TECHNICAL BRIEF
May 2005

Understanding Fibre Channel tape library implementations — native Fibre Channel and routed solutions

Executive summary

How can we offer more flexible, more affordable and more scalable solutions to create better investment protection for our customers and do this without sacrificing reliability or increasing complexity?

In the new world of IT, mounting data growth and new legal mandates for storing and protecting electronic data are putting more pressure on today's data protection solutions. These management issues become even more challenging when combined with the budget issues facing most IT organizations and today's workload issues in IT, specifically those related to data protection. Today's solutions must be more cost-effective upon initial purchase and must be flexible enough to protect an organization's investment for a much longer period of time than in the big budget days of the past. In general, IT managers today are faced with more to do and less budget and resources to use to get it all done. These pressures present an interesting dilemma or opportunity for data protection solution providers today: How can we offer more flexible, more affordable and more scalable solutions to create better investment protection for our customers and do this without sacrificing reliability or increasing complexity?

You look to technology as an enabler to unlock business efficiencies, and you depend on solution providers to help you stay ahead of the game. Recent technological advances, such as Fibre Channel, help IT managers tap into new economies of scale, allow resources to be leveraged across more servers and, most of all, help extend the return on investment period for products purchased today long into the future.

Data protection solutions using Fibre Channel as an interface technology have opened the door for better device utilization and increased financial return on investment. However, in the tape library industry Fibre Channel integration varies from vendor to vendor, and not all implementations are the same. It is important to understand each solution's Fibre Channel implementation methodology and to be confident the solution will indeed yield the anticipated gains in efficiency and long-term investment protection.

One approach connects a tape library's drives and robotic interface directly to the SAN fabric using only native Fibre Channel connections. Another architectural approach to delivering Fibre Channel connectivity involves inserting an active connectivity (or routing) layer between the physical library resources and the SAN fabric.

There are two basic architectural approaches to connecting today's tape subsystems with a Fibre Channel storage area network (SAN). One approach connects a tape library's drives and robotic interface directly to the SAN fabric using only native Fibre Channel connections. Another architectural approach to delivering Fibre Channel connectivity involves inserting an active connectivity (or routing) layer between the physical library resources and the SAN fabric. This approach is commonly used to bridge Fibre Channel connections to older SCSI tape drives or to provide monitoring or management functionality to Fibre Channel implementations. Solutions utilizing this additional layer of Fibre Channel components are commonly called "routed" solutions.

The StreamLine™ modular library series architecture from StorageTek® uses the true native Fibre Channel approach. To provide additional monitoring and management capabilities, the StreamLine library system architecture utilizes a layered software strategy to build its intelligence in a layer above the physical devices. This approach does not force an organization to use proprietary Fibre Channel routing equipment, providing better reliability and reducing system complexity as well as delivering a wider, end-to-end view of the data protection solution. This approach leverages best-in-class native Fibre Channel building blocks giving the user flexibility to evolve all components of the SAN without being required to upgrade and/or being limited by the features/functions of a library vendor's Fibre Channel router. In addition to this flexibility, building

overall system intelligence into a layer above the physical devices provides the user with a wider, more end-to-end view of the whole storage system, including components such as a backup application and SAN switch infrastructure.

When selecting a data protection solution that will be operated in a SAN configuration or that may someday be upgraded to operate in a SAN environment, a user should fully understand the pros and cons of these two architectural approaches before making that purchasing decision. Truly native Fibre Channel implementations provide a high degree of flexibility and inherently better reliability (due to fewer components) than routed solutions. Routed approaches provide vendors with some ability to monitor data path traffic but do this by adding another layer of infrastructure in the data path, which must be purchased, maintained, managed and upgraded through time. Routed solutions would include Fibre-to-Fibre routing as well as protocol conversions such as Fibre-to-SCSI or Fibre-to-iSCSI. Vendors implementing truly native Fibre Channel solutions must find another way to deliver the management and monitoring functionality or the system will lack the enhanced functionality provided by routed solutions. Trade-offs made at this level can make or break the long-term viability of a data protection subsystem. StorageTek's StreamLine architecture gives users the best of both worlds by offering unmatched intelligence in its monitoring and management capabilities without forcing the use of a proprietary routed solution.

Truly native Fibre Channel implementations provide a high degree of flexibility and inherently better reliability (due to fewer components) than routed solutions.

Today's storage challenges

Across a wide range of industries, enterprise IT managers face a common set of challenges. Many of these challenges stem from data growth driven by new applications, new computing capabilities and new business practices.

Increasingly, enterprise data centers need to cope with new data retention requirements coming from their legal departments. In some industries, information must be archived and protected for decades in order to comply with new legislative rules and regulatory requirements dictating retention and protection policies for this mounting volume of electronic data.

To further complicate matters, today's computing workload is no longer only a business-hour activity. To support critical applications such as e-mail, call center operations, order processing and e-commerce applications, around-the-clock data availability — or 24 x 7 x forever computing — is becoming the norm. For a business to stay competitive, system uptime is critical. To keep pace with the requirements for nonstop business operations, all elements of today's storage systems need the highest levels of reliability.

To support critical applications such as e-mail, call center operations, order processing and e-commerce applications, around-the-clock data availability — or 24 x 7 x forever computing — is becoming the norm. For a business to stay competitive, system uptime is critical.

Against this backdrop, budgets for hardware and IT staffing in most organizations are flat or declining. Money for capital expenditures is scarce. Many companies are undergoing consolidation measures to cut operational costs. This often leads to cramped data centers and more equipment in the same or less physical data center space. This trend is making equipment footprint more critical than ever in today's storage solutions.

Sudden, unforeseen changes

New e-mail applications, used in conjunction with integrated office applications from Microsoft, IBM and other vendors, dramatically changed the storage requirements of today's corporate e-mail. In a matter of a few years, typical users required hundreds of megabytes of storage space in their in-boxes and were passing copies of multi-megabyte attachments among one other.

IT managers are often required to respond to unforeseen changes that can cause extreme pain in the data center. Take, for example, the sudden explosive storage requirements brought about by e-mail over the past decade. When e-mail first popped up in data centers, it didn't create a significant storage issue. It consisted mainly of small text messages and it was not made widely available to all employees. New e-mail applications, used in conjunction with integrated office applications from Microsoft, IBM and other vendors, have dramatically changed the storage requirements of today's corporate e-mail. In a matter of a few years, typical users required hundreds of megabytes of storage space in their in-boxes and were passing copies of multi-megabyte attachments among one other. Adding to the use of desktop e-mail, has come a pile of other "e-mail-related" IT issues, such as wireless messaging devices, offline folders, viruses, increased exposure to user errors (such as deleting in-boxes) and unsophisticated tools for e-mail backup and restore — and all of this is in a world where e-mail traffic is happening 24-hours per day. Yet early on, few IT managers projected the dramatic effect that e-mail would have on their data centers. This unplanned growth forced many IT teams to scramble to keep pace with the storage and management issues driven by this new application.

Today's rapidly changing compliance issues are bringing similar challenges to an IT manager's planning process. As governments and the courts evolve their views of electronic data, how it is stored and how it is retained, a tremendous amount of uncertainty exists with regard to data retention, data protection and the policies that drive the underlying storage requirements associated with these activities. Recently, data retention and deletion policies have been tested and challenged in legal proceedings. In many cases, companies have put new data retention policies into place that result in data and copies of data being retained for much longer periods of time than in the past. In the data center, longer retention periods cause another set of issues to crop up associated with technology migrations, obsolete equipment, software revisions and even physical space.

Robust flexibility can help protect an IT manager from the unknown.

Seemingly simple changes in applications or in the way we treat the information these applications produce can have dramatic impacts on the long-term utilization of data protection solutions. These changes are often not understood at the time of the original purchase and often the changes require upgrading or expanding equipment. In some cases, a device may not be able to evolve with these changing needs and may become obsolete. This creates an opportunity for devices that are more flexible and scalable than in the past. Robust flexibility can help protect an IT manager from the unknown.

Unforeseen changes like these combined with ever-present budgetary pressures and no increase in headcount, underscore the need for today's IT managers to do more with less. IT managers need to make better use of existing resources while taking advantage of the gains made possible by new technologies. They need new management solutions that automate time-consuming manual tasks while giving administrators greater control over storage infrastructure and better ability to manage data in an automated manner.

These common challenges are driving the need for new solutions that can provide information lifecycle management capabilities. Information lifecycle management gives companies the tools they need to execute on their internal strategies and policies and facilitate the ability to manage more data with fewer

Yesterday's approaches won't work in this new world. New challenges require new approaches to solve these evolving storage issues — and that is the key to keeping ahead of the curve.

resources over longer periods of time. Yesterday's approaches won't work in this new world. New challenges require new approaches to solve these evolving storage issues — and that is the key to keeping ahead of the curve.

To meet today's IT challenges, storage managers require solutions that improve the overall system's utilization throughout that product's lifecycle. To lengthen this lifecycle, successful solution providers must offer more flexible and more scalable products than in the past. This helps protect an organization from unforeseen changes in its environment. Along with these requirements, consolidation and the 24-hour-a-day computing environment required to support business today increase the expectations placed on overall system reliability, availability and serviceability (RAS).

Leveraging Fibre Channel to keep up with change

Fibre Channel technology allows users to centralize management of storage devices and to leverage the same storage resources across more servers and applications.

Fibre Channel technology is often utilized in today's data protection solutions, allowing tape libraries to be integrated into storage area networks (SANs). Storage area networks are used to help users share and better utilize devices as well as to leverage the high-speed bandwidth of Fibre Channel and increase overall system performance. Fibre Channel technology allows users to centralize management of storage devices and to leverage the same storage resources across more servers and applications. The utilization of a centralized, dedicated high-speed network decreases the amount of network traffic utilized by storage devices yet still allows the systems to be connected and shared by other servers. Often, the centralization capabilities facilitated through the use of Fibre Channel help users accomplish more backup and restore jobs without having to add additional management or storage resources.

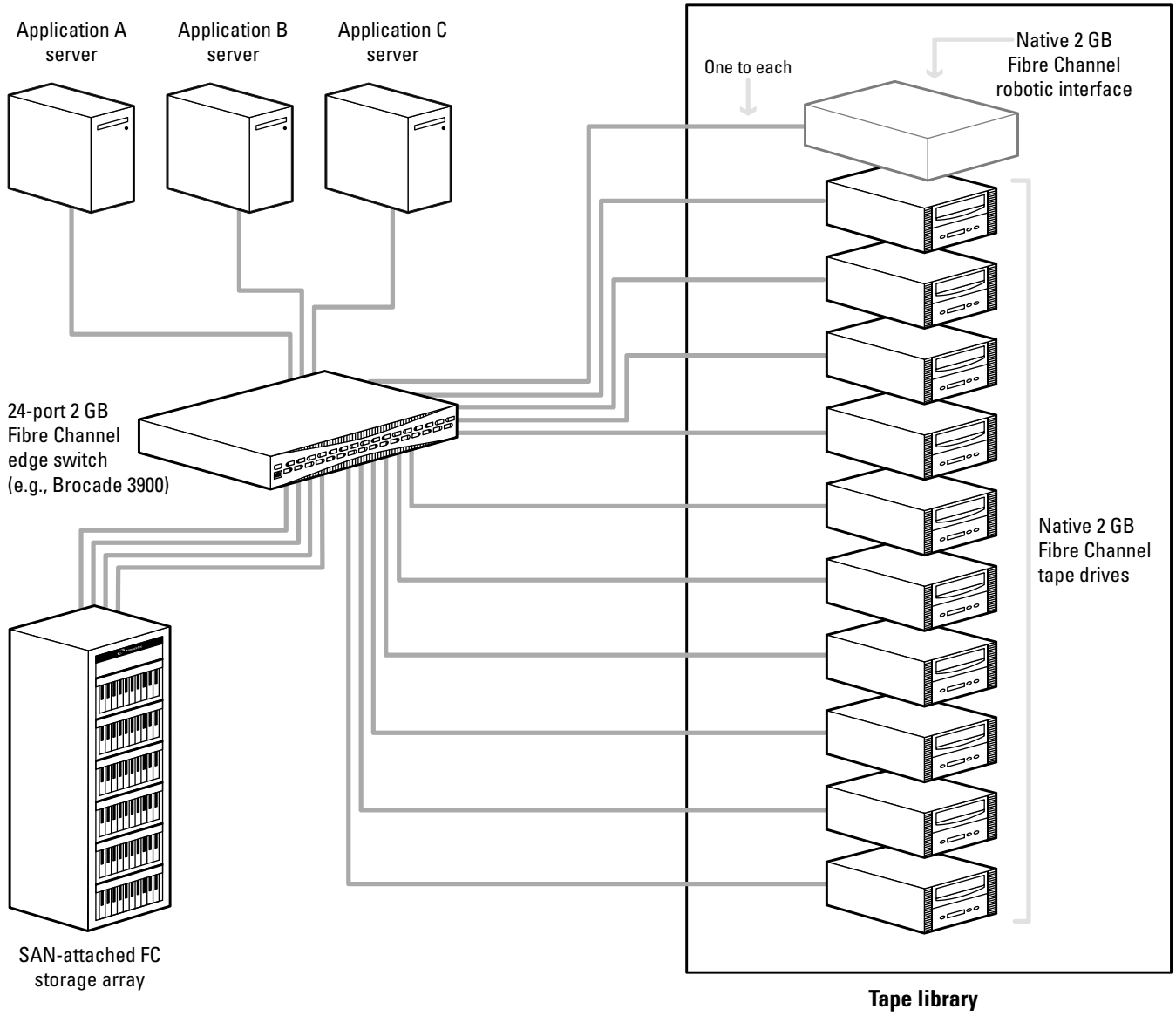
In the tape library marketplace, there are several different approaches to implementing Fibre Channel. Each of these approaches should be fully understood when selecting a tape automation solution. Both approaches allow the tape library to be connected to a Fibre Channel SAN. Careful attention to the implementation methodologies must be paid to make sure the system selected will be able to grow and evolve as needs change. Mistakes made in this selection process can lead to limitations, throughput issues or — even worse — obsolescence of the library.

Today, almost all tape library vendors offer some sort of Fibre Channel connectivity option. These solutions can be classified into one of two basic implementation models: native Fibre Channel solutions or routed Fibre Channel solutions. While some vendors do not specifically classify their Fibre Channel options as "routed" in their marketing materials, it is important to understand the core technology being used inside of any Fibre Channel solution. The following section will explore the advantages and disadvantages of these two approaches.

Implementing Fibre Channel — native Fibre Channel versus routed approaches

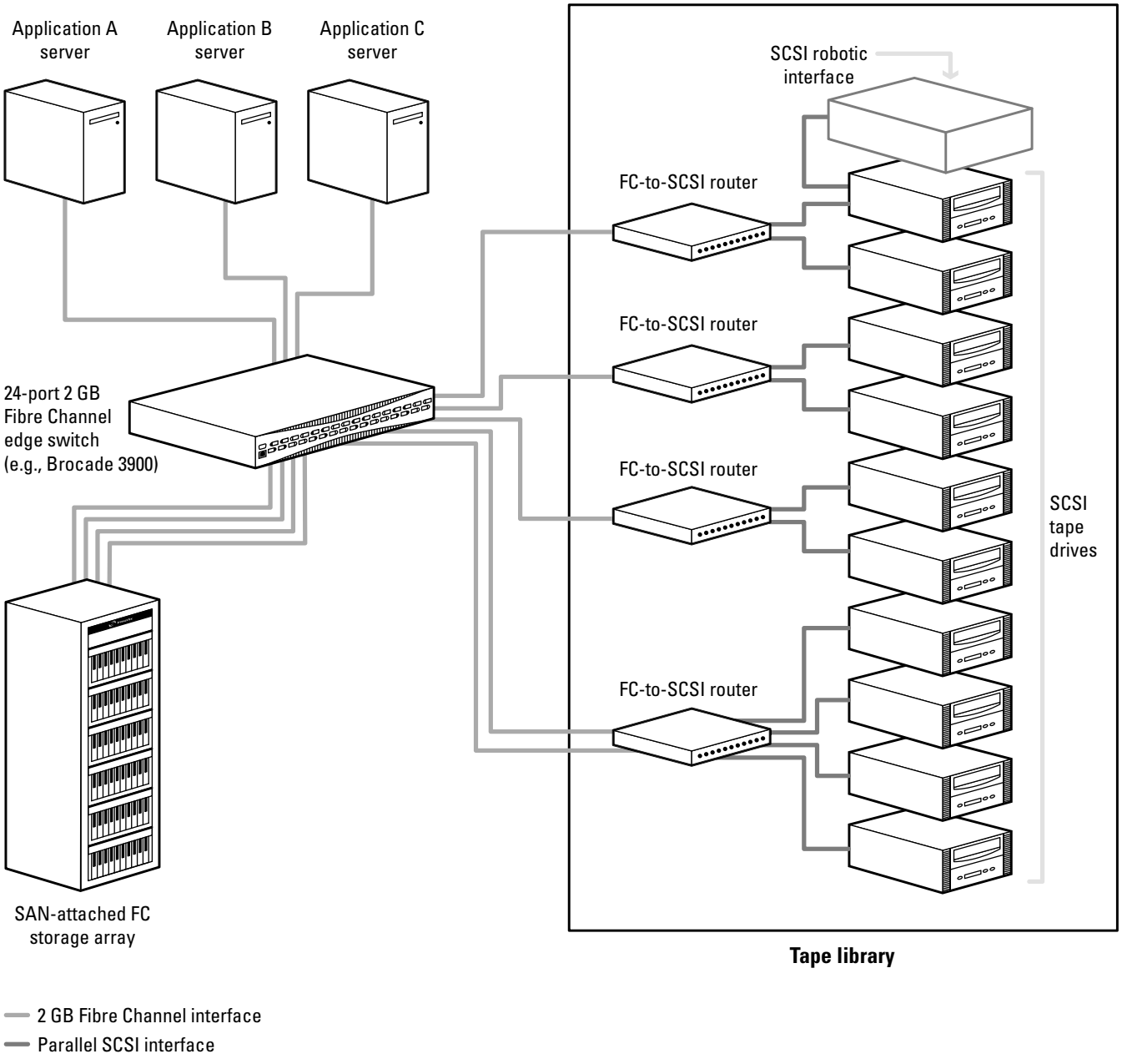
In general, truly native Fibre Channel implementations can be classified as systems in which the tape drives and the robotic interface are connected directly to a switched Fibre Channel infrastructure with no intermediaries in the connection path between the physical devices and the switch infrastructure. These implementations employ a single Fibre Channel cable between each of the library components and the Fibre Channel switch infrastructure. No active components would reside between the two. Figure 1 shows an example of a truly native Fibre Channel implementation.

Figure 1. Basic native Fibre Channel implementation.



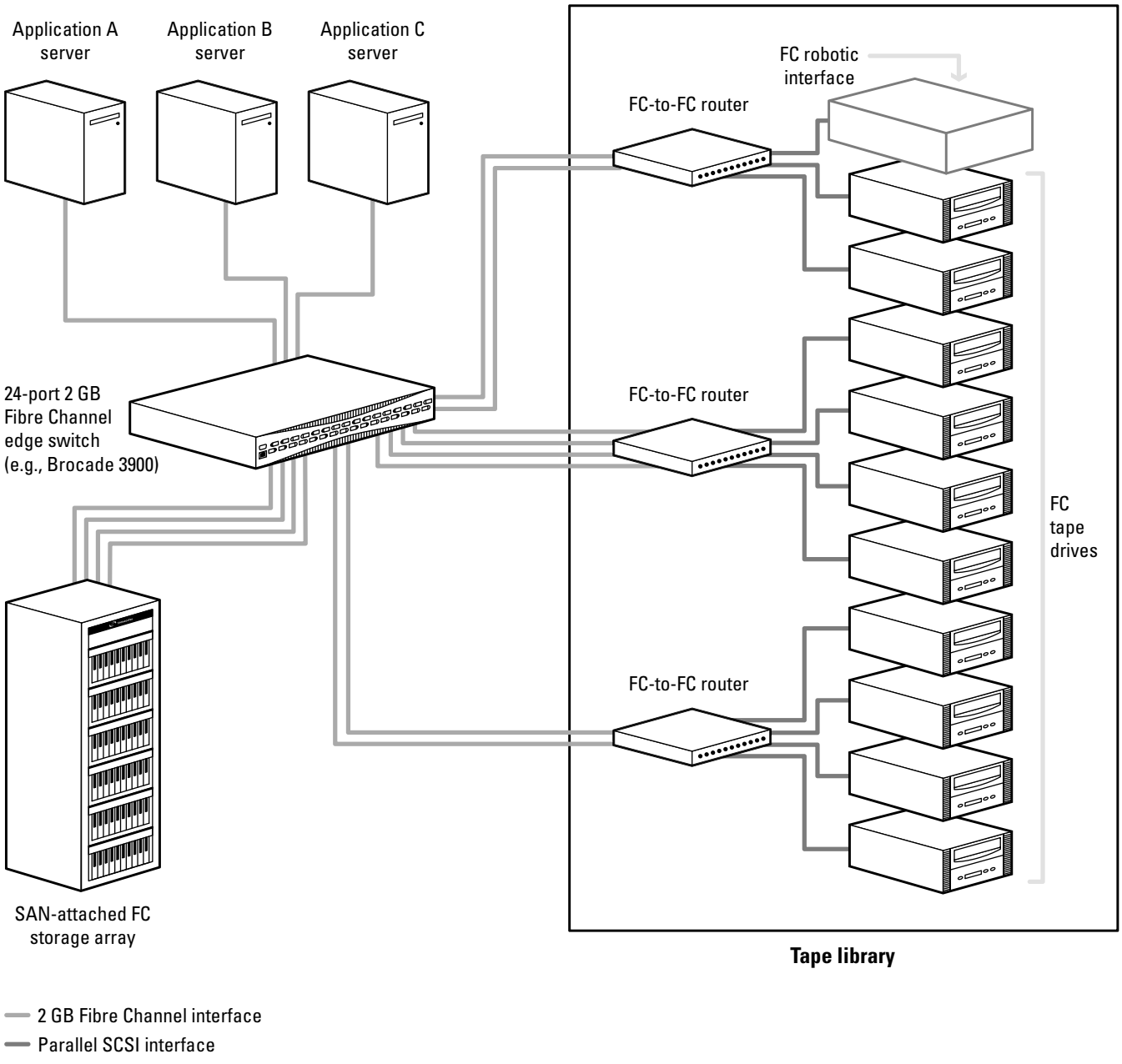
Routed Fibre Channel implementations employ an active layer of interconnect between the physical tape drives and/or the library and the SAN infrastructure. This active layer of controllers has been labeled in numerous ways as Fibre Channel has evolved. At one time, bridges were used to "bridge" two different connectivity layers or protocols. Figure 2 shows an example of a routed Fibre Channel solution using SCSI tape drives. Early in the Fibre Channel days, tape devices were not available with native Fibre Channel interfaces. The lack of native Fibre Channel tape drives created a need for a conversion from older parallel SCSI drive interfaces to the new Fibre Channel interface to allow the library to be connected to the SAN.

Figure 2. Router solution — using embedded FC-to-SCSI routers and SCSI tape drives.



Bridges accomplished this task and facilitated the use of older SCSI tape drives and automation in newer Fibre Channel SAN implementations. Some vendors have embedded additional capabilities, such as zoning, drawing an analogy to TCP/IP network components. Both bridges and routers add an additional layer of complexity to the SAN infrastructure by placing a controller between the physical tape devices and the SAN switches. Recently, some tape automation vendors have started implementing routed solutions that utilize newer Fibre Channel tape drives. These Fibre-to-Fibre routers are typically used to add functionality to the system, such as monitoring, port consolidation or security. Figure 3 shows an example of a Fibre-to-Fibre routed solution.

Figure 3. Routed solution — using embedded FC-to-SCSI routers and FC tape drives.



In general, both solutions facilitate connecting the library subsystem to a Fibre Channel SAN. In selecting a Fibre Channel tape library, it is very important to understand the type of Fibre Channel implementation in each library being compared and to fully understand and weigh the trade-offs and advantages of each approach. Many of the library companies that offer routed solutions do not publicize this fact in their marketing literature. Some of these companies have been pushed to support native Fibre Channel connectivity in products that were initially designed to use routed Fibre Channel. Interestingly, these products often lose much of their functionality if the user implements a native FC option.

Understanding your options: A vendor analysis

As you work to come to a decision concerning a FC-connected tape library, a series of questions should be asked of each solution provider and of your own requirements to identify a particular solution to best meet your needs. A good starting point for these questions is given here. Ask yourself:

- What type of interface am I interested in (routed or native FC)?
- Do I fully understand the trade-offs between these two methodologies?
- How long do I expect to use this device in the data center?
- During that time, will tape technologies and/or interface technologies evolve?
- Will my company need to take advantage of these advances to keep up?

As mentioned earlier, not all vendors promote their solutions explicitly as a routed or native FC solution. Questions that may be useful to ask yourself in determining which approach is being proposed for your solution include:

- Are the tape drives in the solution native Fibre Channel?
- Are there any router or bridge components between the FC drives and the SAN switch?
- If I use a native FC-attached tape drive (with no routers or bridges), what features or functionality do I lose?
- If I use the routed solution, what features and functions do I get?
- If I use a routed solution, what is the cost to upgrade that part of the solution when a new interface comes out (such as 4-gigabit Fibre Channel)?
- Are there any chances that performance issues in the router will become a bottleneck as drives get faster? Can I get this in writing?
- How many drives can be run through each router?
- What is the overall throughput of the router? Is this a tested specification or is this a theoretical calculation?

Figure 4. Fibre Channel implementations by LTO library vendor.

The following table is a summary of a number of tape library vendors and their products, showing the product classifications using the definitions presented earlier. Some vendors do not outwardly market their products as routed solutions.

			Fibre Channel implementation	
Vendor	Library model	Architecture	Routed FC	Native FC
ADIC	Scalar 24	Scalar	Optional	No
ADIC	Scalar 100	Scalar	Optional	No
ADIC	Scalar i2000	iPlatform	Optional[1]	Yes[5]
ATL	M1500/M2500	Prism	Optional[3]	No
ATL	PX720	Prism	Optional[4]	Unknown
HPQ	MSL5030/5060	MSL	Optional[7]	No
HPQ	MSL6030/6060	MSL	Optional[7]	No
Overland	Neo2000/4000	Neo Series	Optional[2]	No
Overland	Neo8000	Neo Series	Optional[2]	Unknown
StorageTek	L20/40/80	L-Series	Optional	No
StorageTek	L180/L700	L-Series	No	Yes
StorageTek	L5500/9310	L-Series	No	Yes
StorageTek	SL500	StreamLine	No	Yes
StorageTek	SL8500	StreamLine	No	Yes
Spectra Logic	T120/T950	Python (QIP)	Yes	Yes[6]

[1] Storage networking option [2] Virtual interface architecture option [3] E1200/160 router option [4] FC420/FC470 bridge options
[5] Configurations lose most iPlatform functionality [6] Configurations lose FQIP functionality [7] StorageWorks Network Storage Router e1200-160 option

Comparing and contrasting the impacts of these FC approaches

The following passages detail a number of system attributes and offer a quick comparison between routed FC approaches and the native FC approach. Not all attributes will relate to every organization initially but careful attention must be paid to many of these attributes because of the nature of change in today's IT industry. Change is inevitable and caution should be taken when thinking of the future when selecting a product that will be expected to meet not only today's needs but will also be expected to evolve with your data center. The key to protecting your investments from an early retirement or an expensive upgrade is to plan for the unexpected by utilizing the most flexible solution available to you at the time of your initial purchase.

Performance

Direct connectivity with the Fibre Channel SAN is a key performance advantage for the native Fibre Channel approach.

Direct connectivity with the Fibre Channel SAN is a key performance advantage for the native Fibre Channel approach. In a perfect world, the routing infrastructure should not, in any way, be a bottleneck to overall system throughput. Over the past decade, advances in tape drive throughput and/or interface technologies have exposed overall system throughput issues in bridges and routers that have necessitated the router being upgraded on top of other system upgrades, such as FC switches or tape drives. Newer LTO Generation 3 tape drives are on the verge of reaching the market, and their performance characteristics are expected to more than double the sustained LTO Generation 2 native throughput per tape drive to over 70 megabytes per second or over 140 megabytes per second with compression. This throughput can create situations in which a single tape drive will nearly saturate a single 2-gigabit FC port. As newer, faster tape drives

bump against this bandwidth limitation, 4-gigabit FC ports will begin to be used in these high-speed environments on both drives and FC switches. Organizations using routed FC solutions will probably require an expensive router upgrade to take advantage of the increased throughput.

Switch vendors spend vast sums of R&D money developing high-speed backplanes and application-specific integrated circuits (ASICs) to keep up with increasing system throughput. ASIC-based solutions are typically far too expensive to develop for most tape library vendors so most routed solutions on the marketplace use embedded processor designs, which inevitably become bottlenecks as system throughput goes up. When a tape library vendor chooses to enter the connectivity realm by developing proprietary controllers or implementing routers, vast resources are required in development to keep pace with the rest of the Fibre Channel industry.

Some library vendors have chosen to integrate FC switch motherboards as an additional component of their routed solutions to facilitate connectivity between routers. By using a switch, performance is not an issue until the port speeds transition in the industry (example from 1 gigabit to 2 gigabit to 4 gigabit). When industry transitions like this happen, both the routers and the switch motherboard(s) must be upgraded. This progression continues to add layers of complexity to these solutions that will need to be maintained, upgraded and managed.

Upgrades

Simplicity is the key to maintaining more reliable solutions.

As discussed in the "Performance" section above, a number of events may occur that would necessitate a connectivity upgrade in a data protection solution. When these events occur, the fewer components there are to upgrade the smoother the upgrade will go. Simplicity is the key to maintaining more reliable solutions. Eliminating complexity should be weighed at every juncture.

Both routed and native FC solutions require upgrades of the core tape drives and switch infrastructure. Some FC switch upgrades are less-costly board or controller swaps, whereas some switch upgrades require obsolescing equipment to keep on the path. Obviously, the fewer solution components that require an upgrade the lower the upgrade costs will be. Routed solution users are forced to not only upgrade the drives and switches but also to upgrade the additional router layer to take advantage of the higher-performance peripherals. Users of native Fibre Channel solutions will only be upgrading the SAN infrastructure and the tape drives to achieve the same result.

Reliability

Overall system reliability is inherently a function of the overall system complexity. The two are inversely proportional in that as system complexity goes up, the system reliability will decrease. For example, the equations used to calculate the mean time between failure (MTBF) in electronic circuit boards actually counts solder connections, IC part counts, pin counts on those ICs and sums them up into an overall MTBF. Simply put, the more parts, the more pins, the lower the MTBF. Overall reliability for a tape library system does not deviate from this rationale. Adding more components to a solution increases the likelihood that something will fail and therefore decreases the system reliability. The routed solutions increase the overall system complexity as compared to native FC implementations.

At times, the increase in system complexity and associated decreased reliability is offset by some other system gain. There are some instances where adding complexity is used to increase uptime and availability. A good example of this would be the use of 2N power infrastructure in devices. Obviously, doubling the number of power supplies in a system doubled the likelihood of the system seeing a failure of one of the supplies. The slight twist on the concept comes through to use of redundant infrastructure so that a failure of a single power supply does not result in an overall system failure (i.e., the system would keep functioning on one supply). Measuring system-level reliability in these types of situations is more complex and is often derived from installed base statistics. Neither routed solutions nor native FC implementations appear to be using this type of technology, thus the original assessment that more complexity yields a less reliable solution should hold true.

Technical support and interoperability

Technical support for routed and native FC solutions is largely the same. The routed solutions sometimes offer zoning and other switch-like functionality that can increase the complexity of a service call. Tools that allow remote access to the physical device mask this somewhat by allowing vendor support experts the ability to interact with the device during the support call. This same functionality is typically built into the rest of the SAN infrastructure, so in many situations a support call involves the setup and debug of both the switch and the router/controller.

Routed solutions tend to be proprietary in nature. This leaves the user largely dependent on the support of a single vendor's technical staff. In contrast, users of non-proprietary native Fibre Channel solutions can draw on the vast worldwide support resources of leading network equipment providers. The major switch vendors, such as Brocade, McDATA and Cisco, have vast teams of engineers who specialize in interconnect setup, debug and troubleshooting.

Another aspect of technical solution support that is worthy of mention is the fact that routed solutions must be "certified" as devices during the interoperability testing with ISV software applications and with IHV products like switches and HBAs. Routers carry a significant amount of embedded firmware and thus interoperability testing and firmware revisions are tracked by ISV and IHV vendors to promote proper operation. Native FC solutions do not require any additional testing or certifications beyond support for the native FC devices. In the early days of routing and bridging, firmware interoperability was a critical issue and

was tested and tracked religiously by ISV/IHV vendors. This same interoperability testing continues today. Routed solutions require an additional layer of firmware tracking for system administrators to deal with. This firmware revision must remain consistent across all routers in the complete solution. As libraries grow in size and increase in the numbers of drives and routers they enclose, care must be taken to maintain this consistency.

Warranty, support and service

Native Fibre Channel solutions and routed solutions tend to carry the same warranty terms as the rest of the tape subsystem. The service uplifts are typically scaled upward with the system's cost and complexity. Routed solutions would typically carry an associated uplift in the maintenance costs and uplifts depending on how the vendor packages this in its product line. Native Fibre Channel implementations also typically carry an uplift to the service contract. The service uplift for native FC tape drives usually scales as the number of drives increases, and most vendors charge a premium for Fibre Channel drives over their SCSI equivalents. Both native FC implementations and routed solutions that use native Fibre Channel drives would be subject to this increase.

Management and monitoring functionality

The StreamLine modular library series architecture adds this intelligent software layer to gather end-to-end information on what is happening at the physical component level.

Vendors providing truly native Fibre Channel solutions rely on the standard management interfaces for the individual components of their solutions to get information about the solutions' health and well-being. This typically involves several different user interfaces to drill down to find root cause for a failed backup job. Some of the routed solution providers have embedded monitoring and/or routing functionality into their controllers and leverage the fact that the router is in the data path to gather data. Typical statistics such as port utilization, throughput trends and library statistics are usually available. StorageTek has built this functionality on top of native Fibre Channel building blocks, rather than embedding it into a controller in the library. The StreamLine modular library series architecture adds this intelligent software layer to gather end-to-end information on what is happening at the physical component level.

The routed approach essentially looks at the storage environment from the inside out. The management view stems from inside the library and focuses on the physical components inside the tape library (routers, robot, tape drives, etc.). StorageTek's approach provides a broader view of the storage environment. It looks at the components or building blocks from the outside in.

Native Fibre Channel approaches leverage industry-standard management tools to gather any management and/or monitoring data (unless the functionality is delivered through another mechanism).

Most of the routed solution providers also offer a native Fibre Channel solution when pressed by customers who are not keen on routed solutions. In general, when customers determine that they want a native Fibre Channel solution to reduce complexity and costs and to increase reliability, most of the additional functionality available from that vendor's routed solutions will not be available.

The StreamLine™ modular library series approach — the best of both worlds

StorageTek has invested a tremendous amount of R&D effort into its new StreamLine library architecture and in delivering best-in-class functionality on top of a native Fibre Channel or SCSI infrastructure. From a customer perspective, the StreamLine architecture delivers a "best of both worlds" value proposition — with all of the feature/functionality provided by routed solutions and the flexibility, simplicity and reliability of a true native Fibre Channel implementation.

StreamLine library software strategy

To deliver best-in-class functionality for a tape subsystem, StorageTek has integrated a feature-rich suite of software products designed to provide an end-to-end view of all aspects of an organization's data protection infrastructure. The StreamLine library software strategy has been built from the ground up with an emphasis on creating a powerful infrastructure foundation that could be built and enhanced for many years to come. The three core functionality areas that make up the StreamLine library software strategy are monitoring, management and control.

Monitoring

Within the StreamLine library software strategy, monitoring functionality is supplied through an infrastructure that provides the ability to gather information at user-defined intervals from all devices in the data protection chain. This data is parsed and stored as "events" in a database. This gives the user the ability to do forward-looking trending as well as historical analysis of all the infrastructure in the data protection stack — physical tape devices, automation, SAN infrastructure and even the backup application.

More proactive methods can be used if more meaningful data is collected from all devices in the data protection chain and intelligent algorithms are applied to this data to look for trends that lead to failures before they become failures.

Historical analysis might consist of gathering information concerning device utilization and media utilization as well as capturing point-in-time events such as a Fibre Channel switch reset during the night that might have caused backup jobs to fail. Several competitive tape libraries provide simple low-level hardware monitoring capabilities from their embedded library controllers. Without the ability to store information in a true database, the embedded controller solution is typically only able to provide limited detail and for a limited period of time. The use of a production database application removes these limitations and opens the world of data collection and intelligent information gathering as we move into the future. The "richness" of this data and the ability to capture more data and for longer periods of time will be key to intelligent correlation of data and physical device health, which is required to begin proactive device management.

For years, customers have longed for the ability to proactively manage physical tape devices and media rather than reactively managing the devices after failures have occurred. Many costly hours are spent in the data center chasing down physical drive failures and finding bad pieces of media. More proactive methods can be used if more meaningful data is collected from all devices in the data protection chain and intelligent algorithms are applied to this data to look for trends that lead to failures before they become failures. Data associated with tape drive error rates and error rates associated with specific pieces of media must first be captured before any proactive actions can be enacted.

StorageTek's StreamLine library architecture and monitoring software opens the door for exactly these types of advancements. This level of device interaction is far more advanced than simple health status indications seen in most products

in the marketplace. Today, monitoring functionality is delivered through an application called Backup Resource Monitor™ software. Backup Resource Monitor software gathers data from hardware devices through TCP/IP connections and an industry-standard protocol called SNMP. More powerful interfaces are working their way into the standards bodies, which will enhance the information-collection capabilities for a product like Backup Resource Monitor software in the future. Backup Resource Monitor software also gathers information from the backup application through each application's log files. Log files are gathered by a software agent, parsed and turned into "events" and stored in the monitoring application's database.

Management

Management capabilities within StorageTek's StreamLine architecture facilitate interactions with the physical hardware in a tape library subsystem. Management functionality is delivered in the form of an application that has embedded link capabilities that facilitate communication with the physical hardware. Web-based browser-like applications have become the standard for management consoles for most hardware products in today's data center. StorageTek's StreamLine™ Library Manager software is included with all StreamLine tape libraries and can be accessed via TCP/IP either remotely or from a local operator panel on the front of the tape library. Facilities to do simple health checks, diagnostics, firmware code management, device configuration and low-level event notification are all included in this embedded application. StreamLine™ Library Manager software provides StorageTek with another solid foundation to which many more features can be added in time.

Control

In today's complex data centers, consolidation and technology migrations are causing many tape solutions to become outdated and necessitating costly new purchases. StorageTek's control functionality facilitates centralized control of a single library among multiple users, servers or software applications. Organizations migrating from one backup software application to another can share a single tape library between the two applications during the transition. Organizations moving from one tape technology to another can take advantage of StorageTek's powerful Any Cartridge Any Slot™ technology for StreamLine™ library system without being dependent on physical partitions or other application limitations.

Best-of-breed solutions utilizing best-of-breed native Fibre Channel building blocks are something only StorageTek's StreamLine library architecture can deliver.

Bottom line

StorageTek's StreamLine architecture delivers a best-of-breed, industry-standard Fibre Channel solution for organizations whose needs are evolving and who expect a storage subsystem that can evolve with them. Routed Fibre Channel solution's limitations are not worth the trade-offs that come with them. Best-of-breed solutions utilizing best-of-breed native Fibre Channel building blocks are something only StorageTek's StreamLine library architecture can deliver.

To protect your organization from the unknown, you need solutions that offer scalability and flexibility for longer investment protection. You need end-to-end tools that make devices easier to use and cut costs from a management standpoint. These capabilities allow you to do more with less to keep up with new and ongoing storage challenges.

Appendix A. Management and monitoring feature-function comparison

	Routed approach Typical capabilities	**Bare native Fibre Channel approach**	**StreamLine architecture with native Fibre Channel approach** Capabilities with StreamLine architecture and associated software
SAN connectivity	Connects FC drives to a SAN via an embedded controller	Connects FC drives directly to the SAN fabric	Connects FC drives directly to the SAN fabric
Monitoring			
Tape drive utilization — data throughput over time	Yes, via physical resource monitoring	No	Yes, via ISV application
Slot utilization — available slots	Yes	No	Yes
Library performance — mounts per hour	Yes	No	Yes
Switch utilization	No or limited capabilities	Switch tools	Yes
Library health checks	Yes	No	Yes
Drive health checks	Yes, but only before drive is taken over by ISV software	No	Yes
SAN infrastructure health checks	Limited capabilities	Switch tools	Yes
Media usage — trend analysis and forecasting	No	No	Yes
Backup application monitoring	No	No	Yes
Single view of backup resources	No	No	Yes
Management			
Remote power reset for drive	Varies	Varies	Yes
Remote tape movement	Varies	Varies	Yes
Diagnostics	Varies	Varies	Yes, for both drives and robotics
Firmware upgrades	Varies	Varies	Yes
Tiered user security	Varies	Varies	Yes
Auditing	Varies	Varies	Yes
Control			
Implementation	Embedded	Embedded	Embedded or external
Native control using SCSI media change command	Yes	Yes	Yes
Software control	Yes, embedded in library	Yes, embedded in library	Yes, via SLM software
Number of logical libraries	Limited	Limited	Unlimited with SLM software
Support of mixed media within a single partition	No	No	Yes
Firewall support	NA	NA	Yes, via SLM software
Dynamically allocate/change logical library configuration	No	No	Yes, via SLM software
Media management-tracking media in/out	No	No	Yes, via SLM software

Appendix B. Solution comparison table: routed versus native FC

	Routed solutions (using SCSI tape drives)	**Routed solutions** (using Fibre Channel tape drives)	**Native Fibre Channel solutions** (using Fibre drives)
External connection type	Fibre Channel to router	Fibre Channel to router	Fibre Channel drives and robot
Tape drive interface	LVD SCSI	Fibre Channel	Fibre Channel
Long-term flexibility	Limited	Limited	Good
Initial costs — drives	Cheaper	More expensive	More expensive
Initial costs — library	Standard SCSI	FC option	FC option + SW
Initial costs — routers	Expensive	More expensive	Not needed
Long-term costs	Routers, drives and SAN must be maintained	Routers, drives and SAN must be maintained	Only drives and SAN must be maintained
Overall complexity	Simple single connection to SAN; can become a bottleneck	Multiple connections to SAN; care must be taken in port consolidation	1:1 connections to SAN
Long-term maintenance	FW, service and physical maintenance on routers, drives and libraries	FW, service and physical maintenance on routers, drives and libraries	FW, service and physical maintenance on only drives and libraries
ISV/IHV issues	Routers, drives and library must be certified	Routers, drives and library must be certified	Only drives and library must be certified
Features and functionality	Router functionality	Router functionality	Additional information from software layer

ABOUT STORAGETEK®

Storage Technology Corporation (NYSE: STK) is a $2 billion global company that enables businesses, through its information lifecycle management strategy, to align the cost of storage with the value of information. The company's innovative storage solutions manage the complexity and growth of information, lower costs, improve efficiency and protect investments. For more information, visit www.storagetek.com, or call 1.800.275.4785 or 01.303.673.2800.

WORLD HEADQUARTERS

Storage Technology Corporation
One StorageTek Drive
Louisville, Colorado 80028 USA
1.800.877.9220 or 01.303.673.5151

TT 0002 A 05/05