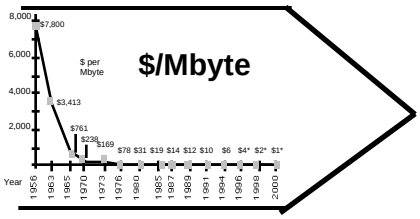
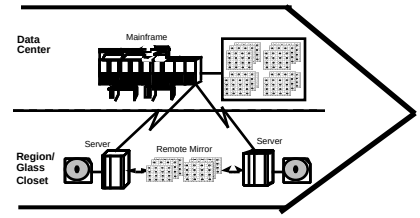
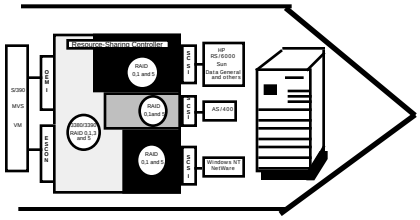
Reader Notes



- **Price/Performance Wars Continue**



- **High Availability Becomes Commodity**



- **Storage Servers Emerge as Vendors Seek New Markets**

Source: Gartner Group

Demand for disk storage within an enterprise is increasing at a 20-percent to 40-percent rate each year. Much of that increase is at the desktop and departmental-server levels (50-percent to 60-percent growth). At the mainframe and midrange host and server levels (25-percent to 35-percent growth), a portion of the growth is in increasing demand for highly available systems in general and mechanisms for high-availability storage, such as RAID 5 (approximately 20-percent storage space overhead), RAID 1 (100-percent mirrored overhead), hot spare drives and disaster recovery sites. Tendencies toward hierarchically stored information cause further duplication and replication of storage needs, further driving up storage demand.

At the same time, price decreases are keeping up with or even outstripping demand, with improvements of street prices in the 35-percent to 45-percent range. Storage vendors are in increasingly difficult positions as hardware moves toward commodity components and commodity margins, forcing each of them to seek out new potential markets. As vendors broaden their market scope and increasingly compete on new fronts, users will benefit from new efforts to provide product differentiation and price competition. However, users will find that a degree of vendor fallout is also likely.

Key Issues

1. **What technology and vendor choices should users make to minimize storage cost and management burdens?**

2. **What are the key differentiators in technology and supplier options for midrange and LAN-based storage?**

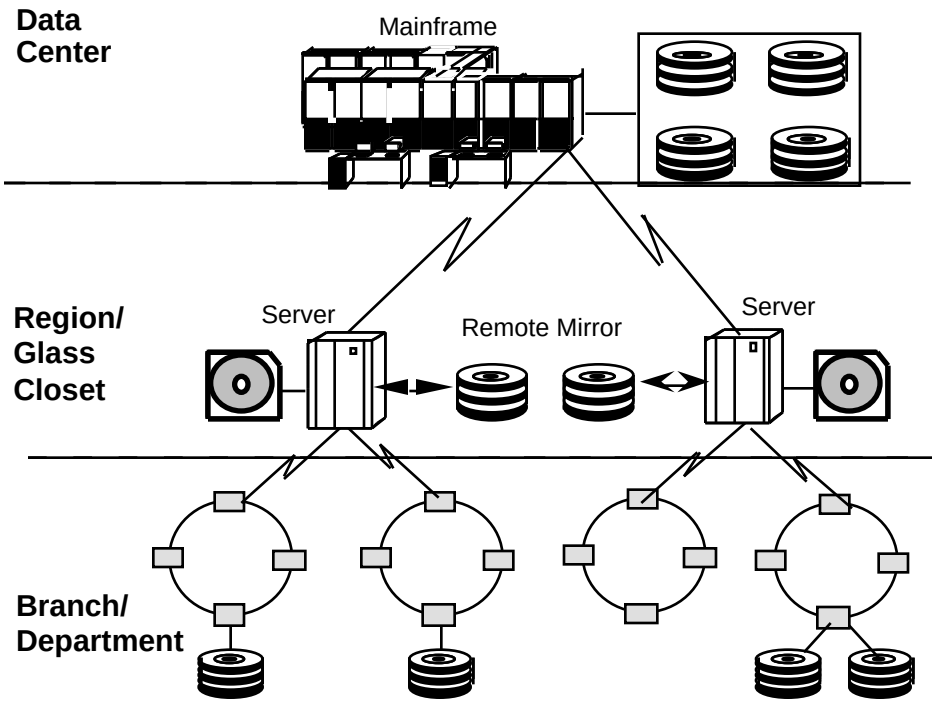
3. **Which storage vendors have the highest potential for differentiation and survival in the coming market consolidation?**

Reader Notes

As hardware commodity prices sweep the storage market, product differentiation and vendor survival should be key concerns for all users. During the five-year planning period, storage demands will continue to expand at dramatic rates for both enterprise and personal needs. New data and information types will challenge acquisition and the management of storage capacity. Examples of this include scanner input at a personal and departmental level, voice recognition for customer and internal business transaction recording, and data-mining and data warehouse initiatives in pursuit of new business competitive advantages. Users will see increased complexities in satisfying centralized as well as distributed storage server needs. In this highly competitive market, vendors will offer new shared-capacity, midrange and LAN-based products. Choices will be complex but critical to an effective server strategy.

What technology and vendor choices should users make to minimize cost and management burdens?

Reader Notes



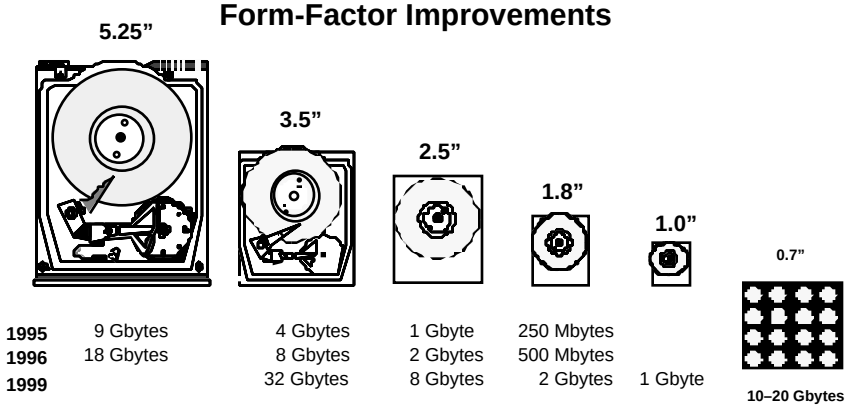
Source: Gartner Group

The parameters that define traditional cost effectiveness are changing, and they will continue to do so. Commodity disk drives and improved network infrastructure will make disk mirroring a de facto standard for local as well as remotely connected shared data. With hardware costs plunging, the threshold beyond which dedicated self-backup becomes economically viable is moving downward relative to the subscription costs of commercial disaster recovery sites. Electronic vaulting and multisite operations are making alternate internal sites more viable options. Declining hardware prices make dedicated hot sites more feasible. In addition, less-expensive hardware makes central sites candidates for an “electronic vault” for servers.

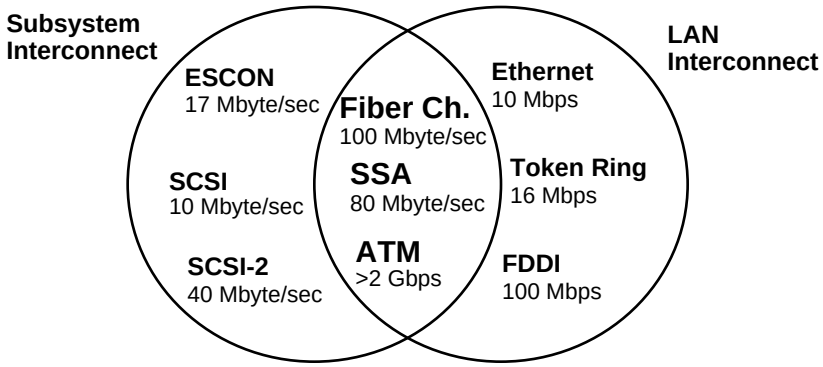
Disk technology will not be an inhibitor to continued increases in demand (0.85 probability). System and network interconnect technologies will merge to enable radically different server configurations, but use will not be widespread (0.8 probability).

Reader Notes

Form-Factor Improvements



Interconnect Speeds



Source: Gartner Group

Key Issue: What technology and vendor choices should users make to minimize storage cost and management burdens?

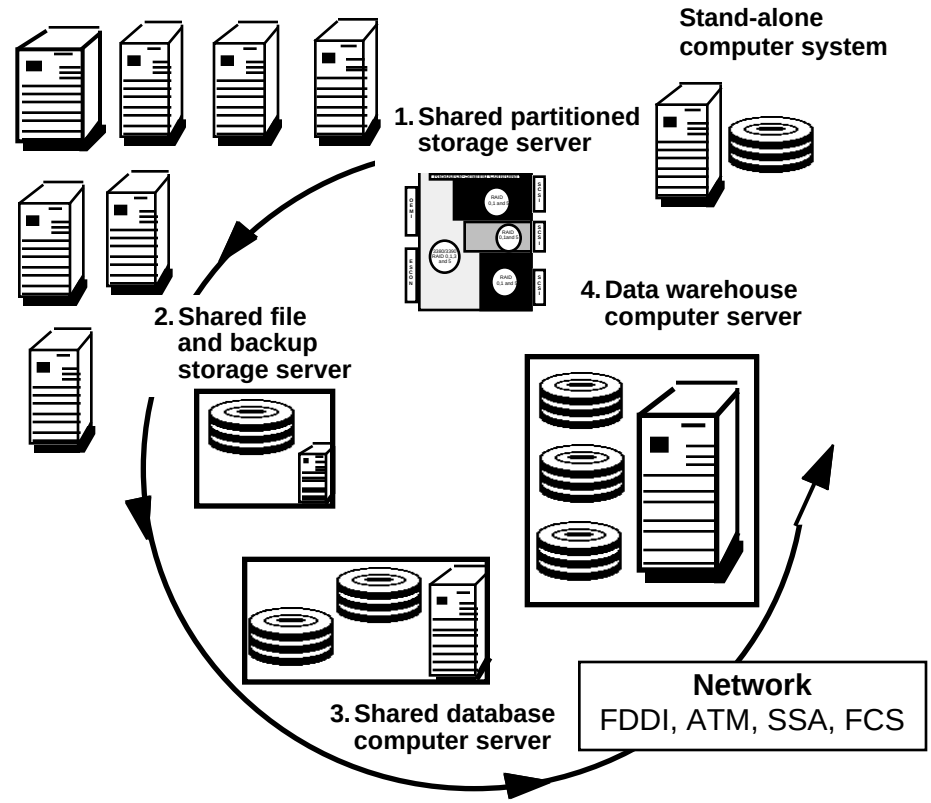
Disk drive technology is no longer an inhibitor. The old theoretical barrier of 1 Gbit per square inch has risen to new limits in the range of 25 Gbits per square inch. Form factors are shrinking at a predictable rate. Eventually, disks smaller than 1 inch will be plugged directly onto a card sharing common electronics and hard-wired RAID schemes. As with solid-state memory chips (RAM), the challenge is to build DASD subsystems that can effectively exploit rapidly advancing disk drive technologies and capacities.

At the same time, interconnect technologies are improving, with potentials for system/storage interconnect techniques and protocols to merge with local- and even wide-area network protocols. The potential benefits from that include new concepts of remote storage for specialized backup servers, stand-alone data and information servers, and disaster site backups.

The evolution of network-based storage servers will be limited because general-purpose computer servers will be adapted and favored over specialized storage-only servers (0.7 probability).

Reader Notes

Progression of Storage Server Types



Source: Gartner Group

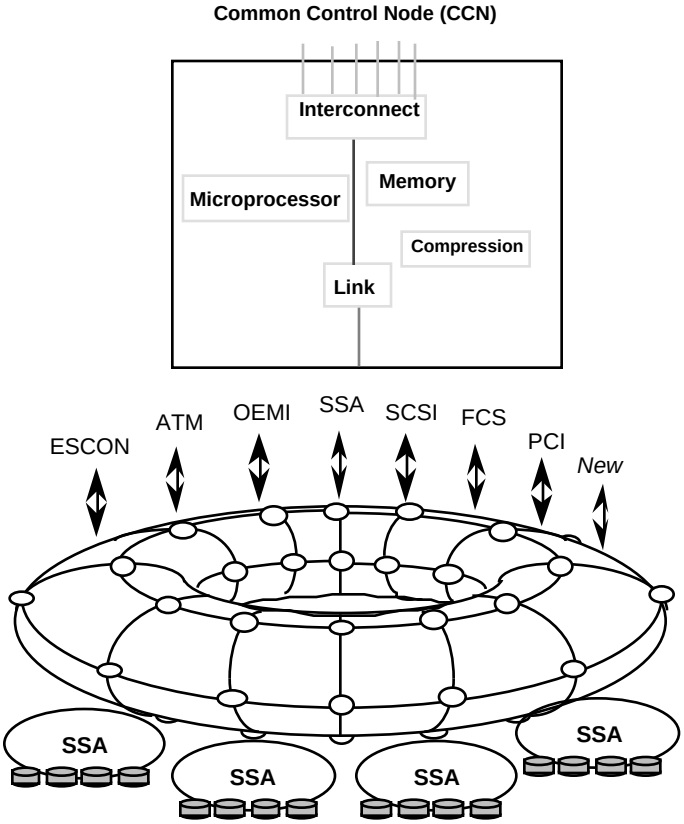
Key Issue: What technology and vendor choices should users make to minimize storage cost and management burdens?

The evolution of storage systems is moving toward greater added value and greater complexity, rather than less. The fact is that storage vendors rightly see less viability in a status quo strategy as commodity prices and increased competition squeeze profitability. Consequently, virtually all storage suppliers are trying to broaden their skills and product market appeal. Their first steps are in leveraging product knowledge with offerings for "open systems," a euphemism for Unix-, NetWare- and/or NT-based systems. Examples are shared partitioned devices for attaching heterogeneous platforms and shared file and "smart" backup/restore capabilities. In time, these more intelligent storage servers can be enhanced to include shared databases and the size-variant of that in data warehouses. Each of these storage server variations will be useful in the right circumstances. We believe that storage-only suppliers will be more successful with basic variations (1, 2) and the systems suppliers more successful in database and data warehouse situations (3, 4), offering enhanced storage capabilities but with more-traditional systems and software packaging.

Torus-ring-based designs will begin availability by mid-1996 on large server/host implementations (0.8 probability). Midrange server use will begin by 1998 (0.7 probability).

Reader Notes

IBM's Enterprise Storage Seascape



Source: Gartner Group

Key Issue: What technology and vendor choices should users make to minimize storage cost and management burdens?

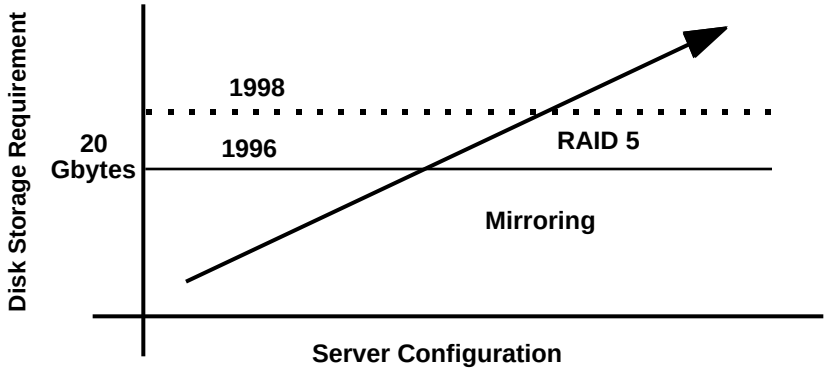
IBM's next generation of storage subsystems will employ what is commonly called a torus ring architecture. In this scheme, scalability is achieved by adding bandwidth in three dimensions. Rather than replacing back planes or whole boxes, a card can simply be inserted to add a level to the torus and increase bandwidth. The loop structure provides fault tolerance if an end node fails. Each CCN can include cache, disk control, channel interface and remote link. By using common sets of advanced technology components in many products, IBM's goal is to have scalable products at much less cost. Therefore, each CCN includes a standard RISC 60x microprocessor like those used in PowerPC-based systems and workstations.

The first early versions from IBM of Seascape are expected in 1996, but full realization of its intent is likely to be a five- to ten-year evolution. In most cases, its applicability will be in storage configurations of multiple terabytes and will largely be overkill and cost ineffective in smaller configurations.

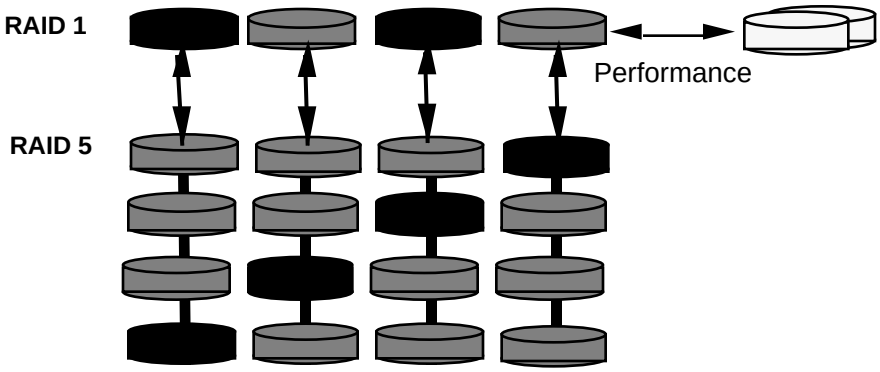
RAID 5 will be common but not omnipresent due to vendor cost issues and user performance demands; mirroring (RAID 1) will be common at the low and high ends of disk storage configurations (0.75 probability).

Reader Notes

Availability and Selection of RAID



Hierarchical RAID



Source: Gartner Group

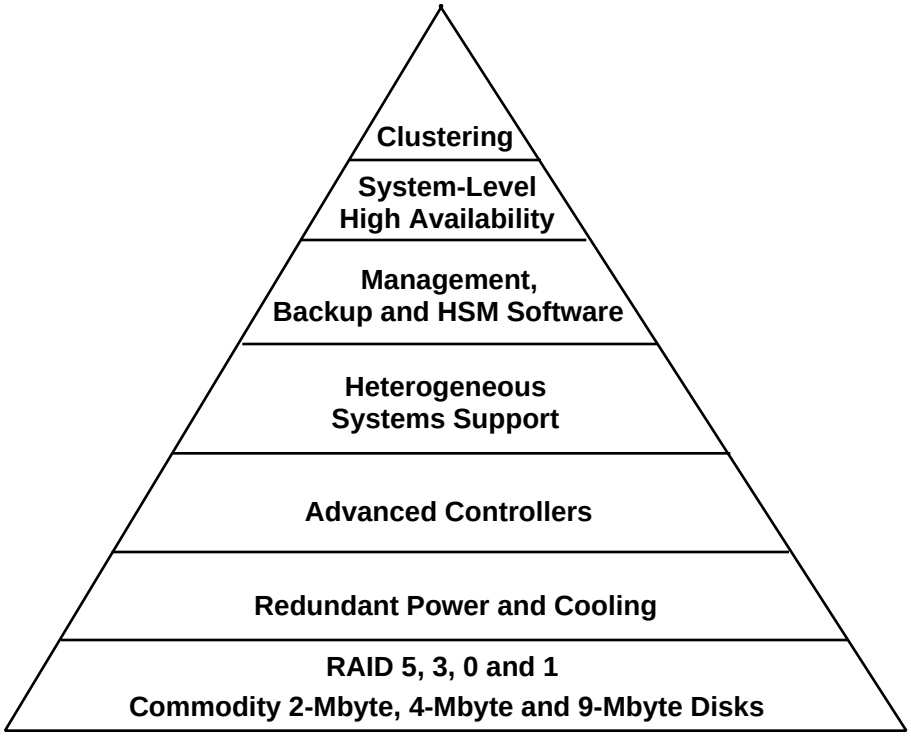
Key Issue: What technology and vendor choices should users make to minimize storage cost and management burdens?

RAID technology has become commonplace for essentially all levels of host and server systems. RAID 5 provides a high-availability solution at reasonable price but with some performance penalty, particularly during disk failure recovery. RAID 1 is a mirroring of disk devices and requires the cost duplication of disk space to gain high availability, but with little to no performance penalty in the event of a single disk failure. Looking forward, we believe that decreasing disk prices coupled with the product costs for RAID 5 controllers will result in RAID 1 solutions, often just software-based, for the relatively small configurations (e.g., 20 Gbytes or less). At the high end, RAID 1 mirroring, usually hardware-based, will become the dominant choice, driven by the combination of lower disk prices and a more intense need for optimal performance.

During this period, we will see RAID 1/RAID 5 hybrid products where data will be moved dynamically to RAID 1 or RAID 5 depending on performance conditions monitored by the system.

What are the key differentiators in technology and supplier options for midrange and LAN-based storage?

Reader Notes



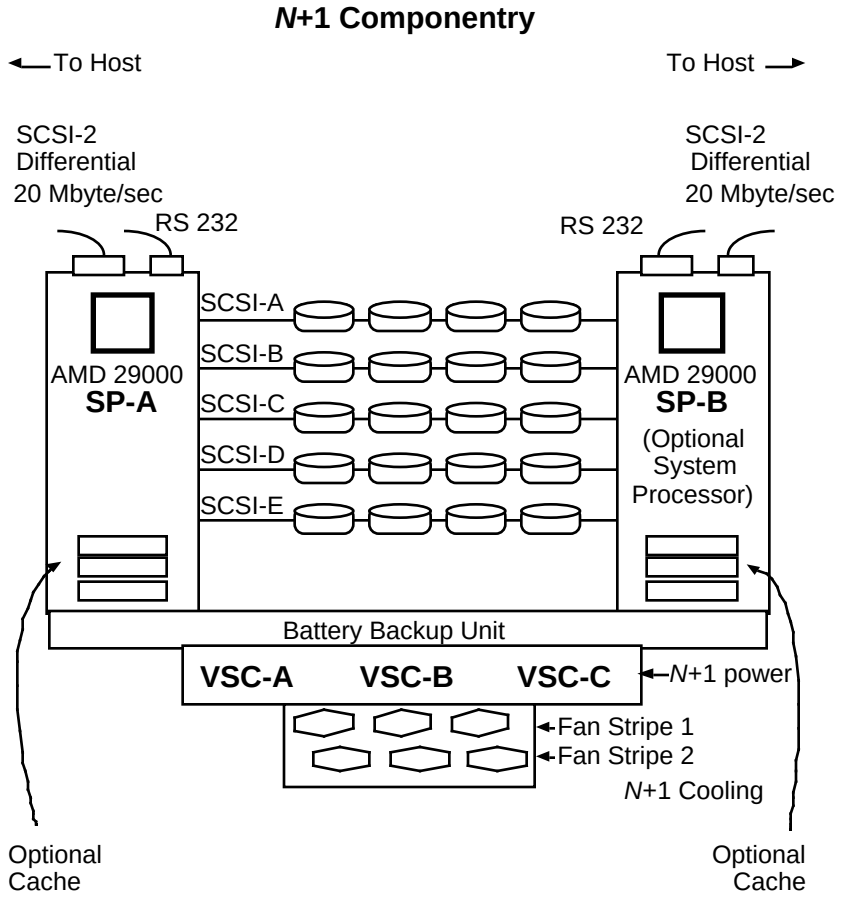
Source: Gartner Group

A bewildering array of vendors is now in the add-on storage business. At the base of the market pyramid, the availability of commodity disks and controllers lowers the barrier to entry for new vendors in the entry-level RAID market. At this end of the spectrum, fully configured RAID 5 subsystems can be purchased for less than U.S.$1 per megabyte.

In examining this Key Issue, we will analyze the differentiators that vendors employ to create RAID subsystems with higher performance, higher availability and higher profit margins.

Differentiator Number 1: Hot Sparing and Redundant Power and Cooling

Reader Notes



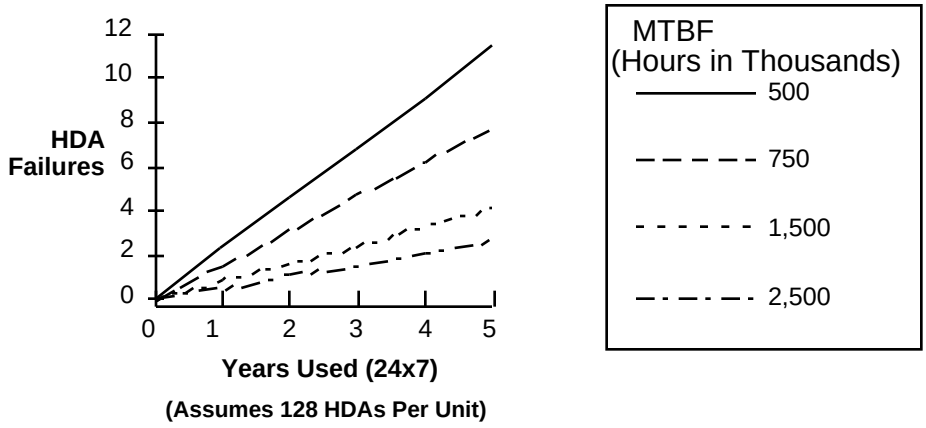
Source: Data General and Gartner Group

Key Issue: What are the key differentiators in technology and supplier options for midrange and LAN-based storage?

RAID systems are, of course, designed to withstand the loss of any single disk without data loss. However, commodity-level RAID systems frequently have at least one single point of failure, which may involve any of the the following components: power supply, controller, fan or cache memory SIMM. Vendors of midtier RAID systems (such as CLARiiON and EMC's Centriplex) allow users to pay for the level of redundancy they desire, while high-end systems might have the redundant components built in as part of the base infrastructure.

A related issue is that of hot disk sparing. In the event of drive failure, midlevel and high-end systems typically have one or more global spares that are dynamically configured to replace the failed drive. The incremental cost of hot disk spares should be viewed in the context of ease of serviceability and any 24x365 uptime requirements.

Cumulative HDA Failures at Varying Reliability Levels



Source: Gartner Group

Key Issue: What are the key differentiators in technology and supplier options for midrange and LAN-based storage?

Most vendors of midlevel and high-end RAID systems have implemented the ability to replace disks without powering down or quiescing the system. However, the cost of hot-pluggable drives may add as much as 50 cents per megabyte to the incremental storage cost (but it declines as drive capacity increases). This cost may not be justifiable, except where RAID subsystem capacity is large and 24x365 uptime is mandatory. Hot pluggability is not typically a user-selectable option. It is a base design decision made by the vendor.

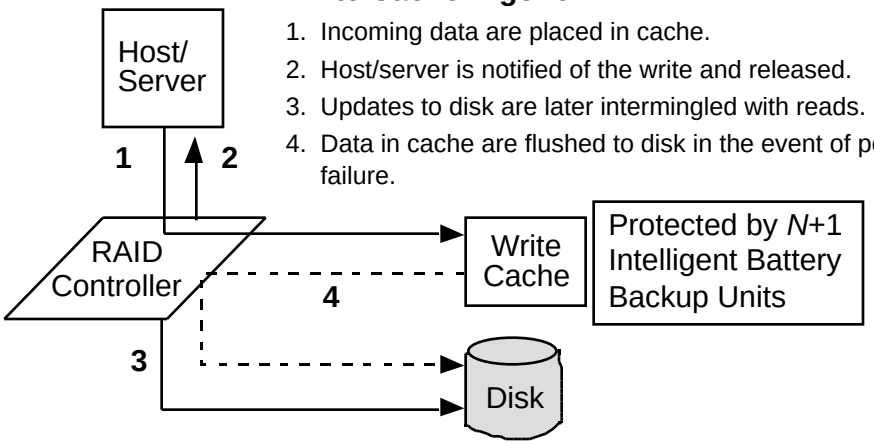
Hot-pluggable power supplies and fan assemblies are available from some RAID vendors (once again, as a base design decision) and should be important buying criteria for 24x365 systems (particularly those located in nonmetropolitan areas). Given that user serviceability of components should result in fewer vendor service calls, reduced maintenance pricing *should* partially offset any incremental cost.

Differentiator Number 3: Performance — Nonvolatile Write Cache and Interconnect Speeds

Reader Notes

Write Cache Algorithm

1. Incoming data are placed in cache.
2. Host/server is notified of the write and released.
3. Updates to disk are later intermingled with reads.
4. Data in cache are flushed to disk in the event of power failure.



Subsystem Interconnect Speeds

	Maximum Data Rate	Year*
SCSI-2 Fast	10 Mbyte/sec	Now
SCSI-2 Fast/Wide (16 bit)	20 Mbyte/sec	Now
SCSI-2 Fast/Wide (32 bit)	40 Mbyte/sec	Now
SSA	80 Mbyte/sec	Now
Fiber Channel	25 Mbyte/sec	Now
Fiber Channel	50 Mbyte/sec	1996
Fiber Channel	100 Mbyte/sec	1996
FDDI	100 Mbps	Now
ATM	155 Mbps	Now
ATM	622 Mbps	?

*First year shipping from at least one vendor

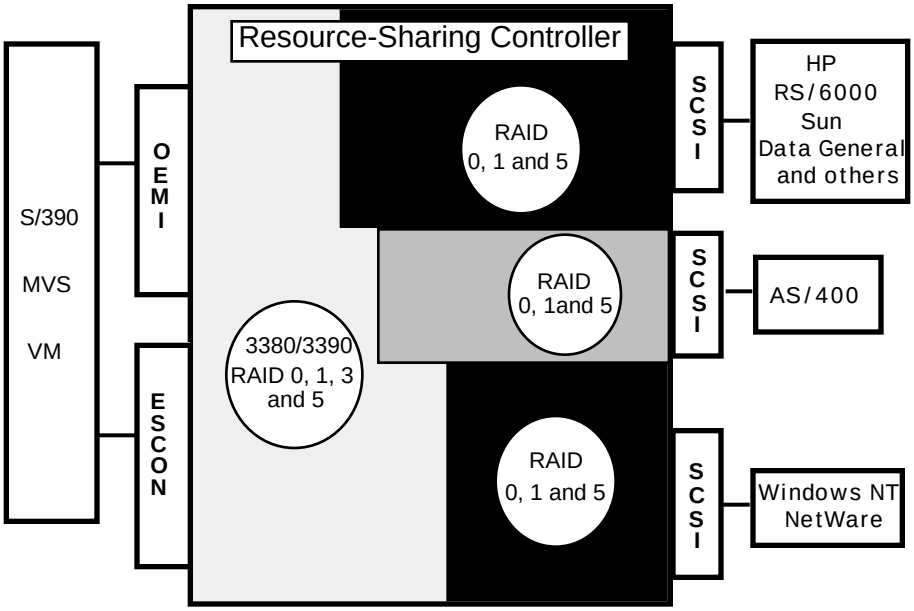
Source: Gartner Group

Key Issue: What are the key differentiators in technology and supplier options for midrange and LAN-based storage?

The well-understood RAID 5 write penalty can be addressed to some degree by the presence of a sufficiently large write cache. Although far from definitive, a study recently published by Oracle and Data General (DG) concludes that a 64-Mb write cache shared by a small number of RAID 5 disks can reduce, and in some cases eliminate, the performance penalty of RAID 5 vs. RAID 0 (striped disk). In general, vendors have not provided meaningful guidance regarding the performance payback of increasing cache sizes.

Data integrity can only be guaranteed if the write cache is both mirrored (to address SIMM failure) and nonvolatile in the event of power failure (either through battery backup or through the use of nonvolatile memory chip technology). Read caches, which in some vendor configurations can grow to the gigabyte range, do not require nonvolatility and may not require mirroring (depending on uptime requirements).

Generalized Storage Sharing



Source: Gartner Group

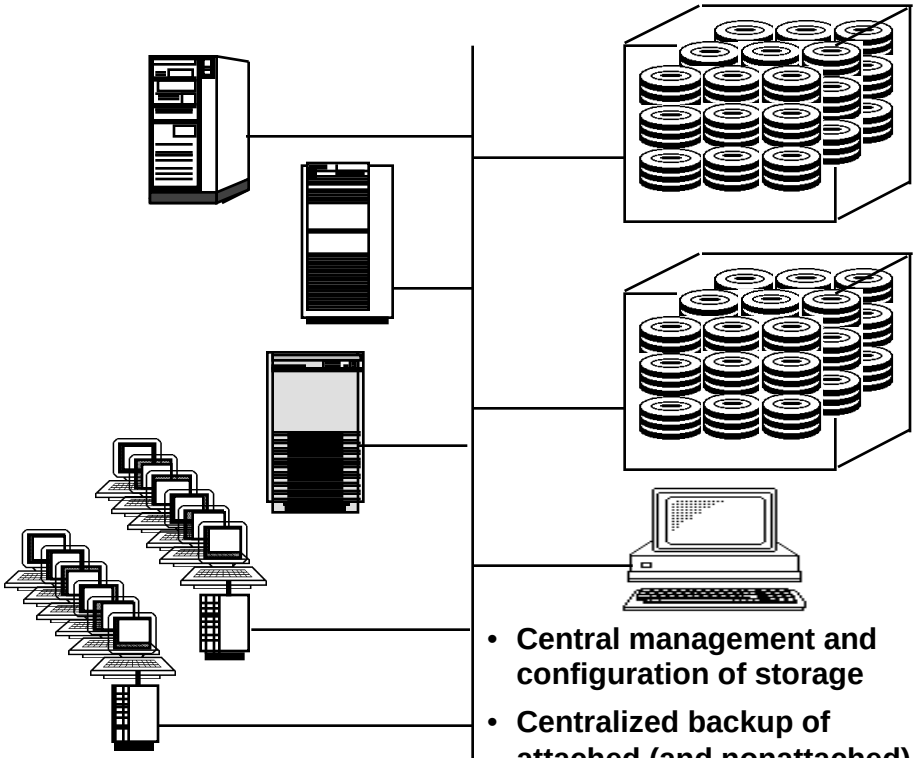
Key Issue: What are the key differentiators in technology and supplier options for midrange and LAN-based storage?

Increasingly, storage and system vendors are designing storage products that can support heterogeneous platforms simultaneously. At the simplest level, this can take the form of a rack-mounted system where each bank of disks is connected to its own controller, which in turn is connected to any supported platform. At the other end of the spectrum is a system like that depicted above, where available storage can be dynamically allocated to any of the supported platforms. Even without the capability for data sharing between platforms, this type of system is likely to appeal to organizations where data are already centralized, or where even near-term platform-specific storage requirements cannot be reliably predicted. The downside of the high-end systems currently is price, where the roughly U.S.$4-per-megabyte cost per configured system is well beyond the U.S.$1.50-per-megabyte midrange mainstream or the less than U.S.$1.00 per megabyte at the departmental LAN server level.

Differentiator Number 5: Management, Backup and HSM Software

Reader Notes

Network-Based Storage Management



- **Central management and configuration of storage**
- **Centralized backup of attached (and nonattached) storage**
- **Centrally implemented HSM**

Source: Gartner Group

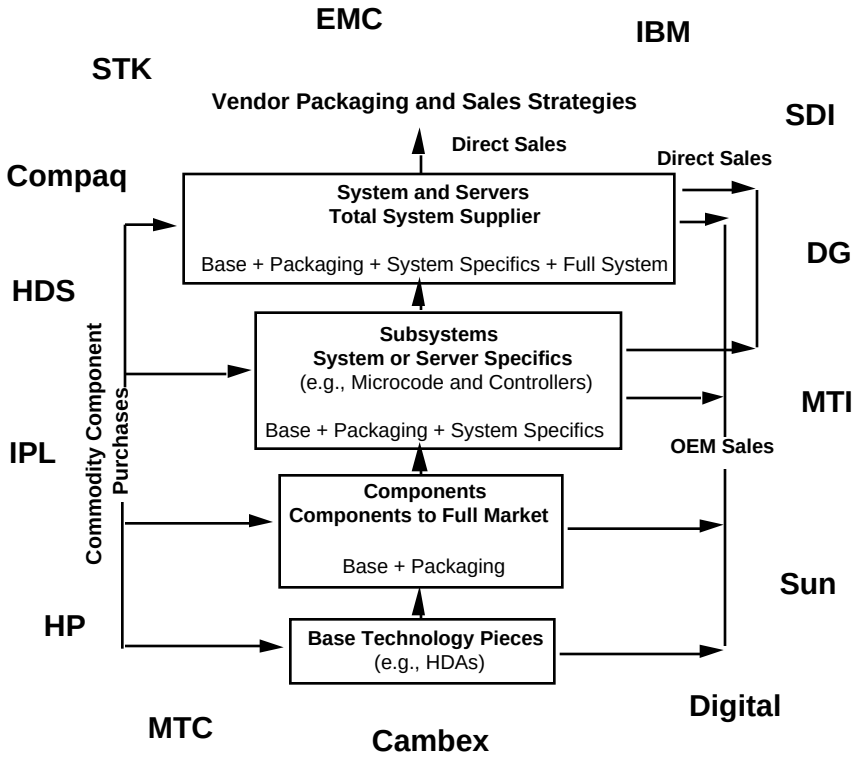
Key Issue: What are the key differentiators in technology and supplier options for midrange and LAN-based storage?

As commoditization of storage systems rises to higher and higher levels (both from a functionality and a gigabytes point of view), vendors are increasingly building or buying software expertise that can result in differentiating (and profit-margin-enhancing) products. EMC's acquisition of Epoch and MTI's acquisition of Raxco's management software division are two cases in point.

Although providing good RAID system management software that runs on a Windows-based PC is fairly straightforward, other software initiatives tend to be more host-system-centric.

Which storage vendors have the highest potential for differentiation and survival in the coming market consolidation?

Reader Notes

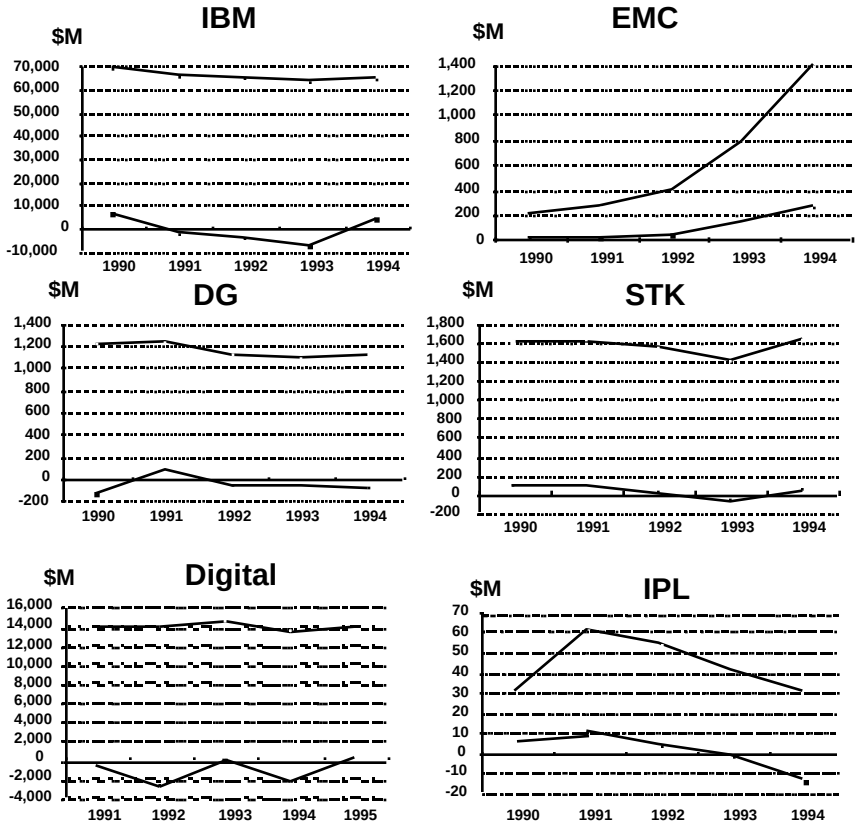


Source: Gartner Group

The model of storage systems engineering has not changed dramatically, but the complexities of the engineering challenges are new and are changing fast. In addition, the business models of many vendors can no longer support the engineering and manufacturing investments required to be full-system companies. There is an opportunity, therefore, for "fleet of foot" engineering companies to contribute and cash in on the new market dynamics.

The model for commodity component suppliers was set in the PC market, where Conner, Seagate and a few other disk suppliers (some no longer in business) began. The system requirements for midrange servers, however, are much greater and are additive to the complexities of RAID, hot standby, remote maintenance and remote diagnostics. In addition, dramatically greater data transfer bandwidths are required. Consequently, the engineering, manufacturing and distribution models are more complex, as shown in the graphic above.

Revenue and Income for Selected Vendors



Source: Gartner Group

Key Issue: Which storage vendors have the highest potential for differentiation and survival in the coming market consolidation?

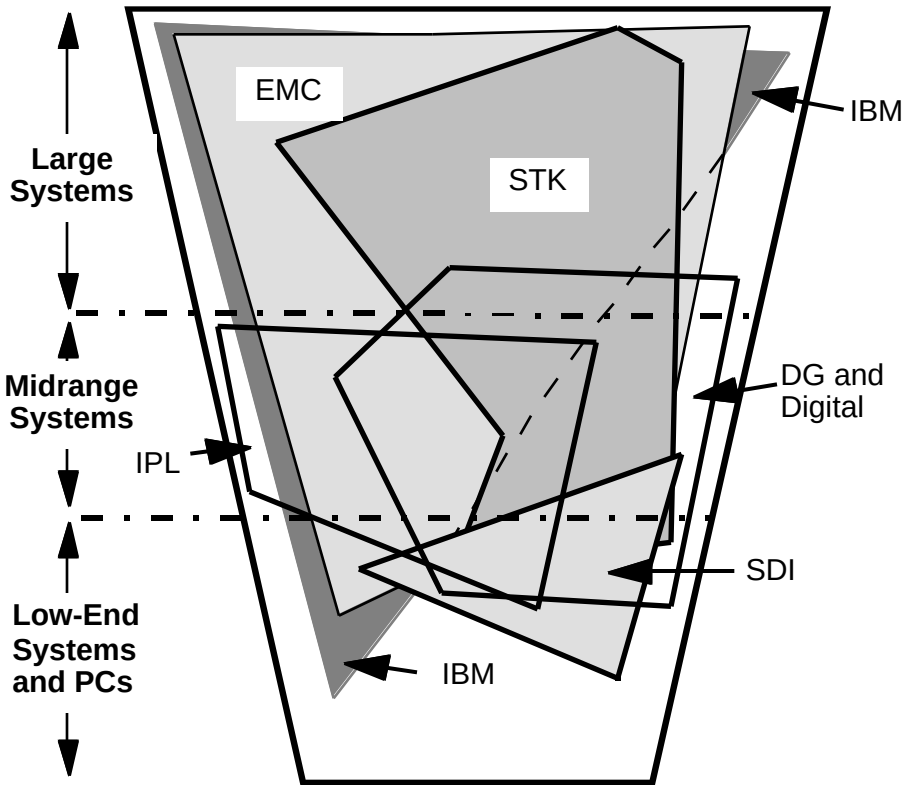
The storage market continues to grow, and at substantial rates (20 percent to 40 percent, depending on the segment), but margins are dropping, making it an increasingly difficult market in which to be profitable. In addition, with rapid changes in technology and predatory shifts from competitors, new product initiatives are increasingly in a "bet your business" category.

The "simple" days were those when PCM storage vendors shadowing their targeted system vendors were able to live and prosper under an umbrella of product introduction rates and product pricing levels that virtually guaranteed profitability for all. Those days are almost gone, with the systems vendors themselves turning desperately aggressive under pressure from slowing system revenues. Several systems vendors, including DG, Digital, IBM and, to a lesser extent, HP, are attempting to take a storage competency and leverage it into the broad market beyond their own systems' market. At the same time, the traditional storage-only vendors are broadening their own focus in attempts to turn low-margin products into high-volume profit.

Technology commonality is enabling storage vendors to broaden their market focus, which will buy time for them but raise the risk that they will not survive (0.8 probability).

Reader Notes

Storage Market vs. Vendor Target — Examples



Source: Gartner Group

Key Issue: Which storage vendors have the highest potential for differentiation and survival in the coming market consolidation?

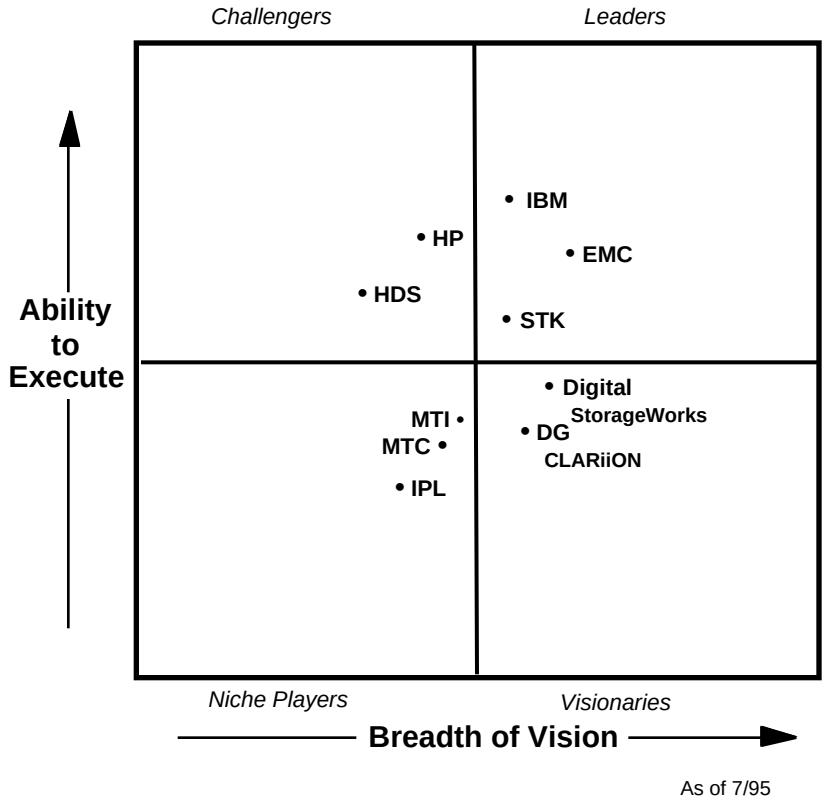
The thirst for profit is forcing most storage vendors to venture beyond their traditional markets of large (e.g., S/390, Unisys) or midrange (e.g., AS/400, VAX) systems and in some form into all other segments. Coincident as well as causal in this dramatic broadening of vendor focus is increasingly common technology (e.g., disk HDAs, controller interconnect, RAID).

The market shift to Unix and the potential from Windows NT is enticing. Both are opportunities but are also dramatically more competitive, lower margin and different from a buying pattern perspective. Many large-systems storage vendors are in the midrange market (e.g., IBM, EMC, STK), but seldom has the technology of one product set been well-leveraged for the other. Midrange vendors have not often ventured to high-end systems as they now must do to cover the Unix market, and none has been in the low-end market. Being profitable will not get easier, even with broader market focus and better-leveraged technology and engineering competence. A major challenge going forward besides continued product innovation will be channel innovation. Most traditional vendors have yet to show an ability to change and adjust effectively.

For the next three years, with product differentiators more difficult and costly to develop, financial staying power is the critical factor in storage vendor survivability (0.7 probability).

Reader Notes

Storage Vendors –– Vision vs. Ability to Execute



As of 7/95

Note: "Breadth of Vision" considers, but is not only, vendor initiatives across the server spectrum.

Source: Gartner Group

Key Issue: Which storage vendors have the highest potential for differentiation and survival in the coming market consolidation?

Success and survival for storage vendors will be a combination of skilled leveraging of critical new product differentiations, rapid product introduction, clever engineering for component-level enhancement and upgrades, channel adaptations, and financial resources and stability. IBM has a strong advantage in the magnitude of its market presence from top to bottom and a reasonable start on commodity channel competence. STK is reviving on Iceberg sales but has yet to demonstrate potential for success at the lower ends of today's market, which carry many of the characteristics of tomorrow's total market. EMC has had dramatic success in large systems, is IBM's greatest competitor in AS/400 and seems dedicated to penetrating the alternative large and midrange Unix as well as the low ends of the market. HP seems to be waking up to the need for better and broader storage competence by advertising its high-end AutoRAID, but at the same time it is forced to OEM DG's CLARiiON for its midrange systems. HP may have the best chance for effective channel adaptation. Digital and DG are both doing well on base technology for Unix systems and are fighting for NetWare share as well as NT market share as it expands.

Reader Notes

- Disk technology will not be an inhibitor to continued increases in demand (0.85 probability). System and network interconnect technologies will merge to enable radically different server configurations, but use will not be widespread (0.8 probability).
- The evolution of network-based storage servers will be limited because general-purpose computer servers will be adapted and favored over specialized storage-only servers (0.7 probability).
- RAID 5 will be common but not omnipresent due to vendor cost issues and user performance demands; mirroring (RAID 1) will be common at the low and high ends of disk storage configurations (0.75 probability).
- Key storage product differentiators for the next two years will include: 1) hot sparing and redundant power and cooling, 2) hot pluggability and user serviceability, 3) performance through nonvolatile write cache and interconnect speeds, 4) heterogeneous platform support and 5) management, backup and HSM software.
- Technology commonality is enabling storage vendors to broaden their market focus, which will buy time for them but raise the risk that they will not survive (0.8 probability).
- For the next three years, with product differentiators more difficult and costly to develop, financial staying power is the critical factor in storage vendor survivability (0.7 probability).