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Managing FlashSystem Performance with IBM Spectrum Control

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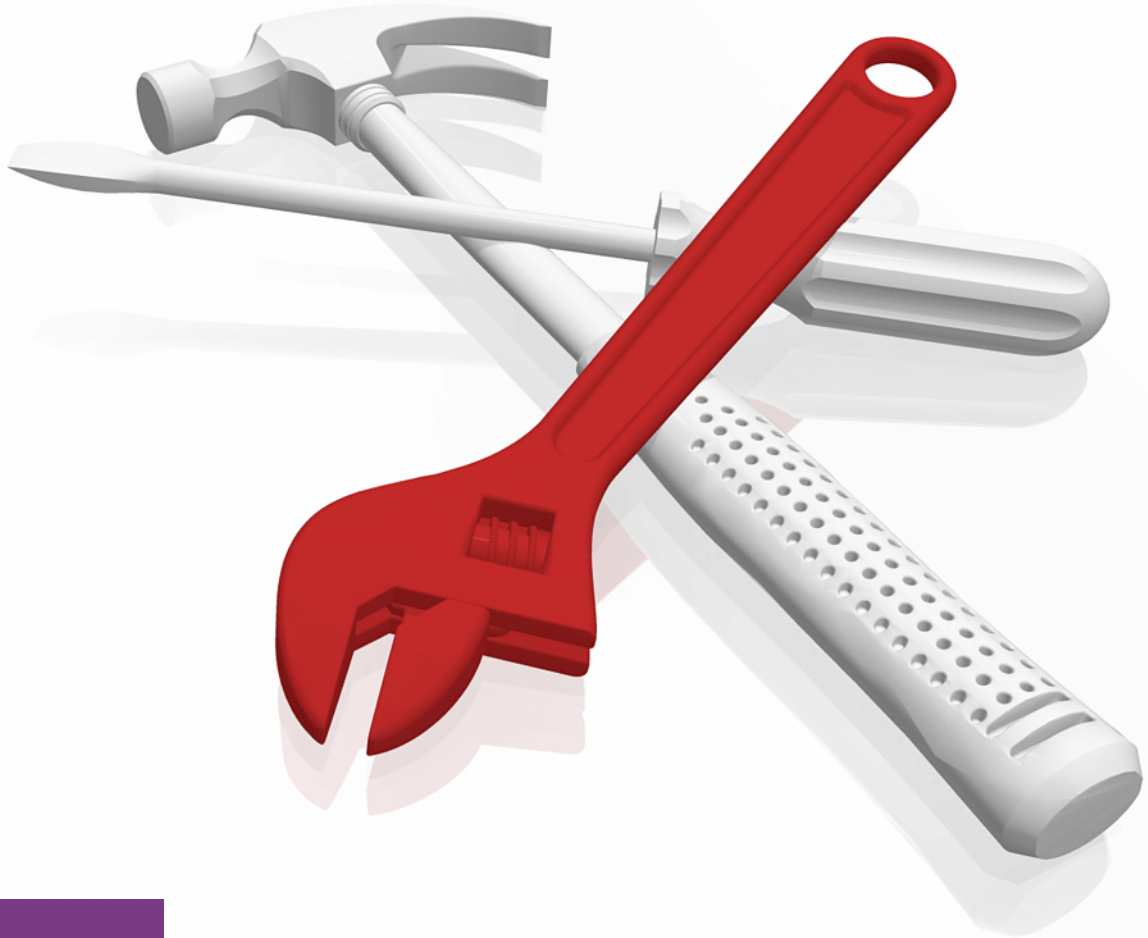

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Managing FlashSystem Performance with IBM Spectrum Control

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Note: Before using this information and the product it supports, read the information in “Notices” on page vii.

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Contents

Preface

This IBM® Redpaper™ publication discusses on performance monitoring for IBM FlashSystem® storage products. The products reviewed are the IBM FlashSystem FS900, the IBM FlashSystem V9000, and the IBM FlashSystem A9000 and A9000R.

For each of the FlashSystem devices, the paper reviews performance monitoring options. The first option is to use features available with the storage management software specific to the respective devices. The other option, which is the focus of this paper, is to use the IBM Spectrum™ Control solution.

Using IBM Spectrum Control™ offers the advantage of having a common tool and unique interface to monitor most devices in your storage infrastructure. This paper explains how to take advantage of the many monitoring features and reporting options offered by IBM Spectrum Control. The paper also gives some guidance on how to set appropriate monitoring thresholds and alerts according to your environment.

Authors

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Thanks to the following people for their contributions to this project:

Bert Dufrasne
Stefan Jacquet
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1

Introduction

This chapter provides a short introduction to IBM FlashSystem products and IBM Spectrum Control.

This chapter includes the following sections:

- IBM FlashSystem products
- IBM Spectrum Control

1.1 IBM FlashSystem products

With FlashSystem products, IBM offers a broad range of industry-leading storage virtualization and data management features to help you address various business needs or application requirements. IBM FlashSystem devices employ the IBM FlashCore® Technology implemented in the IBM MicroLatency® modules.

- For application acceleration, FlashSystem FS900 delivers storage for extreme performance, enterprise reliability, and operation efficiency.

  The FS900 Model AE3 offers performances of up to 1,100,000 I/O per second (IOPS), bandwidth of up to 10 GBps, and latency as low as 90 microseconds. In addition to the extreme performance, the unit is efficient and lowers operating costs and increases efficiency of IT infrastructure by using much less power and space compared to traditional hard disk drive (HDD) and solid-state disk (SSD) solutions. Another key feature is the enterprise-class reliability to protect the data with two-dimensional RAID protection, IBM Variable Stripe RAID™, redundant and hot-swappable components, and concurrent code loads.

  For more information about the latest Flash 900 AE3, see *Implementing IBM FlashSystem 900 Model AE3*, SG24-8414.

  For storage virtualization, FlashSystem V9000 as well as the V5030F and V7000F offer great flash performance based on the Spectrum Virtualize Code with all its features like compression, mirroring, and many more functions.

  IBM FlashSystem V9000 is a fully integrated Tier 1 all-flash enterprise storage solution that delivers the full capabilities of IBM FlashCore technology. Its software-defined storage features simplify data management, improve data security, and preserve your investments in storage. In addition, it provides a rich set of software-defined storage features, including IBM Real-time Compression™, dynamic tiering, thin provisioning, snapshots, cloning, replication, data copy services, and IBM HyperSwap® for high availability.

  IBM FlashSystem V9000 improves business application availability. It delivers greater resource utilization so you can get the most from your storage resources, and achieve a simpler, more scalable, and cost-efficient IT Infrastructure.

  For more information about the functions and how to implement a V9000, see *Implementing IBM FlashSystem V9000*, SG24-8413.

- For the fast growing Hybrid Cloud environments, FlashSystem A9000 and A9000R deliver high performance-oriented all flash storage with multitenancy.

  FlashSystem A9000 and FlashSystem A9000R are functionally built with IBM Spectrum Accelerate software that is optimized to run on a flash storage grid architecture. Some, but not all, notable features are the always-on data reduction feature, pattern recognition, and compression. A9000 and FlashSystem A9000R are designed to deliver high performance, low latency, and ease of use.

  FlashSystem A9000 and FlashSystem A9000R bring together the world-class ease of use from Spectrum Accelerate software and the microsecond response times that are provided by IBM FlashCore technology. Designed for enterprise cloud environments, both FlashSystem A9000 and FlashSystemA9000R offer fast and reliable data storage across a wide variety of workloads. Both FlashSystem A9000 and FlashSystem A9000R use the same firmware, and both offer onsite setup and service that are provided by IBM. They also share a feature set, but significant hardware differences exist. The focus in this paper is monitoring.

  For more information, see *IBM FlashSystem A9000 and IBM FlashSystem A9000R Architecture and Implementation*, SG24-8345.

1.2 IBM Spectrum Control

IBM Spectrum Control is designed to reduce the complexity of managing SAN storage devices by allowing administrators to configure and monitor storage devices and switches from a single console.

Storage admins are continuously faced with the extraordinary challenge of managing very complex storage infrastructures. Spectrum Control is the product that helps to do just that. Features like performance monitoring, provisioning, charge-back reporting, and storage optimization, just to name a few, are all part of this product.

IBM Spectrum Control presents the administrator with a single pane of glass for managing an entire infrastructure for block, file, and object storage. It provides a complete end-to-end view of the environment including the possibility to monitor the performance of various storage entities. It also offers the option to flexibly configure a wide range of customized alerts and thresholds to inform the administrator if anything is violated.

Storage provisioning is a time consuming task for administrators. System administrators often must set up new storage for various applications of various levels of criticality. With Spectrum Control, storage consumers only need to specify the size and required service class for the new volume or file share. Spectrum Control then determine the “best fit” for the storage resource that will host the new volume or share.

Beside storage resource management, charge-back reporting is a feature that has gained more attention in recent releases. It provides easy-to-read reports about storage and a consumer report that can be emailed to a specific owner of applications, departments, physical servers, or hypervisors.

Starting with version 5.2.12, Spectrum Control delivers more value for hybrid cloud environments by using IBM transparent cloud tiering available in IBM Spectrum Scale™. Not only can you identify file systems in IBM Spectrum Scale clusters that use external storage, you can also view the capacity of external storage that is being used. This view provides administrators with an overview of how much storage has been migrated to the cloud. This information allows the administrators to estimate the possibility of a shortfall if data needs to be recalled. Alerting was also enhanced to send notifications on the Cloud Gateway Status during an outage on the external storage.

Further enhancements for IBM Cloud™ Object Storage allow you to monitor the capacity and space usage of sites and identify which Cloud Object Storage slicestor and accessor nodes are at each site. Administrators can also see internal resources like sites, mirrors, and vault space quotas so that they can determine whether any quota limits are being violated.

IBM FlashSystem A9000 and A9000R are now also part of the Spectrum Control support matrix. Users can view capacity information, space usage, and performance data for the storage systems. A key part of this family of systems is the data reduction technology that is integrated in the product. Spectrum Control can report on the data reduction percentage savings.

For a full list of the features that are provided in each of the IBM Spectrum components, see the IBM Spectrum Control website.

2

Viewing performance information

This chapter discusses the following topics:

- Prerequisites for monitoring FlashSystem devices
- Monitoring performance for FlashSystem 840/ FlashSystem 900
- Monitoring Performance for FlashSystem V9000
- Monitoring performance for FlashSystem A9000 or A9000R
- IBM Spectrum Control reporting options

2.1 Prerequisites for monitoring FlashSystem devices

Although setting up a Network Time Protocol (NTP) server and configuring all devices in the data center to have the time synchronized is relevant for all device monitoring, it is especially important and necessary when monitoring FlashSystem 840 or FlashSystem 900 devices with IBM Spectrum Control.

For most of the devices, IBM Spectrum Control uses the time stamp reported by the devices when saving the performance data in its database. For FlashSystem 840 and FlashSystem 900, performance data statistics are collected through SNMP. Because SNMP does not provide the date and time information of the device, the IBM Spectrum Control server's time stamp is used.

To use the end to end view provided by IBM Spectrum Control to troubleshoot performance-related issues across your data center, it is essential to have all your devices including the IBM Spectrum Control server configured with an NTP server.

Reference: For more information about setting up an NTP server for your devices, see the *Usage of an NTP Server in Storage Area Network environments* white paper.

2.1.1 Adding FlashSystem devices to IBM Spectrum Control

Any device that you want to monitor with Spectrum Control must be added to the Spectrum Control database.

To add a FlashSystem device, complete these steps:

1. Click **Add Storage System** from the Block Storage Overview in the Spectrum Control main window, and select **FlashSystem Family**, as shown in Figure 2-1.

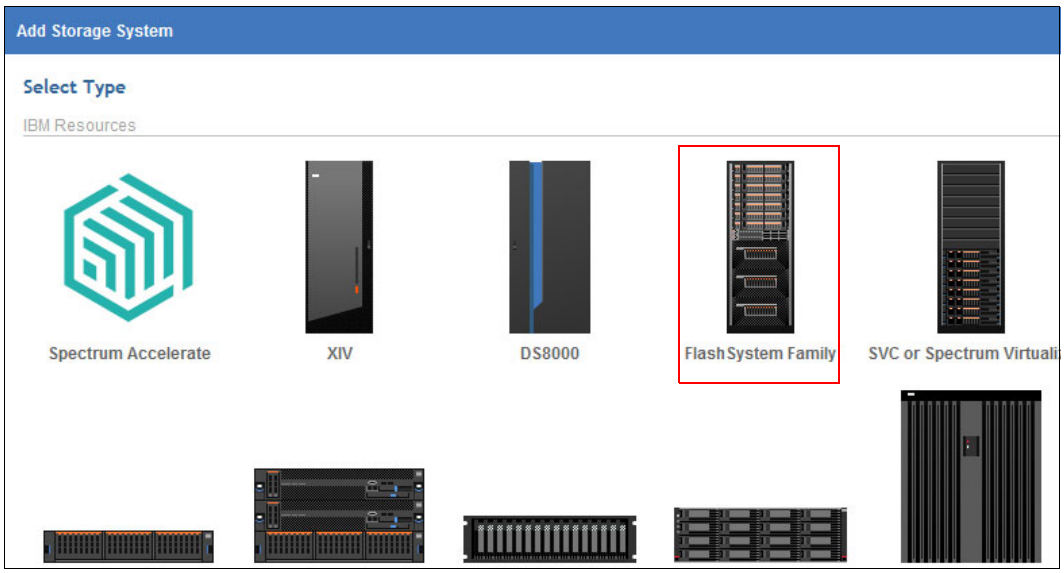

Figure 2-1 Add Storage System window

2. After selecting **FlashSystem Family,** select the appropriate radio button for the corresponding FlashSystem device that you want to add, as shown in Figure 2-2.

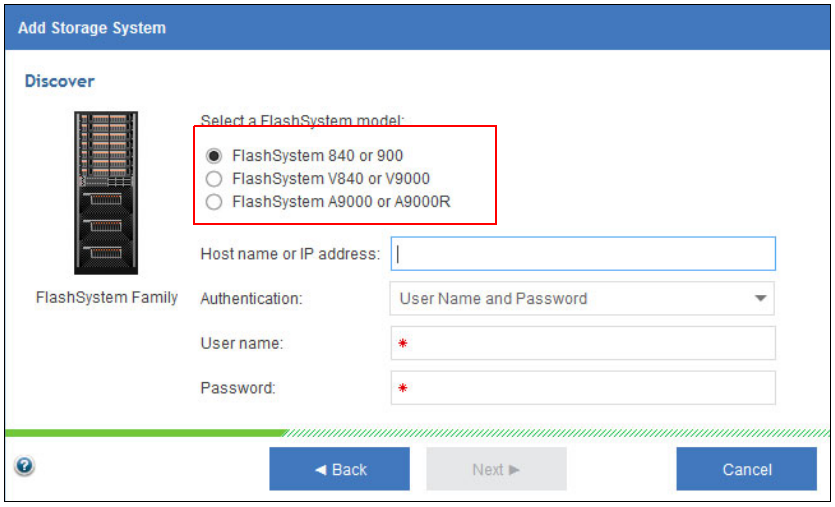

Figure 2-2 Select Flash System model window

Instead of using user name and password for authentication, an SSH key can be used. For more details, see Appendix A, “Using SSH key for device configuration” on page 103.

3. After devices are added to IBM Spectrum Control, the probe (daily collection of status, health, configuration, and capacity information (1)) and the performance monitoring (2) can be scheduled, as shown in Figure 2-3.

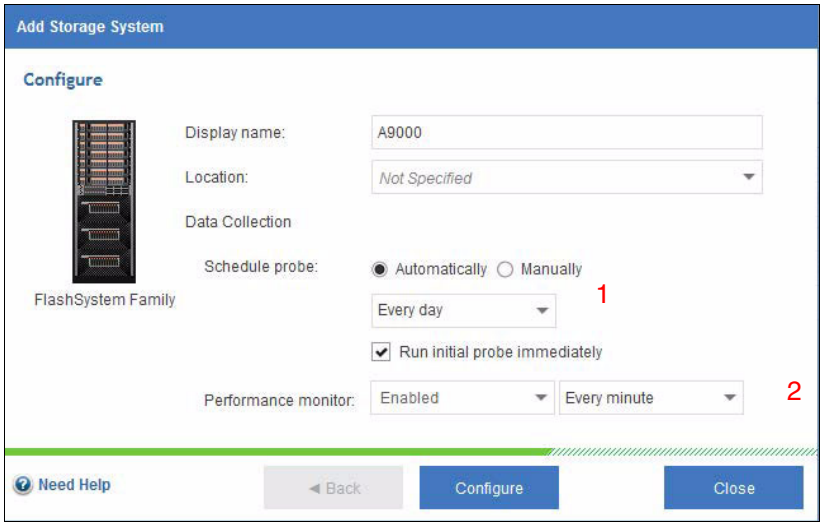

Figure 2-3 Schedule probe and Performance monitor

4. If you select the automatic probe schedule as shown in Figure 2-3 on page 7, IBM Spectrum Control automatically balances all device probes that are set to automatic probe schedule across the time frame configured in **Settings/Automated Probe Schedule**. See Figure 2-4.

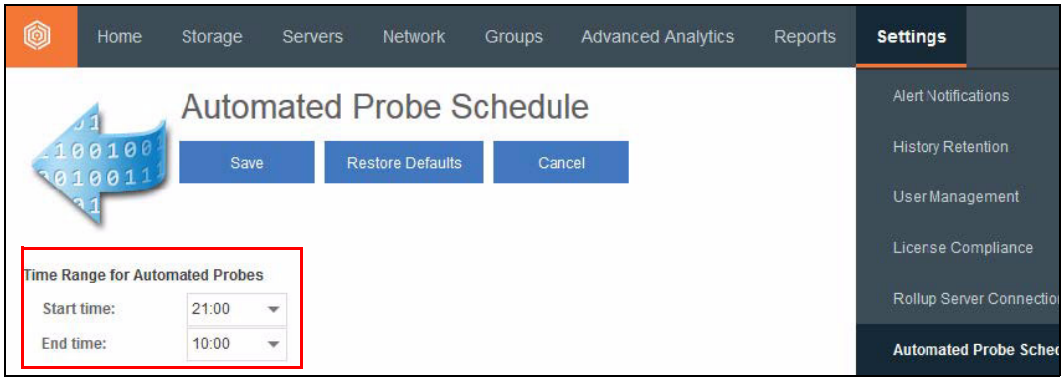

Figure 2-4 Automated Probe Schedule

5. When you select manual probe schedule, you can set the time of the day for when the probe runs on that device. However, it is desirable to have the probes of the individual devices balanced as much as possible, as shown in Figure 2-5.

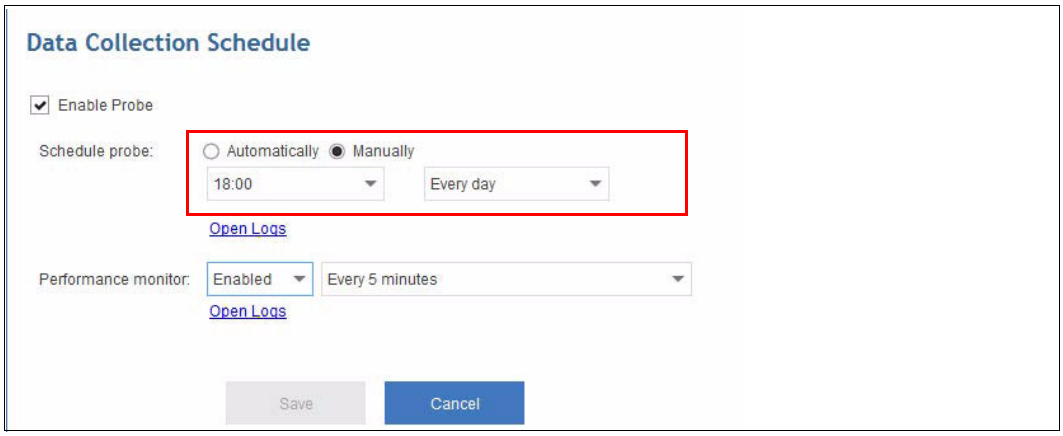

Figure 2-5 Manual probe schedule

6. The default monitoring interval is set to every minute. The default can be changed to a longer interval, as shown in Figure 2-6.

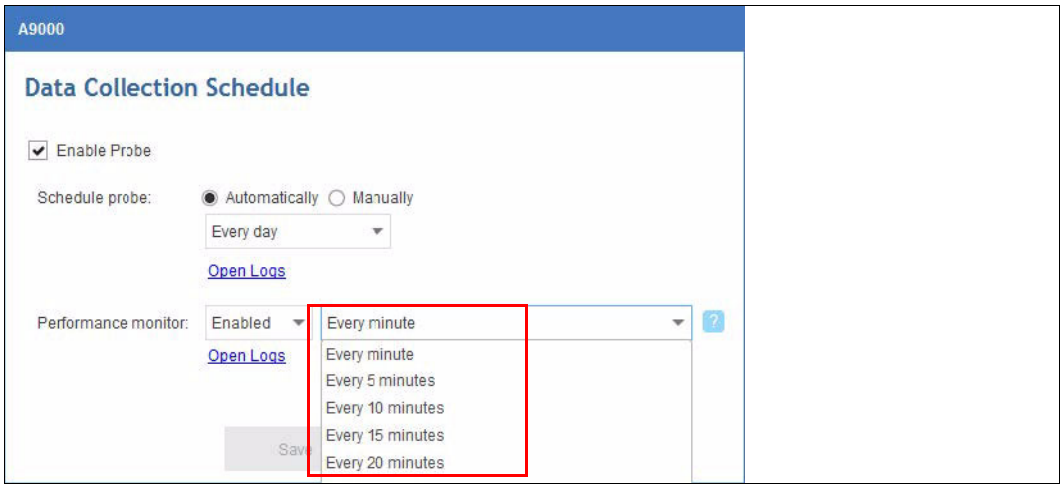

Figure 2-6 Performance monitor interval

One-minute performance data is kept for seven days, but they are also aggregated to five-minute samples, and hourly and daily data. The retention time settings for samples, and hourly and daily data can be configured in the **History Retention** time settings window in IBM Spectrum Control, as shown in Figure 2-7.

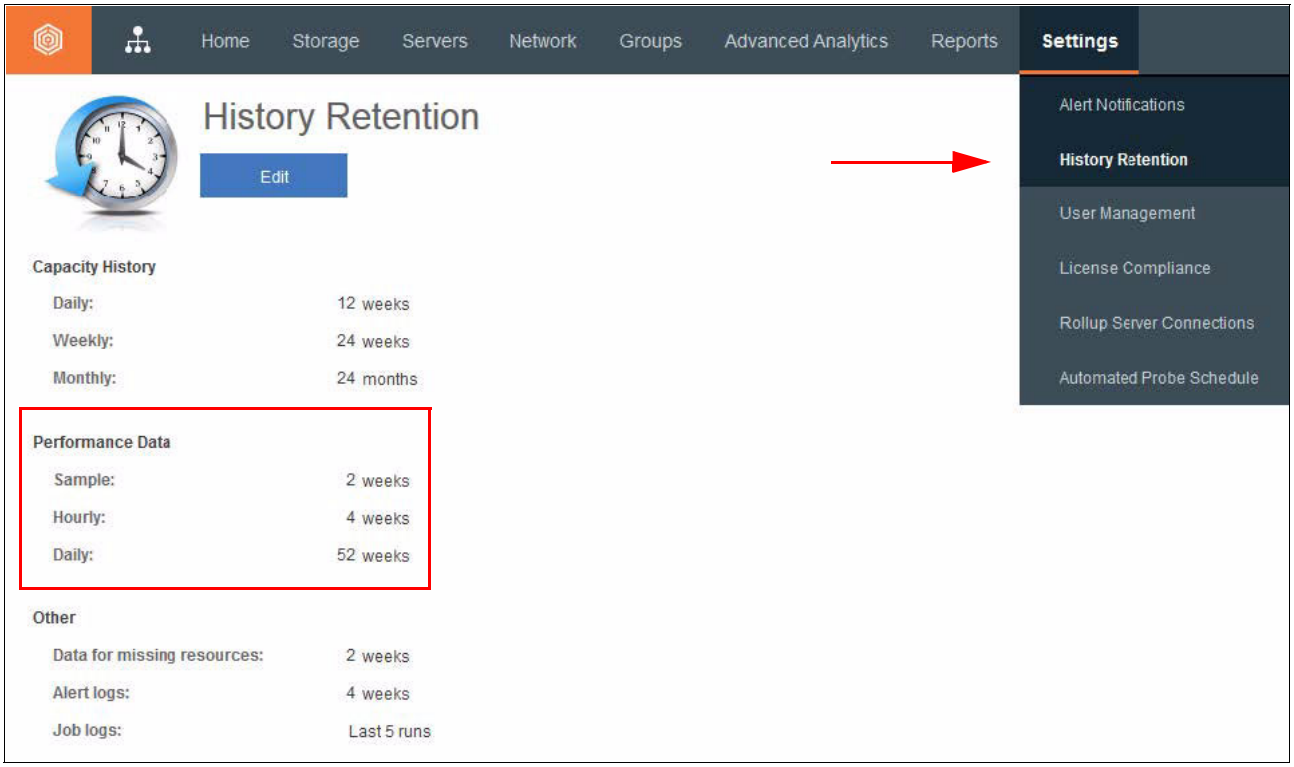

Figure 2-7 History Retention time settings

Because all performance monitoring data, like any other data that IBM Spectrum Control collects are kept in a DB2® database called TPCDB, a compromise between data accuracy, retention time settings, database size, CPU, and memory of the Spectrum Control server is necessary.

When collecting performance data, IBM Spectrum Control collects the device's performance counters after each interval. After two intervals, the delta is calculated and divided by the interval. Therefore, the shorter the interval, the more likely peaks will be visible.

2.1.2 Considerations for Performance Monitoring with IBM Spectrum Control

After performance data is collected, it can be viewed in the IBM Spectrum Control GUI, at different levels, for the complete Storage System and for almost all of its internal resources.

Accessing performance data in IBM Spectrum Control is consistent across all levels. The examples in this chapter are for A9000 volumes, as shown in Figure 2-8.

You can access the performance charts using these methods:

- Selecting the Performance tab (1) opens the performance chart to display the top five volumes with the most total I/O. Depending on the number of volumes in Spectrum Control, this operation can take a few seconds.
- Using sorting and filtering, you can identify and highlight the volumes of interest. Click **View Performance** (2) to open a new window with the performance chart.

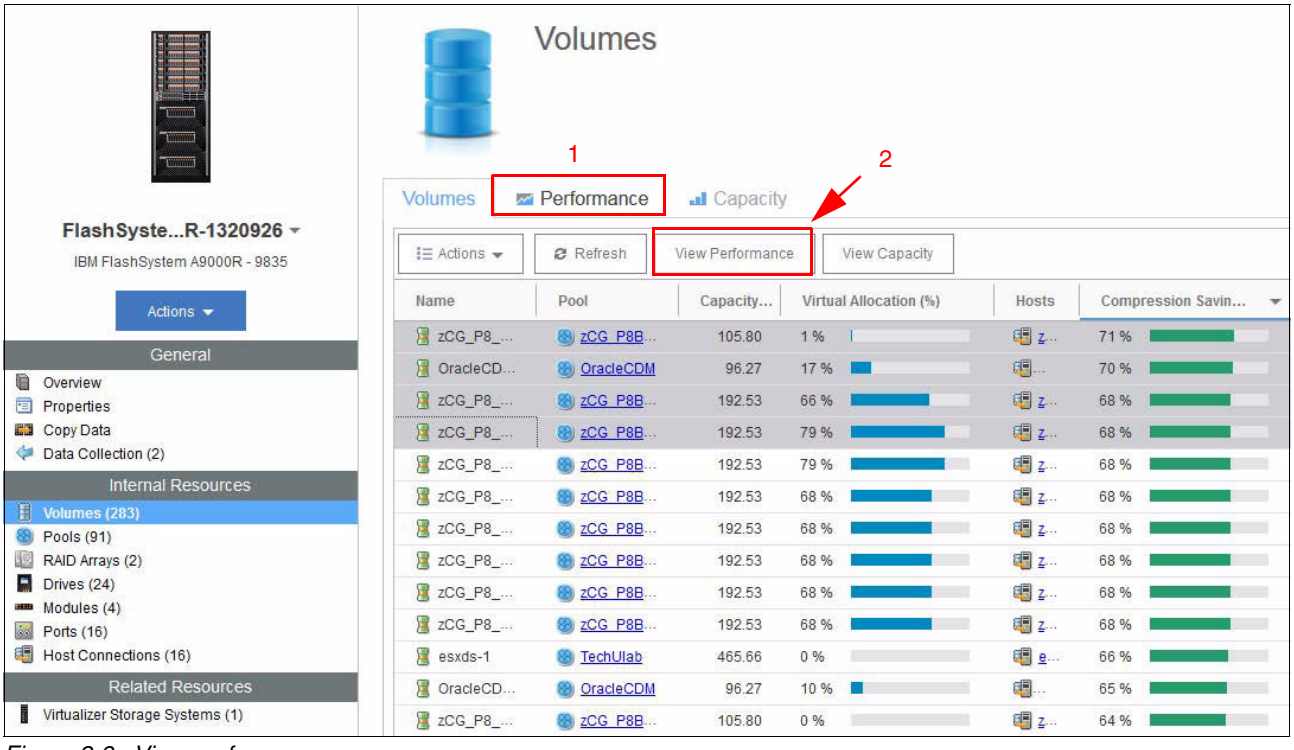

Figure 2-8 View performance.

in Figure 2-9, the performance chart shows the performance graphs for the individual volumes (1) and the selected metrics (2). The time frame can be either relative or absolute. The performance graphs can be opened in a new window (5). The URL of the chart being displayed can be bookmarked for future use. The metrics of the table underneath the chart can be selected by clicking **Edit Table Metrics** (6) and can be sorted (7). The selected and highlighted volumes are then shown in the chart.

Figure 2-9 Performance chart tangerine

The metrics to be displayed can be chosen as shown in Figure 2-10

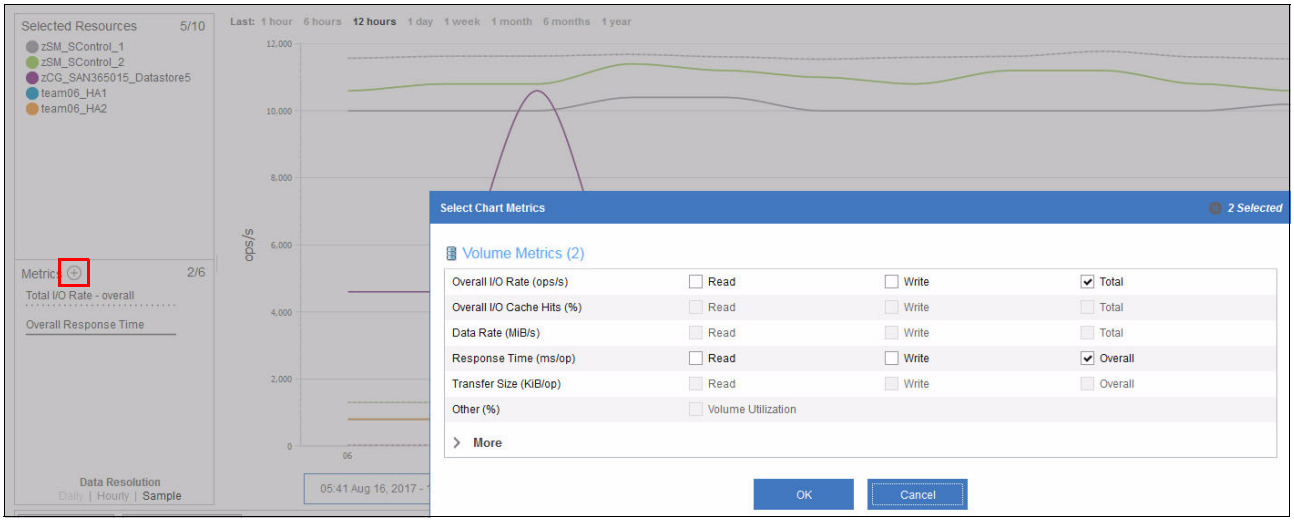

Figure 2-10 Select Performance metrics

Up to 10 different volumes can be selected. Up to six different metrics with two different units can be displayed at the same time because only two y-axis can be displayed.

Although displaying each individual volume and displaying each individual metric can be toggled on and off, it might be confusing having that many graphs in one chart.

Figure 2-11 shows the performance for only one volume, although three were initially selected, because two of them were deselected (1). The same behavior applies to the performance metrics where only two of the six metrics were selected to be displayed (2).

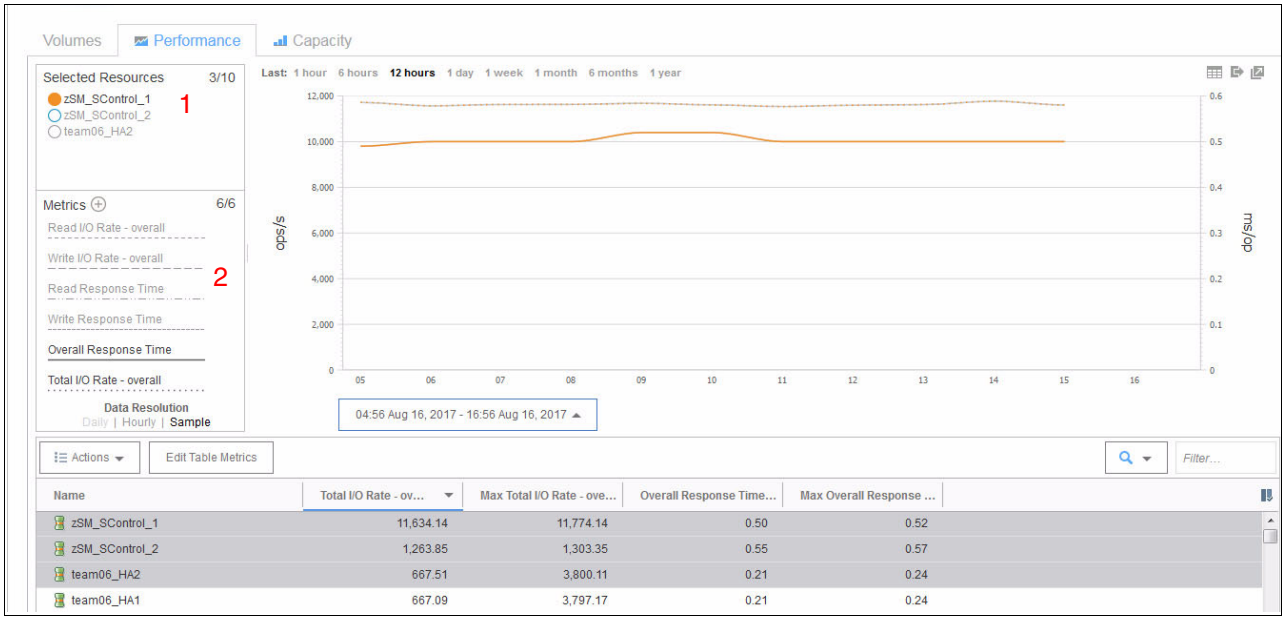

Figure 2-11 Volume performance chart in IBM Spectrum Control

To show more metrics with different units, the performance data can also be displayed as a table by using the toggle chart/table function (1) and then adding additional metrics as columns to the table (2), as shown in Figure 2-12.

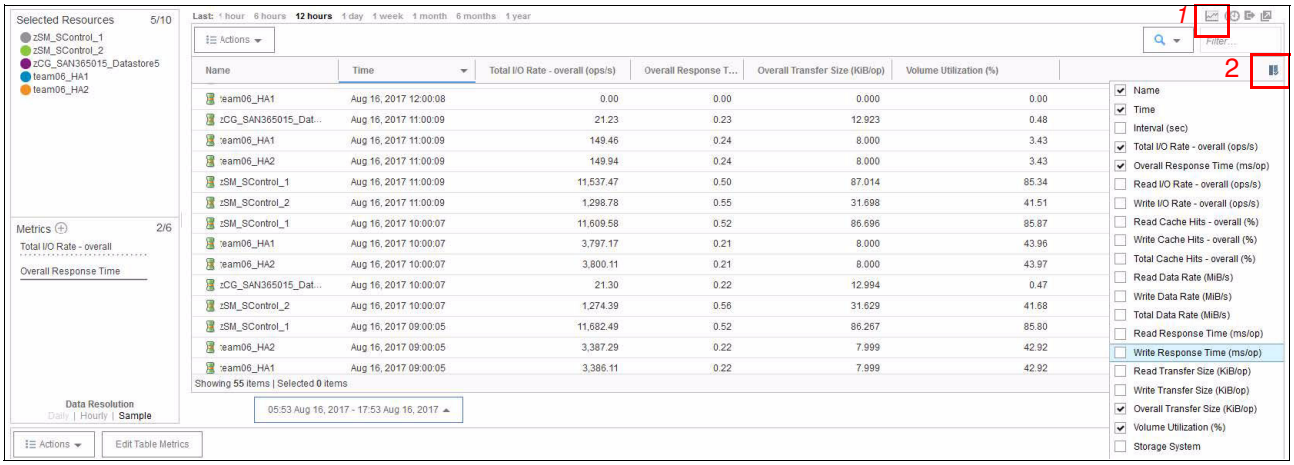

Figure 2-12 Table view of performance chart

Depending on the time frame that is selected (and the history retention time settings), the granularity of the performance chart changes automatically:

- One minute sample data, if collected, is shown for one hour, six hours, 12 hours, or one day range. Otherwise, the five minute sample data is used.
- Five minutes sample data is shown for one week.
- Hourly data is shown for one month.
- Daily data is shown for one year.

When you decrease the granularity, the data accuracy also decreases. For the time range of one day, the one-minute sample data is available, as well as aggregated hourly data. The granularity can be manually adjusted. Although the averages of Total I/O and Response Time are almost the same, the maximum values differ a lot, which can be seen in the table underneath the graphs but can already be assumed when looking at the graphs.

Comparison of sample versus hourly data can be seen in Figure 2-13 and in Figure 2-14.

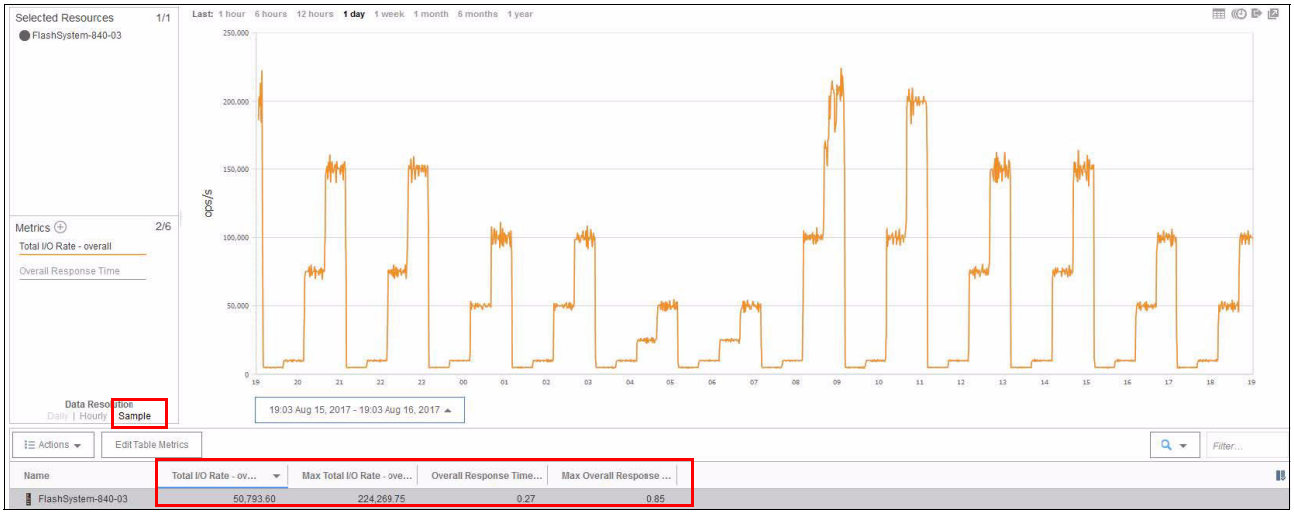

Figure 2-13 Sample data

Figure 2-14 shows the hourly data for the same period.

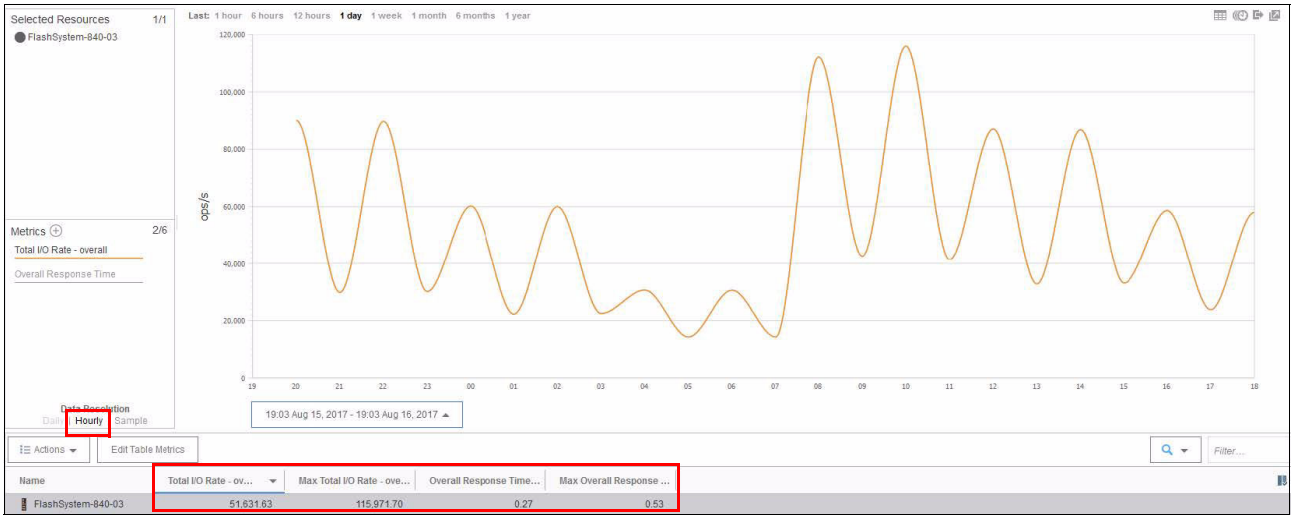

Figure 2-14 Hourly data

For troubleshooting purposes, the displayed time frame should be small enough so that the smallest interval data can be shown.

Figure 2-15 illustrates the drill up and drill down capability available in IBM Spectrum Control.

Because in this example the V9000 write response time shows a peak at a certain time, this functionality can be used to show for the same time frame the V9000's pools or V9000's volume write response time to determine the root cause of those peaks.

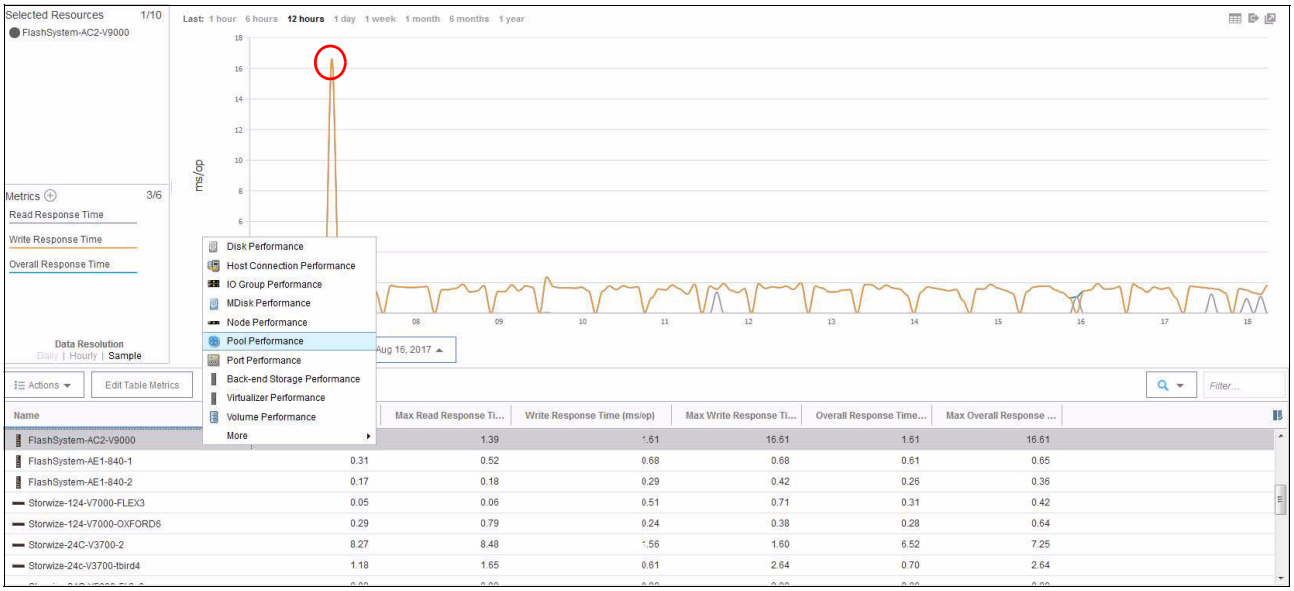

Figure 2-15 Drill up and drill down functionality

The new performance charts open in separate windows and can be arranged for comparison purposes.

The date and time settings of multiple windows can be synchronized by using the **Synchronize Time** feature, as shown in Figure 2-16.

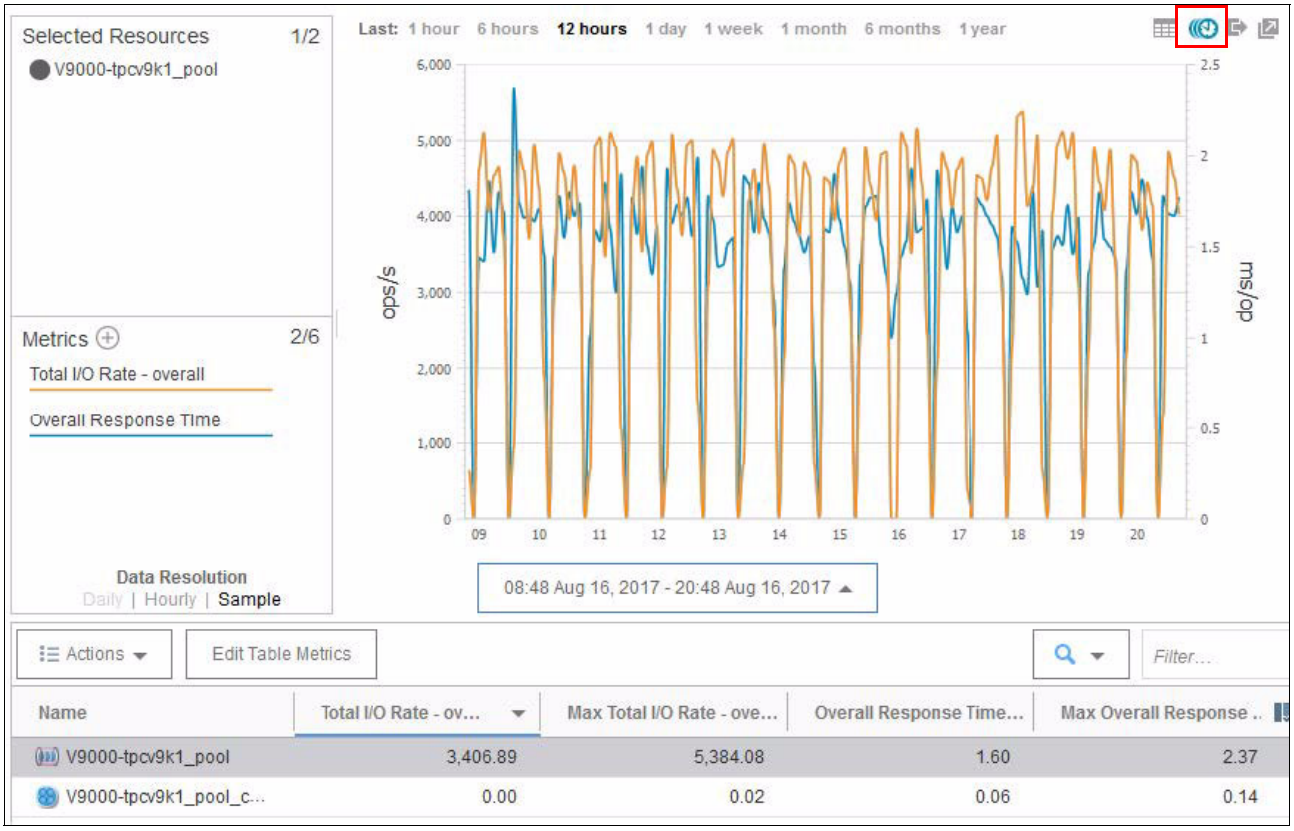

Figure 2-16 Synchronize time

2.1.3 Special considerations for FlashSystem devices

At the time of writing, IBM Spectrum Control version (v 5.2.15) is limited to showing Fibre Channel ports only. If the FlashSystem device is equipped with InfiniBand, iSCSI, or FCoE ports, these ports will not be displayed in IBM Spectrum Control. In this case, no port performance data will be collected.

Performance metrics that are only available in the native FlashSystem GUI can be accessed easily in IBM Spectrum Control by clicking **Actions** → **Open Storage System GUI**, as shown in Figure 2-17 on page 16.

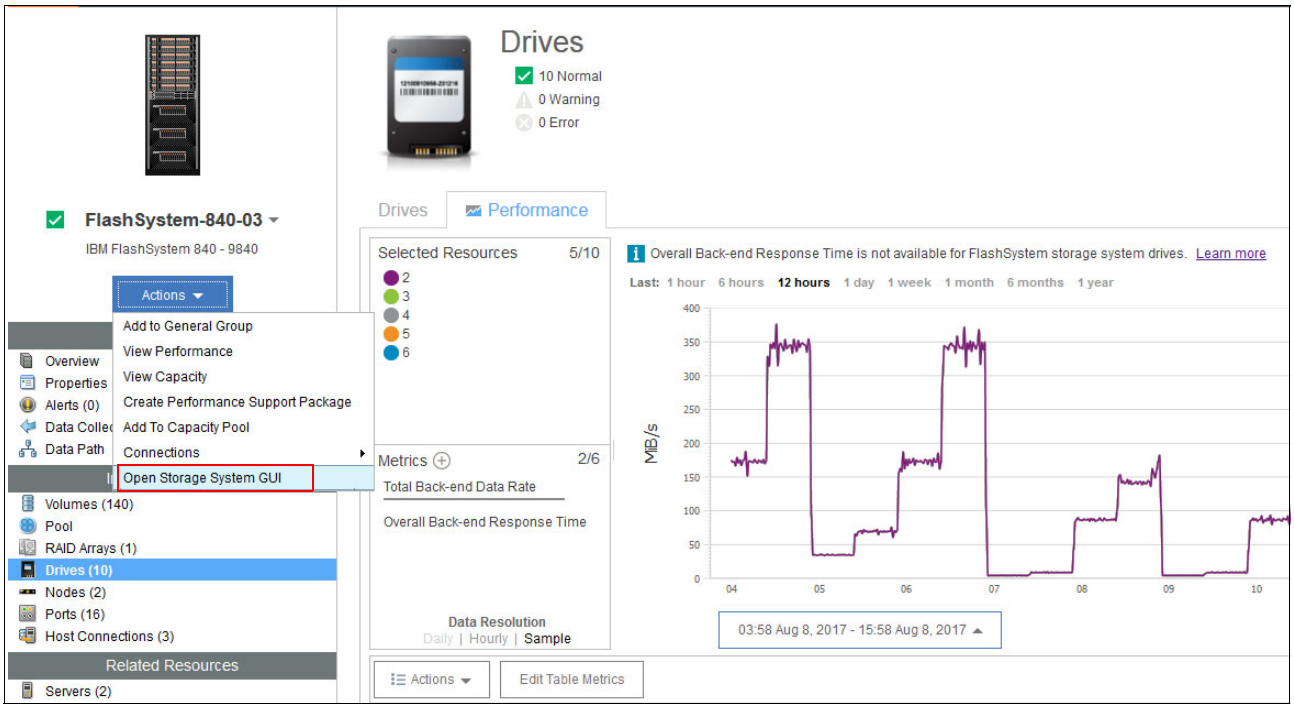

Figure 2-17 Open Storage System GUI functionality in IBM Spectrum Control

Some FlashSystem devices like the V9000 also offer a direct link to the system's performance graphs by clicking **Action** → **View Real-Time Performance**, as shown in Figure 2-18. This function can also be used to view real-time performance values if the one-minute interval data that can be shown in IBM Spectrum Control is not detailed enough.

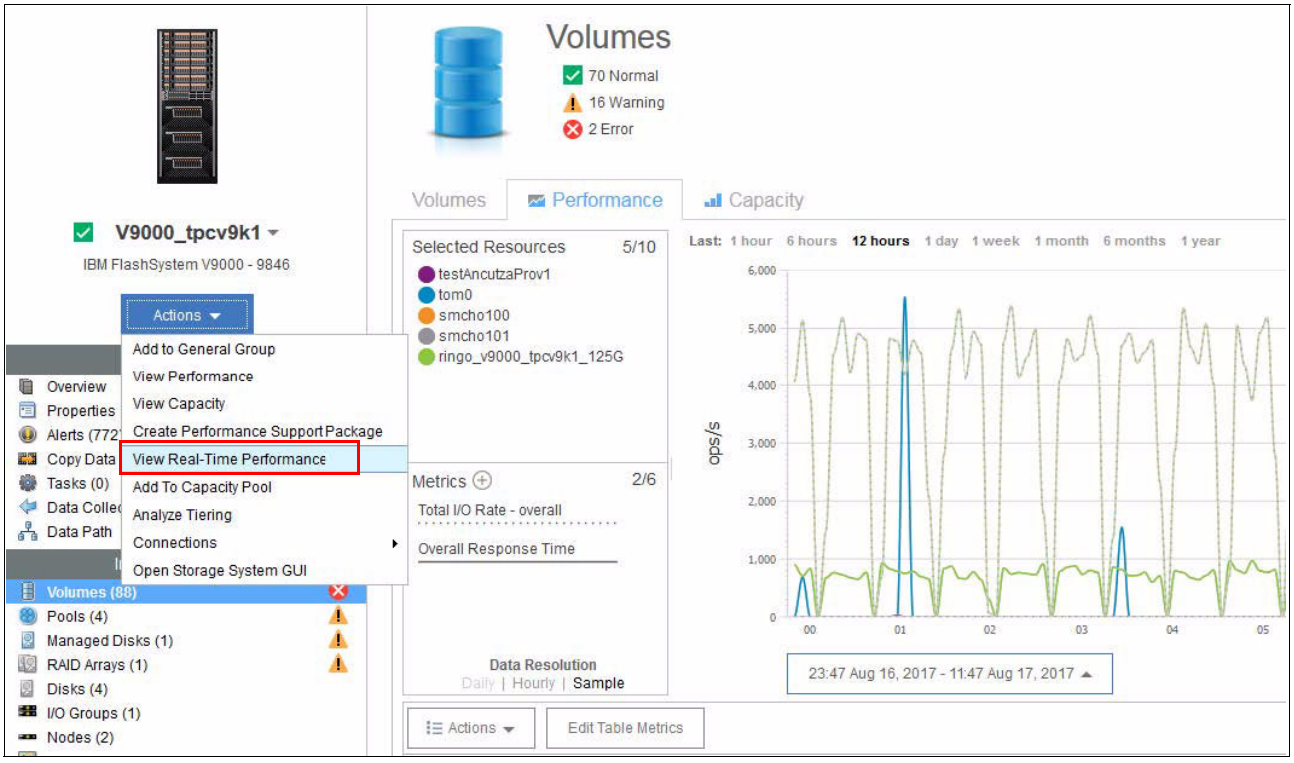

Figure 2-18 View real-time performance

2.2 Monitoring performance for FlashSystem 840/ FlashSystem 900

This section discusses performance monitoring for FlashSystem 840 and FlashSystem 900, first using the system Storage Management native tools and then using Spectrum Control.

2.2.1 Monitoring FlashSystem 840 an FlashSystem 900 using native tools

You can monitor the performance by using the system native tools available from the FlashSystem built-in Storage Management GUI. This GUI is web-based and can be used with any browser pointed at the management IP address of the FlashSystem 840 or 900 to be monitored. Note that Java Script and cookies must be enabled in your browser.

Log in to the GUI

To log in and open the Monitoring Performance window, complete these steps:

1. Enter your login credentials in the login window, as shown in Figure 2-19. Because the performance monitor is just a monitoring tool, any user role can be used here, and specifically, the monitor role.

Figure 2-19 Log-in window for a Flash 840

2. After a successful login, you can open the Monitoring function by clicking the **Monitoring** icon, and then selecting **Performance**, as shown in Figure 2-20.

Figure 2-20 Opening the Monitoring Performance window

Performance Monitor

Figure 2-21 shows the Performance Monitor window. Labels were added to indicate specific areas of interest.

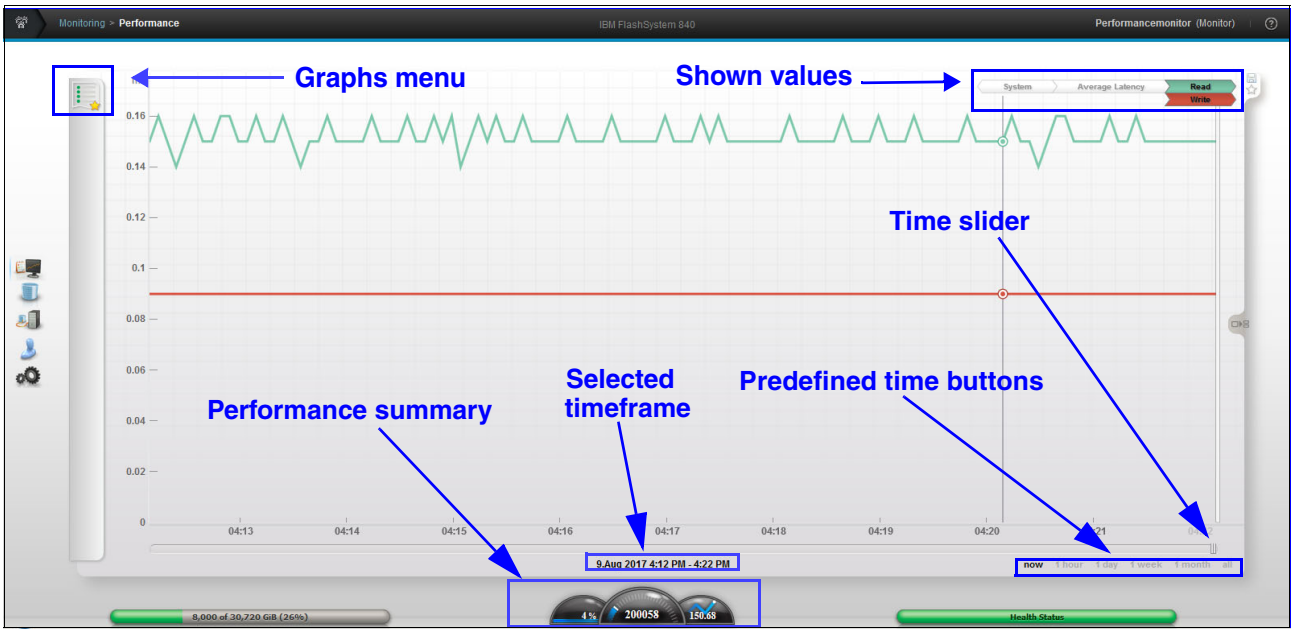

Figure 2-21 Performance Monitor Entry window

By default, the display shows the average latency for read and write operations at a system level. The x-axis shows the time frame (default is 10 minutes) and the y-axis shows selected value, such as latency in this example.

The time frame can be changed by clicking the **Time** buttons:

- now
- 1 hour
- 1 day
- 1 week
- all

The “all” selection includes all the collected data, for up to 300 days.

At the bottom of the diagram, a slider can be used to display the targeted time frame for further analysis of this period. This slider has two parts:

- One part to set the starting point
- One part to set the endpoint to focus on a shorter time frame or one in the past.

The selected start and end time or date are also shown under the x-axis.

Graphs menu

The **Graphs** menu is accessed from the upper left of the Performance Monitoring window. The following different types of graph can be selected:

- System I/O
- System Latency
- System Bandwidth
- Interface Port Total IOPS
- Interface Port Total Queue Depth

Figure 2-22 shows the **Graphs** menu with five predefined graphs. Other graphs can be created as described in “Customize chart tab” on page 20. The different graphs can be chosen based on specific needs. This figure shows the menu for Fibre Channel ports. If there are other ports installed in the storage system, such as iSCSI or InfiniBand, then they are shown as well.

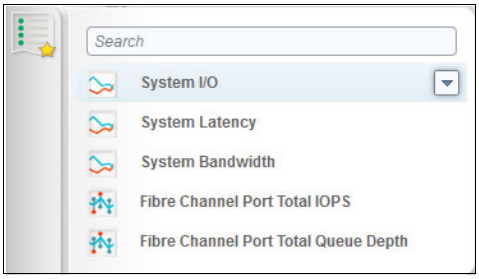

Figure 2-22 Graphs menu

The content and meaning of the selectable graphs is as follows:

- System I/O

  The System I/O graph displays the average number of read, write, and total I/O operations per second (IOPS) over the sample period. Each request type (read, write, and total) is represented by a different color line.

- System Latency

  The System Latency graph displays the average amount of time in milliseconds (ms) that each read and write I/O request takes over the specified sampling period. Each request type (read and write) is represented by a different color line. The user can see the average or the maximum latency, but not both at the same time.

- System Bandwidth

  The System Bandwidth graph displays the average number of megabytes per second (MBps) of read, write, total, and rebuild bandwidth over the sample period. Each bandwidth type (read, write, total, and rebuild) is represented by a different color line. There is one line graph for each system that is selected.

- Average Port IOPS

  The Average Port IOPS graph displays the average number of read, write, and total IOPS for all ports on all adapters over the sample period.

- Average Port Queue Depth

  The Average Port Queue Depth graph displays the average number of operations of that type for all ports on all adapters over the sample period.

Customize chart tab

The default graphs can be edited and customized. Click below the graphs menu icon on the left side to select the Resources. Figure 2-23 shows some options to customize the graphs at a system level.

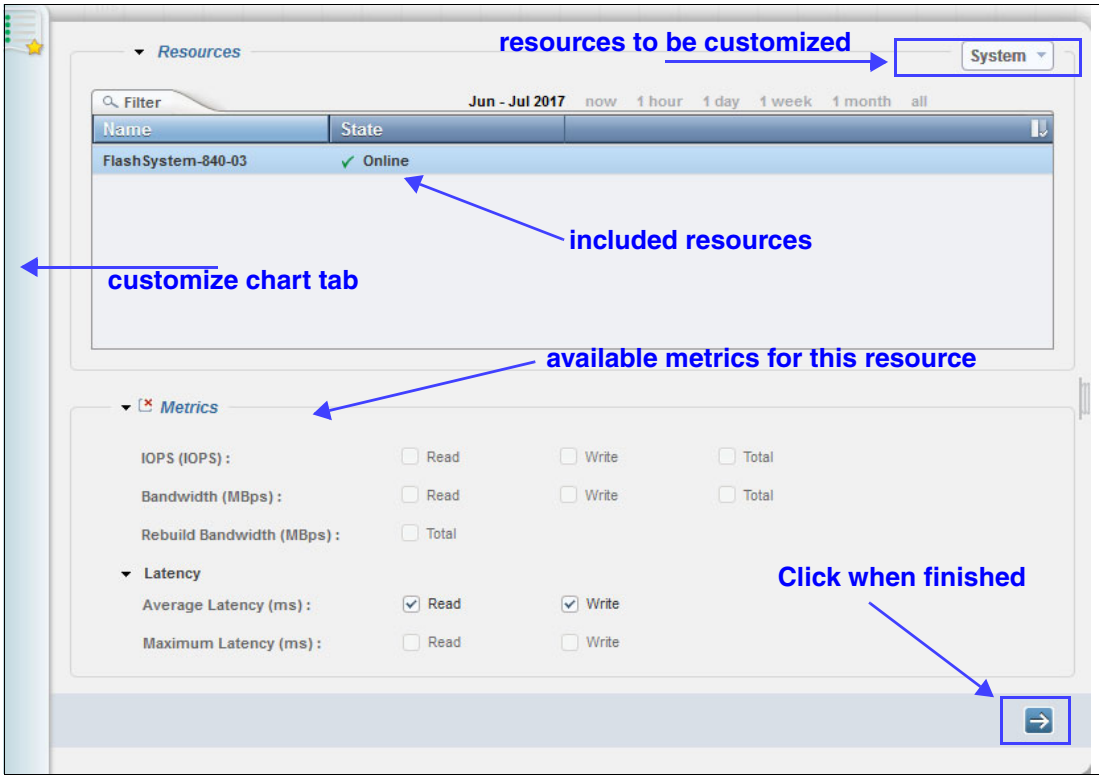

Figure 2-23 Customize graphs

The resources to be customized can be selected in the upper right corner of this menu. The following available resources are available for customization:

- System
- Flash Modules
- Interface ports

Based on the selected level, different set of resources can be selected. At the system level, configured systems can be selected. In our example, there is only one system. At the Flash module level, up to six modules can be selected. At the interface port level, up to six ports can be selected. If more than six are chosen, they are summarized as a single resource with a single line in the chart.

If the selected resource is an interface, the representation is particular: For each port, a corresponding line is shown, but the color is based on the adapter. So if three ports are selected, one from adapter 1 and two from adapter 2, three lines are shown in the graph (one for each adapter and port), but only two colors are shown (one color per adapter). This system can be confusing at first.

Figure 2-24 shows this situation in detail. In the upper right corner is the caption that lists only Host Adapter 1 Canister 1 and Host Adapter 2 Canister, each with its own color. Because three ports are selected in the customized chart, they are all shown in the chart. As visible in the detail box, there are three lines shown with the color based on the HBA.

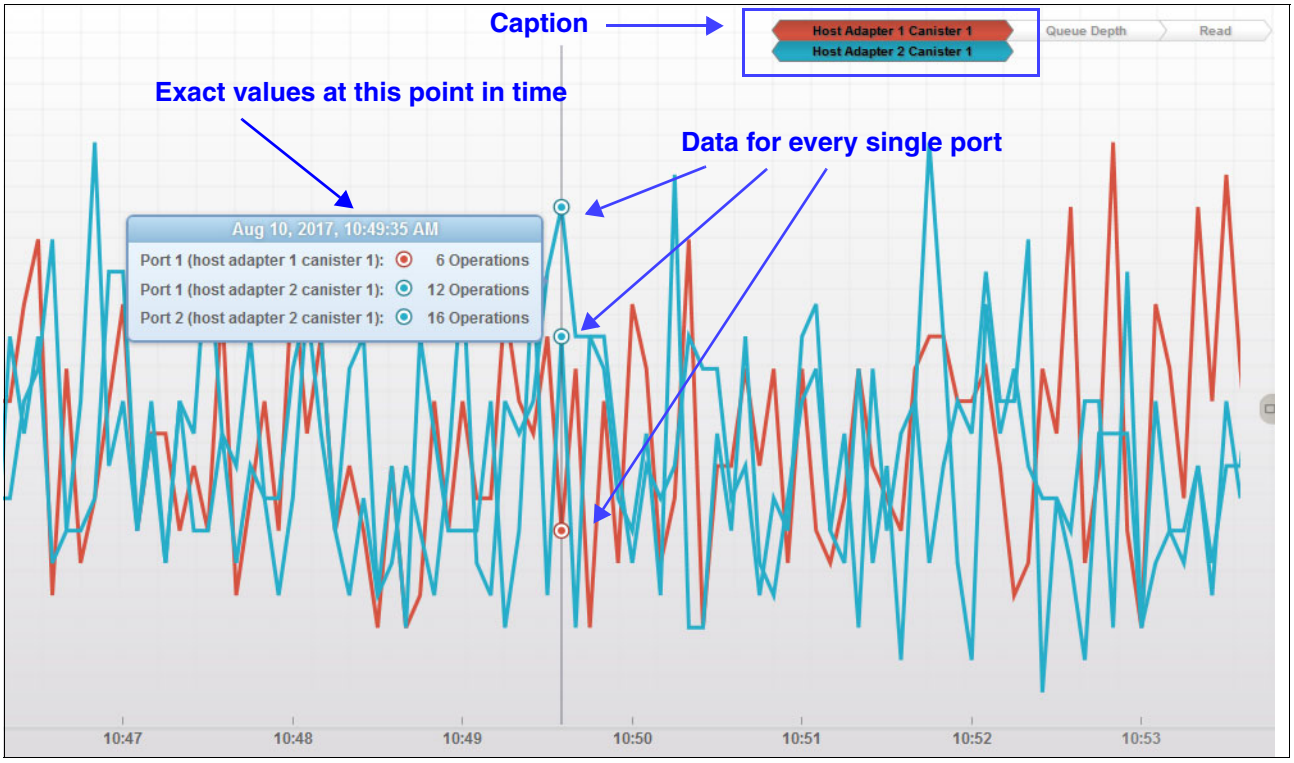

Figure 2-24 Chart for Fibre Channel ports

By clicking the graph at a particular point in time, all values for the existing lines are shown in a single box. By using this function, exact values can be made visible.

The metrics shown in the chart depend on the selected resource. Not all metrics can be shown at the same time. Only compatible metrics can be shown within the same chart. See also Figure 2-42 on page 34. There is no option for a second y-axis.

For a complete table of the available metrics, see Table 2-1 on page 32 for the native or built-in area. For a detailed description of every metric, select **Help Contents**, as shown in Figure 2-25.

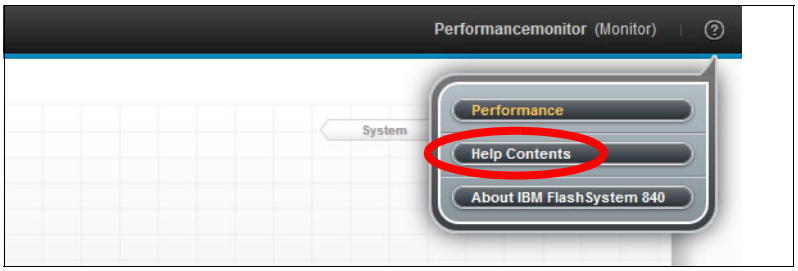

Figure 2-25 Performance Help

Equipped with all this information, users can now build their own customized graphs to monitor different metrics. If you want to compare different metrics that cannot be shown in a single chart, you can easily add a second chart to the view. For instance, if you want to compare IOPS with latencies, bring them into the same view by clicking the symbol shown in Figure 2-26.

Figure 2-26 Adding a second chart

In the customized chart, the resources and metrics can be selected. An illustration is shown in Figure 2-27.

Figure 2-27 View with two charts

Both graphs have the same scale in the x-axis because they are by default linked. To view different time frames or have a different scale on the x-axis, the charts can be unlinked by clicking the small symbol in the middle on the right side, as shown in Figure 2-28. You can click the same symbol link the charts again.

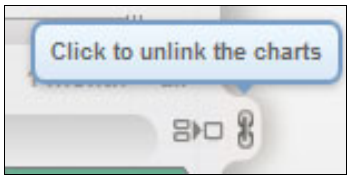

Figure 2-28 Unlink charts

You can create a bookmark to customized charts that are important or used often. This bookmark adds those charts to the Favorites in the **Charts** menu. A chart that is often used or shared by a team, it can be added to the predefined charts for easy access and sharing. To add a chart to the **Charts** menu, create your chart and then click the small yellow star on the right side of the chart. You also must give it a name. When a user adds a chart as a favorite, as shown in Figure 2-29, it becomes available to every other user.

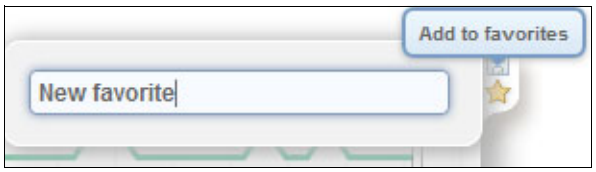

Figure 2-29 Adding and naming the chart

The new favorite chart becomes accessible by using the **Charts** menu. Here the favorite chart can easily be selected, renamed, and deleted by selecting the appropriate action from the pull-down menu, as shown in Figure 2-30.

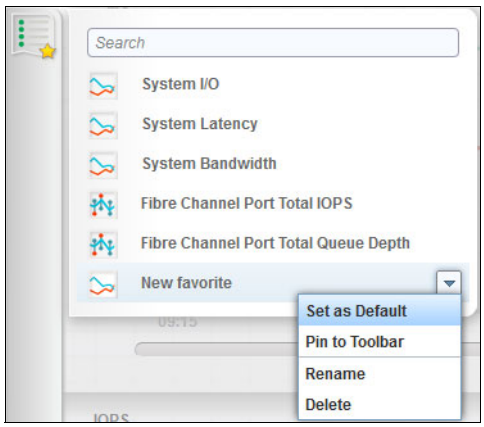

Figure 2-30 Chart menu with a new favorite

From the same menu, you can also set your favorite chart (or any predefined chart) as the default chart or pin it to the toolbar. When added to the toolbar, the chart can be opened with a single click from the toolbar. Figure 2-31 shows how the icons are placed.

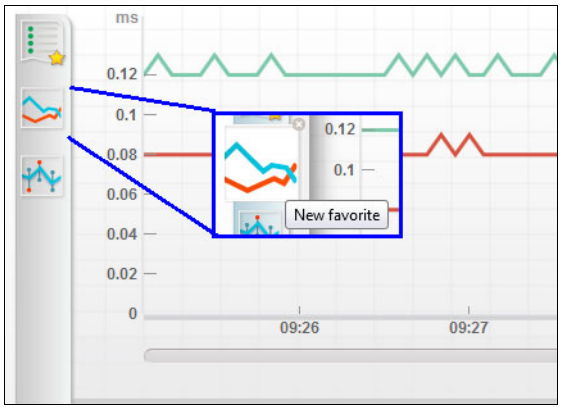

Figure 2-31 Icon placement

When the mouse cursor is placed over the icon, it is magnified and the name of that chart is shown.

Finally, to download and export the values from the chart, click the **Disk** icon near the **Favorites** icon. As a result, a comma-separated values (csv) file is created with all the metrics included in the chart for the complete time frame.

A tool is available on IBM Techdocs that offers an extra way to obtain performance data in an csv file format that includes more metrics. It is called the *IBM Flash System Performance Statistics Data Capture and Extraction Procedure*.

With this procedure, all the data that is collected by the GUI can be downloaded and formatted as a csv file. The file can be used for further analysis in performance studies or in a proof of concept scenario. Just download the files and follow the documentation.

2.2.2 Monitoring FlashSystem 840 / 900 with IBM Spectrum Control

To monitor performance for the s FlashSystem 840 or FlashSystem 900 with IBM Spectrum Control, enable the SNMP agent on the FlashSystem device to allow Spectrum Control to collect performance statistics. The SNMP agent on the FlashSystem device is disabled by default.

Note: FlashSystem 840 and FlashSystem 900 only support SNMP v1, which does not have encryption capability.

SNMP service on the FlashSystem 840/900 can be easily turned on from the Management GUI, as illustrated in Figure 2-32.

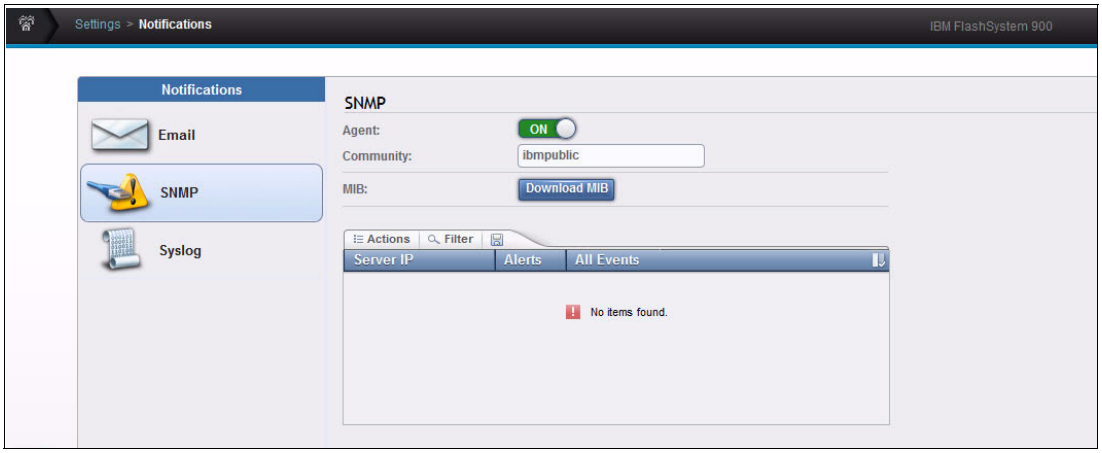

Figure 2-32 FlashSystem 900 Web UI

Alternatively, you can enable SNMP from the FlashSystem CLI as shown in Example 2-1.

Example 2-1 Enabling SNMP from CLI

```
IBM_FlashSystem:FlashSystem-840-03:superuser>lssnmpagent
enabled no
community ibmpublic
IBM_FlashSystem:FlashSystem-840-03:superuser>chsnmpagent -enable yes
IBM_FlashSystem:FlashSystem-840-03:superuser>lssnmpagent
enabled yes
community ibmpublic
IBM_FlashSystem:FlashSystem-840-03:superuser>
```

If you try to schedule performance monitoring without having the SNMP agent enabled on FlashSystem 840 or FlashSystem 900, you are prompted to enable it. Figure 2-33 shows the Data Collection Schedule window.

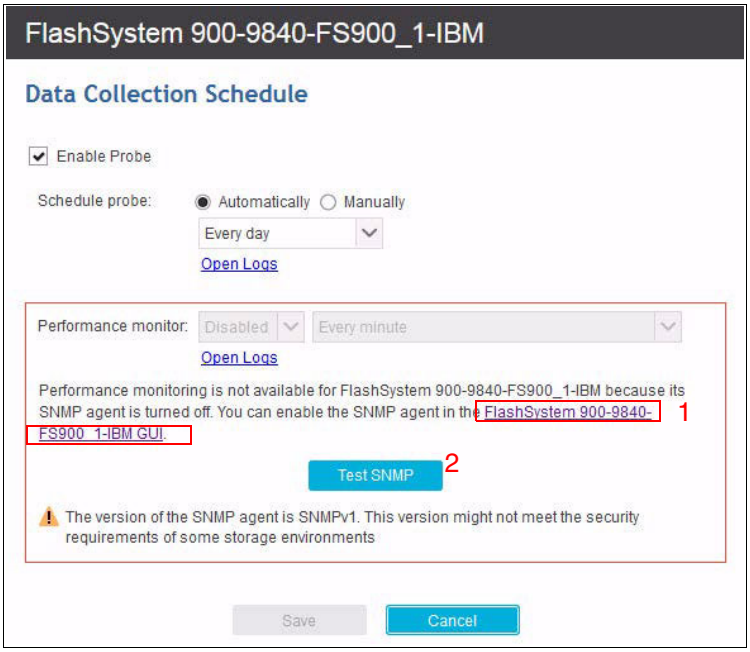

Figure 2-33 Data Collection Schedule window

The SNMP community is automatically detected during the probe. If it is necessary to change the community, then the FlashSystem 840 or FlashSystem 900 might need to first be probed again to continue with the performance data collection.

Important: If your device is behind a firewall, port 161 must be open to get performance data. For more information about ports that need to be open, see the IBM Spectrum Control section of IBM Knowledge Center.

You can use the Hyperlink (1) to open the FlashSystem GUI to enable SNMP as shown in Figure 2-33.

Clicking **Test SNMP** (2) checks whether SNMP is turned on by using the read community to get a confirmation.

Either method opens the default Data Collection window, as shown in Figure 2-34.

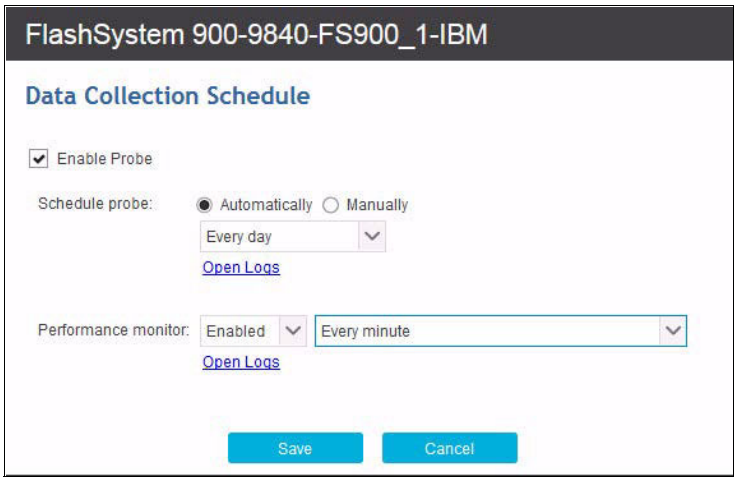

Figure 2-34 Data Collection Schedule

Performance Monitoring for the FlashSystem can now be scheduled.

Because no individual volume performance data is available yet, the Overview window (Figure 2-35 on page 28) shows the following charts:

- Overall System Activity
  - I/ORate (Read/Write/Total)
  - Data Rate (Fed/Write/Total)
  - Response Time (Read/Write/Total) [1]
- Most Active Nodes
  - I/O Rate (Total - per node)
  - Data Rate (Total - per node)
- Drive Activity
  - Back-end Data Rate (Total - per drive)
  - Flash Health Percentage (per drive)
- Most Active Ports
  - Bandwidth (Overall - per Port)

[1] If FlashSystem 840/FlashSystem 900 Firmware version is 1.4.5 or later.

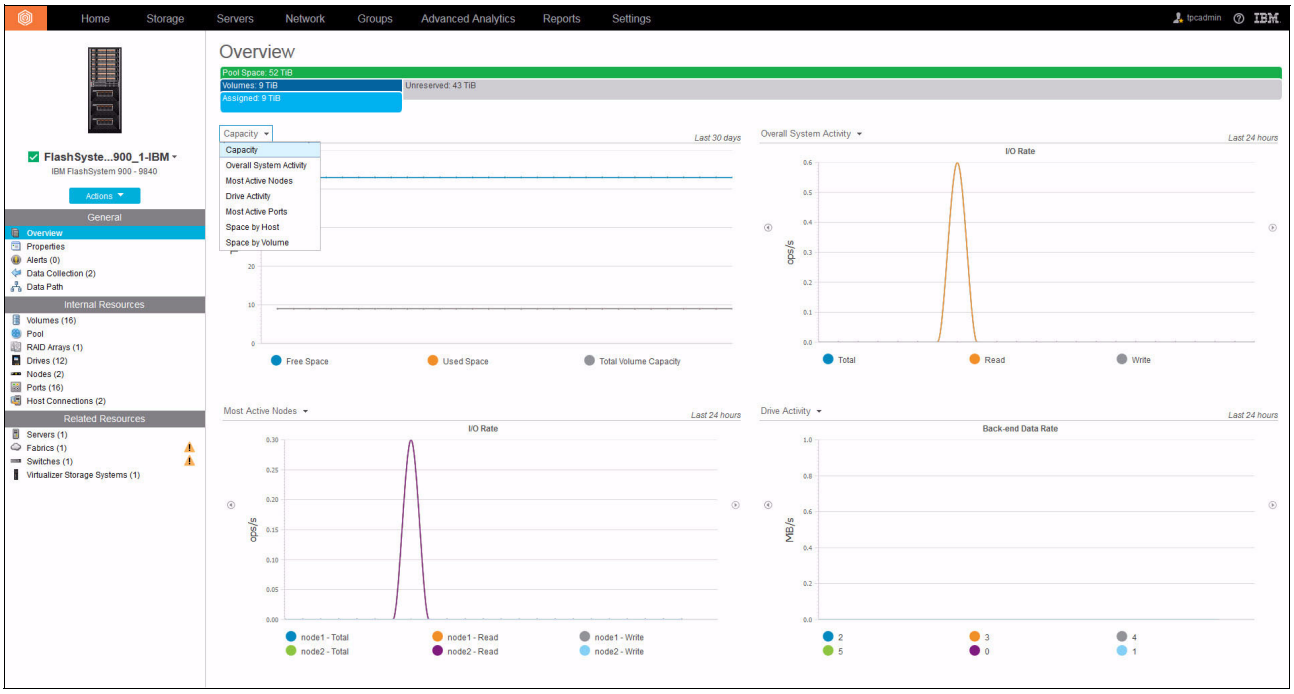

Figure 2-35 FlashSystem 840 / FlashSystem 900 Overview window

Reporting options are described in 2.5, “IBM Spectrum Control reporting options” on page 55.

2.2.3 Performance metrics for IBM FlashSystem 840 / 900

To get performance metrics, the FlashSystem 840 or FlashSystem 900 needs to be at firmware version 1.4.4. or later. To get response time values, the firmware version needs to be 1.4.5 or later.

The FlashSystem 840 or FlashSystem 900 does not provide any performance statistics for volumes. Therefore, there is also no performance data for pools and RAID arrays.

Available performance statistics are primarily for ports. Node and overall FlashSystem 840 or FlashSystem 900 performance statistics are calculated or aggregated from port performance data.

For FlashSystem 840 or FlashSystem 900 that have no Fibre Channel adapters, performance data is only available for the drives.

For the FlashSystem 840 and FlashSystem 900, the Performance tab (1)/ the **View Performance** Button (2) and the **View Performance** action (3) are enabled for ports, drives, nodes and for the overall FlashSystem 840 or FlashSystem 900 system performance. Figure 2-36 shows how to select port performance for FlashSystem 840 / 900.

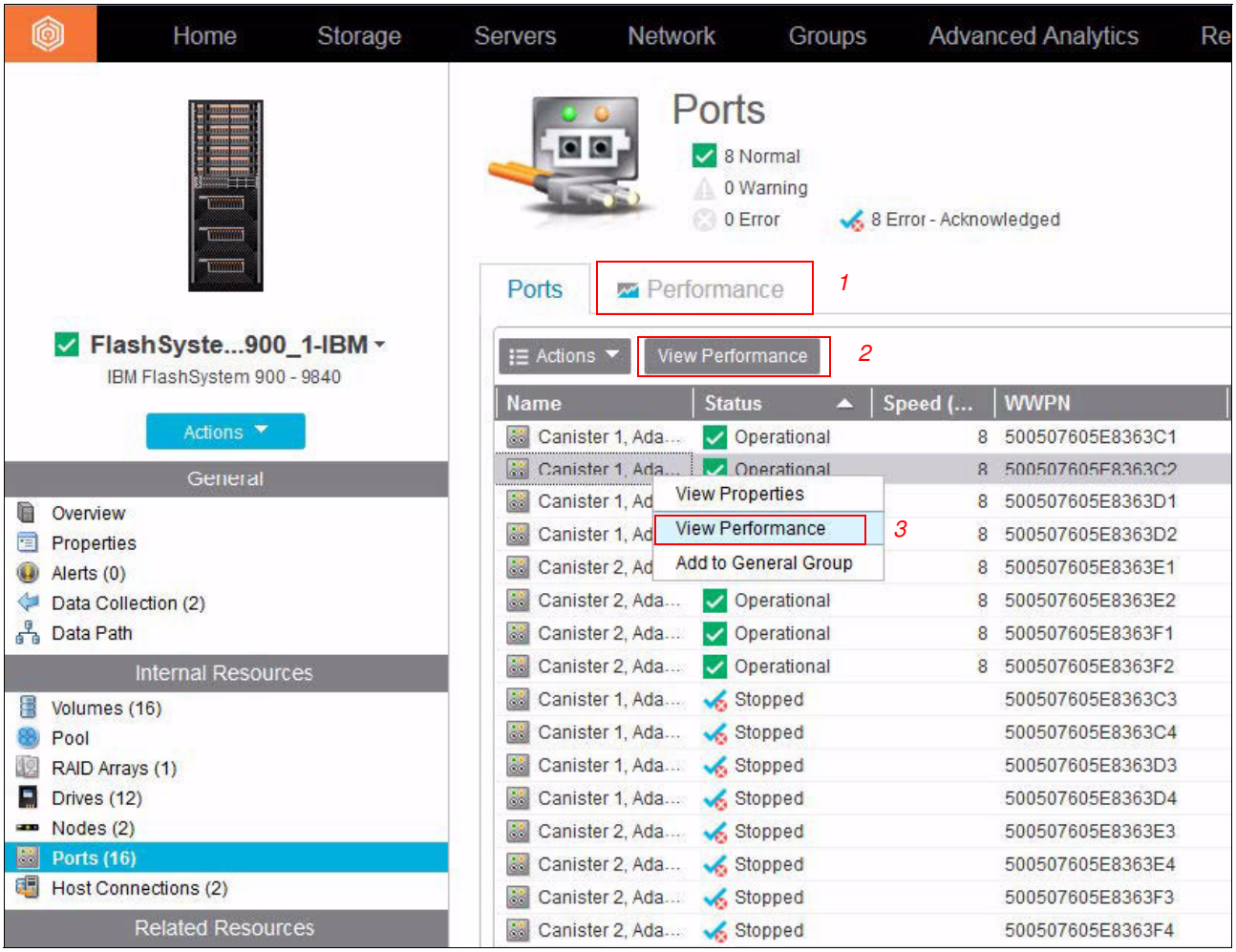

Figure 2-36 Selecting Port Performance for FlashSystem 840 / FlashSystem 900

Available Port Performance metrics

Figure 2-37 shows the selection window for Available Port Performance metrics for FlashSystem 840 and FlashSystem 900.

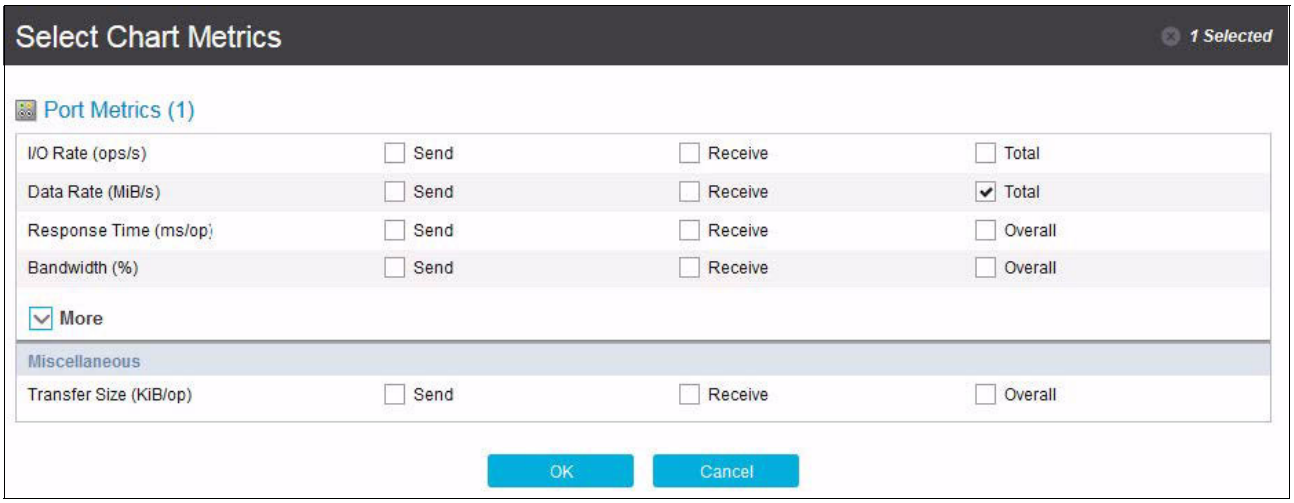

Figure 2-37 Port performance metrics for FlashSystem 840/FlashSystem 900

Available Flash module performance metrics

For the Flash modules, which are shown as drives in IBM Spectrum Control, a metric called *Flash Health Percentage* is available. That percentage decreases when your flash modules suffer degradation. The Flash Health Percentage is calculated based on the number of unusable blocks in the flash module.

Because access to the drives is not I/O based but more like a type of Direct Memory Access, no Back-end I/O Rate metrics are available for the flash modules. Only Data Rates can be reported.

IBM Spectrum Control supports a range of different storage systems that use different flash devices embedded in different kind of modules, such as MicroLatency modules. The generic term *disks* is used instead of *MicroLatency modules*.

Figure 2-38 shows the available Performance Metrics for the FlashSystem 840 / 900 Flash modules.

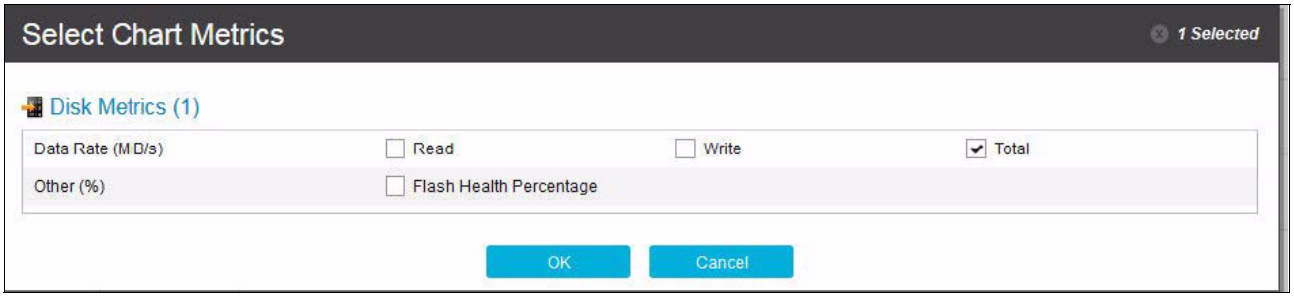

Figure 2-38 Flash Module Performance metrics for FlashSystem 840 / FlashSystem 900

Although the performance chart implies that the FlashSystem 840/FlashSystem 900 can report back-end response time for drives, this metric is not available.

Available Node Performance metrics

The Nodes's Volume metrics are calculated from the Port metrics and show the same values as the Port metrics except the Transfer Size, which is not available in the Volume Metrics tab.

Figure 2-39 shows the selection window for Available Node Performance Metrics for the FlashSystem 840/FlashSystem 900.

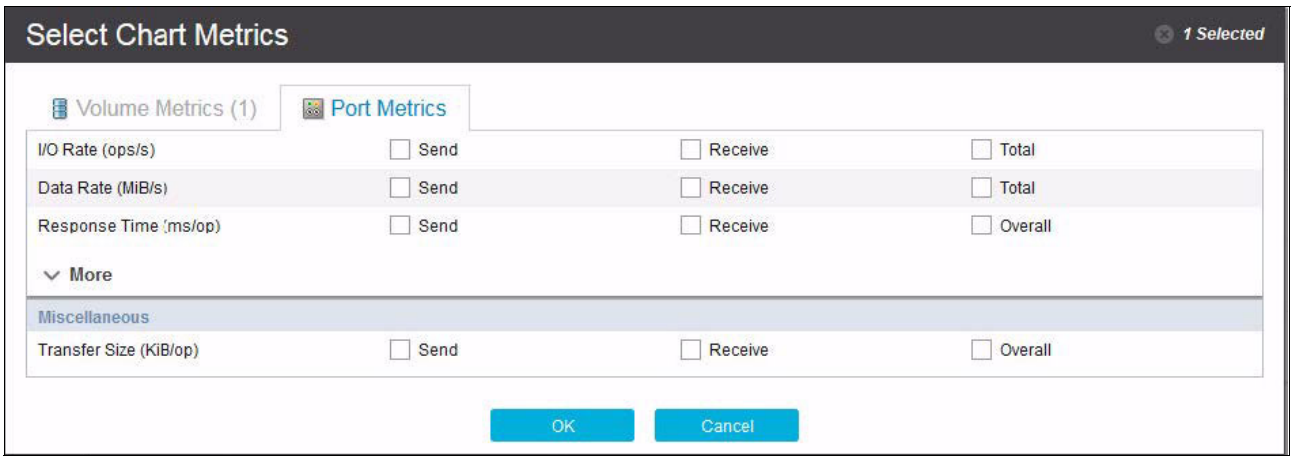

Figure 2-39 Node Performance Metrics for the FlashSystem 840/FlashSystem 900

Although the performance chart implies that the FlashSystem 840/FlashSystem 900 can report on Node's System CPU Utilization, this metric is not available.

Available overall FlashSystem 840 / 900 System Performance Metrics

Figure 2-40 shows the selection window for the overall FlashSystem 840/FlashSystem 900 Port Performance metrics.

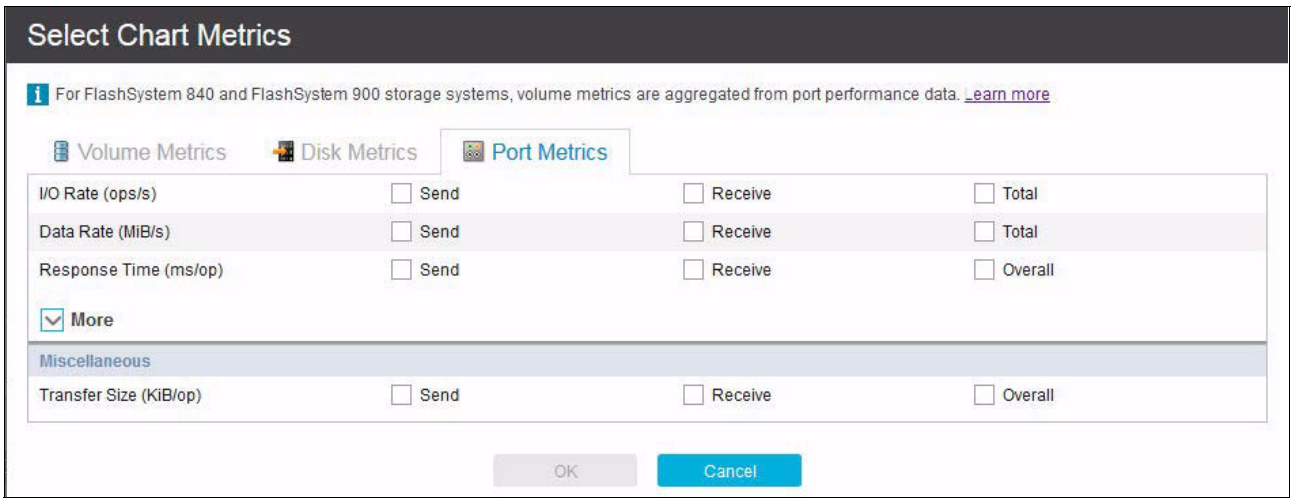

Figure 2-40 Overall FlashSystem 840 / FlashSystem 900 Port Performance metrics

Figure 2-41 shows the window for Overall FlashSystem 840/FlashSystem 900 Disk Performance metrics.

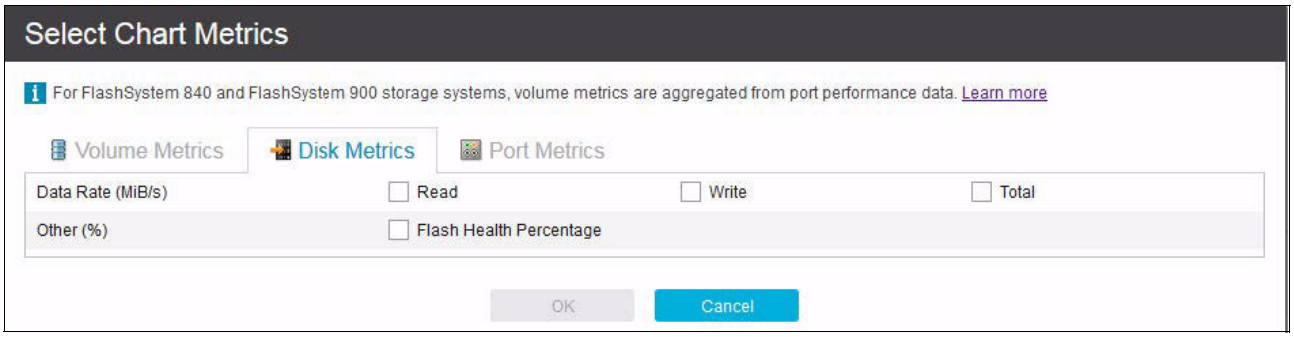

Figure 2-41 Overall FlashSystem 840 / FlashSystem 900 Disk Performance metrics

The Volume's Metrics tab shows the sum of the measured performance of all the ports in the storage system, and therefore shows the same values as the Port Metrics tab, except for the Transfer Size metrics.

2.2.4 Comparing native GUI and Spectrum Control

Table 2-1 shows an overview of available Performance Metrics and where they can be displayed, in the FlashSystem 840 / FlashSystem 900 GUI or in Spectrum Control.

Table 2-1 FlashSystem 840/900 Performance Metrics

Level	Metric	Native	with IBM Spectrum Control
Storage System	IO in ops/s: Read/Write/Total	X	X
Storage System	Bandwidth/Data Rate in MiB/s: Read/Write/Total	X	X
Storage System	Total Rebuild Bandwidth in MiB/s	X	
Storage System	Latency/Response Time in ms/op: Read/Write	X	X
Storage System	Overall Latency/Response Time in ms/op		X
Storage System	Max Latency/Response Time in ms/op: Read/Write	X	
Flash Module / Drives	Flash Health %	X	X
Flash Module / Drives	Power in Watts	X	
Flash Module / Drives	Garbage Collection: User Data %: Hot/Warm/Cold	X	
Flash Module / Drives	Garbage Collection: User Data %: Total Write Amplification Factor	X	
Flash Module / Drives	Background Health Checker: Health Checker Operations: Iterations/Blocks Checked/Wear Leveling Moves	X	
Flash Module / Drives	Background Health Checker: Total Completion Percentage	X	
Flash Module / Drives	Data Rate (MiB/s): Read/Write/Total		X

Level	Metric	Native	with IBM Spectrum Control
Port	IO in ops/s: Read/Write/Total	X	X
Port	Total Read Modify Writes (Operations)	X	
Port	Bandwidth/Data Rate in MiB/s: Read/Write/Total	X	X
Port	Bandwidth Percentage: Send/Receive/Overall		X
Port	Queue Depth Operations	X	
Port	Aligned Command Size Operations: Small/Large	X	
Port	Block Size Operations: Small/Large	X	
Port	Response Time in ms/op: Send/Receive/Overall		X
Port	Transfer Size (KiB/op): Send/Receive/Overall		X
Node: Port metrics	IO in ops/s: Send/Receive/Overall		X
Node: Port metrics	Data Rate in MiB/s: Send/Receive/Overall		X
Node: Port metrics	Response Time in ms/op: Send/Receive/Overall		X
Node: Port metrics	Transfer Size (KiB/op): Send/Receive/Overall		X

Historical data can be seen with native tools for the last 300 days. With IBM Spectrum Control, historical performance data can be seen as configured in the retention time settings as shown in Figure 2-7 on page 9.

With the native FlashSystem 840/900 GUI, you can either select multiple resources or multiple metrics, as shown in Figure 2-42.

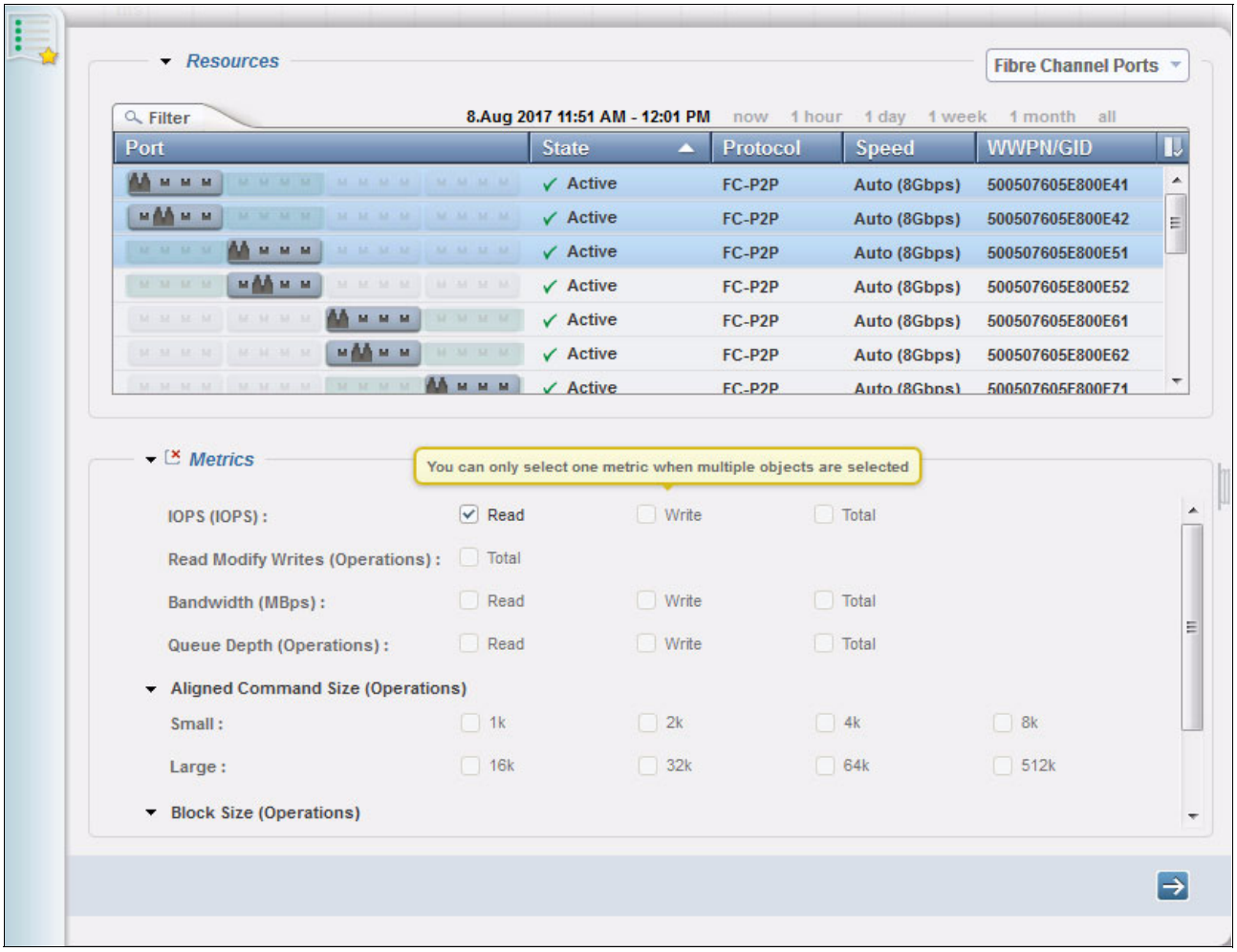

Figure 2-42 FlashSystem 840/900 metrics selection window

You can also select multiple resources and multiple metrics in IBM Spectrum Control, as shown in Figure 2-43.

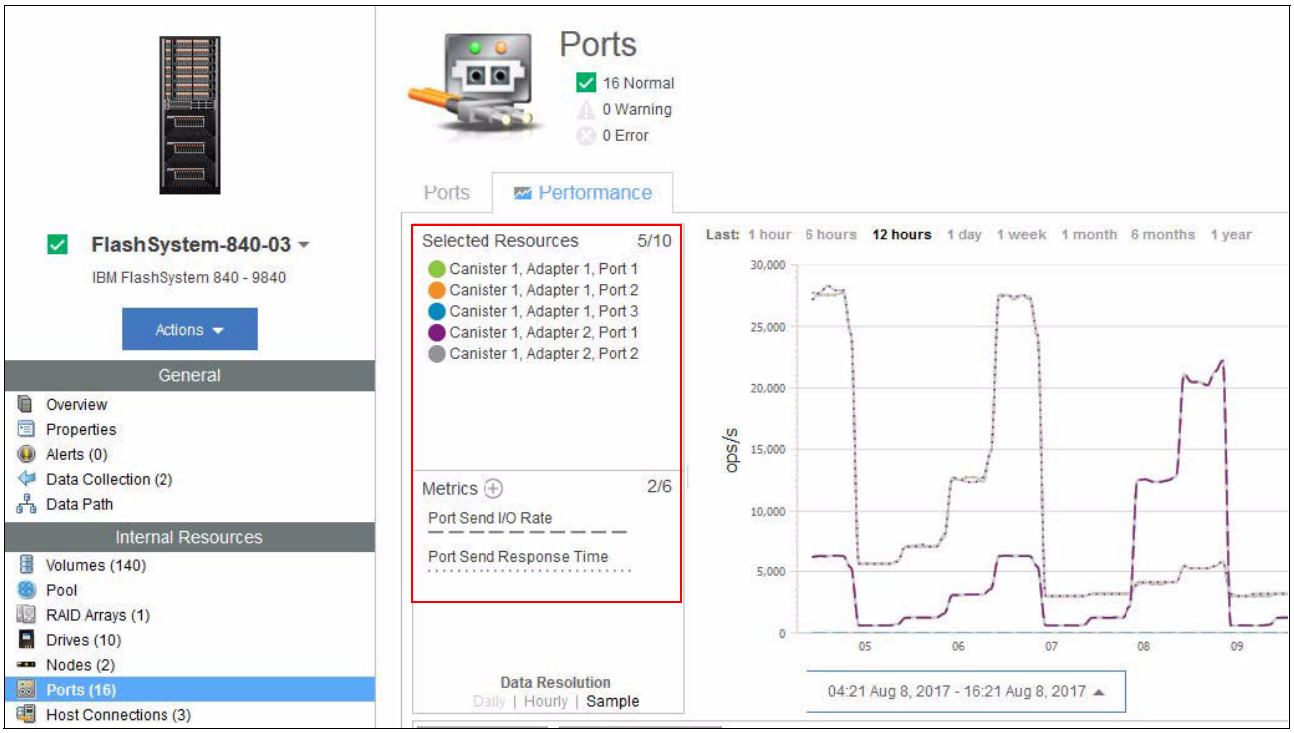

Figure 2-43 Multiple resources and multiple metrics in IBM Spectrum Control

In the FlashSystem 840/900 native storage management GUI, you can easily open a split window to show different resources or different metrics. For example, you can show the systems performance in the upper part of the window and the port performance in the lower window, as illustrated in Figure 2-44.

Figure 2-44 FlashSystem 840/900 split Performance window

In IBM Spectrum Control, you can open different performance windows with the **Open in new window** function and align them to compare the data, as shown in Figure 2-45.

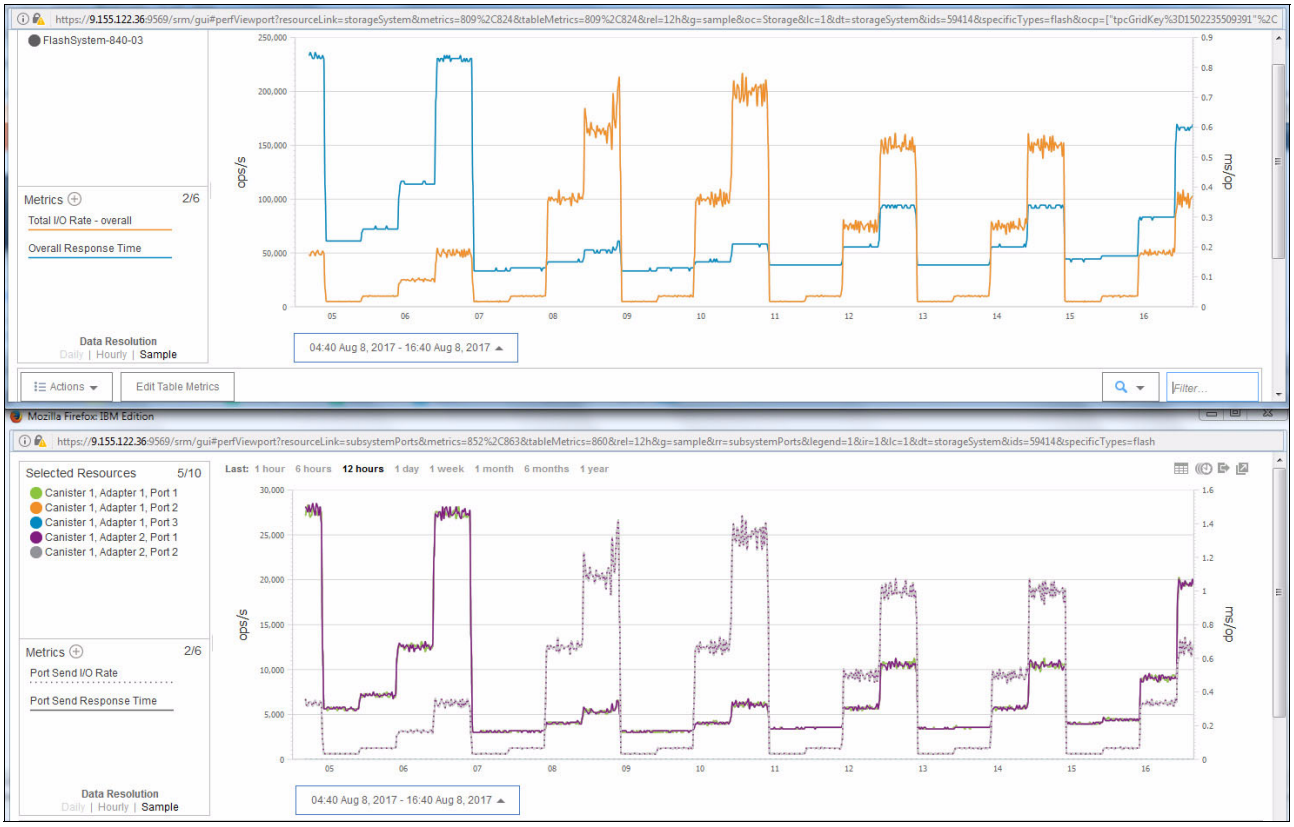

Figure 2-45 Arranging multiple Spectrum Control windows

An advantage of opening and arranging multiple windows with IBM Spectrum Control is that you can easily compare different time ranges. With IBM Spectrum Control, as many windows can be opened and arranged as necessary, whereas with the native FlashSystem 840/900 GUI, the performance chart can only be split into two windows.

The performance charts on the FlashSystem 840/900 are updated every five seconds, whereas in IBM Spectrum Control the minimum interval is one minute. To get real-time performance data, the native FlashSystem 840/900 GUI can be opened from IBM Spectrum Control as shown in Figure 2-17 on page 16.

Although the port performance charts in the FlashSystem 840/900 GUI use the same color for ports that are connected to the same adapter as shown in Figure 2-24 on page 21, IBM Spectrum Control shows each port with its own color, independently of which adapter it is connected to, as shown in Figure 2-30 on page 23.

2.3 Monitoring Performance for FlashSystem V9000

This section describes performance monitoring for FlashSystem V9000, first using the system storage management native tools, and then using Spectrum Control.

2.3.1 Monitoring FlashSystem V9000 with the native tools

FlashSystem V9000 can be managed and monitored from the system GUI or from the CLI. To use the web-based GUI, complete these steps:

1. Enter the system IP address in your browser.
2. Enter your credentials to get access, as shown in Figure 2-46. The examples are based on Version 7.x.

Figure 2-46 V9000 log-in window

3. From the main widow, select **Monitoring** → **System** → **Performance** to open the Performance monitor, as shown in Figure 2-47.

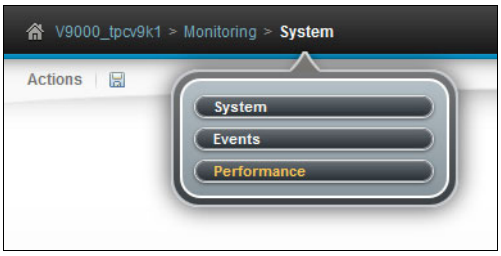

Figure 2-47 Menu to enter the Performance monitor

The Performance Monitor window, shown in Figure 2-48 on page 38, is divided into four sections of equal size that provides information about performance of the different areas. Their location and purpose is:

– CPU Utilization (upper left). Here the usage is shown for these metrics:
  - System CPU %
  - Compression CPU % (only when compression is enabled)

– Volumes (upper right). This view shows the overall volume data for these metrics:
  - Read - Total read traffic of the system
  - Write - Total write traffic for the system
  - Read latency - Average read time per volume
  - Write latency - Average write time per volume
– Interfaces (lower left). The overall statistic for every available port is shown here divided into these metrics:
  - FC - All Fibre Channel traffic
  - iSCSI - All iSCSI traffic
  - SAS - All serial attached SCSI traffic, backend, and frontend
  - IP Remote Copy - Remote Copy traffic over IP connections
– Mdisks (lower right). The overall statistics for MDisks for these categories:
  - Read - Total read traffic of the system
  - Write - Total write traffic for the system
  - Read latency - Average read time per volume
  - Write latency - Average write time per volume

Figure 2-48 V9000 Performance monitor

This view is fixed. All four charts are always displayed at the same place. The monitored time frame is 5 minutes for every chart in this window, giving you the same time frame view of all metrics. In the upper left of the window, two pull-down menus allow you to customize the views. The **System Statistics** menu can be used to select a single control enclosure (here called node) or the whole system. If only one control enclosure needs to be monitored, it can be selected here. The second pull-down menu allows you to display **IOPS** or **MBps**, as shown in Figure 2-49.

Figure 2-49 Changeable settings for the V9000 Performance monitor

For each of the four charts, you can select or clear the measurements to show. The choice depends on the resources being monitored (volume, MDisk, interfaces, or CPU). Because data is collected continuously, after you select a metric for display, you can immediately see the last 5 minutes of collected data. See Figure 2-50.

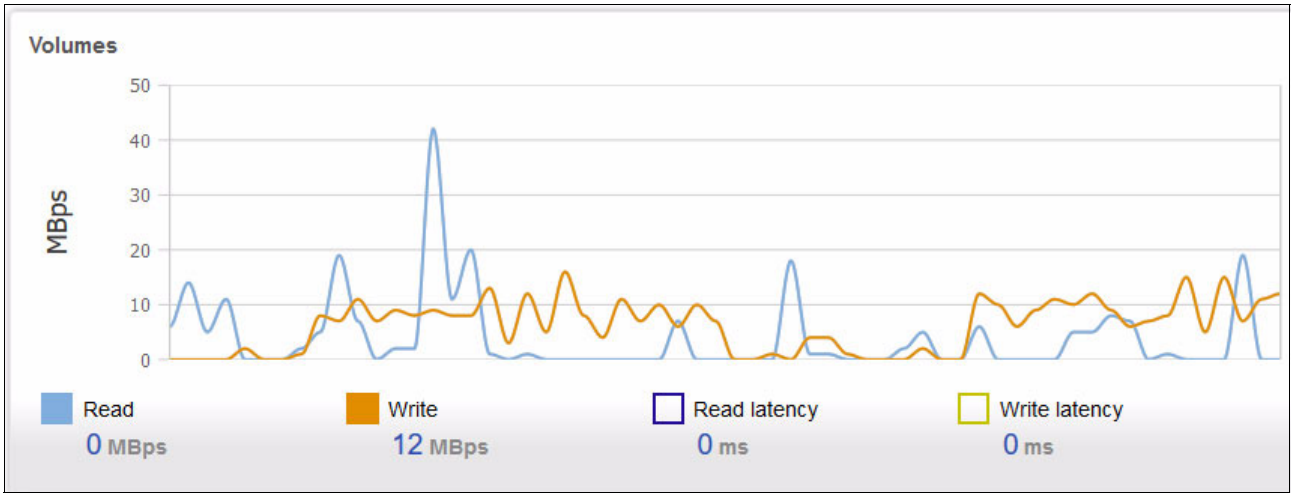

Figure 2-50 Volume performance

To get a detailed value for a single point in time, you can click the curve in every chart and see the detailed values along with the time when those items were measured. Figure 2-51 shows an example for the Interfaces chart.

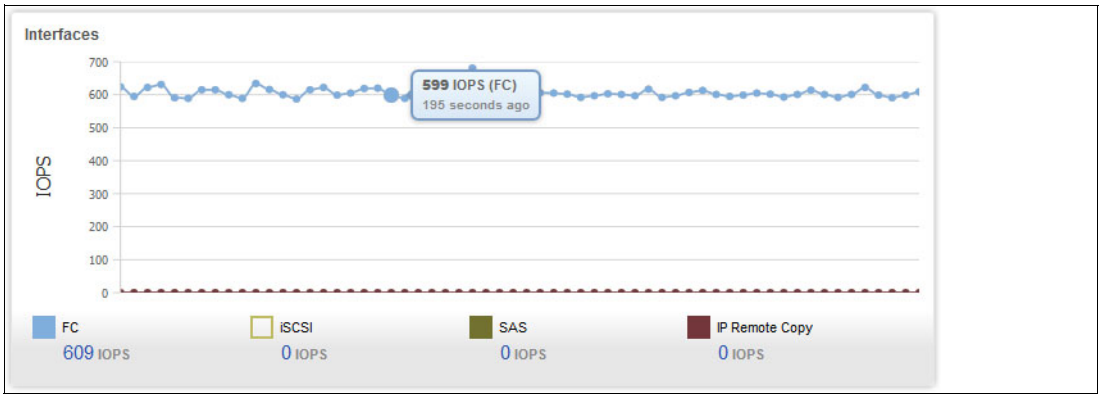

Figure 2-51 Exact value in Performance Monitor

A general view for the complete system is always visible at the bottom of every window in the GUI. It displays as a dashboard and shows real-time values, as illustrated in Figure 2-52.

Figure 2-52 Performance summary visible on every GUI window on the V9000

You can also monitor the V9000 performance through the CLI. The CLI interface uses the same IP address as the GUI. To open a CLI session, complete these steps:

1. Open a Secure Shell (SSH) session.
2. Enter your user ID and password (alternatively, a key can be provided, which is more convenient for scripts and automation) to authenticate with the CLI session.
3. Use the **lsnodestats** and **lssystemstats** commands to get real-time performance data.

> **Note:** From the CLI, the term *node* is often used instead of *control enclosure*. In any output, the term node really stands for control or expansion enclosure.

To get the overall system performance data, issue the **lssystemstats** command. This command displays the most recent values of all node statistics in the system. The command output is a list of all collected statistics for the last available point in time. This output can be formatted with the standard CLI delimiters and filters. A shortened output is shown in Example 2-2.

Example 2-2 Output of lssystemstats

```
IBM_FlashSystem:Cluster:superuser>lssystemstats
stat_name          stat_current stat_peak stat_peak_time
compression_cpu_pc 0            0         170811015618
cpu_pc             2            2         170811015618
fc_mb              0            13        170811015353
fc_io              614          691       170811015353
sas_mb             0            0         170811015618
sas_io             0            0         170811015618
```

To get a history of a single statistic like the CPU usage (`cpu_pc`) in the above example, the **-history** parameter can be used, as shown in Example 2-3.

Example 2-3 Displaying a specific statistic

```
IBM_FlashSystem:Cluster:superuser>lssystemstats -history fc_mb
sample_time  stat_name stat_value
170811015621 fc_mb     320
170811015626 fc_mb     411
170811015631 fc_mb     442
170811015636 fc_mb     404
170811015641 fc_mb     527
```

The **lsnodestats** command shows the same statistics, but based on a single node (that is, enclosure) in the system. That is why two additional columns are in use for the Node ID and Node name. The other columns are the same as for the complete system. In total, there are six columns:

node_id	ID of the reporting node
node_name	Name of the node
stat_name	Name of the statistic that is listed
stat_current	Current value of the statistic
stat_peak	Peak value of the listed statistic during the last 5 minutes
stat_peak_time	Timestamp of the peak value

The values are shown for each node separately. This command can be used if only a single enclosure or node is in focus or needs to be checked. The **-history** parameter can be used also, but must be used with the node ID or node name as additional parameter. Example 2-4 shows the output of the **lsnodestats** command.

Example 2-4 lsnodestats command output

```
IBM_FlashSystem:Cluster_Hotel:superuser>lsnodestats
node_id node_name stat_name          stat_current stat_peak stat_peak_time
1       node1     compression_cpu_pc 0            0         170811023200
1       node1     cpu_pc             2            2         170811023200
1       node1     fc_mb              0            0         170811023200
1       node1     fc_io              306          315       170811023100
1       node1     sas_mb             0            0         170811023200
1       node1     sas_io             0            0         170811023200
```

The performance monitoring capability described here and included with the V9000 native storage management GUI is for real-time monitoring over a short period. Spectrum Control offers the advantage of collecting performance data over an extended period (longer history) and covering more aspects of the system.

The FlashSystem V9000 management GUI collects data for Mdisks, volumes, nodes, and SAS drives automatically. The data collected is part of a support file called *snap*, but the data can be downloaded without downloading the complete snap.

Restriction: The data for Flash modules is not included in the drive data collection.

The data is stored in a single file for every interval. Such an interval can be from 1 minute to up to 60 minutes. The default value is 5 minutes. The limitation here is that the data is stored for 16 intervals maximum. When the 17th interval is started, the oldest data set is deleted. Therefore, the interval time also sets the maximum monitored time frame. If the interval is set to two minutes, 32 minutes of data is stored in the files. However, the default value of five minutes brings 80 minutes of performance data, but the granularity is then five minutes. So, depending on what situation you need to analyze, it is important to decide upfront what data granularity is required.

The interval time can be set by using the **startstats** command. To get all the details and possible parameters, see the command help or consult IBM Knowledge Center.

Keep in mind that the last setting will remain in effect until it is changed again. If the interval was changed for a specific scenario or maybe just for testing, make sure that it is set back to your standard interval to avoid unexpected results in the next data collection.

Note: Do not use the **startstats** command to change the interval if you use an external monitoring software such as IBM Spectrum Control. Change the interval in the monitoring software instead.

The data is collected on a per node basis and not for the complete cluster at a single location. Even though the samples are taken at the same time on all nodes, the data files are stored on their respective collecting nodes. To get all the files for members in the cluster, the data must be copied to the config node before download.

The files are stored in the `/dumps/iostats` directory of each node. To collect the data on the config node, use the **`cpdumps`** command to consolidate before download. The file names have the following format:

- MDisk statistics:

  `Nm_stats_<node_serial_number>_<date>_<time>`

- VDisk statistics:

  `Nv_stats_<node_serial_number>_<date>_<time>`

- Node statistics:

  `Nn_stats_<node_serial_number>_<date>_<time>`

- Disk drive statistics (not for IBM Flash System V9000 Flash Modules):

  `Nd_stats_<node_serial_number>_<date>_<time>`

The **`<node_serial_number>`** gives the information about which node or control enclosure the data is collected, **`<date>`** is the day of collection in the form **`<yymmdd>`**, and the **`<time>`** shows the exact time stamp in the form **`<hhmmss>`**.

The filename `Nv_stats_78AV320_170810_182416` is an example of a file for volume data, collected on the Node with the serial 78AV320, on Aug 10th at 06:24pm. To list all collected data, use the **`lsdumps`** command with the prefix **`iostat`**, as shown in Example 2-5.

Example 2-5 lsdump command

```
IBM_FlashSystem:V9000_tpcv9k1:superuser>lsdumps -prefix /dumps/iostats
id  filename
0   Nv_stats_78AV320_170810_182416
1   Nm_stats_78AV320_170810_182416
2   Nd_stats_78AV320_170810_182416
3   Nn_stats_78AV320_170810_182416
4   Nd_stats_78AV400_170810_182416
5   Nn_stats_78AV400_170810_182416
6   Nv_stats_78AV400_170810_182416
```

Tip: To copy the files from the Flashsystem V9000 to a local workstation the **`pscp`** command, included with PuTTY, can be used. Open a command prompt and change to the directory where pscp.exe is located.

```
C:\pscp>pscp -unsafe -load performancedata user@9.155.121.20:/dumps/iostats/*
c:\v9000data
Using keyboard-interactive authentication.
Password:
Nd_stats_78AV460_170811_0 | 1 kB |   1.4 kB/s | ETA: 00:00:00 | 100%
d_stats_78AV460_170811_0 | 1 kB |   1.4 kB/s | ETA: 00:00:00 | 100%
Nd_stats_78AV460_170811_0 | 1 kB |   1.4 kB/s | ETA: 00:00:00 | 100%
```

Note the following about this output:

- The **`-unsafe`** parameter is needed because wildcards are in use
- A PuTTY session with the name behind the **`-load`** needs to be configured up front. If there is no key stored, **`pscp`** prompts for a password, as shown in the above example.

A complete list with a short explanation of all collected data can be found in IBM Knowledge Center.

2.3.2 Monitoring V9000 with IBM Spectrum Control

In terms of performance monitoring, IBM Spectrum Control basically captures the same information for FlashSystem V9000 as for any other IBM Storwize® family system.

A complete list of performance metrics available for V9000 is listed in the IBM Spectrum Control section of IBM Knowledge Center.

The flash modules can be seen in the disks window, as illustrated in Figure 2-53.

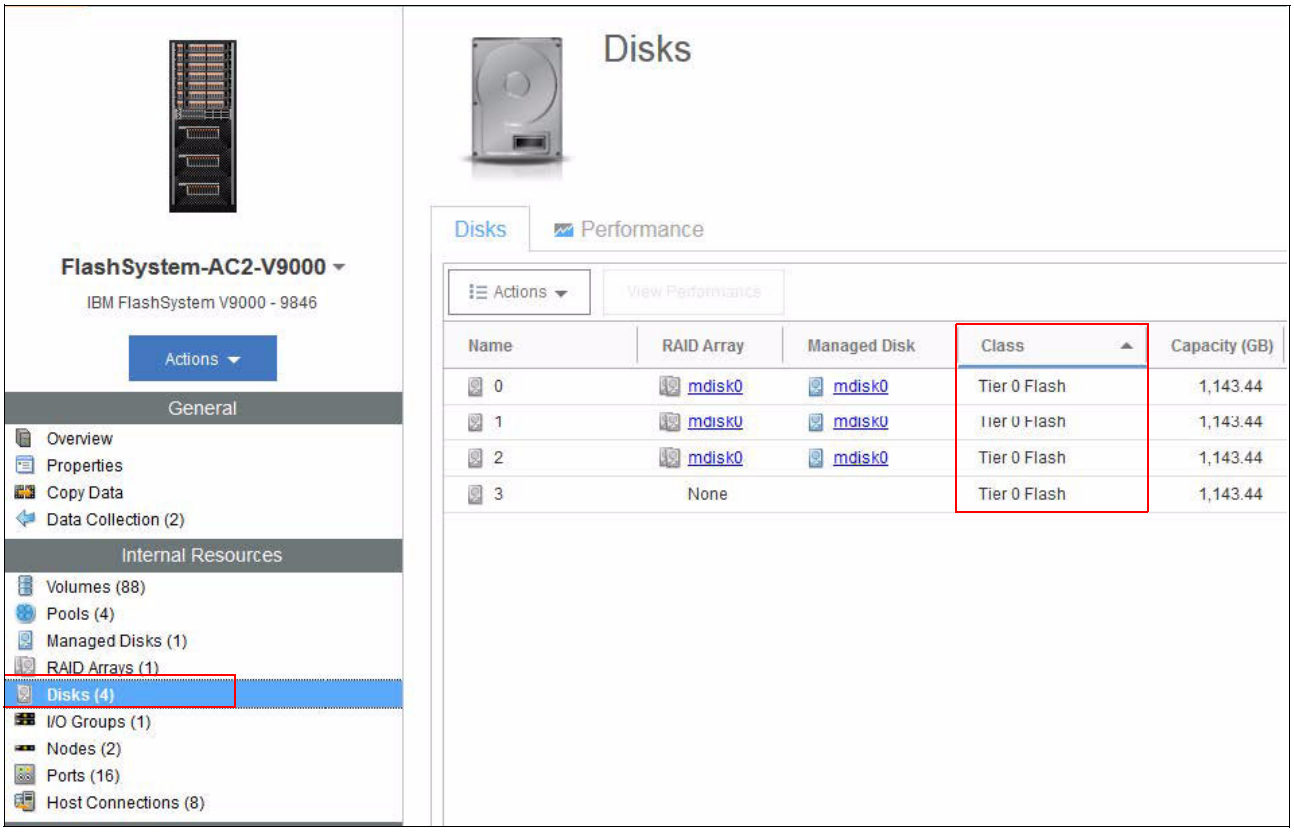

Figure 2-53 V9000 Flash modules in IBM Spectrum Control

Reporting options are described in 2.5, “IBM Spectrum Control reporting options” on page 55.

Drive performance data

The V9000 Nd_stat file contains only statistics of SAS drives, not for Flash modules in a Flash storage enclosure. Therefore, drive performance data cannot be shown in IBM Spectrum Control. For more information, see the IBM FlashSystem V9000 section of IBM Knowledge Center.

Because you can also add enclosures with SAS drives to a V9000, the disks performance tab is available in IBM Spectrum Control for V9000 disks.

Zero Buffer Credit Percentage/Port Send Delay I/O Percentage

The hardware design of the 16 Gb HBAs has changed and they do longer provide zero buffer credit counters. In the past (up until version 5.2.13) Spectrum Control showed an incorrect value of 0.00 for Zero Buffer Credit Timer and Zero Buffer Credit Percentage (%) for 16 Gb ports (as reported by the Storwize systems). Starting with With IBM Spectrum Control v 5.2.14, N/A (rather than 0.00) is shown for these metrics for 16 Gb ports only.

Because the lack of the Zero Buffer credit counters means that there is no way to debug slow-draining device problems in the SAN, new counters (dtdt, dtdc, and dtdm) were introduced with Storwize version 7.8.1. These counters will attempt to measure sent I/O delay by retrieving a subset of traffic that can be measured by software. Therefore the new counters do not replace the zero buffer credit counters. Instead, they represent the delay expected in transmitting data calculated based on the amount of data queued in the port and the estimated port speed. These new counters are available in IBM Spectrum Control starting with version 5.2.14. They can be displayed using the Port Send Delay Time (ms/op), Port Send Delay I/O Percentage (%), or both.

These new counters and therefore the new metrics Port Send Delay Time (ms/op) and Port Send Delay I/O Percentage (%) are available for all ports.

Figure 2-54 shows a comparison of Zero Buffer Credit Percentage and Port Send Delay I/O Percentage.

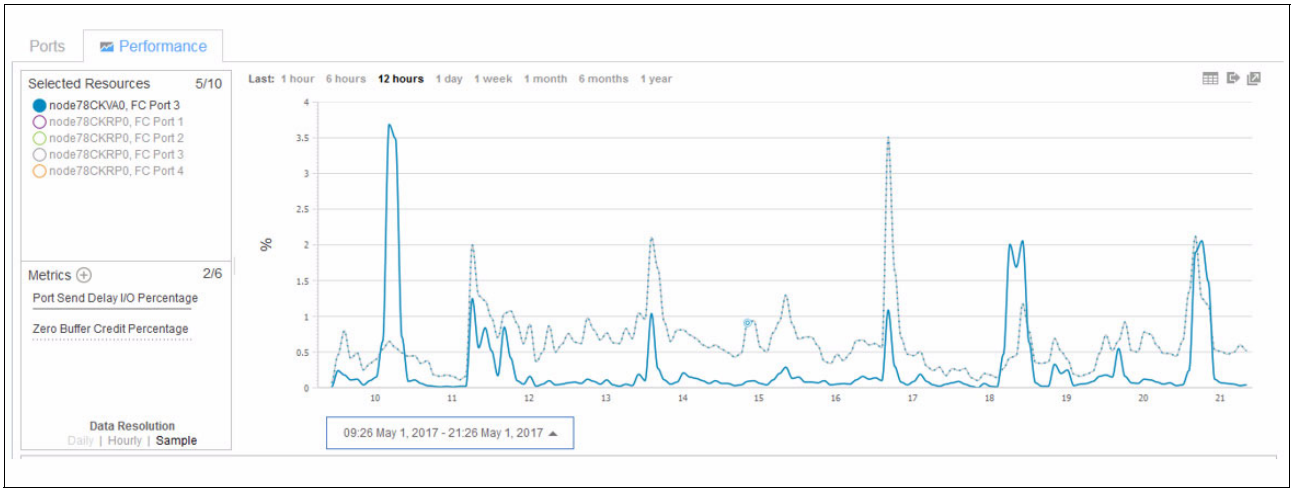

Figure 2-54 Zero Buffer Credit Percentage versus Port Send Delay I/O Percentage

Compression savings %

When using compression on any of the Storwize or SAN Volume Controllers (SVC) devices, always evaluate whether compression savings are worth the effect of compression on the system performance. To get a quick view of the compression savings, sort the volumes in Spectrum Control by compression savings in descending order (1), as shown in Figure 2-55.

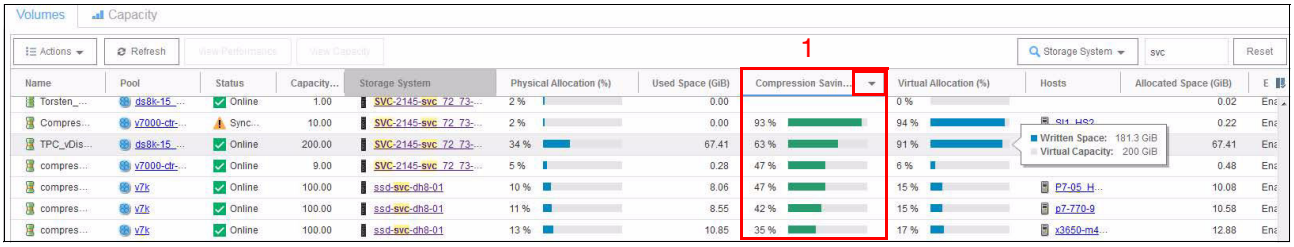

Figure 2-55 Volumes sorted by compression savings

For volumes with low compression savings (< 40%), it might be better to turn compression off. We have seen compressed volumes in the field that were bigger after compression than they were before.

As described in the IBM Spectrum Control section of IBM Knowledge Center, compression Savings is calculated by using this formula:

```
Compression savings % = (1- used space / written space) * 100
```

2.3.3 Comparing V9000 native tools with IBM Spectrum Control

In IBM Spectrum Control, a comprehensive list of performance metrics is available for monitoring V9000 performance, as shown in Table 2-2. The V9000 native GUI provides only a limited set of performance metrics and only on a cumulated/aggregated level per system or per node.

In Spectrum Control, you can see the performance metrics not only cumulated/aggregated for the complete storage system or per node, but also for each individual internal resource.

With IBM Spectrum Control, you also can see all the data historically, which is not possible in the V9000 GUI. The minimum interval in IBM Spectrum Control that can be set to collect performance data is one minute, whereas the performance chart on the V9000 GUI gets updated every five seconds. If you need real-time performance data, use the **View Real-Time Performance** function, as shown in Figure 2-18 on page 16.

Table 2-2 Performance metrics available in the V9000 GUI

Level	Metric	Available in Spectrum Control
System Statistics/Node	CPU Utilization: System %	X
System Statistics/Node	CPU Utilization: Compression %	X
System Statistics/Node	FC Ports : I/O Rate in ops/s /	X
System Statistics/Node	FC Ports : Data Rate in MiB/s	X
System Statistics/Node	iSCSI Ports : I/O Rate in ops/s /	
System Statistics/Node	iSCSI Ports : Data Rate in MiB/s	
System Statistics/Node	SAS Ports : I/O Rate in ops/s /	
System Statistics/Node	SAS Ports : Data Rate in MiB/s	
System Statistics/Node	ip Replication Ports : I/O Rate in ops/s /	
System Statistics/Node	ip Replication Ports : Data Rate in MiB/s	
System Statistics/Node	Volume Read / Write Data Rate in MiB/s	X
System Statistics/Node	Volume Read / Write I/O Rate in ops/s	X
System Statistics/Node	Volume Read / Write Latency in ms	X
System Statistics/Node	MDisk Read / Write I/O Rate in ops/s	X
System Statistics/Node	MDisk Read / Write Data Rate in MiB/s	X
System Statistics/Node	MDisk Read / Write Latency in ms	X

2.4 Monitoring performance for FlashSystem A9000 or A9000R

This section discusses performance monitoring for FlashSystem A9000/A9000R, first using system native tools and then using Spectrum Control.

2.4.1 Monitoring A9000 or A9000R with HyperScale Manager

FlashSystem A9000 and A9000R GUI uses the IBM Hyper-Scale Manager server. The management GUI is accessed by directing your web browser at the Hyper-Scale Manager server (`http://<Hyper-ScaleManager server IP address>:8080` or for secure servers `https://<Hyper-ScaleManager server IP address>:8443`). A login window, as shown in Figure 2-56, prompts you to enter valid credentials.

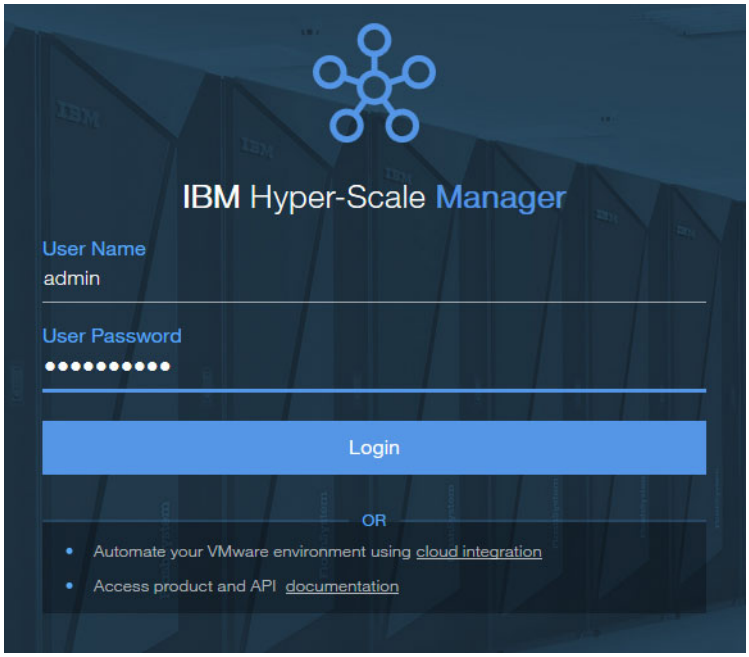

Figure 2-56 IBM Hyper-Scale Manager Login window

Upon successful login, the dashboard is presented. The dashboard lists any Spectrum Accelerate systems, such as A9000, A9000R, or IBM XIV®, included in the inventory and that can be accessed through the same credentials. You can select to focus on just one particular system, as shown in Figure 2-57.

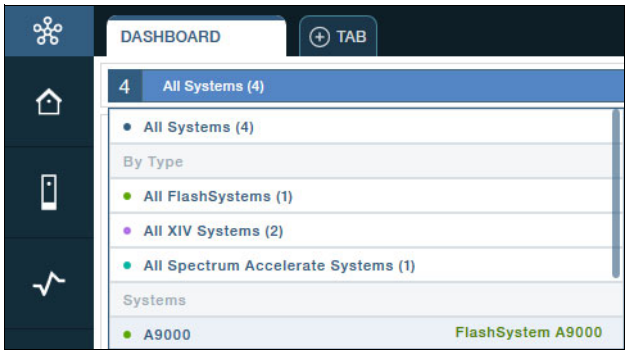

Figure 2-57 Menu to select the system for further actions

The selection of a single system changes the dashboard view to display information related to that particular system only. In the lower right corner, you can see an overview of the system total IOPS and maximum the latency. This information can be used as a first indication. For more detailed information, click the **Statistics** icon to open the **Statistics Views** menu. The first four options in that menu pertain to performance statistics:

- System & Ports Performance Statistics
- Volume Performance Statistics
- Host & Port Performance Statistics
- QoS Performance Statistics

The options are shown in Figure 2-58

Figure 2-58 Different options for performance statistics

If the Volume Performance Statistics is selected, a list of all volumes is created. If **Host & Ports Performance** is selected, a list with all hosts is shown. Below the list, there is one chart for the corresponding selected object and the current IOPS as a metric (see Figure 2-58). For QoS statistics, historic data is shown.

Based on the selection, all corresponding objects are preselected. For instance, if Volumes are the monitored object, all volumes belonging to the particular A9000 are selected.

If there is no object selected, no chart is shown. To enable the chart, select at least one object (Volume, Host, and so on) to get option to open a chart.

Figure 2-59 shows the view with the list of the possible objects that can be monitored and a single chart with the default settings. You can customize that view. Note that the figure is specific to Volumes, but the same actions and selections apply to other objects.

You can filter the view to restrict it to a single or small group of volumes. You can enter and combine different filters.

The columns can be used to have the volumes sorted by size, name, or properties.

The content icon in the top right can be used to customize the columns to be shown.

If the result needs to be saved, the list can be exported into a csv file format.

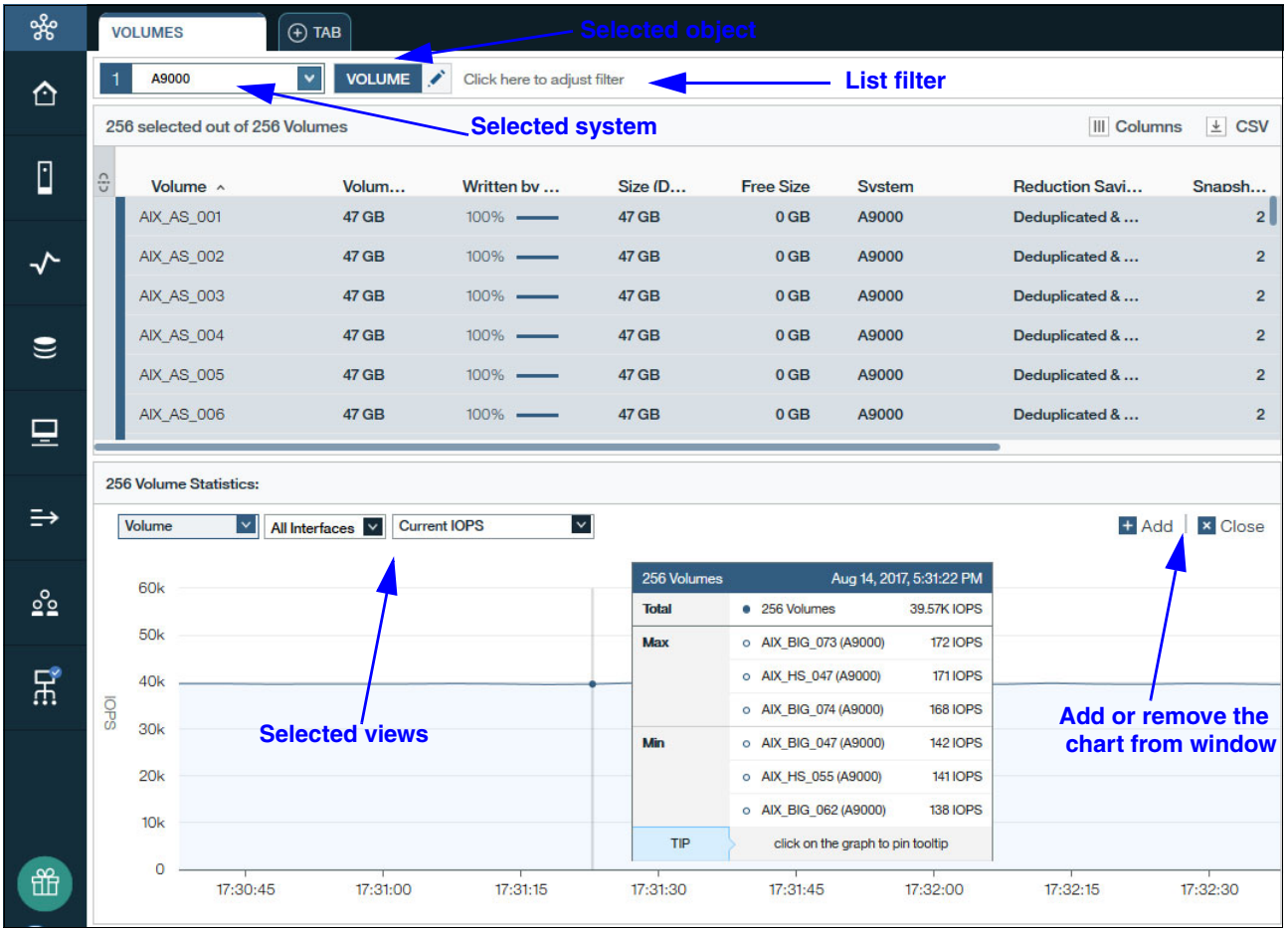

Figure 2-59 Statistics view for an A9000

The objects that are shown in the chart can now be selected. If there no volume is selected, no chart is shown. If this is the case, select at least one chart and click the **Statistics** field at the bottom of the list, as shown in Figure 2-60.

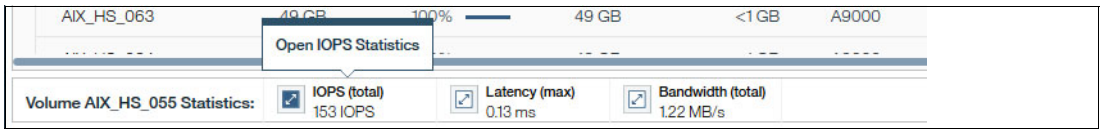

Figure 2-60 Open a chart for performance statistics

The chart with the real-time performance statistics is progressively drawn, and displays the total values for all selected volumes. This feature allows you to monitor a single volume or a group of volumes. For example, you can group all objects that belong to an application, server, or group of servers.

The chart can be further customized by using the pull-down menus in the middle left area of the window (Figure 2-59 on page 48).

The second menu from the left can be used to select the complete system or only one interface.

From the third menu, specific metrics can be selected. Because metrics are different at a System level or host level, the menus are different. The options are as listed here:

- Qos
  - Historic IOPS
  - Historic Latency
  - Historic Bandwidth
- Volumes
  - Current IOPS
  - Historic IOPS
  - Current Latency
  - Historic Latency
  - Current Bandwidth
  - Historic Bandwidth
- Host and Port same as Volumes plus:
  - Written by Host
  - Written by Host + Forecast
- System same as Volume plus
  - Physical usage
  - Physical usage + Forecast
  - Written / Allocated
  - Written / Projected
  - Written / Projected + Forecast
  - Projected / Actual

The current metrics are shown for a predefined time frame. For the historic values, there are many more options to choose from. If one of the historic options is selected, new menus are visible in this chart. One is the type of I/O, Read, Write, or Read+Write. The second one is Memory Hit, Memory Miss or Hit+Miss and the third is the size of the I/O or all together.

Any combination of the menu options is possible, like only reads, which have a Memory Miss and are bigger than 512 KB.

A last menu on the top right of the chart is the Range. The time scale of the chart can be selected here based on preselected ranges such as last hour or last month, or an individual time frame can be selected.

Other charts can be added by clicking the **Add** (**+**) sign. This action opens a second window allowing you to compare two different charts. When a chart is no longer needed, it can be removed with the **Close** (**x**) button.

To get more details about the real-time graphs (current) and the values, click in the chart to open a tooltip window that gives more details about the value at that time. A nice feature for several monitored volumes (or hosts etc) is the ordering. Depending on the number, the Total value as well as the max value and min values are shown. Sometimes the average is also included.

2.4.2 Monitoring A9000 with IBM Spectrum Control

In terms of performance monitoring with IBM Spectrum Control, Flashsystem A9000 and A9000R are showing basically the same information as for the XIV systems. A complete list of available performance metrics is available in the IBM Spectrum Control section of IBM Knowledge Center.

Reporting options are described in 2.5, “IBM Spectrum Control reporting options” on page 55.

Available performance metrics

Performance values are available for the A9000/A9000R grid controllers (interface modules for XIV), but not for the individual flash modules (MicroLatency Modules) that are listed as drives or disks in IBM Spectrum Control. No performance metrics are available for the Flash enclosures that are shown as RAID Arrays in IBM Spectrum Control.

IBM FlashSystem A9000 and IBM FlashSystem A9000R do not track performance statistics for volumes that were never used. Because there are no performance statistics, performance metrics are not shown for these volumes and their related components.

Although the IBM Spectrum Control metrics selection offers the SSD Read Cache Hits % performance metric for the A9000/R as well, they only apply for XIV, which uses solid-state drives for caching only, as described in the hover help shown in Figure 2-61.

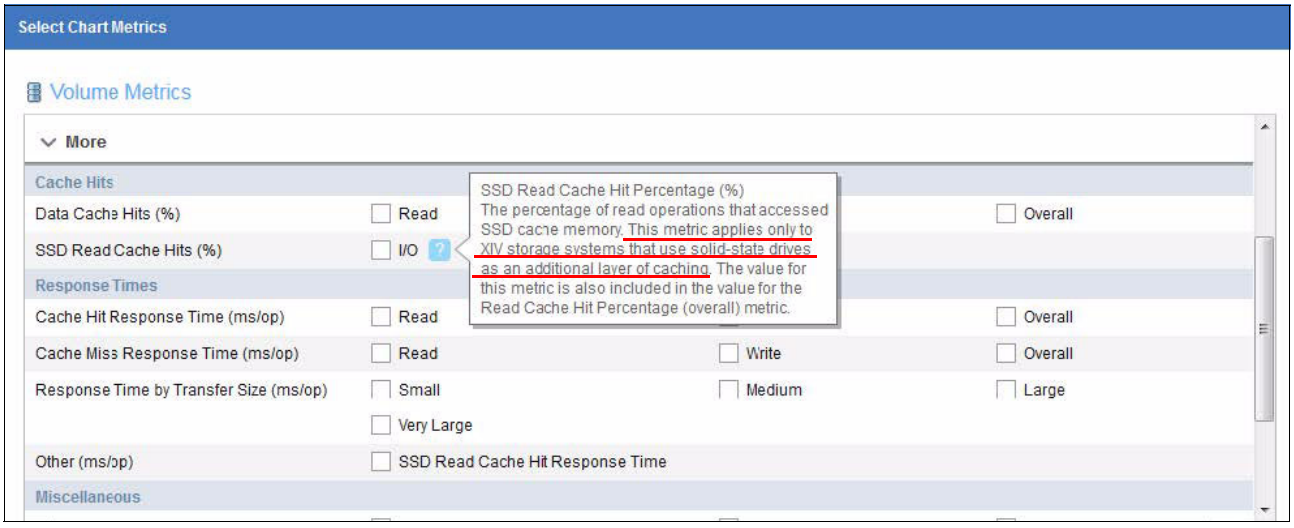

Figure 2-61 A9000 Volume Performance Metric selection

2.4.3 Comparing A9000 Hyperscale Manager GUI with IBM Spectrum Control

Table 2-3 lists the performance metrics available in the Hyperscale Manager UI and IBM Spectrum Control.

Table 2-3 Level of performance metrics

Level	Hyperscale Manager UI	IBM Spectrum Control
System (per interface/module)	X	X
Volumes (per interface/module)	X	X
Domain	X	
Mapped Host	X	X
Mirrored Volumes	X	
Snapshot	X	
Pool		X
Quality of Service	X	
Port		X

With the Hyperscale Manager, the I/O Rate for Memory Hit or Memory Miss can be displayed as shown on Figure 2-62 as well as the total I/O Rate.

Figure 2-62 Hyperscale Manager: Memory Hit versus Memory Miss I/O Rate

This chart can also be customized for individual blocksizes, or a combination of all blocksizes, as shown in Figure 2-63. It cannot be combined with other metrics.

Figure 2-63 Hyperscale Manager: I/O Rate for individual Block sizes

In Spectrum Control, the I/O Rate is shown on one y-axis and the Cache Hit Percentage on the other second y- axis, as illustrated in Figure 2-64.

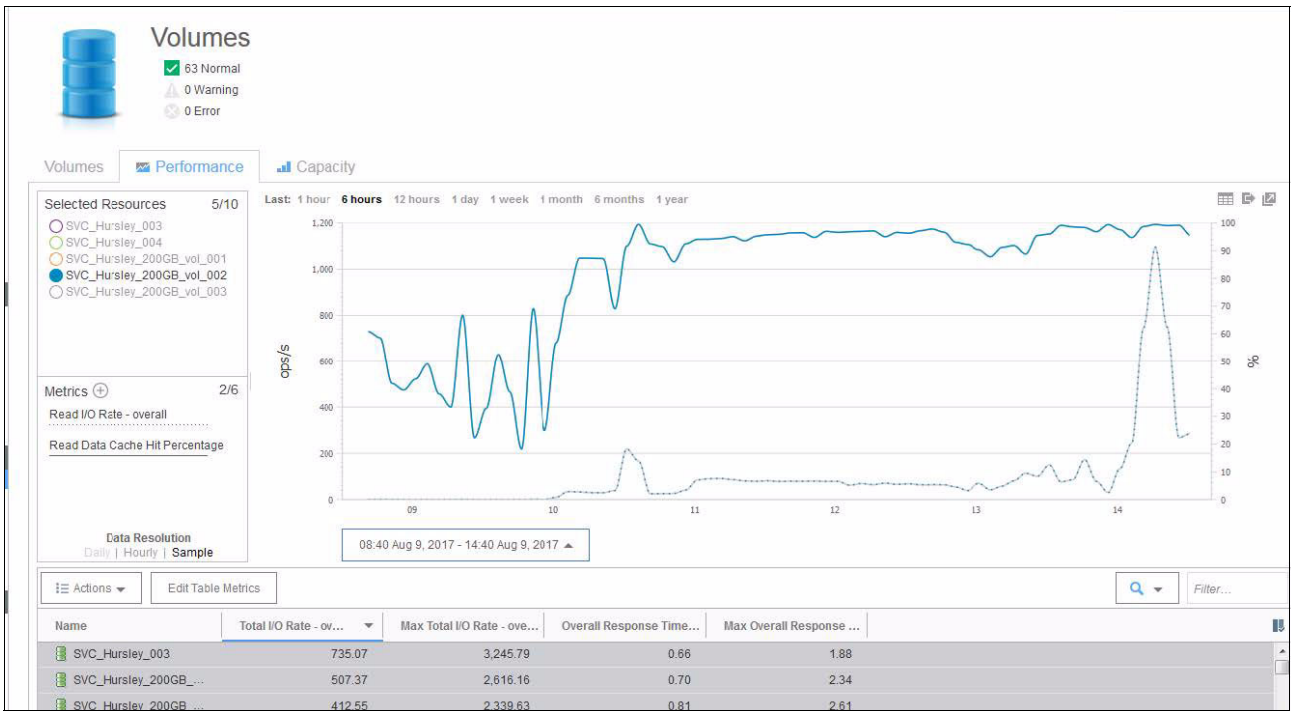

Figure 2-64 Spectrum Control: I/O Rate versus Cache Hit Percentage

Because a third y-axis cannot be displayed, all three metrics (I/O Rate, Cache Hit Percentage, Transfer Size) cannot be shown in the same chart (see also Chapter 2.1.2, “Considerations for Performance Monitoring with IBM Spectrum Control” on page 10). However, it is possible to show all three metrics at the same time in the table view of the graph by using the table/chart toggle (1), as shown in Figure 2-65.

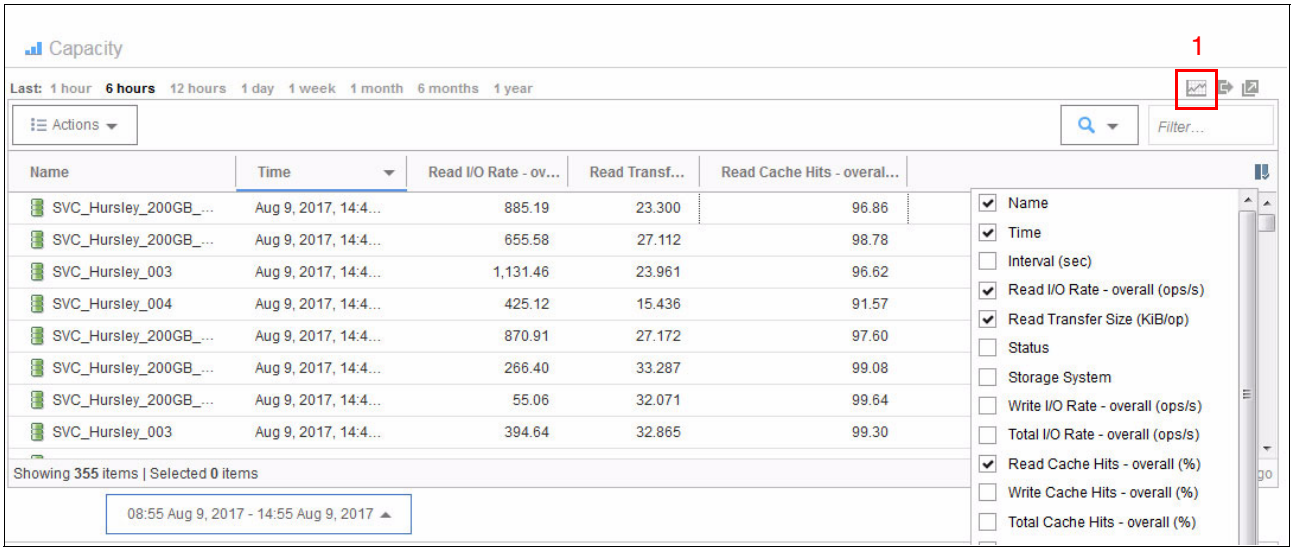

Figure 2-65 Spectrum Control table view of performance diagram

As shown in Figure 2-66 and in Figure 2-67 on page 54, two different charts can be displayed on top of each other with HyperScale Manager. In Spectrum Control, this can be done by arranging multiple charts accordingly, as described in Figure 2.3.3.

Depending on how many resources are being selected, HyperScale Manager shows individual performance graphs (Figure 2-66) or accumulated performance graphs (Figure 2-67 on page 54).

Figure 2-66 Hyper Scale Manager: Individual Performance graphs

Figure 2-67 shows the accumulated performance graphs.

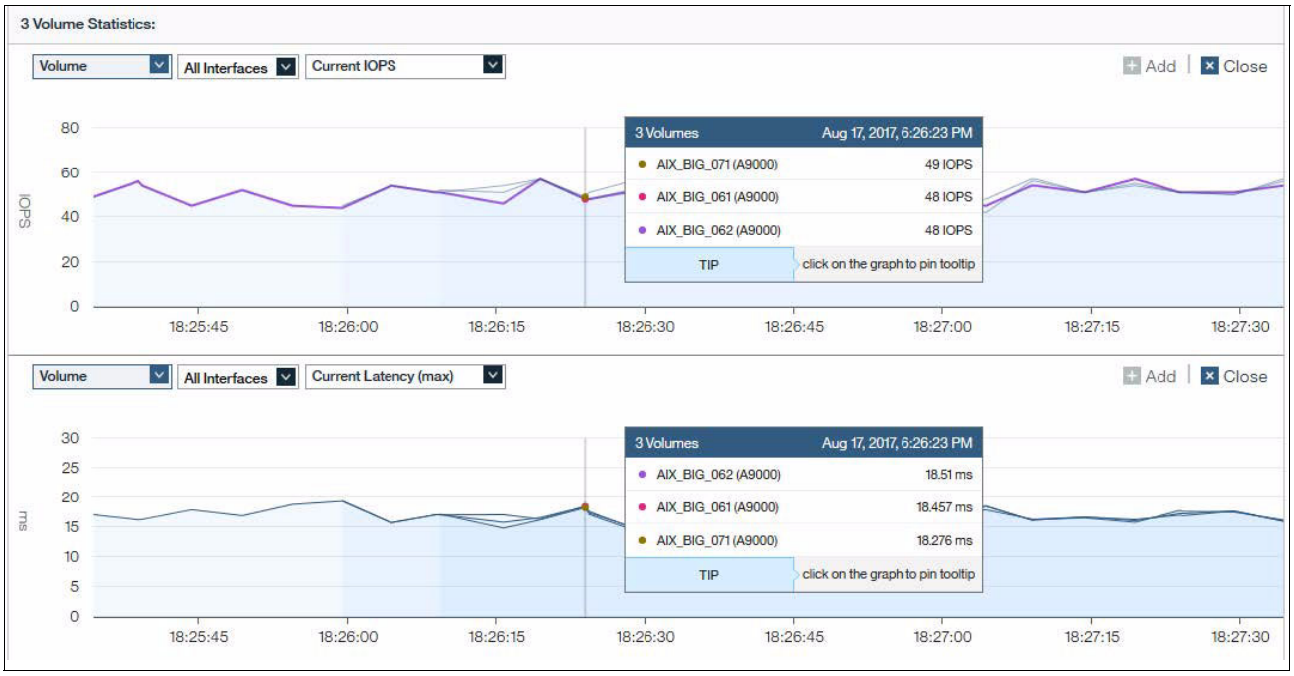

Figure 2-67 Hyper Scale Manager: Accumulated Performance graphs

In Spectrum Control, up to 10 individual graphs can be displayed, as shown in Figure 2-68, and can be individually toggled on/off as described in 2.1.2, “Considerations for Performance Monitoring with IBM Spectrum Control” on page 10.

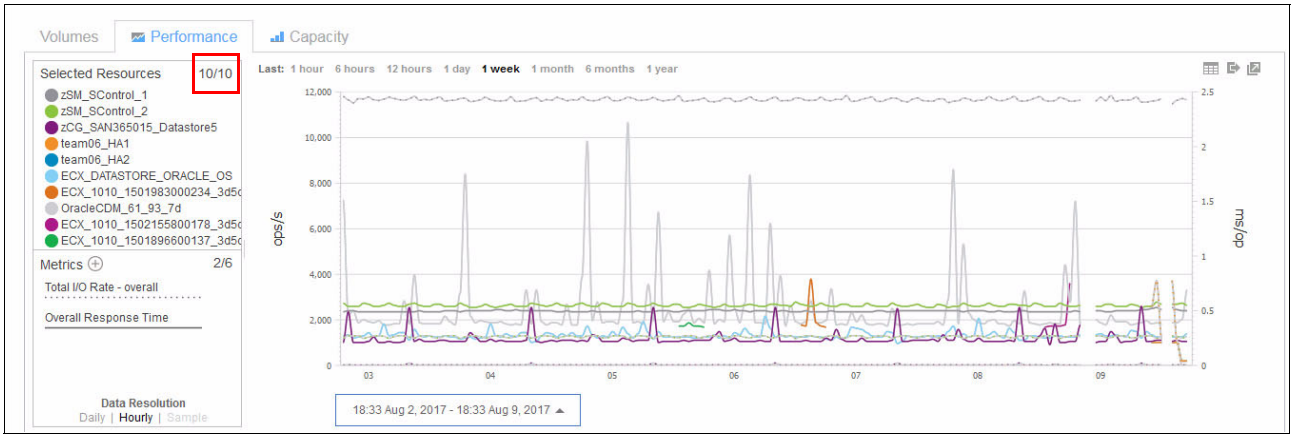

Figure 2-68 Spectrum Control: Up to 10 individual graphs are being displayed

Although IBM Spectrum Control does not show any Quality of Service (QoS) data, volumes belonging to a QoS could be added to an application as described in *IBM Spectrum Family: IBM Spectrum Control Standard Edition*, SG24-8321. Doing so allows performance to be tracked easily for volumes belonging to a certain QoS.

The minimum interval for collecting performance data with IBM Spectrum Control is one minute, whereas HyperScale Manager shows real time performance for every five seconds. Currently, IBM Spectrum Control does not provide the Open Storage System GUI and View Real Time Performance functionality is not available in IBM Spectrum Control for A9000/R.

2.5 IBM Spectrum Control reporting options

IBM Spectrum Control provides numerous ways of reporting about Flash performance data. This section provides an overview of the various options and their appropriate usage in ongoing performance management of IBM FlashSystem storage devices:

- Web GUI Reports
- Create Performance Support Package
- REST API
- IBM Cognos®
- Native SQL Reports

2.5.1 Web GUI reports

IBM Spectrum Control Web GUI provides the following export options (see Figure 2-69):

- To export the data used in the performance chart, click the **Export** icon located in the upper left of the chart (1).
- To export the summary table shown underneath the chart: from the **Action** pull-down (2), click **More** (3) → **Export** (4) → **Select the format** (5).

s

Figure 2-69 Performance data export options

2.5.2 Create Performance Support Package

With IBM Spectrum Control v5.2.10, the **Create Performance Support Package** function has been improved. The purpose of this function is to provide performance data to the IBM device support teams. This feature can also be used for other purposes, but it is not optimized as a generic report generator.

Supported devices are storage systems (both block and file), fabrics, and switches.

Create Performance Support Package using the Web GUI

With IBM Spectrum Control v5.2.10, the **Create Performance Support Package** function is implemented in the IBM Spectrum Control GUI. The function can create reports for a specific time range as a set of compressed CSV files for a single device at a time. Each report is a single CSV file and covers a single resource type. By default, all resource types supported by the specified device are included in the zip file.

To create a Performance Support Package for the FlashSystem storage, complete these steps:

1. Right-click the storage system in the Block Storage Systems window, as shown in Figure 2-70, and select **Create Performance Support Package**.

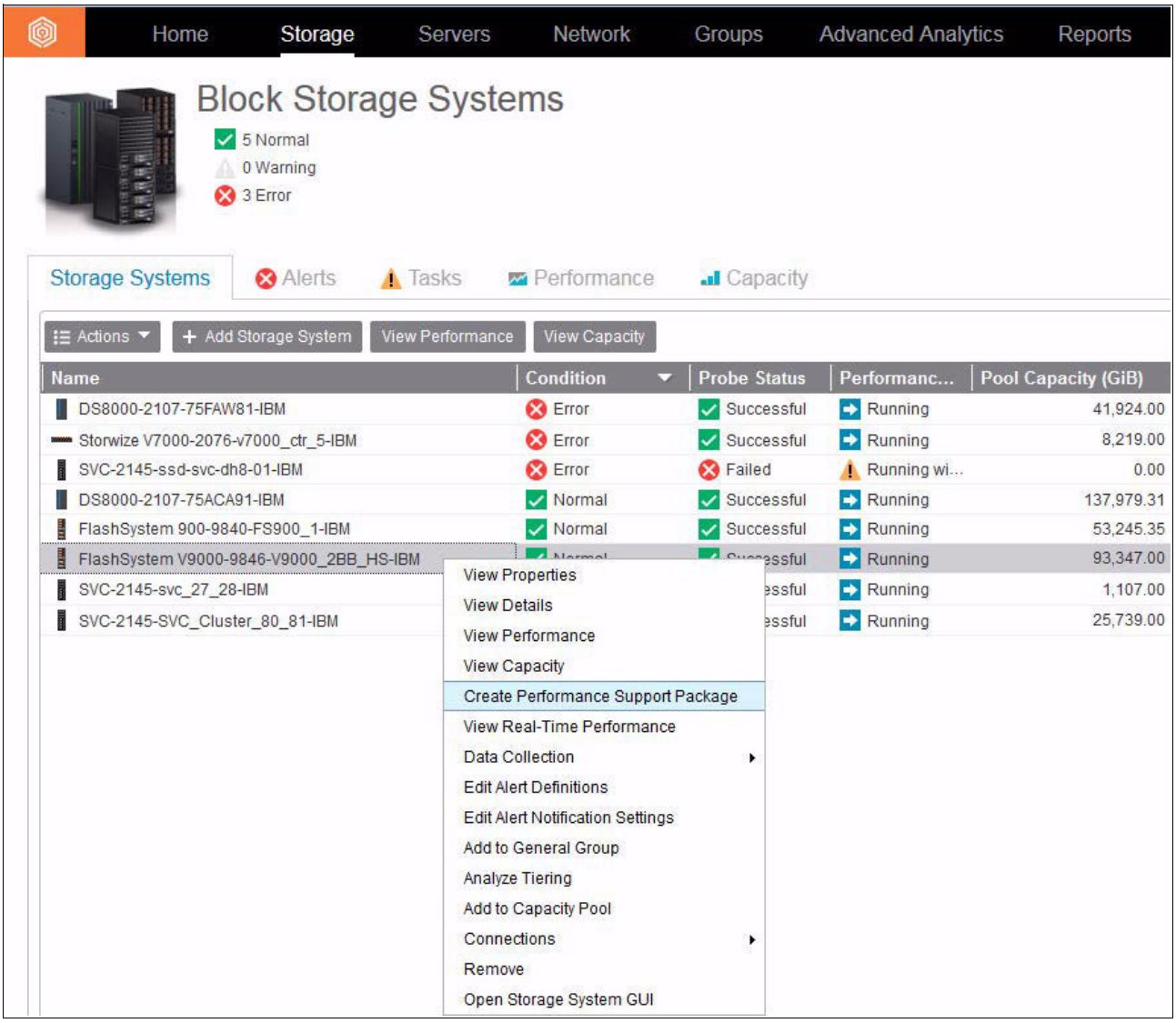

Figure 2-70 Create Performance Support Package in the Web UI

2. The Create Performance Support Package window is displayed, as shown in Figure 2-71. Specify a time range using one of these options:
   - One of the predefined ranges (4, 8, or 12 hours) (1)
   - Clicking the time range and entering a custom range (2)

   For time ranges less than 12 hours, volume data and, if applicable, 1 min interval data are included in the export files. If you select a time range greater than 12 hours, volume data and 1 min interval data are included when you select the **Advanced Package** (3).

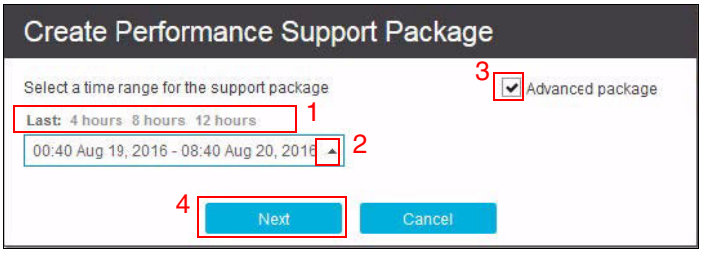

Figure 2-71 Specify time-range for the Performance Support Package

3. Click **Next** (4) and the Spectrum Control server estimates the expected file size, as shown in Figure 2-72.

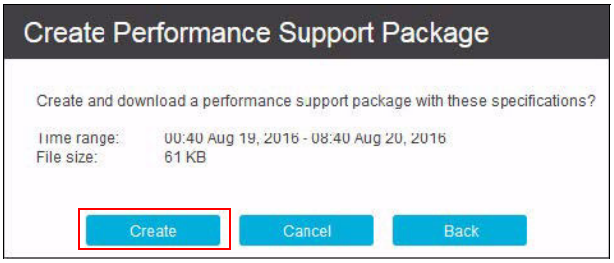

Figure 2-72 Expected File size of the Performance Support Package is shown

4. Click **Create**, as shown in Figure 2-72. Depending on your browser, you might be prompted to specify where to save the zip file.

Using the Export Performance Package script

There is also a script available to export the performance data. The script, called `exportPerformanceData.bat`, is located in the `scripts` directory of the Spectrum Control installation directory, as shown in Example 2-6.

Example 2-6 Directory of the exportPerformanceData script

```
Directory of C:\Program Files\IBM\TPC\scripts

07/21/2017  11:07 PM    <DIR>          .
07/21/2017  11:07 PM    <DIR>          ..
07/21/2017  10:45 PM               684 exportPerformanceData.bat
11/09/2016  05:48 PM    <DIR>          ldap
03/03/2017  05:47 PM    <DIR>          LTPA
06/02/2017  07:26 PM             4,013 sslCert.bat
07/21/2017  10:57 PM               890 startTPCAlert.bat
07/21/2017  10:55 PM               619 startTPCData.bat
07/21/2017  10:57 PM               850 startTPCDevice.bat
07/21/2017  11:07 PM               817 startTPCWeb.bat
07/21/2017  10:57 PM             1,449 stopTPCAlert.bat
```

```
07/21/2017  10:55 PM               616 stopTPCData.bat
07/21/2017  10:57 PM             1,419 stopTPCDevice.bat
07/21/2017  11:07 PM             1,564 stopTPCWeb.bat
04/02/2017  10:26 AM    <DIR>          TPCNew_Data_201704020126
04/02/2017  10:00 AM             1,289 TPCPerf.bat
              11 File(s)         14,210 bytes
               5 Dir(s)  341,685,374,976 bytes free

C:\Program Files\IBM\TPC\scripts>
```

With the script, several parameters can be specified, as shown in Example 2-7.

Example 2-7 exportPerformanceData help

```
C:\Program Files\IBM\TPC\scripts>exportPerformanceData.bat
Calling Spectrum Control Performance Exporter ...

Usage: exportPerformanceData.bat -user <user> -pwd <password> [options] -resNames <resource_names>
   required:
      -user       The user name for logging into the IBM Spectrum Control server.
      -pwd        The password for the specified user name.
      -resNames   One or more storage system, switch, or fabric names as
                  displayed in the UI, delimited by spaces.
                  If a name contains spaces, it should be within quotes.
   options:
      -server     Hostname or IP address of the IBM Spectrum Control server.
                  Default is  localhost.
      -port       Spectrum Control Web server port.
                  Default is  9569.
      -out        The name of the exported zip file, or if  -zip no  is
                  specified, the directory to store the exported data files.
                  Default is the current directory.
      -resTypes   A comma-separated list of resource types for which to export
                  the performance data.
                  Valid values are:
                     storageSystem, nodes, modules, ioGroups, hostConnections
                     pools, raidarrays, mdisks, disks, volumes, filesystems,
                     switches, ports, interSwitchConnections
                  Default is all resource types supported by the specified resource.
      -start      Start time in the "yyyy-MM-dd HH:mm:ss" format, including quotes.
                  Overrides  -last  if both are specified.
      -end        End time in the "yyyy-MM-dd HH:mm:ss" format, including quotes.
                  Default is the current time.
      -last       Length of time range, in hours.
                  Ignored if  -start  is also specified.  Default is 4 hours, 48 hours, or
                  720 hours if -summType sample, hourly, or daily is in effect, respectively.
      -summType   Performance data collection summarization type.
                  Valid values are:  sample, hourly, daily
                  Default is  sample.
      -advPkg     Include 1 minute samples and volume data if available.
                  Valid values are:  yes, no
                  Ignored if the length of the specified time range is 12 hours or less.
                  Default is  no  unless time range is 12 hours or less.
      -zip        Compress the CSV files into a zip file.
                  Valid values are:  yes, no
                  Default is  yes.
```

Example 2-8 shows how to create performance packages including the 1 min interval data and the volume data for two Flash storage systems by specifying custom start and custom end dates.

Example 2-8 Create Export Performance Data Package

```
C:\Program Files\IBM\TPC\scripts>exportPerformanceData.bat -user user -pwd
password -resNames "FlashSystem V9000-9846-V9000_2BB_HS-IBM" "FlashSystem
900-9840-FS900_1-IBM" -start "2016-08-19 08:00:00" -end "2016-08-20 08:00:00"
-advPkg yes
```

Note: Although multiple devices can be specified in the command, the export performance package is processed serially for each device.

Export Performance Package

The downloaded Performance Support Package zip file includes one zip file for each device and each zip file contains csv files for every internal resource type that is supported by the device, as shown in Figure 2-73.

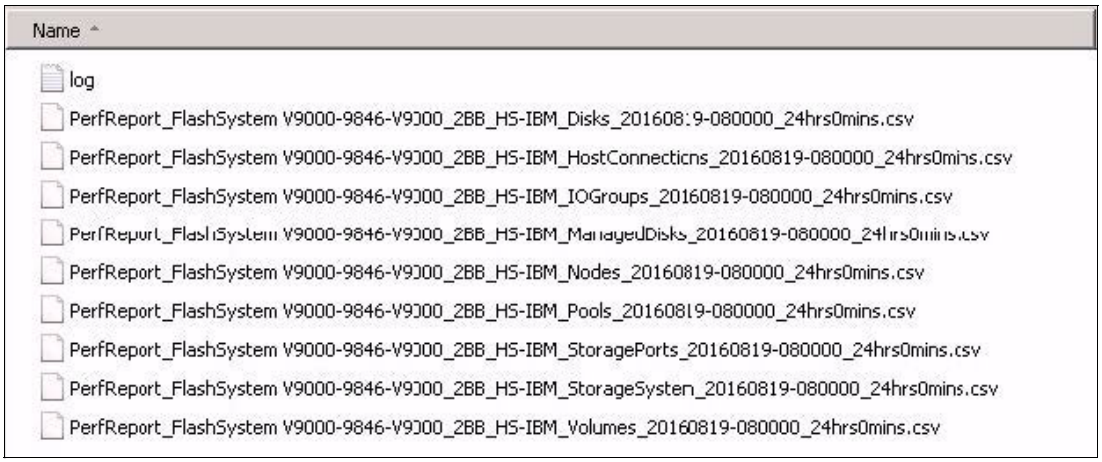

Figure 2-73 Sample Content of Export Performance Package for a V9000 Storage System

If you open one of the csv files, such as for the resource type `volumes`, you will find columns identifying information for each volume, the time stamp, configuration data columns, and performance data columns, as shown in Figure 2-74.

	A	B	C	D	F	G	H	J	V	W	Z	AA	AB	AC	AD	AE	AF	A
1	Storage System	Volume	Time	Inter	Host	Pool	I/O G	Capa	Write I/O Rat	Total	Read Data Rate	Write Data Rate	Total Data Ra	Read Response Tir	Write Respons	Overall Response	Read	Wri
2522	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:33 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1059.15	1517.48	1.79	4.14	5.93	0.38	0.5	0.47	4	
2598	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:34 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1054.72	1511.82	1.79	4.12	5.91	0.39	0.51	0.47	4	
2674	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:35 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1055.3	1508.87	1.77	4.12	5.89	0.39	0.52	0.48	4	
2750	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:37 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1015.98	1453.33	1.71	3.97	5.68	0.39	0.51	0.48	4	
2826	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:38 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1055.78	1504.2	1.75	4.12	5.88	0.39	0.51	0.48	4	
2902	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:39 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1063.08	1516.93	1.77	4.15	5.93	0.39	0.52	0.48	4	
2978	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:40 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1062.68	1514.57	1.77	4.15	5.92	0.39	0.51	0.48	4	
3054	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:41 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1066.95	1529.43	1.81	4.17	5.97	0.39	0.52	0.48	4	
3130	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:42 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1004.32	1437.33	1.69	3.92	5.61	0.39	0.51	0.48	4	
3206	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:43 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1067.15	1525.38	1.79	4.17	5.96	0.39	0.52	0.48	4	
3282	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:44 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1059.55	1517.23	1.79	4.14	5.93	0.39	0.52	0.48	4	
3358	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:45 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1062.62	1515.05	1.77	4.15	5.92	0.39	0.52	0.48	4	
3434	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:46 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	1050.22	1496.05	1.74	4.1	5.84	0.39	0.52	0.48	4	
3510	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:47 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	989.48	1411.55	1.65	3.87	5.51	0.39	0.52	0.48	4	
3586	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:48 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	441.47	626.55	0.72	1.72	2.45	0.4	0.55	0.5	4	
3662	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:49 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	437.95	624.73	0.73	1.71	2.44	0.4	0.55	0.51	4	
3738	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:50 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	439.87	627.92	0.73	1.72	2.45	0.4	0.55	0.51	4	
3814	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:51 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	433.72	622.15	0.74	1.69	2.43	0.39	0.54	0.5	4	
3890	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:52 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	433.47	614.97	0.71	1.69	2.4	0.4	0.56	0.52	4	
3966	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:53 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	835.3	1198.12	1.42	3.26	4.68	0.42	0.64	0.57	4	
4042	FlashSystem V9000-984	AIX_HS_7.7_0	8/21/16 6:54 PM	60	p7-770-04v7.n	mdiskgrp3_	io_grp0	100	876.48	1248.55	1.45	3.42	4.88	0.42	0.63	0.57	4	

Figure 2-74 Sample Output of a Volumes.csv File for a V9000 Storage System

The downloaded zip file also contains a `log.txt` file with many rows per resource type collected and downloaded. If there were any errors during the data collection or the download, they will be shown in the `log.txt` file, as illustrated in Example 2-9.

Example 2-9 log.txt file example

```
Performance report exported with 'sample' data for block storage system A9000 on
August 18, 2017 10:40:34 AM PDT.
Time range of report: August 18, 2017 6:40:24 AM PDT with a duration of 4 hours 0
minutes.

Storage System data: 240 rows were processed.
Port data: 1,440 rows were processed.
Host Connection data: 240 rows were processed.
Pool data: 960 rows were processed.
Volume data: 61,696 rows were processed.
Module data: 723 rows were processed.
```

Note: If you create performance packages for multiple devices, you might run into NTFS restrictions while unzipping the files and receive a “path too long” error. In this situation, either move the files to a directory with a shorter path or rename the files to reduce the length of the path name.

2.5.3 REST API

Although the Representational State Transfer (REST) API implementation for Spectrum Control is not a reporting tool, it can be used to access information about resources in json format.

Using the browser:

The IBM Spectrum Control REST API is hosted here:

`https://<hostname>:9569/srm/REST/api/v1/`

To get a list of StorageSystems with their configuration data, specify the following URL:

`https://<hostname>:9569/srm/REST/api/v1/StorageSystems`

A sample output result is shown in Example 2-10.

Example 2-10 Example output of a REST request for Storage Systems

```
[
   {
      "Acknowledged": "No",
      "Allocated Space": "8,830.84",
      "Assigned Volume Space": "100",
      "Available Pool Space": "685,792.00",
      ....
      "Firmware": "8.1.0.0 (build 137.3.1708160754000)",
      "Last Successful Monitor": "Aug 17, 2017, 20:40:00",
      "Last Successful Probe": "Aug 16, 2017, 21:21:03",
      ....
      "Model": "DH8",
      "Name": "ssd-svc-dh8-01",
      ....
```

```
      "Type": "SAN Volume Controller - 2145",
      "id": "7494"
   },
   {
      "Acknowledged": "No",
      "Allocated Space": "22,994.68",
      ....
      "FlashCopy": "30",
      "IP Address": "9.155.112.248",
      ....
      "Raw Disk Capacity": "64,820.05",
      "Read Cache": "452.56",
      "Remote Relationships": "331",
      "Serial Number": "75FAW81",
      "Shortfall": "27",
      "Status": "Normal",
      ....
      "Type": "DS8000",
      "Unassigned Volume Space": "5,555.81",
      "Unprotected Volumes": "1567",
      "Unreserved Pool Space": "24,245.00",
      "Used Pool Space": "24,003.00",
      "Used Space": "22,994.68",
      "Vendor": "IBM",
      "Virtual Allocation": "49.31",
      "Volumes": "1,861",
      "Write Cache": "32.00",
      "id": "7540"
   },
      ....
}
]
```

Adding the StorageSystem id and a resource type, for example Volumes, to the URL will display a list of volumes for that storage system:

```
https://<hostname>:9569/srm/REST/api/v1/StorageSystems/<StorageSystem id>/Volumes
```

To get a list of available performance metrics for a StorageSystem, add **`Volume id /Performance`** in the URL:

```
https://<hostname>:9569/srm/REST/api/v1/StorageSystems/<StorageSystem
id>/Volumes/<Volume id>/Performance
```

You can also specify a specific metric id:

```
https://<hostname>:9569/srm/REST/api/v1/StorageSystems/<StorageSystem
id>/Volumes/<Volume id>/Performance/<metric id>
```

Example 2-11 shows the response times of a A9000 Volume in json format.

Example 2-11 Using RESTAPI to get performance data

```
https://9.155.122.36:9569/srm/REST/api/v1/StorageSystems/6510O/Volumes/2160532/Per
formance/823

[
   {
```

```
      "metricDetails": {
         "823": {
            "description": "Average number of milliseconds that it took to service
each write operation, for a particular component over a particular time
interval.",
            "name": "Write Response Time",
            "units": "ms\/op"
         }
      }
   },
   {
      "componentId": 2160532,
      "current": [
         {
{
            "x": 1503016447000,
            "y": "0.00"
         },
},
       {
            "x": 1503016747000,
            "y": "16.07"
         },
         {
            "x": 1503016807000,
            "y": "16.07"
         },
         {
            "x": 1503016867000,
            "y": "16.73"
         },
         {
            "x": 1503016928000,
            "y": "16.48"
         },
         {
            "x": 1503016987000,
            "y": "16.69"
         },
         {
            "x": 1503017047000,
            "y": "16.01"
         },
         {
            "x": 1503017107000,
            "y": "16.25"
         },
```


Multiple resources and multiple metrics can be queried at the same time by using the following syntax:

```
https://<hostname>:9569/srm/REST/api/v1/StorageSystems/<StorageSystem
id>/Volumes/Performance?<metric id1>,<metric id2>,<metric id3>&ids=<Volume
id1>,Volume id3>,Volume id3>
```

A sample output is shown in Example 2-12.

Example 2-12 Querying multiple metrics and multiple resources

```
https://9.155.122.36:9569/srm/REST/api/v1/StorageSystems/65100/Volumes/Performance?metrics=823,8
22,821&ids=2160532,2160549,2160521


[
   {
      "metricDetails": {
         "821": {
            "description": "Average number of mebibytes (2^20 bytes) per second transferred for
read and write operations.",
            "name": "Total Data Rate",
            "units": "MiB\/s"
         },
         "822": {
            "description": "Average number of milliseconds that it took to service each read
operation, for a particular component over a particular time interval.",
            "name": "Read Response Time",
            "units": "ms\/op"
         },
         "823": {
            "description": "Average number of milliseconds that it took to service each write
operation, for a particular component over a particular time interval.",
            "name": "Write Response Time",
            "units": "ms\/op"
         }
      }
   },
   {
      "componentId": 2160521,
      "current": [
         {
            "x": 1502985600000,
            "y": null
         },
         {
            "x": 1502987827000,
            "y": "0.32"

....
{
            "x": 1503075600000,
            "y": null
         }
      ],
      "deviceId": 65100,
      "deviceName": "AIX_BIG_001<br \/> A9000",
      "endTime": 1503075600000,
      "label": "Write Response Time",
      "maxValue": 40.56,
      "metricId": 823,
      "minValue": 0.0,
      "precision": 2,
```

```
      "resourceID": 2160521,
      "startTime": 1502989200000,
      "units": "ms\/op"
   },
   {
      "componentId": 2160521,
      "current": [
         {
            "x": 1502989200000,
            "y": null
         },
         {
            "x": 1502989327000,
            "y": "0.20"

....
],
      "deviceId": 65100,
      "deviceName": "AIX_BIG_001<br \/> A9000",
      "endTime": 1503075600000,
      "label": "Read Response Time",
      "maxValue": 101.56,
      "metricId": 822,
      "minValue": 0.0,
      "precision": 2,
      "resourceID": 2160521,
      "startTime": 1502989200000,
      "units": "ms\/op"
   }, },
   {
      "componentId": 2160532,
      "current": [
         {
            "x": 1502989200000,
            "y": null
         },
         {
            "x": 1502989327000,
            "y": "0.00"
```


Tip: The timestamps are shown in epoch time. To convert the timestamps, use the EpochConverter.

The granularity as well as start and end time for the performance data can be specified as well:

```
https://<server>:9569/srm/REST/api/v1/StorageSystems/<id>/Volumes/<vol
id>/Performance/824?granularity=sample&startTime=1471935241000&endTime=14720215680
00
```

Note: The REST API syntax is case sensitive.

Reference: For more information regarding the implementation of the RESTful API in IBM Spectrum Control, see IBM Knowledge Center.

Using Wget

GNU Wget is a free software package that retrieves content from web servers using HTTP, HTTPS, and FTP and is part of the GNU Project.

Reference: wget can be downloaded from the GNU website.

For authentication, a security token can be stored in a file, such as `cookies.txt` for later queries, as shown in Example 2-13.

Example 2-13 Authentication token

```
wget --post-data "j_username=<username>&j_password=<password>" --no-check-certificate
--keep-session-cookies --save-cookies cookies.txt
https://<servername>:9569/srm/j_security_check
```

Now this security token can be used for queries against the IBM Spectrum Control's REST API, as illustrated in Example 2-14.

Example 2-14 Retrieving the authentication token

```
wget --no-check-certificate --load-cookies cookies.txt -O Output.html
https://<servername>:9569/srm/REST/api/v1/StorageSystems/<id>/Volumes
```

In Example 2-15, the previously saved security token in `cookies.txt` is being used for the authentication. The output of this request is then saved in the file `Output.html`, but still in the JSON format.

To parse the JSON output, a tool like JSON query (jq) can be used.

Reference: JSON Query can be obtained from the GitHub website.

Example 2-15 Parsing the json output file

```
C:\Users\IBM_ADMIN>type C:\SpectrumControl\wget\Output.html |jq -r
".[]|[.id,.Name,.Capacity,.\"Storage System\"]|@csv"
"2160667","AIX_HS_027","45.63","A9000"
"2160664","AIX_HS_024","45.63","A9000"
"2160665","AIX_HS_025","45.63","A9000"
"2160666","AIX_HS_026","45.63","A9000"
"2160668","AIX_HS_028","45.63","A9000"
"2160669","AIX_HS_029","45.63","A9000"
"216067O","AIX_HS_030","45.63","A9000"
"2160671","AIX_HS_031","45.63","A9000"
"2160672","AIX_HS_032","45.63","A9000"
"2160673","AIX_HS_033","45.63","A9000"
"2160675","AIX_HS_035","45.63","A9000"
```

To get rid of the quotation marks and backslashes, the **jq** command can be combined with the **sed** utility, as illustrated in Example 2-16.

Example 2-16 The sed utility

```
C:\Users\IBM_ADMIN>type C:\SpectrumControl\wget\Output.html |jq -r
".[]|[.id,.Name,.Capacity,.\"Storage System\"]|@csv" |sed -e "s/\"*//g"
2160667,AIX_HS_027,45.63,A9000
```

```
2160664,AIX_HS_024,45.63,A9000
2160665,AIX_HS_025,45.63,A9000
2160666,AIX_HS_026,45.63,A9000
2160668,AIX_HS_028,45.63,A9000
2160669,AIX_HS_029,45.63,A9000
2160670,AIX_HS_030,45.63,A9000
2160671,AIX_HS_031,45.63,A9000
2160672,AIX_HS_032,45.63,A9000
2160673,AIX_HS_033,45.63,A9000
2160674,AIX_HS_034,45.63,A9000
```

2.5.4 IBM Cognos

In IBM Spectrum Control, it is possible to run and view predefined Cognos reports and create custom reports. The Cognos reporting engine is accessible using the **Reports** action in the top navigation bar.

IBM Spectrum Control provides over 70 predefined reports that display capacity and performance information collected by IBM Spectrum Control. Charts are automatically generated for most of the predefined reports. Depending on the type of resource, the charts show statistics for space usage, workload activity, bandwidth percentage, and other statistics. You can schedule reports and specify to create the report output in HTML, PDF, and other formats. You can also configure reports to save the report output to your local file system or to send reports as mail attachments.

FlashSystem 840/FlashSystem 900 Performance data are not included in the performance package. Therefore, it is not possible to get any performance data for the FlashSystem 840/ FlashSystem 900 using Predefined reports or using the Performance package for custom reports.

However, you can use native SQL for creating queries against the FlashSystem 840/ FlashSystem 900 performance tables. Native SQL Queries can be rendered with IBM Cognos Report Studio.

Reference: For more information regarding the usage of Cognos and its functions, see *IBM Tivoli Storage Productivity Center V5.1 Technical Guide*, SG24-8053, and *IBM Spectrum Family - Spectrum Control Standard*, SG24-8321.

2.5.5 Native SQL reports

IBM Spectrum Control stores all data in a DB2 database called TPCDB that you can query easily by using native SQL.

Connections can also be done using the ODBC interface, for example with Microsoft Excel, or you can render your native SQL Query in IBM Cognos by using IBM Cognos Report Studio.

Tip: Always specify **`with ur for read only`** in your SQL Queries. Otherwise your tables might get locked during the read operation and slow down the TPCDB performance.

For more information see: `Locks and concurrency control` and `read-only-clause` at IBM Knowledge Center.

Performance data for the FlashSystem 840 / FlashSystem 900 are stored in the following DB2 tables:

- Sample performance data for flash modules, nodes, ports, and the entire subsystem:
  - T_PRF_FLSH_MODULE
  - T_PRF_FLSH_NODE
  - T_PRF_FLSH_PORT
  - T_PRF_FLSH_SYSTEM
- Hourly and daily performance data for flash modules, nodes, ports, and the entire subsystem:
  - PRF_T_FLSH_MODULE
  - T_PRF_T_FLSH_NODE
  - T_PRF_T_FLSH_PORT
  - T_PRF_T_FLSH_SYSTEM

An example of querying the Spectrum Control database using native SQL with Microsoft Excel, and an example of how to render a native SQL Query in IBM Cognos is provided in Chapter 5 of *IBM Spectrum Family - Spectrum Control Standard,* SG24-8321.

2.5.6 TPCTOOL

You can use the TPCTOOL command-line interface (CLI) to extract data from the IBM Spectrum Control database. It requires no knowledge of the IBM Spectrum Control schema or SQL query skills, but you need to understand how to use the tool. For more information regarding the TPCTOOL, see these publications:

- *IBM Tivoli Storage Productivity Center V5.2 Release Guide*, SG24-8204
- *Reporting with TPCTOOL*, REDP-4230

To get performance data for FlashSystem 900,you can use TPCTOOL as well. Proceed as follows:

1. Start a command window (**CMD**).
2. From the **<install>/cli** directory enter **tpctool -user** db2admin **-pwd** password to get the tpctool prompt.
3. Enter **lsdev -perf -l** to get the GUID of devices for which performance data is collected as shown in Example 2-17.

Example 2-17 Using TPCTOOL

```
C:\Program Files\IBM\TPC\cli>tpctool -user db2admin -pwd password
tpctool> lsdev -perf -l
GUID              Name                                          Label                    Type                        Status      Timestamp
=================================================================================================================================================
=======
100000051E0B2F42  100000051E0B2F42                              Blueswitch-1                                         UNREACHABLE
2017.07.06:13:26:22
0000020060C14298+0 SVC-2145-svc_72_73-IBM                       SVC-2145-svc_72_73-IBM   IBM SAN Volume Controller NORMAL
2017.08.18:19:48:29
00000200A1200082+0 Storwize V7000-2076-v7000_ctr_5-IBM          v7000_ctr_5              IBM Storwize V7000        NORMAL
2017.08.17:21:38:16
2107.75ACA91+0    DS8000-2107-75ACA91-IBM                       2107.75ACA91             IBM System Storage DS8000 NORMAL
2017.08.18:04:45:24
2810.1340008+0    XIV-2810-XIV_04_1340008-IBM                   XIV_04_1340008           IBM System Storage XIV    NORMAL
2017.08.18:06:24:45
00000200A1C004EA+0 Storwize V7000-2076-v7000_ctr_04-IBM         v7000_ctr_04             IBM Storwize V7000        NORMAL
2017.08.18:05:47:07
0000020063A20412+0 FlashSystem 840-9840-FlashSystem-840-03-IBM FlashSystem-840-03       IBM FlashSystem 840       NORMAL
2017.08.17:21:15:41
2810.1340010+0    XIV-2810-XIV_PFE02_1340010-IBM                XIV_PFE02_1340010        IBM System Storage XIV    NORMAL
2017.08.18:06:31:04
```

```
9835.1320902+0     FlashSystem A9000-9835-A9000R-IBM          A9000R                  FlashSystem A9000R       NORMAL
2017.08.18:12:59:26
9836.1322131+0     FlashSystem A9000-9836-A9000-IBM           A9000                   FlashSystem A9000        NORMAL
2017.08.17:21:44:36
00000203224045BC+0 FlashSystem V9000-9846-Cluster_Hotel-IBM   PFE_V9000(Cluster_Hotel) IBM FlashSystem V9000    NORMAL
2017.08.17:22:03:21
tpctool>
```

4. With **`lstype,`** you get a list of available components, as shown in Example 2-18.

Example 2-18 Output of lstype command

```
tpctool> lstype
Name         Type Description
====================================
subsystem    1    Subsystem
subsys_port  2    "HBA port"
controller   3    Controller
host_conn    4    "Host Connection"
svc_iogrp    5    "SVC I/O Group"
ds_rio       6    "RIO Loop"
stor_pool    7    "Storage Pool"
da           8    "Device Adapter"
ds_rank      9    Rank
array        10   Array
svc_mdisk    11   "SVC Managed Disk"
vol          12   Volume
switch       13   Switch
switch_port  14   "Switch Port"
svc_node     15   "SVC Node"
svc_disk     20   Disk
switch_trunk 27   "Switch Trunk"
```

5. Use **`lsmetrics`** shown in Example 2-19 to get the available performance metrics for the storage subsystem ports of FlashSystem 900.

Example 2-19 Output of lsmetrics command

```
tpctool> lsmetrics -subsys 0000020063A20412+0 -ctype subsys_port
Metric                                    Value
============================================
"Port Send Data Rate"                     858
"Port Receive Data Rate"                  859
"Port Send I/O Rate"                      852
"Port Receive I/O Rate"                   853
"Total Port I/O Rate"                     854
"Total Port Data Rate"                    860
"Port to Host Send I/O Rate"              901
"Port to Host Receive I/O Rate"           902
"Total Port to Host I/O Rate"             903
"Port to Disk Send I/O Rate"              904
"Port to Disk Receive I/O Rate"           905
"Total Port to Disk I/O Rate"             906
"Port to Local Node Send I/O Rate"        907
"Port to Local Node Receive I/O Rate"     908
"Total Port to Local Node I/O Rate"       909
"Port to Remote Node Send I/O Rate"       910
"Port to Remote Node Receive I/O Rate"    911
"Total Port to Remote Node I/O Rate"      912
```

```
"Port to Host Send Data Rate"            913
"Port to Host Receive Data Rate"         914
"Total Port to Host Data Rate"           915
"Port to Disk Send Data Rate"            916
Press Enter To Continue...
```

6. The **getrpt** command as shown in Example 2-20 lists the port sample performance data.

Example 2-20 Output of getrpt command

```
tpctool> getrpt -subsys 0000020063A20412+0 -ctype subsys_port -columns 852,853,854 -level sample
-duration 3600 -start 2017.08.17:08:00:00 -fs ;
Timestamp;Interval;Device;Component;852;853;854
================================================
2017.08.17:08:00:17;302;FlashSystem-840-03;"Canister 1, Adapter 1, Port 1";1264;1262;2526
2017.08.17:08:00:17;302;FlashSystem-840-03;"Canister 1, Adapter 1, Port 2";1264;1262;2526
2017.08.17:08:00:17;302;FlashSystem-840-03;"Canister 1, Adapter 1, Port 3";0;0;0
2017.08.17:08:00:17;302;FlashSystem-840-03;"Canister 1, Adapter 1, Port 4";0;0;0
2017.08.17:08:00:17;302;FlashSystem-840-03;"Canister 1, Adapter 2, Port 1";1262;1264;2526
2017.08.17:08:00:17;302;FlashSystem-840-03;"Canister 1, Adapter 2, Port 2";1264;1262;2526
2017.08.17:08:00:17;302;FlashSystem-840-03;"Canister 1, Adapter 2, Port 3";0;0;0
2017.08.17:08:00:17;302;FlashSystem-840-03;"Canister 1, Adapter 2, Port 4";0;0;0
2017.08.17:08:00:17;302;FlashSystem-840-03;"Canister 2, Adapter 1, Port 3";0;0;0
2017.08.17:08:00:17;302;FlashSystem-840-03;"Canister 2, Adapter 1, Port 4";0;0;0
2017.08.17:08:00:17;302;FlashSystem-840-03;"Canister 2, Adapter 2, Port 3";0;0;0
2017.08.17:08:00:17;302;FlashSystem-840-03;"Canister 2, Adapter 2, Port 4";0;0;0
2017.08.17:08:05:19;301;FlashSystem-840-03;"Canister 1, Adapter 1, Port 1";1242;1250;2492
2017.08.17:08:05:19;301;FlashSystem-840-03;"Canister 1, Adapter 1, Port 2";1245;1246;2492
2017.08.17:08:05:19;301;FlashSystem-840-03;"Canister 1, Adapter 1, Port 3";0;0;0
2017.08.17:08:05:19;301;FlashSystem-840-03;"Canister 1, Adapter 1, Port 4";0;0;0
2017.08.17:08:05:19;301;FlashSystem-840-03;"Canister 1, Adapter 2, Port 1";1244;1247;2492
2017.08.17:08:05:19;301;FlashSystem-840-03;"Canister 1, Adapter 2, Port 2";1246;1245;2492
2017.08.17:08:05:19;301;FlashSystem-840-03;"Canister 1, Adapter 2, Port 3";0;0;0
2017.08.17:08:05:19;301;FlashSystem-840-03;"Canister 1, Adapter 2, Port 4";0;0;0
2017.08.17:08:05:19;301;FlashSystem-840-03;"Canister 2, Adapter 1, Port 3";0;0;0
2017.08.17:08:05:19;301;FlashSystem-840-03;"Canister 2, Adapter 1, Port 4";0;0;0
Press Enter To Continue...
```

3

Setting thresholds and alerts

This chapter describes the following concepts:

- Defining alerts and thresholds in IBM Spectrum Control
- Alert and threshold notifications
- Guidelines for thresholds

3.1 Defining alerts and thresholds in IBM Spectrum Control

IBM Spectrum Control provides multiple possibilities to set up alerts and thresholds to help detect errors at an early stage and alert those responsible. IBM Spectrum Control also provides various options for being notified when a specified threshold was exceeded (see 3.2, “Alert and threshold notifications” on page 82) and how to suppress alerts so that you are not alerted more often than necessary. (see 3.2.6, “Alert suppressions” on page 92).

Alerts/thresholds can be defined at different levels:

- Device level
- Application level
- General group level

3.1.1 Alerts and thresholds at device level

Refer to Figure 3-1. Alerts and thresholds can be set up for each device, individually on the device itself, or on its internal resources (1). Alerts can be set on general conditions, and thresholds can be defined for capacity and performance metrics (2). Alerts can be enabled and disabled by using the switch icon (3). The severity of alerts can be adjusted (4).

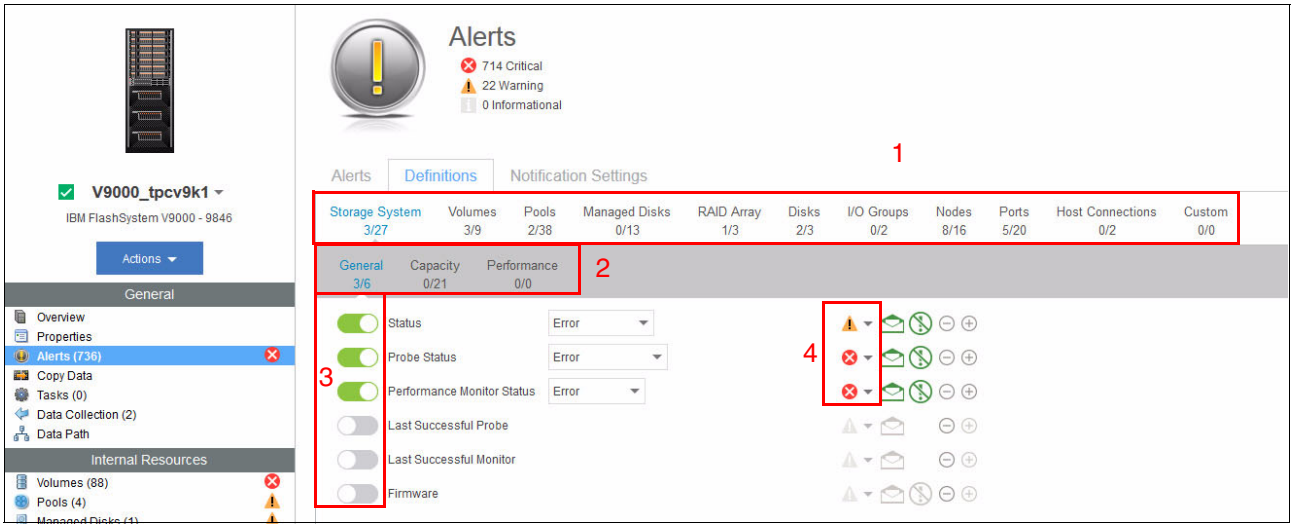

Figure 3-1 IBM Spectrum Control Alert Definition window

Performance thresholds can be defined for every performance metric that can be selected in the performance chart for the selected resource.

In addition to maximum or minimum threshold values (1), threshold ranges with different severities can be defined (2), as shown in Figure 3-2.

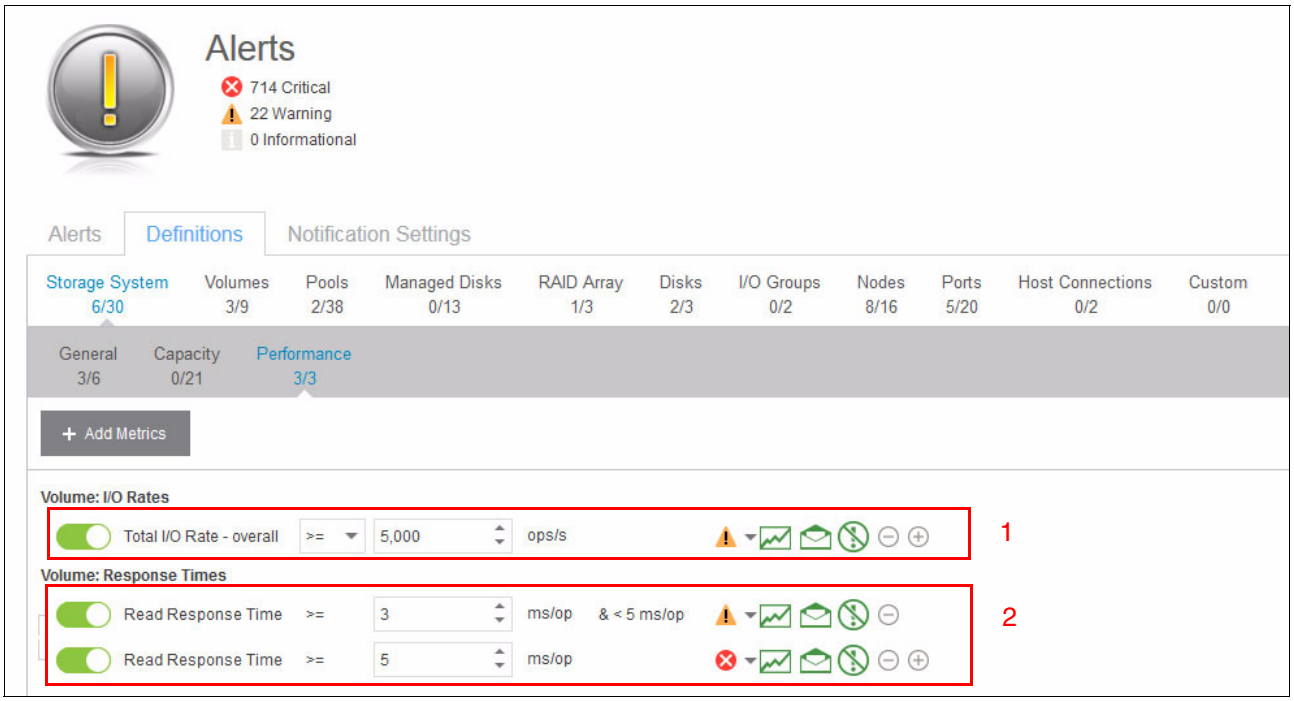

Figure 3-2 Performance Thresholds

Starting with IBM Spectrum Control version 5.2.11, multi-metric, multi-condition, and multi-component thresholds can be defined by using the Custom tab.

With this function, you can define up to five attributes that *all* need to be true to trigger a threshold violation alert, as shown in Figure 3-3. In this example, an alert is only triggered if the read response time is higher than 22 ms *and* the Read I/O Rate is higher than 100 ms/op for volumes that are thin provisioned.

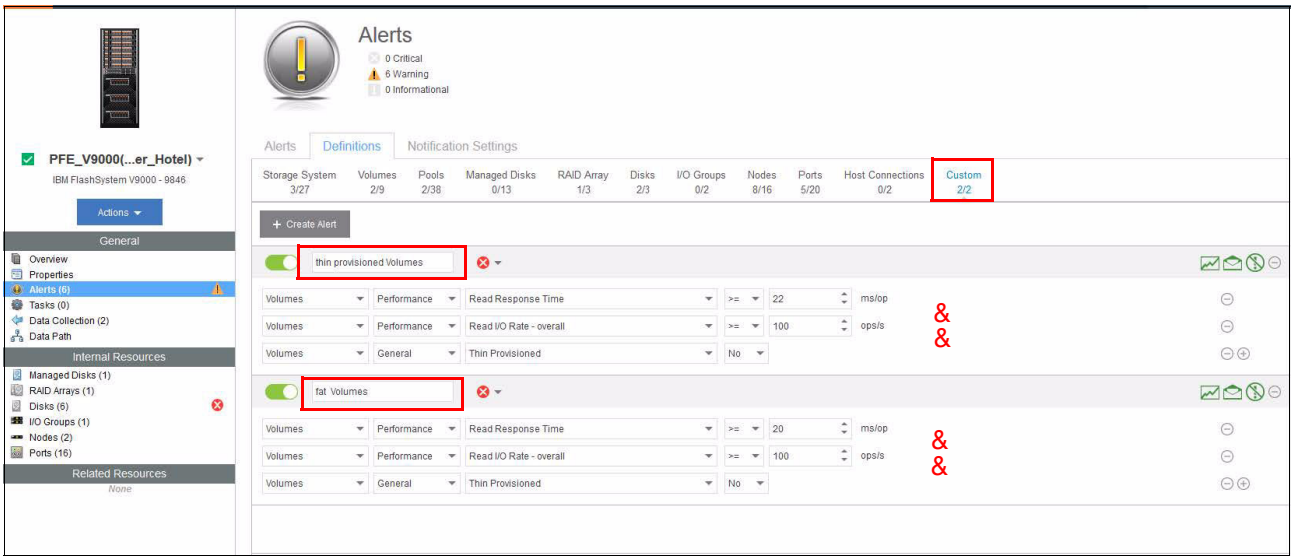

Figure 3-3 Multimetric Alert Definition in Spectrum Control

As shown in Figure 3-4, the combination of multi-components with multi-metrics is also possible using custom alert definitions.

In this example, the alert is only triggered if the read I/O rate is in the range 1,000 - 5,000 ops/s *and* the read response time is higher than 20 ms/op *and* the Pool Activity Score (which is a synonym to Access Density) is higher than 0.7 IOPS/GiB.

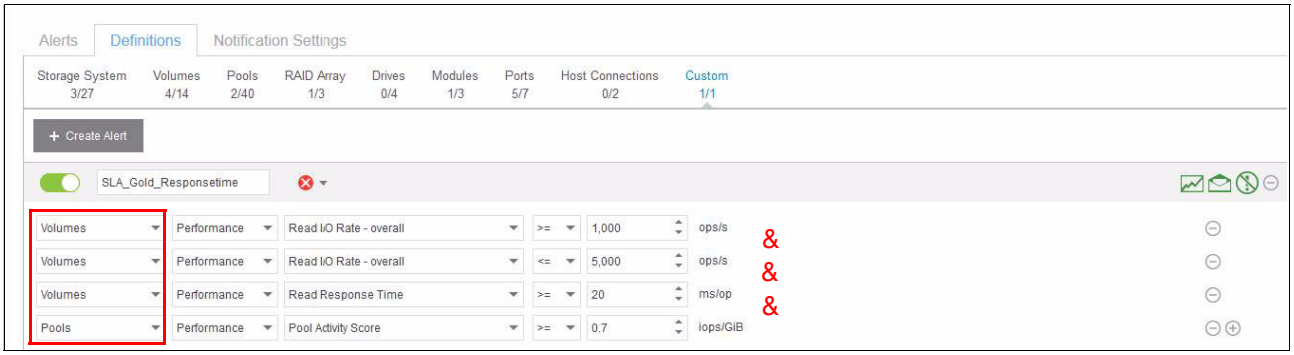

Figure 3-4 Multicomponent Alert Definition in Spectrum Control

Note: Detailed instructions on how to set up custom alerts can be found in the IBM Spectrum Control section of IBM Knowledge Center.

3.1.2 Alerts and thresholds for applications

Volumes in the same storage system might not all have the same performance requirements or performance characteristics, especially when using SAS enclosures in a V9000. Therefore, it might be necessary to set up different thresholds for different volumes or group of volumes.

Similar grouping can be done for other resources, as listed here:

- Applications
- Data stores
- Hypervisors
- File Systems (Only file systems that are monitored through a Storage Resource Agent.)
- File sets
- Servers
- Shares
- Vaults (IBM Cloud Object Storage)
- Virtual Machines
- Volumes
- Volume Groups

There are several options on how you can add resources, such as volumes, to an application:

- Using filters to assign resources to applications

  For more information, see the Spectrum Control section of IBM Knowledge Center.

- Adding resources manually to applications, which is possible using these methods:
  - Adding resources with the command-line interface
  - Adding resources individually with the command-line interface
  - Adding resources using bulk assignment

  For more information, see the IBM Spectrum Control section of IBM Knowledge Center.

The various options for creating applications are also described in section 5.2 of *IBM Spectrum Family: IBM Spectrum Control Standard Edition*, SG24-8321.

After creating applications, alert definitions can be set for the members of an application as described in 3.1.1, “Alerts and thresholds at device level” on page 72 and shown in Figure 3-5.

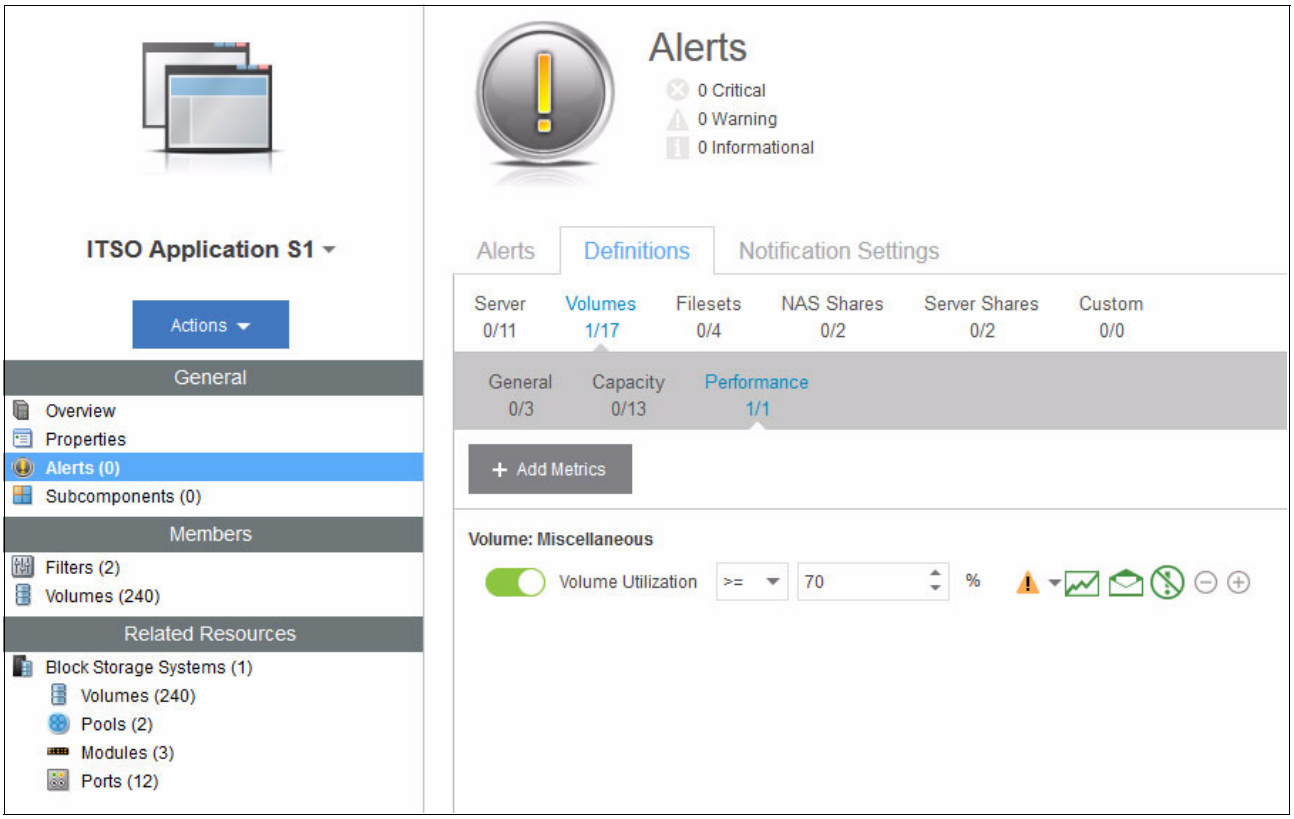

Figure 3-5 Alert definition at application level

Custom Alerts can also be created at an application level.

A hierarchy of applications can be built so that one or more subcomponents can be added to an application, as shown in Figure 3-6.

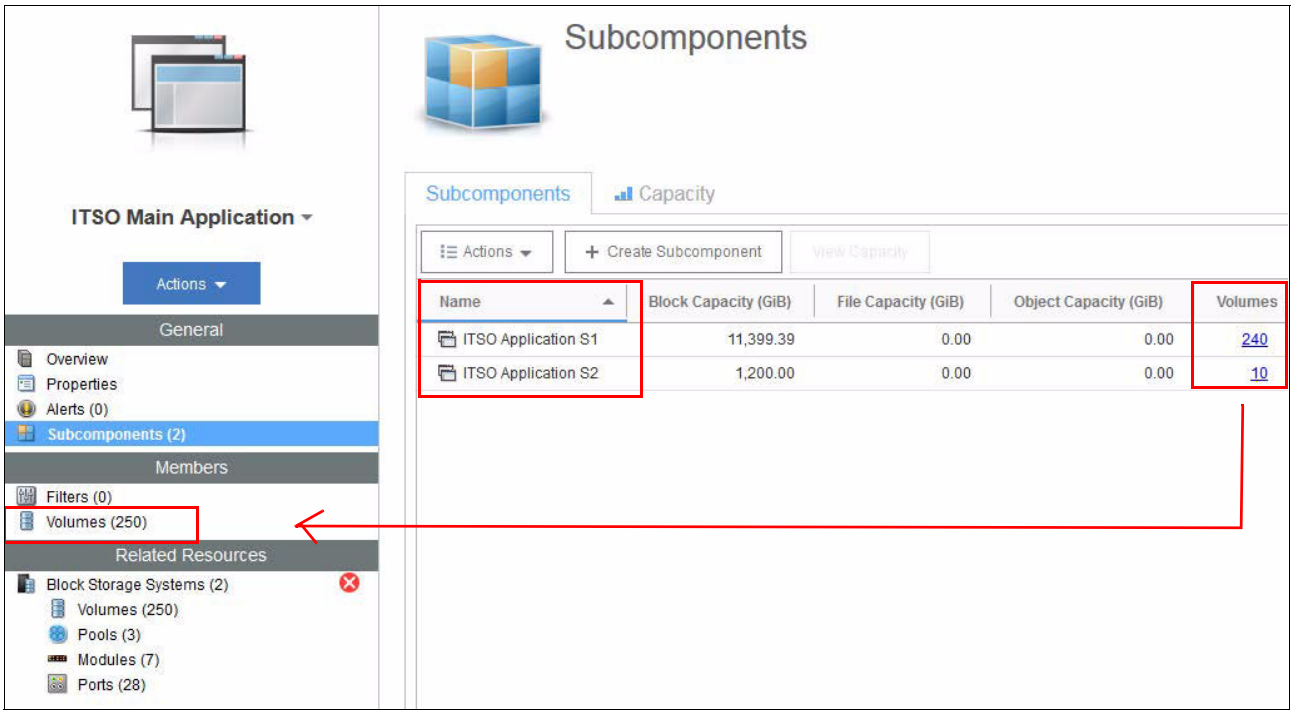

Figure 3-6 Application with Subcomponents

Alerts can be defined on the main applications as well and are valid for all subcomponents and their components, as shown in Figure 3-7.

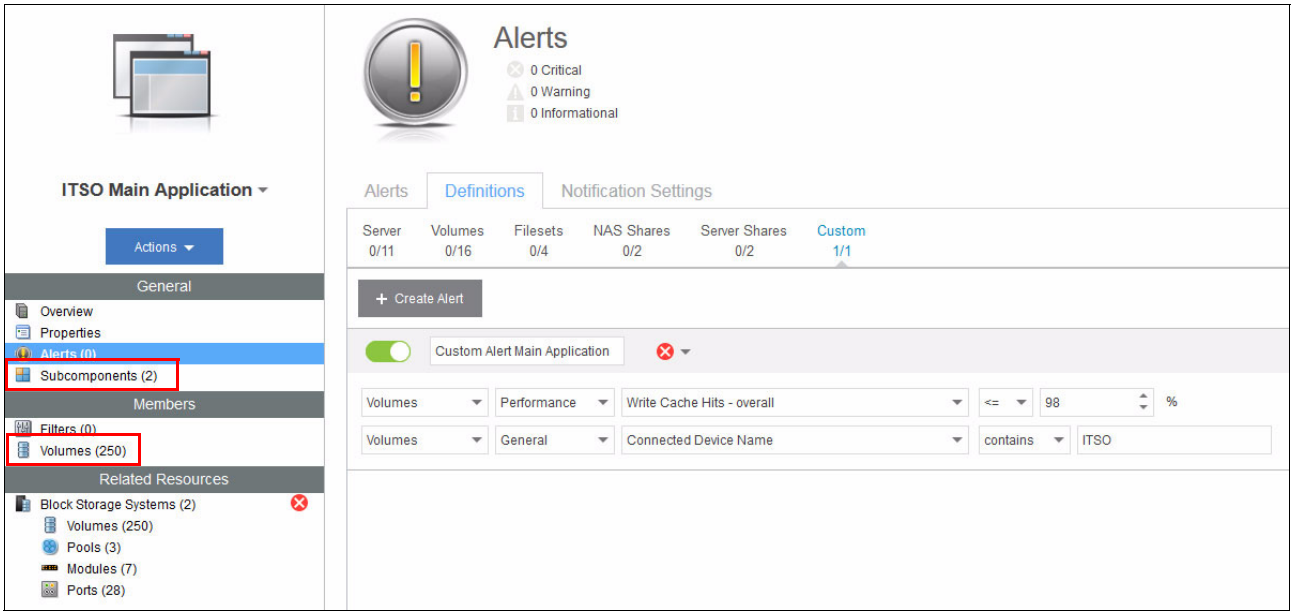

Figure 3-7 Custom alert definition for Application with Subcomponents

Considerations for creating applications

Some restrictions apply on how you can add certain resources:

- VMs cannot be added directly to an application using the GUI. Instead, you must add the VM's agentless servers[1] to applications or use the CLI.
- Vaults can only be added to applications by using the GUI.

The option of using filters to assign resources to applications provides the advantage that the created application becomes self-maintaining. Whenever a volume/resource is being created that matches the defined filter criteria, the volume/resource is automatically added to the application. If filters are not used, the newly created volumes/resources need to be added manually to the application.

If multiple filters are being used to assign resources to an application, then resources that comply to at least one of the filters are added to the application. Multiple filters are combined with the *OR* conjunction, as shown in Figure 3-8.

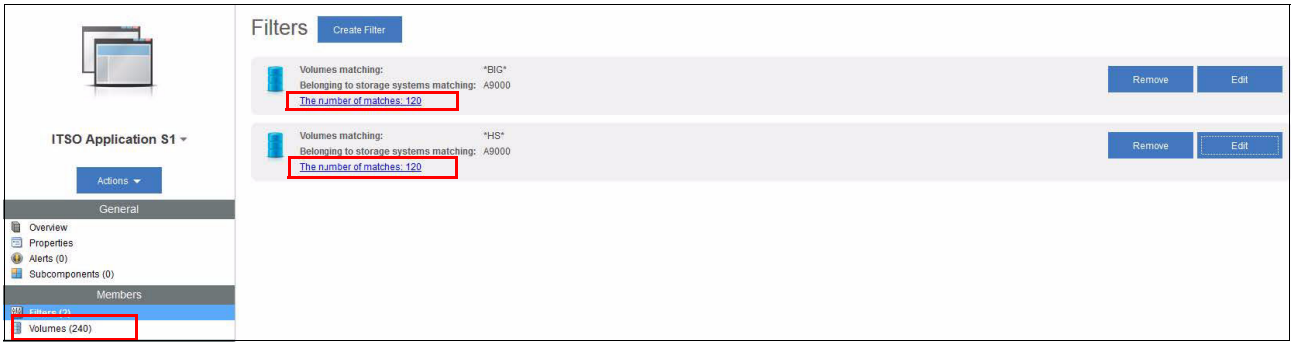

Figure 3-8 Using multiple filters to assign resources to an application

Currently, backend volumes that are virtualized by an SVC or volumes used for the IFS file system within a V7000 Unified are intentionally excluded when filters are used.

[1] Agentless servers are automatically created starting with IBM Spectrum Control v5.2.15.

3.1.3 Alerts and thresholds for general groups

Creating groups with resources others than listed for applications can be done by adding them to a general group. All kinds of resources can be added to a general group as described in the General Groups window in IBM Spectrum Control:

1. Add a resource to a general group from the page where that resource is listed. For example, to add a block storage system, go to the Block Storage Systems window, right-click a storage system, and select **Add to General Group**, as shown in Figure 3-9.

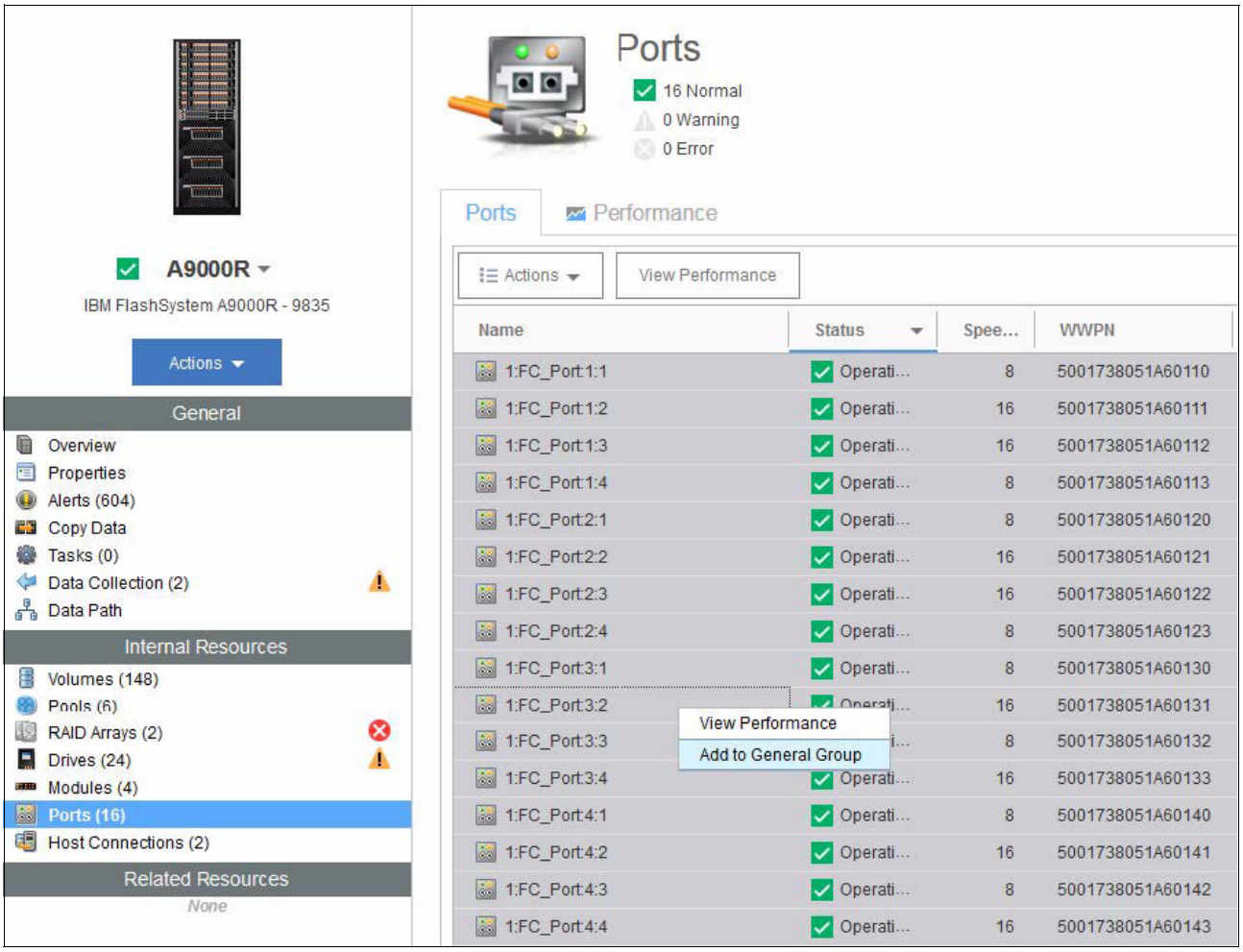

Figure 3-9 Adding Ports to General Group

2. Alerts/Thresholds can then be defined as for applications for the members of the general group, as shown in Figure 3-10.

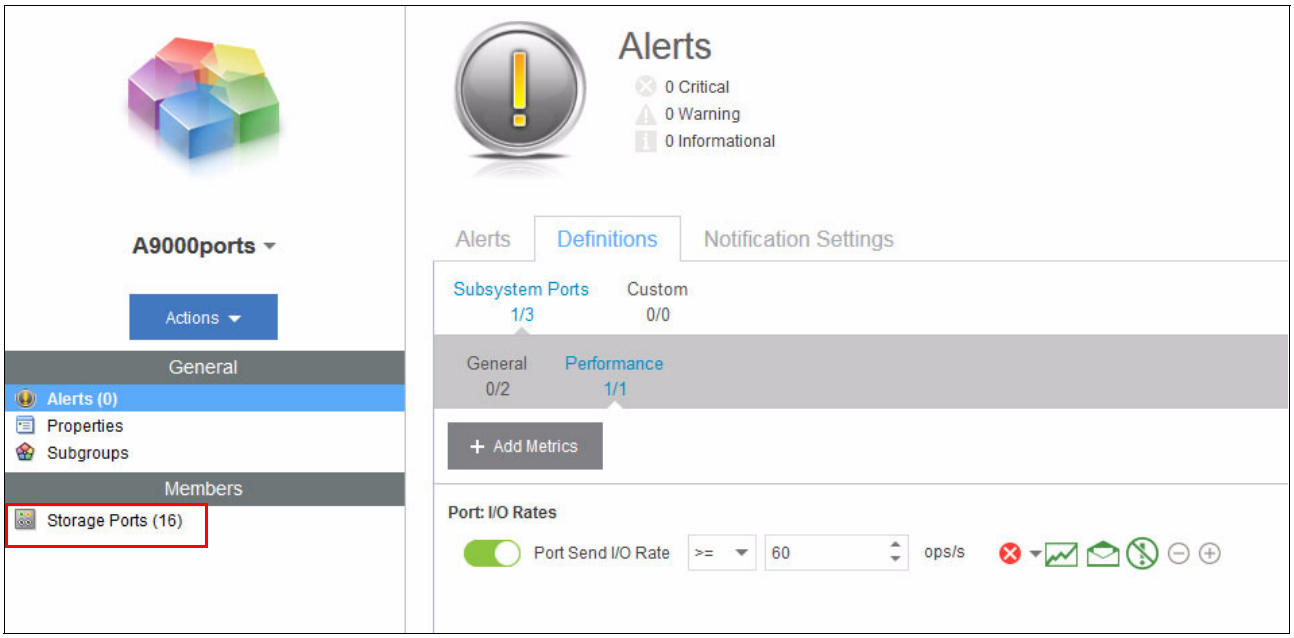

Figure 3-10 General Group Alert definition for A9000 ports

3. To avoid having to specify alerts/thresholds multiple times for the same kind of storage systems, a general group can be created. See Figure 3-11 for an example for FlashSystem A9000.

Figure 3-11 Adding multiple Storage systems to a general group

4. To be able to set up alerts/thresholds on the internal resources of the storage systems, the internal resources need to be added separately to the same general group, as shown in Figure 3-12.

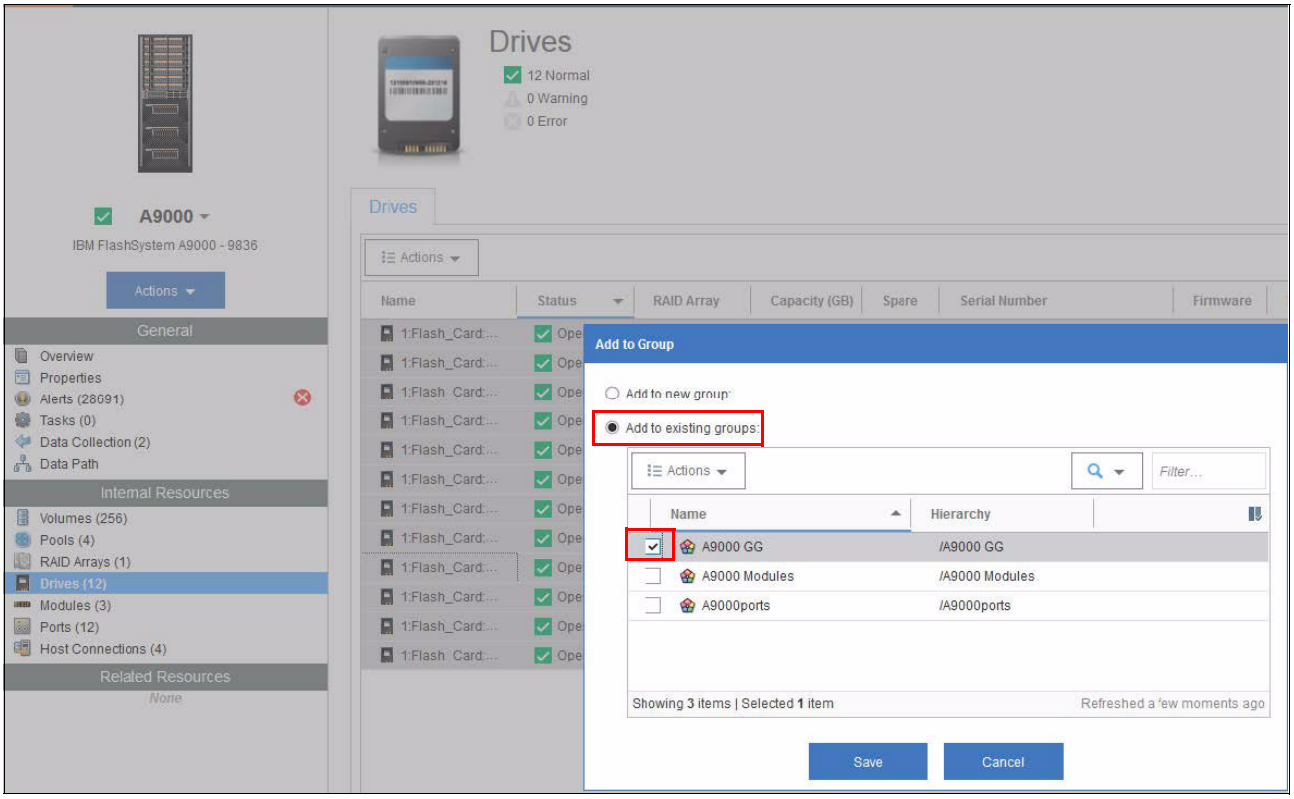

Figure 3-12 Adding internal resources to an existing general group

5. Now all thresholds can be specified on the various members of the general group including custom alerts for multiple components for all resources of the same kind.

   In the members section of Figure 3-13 (1) you can see that two A9000 systems, 404 volumes, and 10 pools were added as members to the A9000 GG General Group.

   Alert definitions can be specified for all kinds of members (2) and you can see how many alert definitions have already been configured and enabled. For instance, in Figure 3-13, one alert has been configured at the storage system level, one at port level, and one custom alert has been set up.

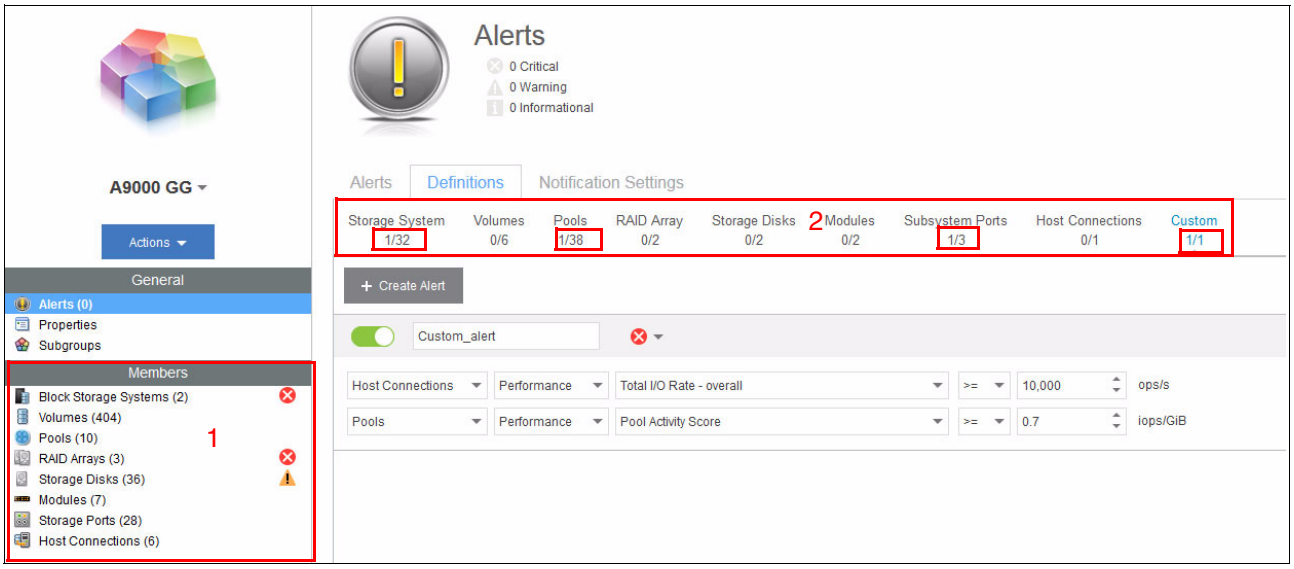

Figure 3-13 Alert definitions for multiple A9000 Storage Systems

General groups can be nested like applications.

3.1.4 Considerations about using applications and general groups

The significant advantage of using applications is that they can be created by using the filter functionality and are therefore self-maintaining.

Applications also have nice overview windows where capacity data and performance data are displayed, as shown in Figure 3-14.

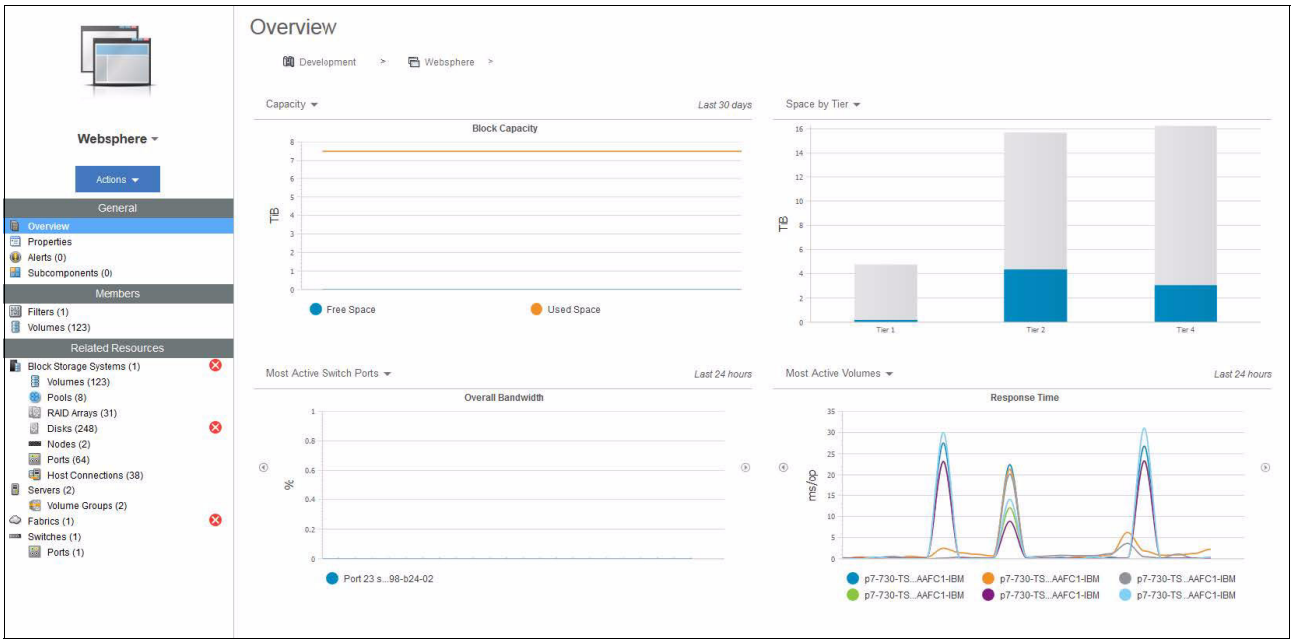

Figure 3-14 Application Overview window

Another advantage of using applications is that they also can be used for chargeback and storage consumer reports as described in the IBM Spectrum Control section of IBM Knowledge Center.

Although you only can add a few resources to applications (see Appendix 3.1.2, “Alerts and thresholds for applications” on page 74), general groups have the advantage that all kinds of resources can be added. This capability includes complete storage systems with all their internal resources. Therefore, alerts need to be defined only once at a general group level rather than configuring alerts for each storage system individually.

Because IBM Spectrum Control already provides default alerts at a device level, it might be necessary to disable them if you create similar alerts at an application or general group level

3.2 Alert and threshold notifications

Alert violations can be seen on various windows in IBM Spectrum Control, including these locations:

- General Alert tab where all alerts can be seen
- Alert tab of each device
- Alert tab of each application
- Alert tab of each of the general groups

An individual alert is shown in Figure 3-15. It shows the actual value (1), the alert condition (2), the (internal) resource that triggered the alert (3), the storage system to which the internal resource belongs (4) and, during a performance threshold violation, the performance chart with data before and after the threshold violation (5) including the defined threshold (6). The threshold violation can be easily detected (7). The chart can be opened in a new window by clicking the **Open New Window** icon (8).

Figure 3-15 Threshold violation window

The affected servers can also be easily detected, as shown in Figure 3-16.

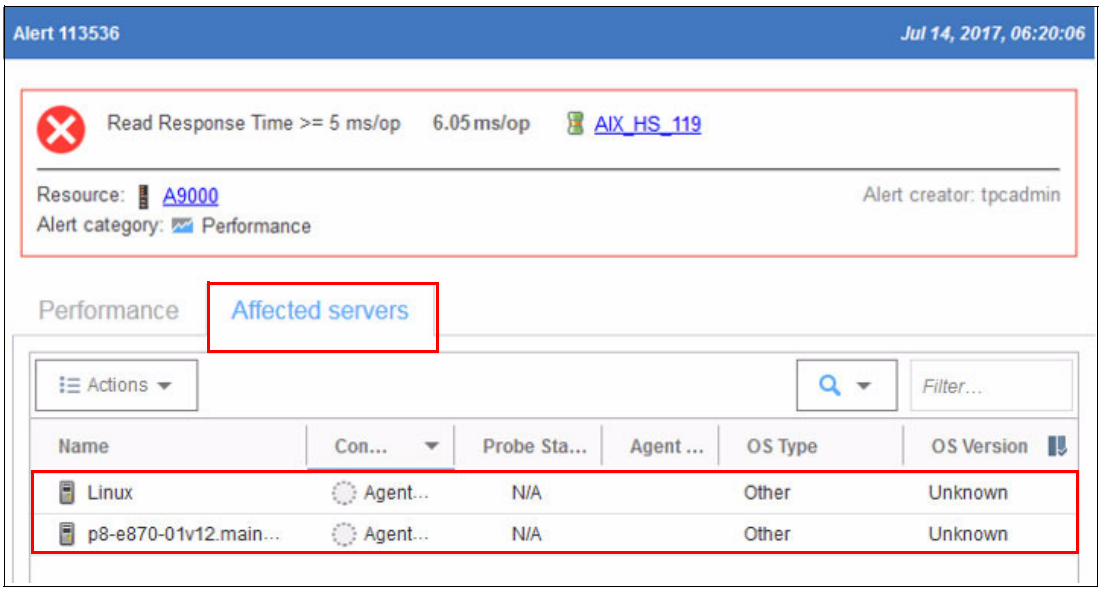

Figure 3-16 Affected Servers

Alerts can be acknowledged, exported, and removed, as shown in Figure 3-17.

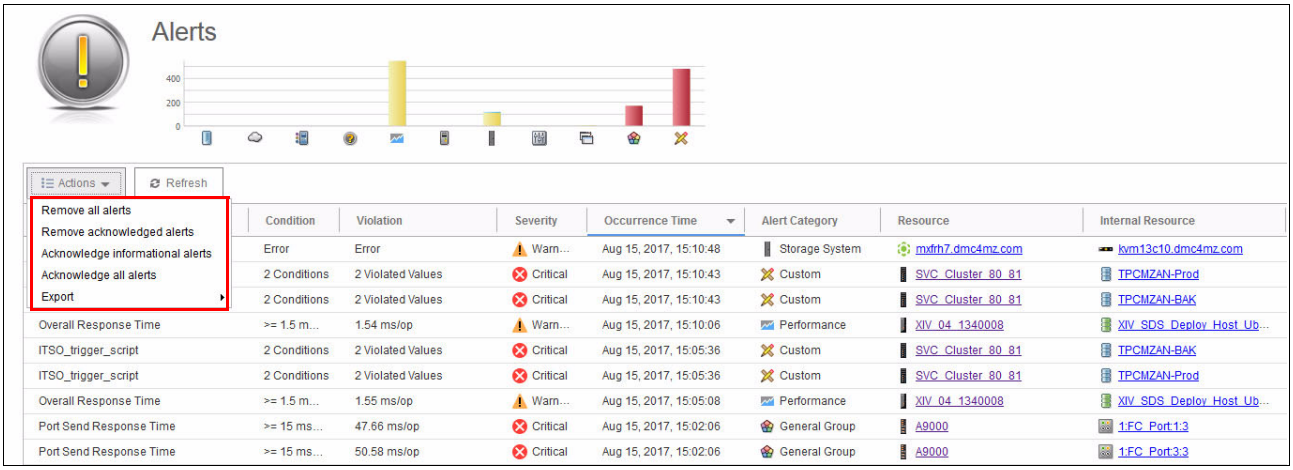

Figure 3-17 Alert actions

Notifications can be configured at these different levels:

- General setting (for email only)
- Per device
- Per group
  - Per application
  - Per subcomponent
  - Per general group
  - Per subgroup
- Per individual alert

For each of the above specified levels, it is possible to define the **Notification** action (1), which can be any of the following actions, as shown in Figure 3-18 (2):

- Create an entry in the Windows log
- Send an email
- Send an SNMP trap
- Send a notification to Netcool/OMNIbus
- Trigger a script based on an alert

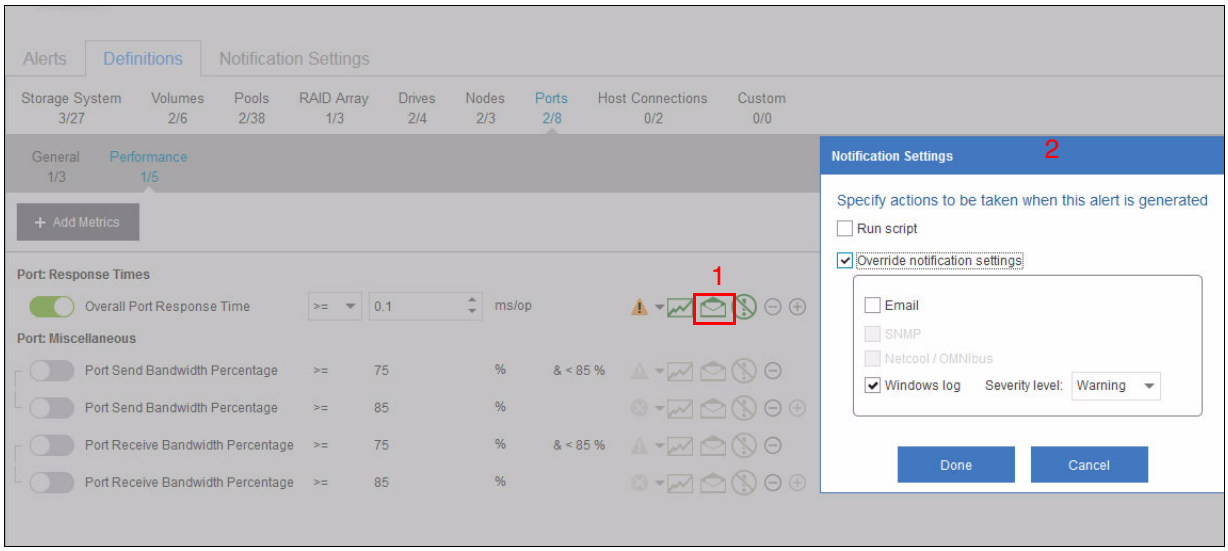

Figure 3-18 Alert configuration

3.2.1 Event notification in Windows log

If configured as shown in Figure 3-18, alert notifications are written to the Windows event log, as shown in Figure 3-19.

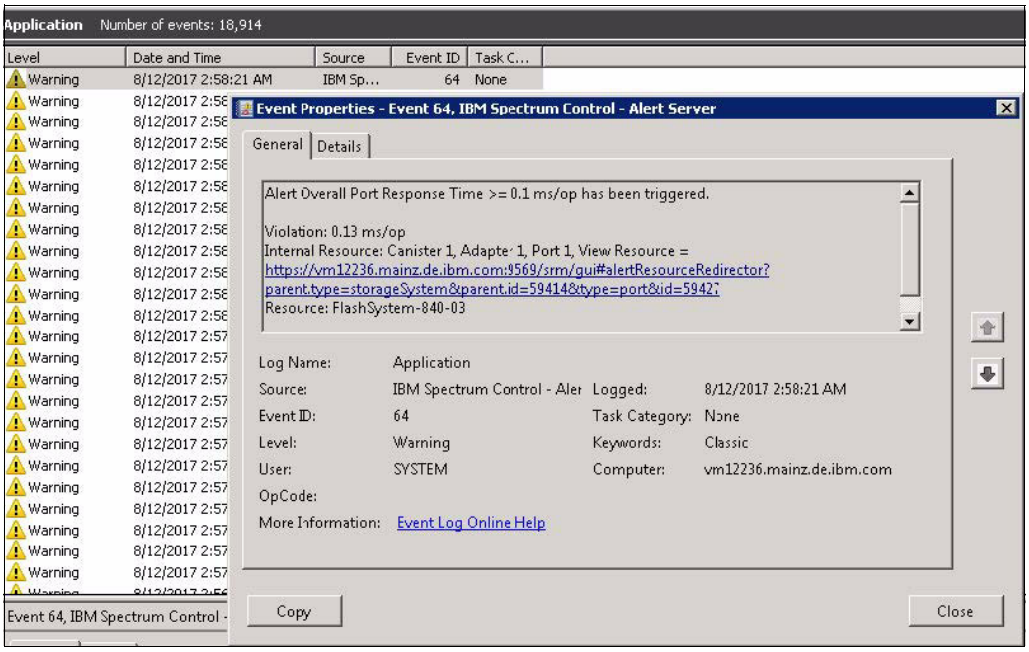

Figure 3-19 Alert notification in Windows log

Detailed information is available for each event logged.

3.2.2 Event notification to be sent by email

A prerequisite for having event notifications being sent by email is the configuration of the email server. To configure the email server, click **Settings** → **Alert Notifications** → **Email**, as shown in Figure 3-20.

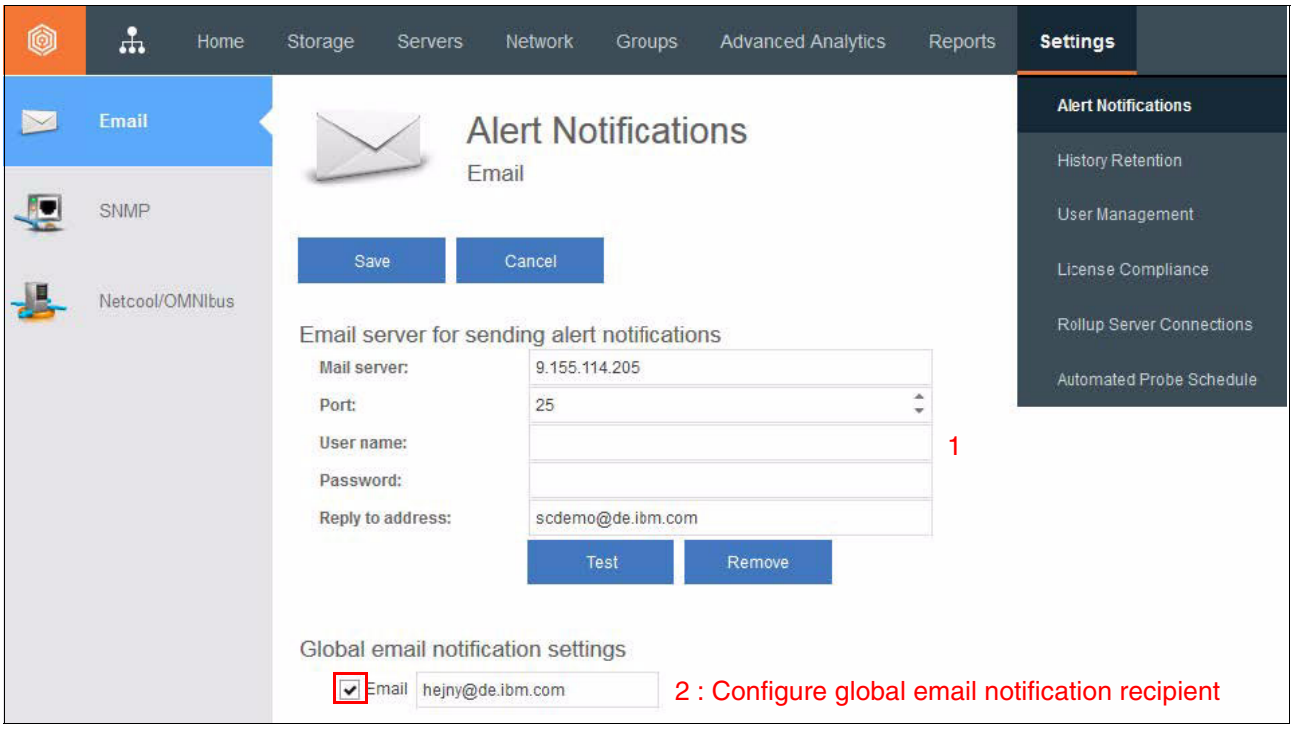

Figure 3-20 Alert Notifications using email

Here the email server can be configured, including authentication credentials (optional) (1). A Global email notification recipient can be set to receive all emails (2).

The recipient for alerts can be overridden for each individual alert definition using the email notification icon (1), selecting **Override notification settings** (2), and specifying the recipient for this specific alert definition (3), as shown in Figure 3-21.

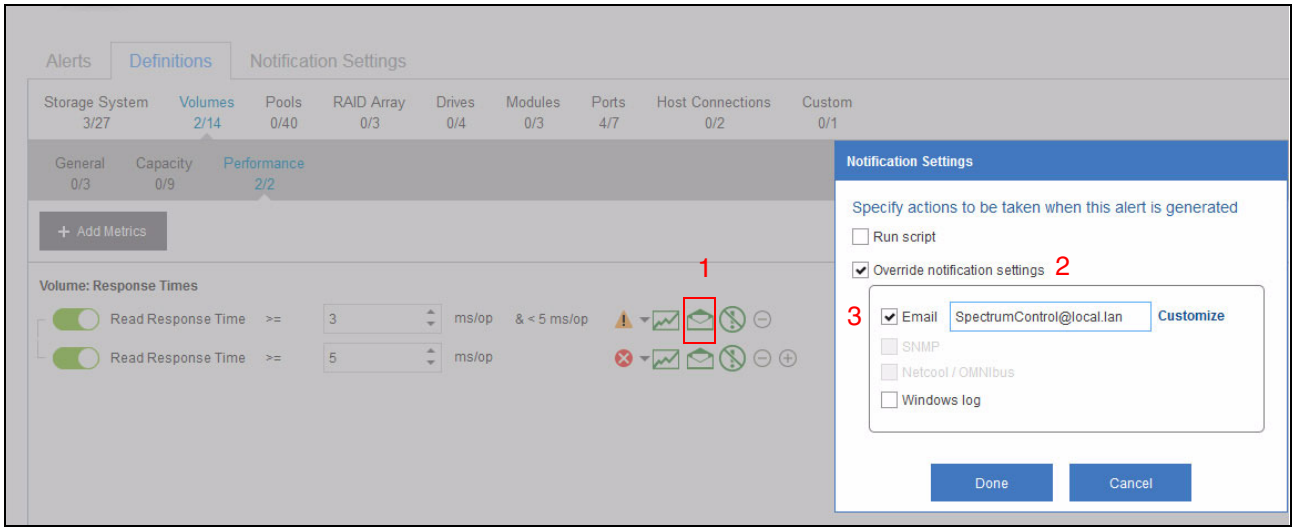

Figure 3-21 Override notification settings

Notification settings can also be overridden at a device or group level using the Notification Settings tab, as shown in Figure 3-22.

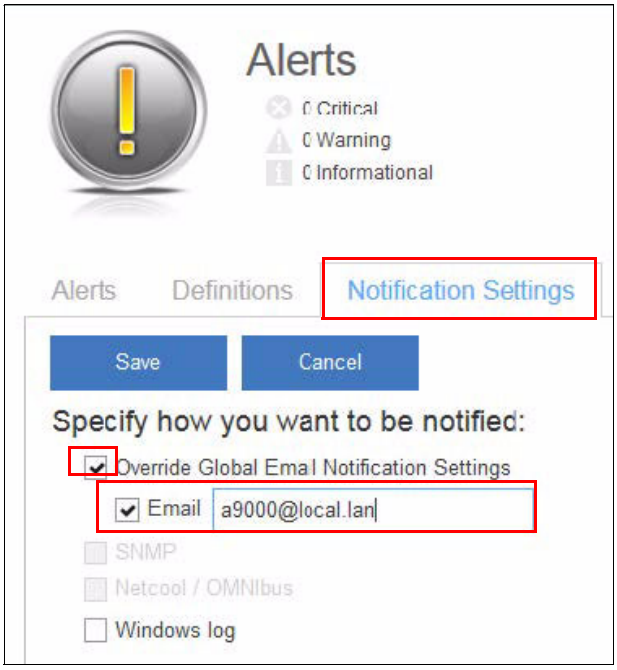

Figure 3-22 Notification Settings

Note: The event notification set at a more detailed level overrides the event notification set at a higher level within the same type. For example, the alert notification definition for an individual alert on an internal resource of a storage system overrides the alert notification definition at the storage system level. Likewise, the alert notification definition of a subcomponent overrides the alert notification definition of an application.

Security standards of the email server are automatically detected. The email server is automatically trusted, so no additional tasks are required.

When an email is sent, IBM Spectrum Control attempts to send it using various connection and encryption mechanisms, from most to least restrictive:

- Attempt Secure Sockets Layer connection from the outset with data always encrypted (usually using port 465)
- Attempt TLS encryption that can be started by STARTTLS command at SMTP level if the server supports it (usually using port 567)
- If both of the above techniques fail, attempt unsecured connection (usually using port 25)

IBM Spectrum Control now accepts all server certificates. This feature allows the administrator to connect to a restricted SMTP server without downloading and importing server certificates into the certificate store for each IBM Spectrum Control server.

The email alert notification shows the condition that was violated (1), the actual value (2), the internal resource (3), and the device to which the internal resource belongs (4). In addition, hyperlinks to the internal resource's properties book (5) and to the alert (6) are included, as shown in Example 3-1.

Example 3-1 Email alert notification sample

```
Alert Read Response Time >= 3 ms/op & < 5 ms/op has been triggered.     1

Violation: 3.22 ms/op       2
Internal Resource: AIX_HS_090,         3
View Resource =
https://vm12236.mainz.de.ibm.com:9569/srm/gui#alertResourceRedirector?parent.type=
storageSystem&parent.id=65100&type=volume&id=2160730       5
Resource: A9000       4

View Alert = https://vm12236.mainz.de.ibm.com:9569/srm/gui#alerts?id=161367    6
```

3.2.3 SNMP

Alert notifications can also be sent by SNMP trap to one or two SNMP destinations, which can be configured by selecting **Settings** → **Alert Notifications** → **SNMP**.

A second SNMP trap receiver can be configured by using the **Add SNMP Destination 2** option, as shown in Figure 3-23.

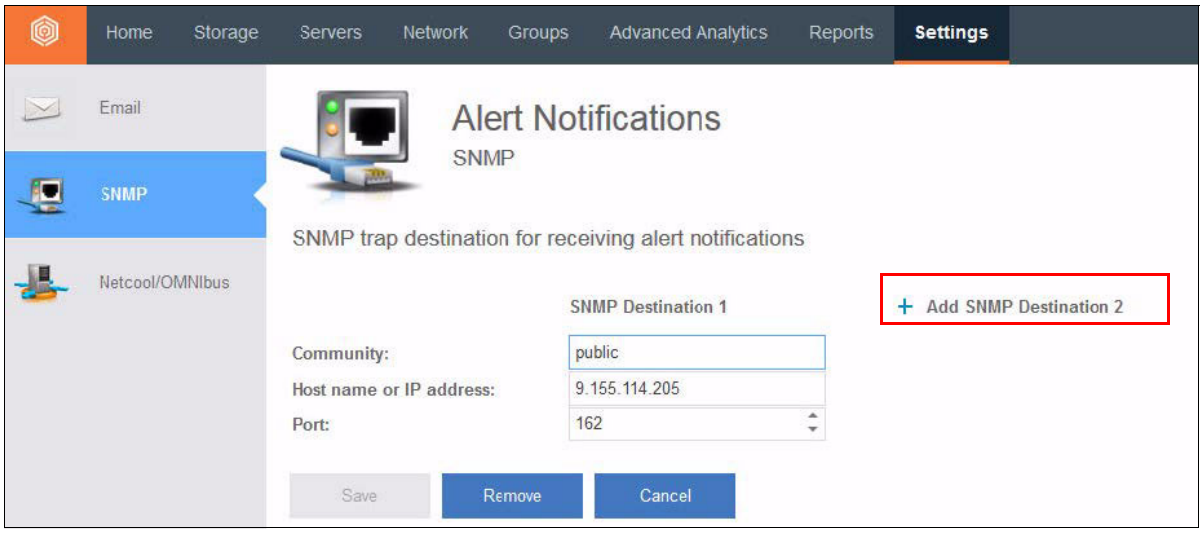

Figure 3-23 Configure SNMP trap receiver

To receive SNMP traps, the SNMP trap receiver must be configured with the appropriate Management Information Base (MIB) file.

The MIB file can be found as specified in Table 3-1.

Table 3-1 Locating the MIB file

Location of MIB file	Directory
Installation media	unzip_dir\data\snmp\tivoliSRM.mib
After IBM Spectrum Control is installed	install_dir\data\snmp\tivoliSRM.mib

3.2.4 Netcool/OMNIbus

Alert notifications can also be sent to a Netcool/OMNIbus server, which can be specified in **Settings** → **Alert Notifications** → **Netcool/OMNIbus**, as shown in Figure 3-24.

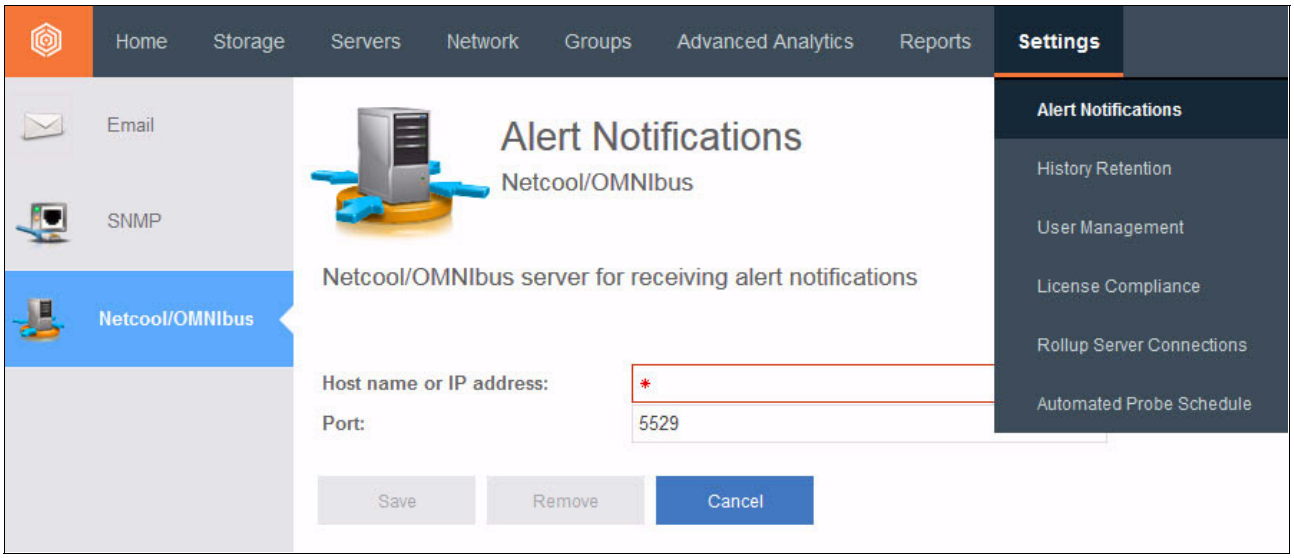

Figure 3-24 Netcool/OMNIbus configuration in IBM Spectrum Control

The Netcool/OMNIbus server must be configured to handle alert notifications sent by IBM Spectrum Control. It requires the Event Integration Facility (EIF) rule files that can be obtained from the IBM Spectrum Control server, as listed in Table 3-2.

Table 3-2 Event Integration Facility (EIF)

Rules file names	Location of rules files in IBM Spectrum Control	Copy rules files to this location in IBM Tivoli® Netcool/OMNIbus
tivoli_eif_tpc.rules tivoli_eif_tpc_tbsm.rules	extracted_installation_image/data/omnibus	$OMNIHOME/probes/arch/

Reference: For more information, see IBM Knowledge Center, at Configuring Tivoli Netcool/OMNIbus alert notifications.

3.2.5 Trigger a script based on an alert

After an alert was triggered, scripts can be run from any server where a storage resource agent (SRA) is deployed (including the IBM Spectrum Control server). After clicking the **Alert notification** icon (1), select **Run script**, and then **Upload script** (3). The available parameters can be passed on to a script are listed (4), as shown in Figure 3-25.

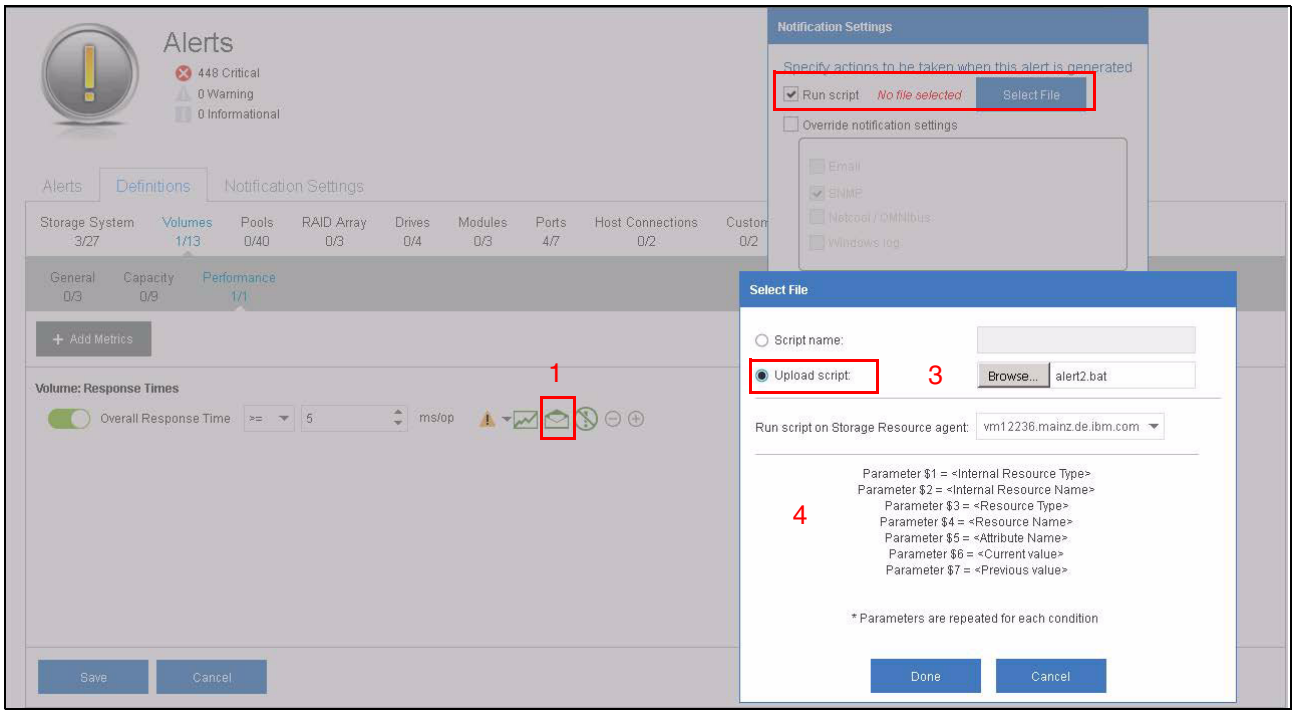

Figure 3-25 Triggered Run script functionality

The script file MUST be in either of these subdirectories:

- `<install_dir>\IBM\TPC\data\scripts`
- `<install_dir>\IBM\TPC\agent\scripts`

It might be necessary to **Enable running scripts on agent** on the server's SRA, as shown in Figure 3-26.

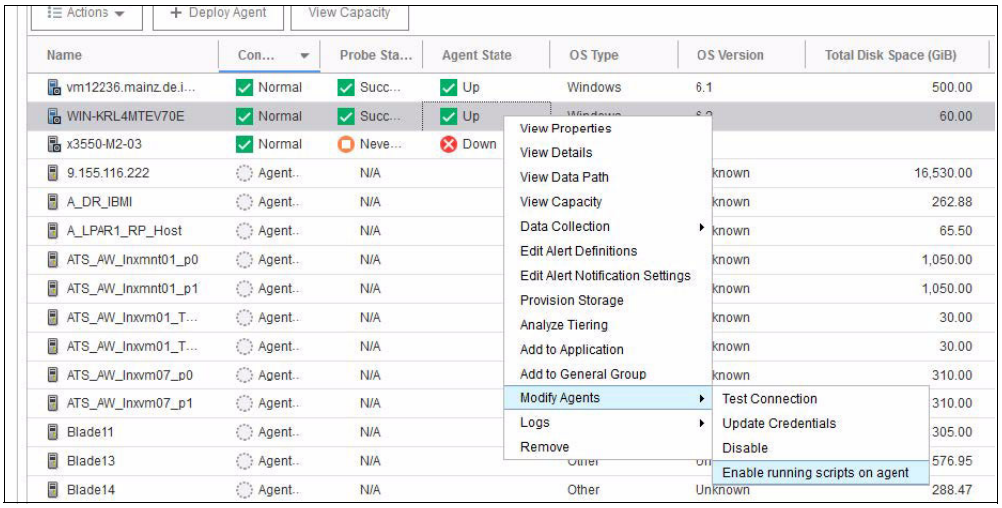

Figure 3-26 Enable running scripts on agent

3.2.6 Alert suppressions

To avoid getting unnecessary alerts, you can proactively suppress alerts that you do not need.

Four different settings can be specified after selecting the **Alert Removal** icon, as shown in Figure 3-27.

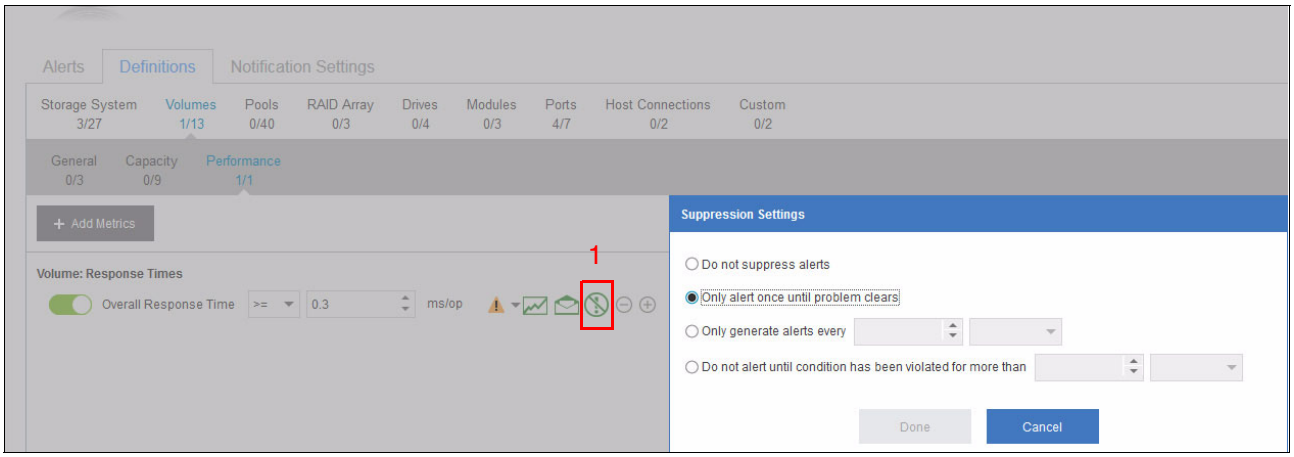

Figure 3-27 Suppression Settings in IBM Spectrum Control

- Option 1: Do not suppress alerts:

  All alerts / threshold violations will generate the specified notification. This setting means that if the performance data is collected every minute, the notifications are sent out every minute while the threshold violation persists.

- Option 2: Only alert once until problem clears (default setting)

  The notification is triggered at the beginning of the threshold violation (1), and no notifications are sent while the threshold violation persists (2). If the threshold violation recurs (3) after it had been cleared (4), the notification will be sent out again, as shown in Figure 3-28.

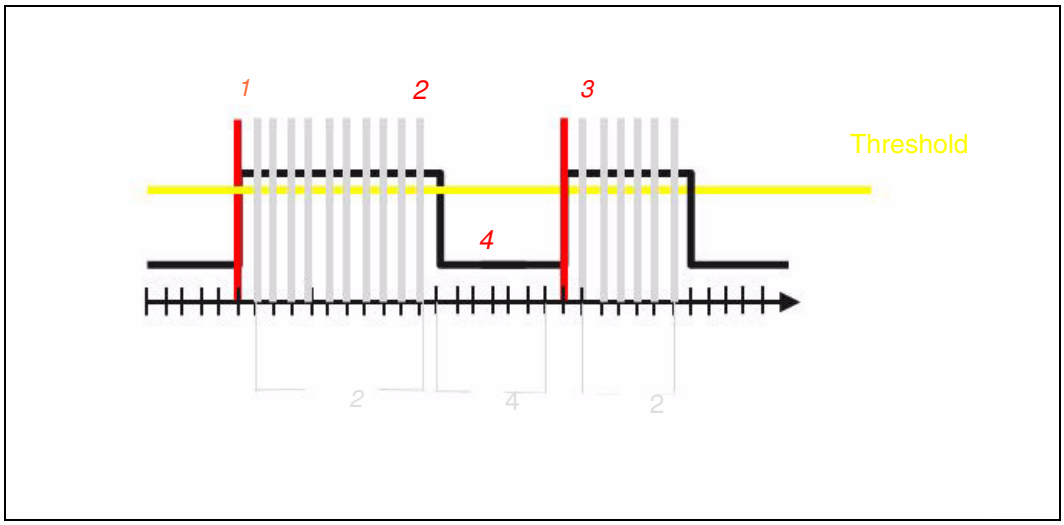

Figure 3-28 Only alert once until problem clears

- Option 3: Only generate alerts every x minute(s)/hour(s)/day(s)

  With option 2, no notification is sent while the problem persists. Therefore, there is no difference between (2) and (4) in the number of notifications that are sent. To get notified if the problem still persists, select this option.

  Figure 3-29 shows that while the threshold violation persists, notifications are sent out every x minute(s)/hour(s)/day(s) (5).

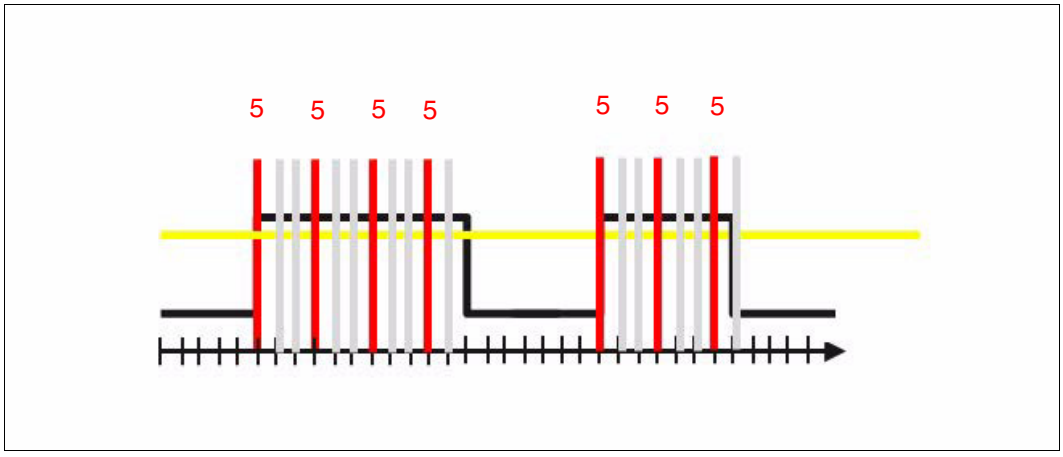

Figure 3-29 Only generate alerts every x minute(s)/hour(s)/day(s)

- Option 4: Do not alert until condition has been violated for more than x minute(s)/hour(s)/day(s)

  Sometimes it is not necessary to be notified if a threshold gets violated just a few times (6). In this case, option 4 might be a good choice. Notifications will only be sent out if the threshold is been violated for more than x minute(s)/hour(s)/day(s) (7), as shown in Figure 3-30.

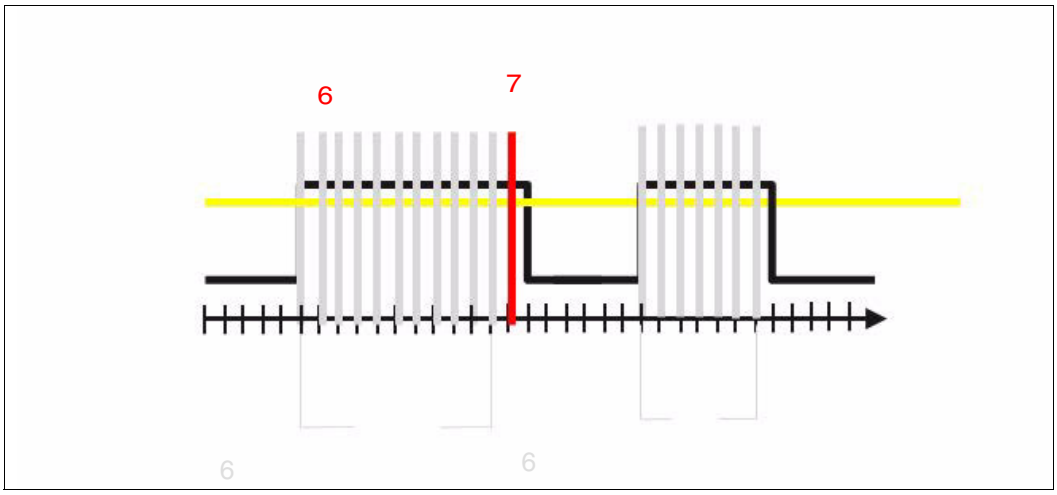

Figure 3-30 Do not alert until condition has been violated for more than x minute(s)/hour(s)/day(s)

Note: Additional information about how to set up alerts and thresholds is available in *IBM Spectrum Family: IBM Spectrum Control Standard Edition*, SG24-8321, and in the IBM Spectrum Control section of IBM Knowledge Center.

3.3 Guidelines for thresholds

The combination of alerts with thresholds in IBM Spectrum Control enables you to automate alerts and customize them for your environment. This automation can save you precious time by avoiding manual checks, and allows faster reaction to events because alerts are sent immediately after being triggered. The administrator can take appropriate actions as soon as the warning or alert is received. It is also possible to run a script based on such alerts for standardized events, completely eliminating any need for manual intervention.

However, do not underestimate the task of preparing and defining the required thresholds for your environment. The better the thresholds and alerts are set, the better the whole system works and the less manual intervention is needed here. Every system, every environment, and every setup has its unique characteristics, so there is no generic rule and predetermined values for the various metrics to monitor.

It is critical that every parameter be set based on your specific setup and needs. Also, your environment is probably not static and your settings will need to be reevaluated and adjusted over time. Changes to your environment might be required by an alternation of the existing system, such as a change of the SAN speed, or the introduction of a new storage system.

This section provides guidance on how to select the right setting for specific aspects of your environment.

3.3.1 Service level agreements

A direct source of information are the internal service level agreements (SLA) mandated in your environment. SLAs are your first source to set thresholds on the corresponding system. If there is an SLA in place that says application “gold” must have latencies better then x ms, then set the alerts close to that value, but with some tolerance. You can do so for every parameter specified in an SLA.

3.3.2 Planning and sizings

To avoid overloading a complete system, use the planning and sizing information to help you determine an upper limit for specific characteristics of your environment and set thresholds accordingly. For example, if a system is able to sustain a maximum 100,000 IOPS, set the threshold to trigger an alert at a value slightly lower than that maximum to help keep the system workload in the range that it was sized for.

Note: There are some metrics in Spectrum Control for which an alert cannot be set. Check in advance if a particular alert can be set or if a combination of other values can act as a workaround to reach the same goal.

3.3.3 Work with your own historical data

IBM Spectrum Control allows you to easily get a summary of the history of many metrics. That history can help you determine the appropriate value to set as the threshold for triggering alerts on those metrics, as observed in your environment. We illustrate in a brief example, based on FlashSystem 840, an approach that you can use for many other metrics.

In IBM Spectrum Control, open the Alerts Definition window for the system in scope. In our example, the Ports tab is selected with Performance metrics, as shown in Figure 3-31.

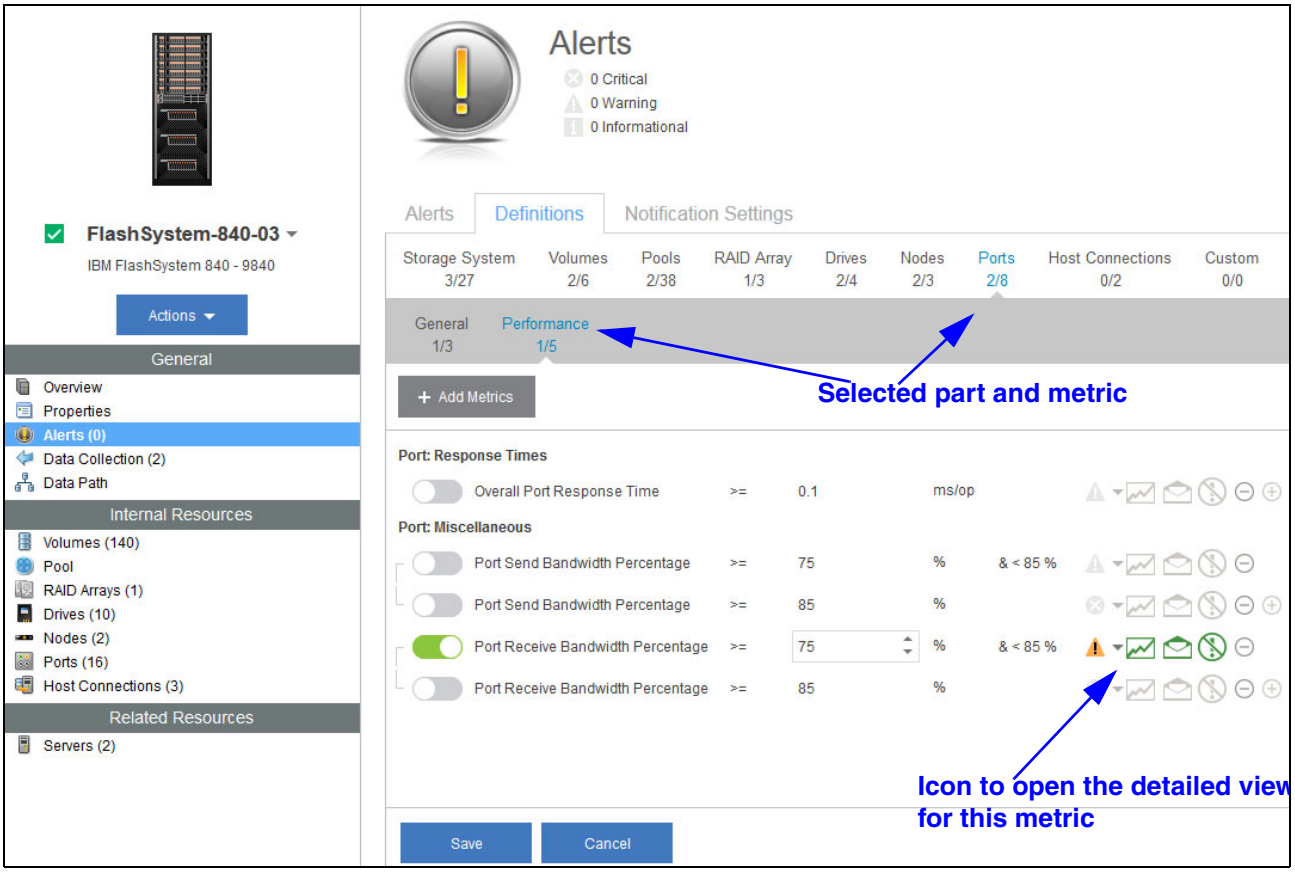

Figure 3-31 IBM Spectrum Control Alerts definition tab

For the resource and metrics that you selected, you can view the typical range in the short summary and set the threshold based on that range. The advantage here is that the user is already on the Alerts tab and knows which thresholds can be set. If you want to see a more detailed history and have more options, you can use the normal performance view of IBM Spectrum Control.

Click the **Chart** icon next to the metric (Port Receive Bandwidth Percentage in our example) to open a chart, as shown in Figure 3-32.

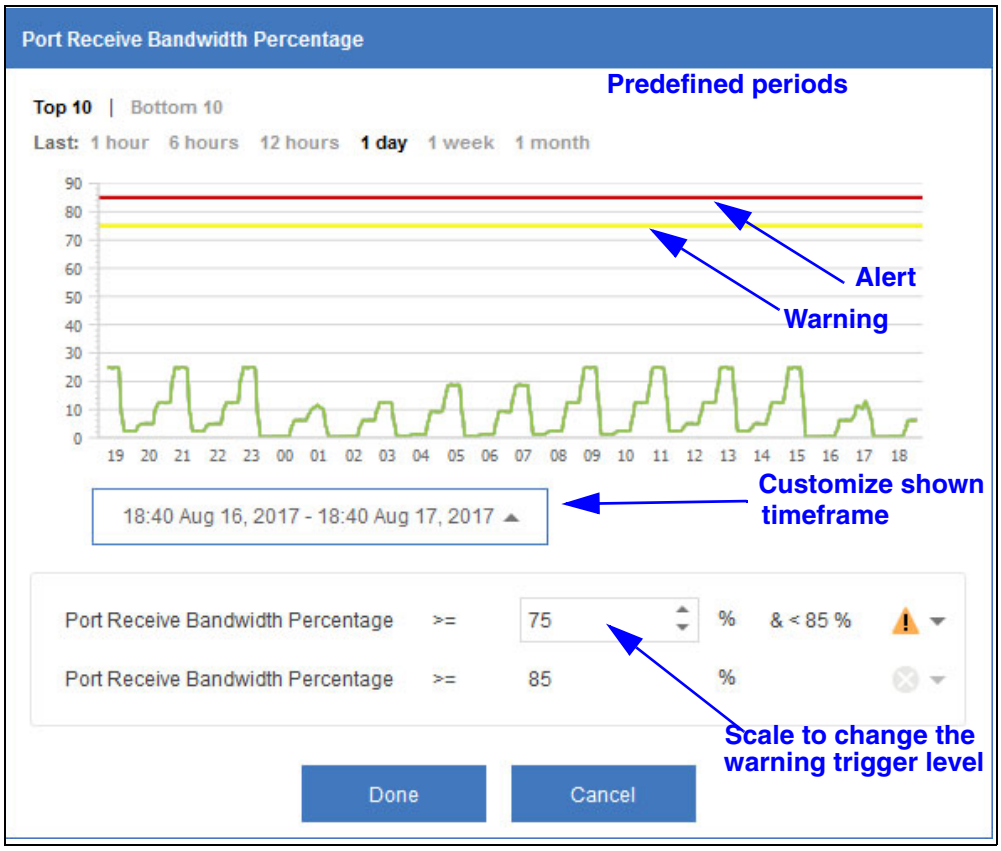

Figure 3-32 Alert Definition detailed view

In this view, the history of this single metric is shown. The time frame can be changed by selecting any of the predefined periods, such as 1 hour, 1 day, 1 week, and so on. You can also customize the time frame.

The yellow line around the 75% in the chart indicates the trigger for a warning, whereas the red one at around 85% is the trigger for an alert.

In the bottom part of the window, you can adjust the value for the warning threshold, which repositions the yellow line.

In this example, you can see that the actual values measured (green curve) are far away from the preset warning and alert thresholds. If wanted, you can adjust them to a closer level.

Make sure of the following before deciding on what value to use:

- Use at minimum a one week time frame to cover at least every weekday, including the weekend. If you have special workloads, for example at end of the month, include this time frame to cover those particular workload situations.
- Evaluate whether the alert threshold must be below the real chart (for example, cache hit ratio) line or above (for example, CPU usage).
- Evaluate whether this threshold is to secure an SLA with a client, or is it just to get a better knowledge of your system or to prepare future planning.

The history of metrics can also be viewed in IBM Spectrum Control standard charts with more details than what you get in the Alerts windows shown in Figure 3-31 on page 96 and Figure 3-32 on page 97. The standard charts provide a more granular view for single resources like a single port.

To better define the settings for thresholds and alerts, you can also combine different values. For example, when looking at latency on ports, you can also set as a condition (filter) that there must be a minimum IOPS on the same port. If there is only a small amount of IOPS on a single resource like a port, a high latency alert might not be relevant. To filter them out and avoid false alarms, set a minimum of IOPS condition along with the latency alert. Another example would be to combine some metrics for volumes with a minimum of space usage. Or you could also combine bandwidth usage in relation to I/O block size.

In summary, whether you rely on SLAs or historical values, or a combination of both, Spectrum Control gives you a lot of flexibility on how to specify alerts and thresholds. Remember to revalidate your settings whenever changes occur in your environment or based on your observations over time.

3.3.4 Device-specific metrics

As already stated, every environment has its own characteristics and properties, so it is impossible to recommend values that will fit every situation. To give some initial guidance, we included some examples, and when applicable, suggested specific values.

Important: Keep in mind that we are discussing examples. Before adopting any of the suggested settings, carefully review the characteristics of your environment. These examples are meant to illustrate the type of thinking that must take place when you decide on which metrics and thresholds to use. They are by no means an exhaustive list of the situations that need to be considered in your environment.

IBM FlashSystem 840/900

This section covers several important metrics for which it is useful to set warnings and alerts. This is not a complete list and these might not fit every case.

Data Rate (MiB/s) of ports

It is important to monitor what amount of data is transferred through the ports. Check that the physical bandwidth limitation is not reached. It is usually worth to combine the amount with transfer size because numerous small IOs can saturate a port faster than the bandwidth shows.

Response time (ms/op) of ports

The response time provides the average number of milliseconds that it took handle a transfer (send or receive). This time is measured for every port, but the alert is for all or at least a group of ports. Keep this fact in mind when you set the threshold. Depending on your situation, it might be worthwhile to use the general groups function to separate them.

If the response is too high, try to find the reason and fix the problem, or balance the ports if it is caused by excessive load and uneven use of ports.

Flash Health percentage of Flash modules

This is not a performance-related measurement. However, decreasing health can lead to decreased performance, and should be checked as a possible reason.

IBM FlashSystem V9000

The V9000 offers many features such as compression and Remote Mirroring. All these functions have their own metrics and should be monitored as well. This section focuses on the general performance functions.

CPU Utilization (%)

The CPU utilization is good first indicator of the overall usage of the system. The overall utilization is the primary threshold that should be set. Because one control enclosure must occasionally handle the load of the second enclosure when it goes offline (such as due to software upgrade, power failure, and so on), the CPU utilization threshold should not be set too high. A good value to start with is 60% to trigger an alert.

If this limit is reached regularly, it can be an indicator that you need to distribute the load to other control enclosures or to plan an upgrade with more or newer hardware.

Managed Disks response time (ms/op)

Because there is no usable measurement of the internal drives, the managed disks metrics are an acceptable alternative for setting an alert. A response time issue with managed disks might indicate that the internal disks are themselves experiencing a degraded response time.

Note: The internal Flash modules or drives have much better response times than an external NL-SAS device. Keep this fact in mind when setting alerts thresholds.

The best parameter on which to set a threshold is the response time for the MDisks. Keep in mind that different types of backend storage have different characteristics, so a grouping can be helpful here as well.

Port metrics

The port metrics on a V9000.are a very important indicator. The Fibre Channel ports are the interface for many types of workload. This is the interface for communication within the system and with its internal and back-end storage, and also, in most cases, the interface to hosts.

The IBM FlashSystem V9000 offers a huge variety of SAN-related counters that allow you to proactively monitor the environment.

Data Rate (MiB/s) of ports

This metric indicates data transferred through the ports. Check that the physical bandwidth limitation is not reached, and set the alerts lower than the physical maximum. It is valuable to combine the data rate with transfer size because IO with a small transfer size can saturate a port faster than the bandwidth indicates.

Response time (ms/op) of ports

The response gives the average number of milliseconds that it took handle a transfer (send or receive). This time is measured for every port, but the alert is for all or at least a group of ports. Have this consideration in mind when you set the threshold. Depending on your setup, it might be valuable to use the general groups function to separate them.

On the V9000, it is also important to separate the type of load. The type of load can be monitored at a node level. The node to local node traffic should see lower latencies than traffic to host remote node. With local node to node traffic such as cache mirroring, it is important to have low latencies, while a remote node at long distance will experience higher latencies. A granular setting of alerts is important here.

Error rates on ports

In general, any error in the SAN is not good, but some are unavoidable. If you monitor error rates, set the alert threshold at an acceptable but nonzero value to avoid flooding your mailbox with alerts.

The value with highest focus and lowest alert trigger level should be the Cyclic Redundancy Check (CRC) error rate. The CRC error rate should be set low. When it starts increasing, an immediate reaction is needed.

In addition, the other error rates like Link Failures, Signal Loss, and Sync Loss are signs of a broken connection. However, note that such errors can happen during a server reboot or other temporary events and not be the indication of a problem. Alternately, higher and steadily increasing error rates values can be a sign of a problem.

Another port metric, which might not be included in other SAN monitoring tools, is the Zero Buffer Credit metric. IBM Spectrum Control allows you to monitor the Zero Buffer Credit Timer (µs) or the Zero Buffer Credit Percentage (%). While the timer shows the number of microseconds for which the port has been unable to send frames due to the lack of buffer credit since the last node reset, the percentage gives the value in relation to the total load. The percentage is typically the value that you want to monitor. Both metrics are from the FlashSystem V9000 perspective, and thus indicate that the FlashSystem V9000 is not able to send data out to the SAN.

Important: Note that the Zero Buffer Credit metrics are not reported with 26 Gb HBAs. However, starting with VSC code V7.8.1, alternative metrics were introduced: Port Send Delay Time and Port Send Delay I/O Percentage.

Figure 3-33 shows the view in IBM Spectrum Control.

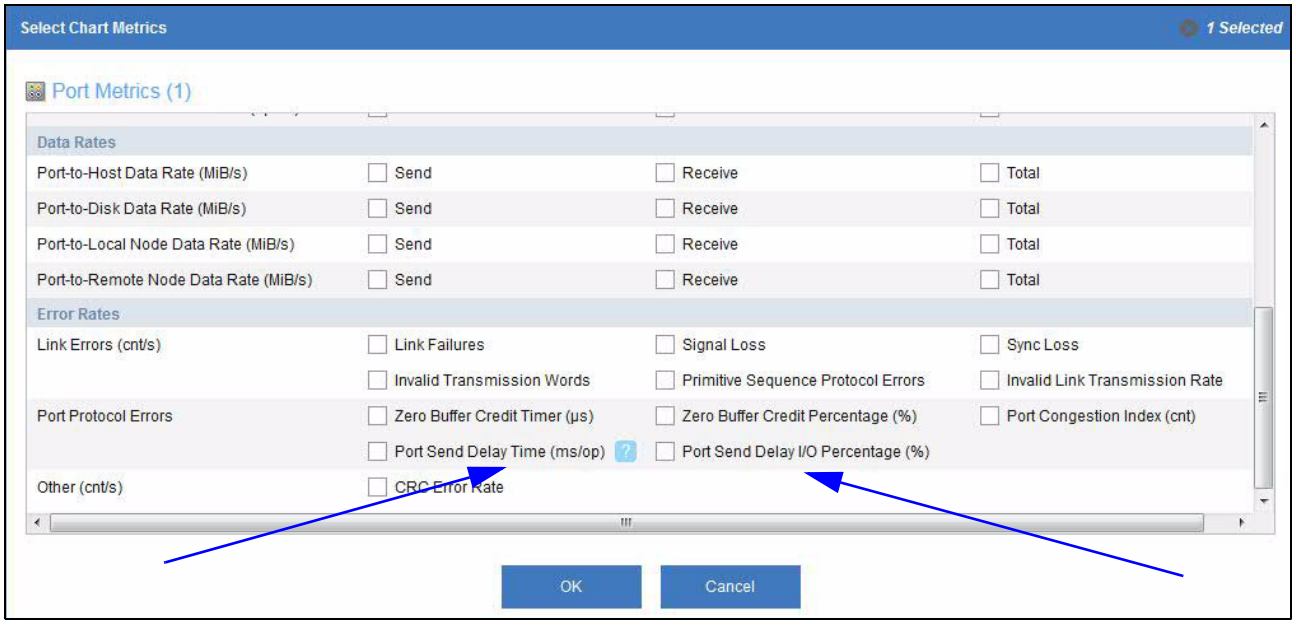

Figure 3-33 New metrics for Port Send delay to replace Zero Buffer Credit

The Port Send Delay Time and Port Send Delay I/O Percentage can be used instead of the Zero Buffer Credit, including for 8 Gb ports. If there are two types in use in the same system, only one metric is enough to monitor both.

Volume compression ratio

Because a good practice for enabling compression on a volume is when you can get a minimum of 40% compression ratio, it is worthwhile to set an alert to be triggered when that 40% threshold is not met. However, a nearly empty volume, like a newly created one, can show bad ratios initially. Therefore, it is relevant to combine the compression ratio and the used capacity. In our example in Figure 3-34, we set the minimum used capacity at 10%. This setting means that the 40% compression threshold is only taken into account for creating an alert if at least 10% of the volume are used.

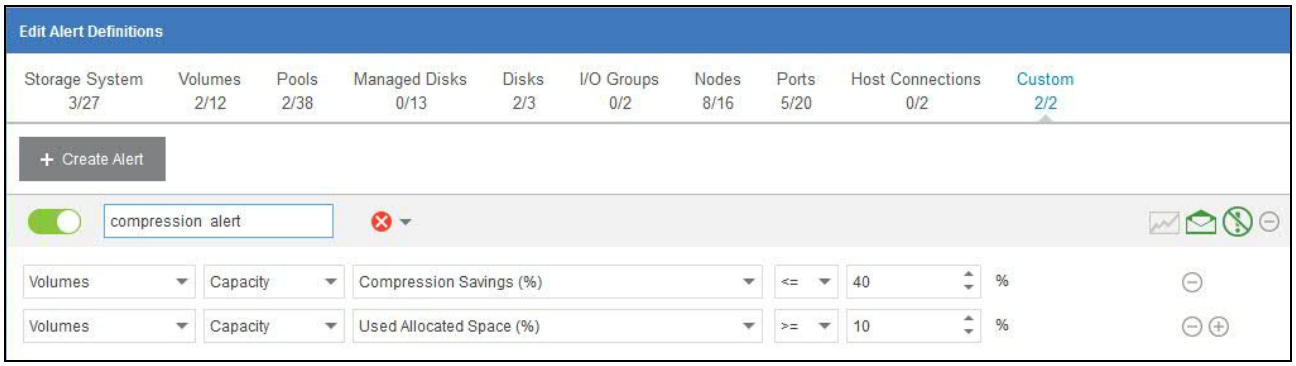

Figure 3-34 Combine Compression Savings and Used Allocated Space

A

Using SSH key for device configuration

For some storage systems, such as FS840, FS900, V840, and V9000, there are two options when configuring a device to IBM Spectrum Control:

- Username and Password
- SSH Key:
  - Upload new key
  - Upload an existing SSH key

You can either use the keys that are provided with IBM Spectrum Control in `...\IBM\TPC\device\conf`, or create your own keys using a key generator such as PuTTYgen. Creating your own keys is safer and therefore preferred.

If you use multiple IBM Spectrum Control servers consider to generate SSH Key pairs for each IBM Spectrum Control server, which will allow you to see which IBM Spectrum Control server is performing which operation on a device eg. to disable /enable access for each IBM Spectrum Control Server.

In this paragraph we will describe how to generate SSH keys using PuTTYgen and how to configure a FS840 to IBM Spectrum Control in using the previously created SSH keys.

Configuring a device using an SSH key

Before generating key pairs, the number of bits in a generated key can be adjusted (1), then the key pair generation can be started by using the **Generate key pair function** (2), as shown in Figure A-1.

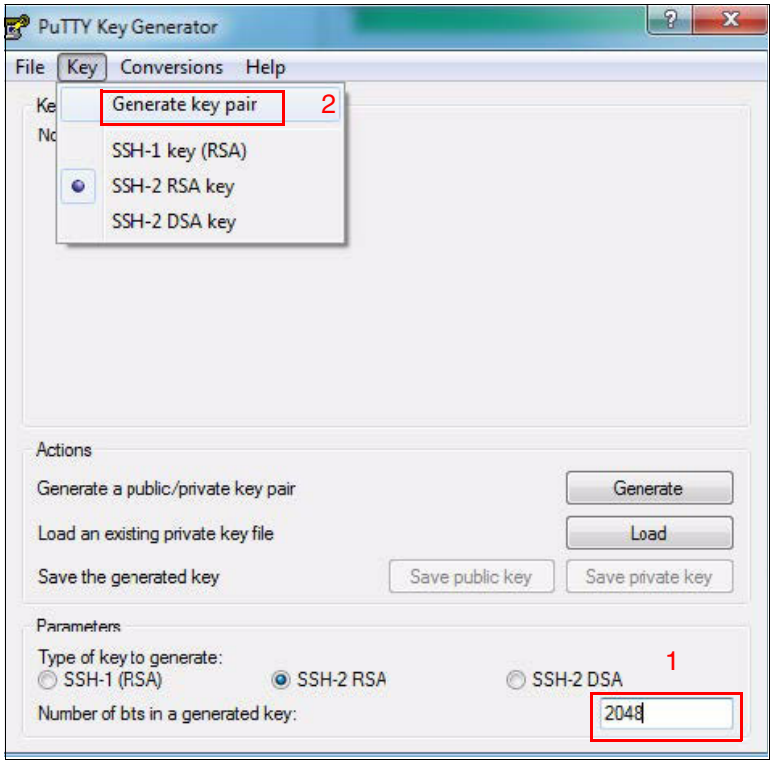

Figure A-1 Generate key pair

While the progress bar proceeds, move the mouse over the blank area (1), as shown in Figure A-2.

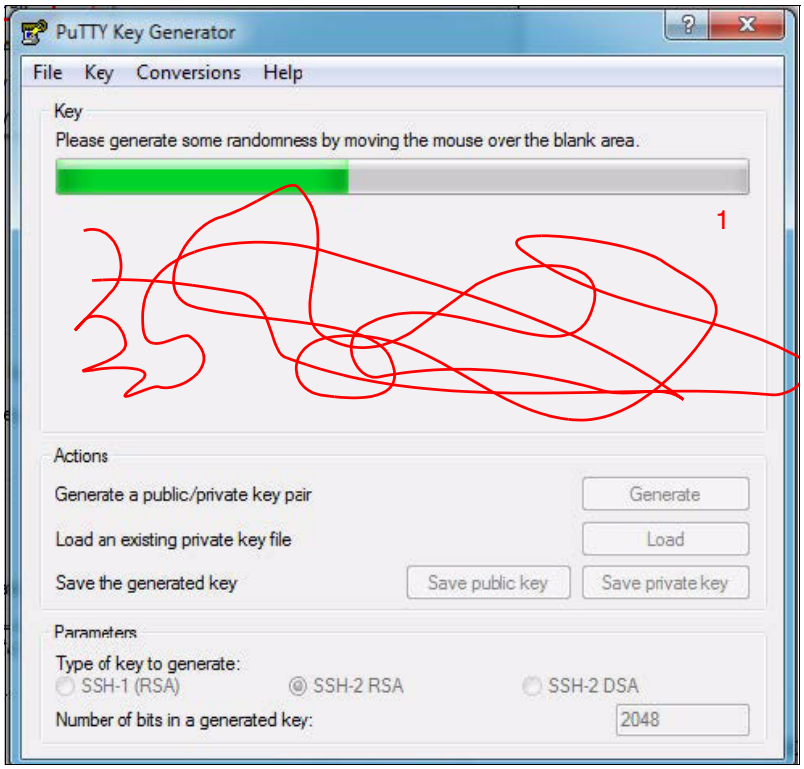

Figure A-2 Key generation

After the keys have been created, save the public key as `.pub` and the private key as `.ppk` (1). A passphrase (2) can be specified to increase security, as shown in Figure A-3.

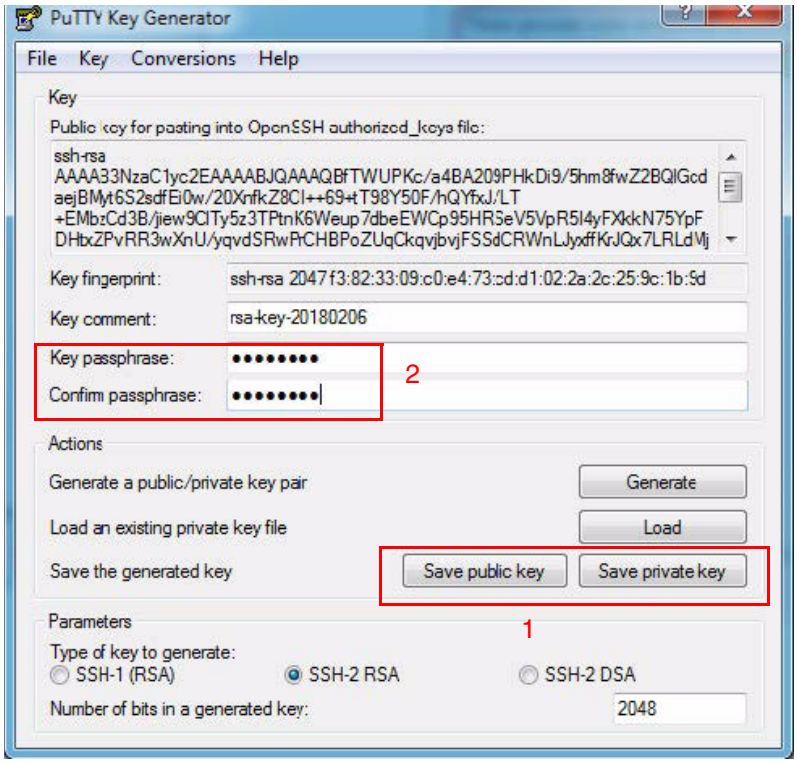

Figure A-3 Save keys

If the storage system does not accept the `.ppk` key, convert it to an OpenSSH (`.pem`) key, as shown in Figure A-4.

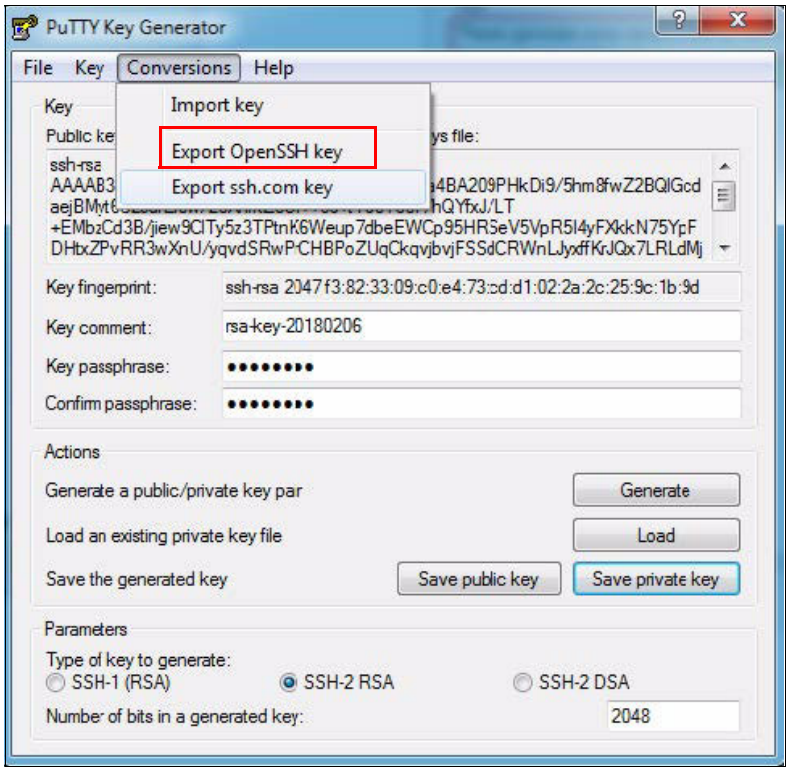

Figure A-4 Convert private key to OpenSSH key

To upload the public key to the storage system create a user on the storage system and upload the public key, as shown in Figure A-5.

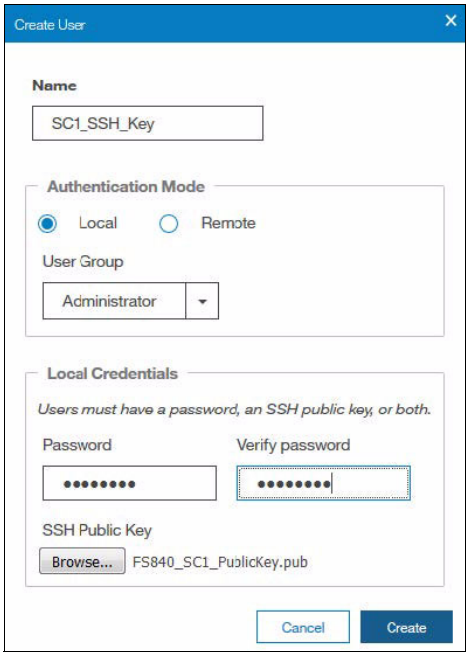

Figure A-5 Upload public key to storage system

To configure the storage device to IBM Spectrum Control, change the Authentication mechanism to Secure Shell, select **Use an existing SSH key**, and upload the appropriate private key, as shown in Figure A-6.

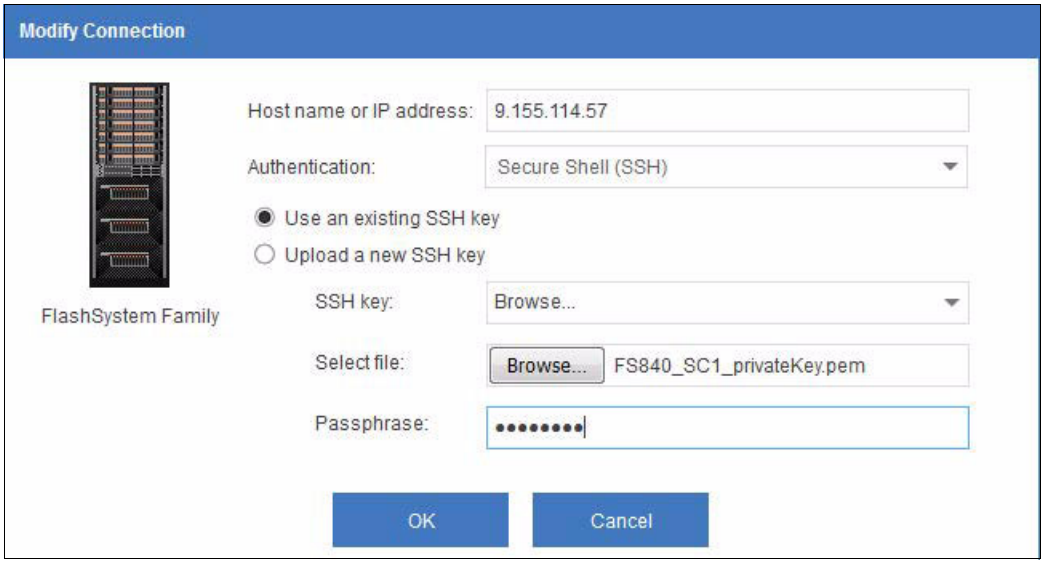

Figure A-6 Configure FS840 with SSH key

Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this paper.

IBM Redbooks

The following IBM Redbooks publications provide additional information about the topic in this document. Note that some publications referenced in this list might be available in softcopy only.

- *IBM FlashSystem A9000 and IBM FlashSystem A9000R Architecture and Implementation*, SG24-8345
- *IBM Spectrum Family: IBM Spectrum Control Standard Edition*, SG24-8321
- *IBM Tivoli Storage Productivity Center V5.1 Technical Guide*, SG24-8053
- *IBM Tivoli Storage Productivity Center V5.2 Release Guide*, SG24-8204
- *Implementing IBM FlashSystem 900 Model AE3*, SG24-8414
- *Implementing IBM FlashSystem V9000 - AC3 with Flash Enclosure Model AE3*, SG24-8413
- *Reporting with TPCTOOL*, REDP-4230

You can search for, view, download or order these documents and other Redbooks, Redpapers, Web Docs, draft and additional materials, at the following website:

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Online resources

These websites are also relevant as further information sources:

- IBM Spectrum Control section of IBM Knowledge Center

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