansion enc.

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MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	9393-X82 RAMAC Virtual Array Turbo	9393-X83 RAMAC Virtual Array	Multiprise 2000 (Internal Disk)	Multiprise 3000 (Internal Disk)	9391-A30 9392-B33 RAMAC 3 Array
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	System/390 MVS, VM, VSE, TPF
RAID level Configured by:	"6" Preset	"6" Preset	1 Preset	5 Preset	5 Preset
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	290* 840*	290* 1680*	17.8 (3390 fmt) 574.4(3390 fmt)	72 216*	45.4 726 (2X racks)
Minimum drives per array	14	14	4	5	8 (2X drawers)
Maximum drives per array	60	60	64	16	128 (2X racks)
Concurrent host channels	8	8	N/A	N/A	*
Drive channels	14	14	N/A	N/A	4, 8*
Array interface to host/net	ESCON, Parallel	ESCON, Parallel	N/A	N/A	ESCON, Parallel
Drive interface	SCSI-2	SSA	SCSI-2	SSA	SCSI-2
Cache size (min, max: MB)	2048, 6144	2048, 6144	32, 1920	32, 2048	256, 8192
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	None	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	18 20	18 80	N/A 20	N/A 40	18 20
DRIVES: Formatted capacity/drive(MB)	4550	9100	9100, 18200	18200	9100
Nominal disk diameter (mm)	95	95	95	35	95
ARRAY SIZE: Inches: H x W x D	72.6 x 47.5 x 32	76.6 x 47.5 x 32	N/A	N/A	62.2 x 29.5 x 38.5
POWER: Power backup	5.17 KVA (max) Cache battery	4.0 KVA (max) Cache battery	.54 KVA Battery	1.32 KVA Battery	3.2 KVA (max.) Battery
FIRST CUSTOMER SHIPMENT	5/99	8/99	1Q97	4Q99	10/96
COMMENTS	*Assumes 3.6X data compress. (STC Iceberg).	*Assumes 3.6X data compress.	Internal disk option for 13 models of S/390 Multiprise 2000 Compatible with 3380, 3390.	*Expandable to 792 GB, with 56 drives. 3380 & 3390 disk formats.	*Attaches to 9390-001/002 controller.

MANUFACTURER	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX
ARRAY MODEL	GDT6117RP	GDT6118RD	GDT6127RP	GDT6128RD	GDT6517RP
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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.	PCI host Windows, NT NetWare, other	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PCI host Windows, NT NetWare, other	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.
RAID level Configured by:	0/1	0/1	0/1	0/1	0/1/4/5/10
RAB EDAP Classification	--	--	--	--	--
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	21	28	35	14
Concurrent host channels	1	1	2	1	1
Drive channels	2-5	1*	2-5	2*	2-5
Array interface to host/net	PCI	PCI	PCI	PCI	PCI
Drive interface	Ultra SCSI	Ultra2 SCSI	Ultra SCSI	Ultra2 SCSI	Ultra SCSI
Cache size (min, max: MB)	4, 64	4, 128	4, 64	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)	132 40	132 80	132 40	132 80	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
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	4/97	7/98	4/97	7/98	4/97
COMMENTS	Upgradable to RAID-4/5/10.	*Plus 1 Ultra SCSI channel.	Upgradable to RAID-4/5/10.	*Plus 1 Ultra SCSI channel.	

MANUFACTURER	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX
ARRAY MODEL	GDT6518RD	GDT6527RP	GDT6528RD	GDT6537RP	GDT6538RD
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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 Windows, NT NetWare, other	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PCI host Windows, NT NetWare, other	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PCI host Windows, NT NetWare, other
RAID level Configured by:	0/1/4/5/10	0/1/4/5/10	0/1/4/5/10	0/1/4/5/10	0/1/4/5/10
RAB EDAP Classification	--	--	--	--	--
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	21	28	35	42	49
Concurrent host channels	1	2	1	3	1
Drive channels	1*	2-5	2*	2-5	3*
Array interface to host/net	PCI	PCI	PCI	PCI	PCI
Drive interface	Ultra2 SCSI	Ultra SCSI	Ultra2 SCSI	Ultra SCSI	Ultra2 SCSI
Cache size (min, max: MB)	4, 128	4, 64	4, 128	4, 64	4, 128
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 80	132 40	132 80	132 40	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
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	7/98	4/97	7/98	4/97	7/98
COMMENTS	*Plus 1 Ultra SCSI channel.		*Plus 1 Ultra SCSI channel.		*Plus 1 Ultra SCSI channel.

MANUFACTURER	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX
ARRAY MODEL	GDT6557RP	GDT6558RD	GDT6618RD	GDT6628RD	GDT6638RD
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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.	PCI host Windows, NT NetWare, other	PCI host NetWare,OS/2,NT DOS,UNIX,Linux	PCI host NetWare,OS/2,NT DOS,UNIX,Linux	PCI host NetWare,OS/2,NT DOS,UNIX,Linux
RAID level Configured by:	0/1/4/5/10	0/1/4/5/10	0/1/4/5/10	0/1/4/5/10	0/1/4/5/10
RAB EDAP Classification	--	--	--	--	--
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	70	77	15	30	45
Concurrent host channels	5	1	1	2	3
Drive channels	2-5	5*	1	2	3
Array interface to host/net	PCI	PCI	PCI	PCI	PCI
Drive interface	Ultra SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)	4, 64	4, 128	16, 128	16, 128	16, 128
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 80	132 80	132 80	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
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	4/97	3/98	5/99	5/99	5/99
COMMENTS		*Plus 1 Ultra SCSI channel.			

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MANUFACTURER	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX	ICP VORTEX
ARRAY MODEL	GDT6658RD	GDT7519RN	GDT7529RN	GDT7619RN	GDT7629RN
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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 NetWare,OS/2,NT DOS,UNIX,Linux	PCI host NetWare,OS/2,NT DOS,UNIX,Linux	PCI host NetWare,OS/2,NT DOS,UNIX,Linux	PCI host NetWare,OS/2,NT DOS,UNIX,Linux	PCI host NetWare,OS/2,NT DOS,UNIX,Linux
RAID level Configured by:	0/1/4/5/10	0/1/4/5/10	0/1/4/5/10	0/1/4/5/10	0/1/4/5/10
RAB EDAP Classification	--	--	--	--	--
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	2	1	2
Maximum drives per array	75	125	250	125	250
Concurrent host channels	3	1	2	1	2
Drive channels	5	1	2	1	2
Array interface to host/net	PCI	PCI	PCI	PCI	PCI
Drive interface	Ultra2 SCSI	FC-AL	FC-AL	FC-AL	FC-AL
Cache size (min, max: MB)	16, 128	31, 128	31, 128	31, 128	31, 128
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 80	132 100	132 100	132 100	132 100
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
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	5/99	4/99	4/99	4/99	4/99
COMMENTS					

MANUFACTURER	INFORTREND	INFORTREND	INFORTREND	INFORTREND	INFORTREND
ARRAY MODEL	IFT-2101U2A* IFT-2101U2B	IFT-2101UA* IFT-2101UB	IFT-3101U	IFT-3101U2G IFT-3101U2G-50	IFT-3101UGA(L) IFT-3101UGB(L)
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	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 DOS, NT, OS/2, UNIX, NetWare	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1/3/5/10 Host	0/1/3/5/10 Host	0/1/3/5/10/30* Port, Panel	0/1/3/5/10/30* Port, Panel	0/1/3/5/10/30* Port
RAB EDAP Classification	--	--	--	--	--
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	45	15*/30	30	45	30
Concurrent host channels	1	1	1, 2	1, 3	1, 2
Drive channels	1, 2	1, 2	1-2	1-3	1, 2
Array interface to host/net	PCI	PCI	Ultra SCSI	Ult.SCSI/LVD/FC	Ultra SCSI
Drive interface	LVD	Ultra SCSI	Ultra SCSI	Ult.SCSI/LVD/FC	Ultra SCSI
Cache size (min, max: MB)	8, 128	8, 64	8, 64	8, 128	8, 64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No -- --	Yes -- --	Yes -- --	Yes -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 80	132 40	40 40	80/100 80/100	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
ARRAY SIZE: Inches: H x W x D	9.21 x 4.2	4.2 x 6.88	1.61 x 4.01 x 6.26	1.61 x 4.01 x 9.47	
POWER: Power backup	None	None	6.5 watts None	None	None
FIRST CUSTOMER SHIPMENT	12/98	8/96	8/96	7/99	8/97
COMMENTS	Flash memory firmware. *Single output channel.	Flash memory firmware. *Single output channel.	Flash memory firmware. *Also RAID 50.	Flash memory firmware. *Also RAID 50.	Flash memory firmware. *Also RAID 50.

MANUFACTURER	INFORTREND	INFORTREND	INFORTREND	INFORTREND	INTEGRIX
ARRAY MODEL	IFT-3102U2	IFT-3102U2G IFT-3102U2G-50	IFT-3102UA	IFT-3102UG IFT-3102UGN	R1500
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	DIST
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 Various	Sun, PC, Mac Solaris, NT, MacOS, Linux
RAID level Configured by:	0/1/3/5/10/30* Port, Panel	0/1/3/5/10/30* Port, Panel	0/1/3/5/10/30* Port, Panel	0/1/3/5/10/30* Port, Panel	0/1/3/5/10 Host, Port
RAB EDAP Classification	--	--	--	--	
Array capacity (Gbytes) MIN MAX	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	105	75	105	6
Concurrent host channels	1, 5	1, 7	1, 5	1, 7	1, 2
Drive channels	1-5	1-7	1-5	1, 7	
Array interface to host/net	Ultra SCSI/LVD	Ult.SCSI/LVD/FC	Ultra SCSI/LVD	Ult.SCSI/LVD/FC	Various
Drive interface	Ultra SCSI/LVD	Ult.SCSI/LVD/FC	Ultra SCSI/LVD	Ult.SCSI/LVD/FC	SCSI-2
Cache size (min, max: MB)	8, 128	8, 128	8, 128	8, 128	32, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	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)	80 80	40/80/100 40/80/100	40/80 40/80	40/80/100 40/80/100	40/80/100 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4200-50000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	95
ARRAY SIZE: Inches: H x W x D	1.6 x 5.7 x 8.8	1.6 x 5.7 x 8.4	1.6 x 5.7 x 8.4	1.6 x 5.7 x 8.4	5.15 x 17.55 x 18.08
POWER: Power backup	Battery option	Battery option	7.5 watts Battery option	Battery option	150 watts
FIRST CUSTOMER SHIPMENT	7/98	10/98	8/96	8/98	
COMMENTS	Flash memory firmware. *Also RAID 50.	Flash memory firmware. *Also RAID 50.	Flash memory firmware. *Also RAID 50.	Daughter boards for drive channels. Flash memory firmware. *Also RAID 50.	Rack option.

MANUFACTURER	INTEGRIX	LAND-5	LAND-5	LEGACY STORAGE SYSTEMS	LEITCH TECHNOLOGY (ASC)
ARRAY MODEL	R2000	DS 2000 ICEbox	FC 2500 ICEbox	UDSS DiskARRAY	RAIDsoft
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Spec High Perf.
MARKET	DIST	DIST, OEM	DIST, OEM	OEM, DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Software Host Software
Host platform, software environment	Sun, PC, Mac Solaris, NT, MacOS, Linux	SCSI, FC host Various		SCSI host NetWare, NT, OS/2, UNIX	Leitch VR Srver VR300 VR400
RAID level Configured by:	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Panel	0/1/3/5/10	0/1/3/5/10	4 Host
RAB EDAP Classification		--	--	--	
Array capacity (Gbytes) MIN MAX	Drive dependent	13.65 327.6	655.2	Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	3	2	3	10
Maximum drives per array	12	18	18	8	50
Concurrent host channels	1, 2	1, 3	1, 3	1, 4	1, 2
Drive channels		3, 3	1, 3	1, 2, 3, 5	1, 2
Array interface to host/net	Various	Ultra SCSI, FC	FC-AL	Ethernet	FC-AL
Drive interface	SCSI-2	Ultra SCSI	FC-AL	Ultra SCSI	FC-AL
Cache size (min, max: MB)	32, 512	64/128		32	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Yes Yes Yes	Option Yes Yes	Option	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	80-100 40	100 100	40 40	100 100
DRIVES: Formatted capacity/drive(MB)	4200-50000	4550-18200	36400	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	8.75 x 19 x 22	10.5 x 17.25 x 28	Rack mount		-- --
POWER: Power backup	150 watts	Dual 400 watts Optional UPS			-- --
FIRST CUSTOMER SHIPMENT		1998	10/99	12/97	5/97
COMMENTS	Dual controllers.		Expandable to 15 units.		For use with ASC video servers.

MANUFACTURER	LIGHTHOUSE TECHNOLOGY	LOCOM	LSI LOGIC	LSI LOGIC	LSI LOGIC
ARRAY MODEL	Harbor	9920	S-Class (D.C.) Data Center	S-Class (Dept.) Department	SH7000 Department MetaStor
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	OEM, DIST	DIST	DIST	DIST
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 host UNIX	* Various	FC-AL host UNIX, NT	FC-AL host UNIX, NT	SCSI,FC-AL host UNIX, NT, DOS SMB, NW, AT
RAID level Configured by:	0/1/3/5/10 Panel	0/1/3/5* *	0/1/3/5/10	0/1/3/5/10	0/1/3/5 Host, Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	720 5000	180 3000	45 1440
Minimum drives per array	3	2	40	10	5
Maximum drives per array	32	16	100	60	80
Concurrent host channels	1, 4	1	2	2	4
Drive channels	1, 8	1-32	6	6	5
Array interface to host/net	Ultra SCSI	*	FC-AL	FC-AL	Ultra2, FC-AL
Drive interface	Ultra SCSI	SSA	Ultra2 SCSI	Ultra2 SCSI	Ultra
Cache size (min, max: MB)	16, 128	*	256	256	256, 768
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
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	* 80	100 80	100 80	80/100 40/100
DRIVES: Formatted capacity/drive(MB)	2000-36000	2200-9100	18200-50000	18200-50000	9100-50000
Nominal disk diameter (mm)	95	95	84	84	95
ARRAY SIZE: Inches: H x W x D	Varies		72 x 22 x 36	20.8 x 21.5 x 27.1	72 x 22 x 36
POWER: Power backup	Cache battery	*	Cache battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	1996	1996	10/98	10/98	4Q97
COMMENTS	CMD controller.	*Determined by user specified controller or software.			

MANUFACTURER	LSI LOGIC	LSI LOGIC	LSI LOGIC	LSI LOGIC	LSI LOGIC
ARRAY MODEL	SH7400 Data Center MetaStor	SH850 Workgroup MetaStor	SYM1000-3621 SYM1000-3702	SYM1000-4766	SYM2000-3240
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	OEM	OEM	OEM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Network Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI,FC-AL host UNIX, NT, DOS SMB	Intel/SPARC NFS, SMB NetW.,Appletalk	SCSI,FC-AL host UNIX, NT, DOS, NetWare, other	FC-AL host UNIX, NT, DOS, NetWare, other	SCSI host UNIX, NT, DOS, NetWare, other
RAID level Configured by:	0/1/3/5 Host, Port	5 Panel,Web brows	0/1/3/5 Host, Port	0/1/3/5 Host, Port	0/1/3/5 Host, Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	90 1080	27.3 180	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	10	3	N/A	N/A	3
Maximum drives per array	60	10	65	N/A	10
Concurrent host channels	6	2	2	2	1
Drive channels	5	2	5	5	2
Array interface to host/net	Ultra2, FC-AL	E'net, various	Ult.SCSI, FC-AL	FC-AL	Ultra SCSI
Drive interface	Ultra	Ultra SCSI	Ultra SCSI	Ultra2 SCSI	Ultra SCSI
Cache size (min, max: MB)	256, 512	64	8, 128	16, 256	8, 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
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	80/100 40/100	80 40	40/100 40	100 80	40 40
DRIVES: Formatted capacity/drive(MB)	9100-50000	9100-50000	Drive dependent	Drive dependent	9100, 18200
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	95
ARRAY SIZE: Inches: H x W x D	72 x 22 x 36	22 x 16 x 29	6.9 x 17.5 x 24	7 x 18.5 x 26	5.25 x 17.5 x 25
POWER: Power backup	Cache battery	Cache battery	Cache battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	4Q97	1Q98	1Q97	2Q98	3Q97
COMMENTS			Controller unit in modular packaging.	Controller unit in modular packaging.	

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MANUFACTURER	MACRO COMPUTER PRODUCTS	MACRO COMPUTER PRODUCTS	MACRO COMPUTER PRODUCTS	MACRO COMPUTER PRODUCTS	MARNER
ARRAY MODEL	MSR1100	MSR3000	MSR7000	MSR8000	Performance Storage
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Mainframe	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	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	Unisys, NT WIN, NetWare	HP, Unisys,NT,UNIX NetWare	Unisys A, V Other SCSI UNIX	Sun SPARC Solaris
RAID level Configured by:	3/5	0/1/4/5/10	0/1/5/10	"7" Preset	0/1/5
RAB EDAP Classification	--			--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent	Drive dependent	Drive dependent Drive dependent	18.2/9.1/22 82/36/65
Minimum drives per array	2	2	2	3	2
Maximum drives per array	10	30	45	48	9
Concurrent host channels	1	1, 2	1, 2	1, 12	1-5
Drive channels	1, 48	2	3	1, 48	
Array interface to host/net	SCSI-2	Ultra2 SCSI	Ultra2 SCSI	Ult. SCSI,FC-AL	SCSI
Drive interface	EIDE	Ultra2 SCSI	Ultra2 SCSI	SCSI-2	SCSI
Cache size (min, max: MB)	--	32, 256		4, 256	--, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	Yes Yes Yes	Yes Yes Yes	Option Yes Yes	Option Yes No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 13	80 80	80 80	10/20/40/100 10	20 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	4300-9100	9100
Nominal disk diameter (mm)	95	95	95	95, 130	95
ARRAY SIZE: Inches: H x W x D		Varies with configuration	Varies with configuration	Varies with configuration	19 x 8.75 x 16
POWER: Power backup				1.3 KVA None	
FIRST CUSTOMER SHIPMENT	1/97	1999	1999	9/96	1997
COMMENTS	Purchased controller.	Dual CMD 5640 controller.		Storage Computer controller. Nonvolatile memory option.	Infortrend controller.

MANUFACTURER	MAXTOR	MAXTOR	MAXTRONIC INTERNATIONAL	MAXTRONIC INTERNATIONAL	MAXTRONIC INTERNATIONAL
ARRAY MODEL	MaxAttach	ReflectIt	Arena M2	Arena LA Arena 99	Arena P3
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Single User	Net/Midrange	Net/Midrange
MARKET	DIST, OEM	DIST, OEM	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Software	Software Network Software	Board Host Hardware	Subsystem Host Hardware	Board Host Hardware
Host platform, software environment	Windows, NT	Windows, NT	IDE host Various	SCSI host Various	IDE host Various
RAID level Configured by:	0 Preset	1 Preset	1	0/1/5	0/1/5
RAB EDAP Classification	--	--	--		
Array capacity (Gbytes) MIN MAX	Drive dependent	Drive dependent	Drive dependent	 80	 120
Minimum drives per array	2	2	2	2/3	3
Maximum drives per array	2	--	2	6	3
Concurrent host channels	1	1	1	1	1
Drive channels	1	1	2	3	3
Array interface to host/net	Ethernet	Ethernet	EIDE	Ultra SCSI	PCI
Drive interface	EIDE	Config. depend.	EIDE	EIDE	EIDE
Cache size (min, max: MB)	--	--	--	8, 128	8, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/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)	1.2/12 16.7, DMA 33	1.2/12 Drive dependent	33 UDMA 33 UDMA	40 33 UDMA	132 33 UDMA
DRIVES: Formatted capacity/drive(MB)	18000, 36000	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	Drive dependent	95	95	95
ARRAY SIZE: Inches: H x W x D	2.5 x 11 x 8.75	-- --		13.8 x 6.9 x 12.2	
POWER: Power backup	60 watts	-- --		250 watts	
FIRST CUSTOMER SHIPMENT	4Q99	4Q99	1999		1999
COMMENTS		Intersystem mirroring.	80486 processor	80486 processor	80486 processor

MANUFACTURER	MAXTRONIC INTERNATIONAL	MAXTRONIC INTERNATIONAL	MAXTRONIC INTERNATIONAL	MICRON ELECTRONICS	MICRON ELECTRONICS
ARRAY MODEL	Arena 99EX Arena LE Arena EX Arena Silver	EX Industrial	Industrial	NF2100	NF3101 NF3100
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Network Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	Micron NT, NetWare	Micron NetWare, NT
RAID level Configured by:	0/1/3/5/10 Panel, Port	0/1/3/5/10	0/1/5	0/1/5/10	0/1/5/10 Host
RAB EDAP Classification	--			--	--
Array capacity (Gbytes) MIN MAX	4.3 50	120	120	54	Drive dependent
Minimum drives per array	2/3	2/3	2/3	2/3	2/3
Maximum drives per array	6	6	6	6	5
Concurrent host channels	1	1	1	1	1
Drive channels	3	3	3	2	
Array interface to host/net	Ultra SCSI	Ultra SCSI*	Ultra SCSI*	PCI	PCI
Drive interface	Ultra SCSI	EIDE	EIDE	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	8, 256	8, 256	8, 128	8, 32	8, 32
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	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	40/80* 33 UDMA	40/80* 33 UDMA	132 40	132 40
DRIVES: Formatted capacity/drive(MB)	9100	Drive dependent	Drive dependent	9100, 18000	9100, 18000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	13.8 x 6.9 x 12.2	6.9 x 19 x 15.75	6.9 x 19 x 15.75		
POWER: Power backup	250 watts	250 watts	250 watts		
FIRST CUSTOMER SHIPMENT	1998			3Q98	1998
COMMENTS	i960 processor.	i960 processor. *Optional LVD.	80486 processor *Optional LVD.	Complete server Mylex controller.	Complete server Mylex controller.

MANUFACTURER	MICRON ELECTRONICS	MICRON ELECTRONICS	MICRON ELECTRONICS	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY
ARRAY MODEL	NF5200	NF6201 NF6200	NF9200 NF9201	DataDock	DV Series
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Single User
MARKET	DIST	DIST	DIST	OEM, DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Host Hardware	Subsystem Host Software	Subsystem Host Software
Host platform, software environment	Micron NT, NetWare	Micron NT	Micron NT, NetWare	SCSI host Apple, NT	Macintosh
RAID level Configured by:	0/1/5	0/1/3/5/10 Host	0/1/3/5/10/30*	0/1 Host	0/1 Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	18.2 86	 54	18.2 648	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2/3	2	2	2
Maximum drives per array	6	6	45	3	6
Concurrent host channels	1	1	1	1, 2	1, 2
Drive channels		2	3	1, 2	1, 2
Array interface to host/net	PCI	PCI	PCI	Ultra2 SCSI	Ultra SCSI
Drive interface	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra SCSI
Cache size (min, max: MB)	8, 32	8, 32	32, 64	.5, 2	.5, 1
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	Option Yes Yes	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 80	132 80	132 80	80 80	40 40
DRIVES: Formatted capacity/drive(MB)	9100, 18000	9100, 18000	9100, 18000	4300-18200	4300-18200
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D				8.25 x 12.25	6.5 x 18 x 18
POWER: Power backup			750 watts	100 watts None	45 watts None
FIRST CUSTOMER SHIPMENT	1999	3Q98	1999	2Q95	2Q95
COMMENTS	Complete server Mylex controller.	Complete server Mylex controller.	Complete server Mylex controller. *Also RAID 50.	Expandable. Rack mount option. Software array.	

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MANUFACTURER	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MOUNTAINGATE DATA SYSTEMS
ARRAY MODEL	ExpressRAID	DataDock 7000	Genesis	GenesisONE	CentraVision
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Software -- Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Software
Host platform, software environment	Apple Power Macintosh	SCSI host Various	Fibre host Various	Apple Mac OS	PCI host Various
RAID level Configured by:	0/1 Host	0/1/3/5/10 Port	0/1/3/5/10	0/1/3/5/10	0/1 Host
RAB EDAP Classification	--	--	--		--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	63 252	63 252	Drive dependent Drive dependent
Minimum drives per array	2	2	7	7	2
Maximum drives per array	6	7	28	28	8
Concurrent host channels	1, 6	1	1, 2	1, 2	1
Drive channels	15, 90	1	1, 4	1, 4	1
Array interface to host/net	--	Ultra SCSI	FC-AL		PCI
Drive interface	--	Ultra SCSI	Ultra SCSI	Ultra SCSI	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 Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Drive dependent Drive dependent	10/20 20/40	100 20/40	100 20/40	132 100
DRIVES: Formatted capacity/drive(MB)	Drive dependent	4300-18200	18200, 36000	9000-36000	4200-23000
Nominal disk diameter (mm)	Drive dependent	95	95	95	95, 130
ARRAY SIZE: Inches: H x W x D	--	18 x 8.75 x 21.5	54 x 26 x 31.5	54 x 26 x 31.5	19 x 8.75 x 21
POWER: Power backup	--	300 watts Cache battery	Cache battery	Cache battery	.48 KVA None
FIRST CUSTOMER SHIPMENT	4Q98	3Q96	1/99	7/99	1997
COMMENTS	Includes drive management features. Requires SCSI controller.	Expandable. Rack mount option.			Anubis RAID software. Rack mount option.

MANUFACTURER	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY
ARRAY MODEL	2550 Gladiator	3200 Gladiator	3500 Gladiator	3600 Gladiator	6700 Gladiator
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Network Hardware
Host platform, software environment	NT, NetWare, Linux	SCSI host UNIX, Windows NT	SCSI host UNIX, Windows NT	FC host UNIX, Windows NT	Fibre host Windows NT, UNIX
RAID level Configured by:	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10
RAB EDAP Classification		--			DTDS+
Array capacity (Gbytes) MIN MAX	54 655	72.8 801.6	109.2 2354.7	109.2 3557.1	218.4 582.4
Minimum drives per array	6	8	12	12	12
Maximum drives per array	36	16	47	71	32
Concurrent host channels		1 or 2	2	2	2
Drive channels		2	4	6	2
Array interface to host/net	Ultra SCSI	Ultra SCSI	Ultra SCSI	FC-AL	FC-HSSDC
Drive interface	Ultra2 SCSI	SCSI-2	Ultra SCSI	Ultra SCSI	FC-HSSDC
Cache size (min, max: MB)		64*	128, 256*	128, 256*	128, 256*
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)	40 40	40 20	40 40	100 40	100 100
DRIVES: Formatted capacity/drive(MB)	9100, 18200	9100-50100	9100-51000	9100-50100	9100, 18200
Nominal disk diameter (mm)	95	90	95	95	95
ARRAY SIZE: Inches: H x W x D		8.75 x 19 x 22 rack	14 x 19 x 23	14 x 19 x 23	17 x 19 x 23
POWER: Power backup		165 watts Cache BBU std.	153 watts UPS option	172 watts UPS option	240 watts BBU power supp
FIRST CUSTOMER SHIPMENT	5/99	6/97	1Q99	9/98	1Q99
COMMENTS		*Per mirrored controller. Dual AC.	*Per mirrored controller. Dual AC. FC-AL option.	*Per mirrored controller. Dual AC.	*Per mirrored controller. Dual AC.

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MANUFACTURER	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MYLEX	MYLEX
ARRAY MODEL	Vivant V10	Vivant V20	Vivant V30	2000 eXtremeRAID	3000 eXtreme RAID
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	Fibre host Windows NT, UNIX	Fibre host Windows NT, UNIX	Fibre host Windows NT, UNIX	PCI host WIN,NT,NetWare UNIX,Linux,oth.	PCI host WIN,NT,NetWare UNIX,Linux,oth.
RAID level Configured by:	0/1/5/10	0/1/5/10	0/1/5/10	0/1/3/5/10/30* Host	0/1/3/5/10/30* Host
RAB EDAP Classification	DTDS+	DTDS+	DTDS+	--	--
Array capacity (Gbytes) MIN MAX	218.4 3006.0	218.4 3006.0	873.6 9619.2	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	12	12	24	2	2
Maximum drives per array	60	60	192	60	250
Concurrent host channels	4-8	16-32	64-96	1	1
Drive channels	2	2	2	4	2
Array interface to host/net	FC-HSSDC	FC-HSSDC	FC-HSSDC	PCI-64 bit	PCI-64 bit
Drive interface	FC-HSSDC	FC-HSSDC	FC-HSSDC	Ultra 160m SCSI	FC-AL
Cache size (min, max: MB)	128, 256*	128, 256*	128, 256*	32, 256	32, 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	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 100	100 100	100 100	133, 266 160	133, 266 100
DRIVES: Formatted capacity/drive(MB)	18200-50100	18200-50100	18200-50100	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	40 x 21 x 26	40 x 21 x 26	70 x 21 x 26		
POWER: Power backup	N/A BBU power supp	N/A BBU power supp	N/A BBU power supp	17.5 w + drives Cache battery	22.5 w + drives Cache battery
FIRST CUSTOMER SHIPMENT	8/99	9/99	10/99	4Q99	4Q99
COMMENTS	*Per mirrored controller. Dual AC.	*Per mirrored controller. Dual AC.	*Per mirrored controller. Dual AC.	*Also RAID 50. SAF-TE, SES, SMART support.	*Also RAID 50. Auxiliary Ultra2 SCSI channel. SAF-TE, SES, SMART support.

MANUFACTURER	MYLEX	MYLEX	MYLEX	MYLEX	MYLEX
ARRAY MODEL	AcceleRAID 352	DAC1164 eXtremeRAID	DAC960-PRL-1 AcceleRAID 150	DAC960-PTL-0 AcceleRAID 200	DAC960-PTL-1 AcceleRAID 250
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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 WIN,NT,NetWare UNIX,Linux,oth.	PCI host WIN,NT,NetWare UNIX,Linux,oth.	PCI host WIN,NT,NetWare UNIX,Linux,oth.	PCI host NetWare, OS/2, NT, UNIX, DOS	PCI host NetWare, OS/2, NT, UNIX, DOS
RAID level Configured by:	0/1/3/5/10/30* Host	0/1/3/5/10/30 Host	0/1/3/5/10/30 Host	0/1/3/5/10 Host	0/1/3/5/10 Host
RAB EDAP Classification	--	--	--	--	--
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	30	30
Concurrent host channels	1	1	1	1	1
Drive channels	2	3	2*	2*	2,*
Array interface to host/net	PCI-64 bit	PCI-64 bit	PCI	PCI	PCI
Drive interface	Ultra 160m SCSI	Ultra2 SCSI	Ultra-2 SCSI	Ultra2 SCSI*	Ultra2 SCSI*
Cache size (min, max: MB)	32, 64	32, 64	4, 16	4, 128	4, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	No -- --	No -- --	No -- --	No -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	133 160	133, 266 80	133 80	132 40, 80	132 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
ARRAY SIZE: Inches: H x W x D				4.2 x 7.225	4.2 x 7.225
POWER: Power backup	17.5 w + drives	17.5 w + drives Cache battery	17.5 w + drives	17.5 watts	17.5 watts
FIRST CUSTOMER SHIPMENT	4Q99	8/98	4Q98	8/98	8/98
COMMENTS	*Also RAID 50. SAF-TE, SES, SMART support.	233 MHz RISC processor. I20 compliant. Also RAID 50.	33 MHz RISC processor. Also RAID 50. *Also uses motherboard SCSI channels.	*Uses mother board SCSI channels. Also RAID 50. SAF-TE & SMART compliant.	*Also uses motherboard SCSI channels. Also RAID 50. SAF-TE & SMART compliant.

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MANUFACTURER	MYLEX	MYLEX	MYLEX	MYLEX	MYLEX
ARRAY MODEL	DAC960PG	DAC960SF	DAC960SX	DAC960SXI	DACPGM
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM	OEM	OEM, DIST	DIST
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 NetWare, OS/2, NT, UNIX	FC-AL host Various	SCSI host Various	SCSI host Various	PCI host NetWare, OS/2, NT, UNIX
RAID level Configured by:	0/1/3/5/10 Host	0/1/3/5/10 Host, Port	0/1/3/5/10 Host	0/1/3/5/10 Host, Panel	0/1/3/5/10/30*
RAB EDAP Classification	--	--	--	--	--
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	15/30/45	90**	30/75**	30/75**	45
Concurrent host channels	1	2	1, 2*	1, 2**	1
Drive channels	1, 2, 3	6	2, 5*	2, 5*	1, 3
Array interface to host/net	PCI	FC-AL	Ultra SCSI	Ultra SCSI	PCI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	4, 128	32, 256	16, 64	16, 256	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	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	100 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
ARRAY SIZE: Inches: H x W x D	4.5 x 13	5.5 x 8	5.70 x 8	3.250 x 5.75 x 8	4.5 x 13
POWER: Power backup	17 watts Battery*	3 watts Battery option	22 watts Cache battery	22 watts Cache battery	17.5 watts Battery
FIRST CUSTOMER SHIPMENT	1/97	4Q97	3/97	3/97	1Q98
COMMENTS	*Option. I2O, SMART, SAF-TE compliant. Online reconfig and expansion.	SAF-TE *Active-Active. **with daughter board. Mirrored cache. Also Raid 50.	*Active-Active failover. **With DBI960SX daughter board. 33 MHz i960 mirrored cache.	*Active-Active failover. **With DBI960SX daughter board. 33 MHz i960 mirrored cache.	i960 processor. *Also RAID-50.

MANUFACTURER	MYLEX	MYLEX	MYLEX	MYLEX	MYLEX
ARRAY MODEL	RAIDPlus	Rome	SANArray FFx	SANArray Pro FL (DACFL)	SANArray Pro FF (DACFF)
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM	OEM, DIST	OEM	OEM
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Chip Set	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	PCI host NT, Windows 95, DOS	Various	FC host UNIX, NT	PCI host NetWare, OS/2, NT, UNIX	NetWare, NT UNIX
RAID level Configured by:	0/1/10 Host	0/1/3/5/10 Host	0/1/3/5/10/30*	0/1/3/5/10/30*	0/1/3/5
RAB EDAP Classification	--	--	--	--	--
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	15/30/45	250	45	500
Concurrent host channels	1	1	1	2-FC-Loops	2
Drive channels	1, 2, 3	1, 2, 3	2	4	4
Array interface to host/net	PCI	PCI	FC-AL	FC-AL	FC-AL
Drive interface	Ultra SCSI	Ultra SCSI	FC-AL	Ultra2 SCSI	FC-AL
Cache size (min, max: MB)	--	4, 128	64, 128	256	32-256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	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	100 100	100 80	100 100
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
ARRAY SIZE: Inches: H x W x D	4.5 x 7		1 x 4 x 9	1.5 x 5.5 x 7.85	1.50 x 5.50 x 7.85
POWER: Power backup	3 watts		10 watts+drives	50.5 watts Cache battery	50.5 watts Cache battery
FIRST CUSTOMER SHIPMENT	3Q97	2Q97	4Q99	4Q98	1Q99
COMMENTS	RAID upgrade to existing host has adapter products.	I20, SMART, SAF-TE compliant. Online reconfig and expansion.	*Also RAID 50. SAN support. External mount. SAF-TE, SES, SMART support.	i960 processor. *Also RAID-50. *Active, Active failover. Mirrored cache.	Dual i960 processors Active-Active failover, failback. Mirrored cache.

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
ARRAY MODEL	AJ2550 PC-DA12	DS1000	DS1000F	DS1000V	DS1100FV
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, OEM	Captive, OEM	Captive	Captive, OEM	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	SCSI host NetWare, NT, DOS, OS/2	SCSI host NT, UNIX	FC-AL host UNIX	SCSI host UNIX	FC-AL host UNIX, NT
RAID level Configured by:	1/5	1/3/5	1/3/5	3	3
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	5 12.5	8.4 211.7	8.4 211.7	36 144	36 144
Minimum drives per array	3	3	3	5	5
Maximum drives per array	6	30	30	20	20
Concurrent host channels	1	2, 4	1, 2	1, 2	1, 2
Drive channels		3		3	
Array interface to host/net	SCSI-2	SCSI-2	FC-AL	SCSI-2	FC-AL
Drive interface	IDE	SCSI-2	SCSI	SCSI-2	SCSI
Cache size (min, max: MB)	2	8, 128	8, 128	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 13.3	20 20	100 20	20 10	100 10
DRIVES: Formatted capacity/drive(MB)	2500	4180-8820	4180, 8820	9000	9000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	12 x 15 x 33.7	22.6 x 14.2 x 28.7	23.6 x 14.2 x 28.7	12.09 x 19 x 26.38	12.09 x 19 x 26.38
POWER: Power backup	70 watts Battery	880 watts Battery	880 watts Battery	650 watts None	650 watts None
FIRST CUSTOMER SHIPMENT	1/97	3/97	9/97	12/96	6/98
COMMENTS					

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
ARRAY MODEL	DS1100V	DS450	N3250 N3760	N3251/N3730	N3255/N3770
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Mainframe	Mainframe	Mainframe
MARKET	Captive	Captive, OEM	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	SCSI host UNIX	SCSI host NT, UNIX	ACOS-4	ACOS-4	ACOS-4
RAID level Configured by:	3	0/1/5 Host, Panel	1/3 Port, host	1 Host	1, 5 Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	36 144	8 35	33.6 134.8	8.4 16.8	101.1 1079.1
Minimum drives per array	5	3	8	8	20
Maximum drives per array	20	6	96	16	200
Concurrent host channels	1, 2	1, 2	2, 4	2, 2	4, 8
Drive channels					
Array interface to host/net	SCSI	Ultra SCSI	NEC-PSI	NEC-PSI	FC-AL
Drive interface	SCSI	SCSI-2	SCSI	SCSI	Wide Ultra SCSI
Cache size (min, max: MB)	--	16, 128	--, 2048	--	512, 16384
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)	None	Auto	None	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 10	40 20	4.5, 6, 20 10	4.5, 6 10	100 40
DRIVES: Formatted capacity/drive(MB)	9000	4000, 8800	2100, 4300	2100	9100
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	12.09 x 19 x 26.38	19.5 x 7 x 23.6	59.8 x 34.6 x 29.9	52.6 x 19.7 x 29.9	70.4 x 74.8 x 35.4
POWER: Power backup	650 watts None	200 watts Battery	3.5 KVA Battery	1.5 KVA None	8.5 watts Battery
FIRST CUSTOMER SHIPMENT	7/97		9/95	9/95	1/99
COMMENTS					

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
ARRAY MODEL	N3732	N3736	N3737	N3738	N3739
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	ACOS-6	ACOS-4	ACOS-4	ACOS-4	ACOS-4
RAID level Configured by:	1 Panel	1 Port	1 Port	1 Port	1 Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	10 42.8	8.2 62.2	16.5 124.3	8.2 62.2	16.5 124.3
Minimum drives per array	16	8	8	8	8
Maximum drives per array	64	20	20	20	20
Concurrent host channels	2, 4	2, 2	2, 2	2, 2	2, 2
Drive channels					
Array interface to host/net	NEC-PSI	SCSI	SCSI	FC-AL	FC-AL
Drive interface	SCSI	SCSI	SCSI	FWD-SCSI	FWD-SCSI
Cache size (min, max: MB)	--, 512	8, 128	8, 128	8, 128	8, 128
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)	None	None	None	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	4.5, 6 10	20 20	20 20	100 20	100 20
DRIVES: Formatted capacity/drive(MB)		2100	4300	2100	4300
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	59.8 x 34.6 x 29.9	52.6 x 23.6 x 35.4	52.6 x 23.6 x 35.4	52.6 x 23.6 x 35.4	52.6 x 23.6 x 35.4
POWER: Power backup	3 KVA None	1.5 KVA Battery	1.5 KVA Battery	1.5 watts Battery	1.5 watts Battery
FIRST CUSTOMER SHIPMENT	7/96	4/97	4/97	4/98	4/98
COMMENTS					

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
ARRAY MODEL	N3761	N3762	N3763	N3764	N3775
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	ACOS-6	ACOS-4	ACOS-4	ACOS-4	ACOS-4
RAID level Configured by:	1 Panel	1/5 Panel	1 Panel	3 Panel	1, 5 Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	15.2 63.2	12.6 202.1	12.6 134.8	16.8 134.8	16.8 269.7
Minimum drives per array	16	12	12	12	8
Maximum drives per array	64	64	64	96	64
Concurrent host channels	2, 4	2, 4	2, 4	2, 4	8, 16
Drive channels					
Array interface to host/net	NEC-PSI	NEC-PSI	NEC-PSI	NEC-PSI	PSI
Drive interface	SCSI	SCSI	SCSI	SCSI	Wide Ultra SCSI
Cache size (min, max: MB)	--, 512	256, 2048	--, 2048	--, 2048	512, 16384
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)	None	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	4.5, 6 10	4.5, 6, 20 10	4.5, 6, 20 10	4.5, 6, 20 10	4.5, 6 40
DRIVES: Formatted capacity/drive(MB)		2100, 4300	2100, 4300	2100, 4300	9100
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	59.8 x 34.6 x 29.9	59.8 x 34.6 x 29.9	59.8 x 34.6 x 29.9	59.8 x 34.6 x 29.9	70.4 x 29.5 x 38.1
POWER: Power backup	3 KVA None	3.2 KVA Battery	3.2 KVA Battery	3.5 KVA Battery	2.5 watts Battery
FIRST CUSTOMER SHIPMENT	3/96	9/97	9/97	9/97	3/98
COMMENTS					

MANUFACTURER	NEC	NEC	NETWORK APPLIANCE INC.	NETWORK APPLIANCE INC.	NETWORK APPLIANCE INC.
ARRAY MODEL	N3776	N7764	F720 Filer	F740 Filer	F760 Filer
DISK/TREND GROUP	Mainframe	Spec High Perf.	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem* Network Software	Subsystem* Network Software	Subsystem* Network Software
Host platform, software environment	ACOS-4	SX-4 SX-5	F720 NFS,CIFS,HTTP, TCP/N	F740 NFS,CIFS,HTTP, TCP/N	F760 NFS,CIFS,HTTP, TCP/N
RAID level Configured by:	1, 5 Port	3	4 Preset	4 Preset	4 Preset
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	16.8 269.7	71.8 565.4	17.0 464.4	17.0 928.8	17.0 1393.2
Minimum drives per array	8	10	2	2	2
Maximum drives per array	64	40	28	28	28
Concurrent host channels	4, 8	1, 2	1	1, 2	1, 3
Drive channels			1	1, 2	1, 3
Array interface to host/net	FC-AL	HIPPI	FC-AL	FC-AL	FC-AL
Drive interface	Wide Ultra SCSI	Fast SCSI	FC-AL	FC-AL	FC-AL
Cache size (min, max: MB)	512, 16384	--	8	32	32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	No Yes Option	Option Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 40	100 10	100 100	100 100	100 100
DRIVES: Formatted capacity/drive(MB)	9100	9100, 18000	17000	17000	17000
Nominal disk diameter (mm)	95	95	95/84	95/84	95/84
ARRAY SIZE: Inches: H x W x D	70.4 x 29.5 x 38.1	61.4 x 32.3 x 29.9	8.75 x 17.25 x 22	8.75 x 17.25 x 22	8.75 x 17.25 x 22
POWER: Power backup	2.5 watts Battery	1.5 watts None	.36 KVA	.36 KVA	.36 KVA
FIRST CUSTOMER SHIPMENT	3/98	12/95	3Q98	3Q98	3Q98
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.

MANUFACTURER	NETWORK STORAGE SOLUTIONS	NETWORK STORAGE SOLUTIONS	NETWORK STORAGE SOLUTIONS	NEXSAN TECHNOLOGIES	NEXSAN TECHNOLOGIES
ARRAY MODEL	SPANStor-GT	SPANStor-LX	SPANStor-SX	XRAID 8K53	XRAID 8K73
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Network Hardware	Software -- Software	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SPANStor NFS, CIFS	SPANStor NFS, CIFS	PCI host NT, UNIX	SCSI host	FC-AL host
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5	0/1/3/4/5/10 Port	0/1/3/4/5/10 Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	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	48	5	5	30	45
Concurrent host channels	4	1	1	1	1
Drive channels	4		3	2	3
Array interface to host/net	PCI	PCI	PCI	Ultra2 SCSI	FC-AL
Drive interface	Ultra SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)	16, 128	64, 128	--	16, 128	16, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	-- -- --	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	132 40	Host dependent Host dependent	80 80	100 80
DRIVES: Formatted capacity/drive(MB)	9000-36000	9000-36000	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	Configuration dependent	20.25 x 17.5 x 20.13	11.75 x 10 x 11	7.0 x 19.0 x 19.1	7.0 x 19.0 x 19.1
POWER: Power backup	1200 watts	360 watts		300 watts	300 watts
FIRST CUSTOMER SHIPMENT	1998	1999	1999	8/99	8/99
COMMENTS	4 processor net attached server.	Complete net attached server.	Complete net attached server.	Tower version available. Chaparral controller.	Tower version available. Chaparral controller.

MANUFACTURER	NEXSAN TECHNOLOGIES	NLYNX SYSTEMS	NSTOR	NSTOR	NSTOR
ARRAY MODEL	XRAID 8V44	e-RAID	AdaptiveRAID	CR8e-340T	CR8e-390T
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	DIST	OEM, DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Software Host Software	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host	IBM AS/400, RS/6000	Various NT	SCSI, PCI host NetWare, NT, UNIX, OS/2	SCSI, PCI host NetWare, NT, UNIX, OS/2
RAID level Configured by:	0/1/4/5/10 Port	0/5	5 Preset	0/1/3/5/10/50* Host	0/1/3/5/10/50* Host
RAB EDAP Classification	--	--		--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	8.4 68.7	Drive dependent	12 32	27 72
Minimum drives per array	2	3/4	Config. depend.	3	3
Maximum drives per array	8	8	Config. depend.	8	8
Concurrent host channels	2	1	Config. depend.	2	2
Drive channels	2	4	Config. depend.	1, 2, 3	1, 2, 3
Array interface to host/net	Ultra SCSI	Ultra SCSI	Config. depend.	Ultra SCSI, PCI	Ultra SCSI, PCI
Drive interface	Ultra2 SCSI	Ultra SCSI	Config. depend.	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	32, 256	8, 256		4, 128	4, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	No 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)	40 80	40 40	Drive dependent Drive dependent	40/132 40	40/132 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	4200, 8600	Drive dependent	4200	9100
Nominal disk diameter (mm)	95	95	Drive dependent	95	95
ARRAY SIZE: Inches: H x W x D	7.0 x 19.0 x 19.1	6.7 x 19 x 28	--	17.5 x 7 x 19.125	17.5 x 7 x 19.125
POWER: Power backup	300 watts	240 watts		150 watts None	150 watts None
FIRST CUSTOMER SHIPMENT	8/99		1999	1Q97	1Q97
COMMENTS	Tower version available. CMD controller.	For AS/400 or RS/6000.	Ultra 160/m support.	Supports SAF-TE specification. Dynam. reconfig Optional rack mount. *Also RAID-30.	Supports SAF-TE specification. Dynam. reconfig Optional rack mount. *Also RAID-30.

MANUFACTURER	NSTOR	NSTOR (ANDATACO)	NSTOR (ANDATACO)	NSTOR (ANDATACO)	NSTOR (ANDATACO)
ARRAY MODEL	NexStor 8Le	FC 3400/3500 GigaRAID	FC 5400/5500 GigaRAID	FC 5600/5700 GigaRAID	GigaRAID/AA
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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, PCI host NetWare, NT, UNIX, OS/2	SCSI host	FC-AL host	FC-AL host	SCSI host UNIX, NT
RAID level Configured by:	0/1/3/4/5/10* Host	0/1/3/5/10 Host,Panel,Port	0/1/3/5/10 Host,Panel,Port	0/1/3/5/10 Host,Panel,Port	0/1/3/5/10 Host,Panel,Port
RAB EDAP Classification	--	DTDS+	DTDS+	DTDS+	DTDS+
Array capacity (Gbytes) MIN MAX	27 288	 534	88 2136	88 2136	144 1080
Minimum drives per array	3	10	10	10	8
Maximum drives per array	8	30	120	120	60
Concurrent host channels	2				
Drive channels	1, 2	5			
Array interface to host/net	FC-AL/Ultra2	FC-AL	FC-AL	FC-AL	Ultra SCSI
Drive interface	Ultra2 SCSI	SCSI-2	FC-AL	FC-AL	Ultra SCSI
Cache size (min, max: MB)	4, 128	--, 128	--, 1500	--, 1500	--, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes	Option Yes	Option Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto				Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100/80 80	 12-15	100 100	100 100	40 40
DRIVES: Formatted capacity/drive(MB)	9100-36000	4000-17800	8800, 17800	8800, 17800	18200
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	17.5 x 7 x 19.125		26.8 x 20.6 x 29.4	26.8 x 20.6 x 29.4	22.4 x 13.7 x 26.5
POWER: Power backup	150 watts None				Dual 300 watts Cache battery
FIRST CUSTOMER SHIPMENT	5/98	2/98	2/98		
COMMENTS	Supports SAF-TE specification. Dynam. reconfig Optional rack mount. *Also RAID-30.		Rack mount option.	Rack mount option.	

MANUFACTURER	NSTOR (ANDATACO)	NSTOR (ANDATACO)	NSTOR (ANDATACO)	NSTOR (ANDATACO)	NSTOR (ANDATACO)
ARRAY MODEL	GigaRAID/FT+	GigaRAID/FT	GigaRAID/HA	GigaRAID/LT	GigaRAID/SX
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	DIST	DIST
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	SCSI host UNIX, NT	SCSI host UNIX, NT	SCSI host UNIX, NT	SCSI host UNIX, NT
RAID level Configured by:	0/1/3/5/10 Host,Panel,Port	0/1/3/5/10 Host,Panel,Port	0/1/5* Host,Panel,Port	0/1/3/5/10	0/1/3/5/10
RAB EDAP Classification	DTDS+	DTDS+	DTDS+		--
Array capacity (Gbytes) MIN MAX	4 80	4 80	 1584		32 576
Minimum drives per array	2	2	4		8
Maximum drives per array	20	10	88		16
Concurrent host channels	1, 2	1, 2	2		1
Drive channels					
Array interface to host/net	SCSI-2	SCSI-2	Ultra SCSI	Ultra2 SCSI	Ultra SCSI, FC
Drive interface	SCSI-2	SCSI-2	Ultra SCSI	Ultra2 SCSI	Ultra SCSI
Cache size (min, max: MB)	8, 64	8, 64	128	16, 64	4, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes		Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto		Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	10/20 10/20	40 40	80 80	20 20
DRIVES: Formatted capacity/drive(MB)	2050-9100	4000-18200	9100-36000	4000-18200	9100-36000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	24.8 x 14 x 30	24.8 x 10.5 x 30	22.4 x 13.7 x 26.5	Configuration dependent	Configuration dependent
POWER: Power backup	880 watts Battery	880 watts Battery	Dual 400 watts Cache battery		300 watts
FIRST CUSTOMER SHIPMENT	1996	1996	7/97	2Q99	2Q97
COMMENTS	Based on CLARiiON array.	Based on CLARiiON array.	Mirrored cache. *Includes "Data Base Raid",with parity protect. for individual disks.		Rack mount option.

MANUFACTURER	NSTOR (ANDATACO)	ONEOFUS	ONEOFUS	ONEOFUS	OPTIMA TECHNOLOGY
ARRAY MODEL	GigaRAID/SXL	FC2200	FC4400AA	FC4400	18000W DisKovery
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Single User
MARKET	DIST	OEM	OEM	OEM	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Software
Host platform, software environment	SCSI host UNIX, NT	FC-AL host Various	FC-AL host Various	FC-AL host Various	Macintosh
RAID level Configured by:	0/1/3/5/10	0/1/4/5/10/50 Panel,Port	0/1/4/5/10/50 Panel,Port	0/1/4/5/10/50 Panel,Port	0/1 Host
RAB EDAP Classification	--	--		--	--
Array capacity (Gbytes) MIN MAX	32 576	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	17.4 17.4
Minimum drives per array	8	2	2	2	2
Maximum drives per array	16	125	125	125	2
Concurrent host channels	1	1	2	2	1
Drive channels		1	2	2	1
Array interface to host/net	Ultra SCSI, FC	FC-AL	FC-AL	FC-AL	PCI
Drive interface	Ultra SCSI	FC-AL	FC-AL	FC-AL	Ultra SCSI
Cache size (min, max: MB)	4, 128	256 max.	256 max.	256 max.	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option 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 20	100 100	100 100	100 100	132 40
DRIVES: Formatted capacity/drive(MB)	9100-36000	Drive dependent	Drive dependent	Drive dependent	9000
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	Drive dependent	95
ARRAY SIZE: Inches: H x W x D	Configuration dependent	3.3 x 5.7 x 9.76		3.3 x 5.7 x 9.76	5.75 x 11.42 x 10.21
POWER: Power backup	300 watts	28.5w + drives	59w + drives	28.5w + drives	20 watts
FIRST CUSTOMER SHIPMENT		1Q98		1Q98	9/94
COMMENTS	Rack mount option.	SAF-TE and SES support. i960CF-33.	SAF-TE and SES support. i960CF-33. Dual controller	SAF-TE and SES support. i960CF-33.	Software array.

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MANUFACTURER	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY
ARRAY MODEL	4200W DisKovery	46W Concorde	8200W DisKovery	DiskArray	GigaBank
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Software	Subsystem Host Software	Subsystem Host Software	Software Host Software	Subsystem Host Hardware
Host platform, software environment	Macintosh	Macintosh	Macintosh	Various	SCSI or FC host Various
RAID level Configured by:	0/1 Host	0/1 Host	0/1 Host	0/1 Host	0/1/3/5/10 Panel
RAB EDAP Classification	--	--	--		--
Array capacity (Gbytes) MIN MAX	4.2 4.2	 44.3	8.6 8.6	-- --	18 144
Minimum drives per array	2	2	2	2	3
Maximum drives per array	2	2	2		8
Concurrent host channels	1	1	1	1	1, 2
Drive channels	1, 2	2-5	1, 2		2-5
Array interface to host/net	PCI	PCI	PCI	SCSI,PCI,other	Ult.SCSI,FC-AL
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	--	--	--	--	4, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No	-- -- --	No Yes Yes
Spare drive (None/Auto/Manual)	None	None	None	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 40	40 40	132 40	Drive dependent	40, 100 40
DRIVES: Formatted capacity/drive(MB)	2100	2300	4100	Drive dependent	2100-22100
Nominal disk diameter (mm)	95	130	95	Drive dependent	95, 130
ARRAY SIZE: Inches: H x W x D	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	15 watts	35 watts	15 watts	-- --	300 watts Battery
FIRST CUSTOMER SHIPMENT	9/94	1997	9/94	1997	1998
COMMENTS	Software array.	Software array.	Software array.		

MANUFACTURER	PACIFIC MICRO DATA	PACIFIC MICRO DATA	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS
ARRAY MODEL	MAST 1420	MAST 9500	1200SX Ultima	2401	2700 PATHFINDER
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Host Hardware	Board Host Software	Board Host Hardware	Board Host Hardware
Host platform, software environment	Various	Various	PC compatible Various	PC compatible Various	PC compatible Various
RAID level Configured by:	0/1/4/5/10 E'net Port	0/1/4/5/10 E'net Port	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host
RAB EDAP Classification	--	--	--	--	--
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	2	2
Maximum drives per array	44	8	4	8	4
Concurrent host channels	1, 2	1	1	1	1
Drive channels	1, 3	1		4	2
Array interface to host/net	Various	Ultra SCSI/PCI	ISA, EISA	ISA, EISA	PCI
Drive interface	Ultra2 SCSI	Ultra2 SCSI	SCSI-2	EIDE	EIDE, Ult.SCSI
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)	Option Yes Yes (per drive)	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)		Auto	Manual, Auto*	Manual, Auto*	Manual, Auto*
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100/80/40 40/80	40/132 40/80	12.5/33 10/20	Host dependent Drive dependent	4/132 10
DRIVES: Formatted capacity/drive(MB)	4300-18000	4300-9100		Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	Varies	Varies		4.5 x 7.4	4 x 14
POWER: Power backup	Varies	Varies		None	N/A N/A
FIRST CUSTOMER SHIPMENT	1999	1999	2Q95	3Q96	4Q94
COMMENTS	Network attached server. Purchased controller.	Purchased controller. Network attached server.	Requires PSI software for RAID-1. *RAID-5 mode.	Audible alarm. *RAID-5 mode.	Requires PSI software for RAID-1. *RAID-5 mode.

MANUFACTURER	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS	PHOENIX INTERNATIONAL	PHOENIX INTERNATIONAL
ARRAY MODEL	dataSHADOW	PCI 2000A Intellicache	PCI 2220I	PDR 5400 Phalanx D	PDR 5500 Phalanx D
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Software	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	PC compatible UNIX, Linux, OS/2, DOS	PC compatible Alpha Various	PC compatible Various	SCSI host UNIX, other	SCSI host UNIX, other
RAID level Configured by:	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	1/3/5/10 Panel, Port	1/3/5/10 Panel, Port
RAB EDAP Classification	--	--	--	--	--
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	24	8	4	6	6
Concurrent host channels	1	1	1	1	4
Drive channels	1, 4	2	2	2	2
Array interface to host/net	VESA, ISA, PCI	PCI	PCI	Ultra SCSI	Ultra SCSI
Drive interface	SCSI	Ultra SCSI	EIDE	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	1, 16	4, 128	--	8, 256	16, 512
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	N/A N/A N/A	-- -- --	-- -- --	Option Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Manual, Auto*	Manual, Auto*	Manual, Auto*	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent 2-5	132 10/20	132 Drive dependent	20/40 20/40	20/40 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
ARRAY SIZE: Inches: H x W x D	N/A	4 x 6.945	4 x 5 x 5	12 x 10 x 15	12 x 10 x 15
POWER: Power backup	N/A None	N/A None	N/A --	120 watts Cache battery	120 watts
FIRST CUSTOMER SHIPMENT	1Q90	3Q97	2Q97		
COMMENTS	*RAID-5 mode.	Audible alarm. *RAID-5 mode.	Audible alarm. *RAID-5 mode	CMD controller.	CMD controller.

MANUFACTURER	PHOENIX INTERNATIONAL	PHOENIX INTERNATIONAL	PHOENIX INTERNATIONAL	PHOENIX INTERNATIONAL	POLYWELL COMPUTERS
ARRAY MODEL	PRMR 5400 Phalanx R	PRMR 5500 Phalanx R	PTR 5400 Phalanx T	PTR 5500 Phalanx T	Poly 800 B9
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Single User
MARKET	DIST	DIST	DIST	DIST	DIST
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	Poly 800 B9 Windows, NT Linux
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 Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	13.5 52
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
Drive channels	2	2	2	2	1, 4
Array interface to host/net	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	PCI
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	EIDE
Cache size (min, max: MB)	8, 256	16, 512	8, 256	16, 512	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes	Option 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)	20/40 20/40	20/40 20/40	20/40 20/40	20/40 20/40	33 UDMA
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	13500
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	95
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	15.8 x 8.2 x 17.8
POWER: Power backup	300 watts	300 watts	300 watts	300 watts	250 watts
FIRST CUSTOMER SHIPMENT					1999
COMMENTS	CMD controller.	CMD controller.	CMD controller.	CMD controller.	

MANUFACTURER	POLYWELL COMPUTERS	POLYWELL COMPUTERS	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY
ARRAY MODEL	Poly Suma 1420	Poly SUMA 8000	NetFORCE 100	NetFORCE 2000 NetFORCE 2200	NetFORCE 2500 NetFORCE 2600
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Ethernet	PCI host NetWare, OS/2, SCO UNIX, NT	Ethernet NT	Ethernet UNIX, NT	Ethernet UNIX, NT
RAID level Configured by:	Host, Panel	0/1/5 Host	5 Preset	0/1/3/5/10 Panel, Port	0/1/3/5/10 Panel, Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent	Drive dependent Drive dependent	20 150	180 900	900 1800
Minimum drives per array	2	2	6	10	30
Maximum drives per array	20	8	6	50	100
Concurrent host channels	1	1	1	1-4	1-4
Drive channels	1, 3	1	3	2	2, 4 (NF 2600)
Array interface to host/net	Various	PCI	PCI	Ethernet, FDDI	Ethernet, FDDI
Drive interface	Ultra2 SCSI	SCSI-2, SCSI-3	EIDE	Ultra SCSI	
Cache size (min, max: MB)		4, 64		32, 512	32, 512
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	Yes (NF 2200) Yes Yes	Yes (NF 2600) Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	133 40/80	133 10/20	132 16.7/33	1.2/12 40	1.2/12 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	18000-36000	18000-50000	18000-50000
Nominal disk diameter (mm)	95	95, 130	95	95	95
ARRAY SIZE: Inches: H x W x D		29 x 10 x 22	12.25 x 6.75 x 13.75	Configuration dependent	Configuration dependent
POWER: Power backup	400 watts	750 watts UPS option		Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	1999	1996	3Q98	1Q99	1Q99
COMMENTS	Purchased controller. Custom configurations.	Purchased controller. Rack mount option.	Rack mount option. SCSI tape option.	Rack mount.	UPS support. Rack mount. Dual servers.

MANUFACTURER	PROCOM TECHNOLOGY	PROMISE TECHNOLOGY	PROMISE TECHNOLOGY	PROMISE TECHNOLOGY	PROMISE TECHNOLOGY
ARRAY MODEL	NetFORCE 1500	FastTrak66 Pro	SuperTrak Pro	SuperTrak66	UltraTrak66
DISK/TREND GROUP	Net/Midrange	Single User	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	Ethernet UNIX, NT	PCI host DOS, WIN, NT OS/2, NetWare	PCI host NT, Windows	PCI host NT, Windows	PCI host NT, Windows
RAID level Configured by:	0/1/3/5/10 Panel, Port	0/1/10 Host, Port	0/1/3/5	0/1/3/5	0/1/3/5
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	72 360	Drive dependent Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	10	4	4	6	8
Concurrent host channels	1	1	1	1	1
Drive channels	2	1, 2	4	6	8
Array interface to host/net	PCI	PCI	PCI	PCI	PCI
Drive interface	Ultra SCSI	EIDE	EIDE	EIDE	EIDE
Cache size (min, max: MB)	32, 128		4, 128	4, 128	4, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No -- --	No Yes No	No No No	No 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 16.6/33/66	132 33 UDMA	132 66 UDMA	132 66 UDMA
DRIVES: Formatted capacity/drive(MB)	18000-36000	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	Drive dependent	95	95	95
ARRAY SIZE: Inches: H x W x D	8.75 x 19 x 21	3 x 4.75 x .5	4.875 x 5.75 x 8	13.5 x 4.5 x .5	15.75 x 7.1 x 19.7
POWER: Power backup	800 watts Cache battery		None	None	.5 VA
FIRST CUSTOMER SHIPMENT	4Q99	3Q98	4Q99	2/00	1/00
COMMENTS		Usable with entry level server.	Controller + 4-drive chassis.		External 8-drive subsystem.

MANUFACTURER	PROWARE TECHNOLOGY	PROWARE TECHNOLOGY	PROWARE TECHNOLOGY	PROWARE TECHNOLOGY	PROWARE TECHNOLOGY
ARRAY MODEL	DataPlum DataPlum Mini	DataPlum Mini-S	DataPlum S	5000I 3000I	5000S 3000S
DISK/TREND GROUP	Single User	Single User	Single User	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1/5/10 Panel, Port	0/1/5/10 Panel, Port	0/1/5/10 Panel, Port	0/1/5/10 Panel, Port	0/1/3/5/10 Panel, Port
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent	Drive dependent	Drive dependent	72	810
Minimum drives per array	3	3	3	2	2
Maximum drives per array	6	3	6	6	105
Concurrent host channels	1	1	1	1	2
Drive channels	3-6	3, 6	1	6	6
Array interface to host/net	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI
Drive interface	EIDE	Ultra SCSI	Ultra SCSI	EIDE	Ultra SCSI
Cache size (min, max: MB)	8, 64	16, 64	16, 64	16, 128	32, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Option No	No No Option	No Option No	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 16.7, 33	40 40	40 33 UDMA	40 16.6	40 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	10.3 x 7.4 x 17.2	5 x 5.8 x 9.4	10.3 x 7.4 x 17.2	20.7 x 8.46 x 20.5	20.7 x 8.46 x 20.5
POWER: Power backup	150 watts None	150 watts None	150 watts None	.88 KVA	.88 KVA
FIRST CUSTOMER SHIPMENT	1999	1999	1999	1996	1996
COMMENTS	486 processor. Mini has 3 drives.			486 processor. Rack mount option is 3000I	486 processor. Rack mount option is 3000S

MANUFACTURER	PROWARE TECHNOLOGY	PROWARE TECHNOLOGY	QUANTUM	RAIDAR SYSTEMS	RAIDELL COMPUTER
ARRAY MODEL	5500S	5960S	Snap! Server	1261 Ultra	IM-7500
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	DIST	DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Board Host Hardware	Board Host Hardware	Subsystem Network Hardware	Subsystem Host Hardware	Board Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	Local Area Net Windows,NT,NFS Novell, Apple	Macintosh System 7.5	ATA Host Various
RAID level Configured by:	0/1/3/5/10 Panel, Port	0/1/3/5/10 Panel, Port	0/1 Network	0/1/3/5/6/10	1 Preset
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent	Drive dependent	20/10 40/20	4 48	Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	8*	8*	2	12	2
Concurrent host channels	2	2	1	1	1
Drive channels	6	6	2	6	2
Array interface to host/net	Ultra SCSI	Ultra2 SCSI	Ethernet	Ultra SCSI	IDE/ATAPI
Drive interface	Ultra SCSI	Ultra2 SCSI	EIDE	SCSI-2	IDE/ATAPI
Cache size (min, max: MB)	32, 128	32, 128	64	1	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	None	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	80 80	1.2/12 33 UDMA	40 20	
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	10000, 20000	4000	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	20.65 x 8.5 x 20.5	20.65 x 8.5 x 20.5	9 x 4 x 15	7.1 x 8.3 x 15.7	3.35 x 5.75 x 8.84
POWER: Power backup	300 watts	300 watts	None	250 watts None	Battery
FIRST CUSTOMER SHIPMENT	3/98	3/98	6/99	1997	2Q99
COMMENTS	486 processor. *Expandable to 45 drives.	i960 processor. *Expandable to 105 drives.	Standalone server.		

MANUFACTURER	RAIDION SYSTEMS (PERIPHERAL TECH. GROUP)	RAIDION SYSTEMS (PERIPHERAL TECH. GROUP)	RAIDION SYSTEMS (PERIPHERAL TECH. GROUP)	RAIDION SYSTEMS (PERIPHERAL TECH. GROUP)	RAIDION SYSTEMS (PERIPHERAL TECH. GROUP)
ARRAY MODEL	RAIDION FC	RAIDION.ha	RAIDION.pci	RAIDION.plus	RAIDION.u2w
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host UNIX, NT, Linux, other	SCSI, FC host UNIX, NT, Linux, other	SCSI host UNIX, NT, Linux, other	SCSI host UNIX, NT, Linux, other	SCSI host UNIX, NT, Linux, other
RAID level Configured by:	0/1/3/5/10 Port, Panel	0/1/3/5/10/50 Port, Panel	0/1/3/5/10/50 Port, Panel	0/1/5 Port, Panel	0/1/3/5/10 Port, Panel
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	18 3700	 4500	18 1450	8.6 492	18 3700
Minimum drives per array	3	3	3	3	3
Maximum drives per array	75	90	30	28	75
Concurrent host channels	up to 5	4	2	1	up to 5
Drive channels	up to 5	5, 6	2	4	up to 5
Array interface to host/net	FC-AL	Ultra2 SCSI, FC	Ultra2 SCSI	Ultra SCSI	Ultra2 SCSI
Drive interface	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	Ultra SCSI	Ultra2 SCSI
Cache size (min, max: MB)	8, 128	8, 128	8, 128	8, 128	8, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes, per drive Yes, per drive	Yes Yes, per drive Yes, per drive	Option Yes, per drive Yes, per drive	No Yes, per drive Yes, per drive	Option Yes, per drive Yes, per drive
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 80	100 80	80 80	40 40	80 80
DRIVES: Formatted capacity/drive(MB)	8600-50000	18200-50000	4300-50000	4300-50000	4300-50000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	Modular, Rack mount	Modular, Rack mount	2.2 x 8.4 x 9.9	2.2 x 8.4 x 9.9	Modular, Rack mount
POWER: Power backup					
FIRST CUSTOMER SHIPMENT		9/99			
COMMENTS					

MANUFACTURER	RAIDION SYSTEMS (PERIPHERAL TECH. GROUP)	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC
ARRAY MODEL	RAIDION.es	FlexArray M	RUAC MX	FiberRAID-HI	FibreArray
DISK/TREND GROUP	Net/Midrange	Single User	Single User	Net/Midrange	Net/Midrange
MARKET	DIST	OEM, DIST	OEM	OEM	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Software	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host UNIX, NT, Linux, other	Various DOS, UNIX, OS/2 NetWare, Syst.7	SCSI host	FC-AL, Switch Various	FC-AL host Various
RAID level Configured by:	0/1/5/50 Port, Panel	0/1 Panel	0/1 Panel	0/1/3/5/10 Host	0/1/3/5/10 Host, Port
RAB EDAP Classification	--	--	--		--
Array capacity (Gbytes) MIN MAX	18 980	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	2	2	2	3
Maximum drives per array	28	4	14	126	112
Concurrent host channels	1	1	1	1	1, 2
Drive channels	1	1, 2	1, 2	2	1, 2
Array interface to host/net	Ultra SCSI	SCSI, SCSI-2	SCSI, SCSI-2	FC-AL	FC-AL*
Drive interface	Ultra SCSI	SCSI-2	SCSI-2	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, per drive Yes, per drive	No Yes Yes	-- -- --	If dual host Yes Yes	Yes* Yes Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Auto	Auto, Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	10 10	10 10	100	100 100
DRIVES: Formatted capacity/drive(MB)	8600-36000	Drive dependent	Drive dependent	Drive dependent	2100-36000
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	2.2 x 8.4 x 9.9*	6.5 x 9.25 x 12.75	1.625 x 5.75 x 8.12		17.4 x 8.7 x 20.6
POWER: Power backup	30 watts None	150 watts	7.5 watts	Cache battery	300 watts Cache battery*
FIRST CUSTOMER SHIPMENT	12/97	3Q96	3Q94	2Q99	1Q97
COMMENTS	*Per module.	3 SCSI channels including host.	3 SCSI channels including host.	*SCSI-3 command set. i960 processor.	Dynamic reconfiguration *Options. Rack mount option.

MANUFACTURER	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC
ARRAY MODEL	FibreArray-HI	FibreRAID-PCI	FlexArray TFX	FlexArray-HI	RAID Server TFX
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Host Hardware	Subsystem Host Hardware	Board Host Hardware	Subsystem Network Hardware
Host platform, software environment	FC-AL host Various	PCI host NT, NetWare, UNIX, Mac	Various DOS, UNIX, OS/2 NetWare, Syst.7	SCSI host	Various NetWare,NT,Mac Win. 95, UNIX
RAID level Configured by:	0/1/3/5/10 Port	0/1/3/5/10 Host, Port	0/1/3/5 Panel, Port	0/1/3/5/10 Panel	0/1/3/5 Panel, Port
RAB EDAP Classification	--	--	--		--
Array capacity (Gbytes) MIN MAX	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		2/3
Maximum drives per array	112	126	75		5/35
Concurrent host channels	1, 2	1, 2	1	1	1
Drive channels	1, 2	1, 2	1, 5	2	1, 6
Array interface to host/net	FC-AL	PCI	SCSI, SCSI-2	Ultra2 SCSI	Ethernet
Drive interface	FC-AL	FC-AL	SCSI-2	Ultra2 SCSI	SCSI-3
Cache size (min, max: MB)	8, 128	8, 128	--		8, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes (option) Yes Yes	Yes (option) -- --	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto, Manual	Auto, Manual	Manual	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	100 100	132 100	20 20	80 80	1.2/12 20
DRIVES: Formatted capacity/drive(MB)	2100-36000	2100-36000	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	95	95
ARRAY SIZE: Inches: H x W x D	19 x 8.7 x 10.6	4.5 x 13.25	19 x 8.7 x 20.6	6.5 x 9.25 x 12.75	19 x 8.7 x 20.6
POWER: Power backup	300 watts Cache battery	15 watts	300 watts	150 watts Cache battery	10 watts+drives
FIRST CUSTOMER SHIPMENT	2Q97	1Q97	4Q96		1Q98
COMMENTS	Dynamic reconfiguration option. Rack mount option.	Dynamic reconfiguration	6 SCSI channels including host. Differential option. Rack option.		Rack or tower.

MANUFACTURER	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC
ARRAY MODEL	RAID Server-M	RUAC II	UltraRAID TAU FlexArray	UltraRAID TBU FlexArray	UltraRAID TCU FlexArray
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	OEM	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Network Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	Windows,NT,Mac NetWare, UNIX	SCSI host Various	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 Host, Panel	0/1/3/5/10 Panel, Port	0/1/3/5 Panel, Port	0/1/3/5 Panel, Port	0/1/3/5 Panel, Port
RAB EDAP Classification		--	--	--	--
Array capacity (Gbytes) MIN MAX	4 36	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	2	75	14	14	7
Concurrent host channels		1	1, 2	1, 2	1
Drive channels		1-5	1, 5	1, 2	1, 5
Array interface to host/net		SCSI, SCSI-2	PCI	PCI	PCI
Drive interface		SCSI-2	SCSI	Ultra SCSI	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 No	No -- --	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto, Manual	Auto, Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)		20 20	132 20/40	132 20/40	132 20/40
DRIVES: Formatted capacity/drive(MB)		Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)		Drive dependent	95	95	95
ARRAY SIZE: Inches: H x W x D	9.25 x 7.63 x 13.21	8.5 x 10.5	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	10 watts+drives	10 watts+drives	10 watts+drives
FIRST CUSTOMER SHIPMENT	1Q98	3Q94	2Q97	2Q97	2Q97
COMMENTS		6 channels including host. Remote monitor. Beeper notification. Differential.	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	RISING EDGE TECHNOLOGIES	RISING EDGE TECHNOLOGIES
ARRAY MODEL	Keystone	MOR1200i	MOR1200S	MOR1200XHA	SkyCap
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	Local Area Net Various	SCSI host Various	SCSI host Various
RAID level Configured by:	0/3/5	0/3/5 Host	0/3/5 Host	0/3/5 Host	0/3/5
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent	5.7	5.7	36.4	7.5
Minimum drives per array	2	5	5	5	2
Maximum drives per array	35	5	5	35	35
Concurrent host channels	1	1	1	1	1
Drive channels		1	1	1	
Array interface to host/net		SCSI-2	Ethernet	SCSI-2	
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 128	4, 128	4, 128	4, 128	4, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No -- Option	No -- Option	Option Yes Yes	No Yes Yes
Spare drive.(None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)		20 20	1.2 20	20 20	
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1300	1300	1300	
Nominal disk diameter (mm)	Drive dependent	130	130	130	
ARRAY SIZE: Inches: H x W x D		17 x 7 x 17	17 x 7 x 17	17 x 7 x 17	
POWER: Power backup		250 watts --	250 watts UPS option	UPS option	
FIRST CUSTOMER SHIPMENT		5/97	5/97	9/97	
COMMENTS	Optical LIM-DOW drive array. Many options.	Optical LIM-DOW drive array. Many options.	Optical LIM-DOW drive array. Many options.	Optical LIM-DOW drive array. Many options.	Disk cartridge drive array. Many options.

MANUFACTURER	ROCK SOLID SYSTEMS	SAGITTA	SAGITTA	SAGITTA	SEEK SYSTEMS
ARRAY MODEL	RS955	EZiRAID	SR-1201-MYFF Salient FC-AL	SR-1294-MYFL SS-1200-SCSI Salient FC-AL	Commander Adaptive RAID
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	OEM, DIST	DIST	DIST	DIST
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	PCI host Windows, NT, DOS Network	FC-AL host	SCSI host	SCSI host Various
RAID level Configured by:	0/1 Preset	0/1/3/5 Host	0/1/3/5 Host, Preset	0/1/3/5 Host, Preset	0/1/5/10 Host
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	12 25	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	3	3	3	4
Maximum drives per array	14	6	12	8	32
Concurrent host channels	1	1	1, 2	1, 2	1, 4
Drive channels	2	1	1, 4	1, 4	1, 8
Array interface to host/net	SCSI-3	PCI	FC-AL	FC-AL	Ult2 SCSI,FC-AL
Drive interface	SCSI-3	Ultra SCSI	FC-AL	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)	--	16			128, 1000
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	Option Yes Yes	Option Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	133 40	100 100	100 80	80/100 80
DRIVES: Formatted capacity/drive(MB)	Drive dependent	4500, 9000	4500-18200	4500-18200	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
ARRAY SIZE: Inches: H x W x D	.5 x 4 x 6	11 x 8 x 11	7.0 x 17.5 x 23.0	7.0 x 17.5 x 23.0	29 x 22 x 22
POWER: Power backup	5 watts None	85 watts	1.1 KVA	1.1 KVA	.65 KVA UPS
FIRST CUSTOMER SHIPMENT	1997	4/97			3Q97
COMMENTS	Hard disk cached CD-ROM controller.		Uses either 7200 or 10000 RPM 1" high drives.	Uses either 7200 or 10000 RPM 1" high drives.	Rack mount option. Network attach option.

MANUFACTURER	SEEK SYSTEMS	SEEK SYSTEMS	SGI	SMS DATA PRODUCTS GROUP	SMS DATA PRODUCTS GROUP
ARRAY MODEL	Escort Adaptive RAID	Sentry Adaptive RAID	Cray FCN-2	S850F	S850S
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Spec High Perf.	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	Captive	DIST	DIST
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	Cray Unicos	SCSI host NT, NetWare	SCSI host NT, NetWare
RAID level Configured by:	0/1/5/10 Host	0/1/5/10 Host	3 Host	0/1/3/4/5/10 Host	0/1/3/4/5/10 Host
RAB EDAP Classification	--	--	--		--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	80 3200	Drive dependent	Drive dependent
Minimum drives per array	4	6	5	2	2
Maximum drives per array	5	7	200	12	12
Concurrent host channels	1, 2	1, 4	1, 5	1	1
Drive channels	1, 10	1, 8	2	2	2
Array interface to host/net	Ult2 SCSI,FC-AL	Ult2 SCSI,FC-AL	Proprietary	FC-AL	Ultra2 SCSI
Drive interface	Ultra2 SCSI	Ultra2 SCSI	FC-AL	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)	128, 1000	128, 1000	--	128	128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	Yes Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	80/100 80	80/100 80	300 14-21	100 80	80 80
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	20000	4500-18200	4500-18200
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	16.5 x 10.25 x 14.5	25.87 x 9.36 x 21	5.25 x 19 x		20 x 10.25 x 22
POWER: Power backup	.28 KVA UPS	.42-.7 KVA UPS	None		
FIRST CUSTOMER SHIPMENT	3Q97	3Q97	4/97	1999	1999
COMMENTS	Rack mount option. Network attach option.	Rack mount option. Network attach option.		Rack option.	Rack option.

MANUFACTURER	SOFTRAID	SOFTRAID	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER
ARRAY MODEL	FireRAID	SoftRAID	Series: 70 Desktop Server	Series: 71 Storage Server	Series: 72 OmniRAID Server
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Software Host Software	Software Host Software	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Macintosh	Macintosh	All SCSI	All SCSI	All SCSI
RAID level Configured by:	0/1 Host	0/1 Host	7	7	3/5/7
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent	Drive dependent	54 437	54 983	54 983
Minimum drives per array	2	2	6	6	6
Maximum drives per array	16*	16*	12	27	48
Concurrent host channels	1	1	1, 2	1, 4	1, 12
Drive channels	--	--	3 to 12	3 to 27	3 to 48
Array interface to host/net	P1394	Any SCSI	SCSI,Ultra SCSI	SCSI,Ultra SCSI	SCSI,Ultra SCSI
Drive interface	P1394	Any SCSI	SCSI	SCSI	SCSI
Cache size (min, max: MB)	--	--	16, 128	16, 128	16, 128
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (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)	Drive dependent Drive dependent	Drive dependent Drive dependent	10/20 Drive dependent	10/20 Drive dependent	20/40 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	95, 130	95, 130	95, 130
ARRAY SIZE: Inches: H x W x D	--	--	15.3 x 17.75 x 18.5	14 x 17 x 28.5	62 x 24 x 36
POWER: Power backup	--	--	8A @ 120VAC 4A @ 220VAC	12A @ 120VAC 6A @ 220VAC	24A @ 120VAC 12A @ 220VAC
FIRST CUSTOMER SHIPMENT	4Q99	1998	2Q92	2Q92	1Q97
COMMENTS	*Per volume.	*Per volume.			Size for R1 model.

MANUFACTURER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE CONCEPTS
ARRAY MODEL	Series: 73 OmniRAID Superserver	Series: 74 OmniRAID Superserver/ES	Concept 812SW	C814F FibreRAID	Express FibreRAID
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Spec High Perf.	Spec High Perf.
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	DIST, OEM	DIST, 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	All SCSI	All SCSI	SCSI host Proprietary	PC, SGI UNIX, NT, OS-9, VXWorks, Irix	PCI host, SGI NT, IRIX
RAID level Configured by:	0/1/3/5/7	0/1/3/5/7	0/3 Port	0/3	0/3
RAB EDAP Classification	--	--	--	--	
Array capacity (Gbytes) MIN MAX	54 3400	54 3400	16 72	36 288	36 288
Minimum drives per array	6	6	4	9	9
Maximum drives per array	48	48	9	9	9
Concurrent host channels	1, 12	1, 12	1	1, 2	1, 2
Drive channels	3 to 48	3 to 48	5	9	9
Array interface to host/net	SCSI,Ultra SCSI	SCSI,Ultra SCSI	SCSI-2	Fibre Channel	Fibre Channel
Drive interface	SCSI	SCSI	SCSI-2	Ultra SCSI	Ultra SCSI
Cache size (min, max: MB)	64, 256	64, 256	2	4, 64	64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	No Yes Yes	No Yes Yes	No Yes Option
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20/40 Drive dependent	20/40 Drive dependent	20+ 20	100 (sustained) 40	80 40
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	4000, 9100	4000-50000	4000-50000
Nominal disk diameter (mm)	95, 130	95, 130	95	95	95
ARRAY SIZE: Inches: H x W x D	78 x 24 x 36	78 x 48 x 36	5.25 x 19 x 21	5.25 x 19 x 21	5.125 x 18.75 x 21
POWER: Power backup	24A @ 120VAC 12A @ 220VAC	48A @ 120VAC 24A @ 220VAC	250 watts Dual power supp	300 None	330 None
FIRST CUSTOMER SHIPMENT	2Q96	3Q97	3/95	4/96	9/98
COMMENTS	Size for C2 model.	Size for C3 model.	Real time control engine. i960 processor.	Real time control engine. i960 processor. Network attach option.	Field upgradable to RAID 3.

MANUFACTURER	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE TECHNOLOGY	STORAGE TECHNOLOGY	STORAGE TECHNOLOGY
ARRAY MODEL	FibreRAID 2000	SentryRAID	9131	9133	9135
DISK/TREND GROUP	Spec High Perf.	Spec High Perf.	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST, OEM	OEM, DIST	DIST	DIST	DIST
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, SGI NT, IRIX	NT, Solaris other	RS/6000, Sun, NT, UNIX	RS/6000, Sun, PC, UNIX, DEC	RS/6000, Sun, PC, UNIX, DEC
RAID level Configured by:	0/3	0/3 Host	0/1/3/5/10 Service func.	0/1/3/5/10 Service func.	0/1/3/5/10 Service func.
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	36 400	36 72	21 704	21 528	126 370
Minimum drives per array	4	4	5	5	3
Maximum drives per array	10	10	80	60	42
Concurrent host channels	1, 2	1, 2	2	2	1
Drive channels	9	5	10	10	10
Array interface to host/net	Fibre Channel	FC-AL	IBM, SCSI-2	SCSI-2	SCSI-2
Drive interface	Ultra SCSI	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	64	64	8, 128	8, 64	8, 32
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Option	No Yes Option	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	85 40	85 80	20 20	20/40 10	20 10
DRIVES: Formatted capacity/drive(MB)	9000-50000	9100-18200	3500,4000,8800	4200, 8800	4200, 8800
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	5.125 x 18.75 x 21	7 x 15 x 15	72 x 29 x 30	24.8 x 10.5 x 30	19.5 x 7 x 19
POWER: Power backup	331 watts		880 watts Battery	575 watts	300 watts
FIRST CUSTOMER SHIPMENT	4Q99	4Q99	1995	1996	1996
COMMENTS		Meets MIL-STD-810E, 901D optional. Removable shuttle holds 5 drives.			

MANUFACTURER	STORAGE TECHNOLOGY	STORAGE TECHNOLOGY	STORAGE TECHNOLOGY	STORAGE TECHNOLOGY	STORAGE TECHNOLOGY
ARRAY MODEL	9137	9140	9145	9153	9393-4 Shared Virtual Array
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Mainframe
MARKET	DIST	DIST	DIST	DIST	DIST
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	FC host UNIX, NT	FC host UNIX, NT	FC host UNIX, NT	System/390 MVS, VM, VSE
RAID level Configured by:	0/1/3/5/10 Service func.	0/1/3/5/10	0/1/3/5/10	0/1/3/5/10	"6" Preset
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	21 729	91 1090	26 1058	45 720	210* 840*
Minimum drives per array	5	10	3	5	14
Maximum drives per array	90	110	120	40	60
Concurrent host channels	2	2	1	2	8
Drive channels	10	2	2	5	16
Array interface to host/net	SCSI-2, FC-AL	FC-AL	FC-AL	FC, Ultra SCSI	ESCON, SCSI-2
Drive interface	SCSI-2, FC-AL	FC-AL	FC-AL	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	8, 64			64, 128	2048, 6144
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	 Option Option	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)	20/40/100 10	100 100	100 100	100 40	18 20
DRIVES: Formatted capacity/drive(MB)	4200, 8800	4500-8800	8820	9000, 18000	4550
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	24.8 x 14 x 30	6.07 x 17.5 x 24	11.25 x 17.5 x 27.2	36.3 x 23.6 x 32.3	76.6 x 47.5 x 32
POWER: Power backup	1000 watts			2073 max.	3.59 KVA Cache battery
FIRST CUSTOMER SHIPMENT	1997		6/98		4/99
COMMENTS					*Assumes 3.6X data compression. (Iceberg).

MANUFACTURER	STORAGE TECHNOLOGY	STORAGEPATH	STORAGEPATH	STORAGEPATH	STORAGEPATH
ARRAY MODEL	9393-6 Shared Virtual Array	SP-18BTHT	SP-5BT	SP-9BR	SP-9BT
DISK/TREND GROUP	Mainframe	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	DIST	DIST	DIST	DIST	DIST
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	SCSI host UNIX, VMS, NT, NetWare, DOS	SCSI host Various	SCSI host UNIX, VMS, NT, NetWare, DOS	SCSI host Various
RAID level Configured by:	"6" Preset	0/3/5 Host	0/1/3/4/5	0/3/5 Host	0/1/3/4/5
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	160* 1680*	2.5 45	16	2.5 28.7	28
Minimum drives per array	16	2	5	2	7
Maximum drives per array	64	15	5	7	7
Concurrent host channels	8	1	1	1	1
Drive channels	16	1	1, 2	1	1, 4
Array interface to host/net	ESCON, SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SSA	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2048, 6144	0, 32	8, 512	--, 32	8, 512
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No Per drive Yes	No No No	No Per drive Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	18 80	20 10	10 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	9100	Drive dependent	4000	Drive dependent	4000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	76.6 x 47.5 x 32	20 x 24 x 24	12.2 x 10.6 x 19.9	8.75 x 19 x 21	
POWER: Power backup	3.59 KVA Cache battery	300 watts	200 watts	300 watts	300 watts
FIRST CUSTOMER SHIPMENT	6/99	4Q94	4Q94	4Q94	4Q94
COMMENTS	*Assumes 3.6X data compression. (Iceberg).	Purchased controller.	Purchased controller.	Rack mount. Purchased controller.	Purchased controller.

MANUFACTURER	STORAGEPATH	STRATUS COMPUTER	SUN MICROSYSTEMS	SUN MICROSYSTEMS	SUN MICROSYSTEMS
ARRAY MODEL	SP-9BTHT	D600 (K121)	A1000/D1000 StorEdge	A3500 StorEdge	A5100/A5200 StorEdge
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	Captive	Captive, DIST	Captive, DIST	Captive, DIST
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 UNIX, VMS, NT, NetWare, DOS	Stratus VOS/FTX	SCSI host NT, Solaris	SCSI host NT, Solaris	NT, Solaris
RAID level Configured by:	0/3/5 Host	1 Preset	0/1/3/5/10 Host	0/1/3/5/10 Host	0/1/5/10
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	2.5 28.7	1.46 Varies by syst.	36 432	90 6400	100 800
Minimum drives per array	2	2	4	8	11
Maximum drives per array	7	Varies by syst.	12	60	22
Concurrent host channels	1	2, 10	2	2	1, 2
Drive channels	1	2, 4	2	5	1, 2
Array interface to host/net	SCSI-2	Proprietary	Ultra SCSI	Ult SCSI,FC-AL	FC-AL
Drive interface	SCSI-1/2	SCSI	Ultra SCSI	Ultra SCSI	FC-AL
Cache size (min, max: MB)	0, 32	.256	24, 80	128, 256	32-64
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Per drive Yes	Yes Yes Yes	No Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	5 Drive dependent	40 40	40 40	100 100
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Varies	9100-36400	9100-32400	9100-36400
Nominal disk diameter (mm)	95	Varies	95	95	95
ARRAY SIZE: Inches: H x W x D	20 x 11.5 x 24	Varies	6.9 x 17.5 x 20.7	Configuration dependent	9.01 x 19.65 x 24.81
POWER: Power backup	300 watts	Drive dependent Battery	500 watts	2475 watts	650 watts
FIRST CUSTOMER SHIPMENT	4Q94	3/91	2Q98	3Q98	3Q98
COMMENTS	Purchased controller.		Expandable to 108 drives.		

MANUFACTURER	SUN MICROSYSTEMS	SYRED DATA SYSTEMS	SYRED DATA SYSTEMS	SYRED DATA SYSTEMS	SYRED DATA SYSTEMS
ARRAY MODEL	A7000 StorEdge	Cruiser	Regency	RegencyPlus	SuperRegency
DISK/TREND GROUP	Mainframe	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware	Board Host Hardware
Host platform, software environment	Various Solaris, MVS NT, UNIX	PCI host UNIX, Windows, NetWare	SCSI host DEC VMS,Solaris NetWare,NT,oth.	SCSI host Various	FC-AL host Various
RAID level Configured by:	0/1/5/10 Panel	0/1/3/4/5/10	0/1/4/5/10 Panel, Port	0/1/3/4/5/10 RS 232	0/1/3/4/5/10 Host
RAB EDAP Classification		--	--	--	--
Array capacity (Gbytes) MIN MAX	217 1994	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	24	2	2	2	
Maximum drives per array	108	45	105	120	240
Concurrent host channels	1, 32	1	4	1	1
Drive channels	2	1, 3	6	7	3
Array interface to host/net	SCSI,BMC,ESCON	PCI	Ult.2SCSI,FC-AL	FC-AL	FC-AL
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra2 SCSI	FC-AL
Cache size (min, max: MB)	1000-4000	4, 64	2, 128	512	512
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	-- -- --	Option -- --	Option -- --	Option -- --
Spare drive (None/Auto/Manual)	Auto	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	132 20/40	20/40/80 20/40	100 40	100 100
DRIVES: Formatted capacity/drive(MB)	9100-18200	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	Drive dependent	Drive dependent
ARRAY SIZE: Inches: H x W x D	7.9 x 39 x 70		3.25 x 5.75 x 10.25	3.25 x 5.75 x 10.25	
POWER: Power backup	Up to 14620 wts	12 watts	30 watts+drive None	Battery	Battery
FIRST CUSTOMER SHIPMENT	2/98	1999	1998	1999	
COMMENTS	Mirrored cache. Expansion system adds up to 216 additional drives(3931 GB)				

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MANUFACTURER	SYRED DATA SYSTEMS	TD SYSTEMS	TD SYSTEMS	TEXA	TEXA
ARRAY MODEL	Supra	OMNISERVE 3	OMNISERVE 4	RST-2GUW RST-4GUW RST-8GUW RST-12GUW	RST-F4GUW RST-F8GUW RST-F18GUW
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Single User
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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	All SCSI hosts Various	Various hosts UNIX, Linux, Windows	SCSI host Mac, DOS, NT NetWare, UNIX	SCSI host Mac, DOS, NT NetWare, UNIX
RAID level Configured by:	0/1/3/4/5/10 Host	1 Preset	1 Preset	0/3/5 Host, Panel	0/3/5 Host, Panel
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	2 12	4 18
Minimum drives per array	2	2		3	3
Maximum drives per array	45	28		3	3
Concurrent host channels	1	1, 2	1, 7	1	1
Drive channels	3	2, 7	1, 7	3	3
Array interface to host/net	Ultra2 SCSI	SCSI-2	SCSI,FC-AL,SSA	Ultra SCSI	Ultra SCSI
Drive interface	Ultra2 SCSI	SCSI-2	SCSI,FC-AL,SSA	SCSI-2	SCSI-2
Cache size (min, max: MB)	32, 128	--	--	1	2
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option -- --	-- -- --	-- -- --	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Manual		Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	Up to 20 20	10-80 10-80	22/16/16 10	22/17/17 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	1000, 6000	2000, 9000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	95	95
ARRAY SIZE: Inches: H x W x D		3.25 x 5.75 x 8.25	5.25 x 9.5 x 12	9.3 x 6.7 x 9.5	9.3 x 6.7 x 9.5
POWER: Power backup	Battery	10-20 watts --	40 watts	100 watts None	100 watts None
FIRST CUSTOMER SHIPMENT	1998	1Q94	3Q98	3/97	3/97
COMMENTS		Options to connect up to 5 hosts; dual ported control. Fast and wide SCSI version.			

MANUFACTURER	TEXA	TEXA	TEXA	TEXA	TEXA
ARRAY MODEL	RST-LP10	RST-LPU10	RST-N10W RST-N20W	RST-NP10	RST-NPU10
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Single User
MARKET	OEM	OEM	OEM	OEM, DIST	OEM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Attachment	Host	Host	Host	Host	Host
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host Mac, DOS, NT NetWare, UNIX	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host Mac, DOS, NT NetWare, UNIX
RAID level	0/1/3/5	0/1/3/5	0/3/5	0/1/3/5	0/1/3/5
Configured by:	Host, Panel	Host, Panel	Host, Panel	Host, Panel	Host, Panel
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	1	1	1	1	1
Maximum drives per array	3	3	3	3	3
Concurrent host channels	1	1	1	1	1
Drive channels	3	3	3	3	3
Array interface to host/net	SCSI-3	Ultra SCSI	SCSI-3	SCSI-3	Ultra SCSI
Drive interface	IDE	IDE	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1	1	1, 2	1	1
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	No	No	No	No	No
Power supply (Yes/No)	No	No	No	No	No
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	15/12/12	22/16/16	15/12/12	15/12/12	22/17/17
drive (MB/Sec)	14	16	10	10	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	3.3 x 5.75 x 8.9	3.3 x 5.75 x 8.9	5 x 5.75 x 8.9	3.3 x 5.75 x 8.9	3.3 x 5.75 x 8.9
POWER:	70 watts	70 watts	80 watts	70 watts	70 watts
Power backup	None	None	None	None	None
FIRST CUSTOMER SHIPMENT	11/95	4/97	8/95	11/95	3/97
COMMENTS	Mounts in 5.25" drive bay.	Mounts in 5.25" drive bay.	Mounts in 5.25" drive bay.	Mounts in 5.25" drive bay.	Mounts in 5.25" drive bay.

MANUFACTURER	TEXA	TEXA	TEXA	TEXA	TEXA
ARRAY MODEL	RST-PM1000M RST-PM2000R	RST-PU3G RST-PU6G RST-PU9G RST-PU18G	RST-PW18G RST-PW24G RST-PW48G	RST-SX12 RST-SX27 RST-SX54	DAF-4000 DAF-8000 DAF-16000 DAF-36000
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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 Mac, DOS, NT NetWare, UNIX	SCSI host Mac, DOS, NT NetWare, UNIX	SCSI host Mac, DOS, NT NetWare, UNIX	SCSI host Mac, DOS, NT NetWare, UNIX	SCSI host UNIX, NetWare, DOS, Mac, NT
RAID level Configured by:	0/1/3/5 Host, Panel	0/3/5 Host, Panel	0/1/3/5 Host, Panel	0/1/3/5 Host, Panel	0/3/5 Host, Panel
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	2 3	2 12	12 32	8 36	4 36
Minimum drives per array	1	1	1	1	5
Maximum drives per array	3	3	3	3	5
Concurrent host channels	1	1	1	1	1
Drive channels	3	3	3	3	5
Array interface to host/net	SCSI-2	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-3
Drive interface	IDE	IDE	IDE	Ultra SCSI	SCSI-2
Cache size (min, max: MB)	.5	.5	1	1	1, 4
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	9/8/8/8 14	17/14/14 16	25/10/15/15 16.6	30/12/22/22 20	16/14/14 10
DRIVES: Formatted capacity/drive(MB)	1000	1000, 6000	6000-16000	4000-18000	1000-9000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	7 x 5.1 x 10.8	7 x 5.1 x 10.8	7 x 5.1 x 10.8	5.2 x 16.7 x 23.8	23.3 x 10.6 x 16.2
POWER: Power backup	80 watts None	50 watts None	45 watts None	70, 100 watts None	250 watts None
FIRST CUSTOMER SHIPMENT	4/96	5/97	6/98	6/98	3/94
COMMENTS					

MANUFACTURER	TEXA	TEXA	TEXA	TEXA	TEXA
ARRAY MODEL	DAV-16Sx DAV-32Sx DAV-72Sx DAV-144Sx	DAV-72Lx/Mx DAV-144Lx/Mx	DAX-8 DAX-16 DAX-36 DAX-144	RST-NC8000W Series	RST-NT8000W Series
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST	OEM, DIST
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 Mac, DOS, NT NetWare, UNIX	SCSI host Mac, DOS, NT NetWare, UNIX	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host Mac, DOS, NT NetWare, UNIX	SCSI host Mac, DOS, NT NetWare, UNIX
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
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	16 144	72 144	10 144	8 18	8 81
Minimum drives per array	3	3	3	3	3
Maximum drives per array	9	9	9	3	9
Concurrent host channels	2	1/2	2	1	1, 2, 3
Drive channels	9	9	6, 9	3	3, 6, 9
Array interface to host/net	Ultra SCSI	Ultra SCSI	Ultra SCSI	SCSI-3	SCSI-3
Drive interface	Ultra SCSI	Ultra SCSI	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	16, 128	16, 256	16, 64	1	1, 2, 3
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes (option)	No Yes (Rear) Yes	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)	39/38/38 20	70/62/62 20	35/32/32 10	17/13/13 10	17/13/13 10
DRIVES: Formatted capacity/drive(MB)	2000, 18000	9000-18000	2500, 4500	4000, 9000	4000, 9000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	5.2 x 16.7 x 23.8	5.2 x 16.7 x 23.8	23.3 x 12.6 x 19.8	7.9 x 6.7 x 11.8	21.2 x 7 x 13.8
POWER: Power backup	350 watts None	280 watts None	350 watts None	120 watts None	250 watts None
FIRST CUSTOMER SHIPMENT	7/96	1/99	1/96	9/96	9/96
COMMENTS	Up to 15 units per 19" rack.				

MANUFACTURER	TEXA	TRANSITIONAL TECHNOLOGY	TRANSITIONAL TECHNOLOGY	TRANSITIONAL TECHNOLOGY	TRUESAN NETWORKS
ARRAY MODEL	RST-X8GUW Series	Prism P2400	Prism P4800	Prism P800	TrueTriumph
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	DIST	DIST	DIST	DIST, OEM
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Network Hardware	Subsystem Host Software
Host platform, software environment	SCSI host Mac, DOS, NT NetWare, UNIX	SCSI host	SCSI host	SCSI host	FC-AL host SGI,NT,Solaris NetWare, other
RAID level Configured by:	0/3/5 Host, Panel	0/1/4/5/10 Host	0/1/4/5/10 Host	0/1/4/5/10 Host	0/1/4/5/10
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	8 144	216	378	72	Drive dependent
Minimum drives per array	3	2	2	2	4
Maximum drives per array	9	24	40	8	56
Concurrent host channels	1	1	1	1	1, 2
Drive channels	3, 6, 9	1	1	1	2
Array interface to host/net	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	FC-AL
Drive interface	Ultra SCSI	Ultra SCSI	Ultra SCSI	Ultra SCSI	FC-AL
Cache size (min, max: MB)	4, 128	8, 516	8, 516	8, 516	64, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	Yes Yes Yes	Yes Yes Yes	No Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	35/30/30 20	40 40	40 40	40 40	100 100
DRIVES: Formatted capacity/drive(MB)	2000, 18000	9100	9100	9100	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	21.2 x 7 x 13.8				Configuration dependent
POWER: Power backup	300 watts None				300-1200 watts
FIRST CUSTOMER SHIPMENT	1/97	1997	1997	1997	1998
COMMENTS	Scalable configuration.	Network attached server Purchased controller.	Network attached server Purchased controller.	Network attached server Purchased controller.	Veritas software array.

MANUFACTURER	TWINCOM	TWINCOM	TWINCOM	UNISYS	UNISYS
ARRAY MODEL	Infinity	Dual Mirror	Network Mirror	ASR 9000	CSM7700 ESM7700 OSR7700
DISK/TREND GROUP	Single User	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM, DIST	OEM, DIST	OEM, DIST	Captive	Captive
ARRAY CONFIGURATION: Type Attachment Implementation	Software -- Software	Software -- Software	Software -- Software	Subsystem Host Hardware	Subsystem Network Hardware
Host platform, software environment	PC DOS, Windows 3	Various Most UNIX versions, Linux	Various Most UNIX versions, Linux	Unisys A series	Unisys NT
RAID level Configured by:	1 Preset	1 Preset	1 Preset	0/1/3/5/10 Host, Port	0/1/5/10
RAB EDAP Classification		--	--	--	
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	17 180	180 2000
Minimum drives per array	2	2	2	5	10
Maximum drives per array	2	32	32	30	120
Concurrent host channels	1	1, 2	1, 4	1, 2	2
Drive channels		--	--	5	2
Array interface to host/net	Host dependent	Host dependent	Host dependent	SCSI-2	FC-AL
Drive interface	Drive dependent	Drive dependent	Drive dependent	SCSI-2	FC-AL
Cache size (min, max: MB)	Host dependent	Host dependent	Host dependent	32, 224	256, 1024
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	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)	Host dependent Drive dependent	Host dependent Drive dependent	Host dependent Drive dependent	10 10	100 100
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	4500-9100	18000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	95	95
ARRAY SIZE: Inches: H x W x D		--	--	17.5 x 17.5 x 24.25	11.25 x 17.5 x 27.6
POWER: Power backup		-- --	-- --	746 watts UPS option	 UPS
FIRST CUSTOMER SHIPMENT		1986	1992	1995	
COMMENTS			Mirrors over a network.		Mirrored cache.

MANUFACTURER	UNISYS	UNISYS	VERITAS SOFTWARE	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS
ARRAY MODEL	OSM 3000	OSR 5000	Veritas Volume Manager (v 3.0)	FlashDisk OpenRAID Tabletop	FlashDisk OpenRAID Pedestal
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	Captive	Captive	OEM, DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Software	Subsystem Host Hardware	Software -- Software	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	Unisys A & V series, other UNIX, NT	Various NetWare, UNIX, NT	Solaris, HPUX, NT, UNIXWare, other	SCSI/FC-AL host Any O/S	SCSI/FC-AL host Any O/S
RAID level Configured by:	0/1/3/5 Port	0/1/3/5/10 Host, Port	0/1/5/10 Host	0/1/3/5/10 RS-232	0/1/3/5/10 RS-232
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	20 270	Drive dependent Drive dependent	50 250	18.2 400
Minimum drives per array	2	5	2	2	2
Maximum drives per array	14	30	Host dependent	5	8
Concurrent host channels	1, 2	1, 4	Host dependent	1, 4	1, 4
Drive channels	1	5	Host dependent		1, 2
Array interface to host/net	Ultra SCSI	Ultra SCSI-2	Various	Ultra2 SCSI	Ultra2 SCSI, FC
Drive interface	Ultra SCSI-2	SCSI-2	SCSI, ESDI, IDE	Ultra2 SCSI	Ultra2 SCSI
Cache size (min, max: MB)	16, 64	32, 224	--	64, 128	64, 256
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- Yes Yes	Option Yes Yes	Yes -- --	Option Yes Yes	Optional Yes Yes
Spare drive (None/Auto/Manual)	Auto, Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	40 20	Drive dependent Drive dependent	80 80	80-100 80
DRIVES: Formatted capacity/drive(MB)	4200-18200	4200, 9000	Drive dependent	9100-50000	9100-50000
Nominal disk diameter (mm)	95	95	Drive dependent	95	95
ARRAY SIZE: Inches: H x W x D	5.05 x 17.05 x 18.44	17.5 x 17.5 x 24.25	--	12.125 x 10.25 x 14.5	19 x 7 x 25
POWER: Power backup	.4 KVA None	785 watts UPS option	-- --	(2) 120 watts UPS	(2) 300 watts Battery, UPS
FIRST CUSTOMER SHIPMENT	1996	9/96	1999	1/99	1/99
COMMENTS			Can mirror logical disks. Bundled w/ Solaris,NT 5.0, HPUX.		

MANUFACTURER	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	XIOTECH	XISTOR	XYRATEX
ARRAY MODEL	FlashDisk OpenRAID Data Center	FlashDisk RAID Rackmount	Magnitude	xi.raid	SR-1201-MYFF Salient FC-AL
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Single User	Net/Midrange
MARKET	DIST	DIST	OEM, DIST	DIST	OEM
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/FC-AL host Any O/S	SCSI/FC-AL host Any O/S	PCI host NT, NetWare, UNIX,Mac,Linux	Xistor dd series Various	FC-AL host
RAID level Configured by:	0/1/3/5/10 RS-232	0/1/3/5/10 RS-232	0/1/5/10 Port	0/1 Host	0/1/3/5 Host, Preset
RAB EDAP Classification	--	--	--	--	--
Array capacity (Gbytes) MIN MAX	18.2 3600	18.2 291.2/500	108 3200	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	8	2	4
Maximum drives per array	72	8/12	64	4	12
Concurrent host channels	1, 36	1, 4	1, 8	1	1, 2
Drive channels		1, 2	2, 8	2	1, 4
Array interface to host/net	Ultra2 SCSI, FC	Ultra2 SCSI, FC	PCI, FC-AL	PCI	FC-AL
Drive interface	Ultra2 SCSI	Ultra2 SCSI	Ultra2 SCSI	SCSI-2	FC-AL
Cache size (min, max: MB)	64, 256	64, 256	256, 512	--	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Option Yes Yes	No Yes Yes	No No No	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	80-100 80	80-100 80	132 80	132 40	100 100
DRIVES: Formatted capacity/drive(MB)	9100-50000	9100-50000	Drive dependent	4000-9000	4500-18200
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	42 or 82 x 23.5 x 34	7 x 19 x 25	58.4 x 17.4 x 25	--	7.0 x 17.5 x 23.0
POWER: Power backup	(2) 300 watts Battery, UPS	(2) 300 watts Battery, UPS	1.2-2.0 KVA UPS	--	1.1 KVA
FIRST CUSTOMER SHIPMENT	1/99	1/99	4Q97	1997	
COMMENTS					Expandable to 360 drives. Uses either 7200 or 10000 RPM 1" high drives.

ASPEC-139

MANUFACTURER	XYRATEX	ZZYZX PERIPHERALS, INC	ZZYZX PERIPHERALS, INC	ZZYZX PERIPHERALS, INC	ZZYZX PERIPHERALS, INC
ARRAY MODEL	SR-1294-MYFL Salient FC-AL	PowerRAID FC	PowerRAID LVD	PowerRAID MAX	PowerRAID LT
DISK/TREND GROUP	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange	Net/Midrange
MARKET	OEM	DIST	DIST	DIST	DIST
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware	Subsystem Host Hardware
Host platform, software environment	FC-AL host	Sun, HP, SGI, other	NT	Sun, HP, SGI, UNIX, NT, other	Sun, HP, SGI, other
RAID level Configured by:	0/1/3/5 Host, Preset	3/5 Host,Panel,Port	3/5 Host,Panel,Port	0/1/3/4/5/10 Host	0/1/4/5/10 Host,Panel,Port
RAB EDAP Classification	--	--	--	--	--
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	8	10*	10*	8*	5*
Concurrent host channels	1, 2	1, 2	1, 2	1, 2	1-2
Drive channels	1, 4	1-6	6	2-6	1-3
Array interface to host/net	FC-AL	FC-AL	Ultra2 SCSI	FC-AL, Ultra2	Ultra SCSI
Drive interface	Ultra2 SCSI	Ultra SCSI**	Ultra SCSI	Ultra2 SCSI	Ultra SCSI
Cache size (min, max: MB)		64, 256	64, 256	128, 256	32, 256
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)	100 80	100 40	80 40	100, 80 80	40 40
DRIVES: Formatted capacity/drive(MB)	4500-18200	9000-50000	9000-50000	9000-50000	9000-50000
Nominal disk diameter (mm)	95	95	95	95	95
ARRAY SIZE: Inches: H x W x D	7.0 x 17.5 x 23.0	Varies	Varies	Varies	Varies
POWER: Power backup	1.1 KVA	75 watts+drives Cache battery	75 watts+drives Cache battery	75 watts+drives Cache battery	75 watts+drives Cache battery
FIRST CUSTOMER SHIPMENT		1998	1998	1999	1997
COMMENTS	Expandable to 44 drives. Uses either 7200 or 10000 RPM 1" high drives.	*Expandable to 90 drives. **LVD option.	*Expandable to 90 drives.	*Expandable to 120 drives.	CMD CRD-5400 controller. *Expandable to 45 drives.

MANUFACTURER	ZZYZX PERIPHERALS, INC	ZZYZX PERIPHERALS, INC			
ARRAY MODEL	PowerRAID II	RocketRAID			
DISK/TREND GROUP	Net/Midrange	Net/Midrange			
MARKET	DIST	DIST			
ARRAY CONFIGURATION: Type Attachment Implementation	Subsystem Host Hardware	Subsystem Host Hardware			
Host platform, software environment	Sun, HP, SGI, other	Sun, HP, SGI, UNIX, other			
RAID level Configured by:	0/1/4/5/10 Host,Panel,Port	0/1/4/5/10 Host			
RAB EDAP Classification	--	--			
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent			
Minimum drives per array	2	2			
Maximum drives per array	5*	8*			
Concurrent host channels	1-4	1, 2			
Drive channels	1-8	3			
Array interface to host/net	Ultra SCSI	Ultra SCSI			
Drive interface	Ultra SCSI	Ultra SCSI			
Cache size (min, max: MB)	64, 512	64, 256			
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes			
Spare drive (None/Auto/Manual)	Auto	Auto			
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 40	40 40			
DRIVES: Formatted capacity/drive(MB)	9000-50000	9000-50000			
Nominal disk diameter (mm)	95	95			
ARRAY SIZE: Inches: H x W x D	Varies	Varies			
POWER: Power backup	75 watts+drives Cache battery	75 watts+drives Cache battery			
FIRST CUSTOMER SHIPMENT	1997	1Q94			
COMMENTS	CMD CRD-5500 controller. *Expandable to 120 drives.	Mylex controller. *Expandable to 45 drives.			

MANUFACTURER PROFILES

1999 DISK/TREND REPORT

MANUFACTURER PROFILES

All manufacturers now producing disk drive arrays, or those which are expected to enter the market, are listed in this section. "1998 total net sales" covers the fiscal year ending in 1998 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, 1998, 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 1998 is used, as cited by the Federal Reserve Bulletin.

Country	Currency	Currency units/U.S. dollar
Canada	Canadian dollar	1.48
France	French franc	5.90
Germany	Deutschmark	1.76
Ireland	Pound	.70
Japan	Yen	131.0
Netherlands	Guilder	1.98
Sweden	Krona	7.95
Switzerland	Swiss franc	1.45
Taiwan	Taiwan dollar	33.55
United Kingdom	Pound	.60

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., was "Multi-Host", which offered a unique method of using microcomputers in network mission critical applications, and offered fault tolerance with "1776 Disk Array Software", which has been phased out.

3WARE, INC.
490 California Avenue
Palo Alto, CA 94306

Founded in early 1997, 3Ware is a startup company developing switched digital storage controllers that support ATA/IDE interface drives. By providing separate channels (2 or 4) for the drives, performance equivalent to that of SCSI channels is obtained. The products are aimed at designers of technical and video editing systems, and will operate in Windows NT systems. Future support for Linux and Novell systems is planned.

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

1999 total net sales: $692,400,000 (FY ending 3/31/99) Net income: ($13,300,000)

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 combining host-executed code with hardware augmentation, to minimize cost while maintaining acceptable performance. 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.

In early 1998, Adaptec announced it was acquiring Symbios Logic from Hyundai for $775 million, adding additional semiconductor and array product lines to Adaptec's products, but the transaction was not completed. The company did acquire Ridge Technology, but disbanded much of its array development team in subsequent reorganizations.

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

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-4000 midrange array series for open systems applications.

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

American Megatrends was founded in the Fall of 1985 as a supplier of software design services and BIOS software. The firm has since added peripheral controllers and utility software to its product line. Active participation in the disk drive array market began in late 1994, at which time the firm introduced a PCI bus array controller operating in RAID-0/1/3/5/10 modes. After a slow start, the firm has succeeded in developing large OEM accounts and has become a major OEM supplier of array controllers. AMI's array controllers introduced in 1996, supported dynamic reconfiguration of an array. Support for clustered processors was added late in 1996. AMI has adopted the I2O architecture across its array controller product line. Controllers for placing RAID on a system motherboard were announced in early 1998. Clustering and SAN support are major AMI initiatives, as are the Ultra2 SCSI, Fiber and PCI interfaces.

AMPEX CORPORATION
500 Broadway
Redwood City, CA 94063

Ampex is best known for its tape magnetic recording equipment, but participated in the data storage industry in earlier years as a disk drive and media supplier. In 1998, the firm acquired Micronet as part of an initiative to expand the

Ampex presence in the image processing market. Micronet continues to operate as a subsidiary corporation.

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

1998 total net sales: $77,519,000 (FY ending 10/31/98) Net income: ($2,434,000)

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.

In June, 1999, nStor acquired 75% of Andataco shares. The remainder was acquired in August by nStor, leaving nStor the surviving corporation.

APPLE COMPUTER
20525 Mariani Avenue
Cupertino, CA 95014

1998 total net sales: $5,941,000,000 (FY ending 9/25/98) Net income: $309,000,000

Apple is one of the pioneers of the personal computer industry and has succeeded in creating a loyal and enthusiastic customer base among individual users. As part of its efforts to improve penetration of corporate markets, Apple began to offer disk drive arrays for its servers, beginning in late 1994, with a software based mirrored array using software licensed from Conley. Apple planned hardware array support for its line of servers in 1996 based upon third party controllers, but this effort was discontinued in 1997. Apple continues to license RAID software from SoftRAID, a Conley spinoff company formed in 1998 after Conley was acquired by EMC.

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.

ARTECON
6305 El Camino Real
Carlsbad, CA 92009

Artecon was 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 1994, the firm began shipping a modular array based upon purchased controllers. In mid-1997, Artecon acquired Falcon Systems, a move that improved Artecon's sales and support presence and also gave the firm an entry into the network attached storage market. In March, 1998, Artecon acquired Storage Dimensions, providing a product line of arrays covering the personal computer market. All SDI operations were moved to Carlsbad. In 1999, Artecon and Box Hill merged, forming a new company named Dot Hill.

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 was acquired in 1997 by Leitch, a Canadian based producer of equipment for the broadcast industry, and now operates as a subsidiary corporation.

AST RESEARCH, INC. (Subsidiary of Samsung Group)
16215 Alton Parkway
Irvine, CA 92713-9658

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 servers. The company was acquired by Samsung in 1997.

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.
2300 Central Expressway
Santa Clara, CA 95050

1999 total net sales: $113,475,000 (FY ending 6/30/99) Net income: ($39,045,000)

Auspex is a major provider of UNIX based NFS network servers that employ a sophisticated multiprocessor architecture and a high speed internal VME bus to obtain unusually high performance. Dedicated processors are assigned to each major system function. Auspex systems employ multiple processor/controller boards dedicated to controlling the array and can provide duplexing and drive spanning as well as mirroring and striping. RAID-0, RAID-1, 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 can now 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.

AVIV CORPORATION
20 Main Street
Acton, MA 01720

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.

BERING TECHNOLOGY
1717 Dell Avenue
Campbell, CA 95008

Bering offered five and ten drive IDE arrays based upon technology originally developed by Allodyne and subsequently acquired by Bering. The arrays have since been discontinued, with production ending in 1998. The company also produces storage subsystems for users of Hewlett-Packard computer systems.

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

1998 total net sales: $72,476,000 Net income: $5,934,000

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 was derived from sales of arrays. Array products included 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 broadened its marketing focus to include the telecommunications industry in recent years and to widen its distribution to adequately cover the U.S. market. In 1999, Box Hill and Artecon combined to form a new company, named Dot Hill, that continues to address the array markets of both organizations.

CAMBEX CORPORATION
360 Second Avenue
Waltham, MA 02154

1998 total net sales: $3,748,933 Net income: ($2,773,177)

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, resulting from declining sales. It filed for Chapter 11 bankruptcy in October, 1997, and emerged from bankruptcy in April, 1998. A subsequent round of additional financing enabled the company to continue its normal operations.

CHAPARRAL NETWORK STORAGE, INC.
1951 Fordham Street
Longmont, CO 80503

Chaparral was founded in 1998 as Chaparral Technologies when it acquired Adaptec's External Storage Systems Division. The name was changed in mid-1999 to better reflect the range of the company's interests, which currently include intelligent routers and RAID controllers. A close relationship with Adaptec, which is an investor, continues. Shipments of RAID controllers to OEMs and distributors began in 1999. FC-AL or Ultra2 SCSI is available on the host side. The drive interface is also Ultra2 SCSI.

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 was planned to be available for Windows NT in 1999. The firm currently markets almost exclusively to integrators in the United States.

CIPRICO, INC.
2800 Campus Drive
Plymouth, MN 55441

1998 total net sales: $30,088,527 (FY ending 9/30/98) Net income: $662,608

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, geophysical exploration and video applications.

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.

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 SCSI-2 support for up to 28 individual disk drives and up to 3 host channels simultaneously. 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, with Ultra SCSI now the most commonly offered interface.

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 enterprise server market.

COMMERCIAL DATA SERVERS
385 Moffett Park Drive, Suite 310
Sunnyvale, CA 94089

CDS, founded in 1994 by Gene Amdahl, has developed an enterprise array based storage subsystem (announced in 1997) based on mainframe processors. Connection to a host system is via fibre channel or ESCON, while drives are connected via Ultra SCSI channels. CMD controllers are used to provide array functionality. The system operates under OS/390, VS/ESA and VSE/ESA.

COMPAQ COMPUTER CORPORATION
20555 SH 249
Houston, TX 77070

1998 total net sales: $31,169,000,000 Net income: ($2,743,000,000)

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 is actively moving into the midrange systems market through its earlier acquisition of Tandem and its 1998 acquisition of Digital Equipment Corporation, and has restructured its storage related operations to address the new markets made available by the acquisitions.

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.

Compaq continues to offer Digital's StorageWorks product line and has extended the StorageWorks brand to cover its storage related products. The firm is expected to gradually replace purchased controllers with those of its own

design and manufacture. The implementation of SAN is a major Compaq initiative, and Compaq's solution is expected to incorporate much of the Digital technology. Compaq and Veritas are working jointly on Compaq's NT based line of storage servers. Compaq now offers ENSA (Enterprise Network Storage Architecture) as its overall design strategy for implementation and management of organization-wide storage systems.

In late 1999, Compaq further intensified its efforts in the storage area by establishing a business unit within the Storage Products Division to create an E-storage Utility product line based on SAN architectures.

CONLEY CORPORATION
125 Sidney Street
Cambridge, MA 02139

Founded in 1992, Conley Corporation was active in the storage equipment market, with activities centered in New York, and in the software development business, with activities located in Cambridge. Conley's software programs included storage management products licensed to a broad range of system and subsystem manufacturers, ranging from Apple Computer, to Hitachi, to EMC. In August, 1998, Conley was acquired by EMC, and the Cambridge software operation became the EMC Cambridge Software Development Center. The New York City based storage equipment operation was spun-off in an employee buyout under the name of Lexias, Inc., with emphasis on enterprise open systems markets. The Macintosh software team was also spun off, becoming a new startup, SoftRAID.

CONNEX
2040 Fortune Drive, Suite 200
San Jose, CA 95131

Founded as Crag Technologies, trhe firm was purchased by Western Digital in early 1999 and renamed Connex. It operates as a wholly owned subsidiary of Western Digital. Technology development is the focus of Connex, which concentrates upon storage subsystems and device-level solutions for NAS and SAN environments.

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.

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.

CSS LABORATORIES
1641 McGaw Avenue
Irvine, CA 92614

Founded in 1984, CSS is an integrator of custom systems for industrial and government applications. The product line includes workstations and servers, the latter available with hardware based arrays using Mylex controllers.

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, was a software array offering RAID levels 0, 1, 4 and 5. The array software operates with most host adapters and interfaces. RAID-1 is also available for Windows systems. A change of name, for marketing reasons, occurred in March, 1995.

DATADIRECT NETWORKS, INC. (Formerly 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. The firm was renamed as DataDirect Networks in March, 1998, reflecting the firm's reorientation as a storage area network solutions provider for imaging applications.

DATA GENERAL CORPORATION
4400 Computer Drive
Westboro, MA 01580

1998 total net sales: $1,462,109,000 (FY ending 9/26/98) Net income: ($152,395,000)

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 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 included 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 was 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 success of the CLARiiON unit and the general financial weakness of Data General resulted in EMC's acquisition of Data General, which was completed in October, 1999. EMC has announced that the CLARiiON operations will be integrated into EMC, while the DG AViiON computer system activities will be operated as a separate subsidiary.

DELL COMPUTER CORPORATION
1 Dell Way
Round Rock, TX 78682

1998 total net sales: $18,243,000,000 (FY ending 1/29/99) Net income: $1,460,000,000

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 storage subsystems (branding them as "PowerVault") in conjunction with its server class systems, which significantly increased the volume of Dell's array shipments in 1997. The firm has formed alliances with CLARiiON, Network Appliance and Veritas to further broaden its server capabilities.

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 fibre channel, Ultra SCSI and Ultra2 SCSI interfaces and up to 256 megabytes of cache.

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. Fibre channel capable "SmartCache V" began shipping in 1998. As with previous designs, array functionality is created when additional modules are installed on the basic SCSI controller board. A new line of subsystems began shipping in late 1994. The firm markets its controllers and arrays to OEMs and through distribution in the U.S. and Europe. About 30% of sales are to non-U.S. markets.

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

A wholly owned subsidiary of Dilog S.A., a Swiss company, DLI was founded in mid-1993. The company is a storage subsystems integrator selling to system integrators and system manufacturers. The "Windjammer" series of array products, based on the firm's own controller, provides RAID-0 and RAID-1 capability and attaches to SCSI host processors. First shipments were in early 1994. DLI also intends to market its controller on an OEM basis. An Ultra-SCSI version was added in 1996, and RAID-3 was added in 1998.

DOT HILL SYSTEMS
6305 El Camino Real
Carlsbad, CA 92009

Formed by the merger of Box Hill and Artecon in mid-1999, the combined company will focus on storage applications in intranets and upon the storage area network market. The initial product line consists of the Fibre Box arrays from Box Hill and the LynxArray series from Artecon, supplemented by the first new products from the combined company, the SANnet series of Ultra2 SCSI and FC-AL arrays.

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

1998 total net sales: $28,466,000 Net income: ($2,657,000)

ECCS is a system 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 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, with data 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.

EMC CORPORATION
171 South Street
Hopkinton, MA 01748

1998 total net sales: $3,973,735,000 Net income: $793,363,000

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.

In 1999, EMC startled the array industry by acquiring Data General, headquartered a few miles down the road, with the intention of using DG's CLARiiON operation to extend its reach further into the midrange storage systems market by integrating the CLARiiON product line into EMC's operations.

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 retained a minority interest (7.5%) in the company. FWB's RAID-0/1 software array, the RAID Toolkit, now bundled into the Hard Disk Toolkit, continues 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.

GATEWAY 2000 (Formerly Advanced Logic Research)
610 Gateway Drive
North Sioux City, SD 57049

ALR, purchased by Gateway in 1997 to bolster its position as a server supplier, was 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 ALR server line continues to be manufactured and marketed by Gateway.

HAMMER STORAGE SOLUTIONS
8450 Central Avenue
Newark, CA 94560

This company was born as a product line within Micropolis, was then spun off as StreamLogic wrestled with Chapter 11 bankruptcy, and is now in the process of acquiring a new identity. 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 had financial problems, filing for Chapter 11 status in mid-1997, reemerging from bankruptcy in 1998, with a change in name to Hammer Storage Solutions. The firm emphasizes sales into graphics and video application areas.

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

1998 total net sales: $47,061,000,000 (FY ending 10/31/98) Net income: $2,945,000,000

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 purchased controllers. In 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, with modest sales success, and the AutoRAID name is being deemphasized in 1999, as new models in the series are incorporated into H-P's enterprise storage product line. H-P also entered into significant disk drive array resale agreements with EMC and Data General's CLARiiON operation, but 1999 was a year of change with new storage equipment partnerships with Hitachi and LSI Logic. The company's storage systems capabilities were further bolstered through the acquisition of Transoft in mid-1999. In the fall of 1999, H-P announced a series of network attached servers incorporating a RAID-5 array. The servers use controllers and software obtained from strategic partners and H-P designed firmware.

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

1998 total net sales: $81,667,000,000 Net income: $6,328,000,000

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 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 in a series of succeeding models. 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.

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, and followed in 1999 with the new generation Multiprise 3000. 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 competi-

tor and adding significant additional disk array subsystem products to its own product line. This arrangement is being phased out in 1999, as IBM starts initial shipments of the 2105 Enterprise Storage Server, with up to 11.2 terabytes of RAID-5 capacity.

In 1999, IBM acquired Mylex in order to expand capabilities in array controllers. Mylex will operate as a wholly owned subsidiary, continuing to compete for OEM controller business.

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.

LEXIAS, INC.
420 Lexington Avenue
New York, NY 10017

Lexias resulted from the employee buyout of the computer equipment portion of the Conley Corporation, when the Conley software development operation

based in Cambridge, Massachusetts, was purchased by EMC. Lexias offered RAID array subsystems targeted primarily at security-conscious enterprise open systems applications, based on StorageWorks hardware. In early 1999, Lexias phased out its hardware based programs.

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. RAID-5 is provided.

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 included caching SCSI controllers with mirroring capability. Sales were mostly to system manufacturers, with a concentration in producers of voice mail systems. Lomas' hardware product programs were dropped in 1999, in favor of software activities.

LSI LOGIC
3718 North Rock Road
Wichita, KS 67226

This Wichita operation 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, later shortened to Symbios, Inc., a wholly owned subsidiary of Hyundai Electronics. LSI Logic purchased the operation in 1998.

LSI Logic produces array controllers which it uses in its own arrays and also sells on an OEM basis to other array producers. 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. The firm's more recently introduced MetaStor subsystem series is targeted at the open systems market through resellers.

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 LSI 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 MICRO TECHNOLOGIES, INC.
14524 61st 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.

MAXSTRAT
801 Buckeye Court
Milpitas, CA 95035

Founded as Maximum Strategy in September, 1986, the company succeeded in becoming a supplier of very high performance array subsystems to a number of major system manufacturers, including IBM, Silicon Graphics and

others. While the firm's first products, shipped in 1987 for use by Walt Disney animators, were RAID-0 configurations, most recent shipments were RAID-3 and RAID-5 disk drive arrays. 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 supported ATM and FCS attachment, but dispensed with the IPI interface in favor of SCSI-2.

The market focus of the company on providing storage subsystems for very high performance UNIX based systems, and developing strength in video server and geological survey markets, was expanded during 1998 with the development of the "Noble" series intended for broader open systems markets. A few years ago, the company decided that the firm's nickname, "MaxStrat", was too good to ignore and the organization adopted it as the company name. In early 1999, the firm was acquired by Sun Microsystems and folded into that company's network storage operation.

MAXTOR NETWORK SYSTEMS GROUP (Formerly Creative Design Solutions)
2260 Agnew Road
Santa Clara, CA 95054

CDS was a specialist in thin servers and controllers for network attached storage. In 1998, the company introduced Kharma, storage management software for its servers that includes mirroring capability. Some of the firm's Plug & Stor servers also include RAID-1 capabilities. The company was acquired by Maxtor in 1999.

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. Video-RAID, Medea's first product, was introduced at the 1997 NAB conference, with first shipments in mid-1997.

MERIDIAN DATA (See Quantum Corporation)

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

1999 total net sales: $1,437,829,000 (FY ending 9/03/99) Net income: $36,524,000

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 computers 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 (Subsidiary of Ampex Corporation)
80 Technology
Irvine, CA 92618

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. The company remains focused on imaging application markets, and was acquired by Ampex in mid-1998.

MOUNTAINGATE DATA SYSTEMS, INC.
9393 Gateway Drive
Reno, NV 89511

MountainGate was formed in 1992 as the result of Lockheed's complete acquisition of Cherokee Data. In 1998, the company completed a management buyout and is now an independent organization. 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 made use of software arrays, except for the Stampede Ultra Array, which offered a hardware based array option. The newer CentaVision systems are oriented toward the video editing market, employing fiber channel technology, but with similar software array capability. Fibre channel interfaces and SAN software became a development priority at MountainGate in recent years. MountainGate was acquired by ADIC in September, 1999, in order to provide ADIC with access to SAN capability.

MTI TECHNOLOGY CORPORATION
4905 East La Palma Ave.
Anaheim, CA 92807

1999 total net sales: $201,649,000 (FY ending 4/3/99) Net income: $10,092,000

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 1995 MTI acquired 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

1998 total net sales: $135,726,000 (FY ending 12/26/98) Net income: ($7,125,000)

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, but was not successful.

Depending upon the model, Mylex controllers attach to a host internal or external bus and can be used with many PC compatible systems. Fibre channel attachment to either host, disk drives, or both is available on some controller models. Mylex, working with Intel as a partner, developed 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. In 1999, Mylex was acquired by IBM. Mylex will operate as a wholly owned subsidiary, and is expected to continue its role as a major supplier of RAID controllers to the OEM market.

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

1999 total net sales: $289,420,000 (FY ending 4/30/99) Net income: $35,613,000

Founded in April, 1992, rapidly growing 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)
5180 Parkstone Drive
Chantilly, VA 20151

Founded in 1989 as Symmetrical Technologies, the company produces a direct network attached storage server that incorporates a disk drive array. Product development focus is shifting towards server software to support network attached storage, with some hardware configurations now discontinued.

NLYNX SYSTEMS INC.
8313 Highway 71 West
Austin, TX 78735

NLynx acquired Decision Data, formerly a division of the Israeli firm IIS, in March, 1999. Decision Data is a specialist in storage systems for the IBM AS/400 and RS/6000. Array products include a RAID-0/RAID-5 subsystem.

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.

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 using purchased controllers. In early 1997, nStor purchased Parity Systems, a California based integrator of array subsystems, followed by the 1998 purchase of Borg Adaptive Technologies, with the use of the former Borg facility in Boulder, Colorado, as an R&D center for nStor. In 1999, nStor acquired Andataco in a move to broaden its product line and expand marketing capabilities.

OPTIMA TECHNOLOGY
17062 Murphy Avenue
Irvine, CA 92614

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.

PACIFIC MICRO DATA, INC.
16751 Millikan Avenue
Irvine, CA 92606

Pacific Micro Data was founded in 1988 as a system 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.

PATHLIGHT TECHNOLOGY, INC.
9 Brown 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. However, SAN systems are now the focus of company activity.

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 system 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.

PERIPHERAL TECHNOLOGY GROUP, INC.
7580 Quattro Drive
Chanhassen, MN 55317

PTG acquired the Streamlogic Raidion, Gandiva and Microdisk array product lines in July, 1998. Originally developed by Micropolis, the firm's disk drive arrays were included in the extensive line of StreamLogic data storage products, for which PTG was the largest U.S. distributor. PTG continues to promote and sell Raidion arrays produced for it by a contract manufacturer, while working on future generations, with marketing activities under the "Raidion Systems" name.

PHOENIX INTERNATIONAL
812 West Southern Avenue
Orange, CA 92665

The Phalanx array series, based on purchased array 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. A more recent line of systems includes RAID 1/0 using IDE drives.

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. Network attached RAID capable servers are now Procom's emphasis.

QUANTUM CORPORATION
500 McCarthy Boulevard
Milpitas, CA 95035

1998 Total net sales: $4,902,056,000 (FY ending 3/31/99) Net income: ($29,535,000)

Quantum is best known for its rigid disk drives and DLT tape drives, but the company entered the array business in 1999 with its acquisition of Meridian Data, which had recently developed a RAID-1 capability for its entry level network attached server. The company is expected to broaden its offerings in the network attached server market, probably offering RAID-5 and other system upgrades in the future.

RAIDTEC CORPORATION
400 Overlook Business Park, Building 12
1360 Union Hill Road
Alpharetta, GA 30004

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. FC-AL drive interfaces became available in early 1998, as did network attached servers using Raidtec's RUAC II controller, enclosure and Ethernet interface.

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 "unit" contains 5 disks in a set, electronically labeled to avoid mismatches of members of sets. Rack or tower mounting is available.

ROCK SOLID SYSTEMS
47428 Fremont Boulevard
Fremont CA, 94358

Rock Solid, founded in 1993, manufactures disk drive controllers, including a mirroring controller that supports from two to 14 SCSI disk drives. The firm's first shipments were in 1996.

RORKE DATA, INC.
9700 West 76th Street
Eden Prairie, MN 55344

Rorke Data is a system integrator specializing in the AV, medical and pre-press markets, but also providing a variety of storage subsystems, some based on purchased RAID controllers.

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 was a manufacturer of midrange systems used in larger networking applications, some of which were developed using technology by Tricord. The firm offered 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 remarketed EMC and CLARiiON arrays. In 1999, Sequent was acquired by IBM.

SGI (SILICON GRAPHICS,INC.)
1600 Amphitheatre Parkway
Mountain View, CA 94043

SGI supplies high performance servers and workstations, with the entertainment and publishing industries among the most visible markets. In 1996 SGI acquired Cray Research, the world leader in supercomputers, and during the 1997-98 period took steps to provide a coordinated product line of high performance systems covering the firm's entire product range. The company's current range of disk drive arrays include resales of arrays from EMC, Data General CLARiiON and Ciprico. The Cray supercomputer product line (currently being spun off) utilizes internally developed disk drive arrays which have been in production for several years.

SMS DATA PRODUCTS GROUP, INC.
1501 Farm Credit Drive
McLean, VA 22102

SMS is a system integrator specializing in the government market. In addition to CD-ROM towers and other storage subsystems, SMS provides RAID subsystems based upon Adaptec controllers and Seagate Barracuda drives. Network attached RAID systems were added in 1999.

SOFTRAID LLC
P.O. Box 1600
Mendocino, CA 95460

SoftRAID was formed in 1998 when EMC bought Conley. The management of Conley's Macintosh software operation acquired the rights to Conley's Apple software products at that time and have been revamping and improving the products since, including adding support for interfaces other than SCSI. The SoftRAID product is currently bundled with Apple's server line.

STORAGE COMPUTER CORPORATION
11 Riverside Street
Nashua, NH 03062

1998 total net sales: $17,051,749 Net income: ($10,890,492)

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 compa-

ny'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 recent years, 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 system 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.

STORAGEPATH (Subsidiary of SWS Corporation)
917 Lawrence Drive
Newbury Park, CA 91320

StoragePath is a storage subsystem integrator serving the midrange systems market. The firm offers attractively packaged equipment, using CMD array controller, 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

1998 total net sales: $2,258,222,000 (FY ending 12/25/98) Net income: $198,248,000

Storage Technology's "Iceberg" array is easily the most famous disk drive array program for mainframe applications 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 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 arrays for open systems markets, 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. STC entered into a deal with IBM, in which IBM took over sales and service responsibility for the firm's mainframe disk storage programs effective July 1, 1996. The IBM deal is being phased out in 1999, and Storage Technology has again initiated its own sales program for a modernized Iceberg.

STRATUS COMPUTER, INC.
111 Powdermill Road
Maynard, MA 01754

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 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 had 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. The company was acquired by Ascend Communications in 1998, but later spun off in early 1999 as a privately owned company, minus those aspects of the Stratus business that were related to telecommunications.

SUN MICROSYSTEMS, INC.
901 San Antonio Road
Palo Alto, CA 94303

1999 total net sales: $11,726,297,000 (FY ending 6/30/99) Net income: $1,156,725,000

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. Recognizing the increasing storage content of its products, Sun created a network storage division in 1998. 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. In 1997, Sun acquired Encore Computer's storage related product line, which became the upper end of Sun's storage offerings. Responsibility for all of the storage products now resides within the Network Storage Division. In 1999, Sun acquired MAXSTRAT, folding the company into its Network Storage Division.

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

1999 total net sales: $86,032,000 (FY ending 6/30/99) Net income: $4,497,000

Founded in 1981 as a system 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. In 1999, Texas Micro was acquired by RadiSys, becoming the RadiSys Communication Platform Division. RadiSys is a manufacturer of embedded systems.

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 and includes Ultra SCSI disk drives.

TRANSOFT NETWORKS, INC.
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, storage area networks and the video production and imaging markets using fiber channel technology

and features supporting storage area networks. In mid-1999, Transoft was acquired by Hewlett-Packard. Transoft operations will continue in Santa Barbara as part of the H-P organization.

TRICORD SYSTEMS, INC.
2905 Northwest Boulevard
Plymouth, MN 55441

1998 total net sales: $3,853,000 Net income: ($2,111,000)

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. Tricord resold Ciprico arrays, and in 1992 added its own RAID-0/1 capability for Tricord file servers. In February, 1997, Tricord indicated it would exit the server market, concentrating on software products for distributed data access and management, and the server business was sold to EFC, a Tricord VAR, in August, 1999.

TRUESAN NETWORKS (Formerly Synapsis Digital)
1875 Charleston Avenue
Mountain View, CA 94043

Synapsys was founded in 1997 as a custom system integrator, and was among the earliest companies to deliver a fibre channel based array. Manufacturing is in Sunnyvale and Taiwan, with most sales on a direct basis. The firm is targeting SAN users as a focus of its marketing and development activities. The company acquired a new identity in 1999, but retained existing product lines.

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

1998 total net sales: $7,208,400,000 Net income: $387,000,000

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.

VERITAS SOFTWARE CORPORATION
1600 Plymouth Street
Mountain View, CA 94043

1998 total net sales: $210,865,000 Net income: $51,648,000

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. In 1998, Veritas acquired the storage software product line of Seagate Software, a transaction which gave Seagate a 35% share in the ownership of Veritas.

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.

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 was for Windows NT and Novell environments, with UNIX support added in 1999. Storage subsystems for SAN is the current area of focus, with the array incorpo-

rated into the SAN-ready subsystem. FC-AL and point-to-point fiber are both supported. The firm emphasizes 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 software based arrays, but can also be equipped with optional hardware controllers.

ZITEL CORPORATION
630 Alder Drive
Milpitas, CA 95035

1998 total net sales: $21,700,000 (FY ending 9/30/98) Net income: ($43,205,000)

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 enjoyed significant licensing revenue from IBM as a result of development activities during the gestation period of IBM's RAMAC mainframe array.

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.)

ACARD TECHNOLOGY
36 Wu Hsing Street
Taipei
Taiwan

ACARD, founded in 1989 under another name, became ACARD in 1996. The company, which designs some of its own chips for manufacture by local producers, is a manufacturer of add-in cards for small computers. The firm's array controllers include boards for SCSI and PCI host systems, all introduced in 1998 or later. Most of ACARD's array controllers are sold to Japanese system integrators.

ACCORDANCE SYSTEMS
31, Section 6 Hsin Yi Road
Taipei
Taiwan

Small RAID-1 and RAID-5 systems are the products of Accordance Systems, which markets them to integrators who resell them under a variety of brand names. The RAID-1 array uses IDE drives and interfaces to an IDE host channel.

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

1997 total net sales: $2,423,106,000 (FY ending 12/97) Net income: $129,951,000

Founded in 1981, Acer is known for its personal computers and related products, and is now one of Taiwan's largest companies. Acer's U.S. subsidiary, Acer America, is 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 AcerAltos server class products are equipped with an array option currently using controllers purchased from third parties. RAID levels 0, 1 and 5 are supported. 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 name and variations, ADTX is a spin-off from IBM, operating as 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. A major portion of ADTX shipments are distributed through IBM's Japan sales organization.

AMAQUEST COMPUTER CORPORATION
Far East World Center
8F, 79 Hsin Tai 5th Road, Section 1
Hsijr, Taipei 221
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.

DATAWORLD INTERNATIONAL CORP.
6F, 2, Section 2 Nan Kang East Road
Taipei, Taiwan

Founded in 1984 as a distributor for Altos, Dataworld integrates disk drive arrays based on the Infortrend controller. The arrays have sold under the firm's Escort brand since 1995.

DTC DATA TECHNOLOGY CORPORATION
8 Technology Road
Science-Based Industrial Park
Hsinchu, Taiwan

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 IDE drives. It plugs into a PC compatible ISA bus computer. Other array controllers subsequently introduced incorporate purchased controllers.

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 products are now major product lines, 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

1999 total net sales: $40,022,793,000 (FY ending 3/31/99) Net income: ($104,106,870)

Fujitsu derives about 66% 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.

After several years of joint ownership by Hitachi (84%) and EDS (16%), Hitachi Data Systems became a wholly owned Hitachi, Ltd., subsidiary in 1999. After extensive 1999 reorganization HDS currently operates in 30 countries, offering computer systems ranging from mainframes and open systems to personal computers, combined with major disk drive array programs for mainframe and open system applications. HDS introduced the 7600 disk storage subsystem for mainframe applications using unique Hitachi 6.5" disk drives, in 1993, followed by succeeding generations of RAID-5 7700 models, with recent versions also using

Hitachi's unique 2.5" 12,000 RPM drive. Starting in 1995, HDS added smaller arrays targeted at emerging open systems applications, followed by a series of updated models.

HITACHI, LTD.
4-6 Kanda-Surugadai
Chiyoda-ku, Tokyo 101

1999 total net sales: $60,895,984,000 (FY ending 3/31/99) Net income: ($2,586,213,700)

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, and in 1983 started selling plug compatible drives for distribution in the European plug compatible 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, Comparex and Olivetti, Hitachi sells comparable products through its own organization to both captive and distributor channels.

INFORTREND, INC.
10F, No. 33, Section 2 San Min Road
Pan Chiao City, Taipei Hsien
Taiwan

Infortrend produces an array controller offering RAID-0, RAID-1, RAID-3, and RAID-5. The controllers have PCI, EISA or SCSI host ports, and are intended for use on IBM PC compatible platforms. The firm is marketing the controllers on an OEM basis, and has achieved considerable success with system integrators in the U.S. and in Taiwan.

MAXTRONIC INTERNATIONAL COMPANY, LTD.
4 Fl, No. 259, Chung Cheng 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

1999 total net sales: $36,331,389,000 (FY ending 3/31/99) Net income: ($1,205,702,200)

NEC has defined its product area as communications and computers, with computer products currently accounting for about 42% 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.

ONEOFUS
4F-1, No. 49, Section 3, Ho-Ping East Road
Taipei
Taiwan

Startup OneofUs was founded by technical staff from Raidtec. The company offers FC-AL array controllers and is oriented towards OEM and integrator sales channels. The company also supplies enclosures incorporating its controllers.

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. A line of inexpensive PCI based controllers was introduced in 1998.

PROWARE TECHNOLOGY CORPORATION
4F, No. 5, Lane 235, Pao Chao 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.

RAIDELL COMPUTER, INC.
10F-4, #77, Section 1, Hsin Tai Wu Road
Hsichih, Taipei Hsien
Taiwan

Raidell produces a RAID-1 system using Ultra ATA interfaced drives. Shipments began in 1999.

TEXA CORPORATION
Nara Building II
2-2-8 Shin-Yokohama
Kohoku-ku, Yokohama 22-0033

Texa (formerly 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.

European Manufacturers

ARCO COMPUTER PRODUCTS (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 shipped in 1997, 1998 and 1999.

AXIS COMMUNICATIONS
Scheelevagen 16
S-223 70 Lund
Sweden

Axis is a major supplier of network controller modules for Ethernet-based network attached storage. The firm has developed a RAID-0/RAID-1 network attached controller which is planned for initial shipment in late 1999. The controller, designated the NAS-100, has an Ultra-SCSI output channel capable of driving a modular RAID-5 controller. Several OEMs are using it in this manner. A number of major OEMs have already signed up with Axis as customers for its NAS-100, as well as a number of smaller organizations, so it appears that Axis may get off to a good start as a supplier of network attached arrays.

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
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 1991, BASF assumed complete ownership, and in November, 1998, Persetel Q Data Holdings Ltd., a South African company, acquired 75% ownership and changed its name to Comparex Holdings Limited. 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 plug compatible 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. RAID-3 was added in 1998. Distributed Logic markets storage subsystems in Europe, Africa and the Middle East, while Diverse Logistics covers the Americas.

EUROLOGIC SYSTEMS LTD.
Maple House
South County Business Park
Leopardstown
Dublin 18
Ireland

Eurologic is a system integrator producing storage subsystems with RAID-0/3/5 capability based upon CMD and Infortrend controllers. The subsystems are equipped with redundant power supplies and fans, and dual AC power feed is offered as an option. Host interfaces for Ultra SCSI and the PCI bus are available. The firm also supplies RAID enclosures to a number of OEMs and integrators. In addition to its administrative and production facilities in Ireland, the firm maintains a U.S. headquarters in Boxborough, Massachusetts.

IIS INTELLIGENT INFORMATION SYSTEMS LTD.
Yokneam
Israel

IIS operates in most countries as Decision Data, which is an IIS division. The firm specializes in storage subsystems for IBM midrange systems, notably the AS/400. Other midrange systems are also supported. Decision Data was acquired by NLynx in March of 1999.

NEXSAN TECHNOLOGIES LIMITED
Imperial House
East Service Road
Raynesway, Derby DE21 7BF
United Kingdom

Nexsan was started in 1999 by storage industry veterans, with most recent experience at Trimm Technologies. The firm started shipments in mid-1999 of a family of RAID subsystems based on CMD and Chaparral controllers and targeted at storage area networks and other open systems applications.

SAGITTA PERFORMANCE SYSTEMS
Langstone Road
Havant, Hampshire PO9 1SA
United Kingdom

Sagitta was formed in 1998 as the result of a management buyout of the disk drive array distributor operations of Xyratex, which continues to manufacture arrays for Sagitta. The company is still located at the Xyratex site. Sagitta provides storage subsystems and networked storage systems with distribution plans to cover Europe, the U.S. and South Africa.

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 FC-AL 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 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. The distribution activities for Xyratex arrays were taken over by Sagitta Performance Systems, a spin-off company formed as the result of a management buyout, but Xyratex continues to offer disk drive arrays on an OEM basis.

DISK/TREND ON DISK

1999 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 statistical tables are provided in text format usable on IBM-compatible computers running under MS-DOS, PC-DOS, or Microsoft Windows. Specification tables are provided in the form of an Excel spreadsheet file.

User instructions for 1999 DISK/TREND on Disk are included on the data diskettes in the form of web browser readable files, and can also be found on the DISK/TREND web site at www.disktrend.com/dtod/dtod.htm. To locate the user instructions on the diskette, set the browser to: file://A:/index.htm. If you are using other than the "A" drive as your floppy disk, then use the appropriate drive letter.

If you are using DISK/TREND on Disk files for years earlier than 1999, please refer to the DISK/TREND Report for the appropriate year and product type for instructions.

A file translation program, DataImport, is available from DISK/TREND to assist in converting the data supplied to the formats of several popular spreadsheets. One copy of DataImport is provided at no extra charge to DISK/TREND subscribers who purchase DISK/TREND on DISK for the first time. Upgrades to DataImport for users with the earlier AutoImport conversion software are available at a special price. Please contact DISK/TREND for details.

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