HP OpenView Storage Area Manager—Storage Optimizer

Using Storage Optimizer to consolidate heterogeneous storage performance monitoring and reduce administration costs

Overview

Part of HP OpenView Storage Area Manager (SAM), HP OpenView Storage Optimizer provides an efficient and consolidated way to manage performance information for storage devices, infrastructure devices, and storage-related host components such as host bus adapters (HBAs).

Storage Optimizer provides a variety of graphical and text-based reporting options. These options enable administrators to analyze historical and current performance information of single device components, such as switch ports, or whole devices. Using baselines and trending information, Storage Optimizer graphs make performance assessment and performance-level prediction easy tasks.

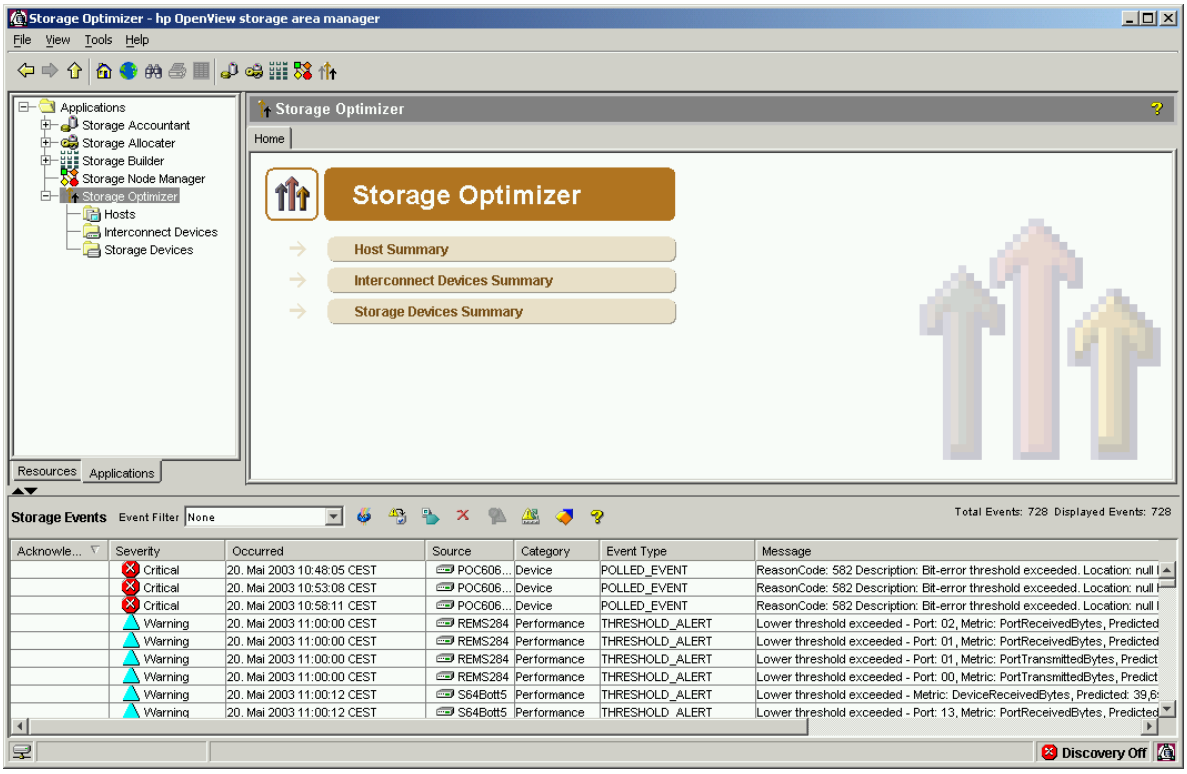
Storage Optimizer reporting capabilities include a variety of resource usage queries and top-N analysis for fast identification of hot spots.

Export of performance information in different formats allows for long-term retention or further use in external (spreadsheet or reporting) applications.

Along with the OpenView SAM Core Services, Storage Optimizer provides consolidated event handling and reporting. The use of automatic reactions (event triggers) for certain events enables faster notification and automated troubleshooting.

One of Storage Optimizer's main functions is to consolidate heterogeneous performance management tools and their associated information into a single comprehensive tool that is capable of processing and filtering this information for further use. In some cases, Storage Optimizer enables performance monitoring, which would not be available through a generic device management application.

Figure 1. Storage Optimizer home page



This paper offers an example methodology for identifying appropriate Storage Optimizer tasks in a given customer scenario and presents some operation procedures along with the benefits gained from this implementation example.

This paper is divided into four sections:

The first section introduces an example company, called Acme Corporation, which represents a typical customer with heterogeneous IT infrastructure, including storage area network (SAN), direct attached storage (DAS) devices, and a variety of operating systems and hardware platforms. Customer issues and needs are identified.

The second section outlines sample planning tasks and describes solutions to the example issues. Planning tasks include identifying physical IT infrastructure components, performance-enabled hardware and software, human resources, and handling policies. The solutions include detailed information about the implementation example derived from the Acme Corporation environment and requirements. Benefits derived from this implementation are detailed.

The third section summarizes the previous sections with a short review of high-level benefits in this Storage Optimizer scenario.

An appendix at the end of this paper provides some additional useful information, along with recommended reading.

This paper is most useful when read before setting up Storage Optimizer. Some of the information used to configure Storage Optimizer might need to be gathered from various sources within your organization.

Storage-related concerns, customer requirements, and Acme Corporation introduction

General considerations

Today, storage is the heart of any IT-driven business. Apart from general availability requirements, companies must be sure they can keep up with the capacity and performance requirements of their applications and infrastructure that support the applications and the business goals.

Especially in terms of consolidated SAN-attached storage, array or infrastructure performance issues immediately impact the attached servers and eventually the application and business levels. In this respect, any kind of performance degradation can have a major impact on service level agreements (SLAs) and general business success.

To avoid problems, companies can choose to overprovision the IT infrastructure, spending more money on hardware but missing the goal of cost efficiency.

Active monitoring is one of the answers but can be excessively complicated because of the number of management and monitoring tools and lack of interoperability and integration. In addition, simple monitoring does not solve all types of problems.

Notification and automated troubleshooting helps solve these problems faster and more efficiently.

Storage Optimizer is a centralized management tool that can provide detailed performance information for storage devices and their associated components, infrastructure devices and device ports, and host information, including HBA, Logical Unit Number (LUN), and file system performance information. Interacting with all supported device managers and host performance agents, Storage Optimizer leverages performance information from three different layers—the storage device, infrastructure, and host operating system—into a single comprehensive user interface.

As a result, Storage Optimizer can simplify management and administrative effort, automate tasks, monitor homogeneous and heterogeneous environments, and identify performance hot spots or under-utilization. Predicting future performance levels and bottlenecks enables proactive management of the storage infrastructure. Storage Optimizer saves time and money, supports hardware purchase decisions, and enables organizations to meet SLAs.

The Acme Corporation

The Acme Corporation is an insurance broker with hundreds of partner offices (franchise agencies) and several organizations to support:

- Corporate management—Decision support and contractual data
- Financial—Enterprise Resource Planning (ERP) and insurance tariff database
- Marketing—Data warehouse and customer database
- Web services—Business-to-consumer (B2C) and business-to-business (B2B) database front end
- Accounting and Controlling—Oracle® database
- Agency support (back office) —Software maintenance and distribution
- Messaging—Microsoft® Exchange 2000

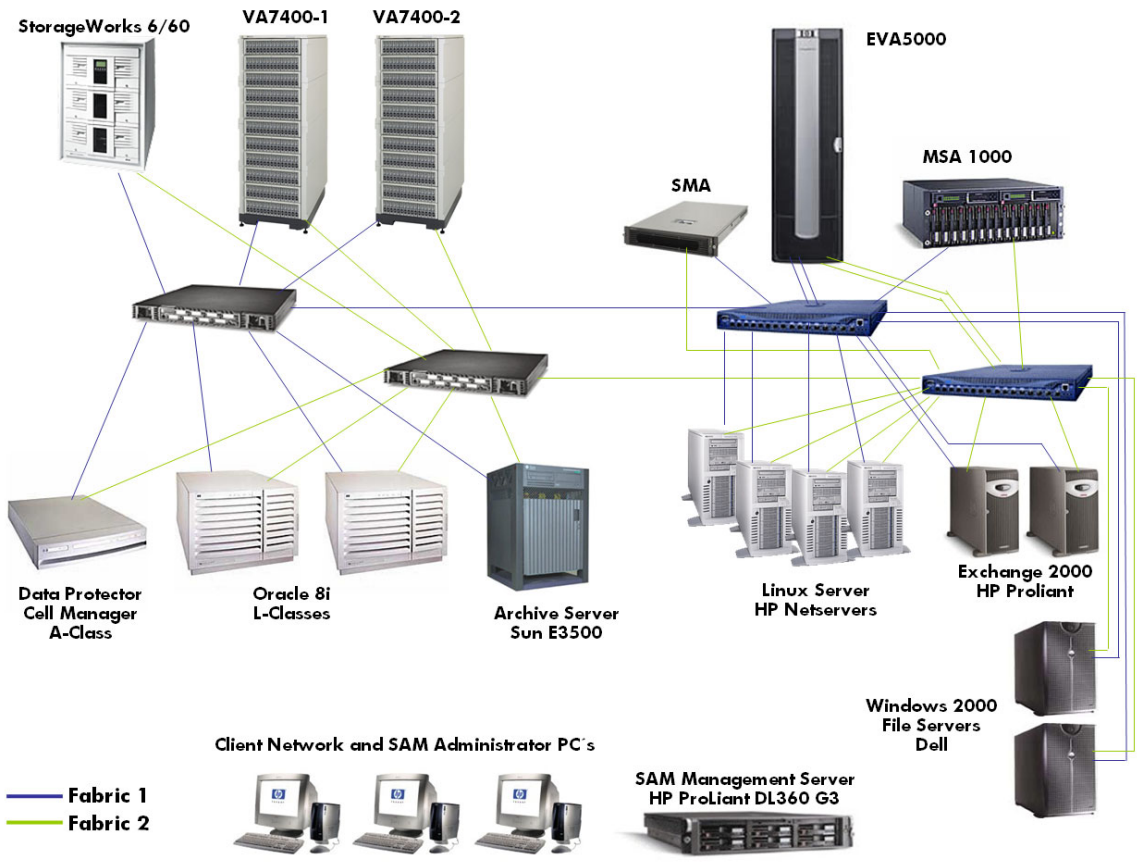
Because of historical organizational issues, Acme still runs about 70 Microsoft Windows® 2000 file servers, most of them with DAS. IT investment plans include consolidating and migrating to a SAN environment, expanding the existing SAN installation.

Currently, the business-critical systems like Oracle 8i, Microsoft Exchange 2000, Web services, and some of the larger file servers have already been migrated to a SAN environment to improve performance, scalability, availability, and backup speed.

Acme Corporation's SAN infrastructure is shown in Figure 2.

Frequently used data or data with higher availability requirements reside on the HP StorageWorks Enterprise Virtual Array (EVA) 5000, while less frequently used data resides on the HP StorageWorks Modular SAN Array (MSA) 1000 to meet storage cost requirements. Exchange data is exclusively stored on the EVA 5000, while Oracle data runs exclusively on the HP StorageWorks Virtual Array (VA) 7400s.

Figure 2. The current Acme Corporation SAN infrastructure (SMA denotes HP StorageWorks Storage Management Appliance)



As indicated in Figure 2, the SAN infrastructure provides two redundant SANs for maximum uptime and performance.

The essential parts of the infrastructure are backed up using HP OpenView Storage Data Protector 5.

Acme Corporation requirements

Acme Corporation still runs about 70 DAS systems. Additionally, the current SAN implementation is close to its port count limit. Accordingly, centralized performance monitoring of all storage and storage-related components—whether SAN attached or direct attached—is a key requirement for Acme. Acme also expects to gather performance information that will enable faster and more proactive decisions about which servers to move to the SAN first, based on performance requirements.

Acme Corporation is moving toward a policy-based IT organization that acts as an independent profit center, of which one of the main goals is the implementation of SLAs. Apart from monitoring components and storage capacity, performance monitoring is a key enabler for maintaining proper operation of all business-critical applications—especially Oracle and Exchange. Storage Optimizer provides this monitoring, the ability to predict future performance bottlenecks, and proactive and automated alerting. Storage Optimizer's functions and features for leveraging heterogeneous reporting tools into a single interface are considered vital for improving staff efficiency and process effectiveness to fulfill the role as an SLA-based profit center.

Current customer issues

The existing infrastructure is a mix of SAN-attached and direct attached storage. Storage management is addressed by multiple legacy tools requiring high administrative effort. In addition, the task of file system performance monitoring is a responsibility of the operating system administrators, while storage device performance monitoring is the responsibility of the storage administration team. Comprehensive management, therefore, currently requires resources from two different teams.

Implementation of performance monitoring for the EVA 5000 is a key requirement for maintaining Exchange 2000 performance SLAs.

The following detailed performance-related customer requirements have been identified:

- Acme requires the ability to monitor performance for the following resources:
  - All file and application servers (Windows, Linux®, HP-UX, and Solaris), regardless of the storage attachment type
  - HP-UX Storage Data Protector backup server
  - Two Brocade Silkworm 2400 switches
  - Two HP StorageWorks 16b switches
  - Two VA7400
  - One EVA 5000
  - One MSA1000
- Acme has insufficient knowledge about potential performance bottlenecks in the SAN environment because the Brocade WebTools only provides real-time monitoring but lacks historical information and export capabilities. Historical information, trend calculation, and performance-level prediction are essential for proper sizing and layout of the SAN as it continues to grow.
- Acme has insufficient knowledge about performance bottlenecks on the non-SAN-attached hosts. Acme also lacks the general performance information that it needs to create a hierarchy of which servers to move to the SAN first according to individual performance requirements. Host performance monitoring should be available on all installed operating systems.
- Acme has only limited insight into SAN backup performance and must identify bottlenecks quickly. The ability to monitor LUN and HBA throughput in correlation with infrastructure and storage device information is necessary to uphold backup SLAs.

- Currently using Brocade WebTools only, Acme has limited options to prove whether the current four-switch SAN layout can still meet application performance requirements (especially of Oracle and Exchange). As the SAN reaches its port-count limit, peek loads and peak load durations must be identified for Acme to decide how to proceed with SAN growth and fan-out.
- Acme plans to expand the existing SAN soon. The current infrastructure is a mix of 1-Gb Brocade Silkworm 2400 switches and faster 2-Gb HP 16b switches. Acme must decide whether the Silkworm 2400s still provide sufficient performance or whether they should be replaced with 2-Gb switches when expanding the SAN. The 2-Gb switches are trunking capable. Acme must also decide whether it is necessary to use trunks and if so, how many ports must be aggregated. Storage Optimizer can provide the respective performance information and long-term trending.
- Acme cannot deliver reliable forecasts around performance issues, such as bottlenecks, to thoroughly prepare migration and upgrade plans, justify investments, or buy hardware "just in time."
- The Acme administrative effort is overwhelming because of the many tools and high demand for manual report generation. Dramatic reduction of handling time and fast and comprehensive reporting is required. Graphical presentation capabilities are important for SLA monitoring and presentation to the CIO.
- Acme does not have a proper SLA monitoring tool in place and can hardly meet SLA requirements because, typically, performance issues first become known after they have grown to be a problem. Even then, identification of the root cause of the problem is still time-consuming and typically impacts performance and availability. The event monitoring and graphical presentation features of Storage Optimizer identify problems faster and more accurately.
- Having many different device management tools makes data extraction and analysis time-consuming, requires external spreadsheets and reporting tools, and incurs additional costs associated with training requirements. Using Storage Optimizer, Acme expects a dramatic reduction in the number of tools necessary and expects to cut training and software license expenses.
- The lack of proactive performance level and performance problem prediction leaves the IT department reactive and renders meeting SLAs more difficult. The active monitoring and prediction capabilities of Storage Optimizer, including active notification options, are paramount in meeting SLAs.

Customer solution, associated tasks, and benefits

Using Storage Optimizer, Acme Corporation can address all its issues.

As part of the pre-deployment preparation, necessary SLA-related and process-oriented questions must be answered. This paper does not detail this phase but, instead, presents some sample questions:

- Which devices or device components should be monitored?
- Which hosts should be monitored? Which maintenance windows are available for agent deployment?
- What timeframe should be used for historical information?
- Which device management tools should be leveraged into Storage Optimizer?
- What performance levels are expected for a given individual device or device component?
- What performance thresholds should not be exceeded?
- What actions should be initiated if certain thresholds are exceeded?
- Are any troubleshooting policies available? Which ones could be automated and to what degree?
- Who is responsible for which devices and should be notified of performance problems?

As mentioned, these questions represent just a small portion of questions to be answered. Most of them should already be defined in SLAs and should be part of post-deployment operation procedures.

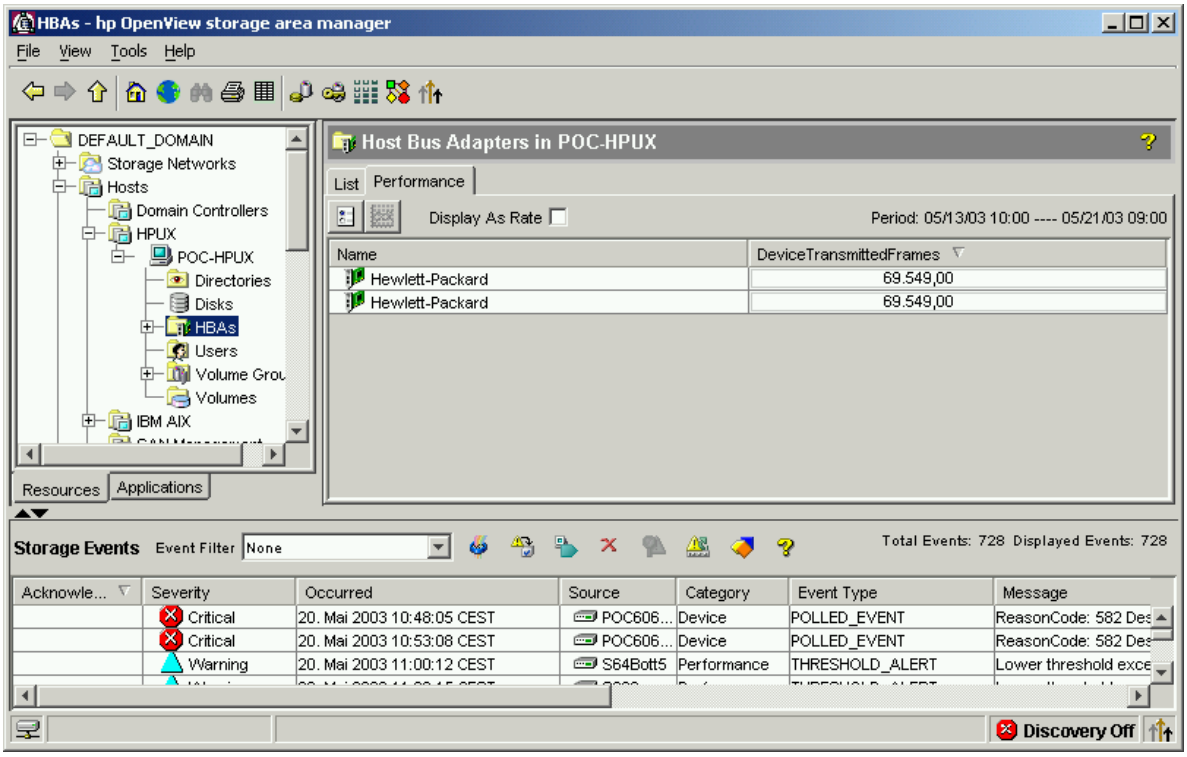
Outline of tasks and benefits

Collection of performance information

Storage Optimizer significantly reduces the amount of time spent on gathering performance information because of its automated and centralized collection methods.

As a first step, performance agents—HP OpenView Performance Agent (previously MeasureWare)—are installed on all hosts. Depending on the agent and operating system type, this installation delivers performance information from logical volumes and disks from the host point of view. In addition, integration with industry-standard Storage Networking Industry Association (SNIA) libraries associated with HBA drivers provides HBA metrics.

Figure 3. Optimizer detail screen. The upper right part of the screen shows HBA performance on the HP-UX host Fibre Channel HBAs.



With the introduction of Storage Optimizer, Brocade switch performance information is extracted from the switches and written to the management server repository. Current and historical performance information is available for text-based or graphical reporting.

Performance can either be displayed on an individual port level or at the device level. Storage Optimizer aggregates port level information. The resulting device level information can predict overall device-level metrics.

Figure 4. Graphical report comparing the port performance of three different ports on a switch. "Autoscale" is enabled, giving a range from 0 to 100 percent of the available performance bandwidth to enable easy comparison of the three ports and visualization of the individual ports, compared to the overall performance boundary.

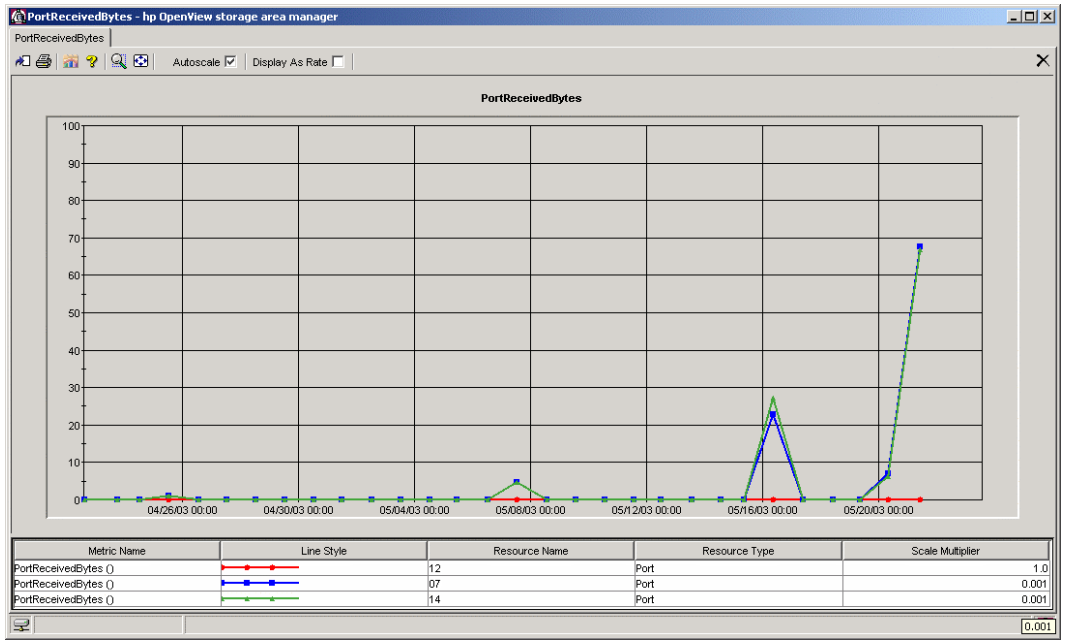


Figure 5. Text-based query across all Fibre Channel switches in the domain, using a characteristic throughput metric—Device Received Bytes—as a measure to compare all four switches and identify potential hot spots.

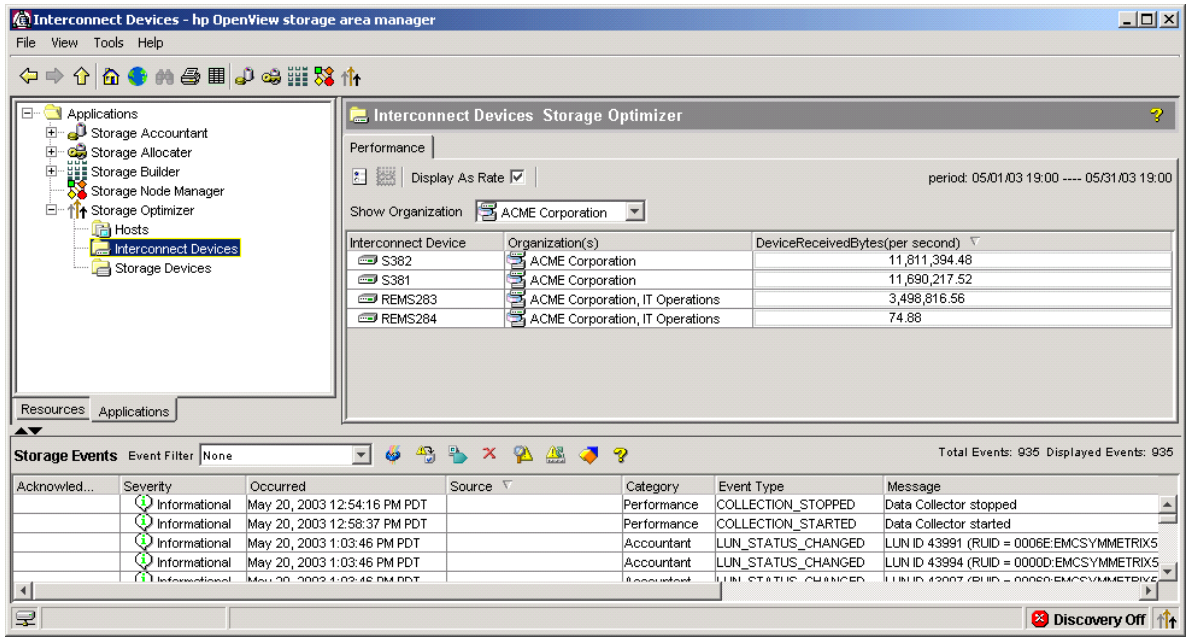
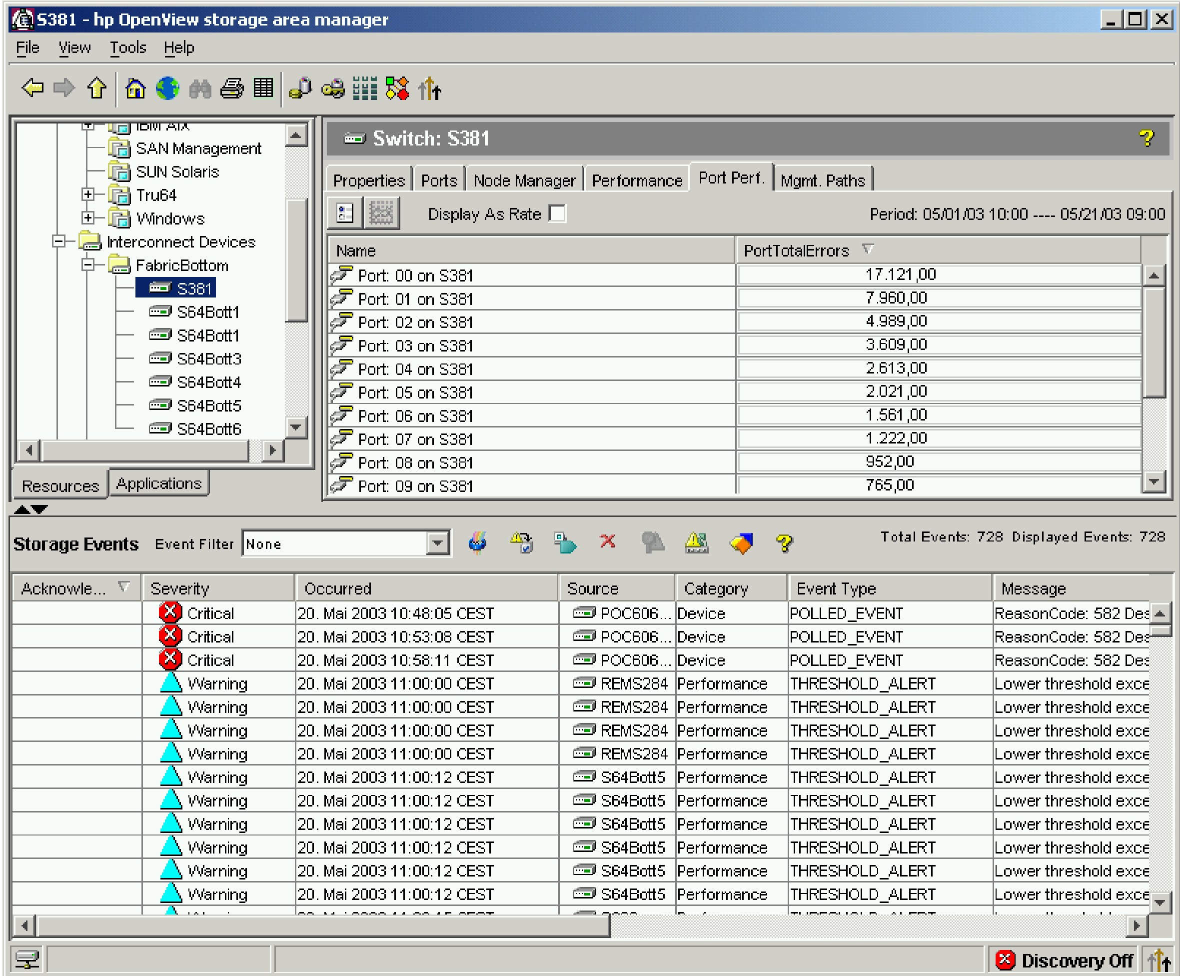


Figure 6. Storage Optimizer detail screen. The upper right part of the screen shows Fibre Channel switch port performance counters for Port Total Errors. This metric is used to identify errors on a Fibre Channel connection. An excessive number might indicate cabling or Gigabit Interface Connector (GBIC) problems.



Using device plug-ins (DPIs), performance data collection from the VA7400s, the EVA 5000, and MSA1000 is enabled. For the EVA 5000, Storage Optimizer adds the capability of performance monitoring, which is not a native feature of the device management application. Using Storage Optimizer, the Storage Management Appliance can perform Fibre Channel inquiries to the EVA's HSV controllers and retrieve device-specific performance information, for example, LUN read and write performance, response times, subsystem read/write ratio, and so on.

For Acme, this functionality provides the data necessary to verify Exchange performance compared to the SLA requirements. Trending provides prediction of hot spots and proactive performance tuning.

In the Storage Optimizer configuration menus, performance collection for all selected resources is then enabled. Performance metrics are then centrally stored on the OpenView SAM management server. Baselining and trending are enabled for all resources to predict performance levels and automatically report on thresholds that are exceeded.

Proactive event notification and identification of bottlenecks

Definition of baselines and thresholds provide automated and consistent monitoring of performance levels on storage devices, infrastructure devices, and the host operating system. With some user settings, threshold levels are automatically generated and monitored. Upon exceeding performance thresholds, events are automatically generated. The usage of event triggers provides active notification to administrators through e-mail or network messages. From there, running scripts or launching external applications can initiate automatic troubleshooting procedures.

The benefits derived from this are:

- Gained knowledge about performance bottlenecks on any level of the IT environment
- Faster reactions through enhanced notification options and notification speed
- Improved troubleshooting speed enabled by event message texts and graphical presentation capabilities
- Enhanced resource usage enabled by performance metrics[1] coming from the device and device component levels and enabling "just-in-time" system optimization
- Improved staff efficiency by replacing several performance tools with consolidated performance reporting and a single user interface
- Improved ability to meet SLA requirements enabled by reporting and prediction, thus reducing bottlenecks and downtime

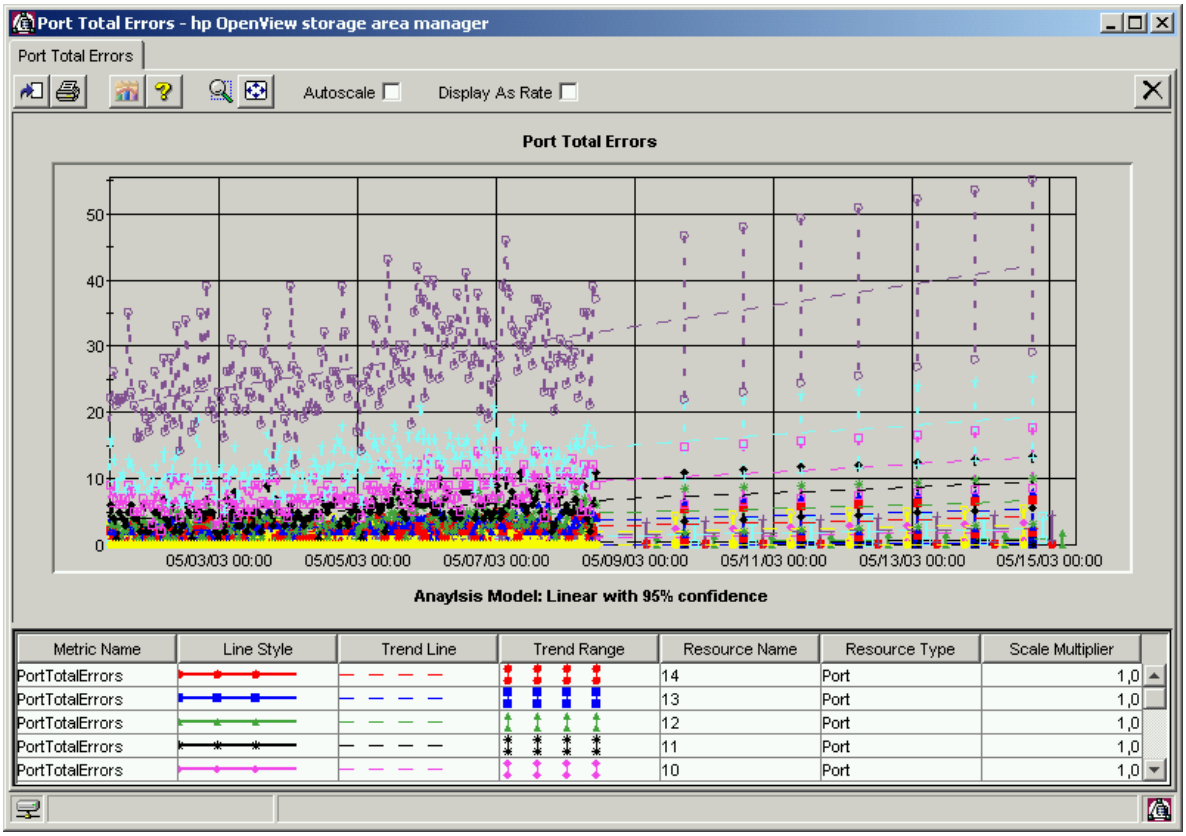
Performance level prediction

Collection of performance data and data retention in the OpenView SAM database provides historical information to predict future performance levels based on various mathematical models. Using this information and the graphical visualization capabilities of Storage Optimizer enables the prediction of future performance levels on each Fibre Channel port or device. This functionality aids in the proper assessment of performance requirements and proper planning of SAN growth.

Predicting future requirements more accurately and replacing guesswork with hard figures enables more accurate purchasing decisions and avoidance of performance bottlenecks.

[1] A more detailed list of supported metrics can be found in the appendix of this white paper.

Figure 7. Storage Optimizer chart showing switch port performance counters and trending information (shown as dashed line).



Having these hard figures available for the host operating system level helps identify the DAS hosts that are encountering storage-based performance problems. In turn, these hosts become primary candidates to be moved to the SAN.

These factors positively impact budgets and meeting budget restrictions. In particular, Storage Optimizer provides the tools needed to meet SLA requirements.

Backup performance assessment

So far, Acme has only used the backup application interface to track backup performance. Because Acme Corporation currently uses Ultrium drives and might upgrade to Ultrium-2 in the future, streaming requirements must be met. In this respect, Acme must ensure that certain throughput levels are maintained throughout the whole datapath. Necessary information must be gathered on all components along the whole datapath, including LUNs, file systems, HBAs, switch ports, inter-switch links (ISLs), and storage devices. Storage Optimizer monitors all these components. If one of these components becomes a critical bottleneck, reporting and event notification capabilities identify these issues long before they might become a problem. This functionality helps guarantee that Acme meets SLA requirements concerning backup speeds and available backup windows. From a business perspective, this kind of information determines upgrade requirements and supports more accurate purchasing decisions.

Fabric monitoring and sizing

Currently, the Acme SAN provides a mixture of two different generations of Brocade switches. Proper SAN fabric monitoring helps identify device and ISL hot spots. Because the SAN is close to the maximum port count limit, over-subscription and resulting performance degradations might be an issue.

Tracking performance, especially for ISLs, enables administrators to identify if the switch-to-switch connections are potential bottlenecks in the overall SAN design. If bottlenecks are identified, administrators can add additional ISLs and configure static routes—a very time-consuming task—bound to the Silkworm 2400s. The second generation HP StorageWorks16b switch provides ISL trunking with automatic load balancing between the ISLs within a trunk.

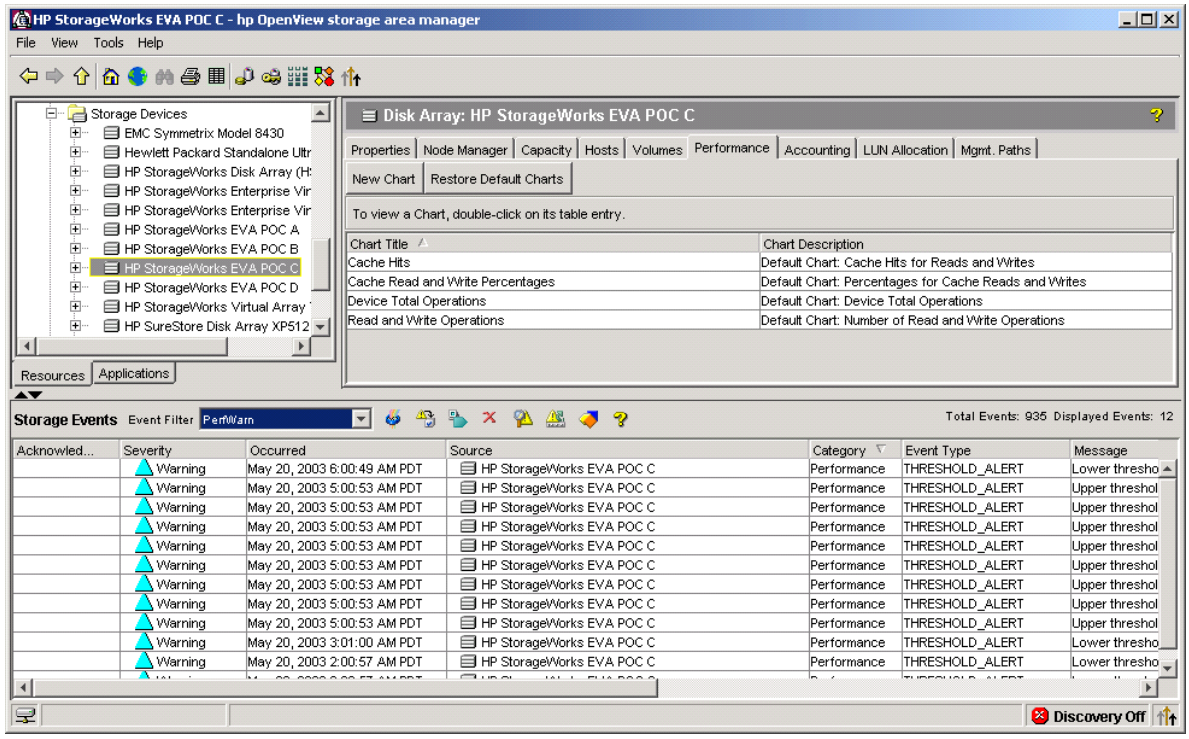
Because Acme plans a SAN expansion and the 2-Gb switch generation supports ISL trunks, Storage Optimizer is used to provide the information needed to determine whether to reuse the 2400s or replace them with 2-Gb switches and ISL trunking. Additionally, Storage Optimizer helps determine the number of ISLs required for a trunk.

The immediate benefits of using Storage Optimizer are proper sizing, resizing, and layout of the existing infrastructure and proper expansion planning. The figures delivered from historical metrics and trending information enable proper infrastructure design and purchasing decisions. The figures can also be used to assess how to reuse the existing Brocade 2400 switches when moving to a larger and faster SAN layout.

Reporting, visualization, and event triggering

Using Storage Optimizer enables Acme to reduce administrative effort dramatically by consolidating performance data collection, processing, and reporting into a single comprehensive tool. The use of event filtering provides faster detection of problems that might impact productivity and availability.

Figure 8. Event filter applied selecting for performance events with severity level "warning" on an EVA 5000. In this example, the use of this filter restricts the number of events being displayed to 12 out of 935 events available in the database, allowing fast access to this specific information.

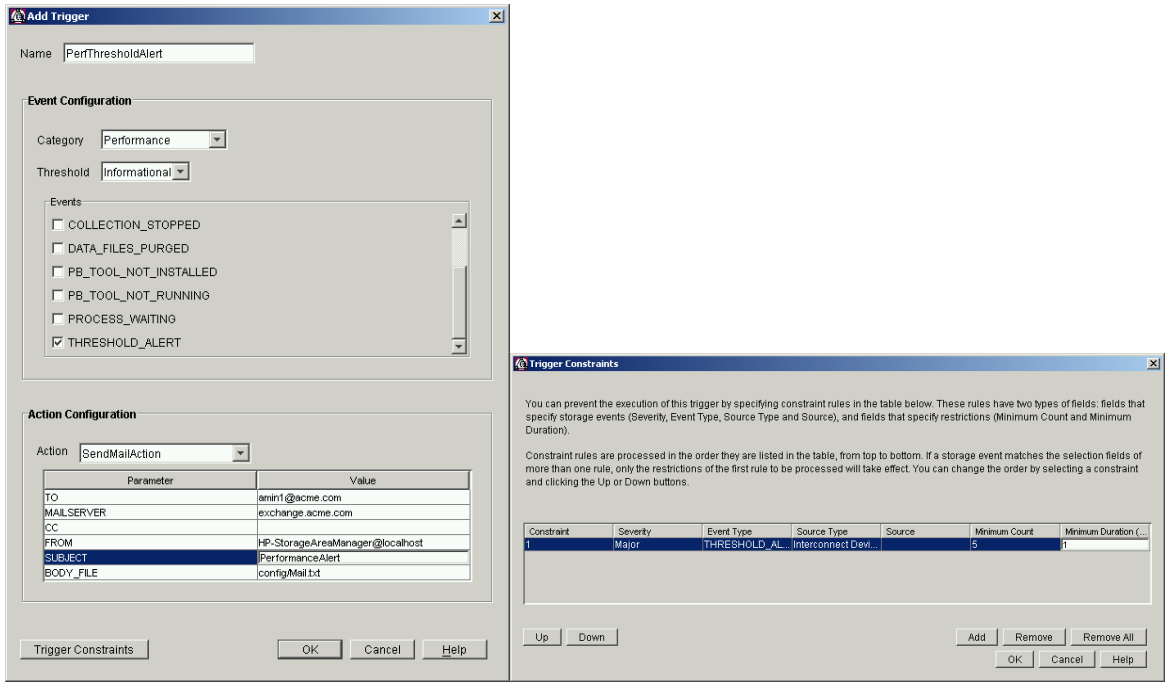


Allowing multiple users to acknowledge performance events, other administrators or operators can track actions already launched or identify who has already dealt with a given problem.

Using event triggers, administrative effort is further reduced, shifting reactions from the human to the software level—from manual intervention to automated reactions.

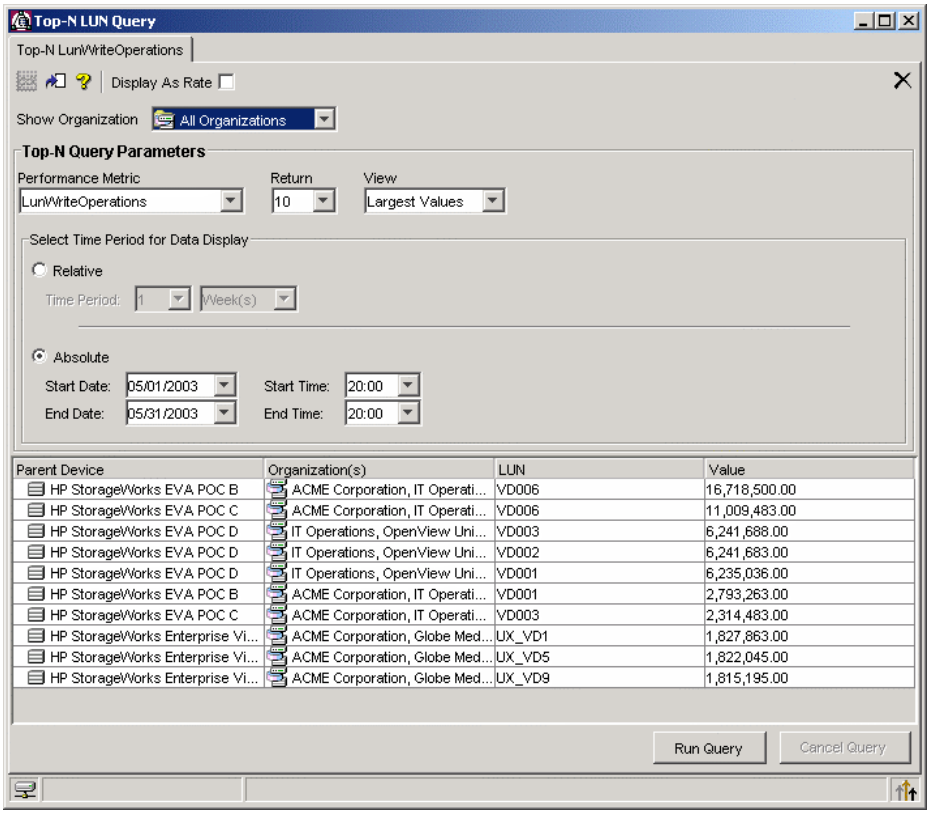
Overall, Storage Optimizer provides a dramatic reduction of administrative effort, thus reducing staff expenses and enabling faster response times.

Figure 9. Two screens showing the configuration of a Storage Optimizer "trigger." The trigger sends an e-mail to an administrator if a performance threshold is exceeded five times for less than one minute each.



From a CIO's perspective, event monitoring provides a method of tracking problems and problem resolution. This functionality enables direct SLA monitoring. Graphical presentation capabilities and top-N queries provide rapid LUN performance assessment and identification of array-based performance hot spots. Early identification of those LUN hot spots avoids performance bottlenecks and either moves data to faster LUNs or optimizes the array LUN or disk layout accordingly.

Figure 10. Top-N query screen for LUNs. The sample query in this screen selects the 10 LUNs with the highest number of LUN write operations. The report queries across all available storage devices.



Because Storage Optimizer metrics are available as graphs or reports, the need for external applications, such as spreadsheet and reporting tools, and further administrative effort is dramatically reduced.

Integration with enterprise management applications

As an additional benefit, integration into high-level enterprise management applications, such as HP OpenView Operations or Service Desk, is achieved seamlessly through bridges or smart plug-ins delivered with the OpenView SAM software. Typically, these enterprise management tools do not provide specific storage-related information. With the integration of the OpenView SAM, the service reporting capabilities—OpenView Service Desk—or the system monitoring capabilities—OpenView Operations—are expanded to include storage. This integration enables these high-level applications to get an even more comprehensive view of the overall IT environment.

Wrap up and review

Storage Optimizer facilitates routine and normally time-consuming management tasks. As such, it can benefit Acme Corporation in several ways.

It reduces the amount of time spent collecting, analysing, and presenting performance information, thus freeing up administrative resources from time-consuming routine tasks. With administrator resources freed up and by providing automated reactions and prediction features, Storage Optimizer dramatically improves IT department responsiveness by allowing them to focus on solving the problems.

As a result of this improved responsiveness, uptime is increased due to the reduction of performance-related problems.

In addition, Storage Optimizer reduces costs by enabling "as needed" and "just in time" hardware purchases to better accommodate infrastructure growth requirements.

Finally, it further reduces costs by saving money previously spent training administrators to use a variety of tools that are now consolidated under Storage Optimizer into a single, easy-to-use application. Having fewer tools and a single comprehensive user interface also reduce the potential for human error, allowing further savings resulting from increased system availability.

Appendix

Additional OpenView SAM information and product manuals are available at http://www.openview.hp.com/go/sam.

OpenView SAM device plug-ins (DPI) are available on the OpenView SAM website at http://www.openview.hp.com/products/dpi/index.html.

Each DPI installation guide contains a detailed list of Storage Optimizer metrics available for this particular device.

Send any comments about this paper to wolfgang.weith@hp.com.

Recommended reading

1. Toigo, Jon William
   The Holy Grail of Data Storage Management
   2nd edition, Prentice Hall PTR, 2000
   ISBN 0-13-013055-9
2. Tardugno, Anthony F., DiPasquale, Thomas R., and Matthews, Robert E.
   IT Services—Costs, Metrics, Benchmarking, and Marketing
   Prentice Hall PTR, 2000
   ISBN 0-13-019195-7

Available metrics

Available metrics are dependent on the device type and vary with different vendors and models. In total, there are several hundreds of different metrics for these different devices.

Across all available platforms and vendors, a selection of "common metrics" reflect information that is available for a certain general type of device, for example, all disk arrays. These common metrics include:

Interconnect devices:

- Total errors (display default)
- Invalid Cyclic Redundancy Checks (CRCs)
- Invalid transmission words
- Link failures
- Primitive sequence protocol errors
- Received bytes and frames
- Signal losses
- Synchronization losses
- Transmitted bytes and frames

Ports on interconnect devices:

- Total errors (display default)
- CRC errors
- Invalid CRCs
- Invalid transmission words
- Link failures
- Primitive sequence protocol errors
- Received frames
- Signal losses
- Synchronization losses
- Transmitted frames

Storage devices:

- Total operations (display default)
- Percentage of reads and writes from cache
- Read and write cache hits
- Read and write operations

LUNs:

- Total operations (display default)
- Percentage of reads and writes from cache
- Read and write cache hits
- Read and write operations

Hosts

- Average logical read operations per second
- Average logical write operations per second
- Average physical read operations per second
- Average physical write operations per second

5982-2448EN, Rev. 1, 05/2004