

iPlatform Architecture and iLayer Management: A Technical White Paper

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Executive Summary

Quantum's iPlatform libraries and integral iLayer management software give disk-like management features to tape libraries to boost backup reliability, reduce service calls, speed up issue resolution, and lower users' operating expenses. The technology also allows users to analyze predictive trend data, evaluate the integrity of their removable media and tape drives, and manage their tape libraries as part of the larger storage environment using standard SRM tools. The overall benefits from the Quantum approach to library management are more effective and reliable backup, reduced management overhead, and lower Total Cost of Ownership. The iLayer management approach also makes it easier for end users to deploy backup systems that mix disk and tape tiers.

Traditional Library Approach

Tape libraries originated as little more than simple mechanical systems to hold tape drives and load and unload media. Management consisted primarily of the features provided by the applications software used to write data to the library's drives. Users who wanted more advanced, system-oriented management had to purchase and load separate library control software on external servers. This approach is still the norm in the industry today—most backup hardware systems provide very few of the robust monitoring and analytical capabilities that have become common in disk storage systems. The absence of management functionality in traditional libraries means that operation often requires an administrator's intervention, diagnosing and resolving problems normally requires a sophisticated and extremely technical field service organization, and even then troubleshooting is often time consuming, expensive, and uncertain. A further disadvantage to this approach is that the backup system is generally isolated from the primary storage systems—it is outside the managed storage environment.

iPlatform Libraries and iLayer Management

Quantum's iPlatform library architecture was designed to give libraries disk-like management features in order to make them easier to operate and maintain, to improve their availability, to reduce their ownership costs, and to allow them to be managed easily along with other storage resources.

The iPlatform libraries have a more advanced physical architecture than conventional libraries, offering internal server-class controllers and memory, slots for I/O blades, many more sensors, internal communication busses, and external network interfaces. This physical architecture allows the iPlatform libraries to integrate Quantum's library management software tools—the iLayer. The iLayer management system greatly expands library capabilities. It provides more efficient management for normal operations, proactive monitoring and alerting functions, context-aware diagnostics, I/O management, and advanced performance and trend analysis tools. The iLayer also provides a standards-based interface that allows the libraries to be managed along with users' disk and SAN fabric resources through standard, third-party SRM tools.

The Quantum iPlatform architecture and iLayer management approach are available in two library platforms which meet a broad range of backup needs, from workgroups to large enterprise data centers. The Scalar i500 is designed for midrange storage environments. It is a rack-mountable library that scales from 2 drives and 36 tape storage positions up to 18 drives and 402 pieces of media. The Scalar i2000 is an enterprise library that scales up to 96 drives and 3,492 tape storage slots. Both library platforms offer easy, modular growth, and they both supply users with the performance, reliability and value of a single, continuous robotics system.



Quantum’s Scalar i500 and Scalar i2000 intelligent tape libraries’ iPlatform architecture and integral iLayer management approach make backup easier to manage, reduce service calls, speed up issue resolution, and reduce costs.

iLayer Management Approach

The iLayer includes a series of integrated tools that provide Quantum iPlatform tape libraries with robust management capabilities previously unavailable in other tape libraries. They include:

- Partitioning and mixed media operation
- Proactive monitoring, alerting, and diagnostics
- I/O management
- Support for SRM tools
- Advanced trend analysis reporting

In the Scalar iPlatform libraries, all of these functions are native—they are integrated into the library and do not require use of external library control servers or software. Integration of the iLayer features means that end users receive their benefits without incurring the maintenance costs and management overhead associated with external components and applications.

Partitioning and Mixed Media Operation Reduce Capital and Operating Expenses

One way to reduce both capital and operating expenses is to consolidate multiple backup operations in a single library. An important function that enables consolidation is partitioning—the ability to make a single physical library look like multiple, logical libraries to outside applications. Partitioning makes it easy for a library to support multiple workgroups, different backup applications, and different drive or media technologies. Partitioning is also valuable when adding a disk tier to backup because it makes it easy to pair one part of the library with disk for performance-critical tasks while allowing other parts of the library to accept backup data directly from hosts.

Mixed Technology Protects Legacy Investment. Related to partitioning is mixed technology support, which includes combining different drive technologies (LTO and SDLT, for example), different drive and media generations (LTO-2 and LTO-3), or different connectivity options (SCSI and Fibre Channel) in a single library. Mixed technology support allows end users to retain the value of their legacy systems while taking advantage of newer technologies and backup consolidation strategies.

Native, integrated support for partitioning and mixed media are critical for end users to derive the maximum value from consolidation. If external library control software has to be purchased, installed, and managed, both acquisition and operating costs can increase dramatically.

Robotics Design Key Element in Partition Support. Critical for effective partitioning is the design of the library's robotics system. Overall, the best performance and maximum flexibility are achieved in libraries that use a single, continuous robotics system. There are several libraries that instead scale by combining multiple modules, each of which is equipped with separate robotics. Whether they stack vertically (like the Overland Neo Series) or horizontally (like the Sun/STK SL8500), libraries designed with separate robotics for each module have a difficult time handling partitioning. The multiple robotic design often forces users to match their partitions to the size of the modules, resulting in difficult management and wasted capacities. When partitions are allowed to cross module boundaries, they severely retard library operations because each media move may require the use of several robotic elements serially. A multiple-robotics design negatively impacts system reliability as well because complex mechanical systems are inherently more failure prone than simpler ones.

Quantum iPlatform Libraries Integrate Support. Quantum's iPlatform libraries offer fully integrated support for library partitioning and mixed technology operations, and they feature a single, continuous robotics system to allow maximum flexibility and highest performance. The Scalar i500 midrange library supports up to 6 logical partitions, and the Scalar i2000 enterprise library supports up to 16. Partitions are flexible in size (some can be as small as one drive and one piece of media), tape technologies may be freely mixed within them, and the drives and media in any partition can be located anywhere in the library—they do not have to be contiguous. Both libraries feature a graphical user interface that makes it simple and intuitive to configure, monitor, and change partitions dynamically.

Proactive Alerting and Diagnostics Increase Reliability and Reduce Service Interruptions

One of the biggest advantages that the Quantum iPlatform libraries offer over more conventional libraries is the way that the iLayer handles monitoring, alerting, and diagnostics to reduce service calls, increase library reliability, and shorten issue resolution time. In many cases, the iLayer technology lets Quantum find resolution before issues become critical and even before end users realize that an issue exists.

Compared to conventional libraries, iPlatform libraries can:

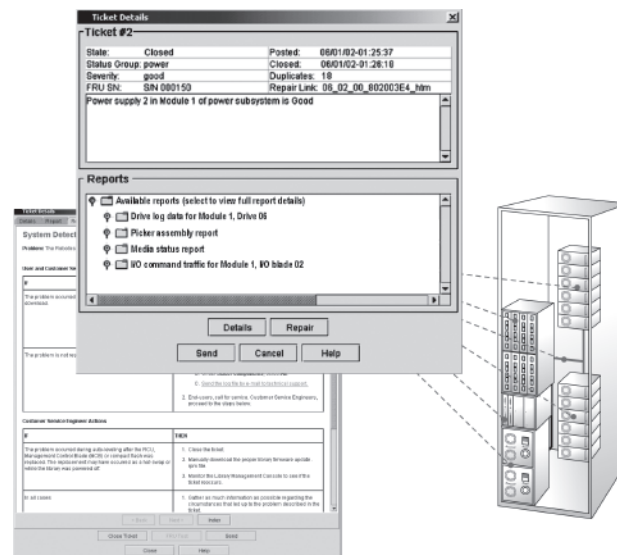
- Reduce the number of service requests by up to 31%
- Reduce the need to send on-site service technicians by up to 51%
- Reduce the number of replacement parts sent by up to 62%
- And shorten the time to resolve a service issue by 30% or more.

How iLayer Diagnostics Are Different. The iPlatform libraries' monitoring and alerting functions use a combination of distributed sensors, log data collection and synchronization systems, relational diagnostic™ logic that analyzes data, and remote reporting technology that forwards both data and diagnostic analysis to library administrators and the Quantum service team.

The library's iLayer constantly monitors hundreds of states in all the key library components and logs data from them. When an abnormal event is detected, the data collectors extract synchronized log data from related components and gather them into a report (called a "RAS ticket"). The iLayer technology then correlates the data to determine probable causes and next steps—if any. If the condition is not serious and corrects itself quickly, the report is kept inside the library to become part of the library's diagnostic history. If the condition is serious, the user is alerted through the library GUI, and the report—with the diagnosis, associated log files, and recommended resolution—is automatically emailed to the administrator and to the Quantum service team. This dataset, gathered and transmitted automatically without manual intervention, is used by the Quantum service team to solve issues rapidly and to call customers with resolution, often before they know there is a problem.

The iLayer selects data to gather based on the resolution history of similar events. To isolate the cause of an event involving drive-media interface, for example, the library may gather multiple datasets from the drive, the history of the particular tape in other drives, the log from the library's media picker, and even the related command traffic that went through the I/O blade between the host and the library. Because they are armed with this history, if the Quantum service team does need to go on site, they can provide faster and more certain issue resolution.

As Quantum collects more event history from the global pool of libraries, the engineering team regularly updates the diagnostic logic and tunes the data selection criteria, further improving diagnosis and resolution times—in other words, the library gets smarter. One result is that the iPlatform libraries have become better at identifying and proactively correcting small problems before they become serious enough to interrupt operations—an example would be warning an administrator about removing a piece media that is deteriorating.



Quantum iPlatform libraries offer more advanced diagnostics than conventional libraries, using their relational diagnostics™ to automatically select, synchronize, and analyze data from hundreds of library components and deliver them remotely. The result is 50% fewer service calls and 30% faster issue resolution.

Extending Intelligence to Include the Storage Ecosystem. In backup systems, a common challenge is determining whether a particular symptom is being caused by a tape library or by conditions at the host, in the applications software, or in the SAN fabric. To address this issue, Quantum has extended its remote diagnostics capability to the systems around the library using our exclusive StorageCare™ Guardian technology. StorageCare Guardian makes it easy for users and the Quantum service team to gather, synchronize, and correlate event data from backup servers and software, the SAN fabric, and

host-bus adapters to provide secure, remote system-level diagnostic services. This end-to-end analysis capability allows Quantum’s service team to assist in diagnosing problems virtually anywhere in the backup system. Without the detailed ecosystem data that StorageCare Guardian provides, other vendors can only ‘point fingers’, forcing the customer to spend more time diagnosing the problem.

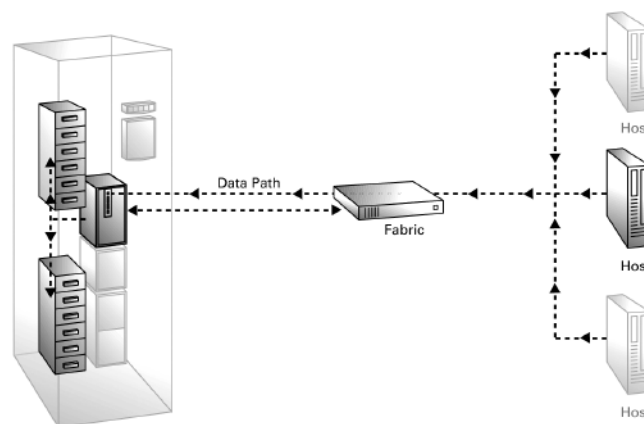
Users report that the process of discovering, diagnosing, and correcting is dramatically improved in iLayer libraries. The manager of backup in a Fortune 100 software company told us he arrived at work one morning to find a voicemail from Quantum telling him a tape drive in his Scalar i2000 needed to be replaced and asking if the service team could install it immediately. A few weeks later the Quantum service group called to tell him there was a bad tape he should remove from the system. In both cases, the Quantum team discovered the issue, pinpointed its cause, and called with a resolution plan before the end-user knew there was a problem. In both cases, the fixes worked the first time. The manager said that “no other equipment in my department has this kind of proactive diagnostic capability.”

I/O Management Provides Better Operation in SANs

Quantum Scalar iPlatform libraries are designed to support optional I/O blades (supplied with Quantum storage networking drives) that provide an integrated layer of management between the library’s drives and the backup fabric to increase system availability, reduce port requirements, and improve security.

Port Aggregation Reduces Costs. At the physical layer, iPlatform library I/O blades connect multiple drives to a single Fibre Channel port to reduce the number of switch ports that must be dedicated to the library. Port reduction reduces hardware costs and simplifies both installation and ongoing backup system management.

Path Verification and System Diagnostics Improve Reliability. The I/O blades and Quantum’s Host Registration Service (HRS) supply management functions that increase overall system reliability and availability by proactively verifying datapath readiness. In complex SAN backup environments, loss of connectivity between host and library drives is usually not discovered until backup jobs are begun, creating situations that can lead to missed backups and associated business risks. Quantum iPlatform libraries with storage networking drives can be configured to proactively verify the health of the data paths between hosts and the library before a backup begins by sending a heartbeat from the host to the library at user-specified intervals. When interrupted connectivity is discovered proactively, users have the opportunity to resolve the issue and still maintain their normal backup schedules.



I/O blades in iPlatform libraries reduce the requirements for switch ports, add proactive path verification functionality, increase diagnostic capabilities, and provide path failover, enhanced security, and automated firmware configuration management.

Blades Enhance Diagnostics. For library and system-level diagnostics, the I/O blades are designed with on-board memory to capture command traffic between the host and the library. This data is available to the library's remote alerting system and relational diagnostic logic. The ability to examine the SCSI command traffic at the time of an abnormal event can often make resolution faster and easier by quickly showing whether the root cause is located in backup hardware, in the SAN, or in the application software.

Failover Provides Redundancy. Quantum I/O blades offer dual ports that can be configured in parallel to provide host-to-library path failover for high availability environments. Dual ported blades give economical open system drive technologies, like LTO, the redundant path protection that is otherwise only available in more expensive mainframe-class devices or through the use of specialized software that is certified with only a limited number of operating systems.

Device Level Security Protects Data. For some users, security within the backup SAN is an important benefit of Quantum I/O blade and iLayer management. An integrated I/O management tool (enhanced Virtual Private SAN-eVPS) supplied with the I/O blade allows administrators to restrict access to the library drives and robotics, including the "virtual robotics" in each library partition. With eVPS, hosts see only the resources assigned to them—to other hosts, the library resources are invisible. This access control is independent of SAN security, and it cannot be overridden by changes to switch zoning.

Self-Directed Configuration Management Reduces Administration, Improves Reliability. Since the I/O blade architecture provides a high-bandwidth, in-band connection to the drives, it allows Quantum to build services into its libraries to reduce administration time by automating configuration management. Two key features are drive identity management and automated firmware management.

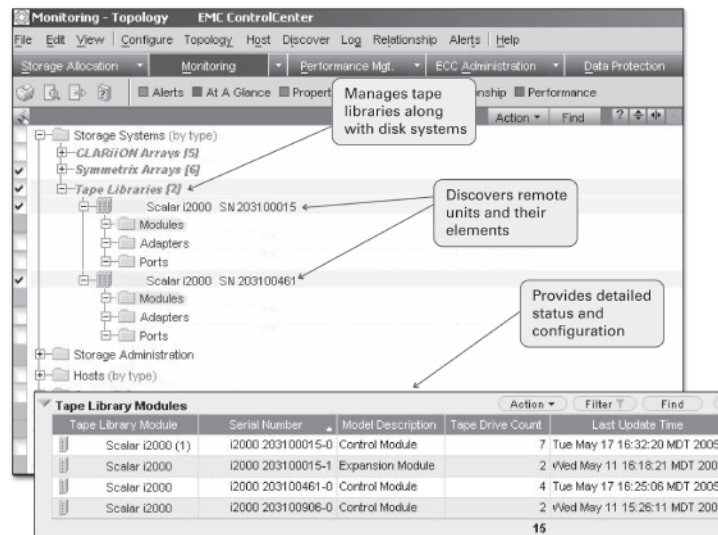
Drive Identity Management. The Scalar I/O blade is configured to present to applications persistent World-Wide Node names and drive serial numbers. Both remain constant even when one physical drive is replaced with another. Persistent identity means that users do not have to change element address tables or drive target information in the host or backup applications when drives are changed.

Firmware Management. Quantum's enterprise iPlatform libraries are designed to use the I/O blade's high speed, in-band path to the drive to load drive firmware from the library's internal memory, eliminating repeated use of firmware upgrade tapes. When a new drive is introduced—either a new drive or a replacement—the library compares the firmware level of the new drive to the other drives in the library and, if the user enables the feature, automatically loads the correct firmware in the new drive so that all the drives match.

Persistent identity presentation and automatic firmware leveling not only save administrators time during configuration changes, but they also prevent potential element address and firmware mis-matches, conditions which can create intermittent faults that are difficult to diagnose.

Built-in SMI-S Support Brings Backup into SRM Environment

In addition to providing library management tools, the iLayer provides an SMI-S interface to allow the library to be managed centrally with users' disk and SAN fabric resources using standard third-party SRM tools, including EMC ControlCenter. By building SMI-S support into the library's main controller, any iPlatform library in any location can be discovered, monitored, and managed directly through SRM tools that support SMI-S library profiles. Integrated support means that this capability is available as a native characteristic of the library and does not require any external proxy servers or separate software agents.



SMI-S support in iPlatform libraries allow them to be managed with the same SRM tools used for disk resources and the SAN fabric. The integrated support provides native SMI-S functionality without requiring use of proxy servers or software agents.

Using the SMI-S interface, SRM tools can discover iPlatform libraries remotely, see their configurations (modules, drives, ports), and view detailed information about them, including serial number ID, firmware revisions, and system configuration data. With some SRM tools, including ControlCenter, users can launch the remote library management interface from the SRM console, providing a single control point for all storage resources in the environment.

With SMI-S based library management administrators can reduce the time needed to maintain their storage network environment by using a single interface to manage all the elements in their backup SAN-hosts, SAN fabric, and library.

Advanced Data Gathering and Trend Analysis—Media Integrity and Drive Usage

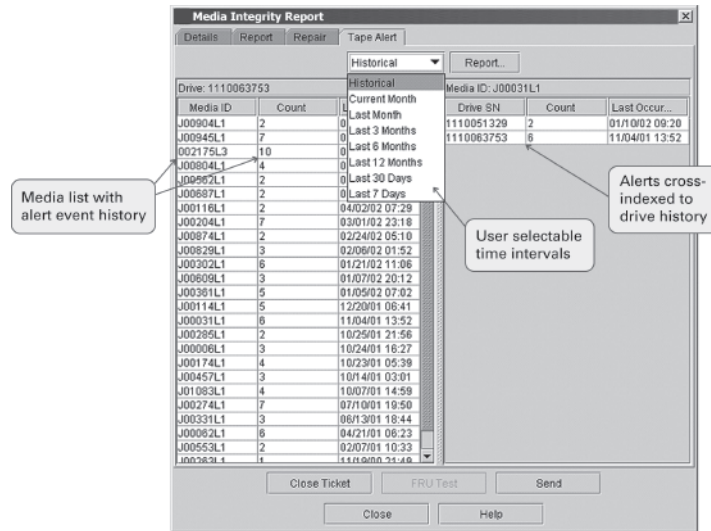
In an effort to provide a more effective overall backup system, the Quantum engineering team leveraged the iPlatform libraries' internal compute capability and data collection system to create a new class of library trend analysis tools. These integrated software tools, targeted at enterprise-scale environments, let administrators improve resource utilization, reduce operating expenses, and increase backup reliability by proactively accessing drive and media trend data in an easy-to-read, highly intuitive format. The iPlatform architecture is flexible, powerful, and designed to allow the continued introduction of new analysis tools as part of future development efforts.

Drive Usage Reports Improve Reliability and Resource Utilization. Long term return on investment in enterprise backup systems is substantially improved when administrators evenly distribute loads between tape drives, but tracking and analyzing drive usage patterns is not a capability supported by conventional libraries or by backup applications. The Scalar i2000, however, tracks the read, write, and mount activity associated with each drive to provide real-time performance metrics. The same data is used by the library's advanced drive trend reporting tools to give end users the information needed to optimize their library resource utilization. Quantum's drive usage reports make it easy for administrators to compare drive usage trend data over variable time periods, showing use patterns (data read, data written, mounts/dismounts) for any single drive, for all the drives in a library, or for all the drives in a partition. IT managers use the drive usage reports to adjust loading to equalize wear, to find underutilized drives, and to discover libraries or partitions that need additional drives. More than just monitoring, the drive usage reports are planning and forecasting tools that help administrators plan budgets and rationalize hardware acquisition.

Media Analysis Protects Integrity. Newly added to the iLayer's enterprise management tools are media integrity analysis reports. These reports are designed to help administrators improve overall backup reliability and reduce costs by using ongoing trend data to evaluate and protect the integrity of their media pool.

Evaluating the condition of removable media can be difficult, and it is an issue that has not been addressed adequately by backup software or by conventional tape libraries. Media defects accumulate slowly over time, error rates can be affected by usage patterns, manufacturer lots, and handling procedures, and it is often difficult to determine if a particular symptom is caused by a drive or a piece of media, especially if only a small number of cases are examined.

Quantum's iLayer media integrity analysis reports give users the data to identify and resolve these problems. Using the database built by the iPlatform library as part of its monitoring, alerting, and diagnostic procedures, the library allows administrators to generate a comprehensive set of media integrity reports. These reports summarize the alert events associated with specific pieces of media, organizing the data using variable views to show trends. Users can look at all the media known to the library, ranking them based on the number of alert events over user defined time periods. They can query the history of any piece of media over various time periods, view the specific classes of alert events, query drive history, and cross-index drive-media error data. Users can specify the time periods for the trend data—it is easy to see all the alert events for all media over the last six months, for example, or to find all the reported events for a specific piece of media since it was introduced to the library, including the ID of every drive it has been loaded in.



The Scalar i2000's media integrity reports give administrators an easy way to use trend data to evaluate and protect their pool of media. The reports include the ability to query the history of every piece of media that has been in the library, including the ID of all drives it has been loaded in.

The media integrity reports provide a full view of the condition of the media pool associated with a specific library, and they are not limited to media in the library at the time the report is created. The history extends to all pieces of media that have ever been in the library, even those now in off-site storage. Organized by barcode ID, the media integrity database is capable of storing and analyzing more than 30,000 media alert events, enough for years of media and media-drive interface trend data. As with the iPlatform configuration data and diagnostic history, the media integrity database is stored in removable flash memory, allowing it to be exported, backed up, and retained even if a library controller is replaced.

Conclusion

Building on their iPlatform architecture and integral iLayer management approach, Quantum's intelligent Scalar library platforms provide new levels of functionality for the tape library category, helping improve end users' data protection process. The Scalar advanced management features make it faster and easier for administrators to install, operate, upgrade, and diagnose the library and the backup and storage ecosystem around it. They provide integrated tools to help make the backup process faster and more reliable, providing I/O management, proactive alerting and diagnostics, email notification, integrated log capture, and even giving users the industry's first comprehensive system for evaluating the integrity of their drives and media and the first integrated support for standard SRM tools. Compared to conventional libraries, Scalar iPlatform libraries reduce service calls by 50%, reduce the overall time needed to resolve issues by nearly one-third, and improve users overall return on investment.



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