

Foglight™ for Storage Management 4.1

User and Reference Guide



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Legend

 **CAUTION:** A CAUTION icon indicates potential damage to hardware or loss of data if instructions are not followed.

 **WARNING:** A WARNING icon indicates a potential for property damage, personal injury, or death.

 **IMPORTANT NOTE, NOTE, TIP, MOBILE, or VIDEO:** An information icon indicates supporting information.

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Getting Started

This chapter introduces you to Foglight for Storage Management, and tells you how to verify that Foglight for Storage Management is capturing storage collection data for all the devices you are interested in monitoring.

NOTE: For information about installing Foglight for Storage Management, configuring Storage Collector agents and the Storage Agent Master, and managing agents and Storage Agent Masters, see the *Managing Storage in Virtual Environments Installation and Configuration Guide*.

This section covers the following topics:

- [Introducing Foglight for Storage Management](#)
- [Navigating Foglight for Storage Management](#)
- [Verifying Storage Collector Agents are Collecting Storage Data](#)
- [Understanding Metric Data in Charts and Tables](#)
- [Modifying and Extending Data Collection](#)
- [Next Steps](#)

Introducing Foglight for Storage Management

Virtual infrastructures add layers of abstraction that obscure the relationship between physical storage and virtual machines. Foglight for Storage Management supports VMWare and Hyper-V virtual environments. It helps you look beyond logical datastores and volumes to see how physical storage components (switches, logical unit numbers (LUNs), arrays, and filers) are impacting virtual machines (VMs).

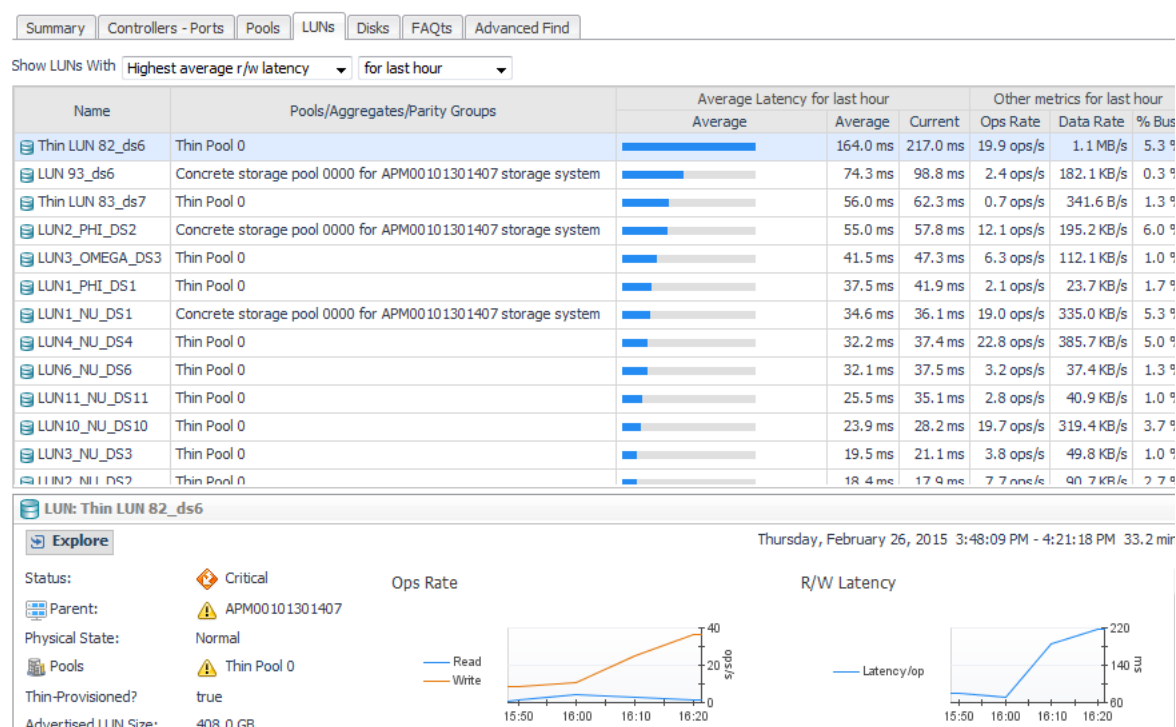
The key concepts for Foglight for Storage Management are “relationship” and “context.” Rather than simply viewing repeated performance metrics, Foglight for Storage Management incorporates the data into an end-to-end view of your virtual storage infrastructure, showing the relationship of the storage and storage area network (SAN) performance to VM performance. You can also investigate performance events in the proper context, viewing the status of the entire topology at the time the performance issues occurred.

Performance Monitoring

Monitoring the performance of your storage infrastructure is critical to maximizing VM performance. Foglight for Storage Management allows you to track:

- Insufficient bandwidth and throughput of SAN switch ports, filers, and storage arrays.
- Over (or under) utilized datastores CSVs, and logical disks.
- I/O bottlenecks for NASVolumes and LUNs, along with the pool providing the physical disk storage for the LUNs and NASVolumes.

Figure 1. Performance Monitoring

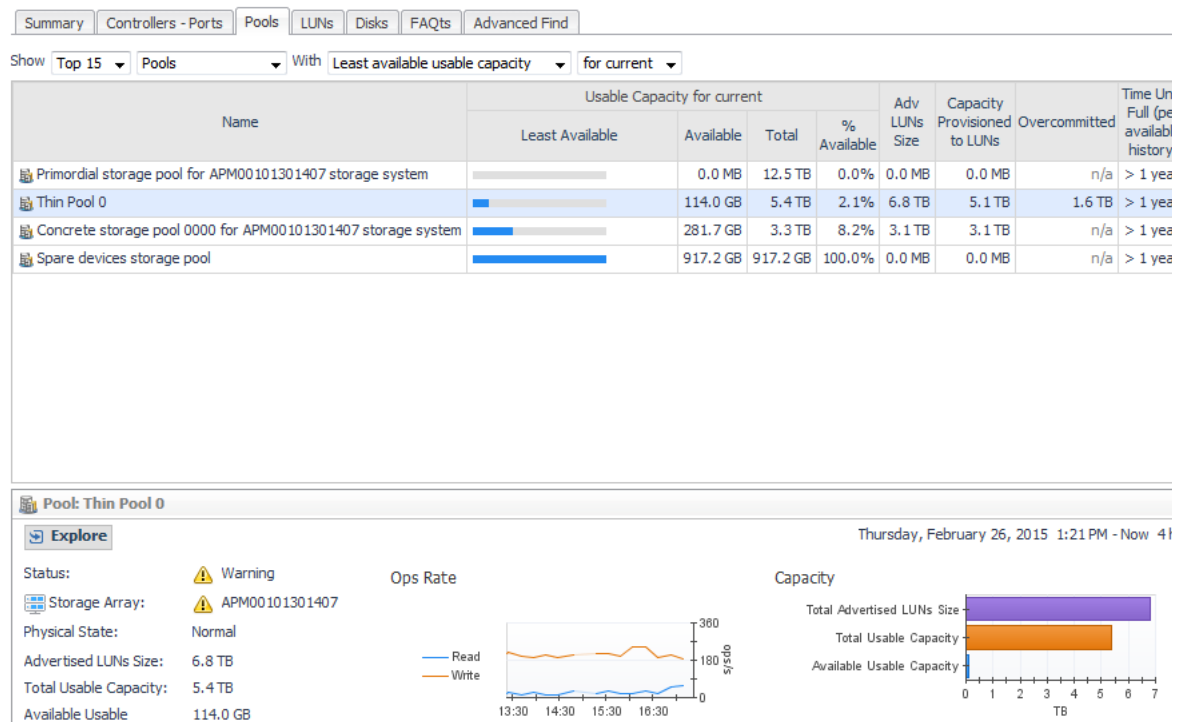


Foglight for Storage Management captures performance metrics from components of your storage infrastructure (SAN switches, LUNs, storage arrays, and filers), evaluates the data based on preconfigured performance and event rules, then presents this data via a detailed graphical interface. With architectural diagrams, graphs, alerts, and drill-down screens, Foglight for Storage Management helps you quickly identify problems in the virtual environment or the physical storage. For more information, see [Monitoring Your Storage Environment](#) on page 19.

Capacity Monitoring

Foglight for Storage Management aids the process of identifying and resolving storage capacity issues. The Foglight for Storage Management virtualization cartridges alert you to datastores and logical volumes in danger of running out of storage. The storage component shows you how the physical storage supporting your virtual infrastructure is configured. The detailed graphical interface of Foglight for Storage Management lets you see storage capacity allocations for arrays and filers, and receive alerts when free disk capacity and free pool capacity fall below thresholds. For more information, see [Monitoring Storage Arrays](#) on page 26, [Monitoring Filers](#) on page 28 and [Monitoring Storage Capacity](#) on page 40.

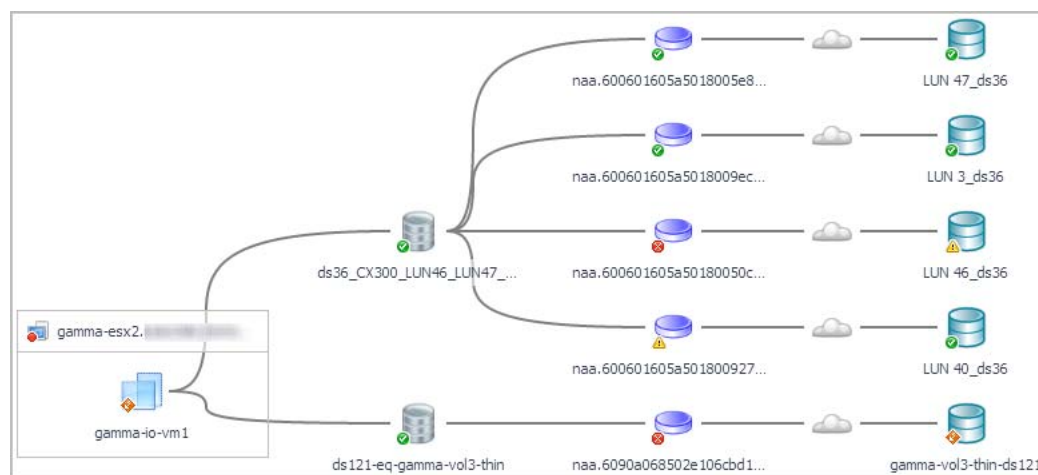
Figure 2. Capacity Monitoring



Connectivity and I/O Performance Monitoring

Foglight for Storage Management provides comprehensive topology views which detail all I/O paths and components on each I/O path from VMs down to their assigned physical storage devices. These views assist in determining where actual performance or connectivity problems are occurring during I/O requests, something which is not possible using traditional virtual infrastructure management tools. For more information, see [Assessing Connectivity and I/O Performance](#) on page 31.

Figure 3. Connectivity and I/O Performance Monitoring.



Navigating Foglight for Storage Management

Foglight for Storage Management is built on the Foglight for Storage Management platform. The following diagram and table introduce the common Foglight for Storage Management screen elements that are used in Foglight for Storage Management dashboards. If you need more information about how to use these elements, open the online help and navigate to Using Foglight for Storage Management > Foglight for Storage Management User Help > Getting Started > Working with Dashboards.

Figure 4. Navigating Foglight for Storage Management.



Table 1. Screen Elements

Screen Element	Description
Navigation Panel	Contains a menu of all the dashboards that you can access based on your role. Select a dashboard to view in the display area. The panel operates like a drawer and can be open or closed using the arrow.
Display Area	Displays the contents of the selected dashboard.
Action Panel	Provides the following functions: <ul style="list-style-type: none"> Lists the actions that you can perform on the current dashboard. Lists the views and data that you can add to a new dashboard or report. Provides access to context-sensitive help and the online help system. The panel operates like a drawer and can be open or closed.

Table 1. Screen Elements

Screen Element	Description
Breadcrumbs	Displays the path of dashboards you navigated to get to the current dashboard. Click a name in the path to return to that dashboard. NOTE: The browser Back button is disabled. Use the breadcrumbs to return to the previous screen.
Time Range	Controls the time period for the data displayed in the dashboard and any drill-down views you access. The default is the last four hours. Click the text to open the time range popup and set the range.
Sparkline	Shows the trend of a metric in a small space. The value beside the sparkline is the current value for the metric in the selected time range. When used in a table, sparklines provide an easy way to compare spikes or other trends in a group of metrics. Click a sparkline to plot all data points for the time period on a graph. NOTE: If the last collection failed for any reason, the sparkline value is <i>n/a</i> .
Status Icons	Displays the status of a storage resource. For more information, see Understanding Status, Alarms, and Rules in Foglight for Storage Management on page 19.

Verifying Storage Collector Agents are Collecting Storage Data

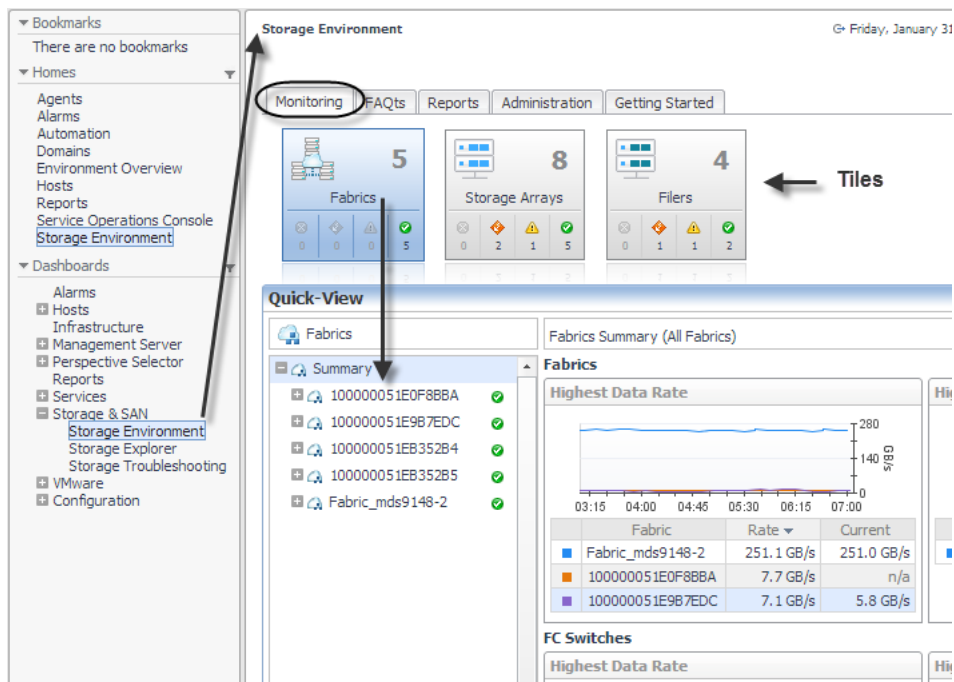
To begin, review the Foglight for Storage Management dashboards to verify you are monitoring the devices you want to monitor. You need the IP address of the Foglight for Storage Management Management Server and your user credentials from the person who installed and configured Foglight for Storage Management.

NOTE: This procedure is intended for Foglight for Storage Management users with the roles of *Storage Administrator*, *VMware Administrator* and *Hyper-V Administrator*.

To log in and confirm the list of monitored devices:

- 1 Open a supported browser. For a list of supported browsers, see the *System Requirements Guide*.
- 2 In the navigation bar, type the IP address followed by the port number 8080. For example:
`http://<Foglight for Storage Management_Management_Server_IP_Address>:8080`
- 3 Log in to Foglight for Storage Management using your user credentials.
- 4 On the navigation panel, expand Dashboards.
These menu items are of particular interest for monitoring storage performance: Storage & SAN, VMware, Hyper-V and Infrastructure.
- 5 Expand Storage & SAN.
The following menu items are available:
 - Storage Environment – Monitor storage devices in your storage environment.
 - Storage Explorer – Find and examine any storage device in your storage environment.
 - Storage Troubleshooting – Determine if a poorly-performing virtual machine is experiencing storage issues.
- 6 Click Storage Environment.
- 7 Ensure the Monitoring tab is selected.
- 8 Click the top half of each active tile and review the list of devices in the quick view.

Figure 5. Storage Environment



- 9 If you do not see a storage device that you think should be monitored, review the list of configured Storage Collector agents.
 - a On the Storage Environment dashboard, click the Administration tab.

TIP: If you do not see the Administration tab, ask your Foglight for Storage Management Administrator to add the role *Storage Administrator* to your user account.
 - b In the Storage Collector Agents list, look for the Storage Collector agent that monitors the missing device or device type. When an agent monitors a device type, click the Edit icon to view a list of named devices in the Edit Agent Properties dialog box.

Figure 6. Storage Collector Agents

Add Refresh Activate Deactivate Start Data Collection Stop Data Collection Remove Agent											
Edit	Agent Name	Foglight Agent Manager Host	Configured	Active	Collection Enabled	Alarms	Last Topo Coll Sts	Collection Time	Last Perf Coll Sts	Collection Time	
<input type="checkbox"/>	brocade---201	stc7bb8qn1.prod.quest.corp	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	<input type="checkbox"/>	n/a	<input type="checkbox"/>	n/a	
<input type="checkbox"/>	brocade-63again	stc7bb8qn1.prod.quest.corp	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1/31/14 5:45 AM	<input checked="" type="checkbox"/>	1/31/14 7:12 AM	
<input type="checkbox"/>	brocade--94	stc7bb8qn1.prod.quest.corp	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1/31/14 5:46 AM	<input checked="" type="checkbox"/>	1/31/14 7:03 AM	
<input type="checkbox"/>	cass	stc7bb8qn1.prod.quest.corp	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1/31/14 5:40 AM	<input checked="" type="checkbox"/>	1/31/14 7:10 AM	
<input type="checkbox"/>	cephus	stc7bb8qn1.prod.quest.corp	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1/31/14 5:41 AM	<input checked="" type="checkbox"/>	1/31/14 7:11 AM	
<input type="checkbox"/>	cisco-57	stc7bb8qn1.prod.quest.corp	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1/31/14 5:43 AM	<input checked="" type="checkbox"/>	1/31/14 7:10 AM	
<input type="checkbox"/>	cisco-58	stc7bb8qn1.prod.quest.corp	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1/31/14 5:42 AM	<input checked="" type="checkbox"/>	1/31/14 7:10 AM	
<input type="checkbox"/>	cisco-67	stc7bb8qn1.prod.quest.corp	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1/31/14 5:40 AM	<input checked="" type="checkbox"/>	1/31/14 7:09 AM	
<input type="checkbox"/>	cisco-68	stc7bb8qn1.prod.quest.corp	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1/31/14 5:40 AM	<input checked="" type="checkbox"/>	1/31/14 7:09 AM	
<input type="checkbox"/>	dell-cmpl	stc7bb8qn1.prod.quest.corp	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1/31/14 5:40 AM	<input checked="" type="checkbox"/>	1/31/14 7:10 AM	
<input type="checkbox"/>	dell-eql	stc7bb8qn1.prod.quest.corp	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1/31/14 5:40 AM	<input checked="" type="checkbox"/>	1/31/14 7:10 AM	

- c If a Storage Collector agent does not exist for a device, or if the agent exists but it is disabled or its data collection is turned off, contact your Foglight for Storage Management Administrator. For instructions about agent tasks, see the *Foglight for Storage Management Installation and Configuration Guide*.

After you finish with Storage Collector agents, verify the virtualization agents.

Collecting Storage Data for Virtualized Devices and Servers

To collect storage data for virtualized devices and servers:

- 1 On the navigation panel, expand the dashboard menu for your virtualization software. For example, either VMware or Hyper-V.

TIP: If you do not see the VMware or Hypver-V menu, ask your Foglight for Storage Management Administrator to add the appropriate administrator role to your user account.

In a Foglight for Storage Management installation without Foglight for Storage Management for Virtualization EE, the following menu items are available when you expand VMware or Hyper-V (additional menu items are available with Foglight for Storage Management for Virtualization EE):

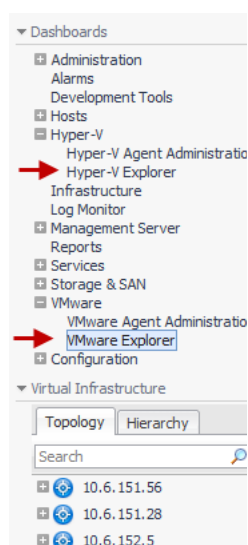
- Agent Administration — Create, edit, and delete the Performance agents to monitor the virtual environment.
- Explorer — Monitor entities in your virtual environment.

- 2 To verify the virtualization agents:

- a Click the Hyper-V or VMware Explorer.

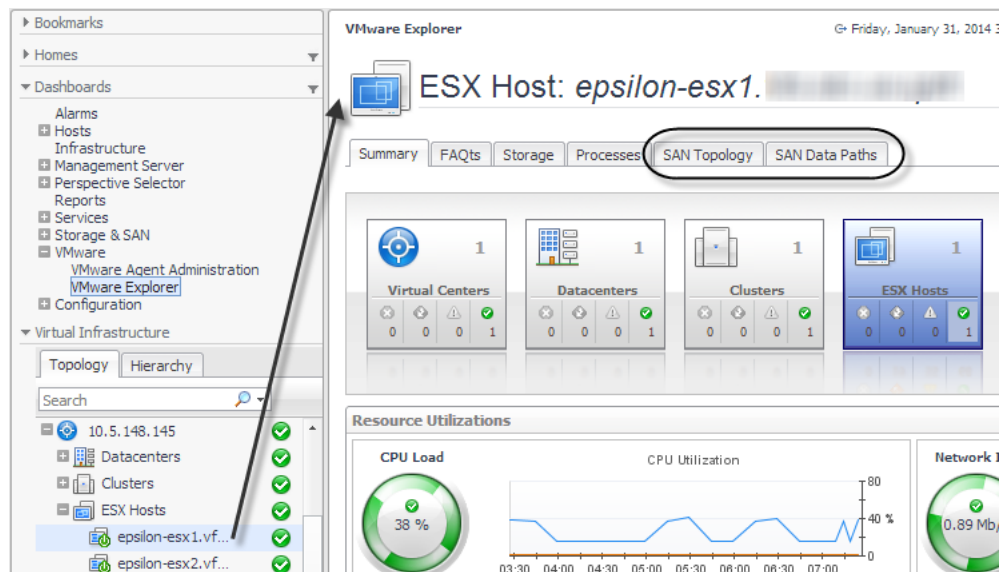
The Explorer opens a Virtual Infrastructure Topology tree—displayed in the navigation panel below the list of Dashboards—that contains branches for each monitored vCenter or Hyper-V server. For detailed information about the dashboards available through this tool, see the *Managing Virtualized Environments User and Reference Guide*.

Figure 7. Explorer.



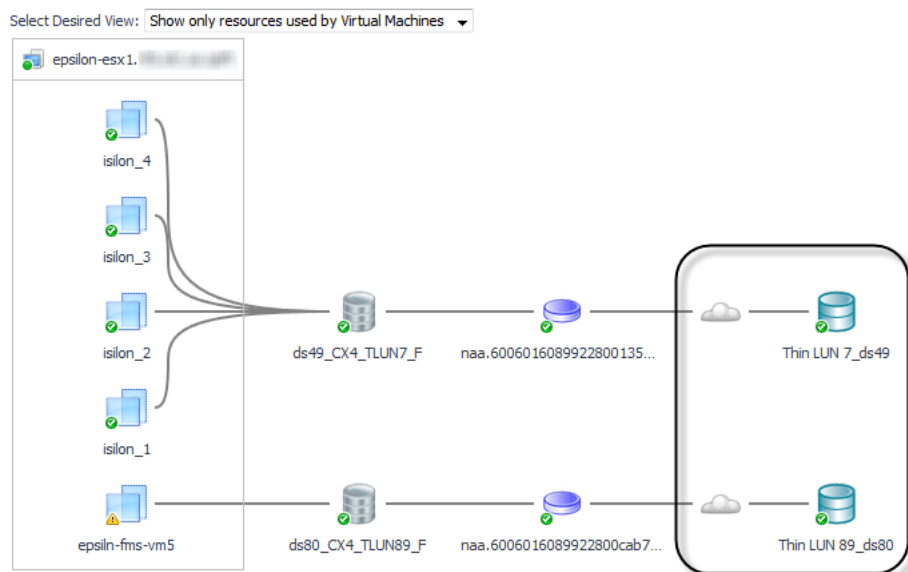
- b If the Virtual Infrastructure Topology list is empty, your Foglight for Storage Management Administrator needs to create a Performance agent to monitor at least one vCenter or Hyper-V server. For instructions, see the *Managing Storage in Virtual Environments Installation and Configuration Guide*.
- c If the list is not empty, expand the tree and select a virtualization host or server.

Figure 8. Example of a VMware ESX host



- d Click the SAN Topology tab.
- e Verify that you can see the storage-side of the virtual infrastructure, identified by the icons that are circled in the following diagram. If these elements are missing, the Performance agent monitoring this host is not collecting the data necessary to make connections to storage and SAN data. To enable storage data collection, see [Collecting Virtual Storage-to-SAN Relationships](#) on page 103.

Figure 9. Topology

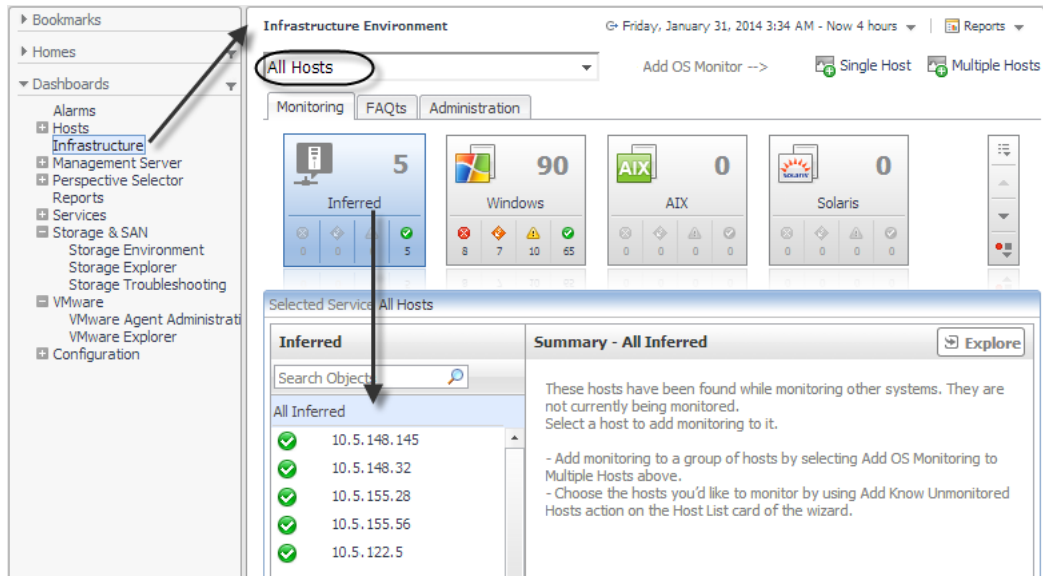


After you finish with Performance agents, review monitored hosts.

- 3 On the navigation panel, click Infrastructure.
 - a In the Select a Service box, select All Hosts.
The tiles organize physical hosts by their operating system.
 - b Click the Inferred tile.

The Inferred tile lists physical hosts that Foglight for Storage Management has inferred based on an analysis of the switch, array, and filer ports it is monitoring (a process called *dependency processing*). When physical hosts are connected to storage devices, you can drill down on a host and view connections in SAN Topology tabs.

Figure 10. Infrastructure Environment



- c If the Inferred tile does not show any inferred hosts, you may want to enable dependency processing to begin collecting the names of inferred hosts. For more information, see [Inferring Physical-Host-to-Storage Relationships](#) on page 104.

You have finished verifying that agents are collecting data.

Understanding Metric Data in Charts and Tables

In the Storage & SAN dashboards, charts and tables display metric data. Data is collected by Storage Collector agents, aggregated into collections, and the collections are published to the SAN & Storage dashboards at regular intervals. For more information about storage collection schedules and the type of data collected, see [Modifying Data Collection Schedules](#) on page 109.

The data displayed in charts and tables represents data for one or more intervals in the selected time range as follows:

- **Current.** The value collected in the last interval in the selected time range. In charts, the last plotted value is the current value.
- **Period.** Aggregated values for the entire selected time range. Period values are often used to provide context for current values.
- **Historical.** Individual values for each collection interval in the selected time period. Historical values are often presented as datapoints in a plot chart or as sparklines to show how metrics changed over the time period.
- **Latest.** Values in the latest collection interval available, *irrespective of the selected time range*. If data collection is enabled, this value reflects the latest collection. If data collection is disabled, this value represents the last collection made by the agent. Although latest values are tracked, the SAN & Storage dashboards do not display these values.

For indepth information about metrics, see <http://communities.quest.com/docs/DOC-12862>.

Values are not available (*n/a*) under the following circumstances:

- The device vendor does not provide the necessary metric. In this case, the text *n/p by vendor* appears after the metric name in column headings.
- A device is *offline* (reported in the State field).
- A device is not actively being used, such as when a disk is configured as a spare (reported in the Used or Role fields).
- For the Latency metric (which is a partially computed metric), when the operations/second value is very low, the latency metric may not be submitted during a collection interval.
- If all other situations do not apply, then it is likely that data collection failed for some reason. If the current value is unavailable for a time range that occurs in the past, you can try changing the selected time range to end before or after the problem interval.

Modifying and Extending Data Collection

You can modify and extend data collection in the following ways. You may want to make these changes now, or adjust the settings in the future if you find a need.

Table 2. Data collection options

Options	Instructions
If not already enabled during installation, collect data about virtualization device-to-SAN relationships and display this information in SAN topology diagrams. Requires a VMware or Hyper-V Performance agent.	Collecting Virtual Storage-to-SAN Relationships on page 103
Infer connections from physical hosts to storage and show the connections in topology diagrams.	Inferring Physical-Host-to-Storage Relationships on page 104
Change the default collection interval.	Modifying Data Collection Schedules on page 109
Modify when rules trigger alarms (change threshold values) and add a list of email addresses to notify when alarms occur.	Managing Foglight for Storage Management Rules on page 114

Next Steps

Your next steps depend on whether you want to monitor your storage environment to identify problems or whether you need to respond to the report of a problem in the virtual infrastructure.

Monitoring Your Storage Environment

The following workflow suggests one approach to monitoring your storage environment and investigating issues. You may prefer a different approach, depending on your monitoring needs.

- 1 Performance Monitoring – Start by assessing alarms on all storage devices. See [Monitoring Storage Performance](#) on page 17.
- 2 Capacity Monitoring – After you acknowledge and/or resolve device-level alarms, you may want to investigate individual storage devices and their components. See [Investigating Storage Devices](#) on page 44.
- 3 Connectivity and I/O Performance Monitoring – You can identify performance or connectivity problems that occur during I/O requests by viewing diagrams that place storage components within the context of the virtualization environment, from VMs and hosts to storage devices. See [Assessing Connectivity and I/O Performance](#) on page 31.

Responding to Problem Reports

Storage Administrators need to respond to reports about problems in the storage environment.

- When you receive reports from colleagues about poorly-performing VMware virtual machines, use the Storage Troubleshooting analysis tool to determine whether resources in the SAN are contributing to the problem. For instructions, see [Troubleshooting Storage Performance](#) on page 95.
- When you receive emails from Foglight for Storage Management about a storage device or component that has entered a problem state, click the link in the email to navigate to the dashboard that provides details about the alarm. To learn how to set up email notifications, see [Configuring Email Notifications for Alarms](#) on page 116.

Monitoring Storage Performance

This chapter introduces the Storage Environment dashboard and guides you through monitoring your storage environment by assessing device status and alarms. The next sections provide alternative approaches to assessing your storage environment through the use of questions or by assessing the connectivity and port performance within the context of your virtual infrastructure. The last section introduces reports.

Introducing the Storage Environment Dashboard

The starting point for monitoring storage performance is the Storage Environment dashboard. The Storage Environment dashboard contains the following tabs:

- **Monitoring Tab** – Monitor your overall storage environment by device type. For more information, see [Monitoring Your Storage Environment](#) on page 19.
- **FAQs Tab** – Use questions to retrieve important data about your monitored storage environment. For more information, see [Asking Questions About the Monitored Storage Environment](#) on page 30.
- **Reports Tab** – Use templates to create reports on your storage environment. For more information, see [Creating Storage Reports](#) on page 43.

TIP: If the Reports tab is missing, your Foglight for Storage Management Administrator may need to add the *General Access* role your user account. For more information, see “Assigning Foglight for Storage Management Roles” in the *Managing Storage in Virtual Environments Installation and Configuration Guide*.

If your Foglight for Storage Management user account includes the *Storage Administrator* role, the Storage Environment dashboard also displays these tabs:

- **Administration Tab** – Manage configured agents, credentials, the Storage Agent Master, and modify data collection settings.
- **Getting Started Tab** – Purchase a product license.

To open the Storage Environment dashboard:

- On the navigation panel, under Dashboards, click Storage & SAN > Storage Environment.

The first time you open this dashboard, the Monitoring tab is displayed, showing the overall status of your monitored storage environment.

Figure 1. Monitoring dashboard



Table 1. The Monitoring tab contains the following screen elements:

Screen Element	Description
Time Range	Controls the period of time represented in the dashboard. The default is the last four hours. For more information, see “Time Range” in the online help.
Tiles	Summarizes how many of each type of device—Fabrics, Storage Arrays, and Filers—are being monitored, and breaks down the total number by alarm severity (from left to right: Fatal, Critical, Warning, and Normal). Tiles control the Quick View area as follows: <ul style="list-style-type: none"> Click the top half of a tile to open the device type’s quick view with the Summary view displayed. Click a status icon in one of the tiles to open the device type’s quick view containing only devices with that status.
Quick View	Contains four areas: Device List, Device Summary, FAQts, and Alarm Summary.
Device List	Displays the list of storage devices that match the selected tile. <ul style="list-style-type: none"> Click <i>Summary</i> to display the top storage devices in terms of key performance or capacity metrics. Click a device name to display metrics for that device only.
Device Summary	Displays performance and capacity metrics for the device selected in the Device List.

Table 1. The Monitoring tab contains the following screen elements:

Screen Element	Description
FAQts	Offers common searches in the form of questions. Scroll through questions, and click Show Me to see the answer to the currently displayed question. For more information, see Asking Questions About the Monitored Storage Environment on page 30
Alarm Summary	Displays a list of alarms for the device selected in the Device List. For more information, see Understanding Status, Alarms, and Rules in Foglight for Storage Management on page 19.

Monitoring Your Storage Environment

When you begin monitoring your storage environment, a good way to start is by identifying poorly-performing devices and resolving the issues that are contributing to the problems. In Foglight for Storage Management, all storage devices and their child components are assigned a status, which enables you to see at glance which elements in your storage infrastructure need attention. Any device that enters a non-Normal status triggers an alarm. For more information, see [Understanding Status, Alarms, and Rules in Foglight for Storage Management](#) on page 19.

The procedures in this section show you how to use the Monitoring tab in the Storage Environment dashboard to assess alarms and drill down to the components used by storage devices, such as the LUNs and NASVolumes that supply the physical storage for datastores.

Understanding Status, Alarms, and Rules in Foglight for Storage Management

In Foglight for Storage Management, all storage devices and their child components are assigned a status, which enables you to see at a glance which entities in your storage infrastructure need attention. Status and alarms are controlled by rules that can be based on data, time, schedules, or events. The rule conditions define which values reflect acceptable behavior (Normal status) and which values warrant an alarm (Warning, Critical, or Fatal status). As the value associated with a monitored entity passes a condition threshold, Foglight for Storage Management generates an alarm and changes the entity's status accordingly.

NOTE: When a component is selected, its detail views display the component's Status followed by its State. *Status* is determined by Foglight for Storage Management as describe above. *State* refers to the physical state of a component as reported by the vendor; if the vendor does not provide the physical state, the state is *unknown*. A component's physical state may affect its status only when an enabled rule triggers alarms based on state. Consult with your Foglight Administrator if you want to enable or create rules that perform this check.

A storage device often has large numbers (thousands) of child components. With a few exceptions, alarms on child components do *not* change the status of the parent device. For example, a failed disk may have a Fatal status, but because arrays are designed to cope with a failed disk, the parent device continues to display a Normal status. The parent device status may be changed by child components in the following circumstances:

- Controller problems typically affect the performance of the storage array or filer, so the parent device inherits the alarm status of the controller. Pool alarms reflect capacity issues and performance problems that can affect many users of the storage array or filer, so the parent device inherits the alarm status of the pool or aggregate.
- When a significant percentage of child components have problems (for example, many disks are failing), the problems may be indicative of a systemic problem. In this case, the parent device status changes when the number of affected child components reaches a threshold defined in rules.

For information about changing default rules and alarm settings, see [Managing Foglight for Storage Management Rules](#) on page 114.

Reviewing the Status of All Devices

Use the Monitoring tab in the Storage Environment dashboard to gain a high-level understanding of the status of the devices in your environment, organized by device type. For a general description of the dashboard, see [Introducing the Storage Environment Dashboard](#) on page 17.

To monitor the storage environment:

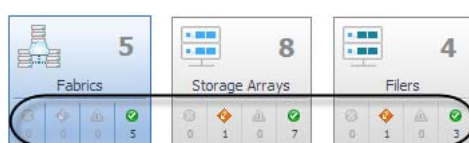
- 1 On the navigation panel, under Dashboards, click Storage & SAN > Storage Environment.
- 2 Click the Monitoring tab.

The time range and selected tile are the same as the last time the dashboard was opened.

Optional—Change the Time Range. For an initial review, use the default time range.

- 3 Scan the lower part of the tiles.

Figure 2. Device status



- 4 If any of the tiles show that there are devices with the Fatal, Critical, or Warning status, do one of the following:
 - To view all levels of alarms, click the top part of a tile that has the highest number of devices with the most severe errors. Go to the next section, [Assessing Storage Alarms](#).
 - To view alarms at one severity level only, such as all Critical alarms, click the Critical status count. Go to the next section, [Assessing Storage Alarms](#).
- 5 If all tiles report that devices are in the Normal status, it means that the devices are operating within acceptable parameters. The next step is to review the devices to see if any of their child components show an alarm status. See one of the following topics:
 - [Monitoring Fabrics](#) on page 22
 - [Monitoring Storage Arrays](#) on page 26
 - [Monitoring Filers](#) on page 28

Assessing Storage Alarms









When a storage device or component enters an unacceptable state (as defined in a rule), the rule that monitors the entity triggers an alarm and sets the status of the resource. Examine the alarm messages starting with the most severe alarms.

This walkthrough assumes that you are looking at alarms of all severity levels in an Alarm Summary view. In many places in the software you can restrict your assessment to resources with the same alarm severity. This can be useful when you want to prioritize your alarm assessment, such as focusing on all storage arrays with Critical alarms first, and then on the Warning alarms.

To assess alarms:

- 1 In the Alarm Summary view, review the alarm messages to understand the issues. If the list contains multiple levels of alarm severity, start with the highest severity alarm.

Figure 3. Alarm Summary view

Alarm Summary				
Sev	Time	Type	Instance Name	Message
	8/16/12 2:10 PM		AMS2100.83040841	Array low unallocated disk capacity. Unallocated capacity on AMS2100.83040841 is 0.00 %. This is lower than the fatal threshold of 0.00 %.
	8/16/12 3:25 PM		APM00064702270	Array low unallocated disk capacity. Unallocated capacity on APM00064702270 is 6.67 %. This is lower than the critical threshold of 10.00 %.
	8/16/12 2:29 PM		EVA4400-1	Array low unallocated disk capacity. Unallocated capacity on EVA4400-1 is 5.56 %. This is lower than the critical threshold of 10.00 %.
	8/16/12 3:25 PM		APM00064702270	Array low unallocated pool capacity. Unallocated capacity on APM00064702270 is 25.80 %. This is lower than the warning threshold of 30.00 %.

TIP: If you see alarms on devices or components that you think are operating within acceptable parameters, consider creating new rules to better suit your environment. For more information, see [Managing Foglight for Storage Management Rules](#) on page 114.

- If you need more details to understand the issue, click the alarm message.

An Alarm window displays more information about the alarm and troubleshooting tips.

TIP: To bypass the Alarm window and go straight to the Choose Diagnostic Focus Time window (described in the next step), click an instance name instead of the message.

Figure 4. Alarms window.



The screenshot shows the 'Alarm' window for the message 'Controller is over busy threshold'. The left sidebar displays 'Storage Array Summary (APM00064702270)' with related inventory items like Controllers (2), FC Ports (4), IP Ports (0), LUNs (63), and Disks (30). The main pane shows the alarm details, including a graph of 'Controller % Busy History' and a 'Troubleshooting' section. A 'Choose Diagnostic Focus Time' dialog is open, allowing the user to select a diagnostic time range. The dialog shows two options: 'Explore at Storage Alarm time' (SP B, Saturday, August 11, 2012, 4:17 PM - 8:17 PM, 4 hours) and 'Explore at Default Diagnostic time' (SP B, Saturday, August 11, 2012, 5:17 PM - 9:17 PM, 4 hours). The 'Diagnose' button is highlighted in the bottom right corner.

- From the Troubleshooting pane, click the Diagnose button.
- Choose the time period to use as your diagnostic time range:
 - Explore at Storage Alarm time. Select this option when you want to view diagrams and other details of the affected component at the time the alarm occurred. Shows data for the time period leading up to and including the alarm time. For example, given an alarm time of 10:32 AM and the default four hour time range, the diagnostic time range is set to 6:32 AM - 10:32 AM.
 - Explore at Default Diagnostic time. Select this option when you want to determine if the situation causing the alarm persisted or if it resolved on its own. Shows data before and after the alarm, with the alarm time positioned three quarters of the way into the time range. For example, given an alarm time of 10:32 AM and the default four hour time range, the diagnostic time range is set to three hours before the alarm and one hour after the alarm, that is, 7:32 AM -

11:32 AM. If the current time falls within the range, for example, it is currently 11:05 AM, the time range is set to 7:32 AM - 11:05 AM.

A component dashboard opens with its time range set to the selected diagnostic time range.

- 5 Review the component dashboard to better understand the data that led to the alarm. If you navigate to other dashboards, the diagnostic time range remains the same.
- 6 When you complete your investigation, in the breadcrumbs, click Storage Environment to return to the Choose Diagnostic Focus Time window. If desired, choose the other diagnostic time range.
- 7 When you are finished, close the Choose Diagnostic Focus Time window, and in the Alarm window click one of the following options:
 - **Acknowledge.** Continues to display the alarm, but it is marked as acknowledged until the alarm is triggered again. For example, for Warnings, an appropriate action may be to acknowledge the alarm and ignore it.
 - **Acknowledge Until Normal.** Continues to display the alarm, but it is marked as acknowledged until the affected component returns to the Normal status. This is useful when a component has failed and you want to know when it is replaced.
 - **Clear.** Deletes the alarm. Choose this option when the situation is resolved.
- 8 Close the Alarm window.

 **TIP:** When you close the window, the time range returns to the time range in use before your alarm analysis. If it does not, in the Time Range either click the Frozen Time Range  icon to return to real time or click the arrow to expand the zonar and set the range. For more information, see “Working in a Current or a Diagnostic Time Range” in the online help.

- 9 Take action to resolve the issue in your storage infrastructure, either by yourself or by notifying the appropriate person.

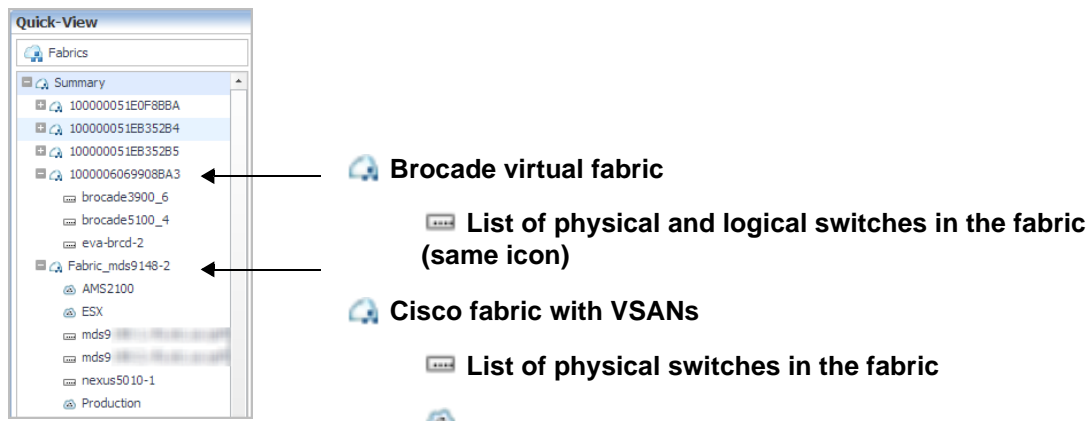
Monitoring Fabrics

Foglight for Storage Management provides insight into both physical and virtual fabrics available with Brocade and Cisco Fibre Channel (FC) switches. A physical fabric is a group of interconnected FC switches. The definition of a virtual fabric differs depending on the vendor:

- Brocade switches enable customers to group ports on physical switches into logical switches. Logical switches and physical switches can then be interconnected into virtual fabrics. Brocade creates logical ISL ports to interconnect logical switches. No metrics are available for LISL ports.
- Cisco switches enable customers to create virtual storage area networks (VSANs) partitioned from a physical fabric. A VSAN is a logical group of ports, where the ports are located on one or more of the interconnected FC switches that form the physical fabric.

Fabrics are displayed in the Fabrics quick view of the Storage Environment dashboard. When you expand a fabric branch to view its components, the list of components varies depending on the type of fabric as follows:

Figure 5. Fabric branch.



This walkthrough introduces the quick views for fabrics and their components.

To monitor fabrics, switches, and VSANs:

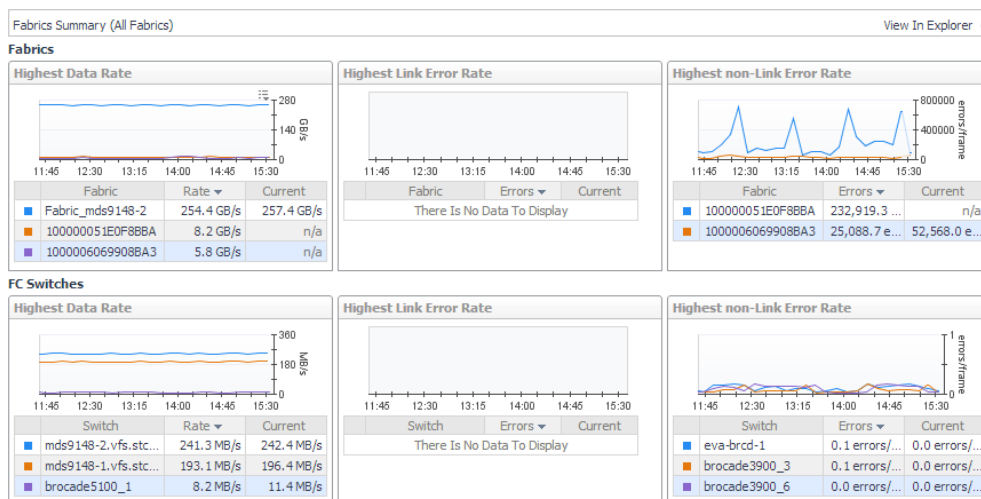
- 1 On the Storage Environment dashboard, ensure the Monitoring tab is selected.
- 2 Click the Fabrics tile to open the Fabrics quick view.

TIP: You can also open this quick view from the navigation panel. For more information, see [Introducing the Storage Explorer](#) on page 44.

- 3 To identify the busiest fabrics in your environment, in the Fabrics list, click Summary.

The Fabrics Summary (All Fabrics) panel opens. The Fabrics view identifies the top three fabrics with the highest average values for **Data Rate**, **Link Error Rate**, and **Non-Link Error Rate**, respectively. The FC Switches view identifies the top three switches in terms of the same metrics. The charts plot the metric values over the time period, while the tables show the average and **current** values for each component.

Figure 7. Fabrics Summary panel.



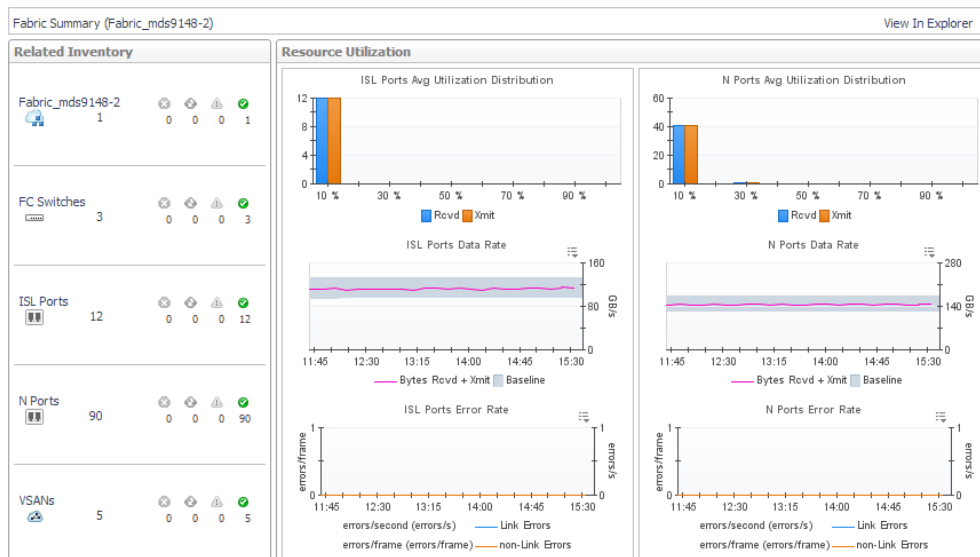
To investigate one of the top three fabrics or switches:

- To explore a top fabric, click its name in a table. See [Exploring a Fabric](#) on page 46.
 - To explore a top switch, click its name in a table. See [Exploring a Switch](#) on page 49.
 - To return to this quick view, in the [breadcrumbs](#), click Storage Environment.
- 4 To monitor the performance of a fabric, in the Fabrics list, click a fabric name.

In the Fabric Summary (*Selected Fabric*), the Related Inventory view contains alarm summaries for the selected fabric as well as its switches, ISL ports, N ports, and VSANs (Cisco fabrics only). The Resource Utilization charts display the following metrics for ISL ports (left) and N ports (right) used by the fabric:

- **Avg Utilization Distribution.** For each type of port, displays aggregated values for [Rcvd Utilization](#) and [Xmit Utilization](#) grouped by percentage of usage. Most of your port utilization should be in the lower percentages. When there are ports performing at high utilization rates, you may want to investigate port performance further.
- **Data Rate.** For each type of port, plots aggregated values for [Data Receive Rate](#) and [Data Send Rate](#) over the time period and displays the [Baseline](#).
- **Error Rate.** For each type of port, plots aggregated values for [Link Error Rate](#) and [Non-Link Error Rate](#) over the time period.

Figure 8. Fabric Summary.



To continue investigating the selected fabric:

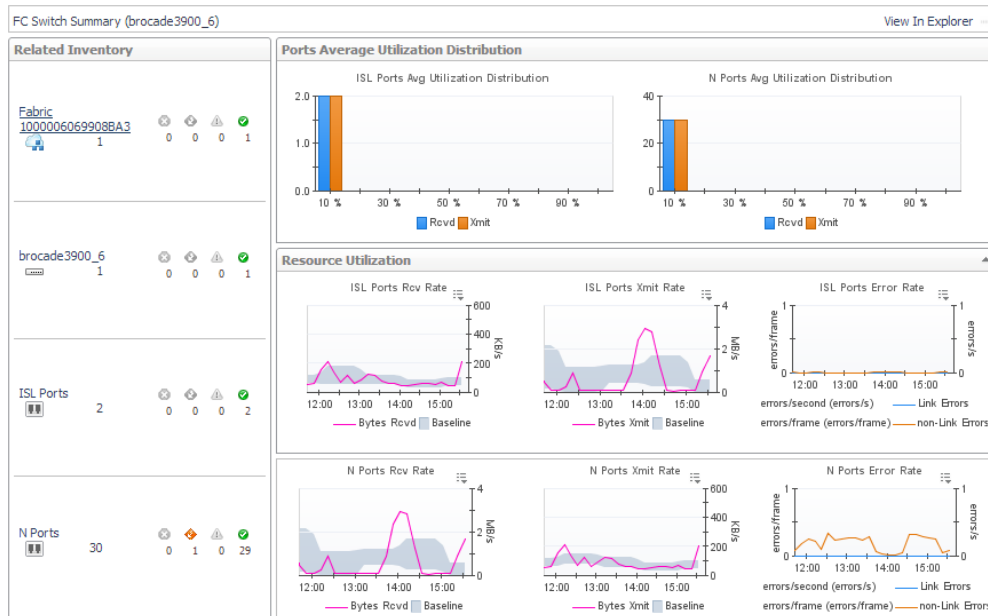
- To explore details about the fabric, its switches, and its ports, click [View in Explorer](#). See [Exploring a Fabric](#) on page 46.
 - To explore an FC switch in the selected fabric, in the Related Inventory view click [FC Switches](#) or an alarm icon, and select a switch. See [Exploring a Switch](#) on page 49.
 - To investigate a port used in the selected fabric, in the Related Inventory view click either [ISL Ports](#) or [N Ports](#) or an alarm icon, and select a port. See [Investigating an FC Switch Port](#) on page 78.
 - *Cisco fabrics only* –To investigate a VSAN used in the selected fabric, in the Related Inventory view click [VSANs](#) or an alarm icon, and select a VSAN. See [Exploring a Cisco VSAN](#) on page 50.
 - To return to the quick view, in the breadcrumbs, click [Storage Environment](#).
- 5 To monitor the performance of a switch (physical or logical), in the [Fabrics list](#), expand a fabric and click a switch.

In the FC Switch Summary, the Related Inventory view contains alarm summaries for the selected switch, the fabric it belongs to, and its ISL ports and N ports. The charts display the following metrics for ISL ports and N ports used by the switch:

- **Ports Average Utilization Distribution.** For each type of port, displays aggregated values for [Rcvd Utilization](#) and [Xmit Utilization](#) grouped by percentage of usage. Most of your port utilization should be in the lower percentages. When there are ports on the switch performing at high utilization rates, you may want to investigate port performance further.

- Rcv Rate. For each type of port, plots aggregated values for [Data Receive Rate](#) over the time period and displays the [Baseline](#).
- Xmit Rate. For each type of port, plots aggregated values for [Data Send Rate](#) over the time period and displays the [Baseline](#).
- Error Rate. For each type of port, plots aggregated values for [Link Error Rate](#) and [Non-Link Error Rate](#) over the time period.

Figure 9. FC Switch Summary



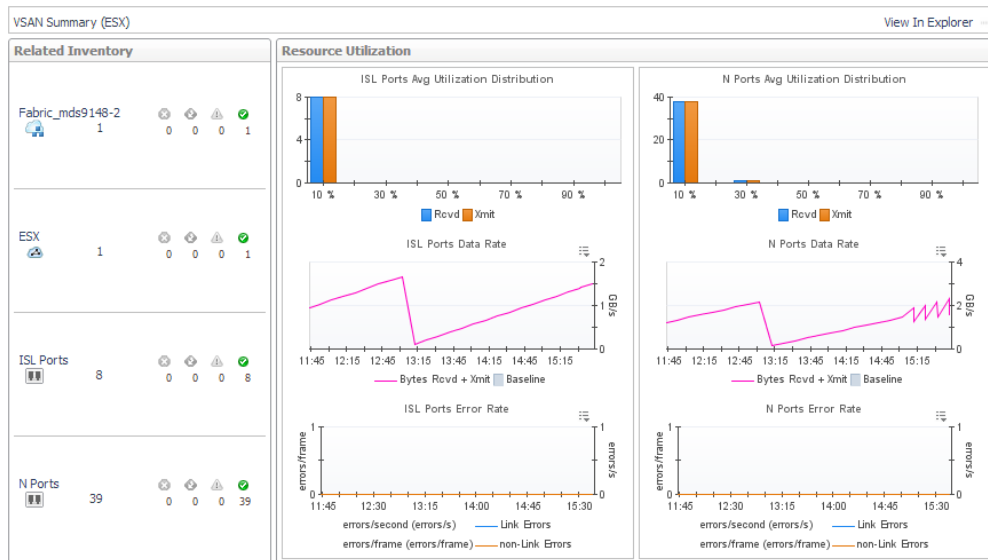
TIP: To identify port performance that has changed, look for values that fall outside the grey [Baseline](#) ribbon.

To continue investigating the selected switch:

- To explore details about the switch and its ports, click [View in Explorer](#). See [Exploring a Switch](#) on page 49.
 - To investigate a port used by the selected switch, in the [Related Inventory](#) view click [ISL Ports](#) or [N Ports](#) or an alarm icon, and then select a port. See [Investigating an FC Switch Port](#) on page 78.
 - To return to the quick view, in the breadcrumbs, click [Storage Environment](#).
- 6 To monitor the performance of a Cisco VSAN, in the [Fabrics](#) list, expand a Cisco fabric and click a VSAN.

In the VSAN Summary, the [Related Inventory](#) view contains alarm summaries for the selected VSAN, the fabric it belongs to, and the ISL ports and N ports used by the VSAN. The [Resource Utilization](#) charts are the same as the charts displayed for a fabric, but the aggregated values include only the ports used by the VSAN.

Figure 10. VSAN Summary.



To continue investigating the selected VSAN:

- To explore details about the VSAN and its ports, click [View in Explorer](#). See [Exploring a Cisco VSAN](#) on page 50.
- To investigate a port used by the selected VSAN, in the Related Inventory view click [ISL Ports](#) or [N Ports](#) or an alarm icon, and then select a port. See [Investigating an FC Switch Port](#) on page 78.
- To return to the quick view, in the breadcrumbs, click [Storage Environment](#).

Monitoring Storage Arrays

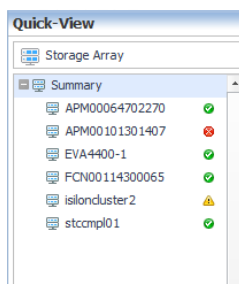
When monitoring storage arrays, or when diagnosing alarms on storage arrays, you may need more detail on the array or its member nodes, controllers, ports, pools, LUNs, or disks. You may also want to determine if any of the child components have alarms that did not affect the array status. This walkthrough introduces the quick view for storage arrays.

To monitor storage arrays:

- 1 On the Storage Environment dashboard, ensure the [Monitoring](#) tab is selected.
- 2 Click the [Storage Arrays](#) tile to open the Storage Arrays quick view.

TIP: You can also open this quick view from the navigation panel. For more information, see [Introducing the Storage Explorer](#) on page 44.
- 3 To identify the most problematic arrays in your environment, in the Storage Arrays list, click [Summary](#).

Figure 11. Storage Arrays list.



The Storage Array Summary summarizes the capacity and performance health of the arrays in the environment.

- Capacity
 - The table is organized by arrays whose pools have the most significant, near-term capacity issues.
 - The categories take into account the estimated time when pool capacity will be full, as well as the current available capacity and the over-provisioning state of the pool.
 - To investigate, click on the array name. See [Monitoring Storage Capacity](#) on page 40.
- Performance
 - The table is organized by arrays with the most LUNs having latency issues.
 - To investigate, click on the array name in the table to drill down to the Array Explorer. Click on the LUNs tab. See [Investigating a LUN](#) on page 81.

Figure 12. Storage Arrays Summary.

Storage Array Summary (All Storage Arrays)						Performance					
Capacity						Performance					
Arrays are ordered by the number of Pools experiencing capacity pressure.						Arrays are ordered by the number of LUNs experiencing high latency					
Name	Severe	High	Monitor	OK	Score	Name	Severe	High	Warning	OK	Rank
APM00101301407	1			3	75	APM00101301407	4	4	6	26	1
APM00064702270				9	100	APM00064702270				1	2
EVA4400-1				4	100	EVA4400-1				11	3
FCN00114300065				6	100	FCN00114300065				5	4
isiloncluster2				1	100	stccmpl01				20	5
stccmpl01				1	100						

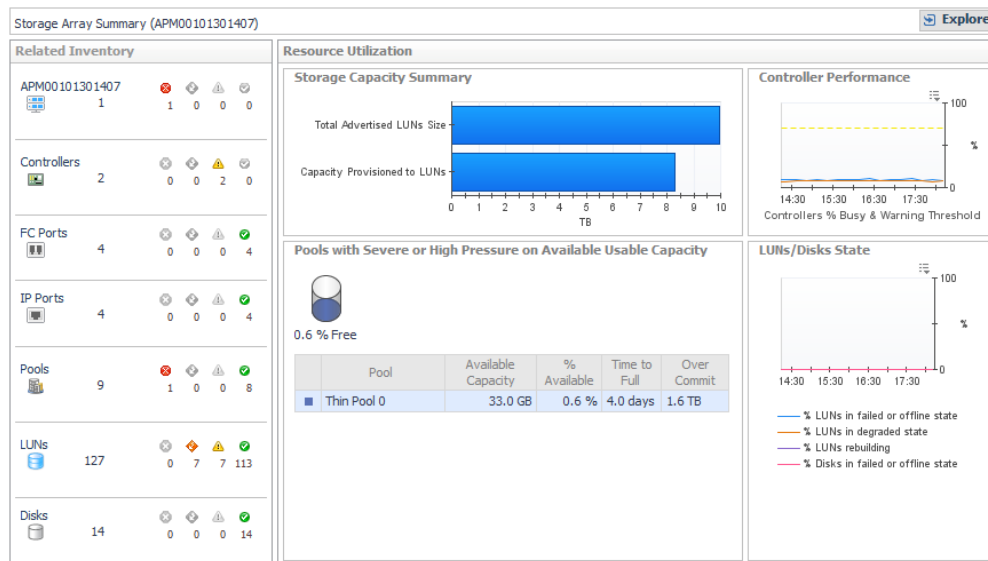
- To monitor a storage array, in the Storage Array list, click a storage array name.

The content of the quick view varies depending on the selected storage array. For most storage arrays (excluding Dell EqualLogic and EMC Isilon), the quick view contains the following embedded views:

- Related Inventory. Contains alarm summaries for the selected storage array and its controllers, FC ports, IP ports, pools, LUNs, and disks.
- Storage Capacity Summary. Displays current values for [Total Advertised LUNs Size](#) and [Capacity Provisioned to LUNs](#).
- Controller Performance. Plots [% Busy](#) values by controller over the time period and displays threshold lines (defined in registry variable *StSAN.Controller.PctBusyThreshold*).
- Pools with Severe or High Pressure on Available Usable Capacity (or Raw Capacity)
 - Displays the pools that have the most significant, near-term capacity issues.
 - Shows the available usable capacity or available raw capacity in the table, depending on the data provided from the device vendor, and the % available.
 - Shows the estimated time when the pool capacity will be full
 - Over commitment is not shown when raw capacity numbers are displayed.
 - The cylinders are colored to show the % of available capacity in the pool.

- **LUNs/Disks States.** Plots the percentage of disks and LUNs in the storage array in problem states. Problem states are reported by the vendor. Resolving these issues may improve LUN performance.

Figure 13. Storage Array Summary.



For more storage array quick views, see the Summary tab description under [Dell EqualLogic Storage Array](#) on page 56 and [EMC Isilon Storage Array](#) on page 59.


- To continue investigating the selected storage array:
 - To explore details about the storage array and its child components, click View in Explorer. See [Exploring a Storage Array](#) on page 54.
 - To investigate a child component, in the Related Inventory view click a component type or a status icon, and then select a component. A component dashboard opens. For help with the dashboard, see one of the following topics:
 - [Investigating a Controller](#) on page 74
 - [Investigating an EqualLogic Member](#) on page 77
 - [Investigating an Isilon Node](#) on page 80
 - [Investigating an Array/File Port](#) on page 73
 - [Investigating a Pool](#) on page 88
 - [Investigating a LUN](#) on page 81
 - [Investigating a Physical Disk](#) on page 86
 - To return to this quick view, in the breadcrumbs, click Storage Environment.

Monitoring Filers

When monitoring filers, or when diagnosing alarms on filers, you may need more detail on a filer and its controllers, ports, NASVolumes, LUNs, aggregates, or disks. You may also want to determine if any child components display alarms. This walkthrough introduces the quick views for filers.

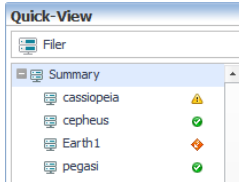
To monitor filers:

- 1 On the Storage Environment dashboard, ensure the Monitoring tab is selected.
- 2 Click the Filers tile to open the Filers quick view.

 **TIP:** You can also open this quick view from the navigation panel. For more information, see [Introducing the Storage Explorer](#) on page 44.

- 3 To identify the busiest filers in your environment, in the Filers list, click Summary.

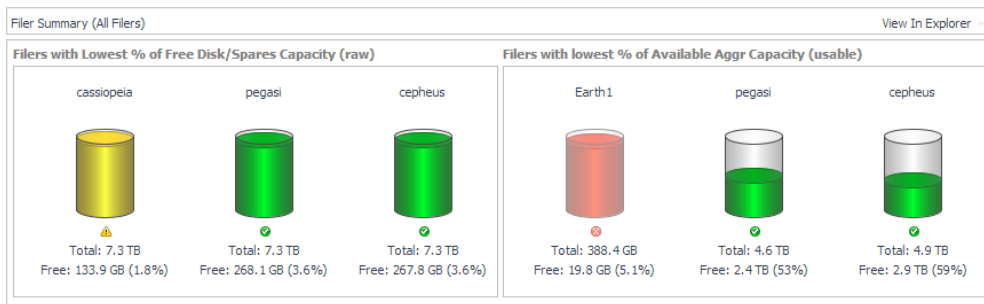
Figure 14. Summary



The Filer Summary view identifies the top three filers in two categories:


- **Filers with Lowest % of Free Disk/Spares Capacity (raw).** Displays cylinders showing the amount of used [Free Disk/Spares Capacity \(Raw\)](#). Below each cylinder, you can see total and free capacity.
- **Filers with Lowest % of Available Aggr Capacity (usable).** Displays cylinders showing the amount of used [Aggr Capacity \(Usable\) Free](#). Below each cylinder, you can see total and free capacity.

Figure 15. Filer Summary view



If you find that cylinder colors do not reflect the acceptable thresholds in your environment, you can ask your Foglight for Storage Management Administrator to edit the threshold values in the following registry variables:

- Disk capacity: *StSAN.FilerDisks.PctUnallocatedCapacityThreshold.[Fatal|Critical|Warning]*
- Aggregate capacity: *StSAN.FilerAggregates.PctUnallocatedCapacityThreshold.[Fatal|Critical|Warning]*

 **NOTE:** Registry variables are global variables that are often referenced by rules. Before editing a registry variable, ensure that the edit will not cause unintended changes to how the affected rules trigger alarms. For more information, search for “Registry Variable” in the online help.

- 4 In the Filer list, click a filer name.

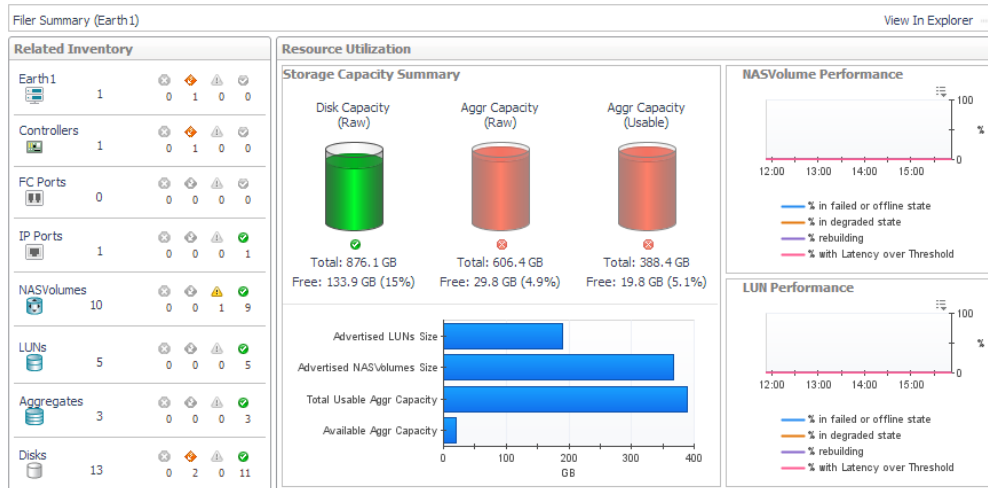
The Related Inventory view contains alarm summaries for the selected filer as well as its controllers, ports, NASVolumes, LUNs, aggregates, or disks. The Resource Utilization charts show capacity and performance metrics for the filer:

- **Storage Capacity Summary.** The cylinders show the amount of capacity consumed in the filer, expressed using [current](#) values for the following pairs of metrics:
 - [Disk Capacity \(Raw\)](#) and [Free Disk/Spares Capacity \(Raw\)](#)
 - [Aggr Capacity \(Raw\) Total](#) and [Aggr Capacity \(Raw\) Free](#)
 - [Aggr Capacity \(Usable\) Total](#) and [Aggr Capacity \(Usable\) Free](#)

The bar chart displays current values for [Advertised LUN Size](#), [Advertised NASVolumes Size](#), [Aggr Capacity \(Usable\) Total](#), and [Aggr Capacity \(Usable\) Free](#).

- **NASVolume Performance.** Plots the percentage of NASVolumes in the filer in problem states. Problem states are reported by the vendor. Resolving issues may improve volume performance.
- **LUN Performance.** Plots the percentage of LUNs in the filer in problem states. Problem states are reported by the vendor. Resolving issues may improve LUN performance.

Figure 16. Filer Summary



5 To continue investigating the selected filer:

- To explore details about the filer and its child components, click **View in Explorer**. See [Exploring a Filer](#) on page 51.
- To investigate a child component, in the **Related Inventory** view click a component type or an alarm icon, and then select a component. A component dashboard opens. For help with the dashboard, see one of the following topics:
 - [Investigating a Controller](#) on page 74
 - [Investigating an Array/File Port](#) on page 73
 - [Investigating a NASVolume](#) on page 84
 - [Investigating a LUN](#) on page 81
 - [Investigating an Aggregate](#) on page 70
 - [Investigating a Physical Disk](#) on page 86
- To return to this quick view, in the breadcrumbs, click **Storage Environment**.

Asking Questions About the Monitored Storage Environment

Another way to find out information about your storage environment is to ask questions. The **FAQts** tab contains frequently-asked questions about storage environments. Answers are displayed in the form of tables and graphs. You can select questions that apply to all storage resources or to a specific type of storage resource.

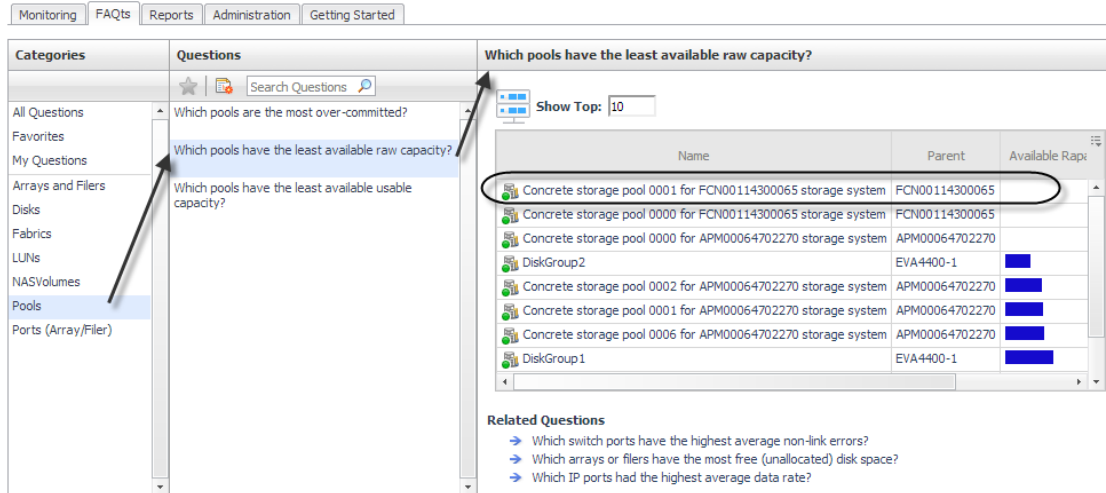
To use the FAQts tab:

- 1 On the **Storage Environment** dashboard, click the **FAQts** tab.
- 2 In the **Categories** pane, click a category to display the questions for that category in the **Questions** pane.

TIP: If the list of questions is long and you want to narrow it down, search for a particular text string using the Search Questions box.

- 3 In the Questions pane, click a question to display the answer in the Answer pane.

Figure 17. Questions pane



- 4 In the Answer pane, you can change the number of results displayed by changing the value of the Show Top box.
- 5 To investigate a component or its parent device, click a name in the Name or Parent column.

Assessing Connectivity and I/O Performance

You can also identify connectivity and port performance problems that occur during I/O requests by assessing storage from the perspective of the virtualization environment. The VMware and Hyper-V Explorers offer an end-to-end look at all the entities that make up your virtual infrastructure, including clusters, hosts, virtualization storage, and virtual machines.

- NOTE:** This workflow assumes that the following requirement is satisfied:
- VMware or Hyper-V Performance agents are defined for the target environment, and the agents are configured to collect storage data. For more information, see [Step 2 in Collecting Storage Data for Virtualized Devices and Servers](#) on page 12.

Introducing the Virtualization Dashboards

This workflow introduces you to the version of the Virtualization dashboards available in Foglight for Storage Management. For detailed information, see the *VMware Monitoring in Foglight for Storage Management User and Reference Guide* or *Hyper-V Monitoring in Foglight for Storage Management User and Reference Guide*.

Table 2. List of dashboards that display virtualization storage environment-to-SAN relationships when data collection is enabled on VMware or Hyper-V Performance agents

Dashboard	SAN Topology Tab	SAN Data Paths Tab
ESX Host/Hyper-V Server	Yes	Yes
Virtual Machine	Yes	Yes
Cluster	Yes	—
Datastore, CSV, logical disk	Yes	—

Table 2. List of dashboards that display virtualization storage environment-to-SAN relationships when data collection is enabled on VMware or Hyper-V Performance agents

Dashboard	SAN Topology Tab	SAN Data Paths Tab
LUN	Yes	Yes
NASVolume	Yes	—

The following workflow walks you through opening a virtualization dashboard and selecting an entity to explore.

To use the virtualization dashboard and topology diagrams:

- 1 On the navigation panel, under Dashboards, click either VMware > VMware Explorer or Hyper-V > Hyper-V Explorer.

TIP: If you do not see the menu, ask your Foglight for Storage Management Administrator to add the role *VMware Administrator* or *Hyper-V Administrator* to your user account.

The Explorer opens an Infrastructure menu below the Dashboards menu on the navigation panel.

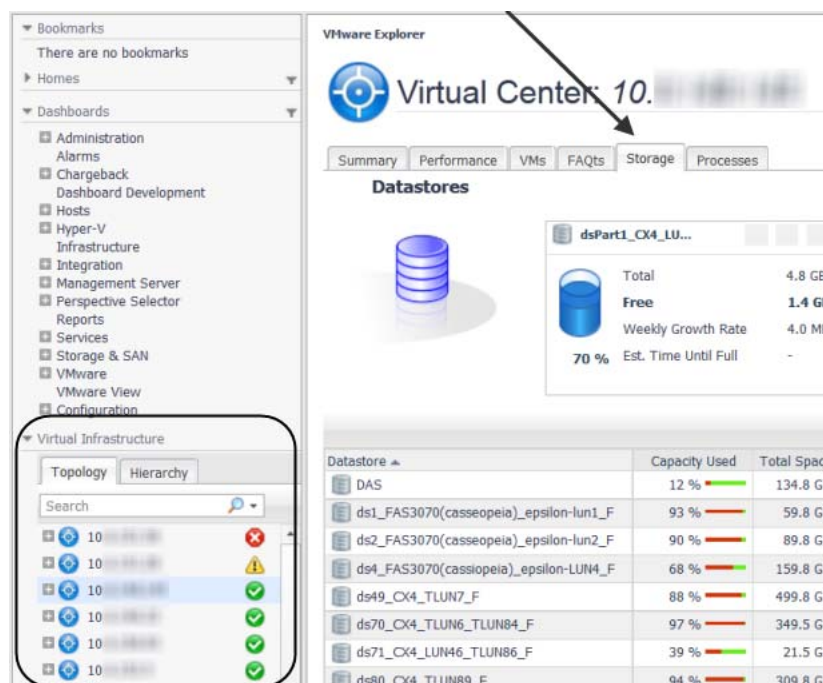
- 2 Under Infrastructure, on the Topology tab, select the desired entity.

The dashboard opens.

NOTE: The topology will display clusters, virtualization servers, and virtual machines. For VMware, it will display Virtual Centers and Datacenters.

- From the Summary tab, you can monitor and investigate entities in your virtual infrastructure using an approach similar to the Storage Environment dashboard.
- When you click the Storage tab, you see a list of all logical storage used by the entity and the associated storage capacity. Click a storage entity name to open the dashboard containing details about the entity.

Figure 18. Entity details



TIP: When the list of entities is long—which is often the case for virtual machines—you can find an entity by typing its full or partial name in the Topology tab's Search box.

When you select a cluster, the dashboard will include SAN Topology tabs. Host/server and virtual machine dashboards will include SAN Data Paths views in addition to SAN Topology that you can explore.

- Click the SAN Topology tab. For instructions about this view, see [Exploring Connectivity with SAN Topology Diagrams](#) on page 34.
- Click the SAN Data Path tab. For instructions about this view, see [Exploring I/O Performance with SAN Data Paths](#) on page 37.

Summary of Icons Used in Topology Diagrams

In topology diagrams, the icons represent entities in your monitored virtual infrastructure and storage infrastructure, as described in the following table. Each icon incorporates a small status icon to show the status of the entity.

Table 3. Icons used in topology diagrams.

















Icon	Represents	Description
	Physical Host	A physical server in your network.
	ESX Host	A physical server hosting the hypervisor-based architecture and virtual machines controlling and managing resources for the virtual machines.
	Hyper-V Server	
	Virtual Machine VMware	A virtual machine running on a host or server.
	Hyper-V	
	Datastore	A datastore or CSV (Cluster Shared Volume) or logical disk is a logical storage structure used to provide virtual machine disks and files.
	Logical Disk	
	CSV	
	Disk Extent	A disk extent is all or part of a host disk that can provide the physical storage for a datastore, CSV or logical disk. The disk extent can be on a local DAS device, or it can be mapped to a LUN on a storage array or filer in the SAN.
	Cloud	Hides port-level complexity in a topology diagram. Click the icon to view ports and their connected devices in a Detail window. NOTE: The SAN Data Paths tab does not use the cloud icon. All ports and their devices are shown in the diagram.
	FC Port	FC ports connect to other FC ports on switches, physical hosts, storage arrays, or filers using fibre-channel network technology in the SAN.

Table 3. Icons used in topology diagrams.

Icon	Represents	Description
	IP Port	IP ports provide access to the IP network for storage devices using iSCSI or other protocols.
	Controller	A controller manages the ports used by a storage array or filer.
	LUN	A LUN (logical unit number) represents a logical SAN block storage device on an array or filer that can be exposed for mapping to a server.
	NASVolume	A NASVolume is a volume whose physical storage is on a filer or unified storage supplier. It can be mounted by an ESX host to provide the physical storage for a datastore using NFS.
	Member or Node	A storage server that works together with other members or nodes in a clustered storage architecture. The array cluster distributes the workloads among the members of the cluster.

Exploring Connectivity with SAN Topology Diagrams

SAN Topology diagrams map the connections through the virtual environment (VMs-to-virtualization storage-to-extents) to the resources in the SAN (LUNs and NASVolumes). Topology diagrams hide port-level details to focus on connectivity. Using this view, you can see which resources have an alarm status along each connection path, and begin to form hypotheses about whether or not the SAN environment is contributing to performance issues in the virtual environment. You can then drill down on resources to test those hypotheses.

In a topology diagram, you can view individual port connections by clicking one or more cloud icons. Details are shown in a separate window.

TIP: If your primary goal is to assess the performance of the ports that are used by the datastores and disk extents connecting to the SAN, use the SAN Data Paths tab instead (when available). For more information, see [Exploring I/O Performance with SAN Data Paths](#) on page 37.

The SAN Topology view displays as a graph for a VM, Datastore or CSV, and for a storage LUN or NASVolume.

The SAN Topology view for a Cluster or server or host will offer the following choices for viewing the topology:

- Show Datastore or CSV resources used by VMs as graph
- Show RDM or pass-through disk resources used by VMs as graph
- Show storage resources used by VMs as table
- Show all storage resources as table

The option to show all storage resources as a table will include Datastores or CSVs that are not used by VMs.

The following workflow explains how you can verify connectivity and the status of entities and storage devices in your infrastructure using a topology diagram. This procedure assumes that you navigated to a topology view from a Virtualization Explorer dashboard (see [Introducing the Virtualization Dashboards](#) on page 31) or from a Storage Explorer component dashboard (see [Investigating a LUN](#) on page 81 or [Investigating a NASVolume](#) on page 84).

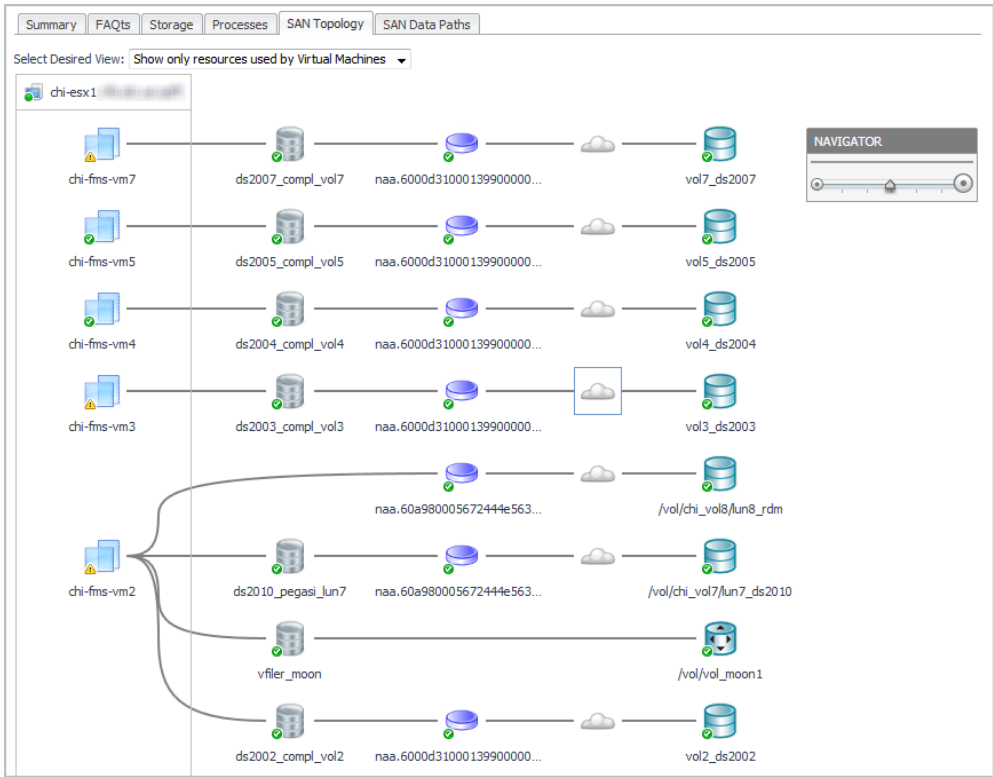
To use a topology diagram graph:

- 1 Click on a Datastore or CSV icon to see the VMs that use this storage. Click on a cloud icon to see the extents that map to the LUN.

NOTE: When viewing the graph for a Cluster, the VMs and disk extents are not displayed on the main graph. When viewing the graph for a server or host, if it supports large numbers of VMs, as in a VDI environment, the VMs will not display on the main graph.

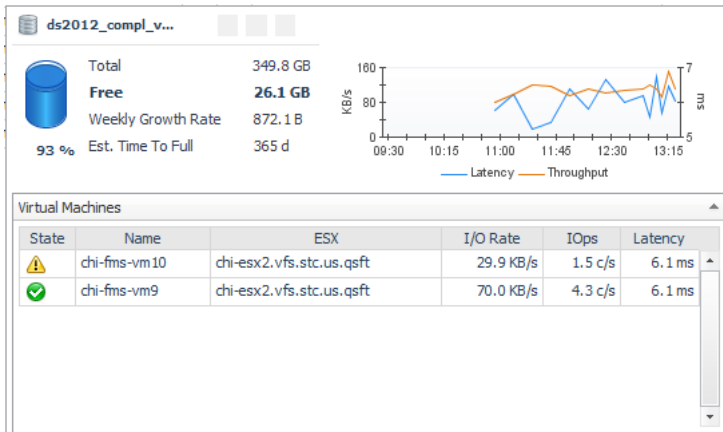
The following image shows virtual machines connected to separate datastores. The disk extents are identified and linked through the network to LUNs. For descriptions of icons, see [Summary of Icons Used in Topology Diagrams](#) on page 33.

Figure 19. Topology diagram.



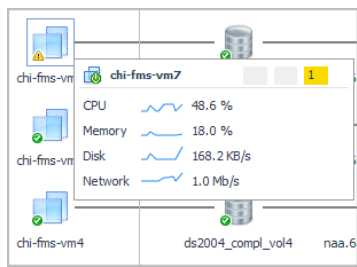
- When a topology diagram has a very large number of elements to be displayed, the graphical representation may be changed to a table for clarity. If the graph is too large to display in the viewing area, you can use the browser’s scroll bars and the Navigator to view the hidden areas. The Navigator enables you to scale the topology diagram and, in large diagrams, drag the viewing area to a different part of the diagram.
- Click a Datastore or CSV icon to see the VMs that use this storage.

Figure 20. VMs using this storage.



- Click any icon to review key details and metrics about the entity.

Figure 21. Key details and metrics.




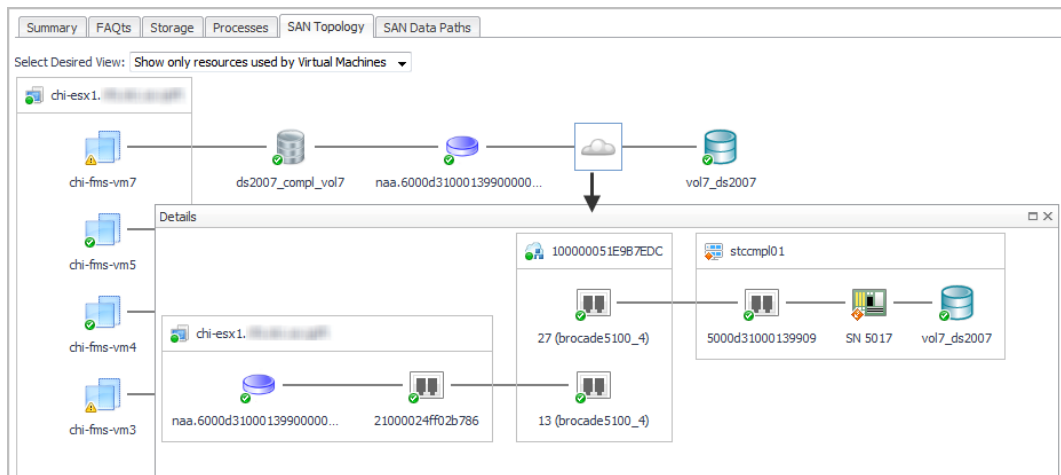
- 5 Click a Cloud  icon to display the ports and SAN paths from the logical storage to the LUN, through the host or server.

Figure 22. Ports and SAN paths.



In this example, you can see that the LUN's controller has a Critical status.


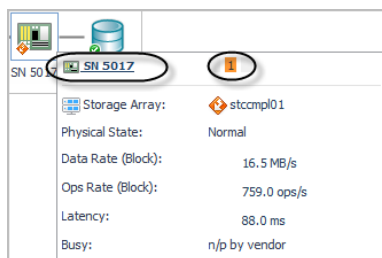
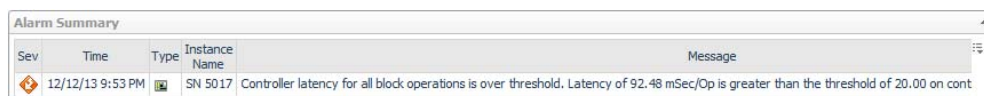
- 6 To investigate an entity, click its icon. For example:
 - a Click the controller  icon.
 - b To view the alarm message, click the alarm count (opens an Alarm Summary window) or the controller name (opens the Controller dashboard).

Figure 23. Alarm message.

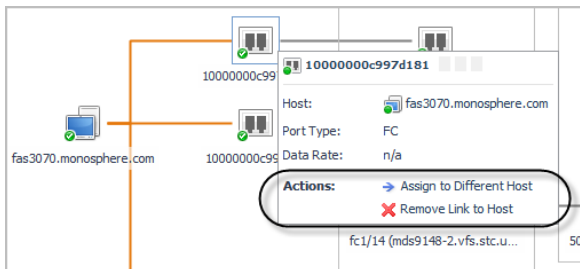


- c The Alarm Summary reports the cause.



- 7 In some topology diagrams, you may see an inferred host (indicated with an orange line). On these diagrams, if an inferred-host-to-port assignment is incorrect, you can click the host port icon and click the appropriate action to correct it.

Figure 24. Incorrect inferred-host-to-port assignment.



To use a topology diagram table:

- 1 Click on a VM cell to display the VMs that use this Datastore or CSV, or RDM. Click on a cloud icon to display the ports and SAN paths from the storage to the LUN, through the hosts or servers.

NOTE: The table view provides the same information as the graphical view.

Summary FAQs Storage SAN Topology					
Select Desired View: Show storage resources used by VMs as table					
Datastore or RDM	VMs		Lun/ NASVolume/ Dir/ DAS	Array / Filer	
ds111_ams_18	2 VMs	n/a	2 disks	n/a	
ds112_ams2100_22	gamma-io-vm4	n/a	2 disks	n/a	
ds26_FAS940(pegasi)_gamma-lun1_F	gamma-io-vm4		/vol/vol2_2/gamma-lun1_ds26	pegasi	
ds36_CX300_LUN46_LUN47_LUN40_LUN3_F	4 VMs		LUN 47_ds36	APM00064702270	
ds36_CX300_LUN46_LUN47_LUN40_LUN3_F	4 VMs		LUN 46_ds36	APM00064702270	
ds36_CX300_LUN46_LUN47_LUN40_LUN3_F	4 VMs		LUN 40_ds36	APM00064702270	
ds36_CX300_LUN46_LUN47_LUN40_LUN3_F	4 VMs		LUN 3_ds36	APM00064702270	
ds39_CX300_LUN37_F	gamma-io-vm4	n/a	/vol/vol5	cassiopeia	

Exploring I/O Performance with SAN Data Paths

The SAN Data Paths tab focuses on input/output performance of the ports used in the data paths connecting the virtual environment to the SAN. This view combines an I/O Data Paths table with a topology diagram that includes port details and I/O performance metrics. The table displays the worst-performing path segment of the possible data paths between each disk extent and the LUN during the time period, helping you to identify bottlenecks resulting in high latency. The diagram enables you see the entities that are capable of doing I/O through each path segment, corresponding to the table rows.

Because the metric values in the SAN Data Paths tab represent the average values over the time period, consider selecting a shorter time range (one hour or less) to help investigate performance spikes. For example, if a customer is complaining about latency issues in the last 15 minutes, you may want to set the dashboard time range to the last 15-30 minutes to focus on the problem period.

TIP: If your primary goal is to discover which SAN resources are used by entities in your virtual environment, use the SAN Topology tab instead. For more information, see [Exploring Connectivity with SAN Topology Diagrams](#) on page 34.

This workflow walks you through using the SAN Data Paths tab from the VMware Explorer's ESX Host dashboard. The content of the SAN Data Paths tab may be slightly different on the Virtual Machine, Datastore, and LUN dashboards, but the flow is the same. The workflow for Hyper-V servers, VMs, and CSVs is similar, but uses the Hyper-V terminology. This workflow continues from [Introducing the Virtualization Dashboards](#) on page 31.

To review data paths:

- 1 On the SAN Data Paths tab, review the In Use I/O Paths table to see the worst-performing path segments in terms of [Latency](#).

The color of the bars (in the table and in the diagram) highlights data values that fall within various thresholds. Metrics without thresholds are displayed in dark blue.

Figure 25. In Use I/O Paths.

Datastore / Disk Extent	Latency	Data Rate	ESX FC Ports --> SAN Util	SAN --> A/F Ports Util	A/F Ctrl Busy	LUN / Volume / Dir	% Competing I/O at LUN
ds121-eq-gamma-vol3-thin	60						
naa.6090a068502e106cbd19	59	16 MB/s	0 %	0 %	n/p by vendor	gamma-vol3-t...	0 %
ds36_CX300_LUN46_LUN47_LUN48	43						
naa.600601605a50180050c7	43	44 MB/s	5 %	16 %	75	LUN 46_ds36	0 %
naa.600601605a5018009275	11	0 MB/s	5 %	16 %	75	LUN 40_ds36	0 %
naa.600601605a5018005e80	10	0 MB/s	5 %	16 %	75	LUN 47_ds36	100 %
naa.600601605a5018009ec1	1	0 MB/s	5 %	16 %	75	LUN 3_ds36	100 %
ds111_ams_18							
naa.60060e80104ab41004f3	20	0 MB/s					

The columns display the following details and metrics. On the Virtual Machine, Datastore, and LUN dashboards, the details and metrics may be slightly different.

- **Datastore/Disk Extent.** List of datastores and the disks that they use, ordered so that the datastores with high-latency disk extents appear at the top. Datastores configured from a NASVolume show only the associated volume; no other data is available. If an *RDM* or *Other* node is displayed, the disk extents under this node are RDMs providing storage directly to the virtual machine.
- **Latency.** Average latency per operation.



NOTE: When physical hosts are inferred, latency values are unavailable because the disk extents that map to the selected LUN are unknown. For more information, see [Inferring Physical-Host-to-Storage Relationships](#) on page 104.
- **Data Rate.** Average data rate for I/O from the ESX or VM to the LUN.
- **ESX FC Ports --> SAN Util.** Displays the busiest link (read or write utilization) in the possible paths between the ESX and the FC switches. Click the cell to display all the port links. Review the topology diagram to see the ports and link utilization. Data is not available for IP ports.
- **SAN --> A/F Ports Util.** Displays the busiest link (read or write utilization) in the possible paths between the FC switches and the array/filer ports. Click the cell to display all the port links. Review the topology diagram to see the ports and link utilization. Data is not available for IP ports.
- **A/F Ctrl Busy.** Displays the CPU % Busy metric for the busiest controller in the data path for a storage array or filer. % Busy values are not available on some devices.
- **LUN / NASVolume / Dir.** Displays the LUN that is mapped to the extent, or displays the NASVolume (filers) or directory (Isilon arrays) providing the storage for a datastore.
- **% Competing I/O at LUN.** Displays the percentage of I/O being experienced by this LUN for all VMs accessing the Datastore, not just those in this ESX. Click the cell to display the top five VMs doing I/O to this LUN.
- **LUN State.** Reports on the state of the LUN as follows:

Table 4. LUN states



Indicates that the LUN is reporting activity that gives an indication of performance problems, it is currently degraded or rebuilding, or the % Busy or Latency metrics are over their thresholds for the time period. Dwell on the cell for details.

Table 4. LUN states

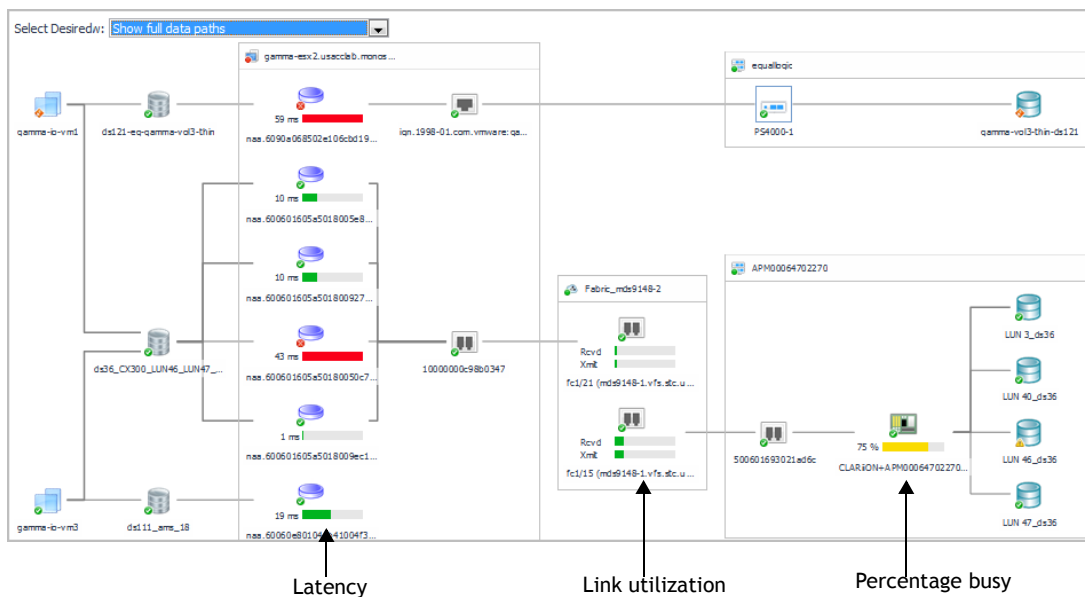
-  Indicates that the vendor does not provide % Busy or Latency metrics.
-  Indicates that either the % Busy metric or Latency metric is within normal range during the time period, and the LUN is not reporting that it is currently degraded or rebuilding. Dwell on the cell for details.

- Latency (ms). Average latency per operation to the LUN during the time period.

- 2 In the diagram, ensure that Select Desired View is set to Show full data paths.


The diagram shows the data paths between datastores and the LUNs providing the physical storage within an ESX host. The bars shown below the icons summarize average latency for hosts (if available), link utilization for FC ports, and percentage busy for controllers. For descriptions of icons, see [Summary of Icons Used in Topology Diagrams](#) on page 33.

Figure 26. Show full data paths.



This diagram highlights how ports are often shared by multiple disk extents. You may be able to trace the cause of a poorly-performing disk extent to poor link utilization values or to some resource issue further down the data path in the SAN. Or if all SAN ports and resources are in a Normal status, you may be able to rule out a storage issue.

- 3 Review the data paths for the worst performing entities to identify bottlenecks that may be contributing to the high latency values.
- 4 To see more of the diagram, use the Navigator to shrink the diagram or move the viewing area. For more information, see [Exploring Connectivity with SAN Topology Diagrams](#) on page 34.

 **TIP:** You can also close the I/O Paths table using the arrow on the far right of the table title bar.

- 5 To investigate an entity, click its icon or name. Use the breadcrumbs to return to this view.
- 6 If you find that the colors used in some metric bars do not reflect acceptable thresholds in your environment, you can ask your Foglight for Storage Management Administrator to edit the threshold values in the following registry variables:

- Latency: *VMW:diskTotalLatency.[warning|critical|fatal]*
- Latency: *HPV:diskTotalLatency.[Warning, Critical, Fatal]*
- Port utilization: *StSAN.FCSwitchPort.Utilization.[Warning|Critical|Fatal]*

- A/F Ctrl Busy: *StSAN.Controller.PctBusyThreshold.[Warning/Critical]*

NOTE: Registry variables are global variables that are often referenced by rules. Before editing a registry variable, ensure that the edit will not cause unintended changes to how the affected rules trigger alarms. For more information, search for “Registry Variable” in the online help.

Monitoring Storage Capacity

FSM closely monitors the capacity being used by the pools in your array or filer. The historical growth of pool capacity usage is analyzed daily to estimate how much time is remaining until the pool becomes full. This capability is critically important for pools that are over-committed with thin-provisioned LUNs and/or NASVolumes.

This section discusses the rules and alarms, views, charts, reports, and configurable values you can use to monitor your pool capacity.

Capacity Trending

FSM performs a linear regression analysis nightly on the historical values of consumed pool capacity.

The Time Until Full (per available history) will use all available history, up to the last 180 days, to project when the pool will become full. The minimum number of days required to compute this trend is defined by the registry variable *StSAN_minDaysForLongHistTrend*. The default is 30 days.

The Time Until Full (per limited history), will use only recent history, up to the last 30 days, to project when the pool will become full. The minimum number of days required to compute this trend is defined by the registry variable *StSAN_minDaysForShortHistTrend*. The default is 20 days. Examining this value is useful primarily when there has been a significant recent change in the pool usage that is expected to continue.

The Time Until Full value is displayed with the following granularity:

- In days, for 0-2 months
- In weeks, for 2-6 months
- In months, for 6-12 months
- As "> 1 year", for anything beyond 365 days
- As "> 1 year" when usage is decreasing or not changing, not increasing.
- As "n/a" when there is insufficient history

The Time Until Full (available history) value is displayed on most screens that show pool data. The Capacity tab of a Pool Explorer will display a chart of the capacity and the trends.

Evaluating Pool Capacity

Pool capacity is evaluated every few hours (after a new topology collection) to determine if a low pool capacity alarm should be generated, and to summarize the number of pools experiencing capacity pressure on the Environment Summary/Monitoring/Summary for Arrays and Filers.

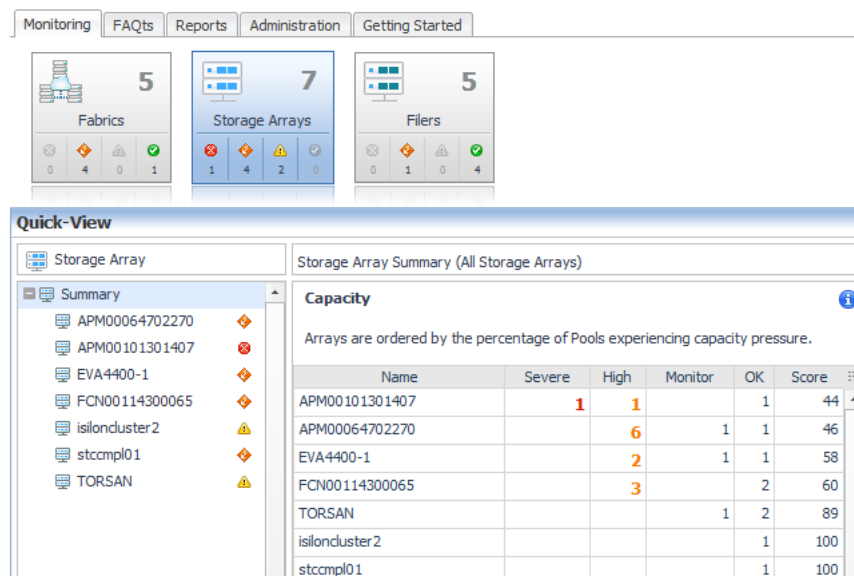
The following factors are examined to determine if a pool is experiencing capacity pressure.

- The over-committed state of the pool
- The absolute capacity available and the % of capacity available
- The estimated Time Until Full

Environment Summary/Monitoring/Summary

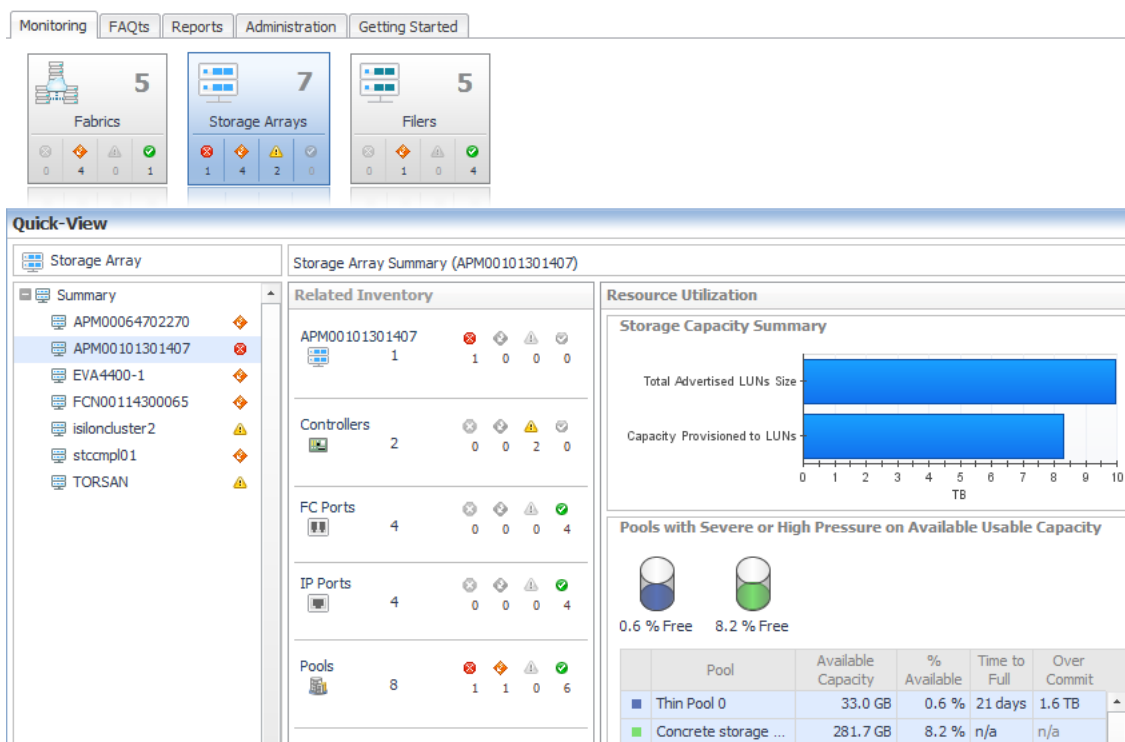
This view will provide you with a quick summary of the arrays in your environment, ordered by low score at the top. The score reflects the percent of pools in your environment with capacity issues.

Figure 27. Storage view



Clicking on the array name will display a view that identifies the pools with Severe or High capacity issues. A low pool capacity alarm will have been generated for every pool that is not OK, if the low pool capacity rule is enabled.

Figure 28. Arrays with capacity issues



Capacity Reports

The SanStorage Pools Capacity Summary Report summarizes the total and available capacity, and estimated time until full, for the pools or aggregates in the selected Storage devices. The report can be optionally limited to the pools or aggregates with thin-provisioned entities.

Low Capacity Rule

The rule StSAN E Pool Low Available Capacity with Email will be evaluated after every collection that provides new capacity information. A fatal alarm will be generated for every pool experiencing severe capacity pressure. A critical alarm will be generated for every pool experiencing high capacity pressure. A warning alarm will be generated for every pool included under the monitor count. No email will be generated for warning alarms.

Registry Variables

The following registry variables are used in the pool capacity evaluations for alarm generation and for determining which pools are experiencing capacity pressure.

These variables are used in pool capacity evaluation to compare to the estimated Time Until Full. For over-committed pools, they will generate alarms as Fatal/Critical/Warning. For pools that are not over-committed, they will generate alarms as Critical or Warning, based on the available capacity in the pool.

- StSAN.Pool.TimeToFull.VerySoon - default 2 weeks
- StSAN.Pool.TimeToFull.Soon - default 4 weeks
- StSAN.Pool.TimeToFull.Warn - default 12 weeks

There variables are used to examine pool capacity when no estimated Time Until Full value is available, and when the Time to Full is very long. Critical or Warning alarms will be generated for pools that are not over-committed. Fatal and Critical alarms will be generated if the pool is over-committed.

- StSAN.Pool.AvailableCapacityThreshold.Critical - default 100 GB
- StSAN.Pool.AvailableCapacityThreshold.Warning - default 200 GB
- StSAN.Pool.PctAvailableCapacityThreshold.Critical - default 5%
- StSAN.Pool.PctAvailableCapacityThreshold.Warning - default 10%

The value of these registry variables can be easily modified to meet the needs of your environment.

Creating Storage Reports

In the Storage Environment dashboard, you can create reports to share with colleagues. You can also copy and edit existing reports. If the Reports tab is not displayed, your Foglight for Storage Management Administrator may need to modify your user account to include the *General Access* role.

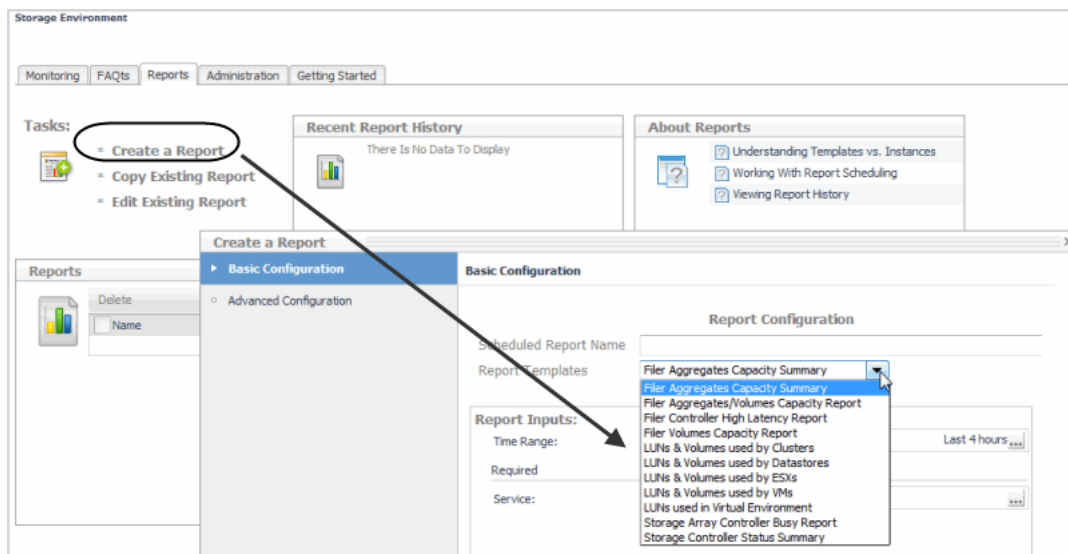
TIP: You can also use the Foglight for Storage Management Reports dashboard available from the Reports link at the top of all dashboards. For more information about this dashboard, see the *Foglight for Storage Management User Guide*.

To create a report:

- 1 On the Storage Environment dashboard, click the Reports tab.

The Create a Report wizard opens. Use the Next and Back buttons to navigate between pages.

Figure 29. Follow the steps in the wizard to select a report template and specify report parameters.



- 2 Click Finish to generate the report.

Investigating Storage Devices

To find out more about the performance of a storage device and its components, you use the Storage Explorer dashboards.

Introducing the Storage Explorer

The Storage Explorer enables you to quickly find and examine any storage device in your storage environment. The Storage Explorer has a Topology tree—displayed in the navigation panel below the list of Dashboards—that contains branches for Fabrics, Filers, and Storage Arrays. The fabrics in the Fabrics branch can be expanded to show FC switches and VSANs. When you select a device from the tree, the Storage Explorer opens a dashboard displaying details about that device.

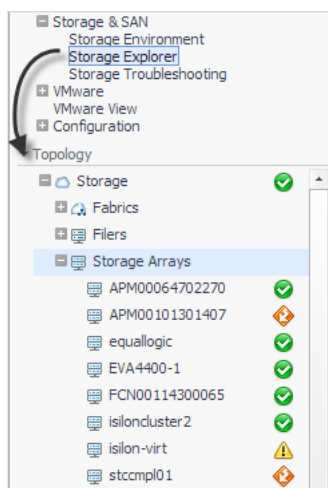
This walkthrough describes how to open the Storage Explorer and select a storage device. If you select a top-level device type node, such as Fabrics, the Storage Environment quick view is displayed. For more information about the quick view, see [Monitoring Your Storage Environment](#) on page 19.

To use the Storage Explorer:

- 1 On the navigation panel, under Dashboards, click **Storage & SAN > Storage Explorer**.

The Topology tree opens below the Dashboards area, containing a list of all monitored storage devices and their status.

Figure 1. The Topology tree



- 2 On the navigation panel, under Topology, select a storage device. Details about the device and its components are displayed in a Storage Explorer dashboard.

All Storage Explorer dashboards have a similar organization.

Figure 2. Common elements of the Storage Explorer dashboards.

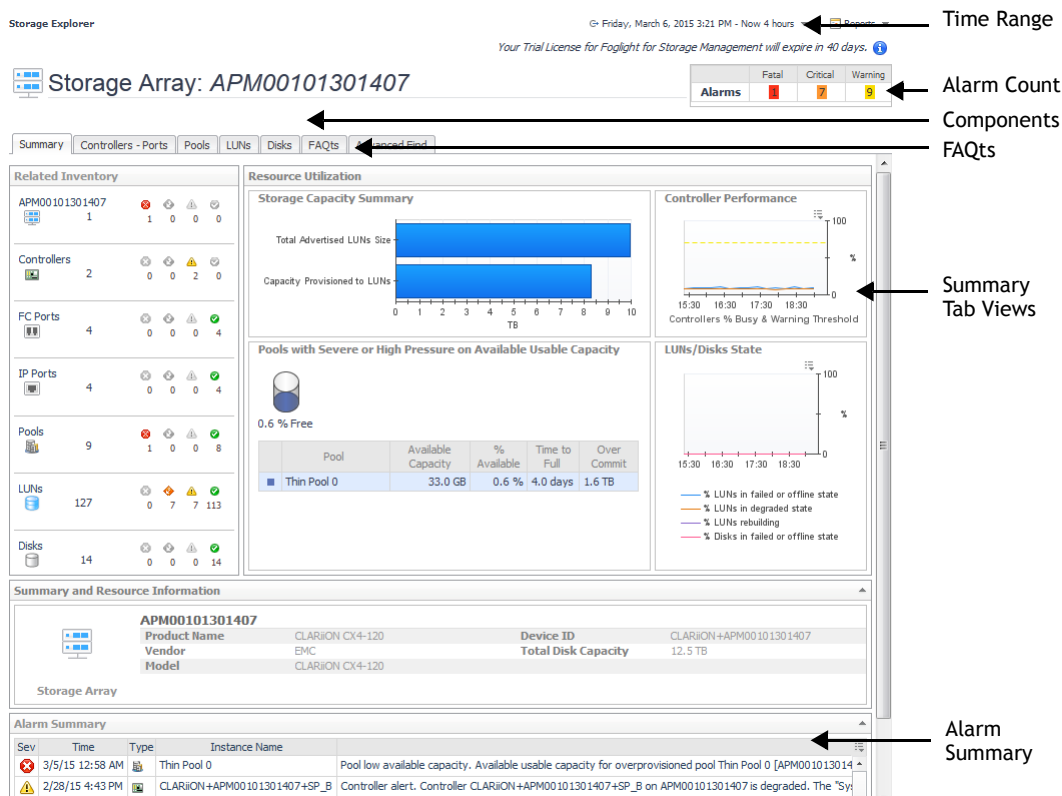


Table 1. Storage Explorer dashboards contain the following common screen elements:

Screen Element	Description
Time Range	Displays and controls the period of time represented in the dashboard. The default is the last four hours. For more information, see “Time Range” in the online help.
Alarm Count	Displays counts of all the alarms at each severity level that are still active (not cleared) at the end of the displayed time range. Unlike the Alarm Summary view, the Alarm Count includes alarms for the device and all its child components. Click an alarm count to display the alarms at that severity level.
Summary Tab Views	<p>When the Summary tab is selected:</p> <ul style="list-style-type: none"> The top view displays the same Related Inventory view and charts that are displayed for this device in the Storage Environment quick view. The Summary and Resource Information view displays physical configuration details for the selected device. The Alarm Summary displays device-level alarms (if any).
Component Tabs	<p>Contains a tab for each type of component used by the selected device, such as ports, drives, and disks.</p> <p>When a component tab is selected:</p> <ul style="list-style-type: none"> The top view displays key performance and/or capacity metrics for the components used by this device. A Details view lists the components by name and displays physical configuration details. The Alarm Summary displays component-level alarms (if any). Other component-specific views may be present.

Table 1. Storage Explorer dashboards contain the following common screen elements:

Screen Element	Description
FAQs Tab	Contains questions appropriate for the selected device type. For information on how to use a FAQs tab, see Asking Questions About the Monitored Storage Environment on page 30.
Alarm Summary	Displays alarms for the selected device (on the Summary tab) or the type of component (on the Component tabs).

For information about each type of Storage Explorer dashboard, see the following topics:

- [Exploring a Fabric](#)
- [Exploring a Switch](#)
- [Exploring a Cisco VSAN](#)
- [Exploring a Storage Array](#)
- [Exploring a Filer](#)


Exploring a Fabric

The Storage Explorer's Fabric dashboard contains information about the selected fabric and its switches as well as all ports used by the switches in the fabric. The data displayed reflects values for the selected time range. This walkthrough describes the contents of each of the tabs and points you to where you can drill down for more details.

To explore a fabric:

- 1 On the navigation panel, under Dashboards, click **Storage & SAN > Storage Explorer**.
- 2 On the navigation panel, under Topology, expand **Fabrics** and select a fabric.

The Fabric dashboard opens with details for the selected fabric.

 **TIP:** You can also open this dashboard from the Storage Environment dashboard by selecting a fabric and clicking **View in Explorer**.

- 3 If the **Alarm Count** displays alarms, you may want to assess the alarms before continuing with this walkthrough. Click a status count to open a list of device and component alarms. For more information, see [Assessing Storage Alarms](#) on page 20.
- 4 In the Summary tab, review performance in terms of key metrics.

The Summary tab contains the same Related Inventory view and Resource Utilization charts as the [Fabric Summary](#) quick view described in [Monitoring Fabrics](#) on page 22. In addition, the tab includes the following views:


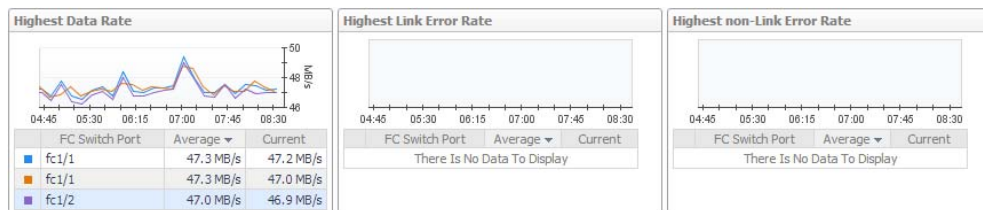
- **Summary and Resource Information.** Displays physical details about the fabric.
- **FC Switch Detail.** For each switch, displays the switch status, type of switch (physical or logical), and **current** value for **Data Rate**, followed by details about the ISL ports and N ports belonging to the switch. Ports details include the number of ports by alarm status and current values for **Link Error Rate** and **Non-Link Error Rate**. Click a  **Sparkline** to plot metric values over the time period.

Figure 4. FC Switch details

FC Switch Details												
FC Switch			ISL Ports						N Ports			
Name	Status	Type	Data Rate	Count	Link Error Rate	non-Link Error Rate	Count	Link Error Rate	non-Link Error Rate	Count	Link Error Rate	non-Link Error Rate
nexus5010-1	✓	Phy	270.9 B/s	4	0.0 errors/s	0.0 errors/frame	2	0.0 errors/s	n/a			
mds9148-2	✓	Phy	236.5 MB/s	4	0.0 errors/s	0.0 errors/frame	44	0.0 errors/s	0.0 errors/frame			
mds9148-1	✓	Phy	193.0 MB/s	4	0.0 errors/s	0.0 errors/frame	44	0.0 errors/s	0.0 errors/frame			
nexus5010-2	✓	Phy	201.8 B/s	0	0.0 errors/s	0.0 errors/frame	6	0.0 errors/s	0.0 errors/frame			

- Alarm Summary. Displays alarms on this fabric.
- 5 Click the ISL Ports tab.
- Highest charts. The charts display the top three ISL ports in the fabric with the highest average [Data Rate](#), [Link Error Rate](#), and [Non-Link Error Rate](#), respectively. The tables show the average and current values for the ports.

Figure 5. Highest charts



- Topology Table (Inter-Switch Connections). For each switch, identifies all ISL port connections with other switches in the fabric.

Figure 6. Topology Table

Topology Table (Inter-Switch Connections)					
FC Switch	Port	Status	Target Switch	Target Port	Status
mds9148-1	fc1/1	✓	mds9148-2	fc1/1	✓
	fc1/2	✓	mds9148-2	fc1/2	✓
	fc1/45	✓	nexus5010-1	fc2/1	✓
	fc1/46	✓	nexus5010-1	fc2/2	✓
mds9148-2	fc1/1	✓	mds9148-1	fc1/1	✓
	fc1/2	✓	mds9148-1	fc1/2	✓
	fc1/45	✓	nexus5010-1	fc2/3	✓
	fc1/46	✓	nexus5010-1	fc2/4	✓
nexus5010-1	fc2/1	✓	mds9148-1	fc1/45	✓
	fc2/2	✓	mds9148-1	fc1/46	✓
	fc2/3	✓	mds9148-2	fc1/45	✓
	fc2/4	✓	mds9148-2	fc1/46	✓

- Port Details. For each switch-plus-port combination, displays the name and type of switch (physical or logical) and the port name, status, and physical state. The metrics represent current values for [Rcvd Utilization](#), [Xmit Utilization](#), [Link Error Rate](#), [Non-Link Error Rate](#), and [Link Speed](#). Click a [Sparkline](#) to plot metric values over the time period.

① **NOTE:** When the selected fabric is a Cisco physical fabric with VSANs, this table includes a VSAN column that identifies the VSANs to which each ISL port is assigned.

Figure 7. Port details

Port Details										
FC Switch	Type	Port	Status	Phys State	VSAN	Rcvd Utilization	Xmit Utilization	Link Error Rate	non-Link Error Rate	Link Speed
nexus5010-1	Phy	fc2/3	✓	Normal	VSAN0001	0.0 %	0.0 %	0.0 errors/s	0.0 errors/frame	8,000 Mb/s
mds9148-2	Phy	fc1/1	✓	Normal	3 VSANs	2.6 %	2.4 %	0.0 errors/s	0.0 errors/frame	8,000 Mb/s
mds9148-2	Phy	fc1/2	✓	Normal	3 VSANs	2.5 %	2.4 %	0.0 errors/s	0.0 errors/frame	8,000 Mb/s
mds9148-2	Phy	fc1/46	✓	Normal	3 VSANs	0.0 %	0.0 %	0.0 errors/s	0.0 errors/frame	8,000 Mb/s
mds9148-2	Phy	fc1/45	✓	Normal	3 VSANs	0.0 %	0.0 %	0.0 errors/s	0.0 errors/frame	8,000 Mb/s
mds9148-1	Phy	fc1/45	✓	Normal	3 VSANs	0.0 %	0.0 %	0.0 errors/s	0.0 errors/frame	8,000 Mb/s
mds9148-1	Phy	fc1/46	✓	Normal	3 VSANs	0.0 %	0.0 %	0.0 errors/s	0.0 errors/frame	8,000 Mb/s
mds9148-1	Phy	fc1/1	✓	Normal	3 VSANs	2.4 %	2.6 %	0.0 errors/s	0.0 errors/frame	8,000 Mb/s
mds9148-1	Phy	fc1/2	✓	Normal	3 VSANs	2.4 %	2.6 %	0.0 errors/s	0.0 errors/frame	8,000 Mb/s

You can add the following metrics to the table by clicking the Customizer icon: [Frame Rate](#), [Data Receive Rate](#), [Data Rate](#), and [Data Send Rate](#).

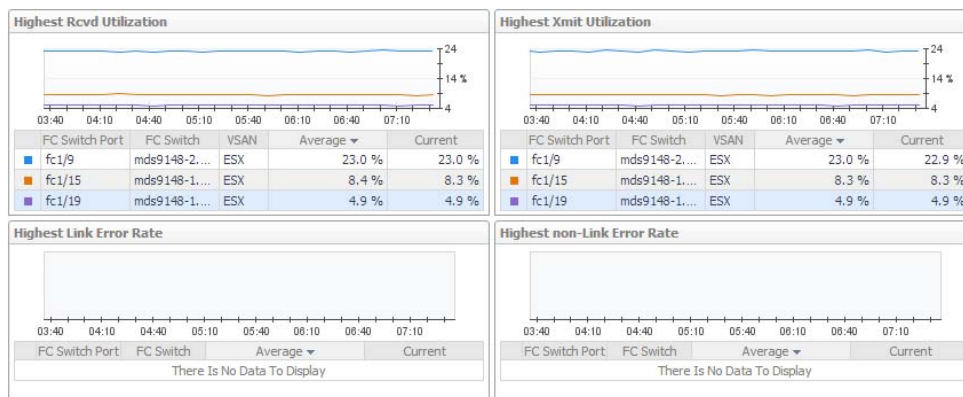
- Alarm Summary. Displays alarms on ISL ports.

6 Click the N Ports tab.

- Highest charts. The charts display the top three N ports in the fabric with the highest average [Rcvd Utilization](#), [Xmit Utilization](#), [Link Error Rate](#), and [Non-Link Error Rate](#), respectively. The tables show the average and current values for the ports.

NOTE: When the selected fabric is a Cisco physical fabric with VSANs, the tables include a VSAN column that identifies the VSAN to which an N port is assigned.

Figure 8. Highest charts




- Port Details. For each switch-plus-port combination, displays the name and type of switch and the port name, status, and physical state. The metrics represent current values for [Rcvd Utilization](#), [Xmit Utilization](#), [Link Error Rate](#), [Non-Link Error Rate](#), and [Link Speed](#). Click a [Sparkline](#) to plot metric values over the time period.

NOTE: When the selected fabric is a Cisco physical fabric with VSANs, this table includes a VSAN column that identifies the VSAN to which an N port is assigned.

Figure 9. Port Details

Port Details										
FC Switch	Type	Port	Status	Phys State	VSAN	Rcvd Utilization	Xmit Utilization	Link Error Rate	non-Link Error Rate	Link Speed
mds9148-1.vf...	Phy	fc1/43	✓	Disabled/Suspend...	n/a	n/a	n/a	0.0 errors/s	n/a	n/a
mds9148-1.vf...	Phy	fc1/48	✓	Disabled/Suspend...	n/a	n/a	n/a	0.0 errors/s	0.0 errors/frame	n/a
mds9148-1.vf...	Phy	fc1/3	✓	Normal	ESX	0.1 %	0.3 %	0.0 errors/s	0.0 errors/frame	4,000 Mb/s
mds9148-1.vf...	Phy	fc1/9	✓	Normal	ESX	0.0 %	0.0 %	0.0 errors/s	0.0 errors/frame	2,000 Mb/s
mds9148-1.vf...	Phy	fc1/29	✓	Offline (link failure)	n/a	n/a	n/a	0.0 errors/s	n/a	n/a
mds9148-1.vf...	Phy	fc1/21	✓	Normal	ESX	0.0 %	0.0 %	0.0 errors/s	0.0 errors/frame	4,000 Mb/s
mds9148-1.vf...	Phy	fr1/17	✓	Normal	Pro	0.0 %	0.0 %	0.0 errors/s	0.0 errors/frame	2,000 Mb/s

You can add the following metrics to the table by clicking the Customizer  icon: [Frame Rate](#), [Data Receive Rate](#), [Data Rate](#), and [Data Send Rate](#).

- **Alarm Summary.** Displays alarms on N ports.
- To investigate further, click the name of a component on any tab:
 - Click a switch name. See [Exploring a Switch](#) on page 49.
 - Click a port name. See [Investigating an FC Switch Port](#) on page 78.
 - For Cisco fabrics with VSANs, click the text in the VSAN column and then select a VSAN. See [Exploring a Cisco VSAN](#) on page 50.
 - Click an alarm. See [Assessing Storage Alarms](#) on page 20.
 - To change the fabric name to a more user-friendly name, click the fabric name in the Summary and Resource Information panel.


The Change Fabric Name dialog appears, allowing you to enter a new name.

Exploring a Switch

The Storage Explorer's FC Switch dashboard contains information about the selected Fibre Channel switch and all ports used by the switch. The data displayed reflects metric values for the selected time range. This walkthrough describes the contents of each of the tabs and points you to where you can drill down for more details.

To explore a switch:

- On the navigation panel, under Dashboards, click **Storage & SAN > Storage Explorer**.
 - On the navigation panel, under Topology, expand **Fabrics**, expand the target fabric, and select a switch.
- The FC Switch dashboard opens with details for the selected switch.

 **TIP:** You can also open this dashboard from the Storage Environment dashboard by selecting a switch and clicking **View in Explorer**.

- If the **Alarm Count** displays alarms, you may want to assess the alarms before continuing with this walkthrough. Click a status count to open a list of device and component alarms. For more information, see [Assessing Storage Alarms](#) on page 20.
- In the **Summary** tab, review performance in terms of key metrics.

The Summary tab contains the same Related Inventory view and Resource Utilization charts as the [FC Switch Summary](#) quick view described in [Monitoring Fabrics](#) on page 22. In addition, the tab includes the following views:

- **Summary and Resource Information.** Displays physical details about the switch.
- **Topology Table (Inter-Switch Connections).** *Brocade logical switches only.* For each switch, identifies all ISL port connections with other switches in the fabric.

- **Alarm Summary.** Displays alarms on the switch.
- 5 Click the ISL Ports tab, if available.

NOTE: This tab is hidden when the switch is a Brocade logical switch that uses only logical ISL ports for inter-switch connections. No metrics are available for logical ISL ports. The Topology Table (Inter-Switch Connections) table appears on the Summary tab instead.

Displays the same information as the [ISL Ports](#) tab on the Fabric dashboard, but the data reflects only the ISL ports used by the selected switch. For more information, see [Exploring a Fabric](#) on page 46.
 - 6 Click the N Ports tab.

Displays the same information as the [N Ports](#) tab on the Fabric dashboard, but the data reflects only the N ports used by the selected switch. For more information, see [Exploring a Fabric](#) on page 46.
 - 7 To investigate further, click the name of a component on any tab:
 - Click a port name. See [Investigating an FC Switch Port](#) on page 78.
 - For Cisco fabrics with VSANs, click the text in the VSAN column and then select a VSAN. See [Exploring a Cisco VSAN](#) on page 50.
 - Click an alarm. See [Assessing Storage Alarms](#) on page 20.

Exploring a Cisco VSAN

The Storage Explorer's VSAN dashboard contains information about the selected Cisco VSAN and all ports that are part of the VSAN. The data displayed reflects metric values for the selected time range. This walkthrough describes the contents of each of the tabs and points you to where you can drill down for more details.

To explore a VSAN:

- 1 On the navigation panel, under Dashboards, click **Storage & SAN > Storage Explorer**.
- 2 On the navigation panel, under Topology, expand **Fabrics**, expand a Cisco fabric with VSANs, and select a VSAN.

The VSAN dashboard opens with details for the selected VSAN.

TIP: You can also open this dashboard from the Storage Environment dashboard by selecting a VSAN and clicking **View in Explorer**.
- 3 If the [Alarm Count](#) displays alarms, you may want to assess the alarms before continuing with this walkthrough. Click a status count to open a list of device and component alarms. For more information, see [Assessing Storage Alarms](#) on page 20.
- 4 In the Summary tab, review performance in terms of key metrics.

The Summary tab contains the same Related Inventory view and Resource Utilization charts as the [VSAN Summary](#) quick view described in [Monitoring Fabrics](#) on page 22.
- 5 Click the ISL Ports tab.

Displays the same information as the [ISL Ports](#) tab on the Fabric dashboard, but the data reflects only the ports that are part of the selected VSAN. For more information, see [Exploring a Fabric](#) on page 46.
- 6 Click the N Ports tab.

Displays the same information as the [N Ports](#) tab on the Fabric dashboard, but the data reflects only the ports that are part of the selected VSAN. For more information, see [Exploring a Fabric](#) on page 46.
- 7 To investigate further, click the name of a component on any tab:
 - Click a port name. See [Investigating an FC Switch Port](#) on page 78.
 - Click an alarm. See [Assessing Storage Alarms](#) on page 20.

Exploring a Filer

Foglight for Storage Management supports NetApp filers. NetApp uses the word *aggregate* instead of pool, but the metrics collected for aggregates and pools are similar. In some filer views, in particular the views on the LUNs tab and Disks tabs, the word pool may be displayed instead of aggregate, but in this context it refers to aggregates.

The Storage Explorer's Filer dashboard contains information about the selected filer and its child components. The data displayed reflects values for the selected time range. This walkthrough describes the contents of each of the tabs and points you to where you can drill down for more details.

To explore a filer:

- 1 On the navigation panel, under Dashboards, click Storage & SAN > Storage Explorer.
- 2 On the navigation panel, under Topology, expand Filers and select a filer.

The Filer dashboard opens with details for the selected filer.

TIP: You can also open this dashboard from the Storage Environment dashboard by selecting a filer and clicking View in Explorer.

- 3 In the Summary tab, review performance in terms of key metrics.

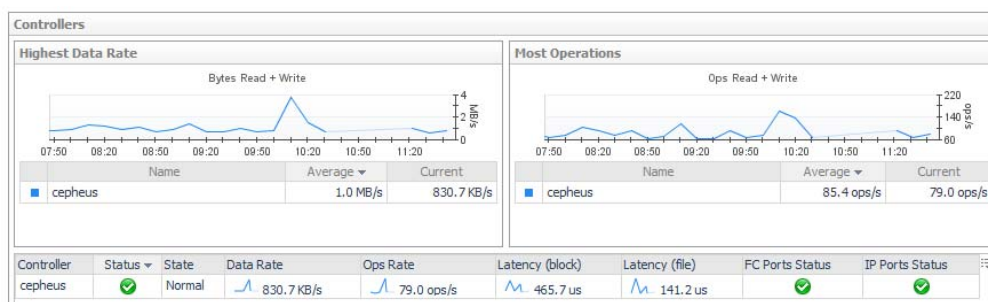
The Summary tab contains the same views as the Filer Summary (Selected Filer) quick view described in [Monitoring Filers](#) on page 28. In addition, the tab includes the following views:

- Summary and Resource Information. Displays physical details about the filer.
- Alarm Summary. Displays alarms on the filer.

- 4 Click the Controllers-Ports tab.

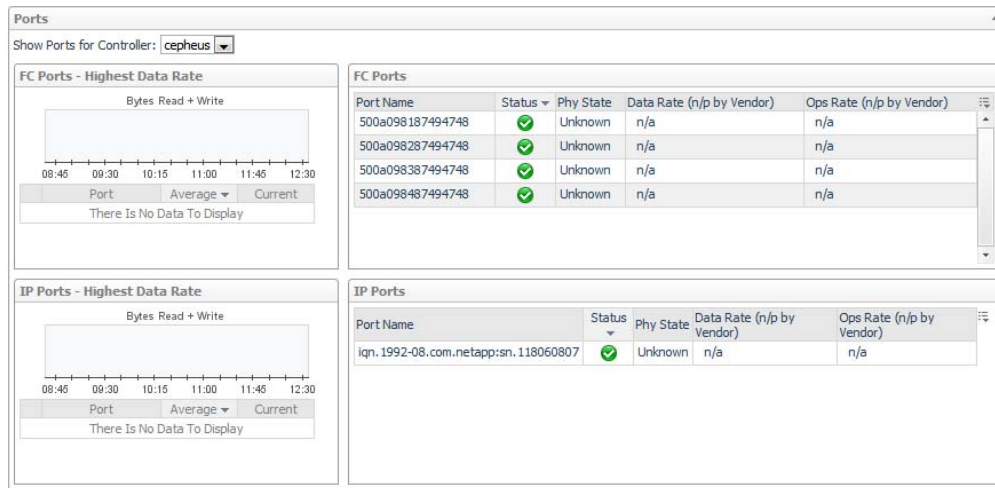
- Controllers. The charts display the controllers with the highest average [Data Rate](#) and [Ops Rate](#). The table displays [current](#) values for each of the charted metrics, plus [Latency](#) by block and file and the most severe alarm status on the FC ports and IP ports associated with this controller.

Figure 10. Controllers



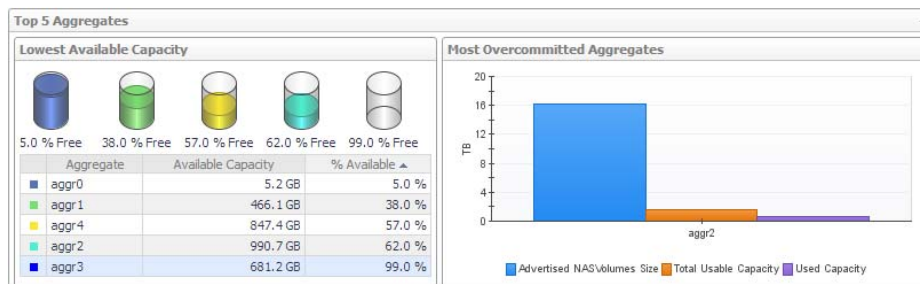
- Ports. Select a controller from the Show Ports for Controller list. The ports associated with the selected controller are displayed, however the port's physical state and performance metrics are unavailable for NetApp filers. The IP ports shown are used for iSCSI I/O to LUNs traffic.

Figure 11. Ports

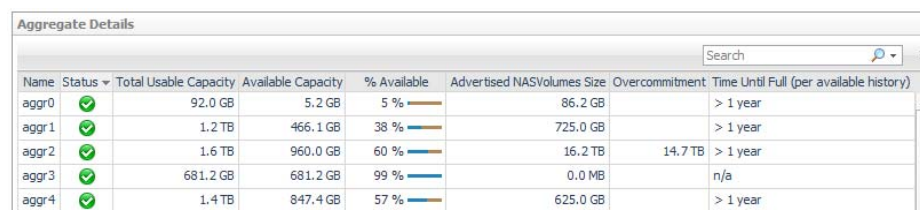


- **Alarm Summary.** Displays alarms on controllers and ports.
- 5 To investigate further, click the name of a component:
- Click a controller name. See [Investigating a Controller](#) on page 74.
 - Click a port name. See [Investigating an Array/File Port](#) on page 73.
 - Click an alarm. See [Assessing Storage Alarms](#) on page 20.
- 6 Click the Aggregates tab.
- **Lowest Available Capacity.** Displays the five aggregates with the lowest average value for [Available Usable Capacity](#) over the time period.
 - **Most Overcommitted Aggregates.** Identifies up to five of the most overcommitted aggregates, and displays current values for [Advertised NASVolumes Size](#), [Total Usable Capacity](#), and [Used Capacity](#).

Figure 12. Top 5 Aggregates



- **Aggregate Details.** For each aggregate, displays the aggregate name, status, and current values for [Total Usable Capacity](#), [Available Usable Capacity](#), [% Available](#), [Advertised NASVolumes Size](#), and [Overcommitment](#).



- **Alarm Summary.** Displays alarms on aggregates.

To investigate further, click the name of a component:

- Click an aggregate name. See [Investigating an Aggregate](#) on page 70.
- Click an alarm. See [Assessing Storage Alarms](#) on page 20.

7 Click the NASVolumes tab.

This view lets you quickly see the top 15 NASVolumes with a selected metric, averaged over the selected time period.

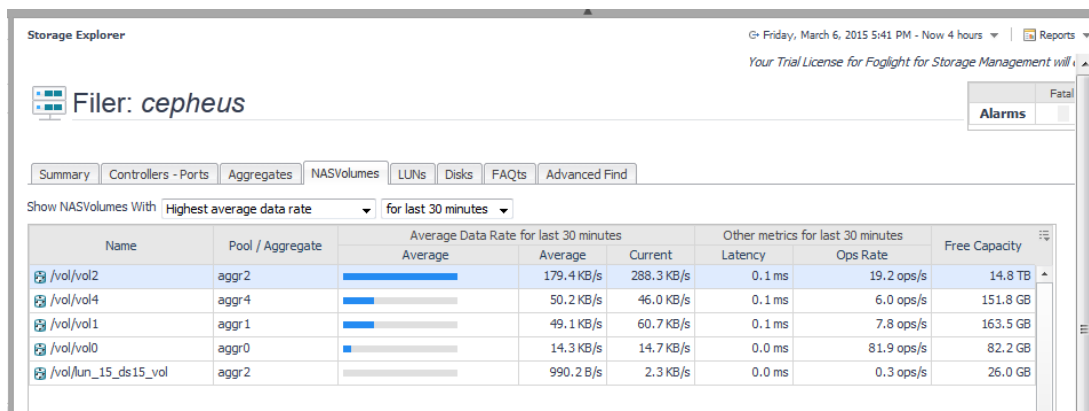
Selecting the time period "for current" shows the NASVolumes with the worst current metric.

Selecting the time period "last 30 minutes, last hour, last 4 hours" shows the NASVolumes with the worst average values in that time period.

NOTE: The selected time range looks at the average of values from collections that completed between the time at the end of the zonar, and the selected period before that.

The bars in the Average column show the values of the other items' metric relative to the first (highest) item.

Figure 13. NASVolumes tab



Click on a name in the table, and summary details about that item will be displayed in details panel below. This panel will display the exact time period of the completed collections in the selected timerange.

Figure 14. Summary detail



To further investigate the selected item, click Explore in the details panel. See [Investigating a NASVolume](#) on page 84.

- Alarm Summary. Displays alarms on NASVolumes.

To investigate further, click an alarm. See [Assessing Storage Alarms](#) on page 20.

8 Click the [LUNs tab](#).

9 Click the [Disks tab](#).

① **NOTE:** To investigate a NASVolume, LUN, or Disk that is not included in the Top 15 items on the NASVolumes, LUNs, or Disks tab, use the Advanced Find functionality on the Advanced Find tab to query for the desired items. For more information, see [Advanced Find](#) on page 66

Exploring a Storage Array

The Storage Explorer's Storage Array dashboard contains information about the selected storage array and its child components.

The tabs displayed on the dashboard differ depending on the selected storage array:

- [Non-Clustered Storage Arrays](#) (supported storage arrays except EqualLogic and Isilon)
- [Dell EqualLogic Storage Array](#)
- [EMC Isilon Storage Array](#)

Non-Clustered Storage Arrays

Most supported storage arrays are displayed as described in this walkthrough. If you are using Dell EqualLogic arrays or EMC Isilon arrays, see [Dell EqualLogic Storage Array](#) or [EMC Isilon Storage Array](#) instead.

This walkthrough describes the contents of each of the tabs and points you to where you can drill down for more details. The data displayed reflects values for the selected time range.

To explore storage arrays:

- 1 On the navigation panel, under Dashboards, click [Storage & SAN > Storage Explorer](#).
- 2 On the navigation panel, under Topology, expand [Storage Arrays](#) and select a storage array.

The Storage Array dashboard opens with details for the selected storage array.

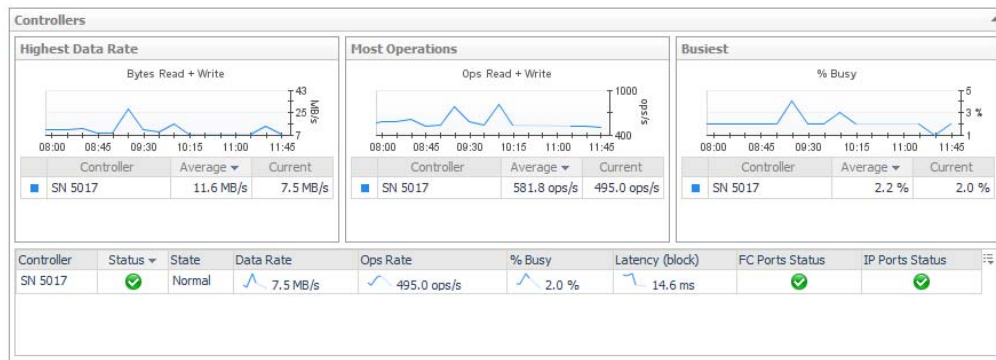
① **TIP:** You can also open this dashboard from the Storage Environment dashboard by selecting an EqualLogic storage array and clicking [View in Explorer](#).

- 3 If the [Alarm Count](#) displays alarms, you may want to assess the alarms before continuing with this walkthrough. Click a status count to open a list of device and component alarms. For more information, see [Assessing Storage Alarms](#) on page 20.
- 4 In the Summary tab, review performance in terms of key metrics.

The Summary tab contains the same views as the Storage Array Summary (*Selected Storage Array*) quick view described in [Monitoring Storage Arrays](#) on page 26. In addition, the tab includes the following views:

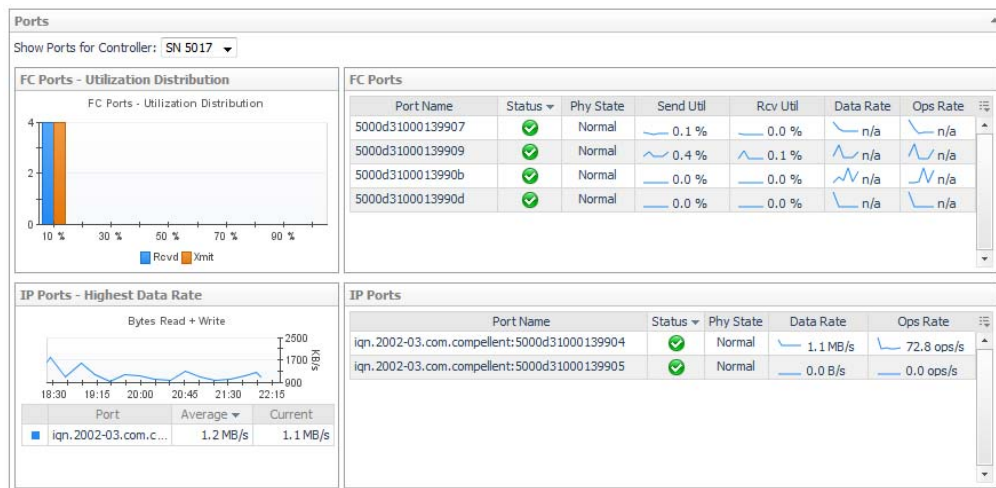
- **Summary and Resource Information.** Displays physical details about the storage array.
 - **Alarm Summary.** Displays alarms on the storage array.
- 5 Click the [Controllers-Ports](#) tab.
 - **Controllers.** The charts display the controllers with the highest average [Data Rate](#), [Ops Rate](#), and [% Busy](#), if available. The table displays [current](#) values for each of the charted metrics, plus [Latency](#) if available, and the most severe alarm status on the FC ports and IP ports associated with this controller.

Figure 15. Controllers



- **Ports.** Select a controller from the Show Ports for Controller list. The chart will display port utilization distribution, if the array provides the operating link speed of the ports. Otherwise, the Data Rate of the 3 busiest ports will be displayed. The tables will display all available current metrics for each port.

Figure 16. Ports



Alarm Summary. Displays alarms on controllers and ports.

To investigate further, click the name of a component:

- Click an aggregate name. See [Investigating an Aggregate](#) on page 70.
- Click an alarm. See [Assessing Storage Alarms](#) on page 20.

6 Click the Pools tab.

- **Show Top 15/All Pools/Pools w Thin LUNs With ...** This view lets you quickly see the top fifteen or all LUNs with a selected metric, averaged over the selected time period. The performance metrics that may be available for selection, depending on the array type, include:
 - R/w latency
 - Average queue depth
 - Data rate
 - Ops rate to disk

The capacity metrics that may be available for selection, depending on the array type, include:

- Least time until full
- Least or most available usable capacity

- Least or most available raw capacity

Selecting the time period "for current" shows the LUNs with the worst current metric.

Selecting the time period "last 30 minutes, last hour, last 4 hours" shows the LUNs with the worst average values in that time period. These time periods are available only for performance metrics.

- ① **NOTE:** The selected timerange looks at the average of values from collections that completed between the time at the end of the zonar, and the selected period before that.

The bars in the Average column show the values of the other items' metric relative to the first (highest) item.

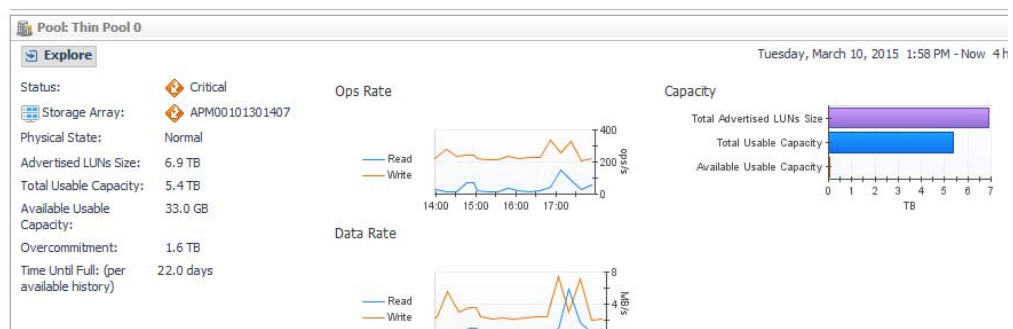
- ① **NOTE:** Selecting Pools w Thin LUNs is useful for monitoring Pools whose available capacity can change quickly because it contains thin-provisioned LUNs.

Figure 17. Pools tab

Summary Controllers - Ports Pools LUNs Disks FAQs Advanced Find				
Show	All	Pools	With	Highest average ops rate to disk
				for current
Name		Ops Rate to disk for current		Other performance metrics for current
		Average	Current	Data Rate
Concrete storage pool 0000 for APM00101301407 storage system		<div></div>	261.6 ops/s	261.6 ops/s
Thin Pool 0		<div></div>	190.6 ops/s	190.6 ops/s
				1.9 MB/s
				2.3 MB/s

Click on a name in the table to display summary details about that item in the details panel below. This panel displays the exact time period of the completed collections in the selected timerange.

Figure 18. Summary details



To further investigate the selected item, click "Explore" in the details panel.

- Alarm Summary. Displays alarms on pools.

To investigate further, click an alarm. See [Assessing Storage Alarms](#) on page 20.

- 7 Click the [LUNs tab](#).
- 8 Click the [Disks tab](#).
- 9 Click the Advanced Find tab to investigate a LUN or Disk that is not included in the Top 15 items on the LUNs or Disks. Use the Advanced Find functionality to query for the desired items. For more information, see [Advanced Find](#) on page 66.

Dell EqualLogic Storage Array

Foglight for Storage Management monitors Dell EqualLogic array groups. In the interface, groups are categorized as Storage Arrays, and array members are called *Member Nodes* or simply *Members*.

This walkthrough describes the contents of each of the tabs and points you to where you can drill down for more details. The data displayed reflects values for the selected time range.

To explore an EqualLogic storage array:

- 1 On the navigation panel, under Dashboards, click **Storage & SAN > Storage Explorer**.
- 2 On the navigation panel, under Topology, expand **Storage Arrays** and select an EqualLogic group.

The Storage Array dashboard opens with details for the selected EqualLogic group.

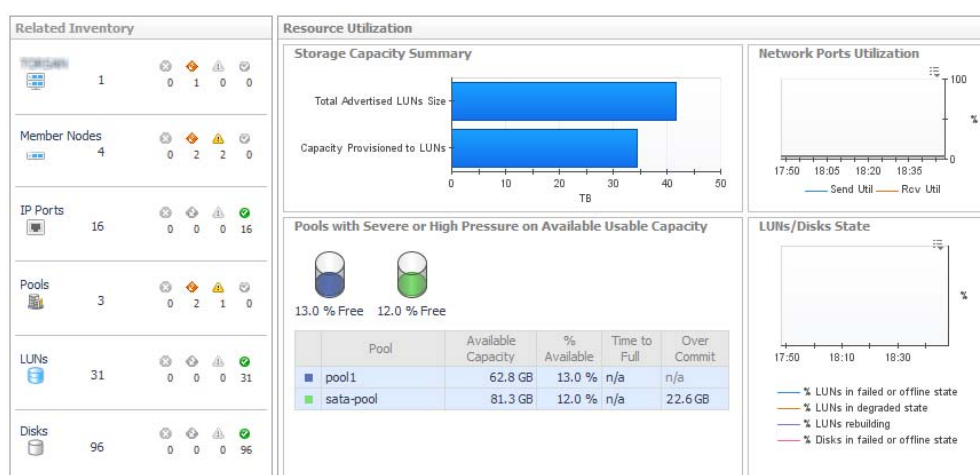
TIP: You can also open this dashboard from the Storage Environment dashboard by selecting a storage array and clicking **View in Explorer**.

- 3 If the **Alarm Count** displays alarms, you may want to assess the alarms before continuing with this walkthrough. Click a status count to open a list of device and component alarms. For more information, see [Assessing Storage Alarms](#) on page 20.
- 4 In the **Summary** tab, review performance in terms of key metrics.

The Storage Explorer's Summary tab contains the same views as the Storage Environment's quick view for EqualLogic storage arrays:

- **Related Inventory.** Contains alarm summaries for the selected storage array and its member nodes, IP ports, pools, LUNs, and disks.
- **Storage Capacity Summary.** Displays current values for **Total Advertised LUNs Size** and **Capacity Provisioned to LUNs**.
- **Network Ports Utilization.** Plots aggregated current values for **Send Util** and **Rcv Util** over the time period.
- **Pools with Severe or High Pressure on Available Usable Capacity:**
 - Displays the pools that have the most significant, near-term capacity issues.
 - Shows the available usable capacity in the table, the % available, and over commitment.
 - Shows the estimated time when the pool capacity will be full, if available.
 - The cylinders are colored to show the % of available capacity in the pool.
- **LUNs/Disks States.** Plots the percentage of disks and LUNs in the storage array in problem states. Problem states are reported by the vendor. Resolving these issues may improve LUN performance.

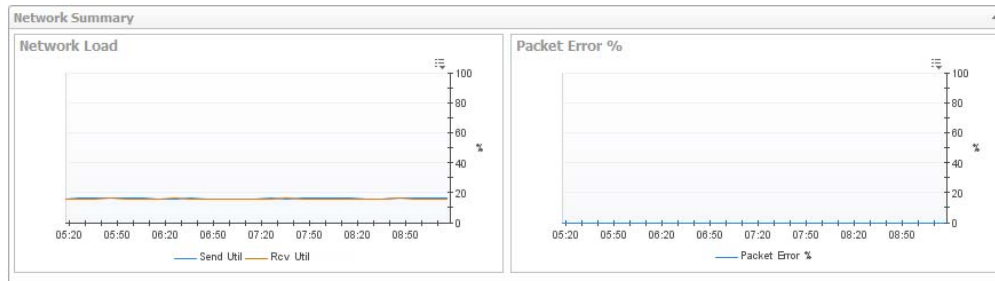
Figure 19. LUNs/Disks States



In addition, the tab includes the following views:

- Summary and Resource Information. Displays physical details about the storage array.
 - Alarm Summary. Displays alarms on the storage array.
- 5 Click the Network tab.
- Network Summary. Identifies the load on the network, in terms of **Send Util** and **Rcv Util**, and the **Packet Errors %** over the time period.

Figure 20. Network Summary




- Port Status Filter. Click to show only ports with the selected status in the Port Details table.
- Port Details. For each member-plus-port combination, displays **current** values for **Data Rate**, **Send Util**, **Rcv Util**, **Packet Errors %**, and **Link Speed**. Click a  **Sparkline** to plot metric values over the time period. Also displays the member's IPv4 and IPv6 addresses, if available.

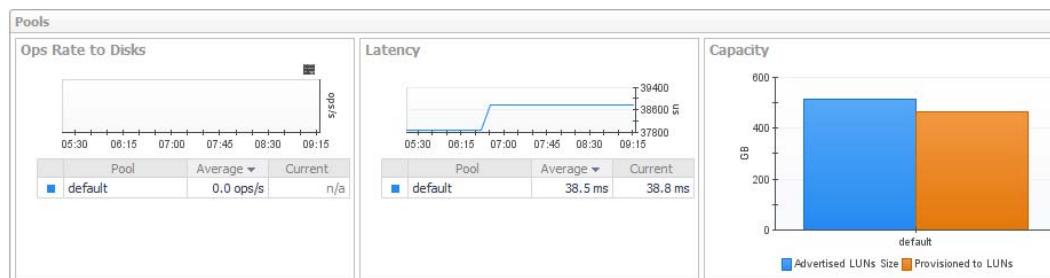
Figure 21. Port Status

Port Status Filter [Unset]

Member	Port	Status	Phys State	Data Rate	Send Util	Rcv Util	Packet Errors	Link Speed	IPv4	IPv6
PS4000-1	eth0		Normal	62.5 MB/s	26.0 %	26.4 %	0.0 %	1,000.0 Mb/s	10.10.10.10	2001:db8::1
PS4000-1	eth1		Normal	13.7 MB/s	5.7 %	5.8 %	0.0 %	1,000.0 Mb/s	10.10.10.11	2001:db8::2

- Alarm Summary. Displays alarms on ports.
- 6 Click the Pools-Members tab.
- Highest charts. Display the pools with the highest average value for **Ops Rate** and **Latency**. Also shows aggregated values for **Total Advertised LUNs Size** and **Capacity Provisioned to LUNs** for all members.

Figure 22. Pools-Members




- Pool Details. For each pool, displays its name, status, and current values for **Data Rate**, **Ops Rate**, **Latency**, **Average Queue Depth**, **Total Advertised LUNs Size**, **Total Usable Capacity**, **Available Usable Capacity**, **Capacity Provisioned to LUNs**, and **Overcommitment**. Click a  **Sparkline** to plot metric values over the time period. Also identifies pool members.

Figure 23. Pool Details

Pool Details											
Name	Status	Data Rate	Ops Rate to Disks	Latency	Avg Q Depth	Adv LUNs Size	Usable Capacity	Available Usable Capacity	Provisioned Usable Capacity	Overcommitment	Members
default		71.3 MB/s	n/a	38.8 ms	n/a	514.1 GB	1.3 TB	403.1 GB	465.3 GB	n/a	PS4000-1

- **Member Details.** For each member, displays its name, parent pool, status, and current values for [Data Rate](#), [Ops Rate](#), [Latency](#), [Send Util](#), [Rcv Util](#), [Total Usable Capacity](#), [% Used](#), and [% of Pool](#). Also displays the RAID level in use for the member.

Figure 24. Member Details

Member Details											
Name	Pool	Status	Data Rate	Ops Rate	Latency	Send Util	Rcv Util	Usable Capacity	% Used	% of Pool	RAID Policy
PS4000-1	default		71.5 MB/s	579.6 ops/s	0.0 ms	15.9 %	16.1 %	1.3 TB	35 %	100 %	raid50-nospares

- **Alarm Summary.** Displays alarms on pools and members.
- 7 Click the [LUNs tab](#).
 - 8 Click the [Disks tab](#).
 - 9 To investigate further, click the name of a component on any tab:
 - Click a port name. See [Investigating an Array/Filer Port](#) on page 73.
 - Click an array member name. See [Investigating an EqualLogic Member](#) on page 77.
 - Click a pool name. See [Investigating a Pool](#) on page 88.
 - Click an alarm. See [Assessing Storage Alarms](#) on page 20.
 - 10 Click the Advanced Find tab to investigate a LUN or Disk that is not included in the Top 15 items on the LUNs or Disks. Use the Advanced Find functionality to query for the desired items. For more information, see [Advanced Find](#) on page 66.

EMC Isilon Storage Array

Foglight for Storage Management monitors EMC Isilon clusters. In the interface, clusters are categorized as *Storage Arrays*, and the nodes are called *Member Nodes* or simply *Members*.

This walkthrough describes the contents of each of the tabs and points you to where you can drill down for more details. The data displayed reflects values for the selected time range.

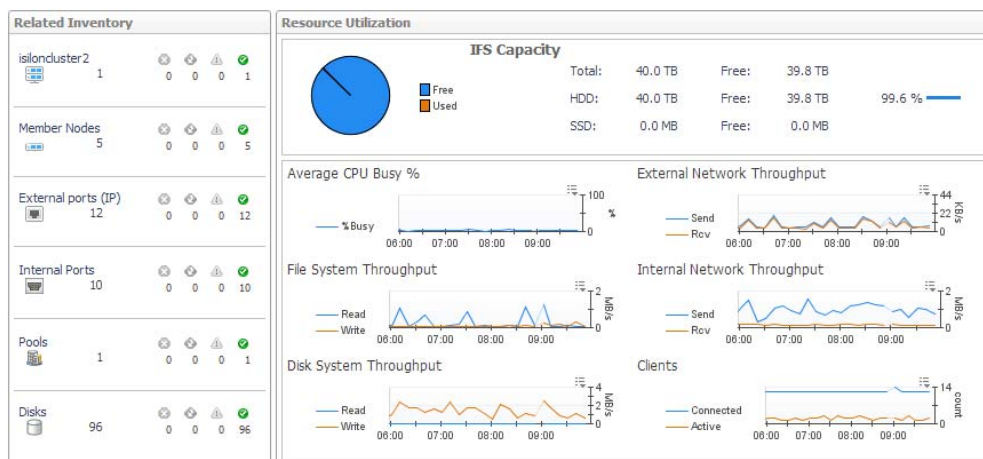
To explore an Isilon storage array:

- 1 On the navigation panel, under Dashboards, click Storage & SAN > Storage Explorer.
- 2 On the navigation panel, under Topology, expand Storage Arrays and select an Isilon cluster.
The Storage Array dashboard opens with details for the selected Isilon cluster.

TIP: You can also open this dashboard from the Storage Environment dashboard by selecting an Isilon storage array and clicking View in Explorer.
- 3 If the [Alarm Count](#) displays alarms, you may want to assess the alarms before continuing with this walkthrough. Click a status count to open a list of device and component alarms. For more information, see [Assessing Storage Alarms](#) on page 20.
- 4 In the Summary tab, review performance in terms of key metrics.
The Storage Explorer's Summary tab contains the same views as the Storage Environment's quick view for Isilon storage arrays:
 - **Related Inventory.** Contains alarm summaries for the selected storage array and its member nodes, external ports, internal ports, pools, and disks.

- **IFS Capacity.** The chart displays **IFS Capacity: Free** and **IFS Capacity Used** for the IFS file system. In addition, the following metrics pairs are displayed:
 - **IFS Capacity: Total** and **IFS Capacity: Free**
 - **IFS Capacity: HDD Total** and **IFS Capacity: HDD Free**
 - **IFS Capacity: SSD Total** and **IFS Capacity: SSD Free**
 - **Average CPU Busy %.** Displays the aggregate value of **% Busy** for all nodes in the array over the time period.
 - **File System Throughput.** Plots **Data Read Rate** and **Data Write Rate** to the file system over the time period.
 - **Disk System Throughput.** Plots **Data Read Rate** and **Data Write Rate** to the disk over the time period.
 - **External Network Throughput.** Plots the **Rcv Data Rate** and **Send Data Rate** for the external network over the time period.
- ① **TIP:** If you prefer to see the **Send Util (% of max)** and **Rcv Util (% of max)** based on the rated maximum speeds of the ports (actual port speeds are not available from Isilon arrays) in the external network, ask your Foglight for Storage Management Administrator to edit the registry variable `StSAN_StoragePortShowUtilMax` and set `ISLN_E_IP=true`.
- **Internal Network Throughput.** Plots the **Rcv Data Rate** and **Send Data Rate** for the internal network over the time period.
 - **Clients.** Plots clients connected versus clients that are actively using the network over the time period.

Figure 25. Clients



In addition, the tab includes the following views:

- **Summary and Resource Information.** Displays physical details about the storage array.
- **Alarm Summary.** Displays alarms on the storage array.

5 Click the Network tab.

Use this tab to understand network utilization and packet errors by port.

External Network Summary

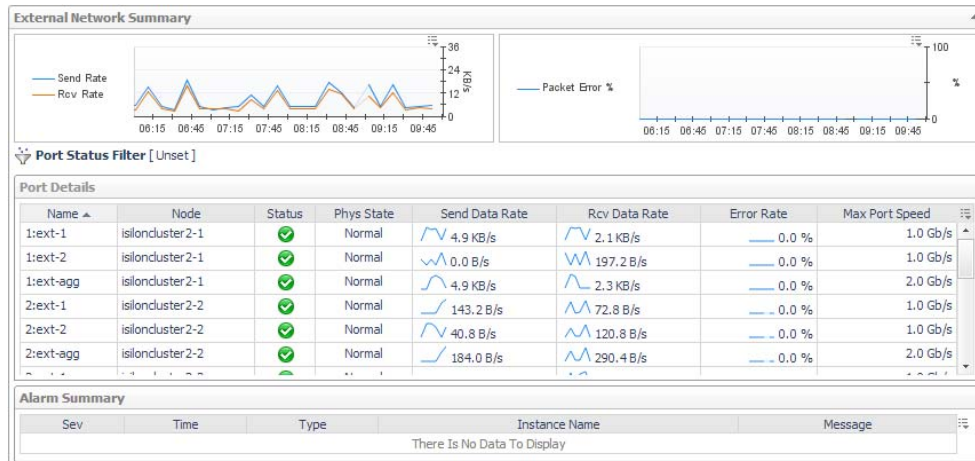
- **Charts.** Plot aggregated values for **Send Data Rate** and **Rcv Data Rate**, and **Packet Errors %** for the external network connections over the time period.
- **Port Status Filter.** Click this link to show only ports with a selected status in the Port Details table.

- Port Details. For each port used by the external network, identifies the port name, parent node, status, physical state, and [current](#) values for [Send Data Rate](#), [Rcv Data Rate](#), and [Packet Errors %](#). Also displays the maximum speed of the port. Click a [Sparkline](#) to plot metric values over the time period.

NOTE: When the registry variable `StSAN_StoragePortShowUtilMax` is set to show port utilization, this table also displays [Rcv Util](#) and [Send Util](#).

- Alarm Summary. Displays alarms on ports used by the external network.

Figure 26. Alarm Summary



Internal Network Summary

- Charts. Plot aggregated values for [Send Data Rate](#), [Rcv Data Rate](#), and [Packet Errors %](#) for the internal network connections over the time period.
- Port Status Filter. Click this link to show only ports with a selected status in the Port Details table.
- Port Details. For each port used by the internal network, identifies the port name, parent node, status, physical state, and [current](#) values for [Send Data Rate](#), [Rcv Data Rate](#), and [Packet Errors %](#). Also displays the maximum speed of the port. Click a [Sparkline](#) to plot metric values over the time period.

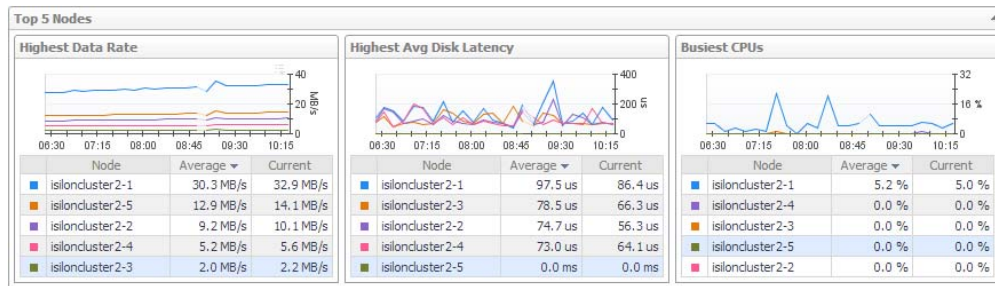
NOTE: When the registry variable `StSAN_StoragePortShowUtilMax` is set to show port utilization, this table can also display [Rcv Util](#) and [Send Util](#).

- Alarm Summary. Displays alarms on the external network and its ports.

6 Click the Member Nodes tab.

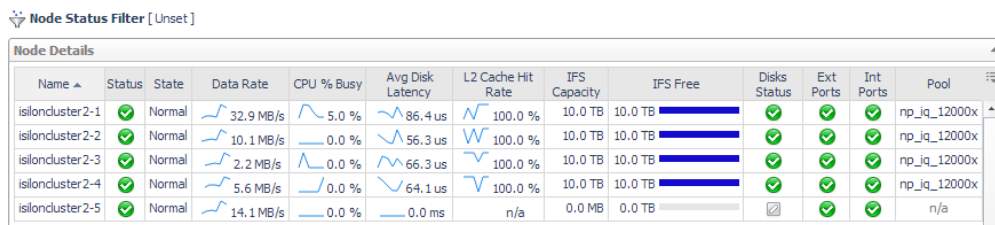
- Top 5 Nodes. Displays the top five member nodes with the highest average value for [Data Rate](#), [Latency](#), and [% Busy](#). The charts plot values over the time period, while the tables show the average and current values for each node.

Figure 27. Top 5 Nodes



- **Node Status Filter.** Click to show only member nodes with the selected status in the Node Details table.
- **Node Details.** For each member node, displays its name, status, physical state, and current values for **Data Rate**, **% Busy**, **Latency**, **L2 Cache Hit Rate**, **IFS Capacity**, and **IFS Capacity: Free**. Also displays the worst status of the node's disks, external network ports, and internal network ports, and identifies the node's parent pool. Click a **Sparkline** to plot metric values over the time period.

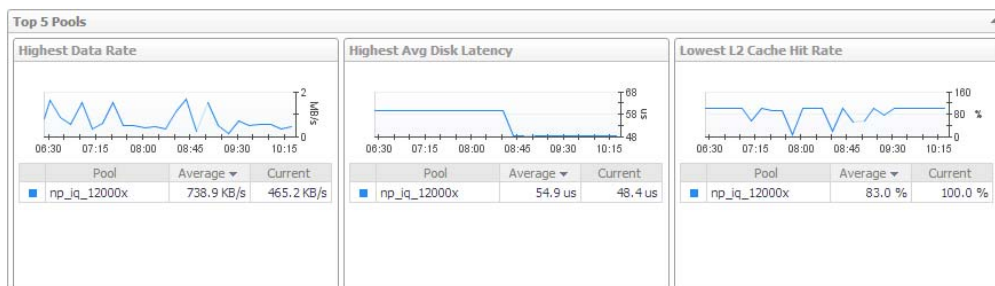
Figure 28. Node Status



You can add the following metrics to the table by clicking the Customizer icon: **L1 Cache Hit Rate**, **Send Data Rate** and **Rcv Data Rate**. You can also choose to display other Isilon details, such as Total Disk IOPS and Model.

- **Alarm Summary.** Displays alarms on nodes.
- 7 Click the Pools tab.
- **Top 5 Pools.** Displays the top five pools with the highest average value for **Data Rate** and **Latency**, and the lowest average value for **L2 Cache Hit Rate**. The charts plot values over the time period, while the tables show the average and current values for each pool.

Figure 29. Top 5 Pools



- **Pool Status Filter.** Click to show only pools with the selected status in the Pool Details table.
- **Pool Details.** For each pool, displays its name, status, and current values for **Data Rate**, **Latency**, **L2 Cache Hit Rate**, **IFS Capacity**, **IFS Capacity: Free**, **HDD % Free**, and **SDD % Free**. Also displays the tier that the pool belongs to and the worst status of nodes associated with the pool. Click a **Sparkline** to plot metric values over the time period.

Figure 30. Pool Status Filter

Pool Status Filter [Unset]

Pool Details										
Name	Status	Data Rate	Avg Disk Latency	L2 Cache Hit Rate	IFS Capacity	IFS Free	HDD % Free	SSD % Free	Tier	Nodes Status
np_iq_12000x	✓	465.2 KB/s	48.4 us	100.0 %	40.0 TB	40 TB	99.6 %	n/a	n/a	✓

You can add the following metrics to the table by clicking the Customizer icon: [Ops Rate](#), [% Busy](#), and [L1 Cache Hit Rate](#).

- Alarm Summary. Displays alarms on pools.
- 8 Click the IFS tab.
- Current Capacity Usage. For each pool or tier, displays the following sets of metrics:
 - IFS Capacity: HDD Total, IFS Capacity: HDD Used, IFS Capacity: HDD Free, and HDD % Free
 - IFS Capacity: SDD Total, IFS Capacity: SDD Used, IFS Capacity: SDD Free, and SDD % Free

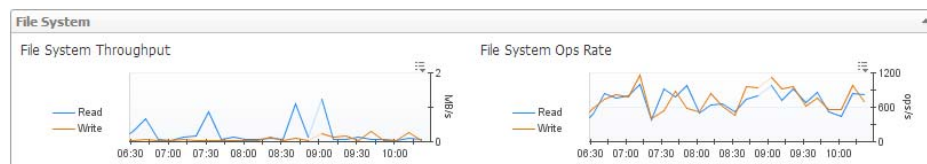
Figure 31. Current Capacity Usage

Current Capacity Usage

Tier / Pool	HDD				SSD			
	Size	Used	Free	% Free	Size	Used	Free	% Free
np_iq_12000x	40.0 TB	176.0 GB	39.8 TB	99.6 %	0.0 MB	0.0 MB	n/a	n/a

- File System. Plots [Data Read Rate](#) and [Data Write Rate](#) values and [Read Ops Rate](#) and [Write Ops Rate](#) values for the file system over the time period.

Figure 32. File System



- Exported Directories. For each exported directory, states whether the directory is used in the monitored environment. When Used=true, you can click the directory name to view a topology diagram showing the datastores that mount the directory.

Figure 33. Exported Directories

Exported Directories

Exported Directory	Used
/ifs	false
/ifs/santadara/sc1	true
/ifs/santadara/sc2	true
/ifs/santadara/sc3	true
/ifs/santadara/sc4	true
/ifs/santadara/sc5	true
/ifs/santadara/sc5/sc5_1	true
/ifs/santadara/sc7	true

- 9 Click the [Disks](#) tab.
- 10 To investigate further, click the name of a component on any tab:
- Click a port name. See [Investigating an Array/Filer Port](#) on page 73.
 - Click a member node name. See [Investigating an Isilon Node](#) on page 80.
 - Click a pool name. See [Investigating a Pool](#) on page 88.

- When a directory is used in the monitored environment, click the directory name. See [Investigating a Directory](#) on page 76.
 - Click an alarm. See [Assessing Storage Alarms](#) on page 20.
- 11 Click the Advanced Find tab to investigate a Disk that is not included in the Top 15 items on the Disks. Use the Advanced Find functionality to query for the desired items. For more information, see [Advanced Find](#) on page 66.

Common Data for Filers and Storage Arrays

LUNs tab

A LUN (logical unit) is the block storage element made available by an array or filer to a server.

- Show LUNs With ...

This view lets you quickly see the top 15 LUNs with a selected metric, averaged over the selected time period.

- Selecting the time period "for current" shows the LUNs with the worst current metric.
- Selecting the time period "last 30 minutes, last hour, last 4 hours" shows the LUNs with the worst average values in that time period.

NOTE: The selected time range looks at the average of values from collections that completed between the time at the end of the zonar, and the selected period before that.

The bars in the Average column show the values of the other items' metric relative to the first (highest) item.

Figure 34. Show LUNs with

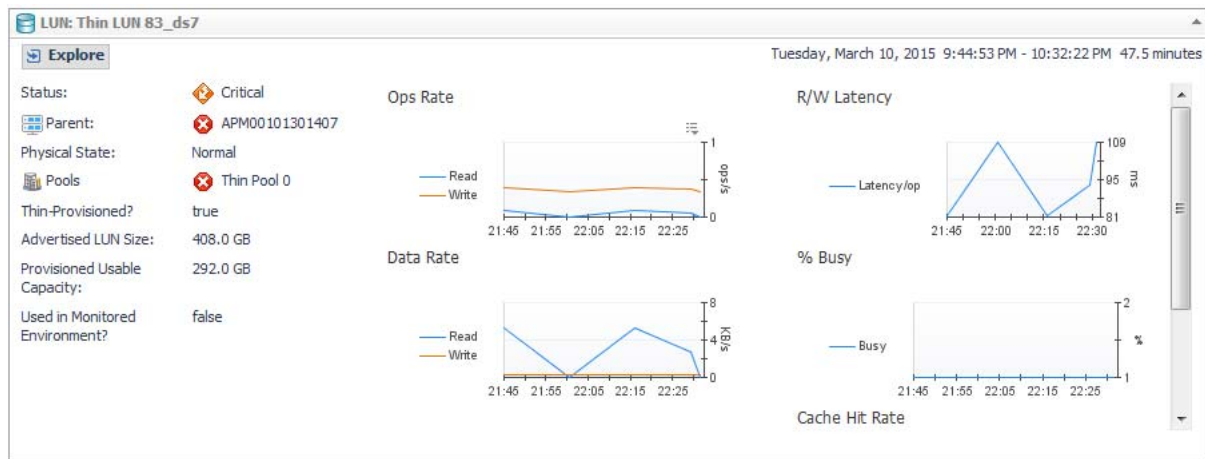
Show LUNs With Highest average r/w latency for last hour

Name	Pools/Aggregates/Parity Groups	Average Latency for last hour			Other metrics for last hour		
		Average	Average	Current	Ops Rate	Data Rate	% Busy
Thin LUN 83_ds7	Thin Pool 0	<div><div></div></div>	92.9 ms	108.7 ms	0.4 ops/s	2.7 KB/s	1.0 %
LUN 93_ds6	Concrete storage pool 0000 for APM00101301407 storage system	<div><div></div></div>	66.1 ms	26.0 ms	0.3 ops/s	12.7 KB/s	0.0 %
LUN109_OMEGA_DS1	Thin Pool 0	<div><div></div></div>	60.4 ms	62.0 ms	0.5 ops/s	1.3 KB/s	0.0 %
LUN 94_ds5	Concrete storage pool 0000 for APM00101301407 storage system	<div><div></div></div>	42.5 ms	n/a	0.0 ops/s	1.2 KB/s	0.0 %
LUN4_OMEGA_DS4	Thin Pool 0	<div><div></div></div>	38.4 ms	36.3 ms	0.6 ops/s	2.5 KB/s	0.0 %
Thin LUN 82_ds6	Thin Pool 0	<div><div></div></div>	38.0 ms	28.4 ms	4.7 ops/s	48.1 KB/s	3.0 %
LUN2_PHI_DS2	Concrete storage pool 0000 for APM00101301407 storage system	<div><div></div></div>	37.0 ms	37.3 ms	15.2 ops/s	309.8 KB/s	4.0 %
LUN11_NU_DS11	Thin Pool 0	<div><div></div></div>	35.4 ms	31.0 ms	12.6 ops/s	200.8 KB/s	3.5 %
LUN1_NU_DS1	Concrete storage pool 0000 for APM00101301407 storage system	<div><div></div></div>	31.7 ms	32.9 ms	15.0 ops/s	228.4 KB/s	4.8 %
LUN3_OMEGA_DS3	Thin Pool 0	<div><div></div></div>	31.0 ms	30.4 ms	3.3 ops/s	51.2 KB/s	1.0 %
LUN1_PHI_DS1	Thin Pool 0	<div><div></div></div>	30.2 ms	27.0 ms	3.6 ops/s	73.2 KB/s	1.5 %
LUN4_NU_DS4	Thin Pool 0	<div><div></div></div>	26.7 ms	24.9 ms	24.1 ops/s	382.7 KB/s	4.8 %
LUN10_NU_DS10	Thin Pool 0	<div><div></div></div>	21.9 ms	20.9 ms	18.3 ops/s	301.7 KB/s	3.7 %

NOTE: The metrics available in the drop down for selection include only the metrics made available by that particular array or filer vendor.

Click on a name in the table, and summary details about that item will be displayed in details panel below. This panel will display the exact time period of the completed collections in the selected time range.

Figure 35. LUNs



To further investigate the selected LUN, click Explore in the details panel. See [Investigating a LUN](#).

- **Alarm Summary.** Displays alarms on LUNs, disks. To investigate further, click an alarm. See [Assessing Storage Alarms](#) on page 20.

Disks tab

- **Show Disks With...**

This view lets you quickly see the top 15 disks with a selected metric, averaged over the selected time period.

- Selecting the time period “for current” shows the disks with the worst current metric.
- Selecting the time period “last 30 minutes, last hour, last 4 hours” shows the disks with the worst average values in that time period.

NOTE: The selected timerange looks at the average of values from collections that completed between the time at the end of the zonar, and the selected period before that.

The bars in the Average column show the values of the other items' metric relative to the first (highest) item.

NOTE: The metrics available in the drop down for selection include only the metrics made available by that particular array or filer vendor.

Figure 36. Averages

Show Disks With Highest average % busy for current

Name	Pools/Aggregates/Parity Groups	Busy for current			Other metrics for current	
		Average	Average	Current	Ops Rate	Data Rate
0_0_2	Concrete storage pool 0000 for APM00101301407 storage system	<div></div>	19.0 %	19.0 %	47.3 ops/s	1.3 MB/s
0_0_4	Concrete storage pool 0000 for APM00101301407 storage system	<div></div>	18.0 %	18.0 %	48.2 ops/s	1.4 MB/s
0_0_5	Concrete storage pool 0000 for APM00101301407 storage system	<div></div>	18.0 %	18.0 %	48.6 ops/s	1.4 MB/s
0_0_7	Thin Pool 0	<div></div>	17.0 %	17.0 %	38.3 ops/s	1.0 MB/s
0_0_0	Concrete storage pool 0000 for APM00101301407 storage system	<div></div>	16.0 %	16.0 %	50.2 ops/s	1.4 MB/s
0_0_1	Concrete storage pool 0000 for APM00101301407 storage system	<div></div>	16.0 %	16.0 %	50.8 ops/s	1.4 MB/s
0_0_9	Thin Pool 0	<div></div>	16.0 %	16.0 %	37.2 ops/s	1.0 MB/s

Click on a name in the table, and summary details about that item will be displayed in the Details panel below. This panel will display the exact time period of the completed collections in the selected time range

Figure 37. Details panel.



To further investigate the selected disk, click Explore in the details panel. See [Investigating a Physical Disk](#).

- **Alarm Summary.** Displays alarms on disks. To investigate further, click an alarm. See [Assessing Storage Alarms](#) on page 20.

Advanced Find

The tabs for specific entities (like LUNs, Disks, Pools, NASVolumes) quickly identify the Top 15 objects exhibiting the "worst" values for a particular metric. Often, however, there is a need to locate objects by name, or with other characteristics. Use the Advanced Find functionality to locate these items.

Queries can be constructed using a combination of Property conditions and Metric conditions.

Figure 38. Advanced Find

Summary Controllers - Ports Pools LUNs Disks FAQs Advanced Find

Find LUNs

With these Properties And With these Metric Conditions (the unset condition(s) will be ignored)

Name Like period metric

Status ☐ Normal ☐ Warning ☐ Critical ☐ Fatal

Physical State ☐ Normal ☐ Rebuilding ☐ Degraded ☐ Unknown ☐ Other

Perform Query

Note: In a large environment, the query can take several minutes to return results!

Latest Query

LUN Query Result

Name	Status	State	Pools/Aggregates/Parity Groups	Used	Advertised LUN Size	Protection	Thin?
There Is No Data To Display							

Using the Property Conditions

Finding Entities by Name

To find entities by name:

- 1 Select the desired entity type to search for in the Find drop down.
- 2 Type the string to search for in the Name Like field.
- 3 Click Perform Query.
 - All items with that string anywhere in their name will be returned.
 - `_` is a positional wildcard, that can match a single character. For example, `C_D` would match `decode`, but would not match `record`
 - `%` is a non-positional wildcard. For example, `C%D` would match `record`

Finding Entities with Current Status or Physical State

To find entities with current status or physical state:

- 1 Select the desired entity type to search for in the Find drop down.
- 2 In Properties, check the status boxes to retrieve entities with that status or state.
- 3 Click Perform Query.

For example, This example searches for LUNs whose names include a particular string, and have a non-normal alarm state.

The query will take a short time to execute. When it completes, the Latest Query panel will summarize the query conditions. The Query Result panel will display the LUNs found to match the query conditions. The table header displays the time period used for evaluating the query conditions.

Figure 39. Query Conditions

Find **LUNs**

With these Properties

Name Like

Status ☐ Normal ☒ Warning ☒ Critical ☒ Fatal

Physical State ☐ Normal ☐ Rebuilding ☐ Degraded ☐ Unknown ☐ Other

And With these Metric Conditions (the unset condition(s) will be ignored)

Perform Query

Note: In a large environment, the query can take several minutes to return results!

Latest Query

LUNs in APM00101301407 with name like "M%G" AND Status in (Warning, Critical, Fatal)

LUN Query Result (3/17/15 7:29:59 AM - 3/17/15 11:29:59 AM)

Name	Status	State	Pools/Aggregates/Parity Groups	Used	Advertised LUN Size	Protection	Thin?
LUN109_OMEGA_DS1		Normal	Thin Pool 0	false	60.0 GB	RAID6	false
LUN3_OMEGA_DS3		Normal	Thin Pool 0	false	200.0 GB	RAID6	false
LUN4_OMEGA_DS4		Normal	Thin Pool 0	false	100.0 GB	RAID6	false

Using the Metric Conditions

The metric conditions area lets you easily construct a more complex query that can include up to 3 conditions on metrics.

Figure 40. Metrics conditions

And With these Metric Conditions (the unset condition(s) will be ignored)

1

2

3

4

5

6

period metric > +

To use the metric conditions:

- 1 **Period.** Refers to the time range on the zonar displayed in the upper right-hand corner. Select the time the query should use for the metric values. When *n/a* is selected, this condition is ignored.
- 2 **Metric.** This drop down shows the metrics available for this entity type for this vendor.
- 3 The third drop down list provides the comparison operator.
- 4 Use the fourth field to enter the value to use for the comparison.
- 5 Use the fifth drop down to select the units for the value you entered. The units selection will change based on the type of metric selected.
- 6 Click the + icon if you want to add another condition. The next condition row will be preceded by a AND/OR selector. A trash can icon will appear to the right of the + icon to let you remove a condition.

Up to 3 conditions can be defined. When the + icon is clicked to display the 3rd condition row, parentheses will be displayed around the first 2 conditions, indicating the order of evaluation.

And With these Metric Conditions (the unset condition(s) will be ignored)

(period metric < 20.0 ms +

OR period metric < 20.0 ms) +

AND period metric < 20.0 ms +

For example, the following query looks for LUNs that had low average latency during the period, but had a higher latency at the last collection. The query will take a short time to execute. When it completes:

- The Latest Query panel will summarize the query conditions.
- The Query Result panel will display the LUNs found to match the query conditions. The table header displays the time period used for evaluating the query conditions. The metrics used in the query conditions will be displayed in the results table.

Figure 41. Query results

Summary Controllers - Ports Pools LUNs Disks FAQs Advanced Find

Find LUNs

With these Properties And With these Metric Conditions (the unset condition(s) will be ignored)

Name Like

Status ☐ Normal ☐ Warning ☐ Critical ☐ Fatal

Physical State ☐ Normal ☐ Rebuilding ☐ Degraded ☐ Unknown ☐ Other

Period Average R/W Latency < 20.0 ms +

AND Current R/W Latency > 20.0 ms +

Perform Query

Note: In a large environment, the query can take several minutes to return results!

Latest Query

LUNs in APM00101301407 with Period Average R/W Latency < 20.0 ms AND Current R/W Latency > 20.0 ms

LUN Query Result (3/17/15 7:50:08 AM - 3/17/15 11:50:08 AM)

Name	Status	State	Pools/Aggregates/Parity Groups	Used	R/W Latency (Period Average)	R/W Latency (Current)	Advertised LUN Size	Protection	Thin?
LUN 16_ds27		Normal	Concrete storage pool 0000 f...	true	13.9 ms	33.8 ms	20.0 GB	RAID6	false
LUN 20_ds46		Normal	Concrete storage pool 0000 f...	true	16.0 ms	36.3 ms	20.0 GB	RAID6	false
LUN4_OMEGA_DS4		Normal	Thin Pool 0	false	16.1 ms	21.4 ms	100.0 GB	RAID6	false

To investigate further

- Click the name of an entity in the table, to drill down to the explorer view for that entity.
- Click on an alarm Status icon, to display the alarms for that entity.

Investigating Storage Components

To gain a complete picture of the performance of a storage device, you need to understand how its child components are performing.

Introducing Storage Component Dashboards

A component dashboard is a drill-down view that displays physical details about a selected component, performance and capacity metrics, and alarms. Some also include a topology diagram that shows how the component fits into the monitored environment; for more information, see [Exploring Connectivity with SAN Topology Diagrams](#) on page 34.

For information about each type of component dashboard, see the following topics:

- [Investigating an Aggregate](#)
- [Investigating an Array/Filer Port](#)
- [Investigating a Controller](#)
- [Investigating a Directory](#)
- [Investigating an EqualLogic Member](#)
- [Investigating an FC Switch Port](#)
- [Investigating an Isilon Node](#)
- [Investigating a LUN](#)
- [Investigating a NASVolume](#)
- [Investigating a Physical Disk](#)
- [Investigating a Pool](#)

Investigating an Aggregate

The data displayed in the dashboard reflects values for the aggregate over the selected time range. This walkthrough describes the contents of each of the tabs.

To explore an aggregate:


- 1 On a dashboard, click an aggregate name.
The Aggregate dashboard opens.
- 2 Review overall performance in the Summary tab.
 - **Aggregate Details.** Displays the aggregate's status, parent filer, and current values for [Advertised NASVolumes Size](#), [Total Usable Capacity](#), [Available Usable Capacity](#), [Overcommitment](#), [Data Rate](#), and [Ops Rate](#). Click a  [Sparkline](#) to plot metric values over the time period.

Figure 1. Aggregate Details



- Pool Performance. Displays the same performance metrics found in the Aggregate Details view, but in chart format.

Figure 2. Pool Performance



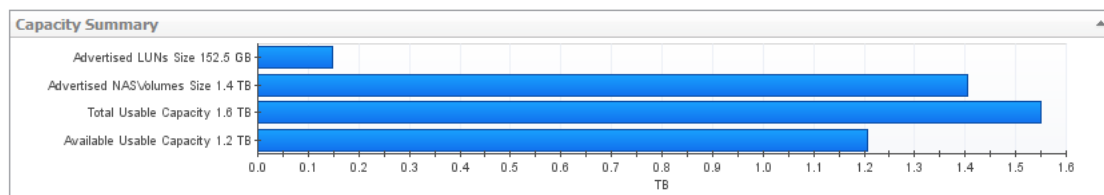
- Perform Pool Change Analysis. Click to identify the NASVolumes and LUNs primarily responsible for increased I/O. For more information, see [Analyzing the Pool](#) on page 100.
- Perform Pool Load Analysis. Click to identify the busiest NASVolumes and LUNs, and rank them based on their activity during the same time range *over the last 30 days*. For more information, see [Analyzing the Pool](#) on page 100.

3 Click the Capacity tab.

Displays the following:

- Capacity Summary

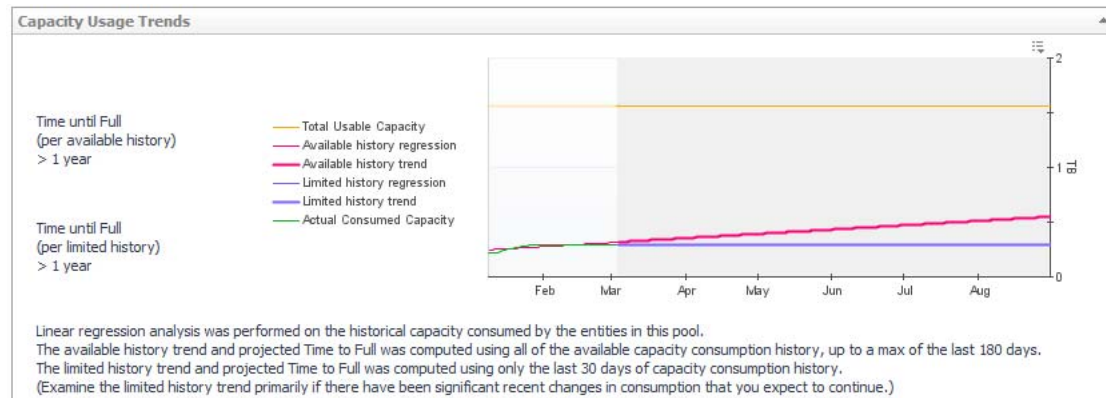
Figure 3. Capacity Summary



- Capacity Usage Trends: Chart provides a visual display of the estimated capacity consumption in the future, based on a regression analysis of the historical capacity consumption.


NOTE: If time until full shows "n/a", it means enough historical data has not been collected yet. Mouse over to show how much more data is required. For more information, see [Capacity Trending](#) on page 40.

Figure 4. Capacity Usage Trends



4 Click the Consumers tab.

Displays the NASVolumes and LUNs that are configured out of this aggregate.


- **Aggregate Details.** Displays the aggregate's status, parent filer, and current values for [Advertised LUNs Size](#), [Advertised NASVolumes Size](#), [Total Usable Capacity](#), [Available Usable Capacity](#), and [Overcommitment](#).
- **NASVolumes Using This Aggregate.** For each volume, displays its name, status, physical state, and whether the NASVolume is used by an entity in the monitored environment. The metric columns display current values for [Data Rate](#), [Latency](#), [Advertised NASVolumes Size](#), [Used Capacity](#), and [% Used](#). Click a  [Sparkline](#) to plot metric values over the time period.

The remaining columns provide the following details:

- **Protection.** Displays the type of protection in use on the volume.
- **Thin?.** Indicates whether the volume is thin-provisioned (true) or thick-provisioned.
- **vFiler.** The name of the aggregate's parent virtual filer.

Figure 5. NASVolumes Using this Aggregate

Name	Status	Phy State	Used	Data Rate	Latency	Advertised Size	Used Capacity	% Used	Protection	Thin?	vFiler
/vol/vol12		Normal	false	0.0 B/s	0.0 ms	25.0 GB	15.5 GB	62 %	Complex Stripe Parity	false	Earth1
/vol/vol17		Normal	false	0.0 B/s	0.0 ms	18.0 GB	16.0 GB	89 %	Complex Stripe Parity	false	Earth1
/vol/vol18		Normal	false	0.0 B/s	0.0 ms	6.0 GB	4.0 MB	0 %	Complex Stripe Parity	false	Earth1
/vol/vol19		Normal	false	0.0 B/s	0.0 ms	30.0 GB	21.0 MB	0 %	Complex Stripe Parity	false	Earth1
/vol/vol6		Normal	false	0.0 B/s	0.0 ms	20.0 GB	14.0 MB	0 %	Complex Stripe Parity	false	Earth1
/vol/vol8		Normal	false	0.0 B/s	0.0 ms	30.0 GB	21.0 MB	0 %	Complex Stripe Parity	false	Earth1
/vol/vol9		Normal	false	0.0 B/s	0.0 ms	30.0 GB	1.0 GB	3 %	Complex Stripe Parity	false	Earth1

- **LUNs Using This Aggregate.** For each LUN, displays its name, status, physical state, and whether the LUN is used by an entity in the monitored environment. The metric columns display current values for [Data Rate](#), [Ops Rate](#), [Latency](#), [% Busy](#), and [Advertised LUNs Size](#). Click a  [Sparkline](#) to plot metric values over the time period.

The remaining columns provide the following details:

- **Protection.** Displays the type of protection in use on the LUN, such as the RAID level.
- **Thin?.** Indicates whether the LUN is thin-provisioned (true) or thick-provisioned.
- **vFiler.** The name of the aggregate's parent virtual filer.

Figure 6. LUNs Using this Aggregate

LUNs Using This Aggregate											
Name	Status	State	Used	Data Rate	Ops Rate	Latency	% Busy (n/p by Vendor)	Advertised LUN Size	Protection	Thin?	vFile
/vol/vol12/lun1	✓	Normal	false	0.0 B/s	0.0 ops/s	n/a	n/a	15.0 GB	Complex Stripe Parity	false	Earth1
/vol/vol17/lun17	✓	Normal	true	0.0 B/s	0.0 ops/s	n/a	n/a	16.0 GB	Complex Stripe Parity	false	Earth1
/vol/vol9/lun9	✓	Normal	true	0.0 B/s	0.0 ops/s	n/a	n/a	1.0 GB	Complex Stripe Parity	false	Earth1

5 Click the Disks tab.

Displays the disks used by the selected aggregate. For more information, see [Common Component Disk Tab Data](#) on page 93.

6 To investigate further:

- Click a NASVolume name. See [Investigating a NASVolume](#) on page 84 (includes a topology diagram).
- Click a LUN name. See [Investigating a LUN](#) on page 81 (includes a topology diagram).
- Click a disk name. See [Investigating a Physical Disk](#) on page 86.
- Click an alarm. See [Assessing Storage Alarms](#) on page 20.

Investigating an Array/Filer Port

The data displayed in the dashboard reflects values for the component over the selected time range. This walkthrough describes the contents of each of the tabs.

To explore a port:

1 On a dashboard, click a filer or storage array port.

The Array/Filer Port dashboard opens.

2 Review overall performance in the Summary tab.

- Details. Displays the port's status, physical details, parent storage array or filer, port controller (for filers and non-cluster arrays) or member node (for cluster arrays), and current values for [Data Rate](#), [Ops Rate](#), [Xmit Utilization](#), and [Rcvd Utilization](#).

Figure 7. Details

Details			
Status:	✓ Normal	Controller:	✓ SN 5017
Storage Array:	✓ stccmpl01	Op Link Speed:	8.0 Gb/s
Physical State:	Normal	Rated Max Speed:	8.0 Gb/s
		Port Type:	FC
			External
		Alias:	Compellent-P2 Brocade

- Charts. Displays the following metrics over the time period, if available:
 - Data Rate. Plots values for [Data Rate](#), [Data Read Rate](#), and [Data Write Rate](#).
 - Ops Rate. Plots values for [Ops Rate](#), [Read Ops Rate](#), and [Write Ops Rate](#).
 - Port Utilization. Plots values for [Send Util](#) and [Rcv Util](#).

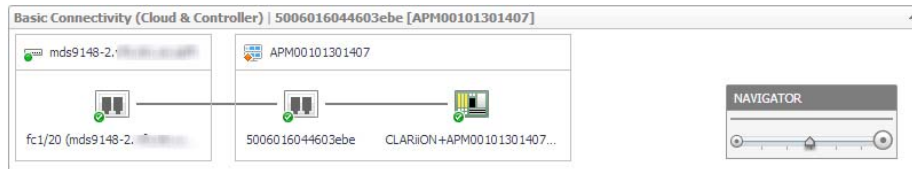
Figure 8. Data Rate



- Alarm Summary. Displays alarms on the port.

- 3 If available, click the Topology tab. This tab is displayed for Fibre Channel (FC) ports only.
 - **Basic Connectivity (diagram).** Displays the selected port (left box) and its connection to its controller. If the port is an FC port, the N port on the fibre switch it connects to is also displayed.
 - Click an icon for details about the device connected to the port.
 - Click a device name to open a list of components that you can drill down on.

Figure 9. Basic Connectivity



- **Port Dependencies.** On separate tabs, displays connections to LUNs (through the selected port) from virtual machines, ESX or Hyper-V servers, and physical hosts. If the selected port has problems or failures, the connected VMs or hosts may exhibit performance problems.

Figure 10. Port Dependencies

Port Dependencies: VM to LUN | Port Dependencies: Server to LUN | Port Dependencies: Host to LUN | LUNs Able to Use This Port

Virtual Machines and LUNs that can communicate through this port:

Virtual Machine	Datstore/ CSV/ Logical Disk	LUN	Array/File
delta-fms-vm10	ds59_CX4_LUN107	LUN 107	APM00101301407
delta-fms-vm11	ds62_CX4_LUN108	LUN 108	APM00101301407
delta-fms-vm5	ds40_CX4_LUN32	LUN 32	APM00101301407
delta-fms-vm6	ds42_CX4_LUN88	LUN 88	APM00101301407
delta-fms-vm7	ds43_CX4_LUN91	LUN 91	APM00101301407
delta-fms-vm8	ds44_CX4_LUN103	LUN 103	APM00101301407
delta-fms-vm9	ds45_CX4_LUN106	LUN 106	APM00101301407
delta-fms-vm10	ds45_CX4_LUN106	LUN 31	APM00101301407
epsin-fms-vm1	ds70_CX4_TLUN6_TLUN84_F	Thin LUN 6_ds70	APM00101301407
epsin-fms-vm2	ds70_CX4_TLUN6_TLUN84_F	Thin LUN 84_ds70	APM00101301407
epsin-fms-vm2	ds49_CX4_TLUN7_F	Thin LUN 7_ds49	APM00101301407

- 4 To investigate further:
 - In the topology diagram, click a port or controller icon to navigate to related components.
 - Click an alarm. See [Assessing Storage Alarms](#) on page 20.

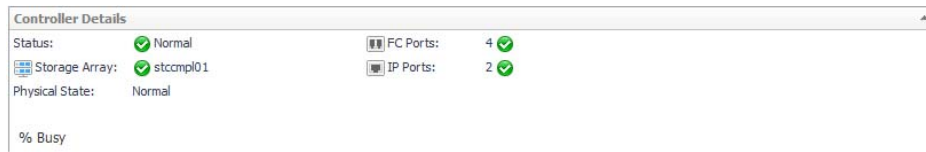
Investigating a Controller

Controllers manage the ports used by a non-cluster storage array or filer. The data displayed in the dashboard reflects values for the component over the selected time range. The Controller dashboard has two tabs.

To explore a controller and its ports:

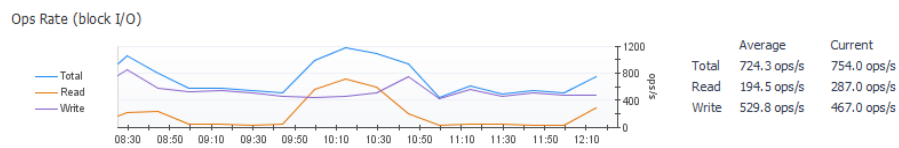
- 1 On a dashboard, click a controller name.
The Controller dashboard opens.
- 2 Review overall performance in the Summary tab.
 - **Controller Details.** Displays the controller's status, physical details, and parent device.

Figure 11. Controller Details



- Charts. Displays the following metrics over the time period, if available:
 - Data Rate. Plots values for [Data Rate](#), [Data Read Rate](#), and [Data Write Rate](#).
 - Ops Rate. Plots values for [Ops Rate](#), [Read Ops Rate](#), and [Write Ops Rate](#).
 - Latency. Plots values for latency.
 - % Busy.

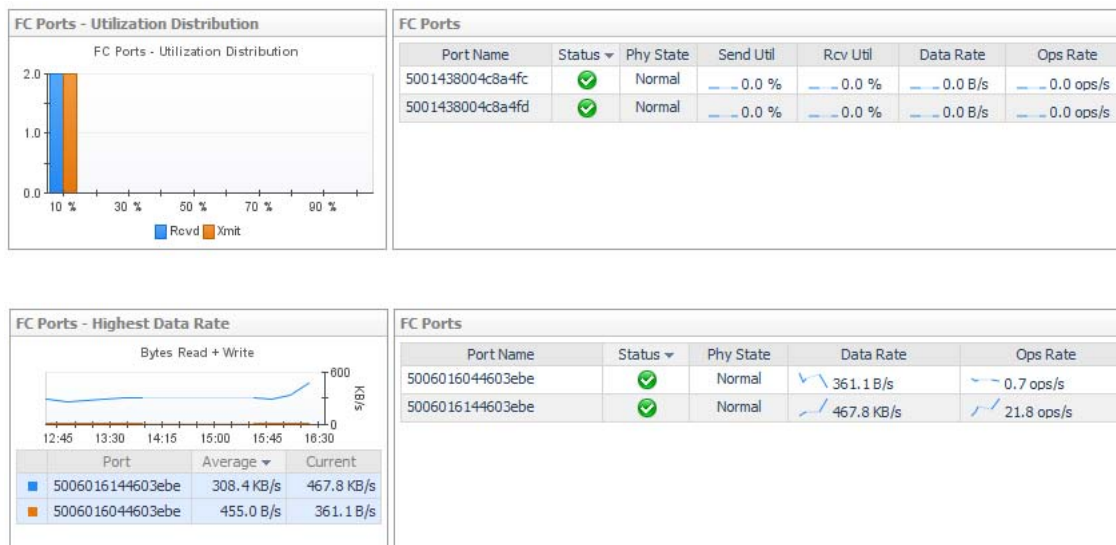
Figure 12. Ops Rate



- Alarm Summary. Displays alarms on the controller.
- 3 Review Port performance in the Port tab.
- FC Ports/IP Ports charts.
 - If the operational link speeds for the ports are available, a chart will be displayed that shows the performance of the ports based on their average utilization in the time period.
 - If the operational link speeds for the ports are not available, a chart will be displayed with the top three ports with the highest average Data Rate in the time period.
 - Port Details. List the ports, their status and physical state, and current values for [Data Rate](#) and [Ops Rate](#). Click a [Sparkline](#) to plot metric values over the time period.

NOTE: Port metrics are not available for NetApp filers. The Ports tab is not displayed.

Figure 13. FC Ports



4 To investigate further:

- Click a port name. See [Investigating an Array/Filer Port](#) on page 73.
- Click an alarm. See [Assessing Storage Alarms](#) on page 20.

Investigating a Directory

In Isilon storage arrays, directories are mounted by datastores. The data displayed in the dashboard reflects values for the directory over the selected time range. The Directory dashboard has one tab.

To explore a directory:

- 1 On a dashboard, click a directory name.
The Directory dashboard opens.
- 2 Review overall performance in the Summary tab.
 - Details. Displays the directory's status, physical details, and parent device.

Figure 14. Details



- Topology. Displays the connections from datastores to the selected directory.

Figure 15. Topology



- 3 To investigate further, click an icon to see more detail about the entity it represents, and if desired, select a component name in the detailed view to navigate to the dashboard for that component.

Investigating an EqualLogic Member

The data displayed in the dashboard reflects values for the selected EqualLogic array member over the time range. This walkthrough describes the contents of each of the tabs.

To explore an EqualLogic member:

- 1 In a topology diagram or from the EqualLogic Storage Array dashboard, click an array member name. The Member Node dashboard opens.
- 2 Review overall performance in the Summary tab.
 - Related Inventory. Displays a list of components from the perspective of the member (rather than the storage array).
 - Resource Utilization charts. Compares resources used by the member against resources used by the pool.
 - Capacity Summary charts. Displays [Used Capacity](#) and [Available Usable Capacity](#).
 - Data Rate charts. Plots values for [Data Read Rate](#) and [Data Write Rate](#).
 - Ops Rate charts. Plots values for [Read Ops Rate](#) and [Write Ops Rate](#).
 - Latency charts. Plots values for [Read Latency](#) and [Write Latency](#).

Figure 16. Overall Performance summary



- Member Network Load. Plots the member's [Send Util](#) and [Rcv Util](#) over the time period.
 - Summary and Resource Information. Displays physical details about the member.
 - Alarm Summary. Displays alarms on the member.
- 3 Click the Network tab. Displays the same information as the [Network tab](#) on the EqualLogic Storage Array dashboard, but the data reflects only the selected member. For more information, see [Dell EqualLogic Storage Array](#) on page 56.
 - 4 Click the Disks tab.

Displays only the disks used by the selected member. For more information, see [Common Component Disk Tab Data](#) on page 93.

Investigating an FC Switch Port

The data displayed in the dashboard reflects values for the component over the selected time range. This walkthrough describes the contents of each of the tabs.

NOTE: If the port is a Brocade logical ISL, no metrics are available.

To explore a switch port:

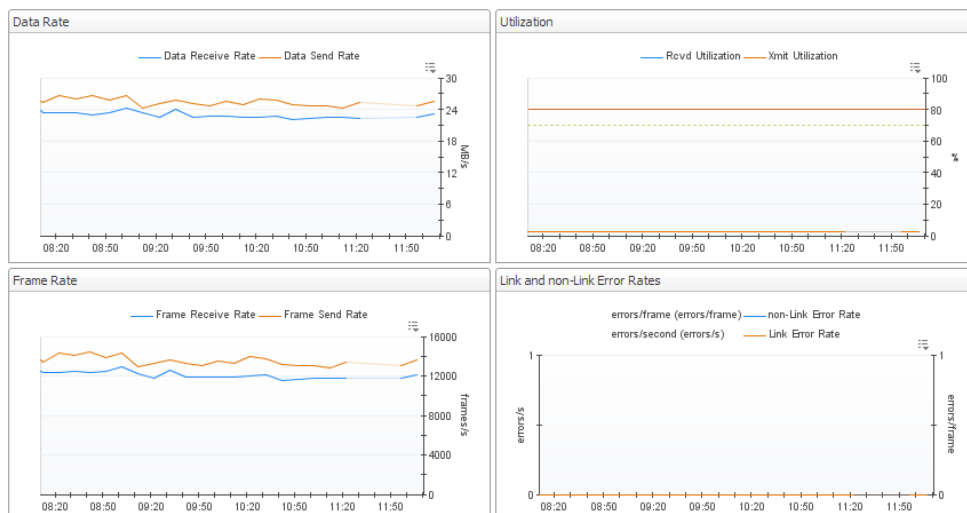
- 1 On a dashboard, click an FC switch port.
The FC Switch Port dashboard opens.
- 2 Review overall performance in the Summary tab.
 - Details. Displays the port's status, physical details, parent switch, parent fabric, VSAN (if applicable), and current values for [Data Rate](#), [Frame Rate](#), [Link Error Rate](#), and [Non-Link Error Rate](#). Click a [Sparkline](#) to plot metric values over the time period.

Figure 17. Details

Details			
Status:	Normal	FC Switch:	mds9148-1.vfs.stc.us.qsft
Physical State:	Normal	Fabric:	Fabric_mds9148-2
Port Type:	ISL	VSAN:	3 vsans
WWN:	2001000573d92270	Max Port Speed:	8,000 Mb/s
		Link Speed:	8,000 Mb/s
		Data Rate:	48.8 MB/s
		Frame Rate:	25,734.4 frames/s
		Link Error Rate:	0.0 errors/s
		non-Link Error Rate:	0.0 errors/frame

- Charts. Charts plot the following metric pairs over the time period:
 - Data Rate. Plots values for [Data Receive Rate](#) and [Data Send Rate](#).
 - Utilization. Plots values for [Rcvd Utilization](#) and [Xmit Utilization](#).
 - Frame Rate. Plots values for [Frame Receive Rate](#) and [Frame Send Rate](#).
 - Errors. Plots values for [Link Error Rate](#) and [Non-Link Error Rate](#).

Figure 18. Charts



- Alarm Summary. Displays alarms on the port.
- 3 Click the Topology tab.

The contents of this tab depends on the type of port selected.

ISL Port:

- **Switch-to-Switch Connectivity diagram.** Displays the selected ISL port (left box) and its connection to another ISL port (right box). Click a port icon for details about the device connected to the port.

Figure 19. Switch-to-Switch Connectivity diagram



- **Topology Table (Inter-Switch Connections).** Identifies all ISL port connections from this port's parent switch to other switches in the fabric.

Figure 20. Topology Table

FC Switch	Port	Status	Target Switch	Target Port	Status
mds9148-1	fc1/1	✓	mds9148-2	fc1/1	✓
	fc1/2	✓	mds9148-2	fc1/2	✓
	fc1/45	✓	nexus5010-1	fc2/1	✓
	fc1/46	✓	nexus5010-1	fc2/2	✓

N Port:

- **Basic Connectivity (table).** Displays the ESX hosts and/or physical hosts connected to the selected N port through their host ports. An N port can have connections to multiple host ports using NPV technology.
- **TIP:** If hosts in the Host Name column are *(unknown)*, you may be able to use dependency processing to infer the host names associated with the host ports. For instructions, see [Inferring Physical-Host-to-Storage Relationships](#) on page 104.
- **Basic Connectivity (diagram).** Displays the selected N port (left box) and its connection to a filer or storage array port (right box). Click a port icon for details about the device connected to the port.
- **Select Host Port(s).** Controls the set of hosts displayed in the Port Dependencies table.
- **Port Dependencies.** On separate tabs, displays connections to LUNs (through the selected port) from virtual machines, ESX or Hyper-V servers, and physical hosts. If the selected port has problems or failures, the connected VMs or hosts may exhibit performance problems.

Figure 21. Port Dependencies

Virtual Machine	Datastore/CSV/Logical Disk	LUN	Array/Filer
delta-fms-vm10	ds59_CX4_LUN107	✓ LUN 107	APM00101301407
delta-fms-vm11	ds62_CX4_LUN108	✓ LUN 108	APM00101301407
delta-fms-vm5	ds40_CX4_LUN32	✓ LUN 32	APM00101301407
delta-fms-vm6	ds42_CX4_LUN88	✓ LUN 88	APM00101301407
delta-fms-vm7	ds43_CX4_LUN91	✓ LUN 91	APM00101301407
delta-fms-vm8	ds44_CX4_LUN103	✓ LUN 103	APM00101301407
delta-fms-vm9	ds45_CX4_LUN106	✓ LUN 106	APM00101301407
delta-fms-vm9	ds45_CX4_LUN106	✓ LUN 31	APM00101301407
epsilin-33-vm3	ds49_CX4_TLUN7_F	✓ Thin LUN 7_ds49	APM00101301407

4 To investigate further:

- Click a VSAN link and then select the name of the VSAN. [Exploring a Cisco VSAN](#) on page 50.
- Click an alarm. See [Assessing Storage Alarms](#) on page 20.

Related Topics

- [Introducing Storage Component Dashboards](#)
- [Exploring a Fabric](#)
- [Exploring a Switch](#)
- [Exploring a Cisco VSAN](#)

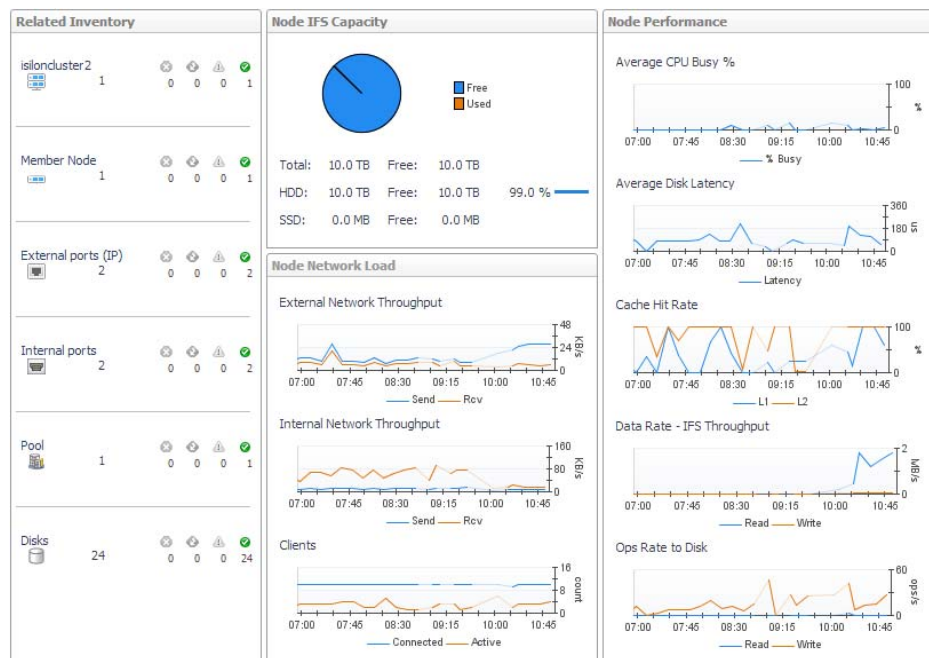
Investigating an Isilon Node

The data displayed in the dashboard reflects values for the selected Isilon node over the time range. This walkthrough describes the contents of each of the tabs.

To explore an Isilon node:

- 1 In a topology diagram or from the Isilon Storage Array dashboard, click a member node name.
The Member Node dashboard opens.
 - 2 Review overall performance in the Summary tab.
 - **Related Inventory.** Displays a list of components from the perspective of the member node (rather than the storage array).
 - **IFS Capacity.** The chart displays [IFS Capacity: Free](#) and [IFS Capacity Used](#) for the IFS file system. In addition, the total capacity is broken down into hard disk drive and solid state drives metrics as follows:
 - Total. [IFS Capacity: Total](#) and [IFS Capacity: Free](#)
 - HDD. [IFS Capacity: HDD Total](#) and [IFS Capacity: HDD Free](#)
 - SSD. [IFS Capacity: SDD Total](#) and [IFS Capacity: SDD Free](#)
 - **Node Network Load.** Charts plot the following metric pairs:
 - **External Network Throughput.** Plots the [Send Data Rate](#) and [Rcv Data Rate](#) for the external network over the time period.
- TIP:** If you prefer to see the [Send Util \(% of max\)](#) and [Rcv Util \(% of max\)](#) based on the rated maximum speeds of the ports (actual port speeds are not available from Isilon arrays) in the external network, ask your Foglight for Storage Management Administrator to edit the registry variable `StSAN_StoragePortShowUtilMax` and set `ISLN_E_IP=true`.
- **Internal Network Throughput.** Plots values for [Send Data Rate](#) and [Rcv Data Rate](#).
 - **Clients.** Clients connected versus clients that are actively using the network.
 - **Node Performance.** Charts plot the following metrics for the selected node over the time period: [% Busy](#), [Latency](#), [L1 Cache Hit Rate](#), [L2 Cache Hit Rate](#), [Data Read Rate](#), [Data Write Rate](#), [Read Ops Rate](#), and [Write Ops Rate](#).

Figure 22. Node Performance



- **Summary and Resource Information.** Displays physical details about the member node.
 - **Alarm Summary.** Displays alarms on the member node.
- 3 Click the Network tab.
Displays the same information as the [Network tab](#) on the Isilon Storage Array dashboard, but the data reflects only the selected member node. For more information, see [EMC Isilon Storage Array](#) on page 59.
 - 4 Click the Disks tab.
Displays disks used by the selected member. For more information, see [Common Component Disk Tab Data](#) on page 93.

Related Topics

- [Introducing Storage Component Dashboards](#)
- [EMC Isilon Storage Array](#)

Investigating a LUN

A LUN (logical unit number) represents a logical SAN block storage device on an array or filer that can be exposed for mapping to a server. The data displayed in the dashboard reflects metric values for the LUN over the selected time range. This walkthrough describes the contents of each of the tabs.

To explore a LUN:

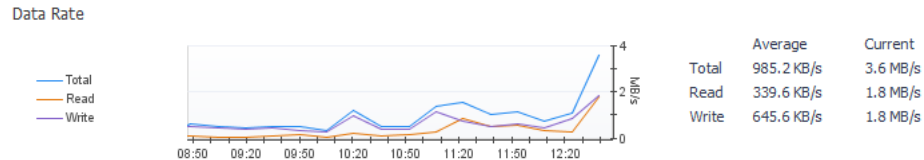
- 1 On a dashboard, click a LUN name or icon.
The LUN dashboard opens.
- 2 Review overall performance in the Summary tab.
 - **Details.** Displays the LUN's status, physical details, parent device and capacity metrics.

Figure 23. Details

Details			
Status:	Normal	Advertised LUN Size:	18.0 GB
Parent:	AMS2100.83040841	Provisioned Usable Capacity:	18.0 GB
Physical State:	Normal	Provisioned Raw Capacity:	20.6 GB
		Thin-Provisioned?:	false
		Protection:	RAID5
		Used In Monitored Environment?:	true

- Charts. Plot values over the time period for these metrics, if available: [Ops Rate](#), [Data Rate](#), [Latency](#), [% Busy](#), [Cache Hit Rate](#), and [Average Queue Depth](#).

Figure 24. Data Rate



- Pool Details. Identifies the pools to which the LUN belongs.

Non-clustered storage arrays – Displays performance and capacity metrics for the pools relevant to the selected LUN. For more information, see [Performance Metrics](#) on page 118 and [Capacity Metrics](#) on page 121.

Figure 25. Pool Details

Pool Details												
Name	Status	State	Data Rate	Ops Rate to Disks	Total Raw Capacity	Available Raw Capacity	Adv LUNs Size	Total Usable Capacity	Available Usable Capacity	Capacity Provisioned to LUNs	Over Commitment	Time to Full (available history)
Concrete storage pool 0005 f...	Normal	Normal	404.3 B/s	1.4 ops/s	267.3 GB	137.3 GB	80.0 GB	133.6 GB	68.6 GB	80.0 GB	n/a	> 1 year
Concrete storage pool 0002 f...	Normal	Normal	404.3 B/s	2.4 ops/s	133.2 GB	34.8 GB	77.2 GB	66.6 GB	17.4 GB	77.2 GB	n/a	> 1 year

EqualLogic storage arrays—Displays the same information as the Pool Details view on the [Pools-Members](#) tab of the EqualLogic Storage Array dashboard, but the data reflects only the pools relevant to the selected LUN. For more information, see [Dell EqualLogic Storage Array](#) on page 56.

Figure 26. Pool Details

Pool Details												
Name	Status	Data Rate	Ops Rate to Disks	Latency	Avg Q Depth	Adv LUNs Size	Total Usable Capacity	Available Usable Capacity	Capacity Provisioned to LUNs	Overcommitment	Time Until Full (per available history)	Members
sata-pool	Normal	5.7 MB/s	397.7 ops/s	4.3 ms	3.2	12.1 TB	10.5 TB	1.3 TB	8.3 TB	2.6 TB	n/a	member1

- Alarm Summary. Displays alarms on the LUN.

3 Click the Topology tab.

Displays the datastores, CSVs, or logical disks that get their physical storage from the selected LUN, the VMs that do the I/O, and if dependency processing is enabled, the (most likely) physical host connected to the LUN. For more information on dependency processing, see [Inferring Physical-Host-to-Storage Relationships](#) on page 104.

Figure 27. LUN providing storage to VMware VMs

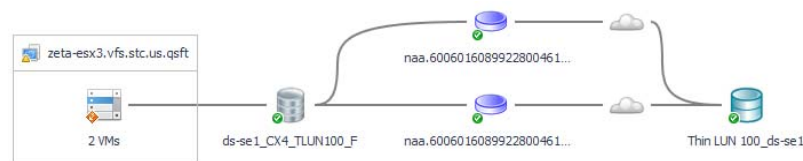
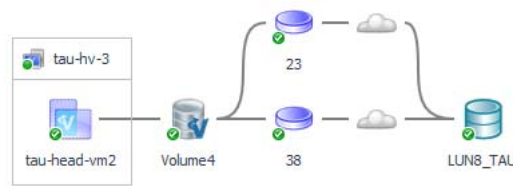


Figure 28. LUN providing storage to Hyper-V VMs



- Click a Cloud icon to reveal the ports and paths from disks extents to the LUN, through a particular server. For more information, see [Exploring Connectivity with SAN Topology Diagrams](#) on page 34.
 - Click an icon, then select a component name to navigate to the component dashboard. For example, if you select the VM icon, you can see a list of the VMs that use the storage and select one that warrants further investigation.
- 4 Click the SAN Data Paths tab.
- Displays the datastores or servers, CSVs or logical disks that get their physical storage from the selected LUN, and the VMs that do I/O to them and the LUN.
- 5 Review the I/O Paths table to assess the worst performing path segment of the possible data paths between each disk extent and the LUN during the time period. This helps you to identify bottlenecks resulting in high latency. For general information about how to use a Data Paths tab, see [Exploring I/O Performance with SAN Data Paths](#) on page 37. For information specific to the LUN Data Path tab, see below.

TIP: For metrics that have thresholds, the color of the bars highlight data values that fall within normal, warning, critical, and fatal thresholds. Thresholds are set in the registry variables `StSAN.FCSwitchPortUtilization.[Warning|Critical|Fatal]`.

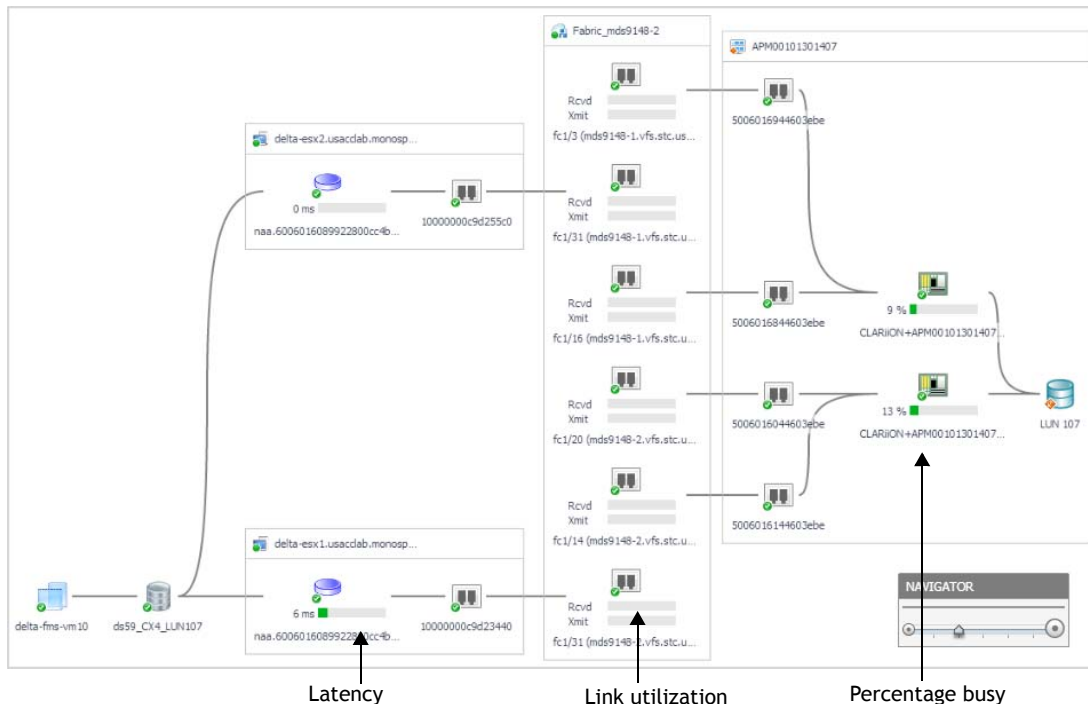
Figure 29. I/O Paths

ESX/VM	Latency	Data Rate	% Total I/O in ESX	ESX FC Ports --> SAN Util	SAN --> A/F Ports Util	% Total I/O at LUN
delta-esx1.usacclab.monosphere.com	6 ms	27 KB/s				
delta-fms-vm10		27 KB/s	100 %	0 %	0 %	100 %
delta-esx2.usacclab.monosphere.com	0 ms	0 KB/s				

- NOTE:** The column headings may vary between VMware and Hyper-V. Where the names differ, the column headers will be listed for VMware and Hyper-V respectively.
- ESX/VMs or Hyper-V Server/VM. List of servers and the VMs they host.
 - Latency. Average latency per operation in the time period.
 - Data Rate. Average data rate for I/O from the ESX or VM to the LUN over the time period.
 - % Total I/O in ESX or % Total I/O in Hyper-V Server. When multiple VMs on a server are performing I/O to the same LUN, displays the percentage of the total I/O performed by this VM.
 - ESX FC Ports --> SAN Util or Hyper-V Server FC --> Ports SAN Util. Displays the busiest link (read or write utilization) over a time period. Click the cell to display all the port links. Review the topology diagram to see the ports and link utilization. Data is not available for IP ports.
 - SAN --> A/F Ports Util. Displays the busiest link (read or write utilization) over the time period. Click the cell to display all the port links. Review the topology diagram to see the ports and link utilization. Data is not available for IP ports.
 - % Total I/O at LUN. When VMs on multiple servers are doing I/O to the same LUN, displays the percentage of the total I/O performed by this server.
 - LUN Latency (ms). Displays the latency of LUN in ms.

- 6 Review the diagram to understand the path from disk extents through the SAN to LUNs. The topology diagram is enhanced to show the FC ports and to display latency, link utilization, and for controllers, percent busy.

Figure 30. Topology diagram



NOTE: When physical hosts are inferred by dependency processing and not monitored directly by agents, the disk extents on the host that map to the selected LUN are unknown and therefore no latency values are available. For instructions on how to enable dependency processing, see [Inferring Physical-Host-to-Storage Relationships](#) on page 104.

- 7 To investigate further:

- Click a host, VM, or virtual storage name or icon. See the *Managing Virtualized Environments User and Reference Guide*.
- Click a disk name or icon. See [Investigating a Physical Disk](#) on page 86.
- Click a port name or icon. See [Investigating an Array/File Port](#) on page 73.
- Click a controller name or icon. See [Investigating a Controller](#) on page 74.
- Click an alarm. See [Assessing Storage Alarms](#) on page 20.

Related Topics

- [Introducing Storage Component Dashboards](#)
- [Exploring a Filer](#)
- [Exploring a Storage Array](#)

Investigating a NASVolume

A NASVolume is a volume whose physical storage is on a filer or unified storage supplier. It can be mounted by an ESX host to provide the physical storage for a datastore using NFS. The data displayed in the dashboard

reflects metric values for the NASVolume over the selected time range. This walkthrough describes the contents of each of the tabs.

To explore a NASVolume:

- 1 On a dashboard, click a NASVolume name.
The NASVolume dashboard opens.
- 2 Review overall performance in the Summary tab.
 - **Details.** Displays the volume's status, physical state, physical details, parent devices, and alarms on disks in the volume. Also displays current values for [Advertised NASVolumes Size](#), [Used Capacity](#), and [% Used](#).

Figure 31. Details

Details					
Status:	✔ Normal	Advertised Size:	640.0 GB	Thin-Provisioned?:	true
Filer:	⚠ cassiopeia	Used Capacity:	461.1 GB	Protection:	Complex Stripe Parity
Physical State:	Normal	% Used:	72.1 %	Used In Monitored Environment?:	false
vFiler:	cassiopeia				

- **Charts.** Displays the following metrics over the time period:
 - **Data Rate.** Plots values for [Data Read Rate](#) and [Data Write Rate](#).
 - **Ops Rate.** Plots values for [Read Ops Rate](#), [Write Ops Rate](#) and [Other Ops](#).
 - **Latency.** Plots values for [Read Latency](#) and [Write Latency](#).

Figure 32. Ops Rate



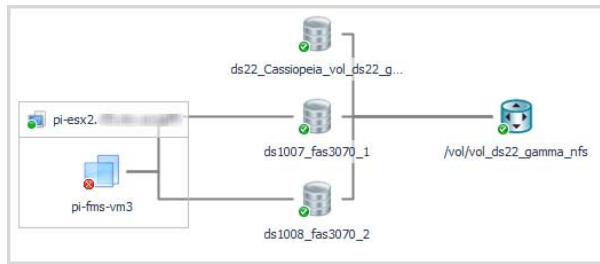
- **Aggregate Details.** Displays values for [Total Usable Capacity](#), [Available Usable Capacity % Available](#), [Advertised NASVolumes Size](#), and [Overcommitment](#).

Figure 33. Aggregate Details

Aggregate Details						
Name	Status	Total Usable Capacity	Available Capacity	% Available	Advertised NASVolumes Size	Overcommitment
aggr2	✔	1.5 TB	1.1 TB	73 %	16.1 TB	14.6 TB

- **Alarm Summary.** Displays alarms on the NASVolume.
- 3 Click the Topology tab.
Displays the datastores that get their physical storage from the selected volume as a NAS mount and the VMs that do I/O to these datastores. For more details, click an icon or an entity name. For more information about using this view, see [Exploring Connectivity with SAN Topology Diagrams](#) on page 34.

Figure 34. Topology



4 Click the Disks tab.

Displays the disks used by the NASVolume. For more information, see [Common Component Disk Tab Data](#) on page 93.

5 To investigate further:

- Click a host, VM, or datastore name or icon. See the *Managing Virtualized Environments User and Reference Guide*.
- Click an alarm. See [Assessing Storage Alarms](#) on page 20.

Related Topics

- [Introducing Storage Component Dashboards](#)
- [Exploring a Filer](#)
- [Investigating an Aggregate](#)




Investigating a Physical Disk

The data displayed in the dashboard reflects values for the selected disk over the selected time range. The Physical Disk dashboard has only one tab.

To explore a physical disk:

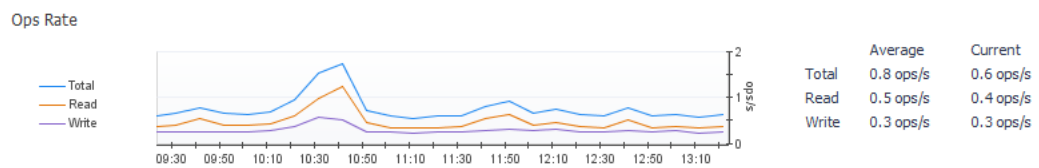
- 1 On a dashboard, click a disk name.
- 2 Review overall performance in the Summary tab.
 - Disk Details. Displays the disk's status, physical details, parent device, and size if available.

Figure 35. Disk Details

Disk Details					
Status:	 Normal	Disk Size:	133.9 GB	RPM:	15K
 Filer:	 cassiopeia	Role:	data	Interface:	FC
		Physical State:	Normal		

- Charts. Displays the following metrics over the time period:
 - Data Rate. Plots values for [Data Rate](#), [Data Read Rate](#), and [Data Write Rate](#).
 - Ops Rate. Plots values for [Ops Rate](#), [Read Ops Rate](#), and [Write Ops Rate](#).
 - Latency. Plots values for [Latency](#), [Read Latency](#), and [Write Latency](#).
 - Busy %. Plots values for [% Busy](#).
 - Queue Depth. Plots depth of the queue.

Figure 36. Ops Rate



- **Pool Details (Arrays only).** Displays performance and capacity metrics for the pools to which this disk contributes resources. For more information, see [Performance Metrics](#) on page 118 and [Capacity Metrics](#) on page 121. To investigate a pool, click its name. For more information, see [Investigating a Pool](#) on page 88.

Figure 37. Pool Details

Pool Details												
Name	Status	State	Data Rate	Ops Rate to Disks	Total Raw Capacity	Available Raw Capacity	Adv LUNs Size	Total Usable Capacity	Available Usable Capacity	Capacity Provisioned to LUNs	Over Commitment	Time to Full (available history)
Concrete storage pool 0005 f...	✓	Normal	404.3 B/s	1.4 ops/s	267.3 GB	137.3 GB	80.0 GB	133.6 GB	68.6 GB	80.0 GB	n/a	> 1 year
Concrete storage pool 0002 f...	✓	Normal	404.3 B/s	2.4 ops/s	133.2 GB	34.8 GB	77.2 GB	66.6 GB	17.4 GB	77.2 GB	n/a	> 1 year

EqualLogic storage arrays—Displays the same information as the Pool Details view on the [Pools-Members](#) tab of the EqualLogic Storage Array dashboard, but the data reflects only the pools relevant to the selected disk. For more information, see [Dell EqualLogic Storage Array](#) on page 56.

Figure 38. Pool Details - EqualLogic

Pool Details											
Name	Status	Data Rate	Ops Rate to Disks	Latency	Avg Q Depth	Adv LUNs Size	Total Usable Capacity	Available Usable Capacity	Capacity Provisioned to LUNs	Overcommitment	Time Until Full (per available history)
sata-pool	⚠	5.7 MB/s	397.7 ops/s	4.3 ms	3.2	12.1 TB	10.5 TB	1.3 TB	8.3 TB	2.6 TB	n/a

Isilon storage arrays—Displays the same information as the Pool Details view on the [Pools](#) tab of the Isilon Storage Array dashboard, but the data reflects only the pools relevant to the selected disk. For more information, see [EMC Isilon Storage Array](#) on page 59.

Figure 39. Pool Details - Isilon

Pool Details										
Name	Status	Data Rate	Avg Disk Latency	L2 Cache Hit Rate	IFS Capacity	IFS Free	Time Until Full (per available history)	HDD % Free	SSD % Free	Node Status
np_lq_12000x	⚠	2.0 MB/s	143.0 us	100.0 %	38.8 TB	35 TB	n/a	90.0 %	n/a	⚠

- **Aggregate Details (Filers only).** Lists the aggregates to which this disk contributes resources. For each aggregate, displays its name, status, physical state, and current values for [Total Usable Capacity](#), [Available Usable Capacity % Available](#), [Advertised NASVolumes Size](#), and [Overcommitment](#). To investigate an aggregate, click its name. See [Investigating an Aggregate](#) on page 70.

Figure 40. Aggregate Details

Aggregate Details							
Name	Status	Total Usable Capacity	Available Capacity	% Available	Advertised NASVolumes Size	Overcommitment	Time Until Full (per available history)
aggr4	✓	668.1 GB	297.8 GB	44 %	671.5 GB	3.4 GB	> 1 year

- **Alarm Summary.** Displays alarms on the disk.

Related Topics

- [Introducing Storage Component Dashboards](#)
- [Exploring a Filer](#)
- [Exploring a Storage Array](#)

Investigating a Pool

Displays a summary of details for the selected pool, including a selection of size, capacity, data rate, and latency metrics. The data displayed in the dashboard reflects values for the pool over the selected time range.



The Pool dashboard is very similar for non-clustered storage arrays and EqualLogic storage arrays. The Isilon storage array requires its own Pool dashboard, which is discussed separately. The following walkthroughs describe the contents of each of the tabs.

Pool belonging to a non-clustered storage array or EqualLogic storage array

To explore a pool:

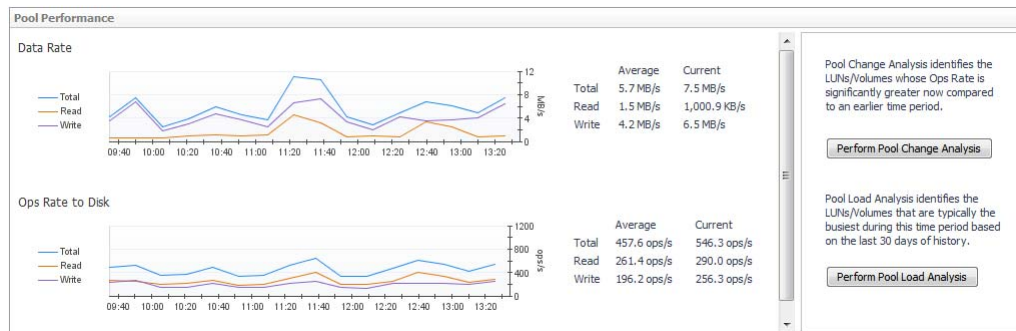
- 1 On a dashboard, click a pool name.
The Pool dashboard opens.
- 2 Review overall performance in the Summary tab. From here you can initiate further analysis of the pool in terms of performance and, in some cases, pool capacity.
 - **Pool Details.** Displays the pool's status, parent storage array, and current values for [Total Raw Capacity](#), [Available Raw Capacity](#), [Total Advertised LUNs Size](#), [Total Usable Capacity](#), [Available Usable Capacity](#), and [Overcommitment](#), if available.

Figure 41. Pool Details

Pool Details					
Status:	 Critical	Advertised LUNs Size:	7.2 TB	Total Raw Capacity:	7.2 TB
Storage Array:	 APM00101301407	Total Usable Capacity:	5.4 TB	Available Raw Capacity:	310.4 GB
Physical state:	Normal	Available Usable Capacity:	218.0 GB		
		Overcommitment:	1.9 TB		

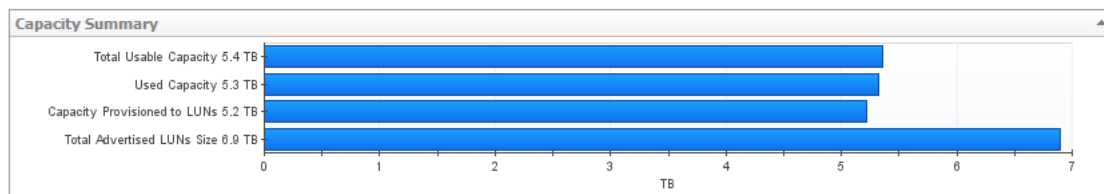
- **Charts.** Displays the following sets of metrics over the time period, if available:
 - Data Rate. Plots values for [Data Rate](#), [Data Read Rate](#), and [Data Write Rate](#).
 - Ops Rate to Disk. Plots values for [Ops Rate](#), [Read Ops Rate](#), and [Write Ops Rate](#).
 - Latency. Plots values for [Latency](#), [Read Latency](#), and [Write Latency](#).
 - Average Queue Depth. Plots values for [Average Queue Depth](#).

Figure 42. Pool Performance



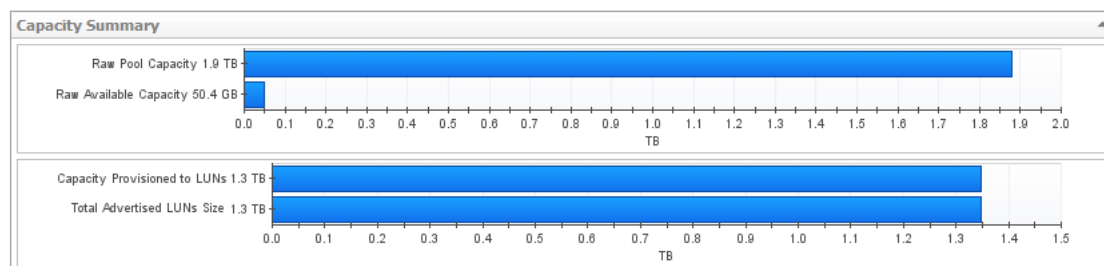
- **Perform Pool Change Analysis.** Click to identify the LUNs primarily responsible for increased I/O. For more information, see [Analyzing the Pool](#) on page 100.
 - **Perform Pool Load Analysis.** Click to identify the busiest LUNs, and rank them based on their activity during the same time range *over the last 30 days*. For more information, see [Analyzing the Pool](#) on page 100.
 - **Alarm Summary.** Displays alarms on the pool.
- 3 Click the Capacity tab.
- **Capacity Summary.** Pools in most arrays will display data similar to the data shown below.

Figure 43. Capacity Summary



For some arrays, pool capacity in Usable terms is not available. Then the capacity summary will display with total capacity in raw terms instead of usable terms.

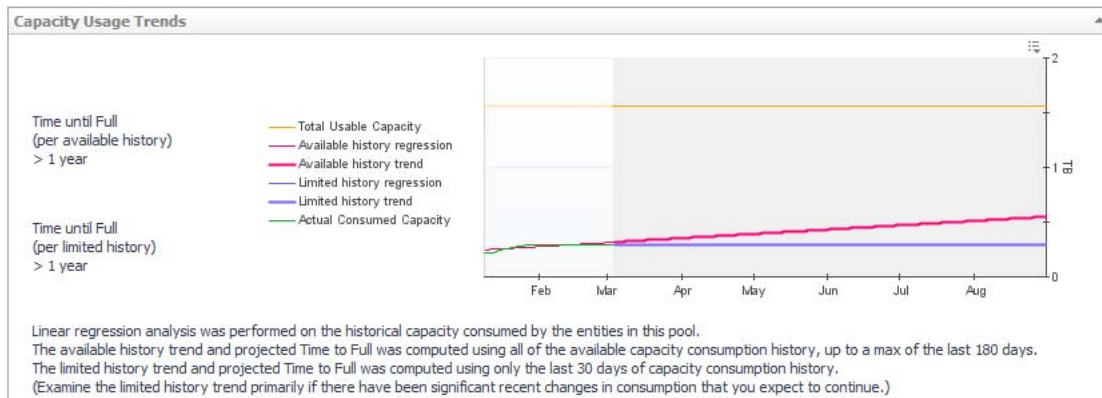
Figure 44. Capacity Summary - raw terms



- **Capacity Usage Trends.** Provides a visual display of the estimated capacity consumption in the future, based on a regression analysis of the historical capacity consumption.

If time until full shows n/a, it means enough historical data hasn't been collected yet to perform an analysis. Mouse over for additional information. For more information, see [Capacity Trending](#) on page 40.

Figure 45. Capacity Usage Trends

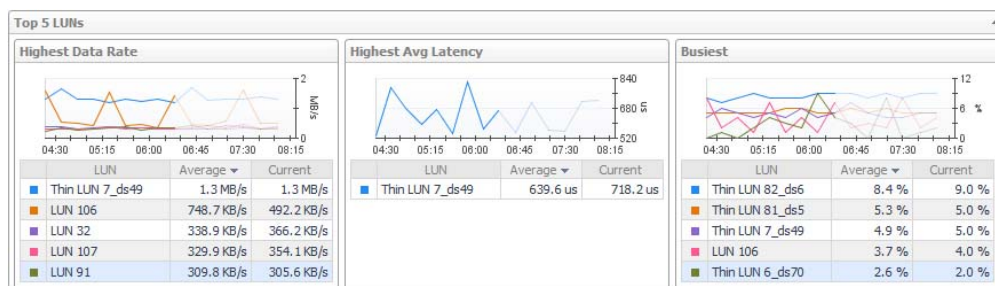


- 4 Click the LUNs tab. This tab displays the LUNs carved from this pool.

A LUN (logical unit) is the block storage element made available by an array or filer to a server.

- Top 5 LUNs. Displays the top five LUNs with the highest average value for [Data Rate](#), and the performance metrics most useful for this array or filer.

Figure 46. Top 5 LUNs



- LUN Status Filter. Click to show only LUNs with the selected status in the LUN Details table.
- LUN Details. For each LUN, displays its status, physical state, parent pool or aggregate, and whether the LUN is used by an entity in the monitored environment. The metric columns display current values for [Data Rate](#), [Ops Rate](#), [Latency](#), [% Busy](#), [Average Queue Depth](#), [L1 Cache Hit Rate](#), and [Total Advertised LUNs Size](#). Click a [Sparkline](#) to plot metric values over the time period.

NOTE: If a metric is not available for this particular array or filer, the column is not displayed.

The remaining columns provide the following details:

- Protection. Displays the type of protection in use on the LUN, such as the RAID level.
- Thin?. Indicates whether the LUN is thin-provisioned (true) or thick-provisioned.
- IQN. Displays the iSCSI Qualified Name. Click the Customizer to add this column.
- vFiler. *Filers only*. Displays the name of the virtual filer associated with the LUN.

- Alarm Summary. Displays alarms on LUNs.

- 5 Click the Disks tab.

Displays the disks used by the selected pool. For more information, see [Common Component Disk Tab Data](#) on page 93.

- 6 To investigate further:

- Click a LUN name. See [Investigating a LUN](#) on page 81.
- Click a disk name. See [Investigating a Physical Disk](#) on page 86.

Pool belonging to an Isilon storage array

To explore a pool for an Isilon storage array:

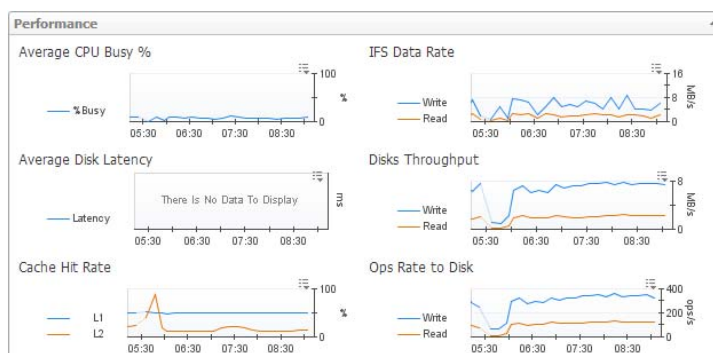
- 1 On an Isilon-related dashboard, click a pool name.
The Pool dashboard opens.
- 2 Review overall performance in the Summary tab.
 - Pool Details. Displays the pool's status, parent storage array, and current values for **IFS Capacity: Free** and **IFS Capacity Used** for the IFS file system. In addition, the total capacity is broken down into hard disk drive and solid state drives metrics as follows:
 - Total. **IFS Capacity: Total** and **IFS Capacity: Free**
 - HDD. **IFS Capacity: HDD Total** and **IFS Capacity: HDD Free**
 - SSD. **IFS Capacity: SDD Total** and **IFS Capacity: SDD Free**

Figure 47. Pool Details



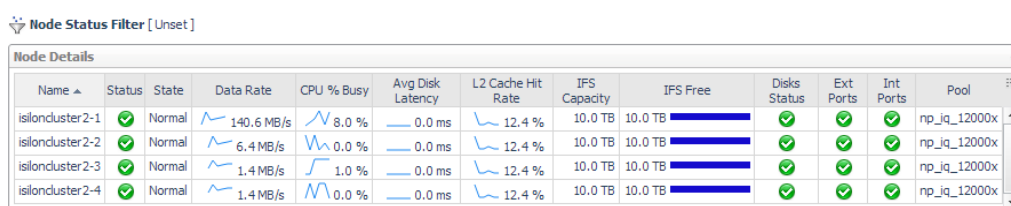
- Performance. Charts plot the following metrics for the selected pool over the time period: **% Busy**, **Latency**, **L1 Cache Hit Rate**, **L2 Cache Hit Rate**, **Data Read Rate**, **Data Write Rate**, **Read Ops Rate**, and **Write Ops Rate**.


Figure 48. Performance



- Node Status Filter. Click to show only member nodes with the selected status in the Node Details table.
- Node Details. For each node belonging to the pool, displays its name, status, physical state, and current values for **Data Rate**, **% Busy**, **Latency**, **L2 Cache Hit Rate**, **IFS Capacity**, and **IFS Capacity: Free**. Also displays the worst status of the node's disks, external network ports, and internal network ports, and identifies the node's parent pool. Click a **Sparkline** to plot metric values over the time period.

Figure 49. Node Status



You can add the following metrics to the table by clicking the Customizer  icon: [L1 Cache Hit Rate](#), [Send Data Rate](#) and [Rcv Data Rate](#). You can also choose to display other Isilon details, such as Total Disk IOPS and Model.

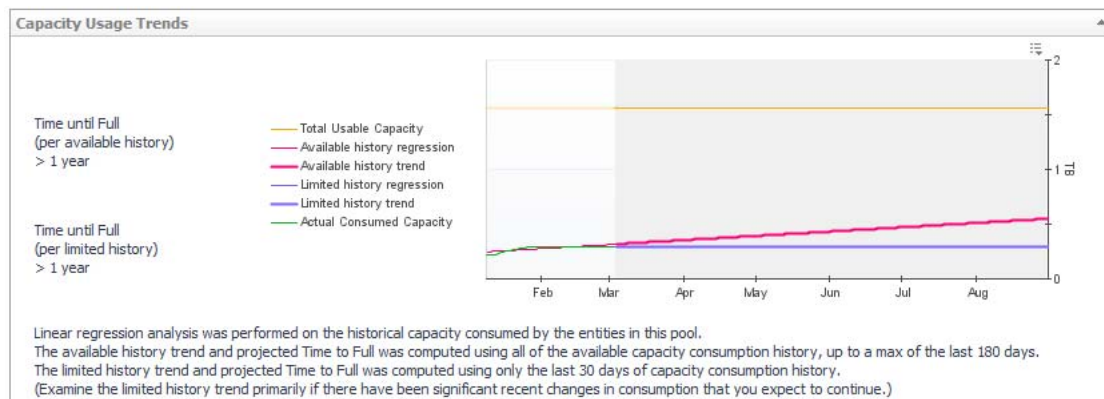
- Alarm Summary. Displays alarms on the pool.

3 Click the Capacity tab.


- Capacity Usage Trends. Provides a visual display of the estimated capacity consumption in the future, based on a regression analysis of the historical capacity consumption.

If time until full shows n/a, it means enough historical data hasn't been collected yet to perform an analysis. Mouse over for additional information. For additional information, see [Capacity Trending](#) on page 40.

Figure 50. Capacity Usage Trends

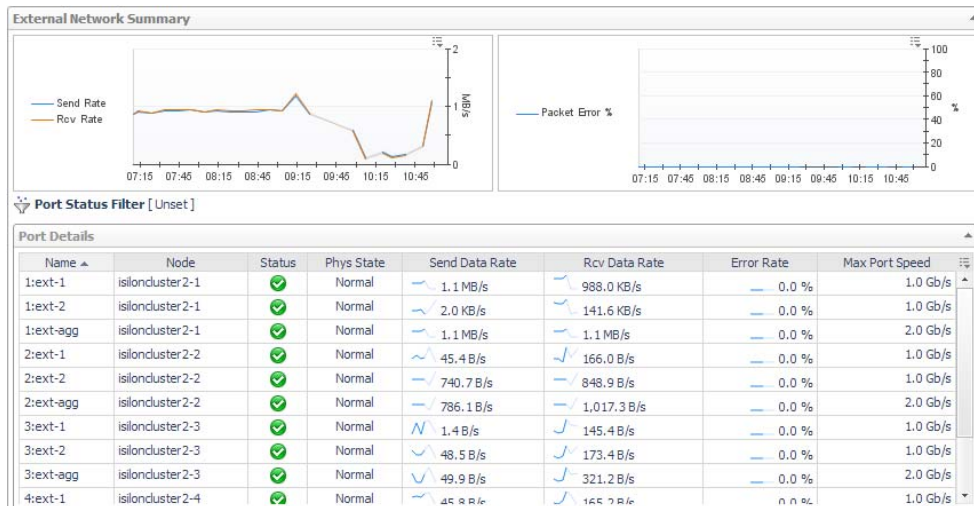


4 Click the Network tab. Assess the performance of the ports in the External Network from the perspective of the pool.

- Charts. Plot aggregated values for [Send Data Rate](#) and [Rcv Data Rate](#), and [Packet Errors %](#) for the external network connections over the time period.
- Port Status Filter. Click to show only ports with a selected status in the Port Details table.
- Port Details. For each port used by the external network, identifies the port name, parent node, status, physical state, and [current](#) values for [Send Data Rate](#), [Rcv Data Rate](#), and [Packet Errors %](#). Also displays the maximum speed of the port. Click a  [Sparkline](#) to plot metric values over the time period.

 **NOTE:** When the registry variable `StSAN_StoragePortShowUtilMax` is set to show port utilization, the chart and table display [Rcv Util \(% of max\)](#) and [Send Util \(% of max\)](#).

Figure 51. External Network Summary



- Alarm Summary. Displays alarms on ports used by the external network.
- 5 Click the Disks tab. Displays the disks used by the selected pool. For more information, see [Common Component Disk Tab Data](#) on page 93.
 - 6 To investigate further, click a disk name. See [Investigating a Physical Disk](#) on page 86.

Common Component Disk Tab Data

The Disks tab can be found on the following dashboards:

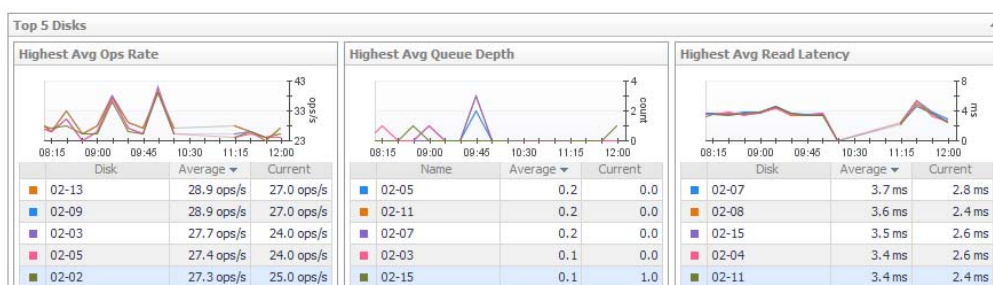
- Member/Node
- Pool
- Aggregate
- NASVolume.

The Disks tab displays the physical disks associated with the selected entity.


NOTE: The images in this section reflect an EMC CLARiiON storage array, but the views should be similar for any filer or storage array. For filers, where the word *pool* is used, it means *aggregate*.


- Top 5 Disks. Displays the top five disks with the highest average value for [Ops Rate](#) and the performance metrics most useful for this array or filer.

Figure 52. Top 5 Disks



- Disk Status Filter. Click to show only disks with the selected status in the Disk Details table.


- **Disk Details.** For each disk, identifies its status, physical state, parent pool or aggregate, and **Disk Size**, and then displays current values for **Ops Rate**, **% Busy**, **Average Queue Depth**, **Data Rate**, and **Latency**. Click a  **Sparkline** to plot metric values over the time period.

 **NOTE:** If a metric is not available for this particular array or filer, the column is not displayed.

The remaining columns provide the following details:

- **Role.** Displays the role played by the disk in the pool, such as disk or spare.
- **RPM.** Displays revolutions per minute as reported by the vendor.
- **Disk Interface.** When available, displays the type of interface, such as SATA or SCSI.
- **Member.** *EqualLogic and Isilon only.* Displays the name of the member node where the disk physically resides.

Figure 53. Disk Status Filter

 **Disk Status Filter** [Unset]

Disk Details									
Name	Status	Phy State	Pools	Disk Size	Ops Rate	Avg Q Depth	Data Rate	Latency	Role
01-01		Normal	Assigned	465.8 GB	0.0 ops/s	0.0	0.0 B/s	0.0 ms	Disk
01-05		Normal	Assigned	465.8 GB	0.0 ops/s	0.0	0.0 B/s	0.0 ms	Disk
01-09		Normal	Assigned	465.8 GB	0.0 ops/s	0.0	0.0 B/s	0.0 ms	Disk
01-13		Normal	Assigned	465.8 GB	0.0 ops/s	0.0	0.0 B/s	0.0 ms	Disk
01-14		Normal	Assigned	465.8 GB	0.0 ops/s	0.0	0.0 B/s	0.0 ms	Disk
01-16		Normal	Assigned	465.8 GB	0.0 ops/s	0.0	5.0 KB/s	0.0 ms	Disk
02-01		Normal	Assigned	558.9 GB	0.0 ops/s	0.0	0.0 B/s	0.0 ms	Spare
02-02		Normal	Assigned	558.9 GB	25.0 ops/s	0.0	376.0 K...	3.6 ms	Disk
02-03		Normal	Assigned	558.9 GB	24.0 ops/s	0.0	357.0 K...	3.6 ms	Disk
02-04		Normal	Assigned	558.9 GB	24.0 ops/s	0.0	422.0 K...	3.7 ms	Disk
02-05		Normal	Assigned	558.9 GB	24.0 ops/s	0.0	344.0 K...	3.6 ms	Disk

- **Alarm Summary.** Displays alarms on disks.

Troubleshooting Storage Performance

NOTE: This chapter is intended for Foglight for Storage Management users with the role of Storage Administrator.

Administrators may receive problem reports from stakeholders about the performance of a VMware virtual machine (VM). When the suspected cause is storage, the Administrator can run an automated analysis using the Storage Troubleshooting dashboard. The analysis can quickly rule out a storage issue, allowing the Administrator to focus on other areas. Conversely, if a storage issue is found to be contributing to poor performance, the results of the analysis clearly highlights the datastores or RDM disk extents that require attention.

This chapter describes how to start an investigation, analyze the results, and change latency thresholds. It also summarizes the algorithm used to identify and assess storage performance issues.

Starting a Troubleshooting Investigation

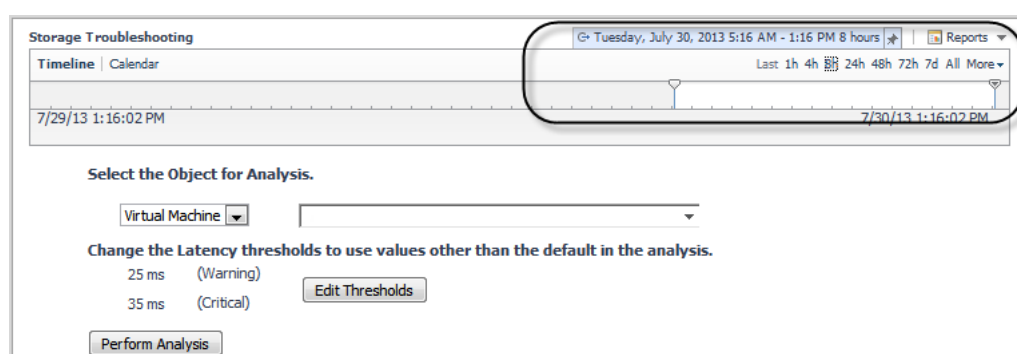
Before beginning an investigation, you should ask the person reporting the issue the following questions:

- What is the host name of the affected virtual machine?
- When did you first notice the performance issues? The reported time frame determines how you set the zonar time range.

To investigate a potential storage performance issue:

- 1 On the navigation panel, under Dashboards, choose Storage & SAN > Storage Troubleshooting.
- 2 Set the zonar to encompass the reported time frame, up to a maximum of 8 hours.

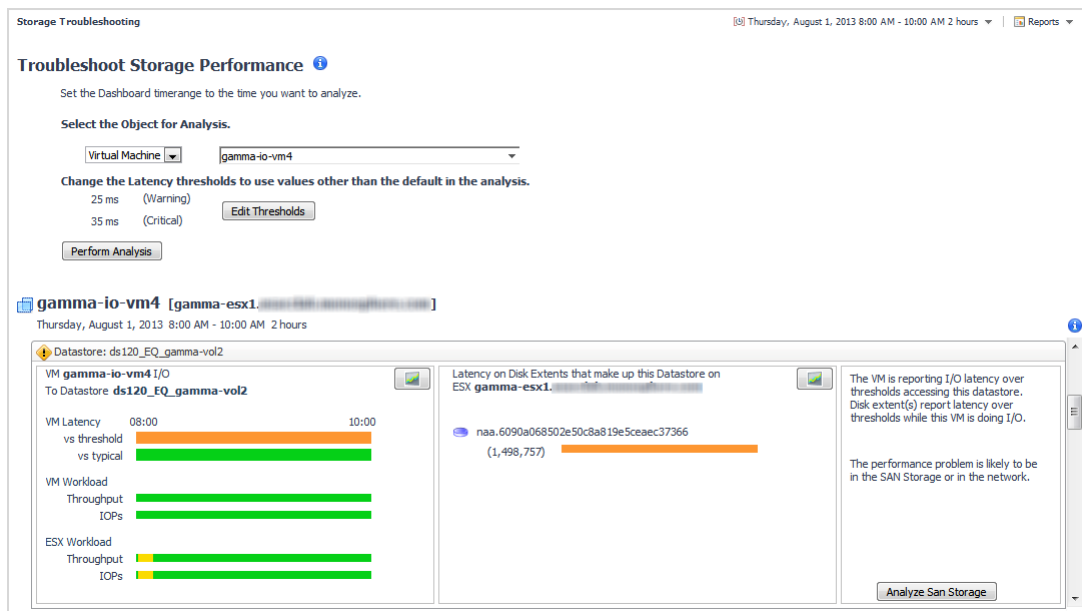
Figure 54. The zonar is located in the upper right corner of the dashboard.



- 3 Type the host name of the virtual machine.
- 4 The latency threshold values are set automatically based on the latency registry variables. If different values would be more meaningful for your analysis, see [Changing Latency Thresholds](#) on page 101.
- 5 Click Perform Analysis.

Depending on the complexity of the analysis request, it may take a little time before the results of the analysis appear on the dashboard.

Figure 55. Troubleshoot Storage Performance



Recall that a virtual machine can get its storage either from a datastore (connected in turn to one or more disk extents or to a NASVolume) or directly from an RDM disk extent (without a datastore). In the analysis results, each datastore or RDM disk extent that is connected directly to the selected virtual machine is represented by a separate view.

6 Review the icons displayed in the title bars of each datastore/RDM view.

- If a Normal icon appears in *all* title bars, the performance issue is *not* storage-related. This investigation is complete.
- **TIP:** In some cases, the Diagnosis summary (right-hand panel) may contain hints about where to look next. For example, increased I/O (as compared to typical I/O for this period) may indicate that an application is behaving differently than before.
- If the Attention icon appears in one or more title bars, continue your investigation following the workflow described in [Analyzing Storage Issues](#).

Analyzing Storage Issues

If the view for a datastore or RDM disk extent shows the Attention icon, the troubleshooting algorithm has discovered evidence of a performance problem related to storage. The problem may or may not be in the SAN Storage environment. Review the details to determine the cause of the performance issue.

Each datastore/RDM view has three summary panels (from left to right):

- VM I/O to Datastore/RDM (first panel)
- Latency for Disk Extents (middle panel)
- Diagnosis (last panel)

A virtual machine may be connected to multiple datastores and RDM disk extents, each of which may report varying degrees of problems. When a virtual machine has more than one datastore/RDM view, start by scanning the timeline bars in the VM I/O to Datastore/RDM panel to identify a datastore/RDM with consistently slow I/O performance or significant changes from typical performance.

The following workflow describes one way to identify a latency problem in the collected SAN Storage environment. While the details in your investigation may differ, the general workflow should be similar to this one.

To analyze storage issues:


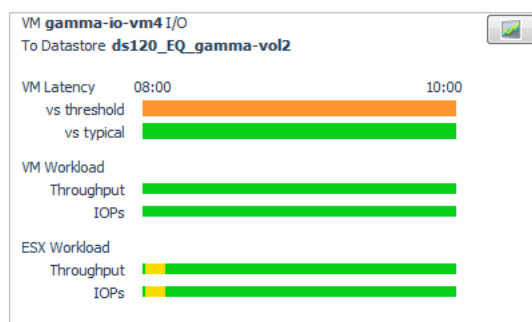
- 1 In a view showing the Attention  icon, scan the VM I/O to Datastore/RDM summary (first panel). Look for timeline bars that primarily show colors such as yellow, orange, or pink, that is, any color other than green (which represents acceptable activity).

Figure 56. VM I/O to Datastore/RDM summary



In this example, the VM Latency vs Threshold timeline is orange, which means the virtual machine is consistently exceeding the default latency thresholds that were specified for the analysis. We should focus our investigation here.

The VM Latency vs Typical timeline is green, which means that the latency is typical for the time period; this behavior has been going on for some time. The typical values are statistical values determined by IntelliProfile from activity within the last 30 days.

- 2 Now look at the Latency for Disk Extents summary (middle panel) to identify the disk extents that are contributing to the problem.


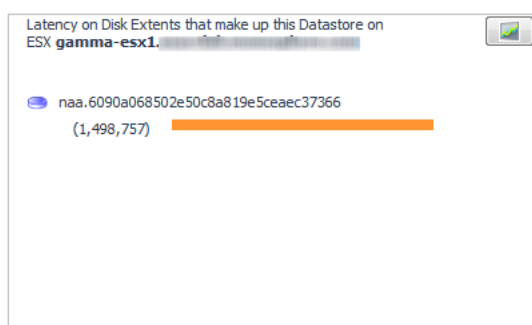

 **NOTE:** When a datastore is connected to a NASVolume, this panel is empty.

Figure 57. Latency for Disk Extents

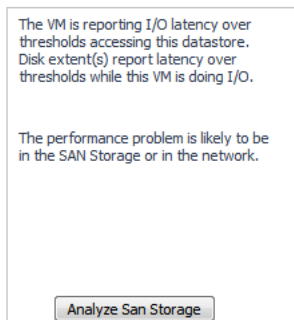


In this case, there is only one disk extent attached to the datastore. Its timeline is orange, which means the disk extent is exceeding latency thresholds. The number in brackets indicates that the virtual machine was performing I/O to the disk extent while the VM was experiencing latency. The larger the number, the more I/O was occurring. When this number is zero, no I/O occurred while the VM was experiencing latency.

 **TIP:** In your own investigations, you may have more than one disk extent, in which case you may be able to see that one disk extent is slow while the others are normal. Or you may have multiple virtual machines sharing the same disk extent. In this case, the Diagnosis panel may display a message to let you know that the latency may not reflect this virtual machine alone.

- 3 Next, review the notes in the Diagnosis summary (last panel).

Figure 58. Diagnosis summary



In this case, one of the notes describes a correlation between the virtual machine latency and the disk extent latency. The other note points toward a problem in the SAN Storage or the network, and below is a button that begins an analysis of the SAN Storage.

NOTE: If the troubleshooting algorithm determines that the issue is likely in the SAN Storage environment, and if the SAN Storage is provided by an element that the Foglight for Storage Management system is monitoring, the Analyze SAN Storage button appears in the Diagnosis panel.


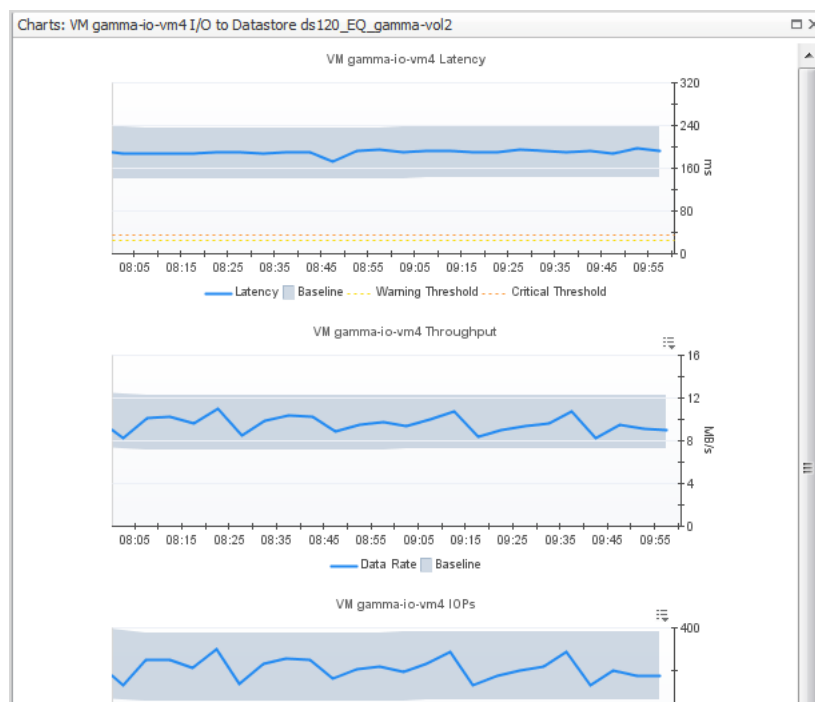
- 4 Before analyzing the SAN Storage, you may want to quantify the performance issue by reviewing the metric values that underlie the timeline bars in the summary panels.
 - a In the VM I/O to Datastore/RDM summary, click the Chart  icon.

Figure 59. Metric values



The charts show the values of the metrics over the time period. Some charts also contain a baseline range, which shows a statistical range of values encountered over the last 30 days. Spikes outside of the normal range represent a significant change in behavior that may warrant further investigation.

In this case, the top chart shows that the VM I/O latency is hovering around 200 m/s, well above the default 25 m/s and 35 m/s latency thresholds.

b Close the window.


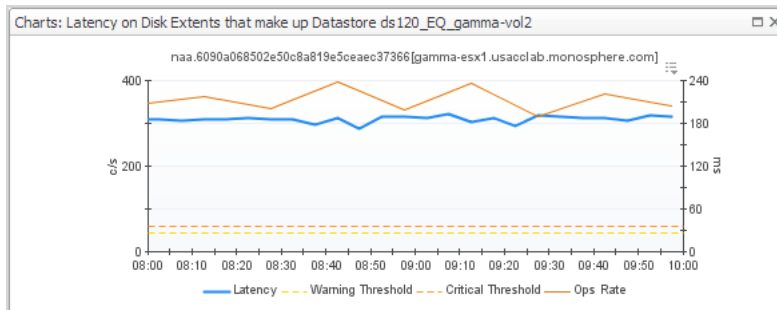
c In the Latency for Disk Extents summary, click the Chart  icon.

Figure 60. Disk Extent latency values



The chart shows the disk extent latency values hovering around 180 m/s. The latency here may reflect the activity of multiple VMs doing I/O or the performance within the ESX itself. It is clear that a significant delay is occurring in the disk extent.

d Close the window.


5 In the Diagnosis panel, click Analyze SAN Storage.

The Storage-Side Analysis window breaks down performance by the Extent, the LUN to which it belongs, and the pool to which the LUN belongs.

Figure 61. Storage-Side Analysis



This view shows that the disk extent is slow for all virtual machines and for the selected virtual machine. The disk extent to LUN I/O performance also exceeds latency thresholds, though its current performance is within the baseline range, which shows a statistical range of typical values encountered over the last 30 days. This indicates the high latency has been occurring for some time. If you want to see the metric

values, click the Chart  icon.

- 6 The next step in the investigation depends on the state of the pool.
 - If the pool timeline bars are green, the investigation is complete.
 - If the pool timeline bars are a color other than green, you can analyze the changes within the pool and the load on the pool. Continue the investigation by following the workflow in [Analyzing the Pool](#).

In this example, the pool's Avg Queue Depth timeline bar is yellow. The note beside the bar suggests that this may be a cause of slow I/O to the LUN. The pool warrants further investigation.

Analyzing the Pool

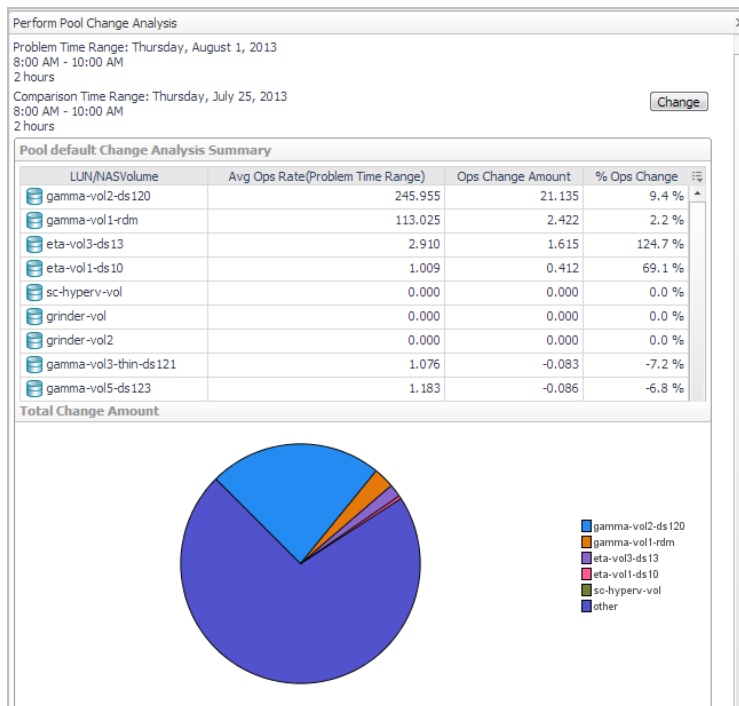
When pool timeline bars show abnormal average queue depth or ops rate, analyze the changes within the pool and the load on the pool.

- **Perform Pool Change Analysis.** The Pool Change analyzer identifies the LUNs primarily responsible for increased I/O. It compares LUN activity in the problem time range with LUN activity during the same time range in the past. Changes are reported in terms of average operations rate and change amount.
- **Perform Pool Load Analysis.** The Pool Load analyzer identifies the busiest LUNs and ranks them based on their activity during the same time range over the last 30 days (not the current time frame). Activity is measured in operations per second.

To analyze the pool:

- 1 From the Server-Side Analysis window or the Pool Explorer window, click Perform Pool Change Analysis.

Figure 62. Perform Pool Change Analysis

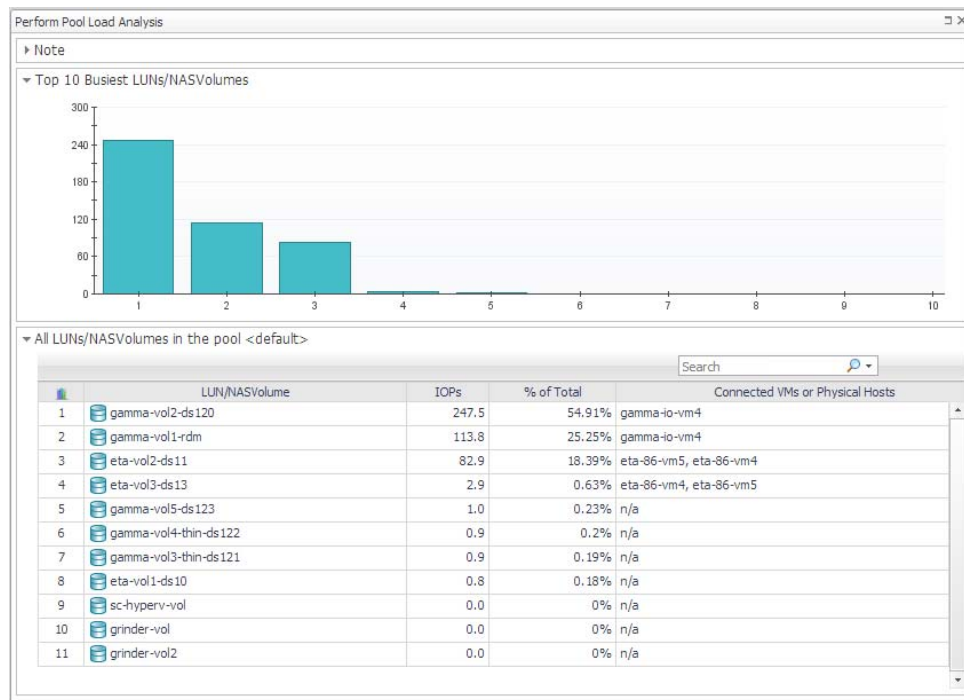


The analyzer compares activity for all the LUNs in the pool during the problem time range with their activity a week ago. In this example, the table and pie chart confirm that the LUN with the highest average operations rate and change amount is the LUN that includes the disk extent used by the poor performing virtual machine.

TIP: You can change the comparison time range by clicking Change and selecting a new date and time range.

- 2 Close the window.
- 3 Click Perform Pool Load Analysis.

Figure 63. Perform Pool Load Analysis



The chart and table show the top ten busiest LUNs. The analysis is based on the last 30 days of activity during this time range. In this example, the table confirms that the top two busiest LUNs are connected to the poor performing virtual machine.

- 4 Close the window.
- The investigation is complete.

Changing Latency Thresholds

One way Foglight for Storage Management determines if the performance problem is occurring in the SAN storage environment is to evaluate latency against the thresholds defined for latency in registry variables. The latency thresholds used for analysis are, by default, the same thresholds as are used for generating latency alarms. If you think it would be helpful to adjust the threshold values for your analysis, you can change the threshold values using the Storage Troubleshooting dashboard. The original registry variables are not updated.

TIP: If you change thresholds, you can restore the default values later using the Reset button.

To change the latency thresholds:

- 1 In the Storage Troubleshooting dashboard, click Edit Thresholds.
- 2 Specify the new thresholds in milliseconds for one or both of Warning and Critical.
- 3 Click Apply.

Understanding the Troubleshooting Algorithm

To determine if the problem is likely to be a storage performance problem, Foglight for Storage Management evaluates latency metrics against thresholds and typical performance, and disk extent metrics against the I/O being performed to the extent by the virtual machine. If the likely cause of the problem is slow performance in the SAN Storage environment, Foglight for Storage Management examines the LUN or NASVolume. If no circumstances, such as a rebuild, are identified as a cause of high latency, the pool is examined.

Managing Data Collection, Rules, and Alarms

NOTE: This chapter is intended for users with the role *Storage Administrator*. Some tasks also require the Foglight for Storage Management role of *Administrator* (as noted) to manage agents and rules.

You can collect additional types of relationship data, change collection schedules, manage rules, and manage alarms.

- [Collecting Virtual Storage-to-SAN Relationships](#)
- [Inferring Physical-Host-to-Storage Relationships](#)
- [Modifying Data Collection Schedules](#) (*Administrator* role required)
- [Managing Foglight for Storage Management Rules](#) (*Administrator* role required)
- [Managing Alarm Settings](#)
- [Troubleshooting Database Limits](#)

If you are looking for information about configuring Foglight for Storage Management agents and agent masters, reviewing agent alarms, creating support bundles, or backing up data, see the *Managing Storage in Virtual Environments Installation and Configuration Guide*.

Collecting Virtual Storage-to-SAN Relationships

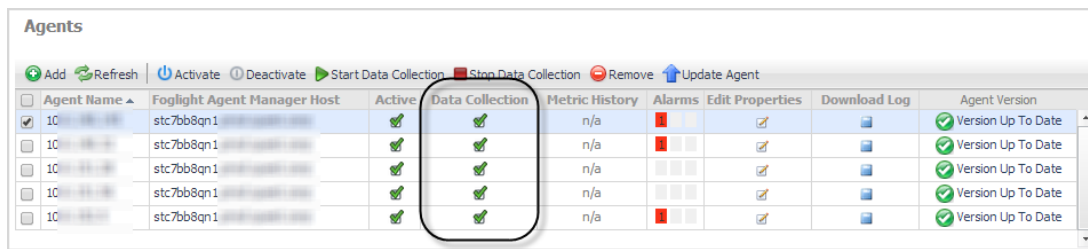
To include virtual storage-to-SAN relationships in your topology diagrams, you need to enable storage collection on your VMware or Hyper-V Performance agent. If you did not enable this option when defining the agent, you can enable it by editing the agent.

NOTE: If you cannot see the Administration dashboards, ask your Foglight for Storage Management Administrator to add the role *VMware Administrator* or *Hyper-V Administrator* to your user account.

To update an existing virtualization agent to add the collection of storage data:

- 1 On the navigation panel, under Dashboards, click VMware > VMware Agent Administration or Hyper-V > Hyper-V Agent Administration.
- 2 In the Agents table, locate the Agent. In the Data Collection column, you can see whether general data collection is enabled for this agent. Storage data collection, however, is not enabled by default.

Figure 1. Agents



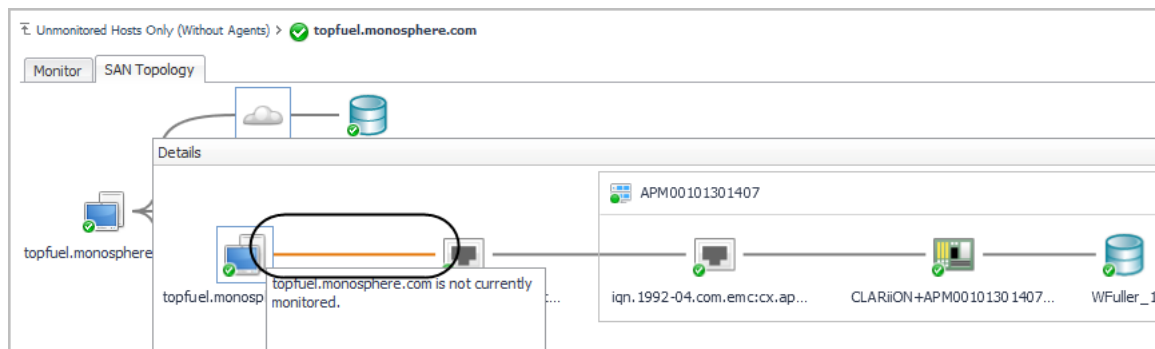
Agent Name	Foglight Agent Manager Host	Active	Data Collection	Metric History	Alarms	Edit Properties	Download Log	Agent Version
10-10-10-10	stc7bb8qn1	✓	✓	n/a	✓	✎	📄	✓ Version Up To Date
10-10-10-10	stc7bb8qn1	✓	✓	n/a	✓	✎	📄	✓ Version Up To Date
10-10-10-10	stc7bb8qn1	✓	✓	n/a	✓	✎	📄	✓ Version Up To Date
10-10-10-10	stc7bb8qn1	✓	✓	n/a	✓	✎	📄	✓ Version Up To Date
10-10-10-10	stc7bb8qn1	✓	✓	n/a	✓	✎	📄	✓ Version Up To Date

- 3 To enable storage data collection for an agent, click the agent's Edit ✎ icon.
- 4 Select the Enable Storage Collection check box and click Save.

Inferring Physical-Host-to-Storage Relationships

If you want to understand how storage resources are being accessed by the physical hosts in your network, without using agents to monitor the hosts directly, you can enable dependency processing. Dependency processing collects FC switch zone information and LUN connection information from arrays and filers, analyzes each host port used for storage I/O, and infers the (most likely) physical host associated with the port. When dependency processing is enabled, relevant topology diagram are enhanced to show inferred hosts connected to the ports that are used for storage I/O. Connections from inferred hosts are shown as orange or blue lines.

Figure 2. Topology diagrams with inferred hosts



In future, if you decide you want to collect data about inferred physical hosts, you can begin monitoring the hosts by configuring Infrastructure agents. For instructions, see [Reviewing Inferred Hosts](#) on page 108.

Enabling Dependency Processing

Dependency processing requires that you have VMware Performance agents configured to monitor your vCenters, and that storage collection is enabled on the agents. For more information, see “Configuring VMware Performance Agents” in the *Managing Storage in Virtual Environments Installation and Configuration Guide*.

To enable dependency processing:

- 1 On the navigation panel, under Dashboards, click Storage & SAN > Storage Environment.
- 2 Click the Administration tab.
- 3 Click Enable Physical Host to Storage Dependency Processing.
- 4 In the Physical Host Support message box, click Yes.

The dependency processing algorithm collects information and runs a host-resolution process. This may take some time.

When the processing completes, the Enable Physical Host to Storage Dependency Processing Task changes to Disable Physical Host to Storage Dependency Processing Task, and a new task, Review Physical Host FQDNs, appears in the task list.

Figure 3. Tasks



5 Next Step: [Reviewing and Editing Host-Port Assignments](#)

Reviewing and Editing Host-Port Assignments

After enabling dependency processing, it is a good idea to review the list of inferred hosts derived from this process. You can verify that the inferred hosts are correct for the specified port, fix errors, and provide missing host names. For this task, you use the Review Physical Host FQDNs dashboard.

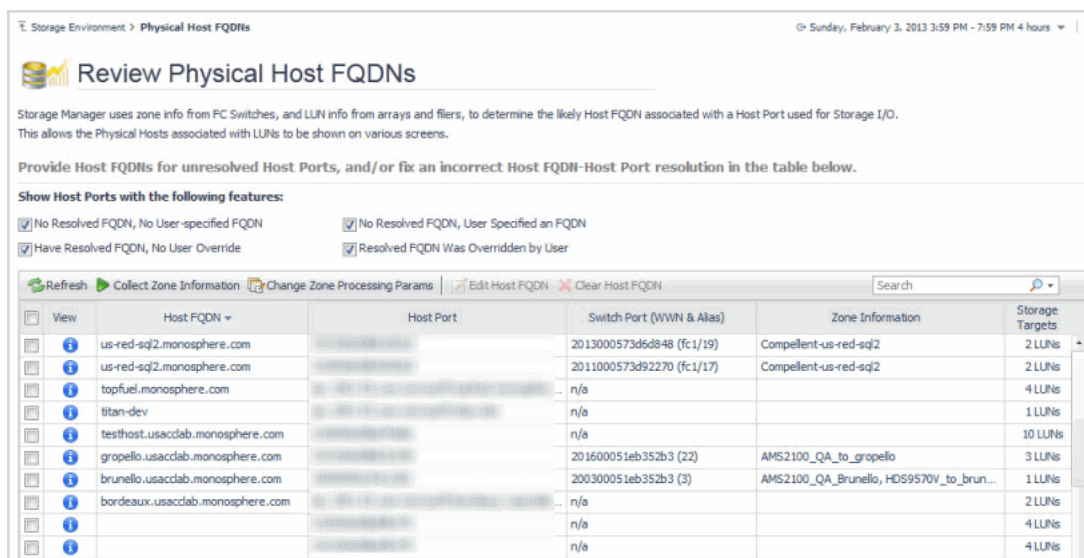
NOTE: The Review Physical Host FQDNs dashboard also contains host-port assignment for physical hosts that are being monitored by an agent.

To review the list of hosted identified by dependency processing:

- 1 On the Storage Environment dashboard, in the Administration tab, click Review Physical Host FQDNs.

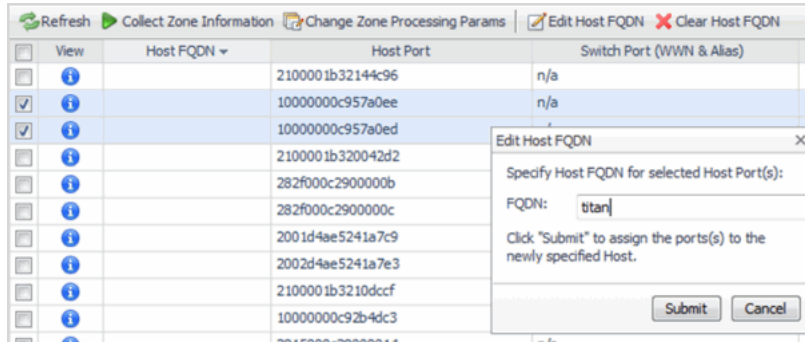
The Review Physical Host FQDNs dashboard opens. The table displays the list of hosts, the associated port carrying storage I/O, zone information for switch ports, and the number and type of storage resources accessed. You can filter the contents of the table using the Show Host Ports check boxes.

Figure 4. Review Physical Host FQDNs



- 2 To add missing host names or change existing host names:
 - a Click the row check boxes for the port assignments you want to change. All selected ports will be assigned the same host name.
 - b Click Edit Host FQDN.

Figure 5. Edit Host FQDN



- c Type the fully qualified domain name for the host, and click Submit.

The table displays the new host-port assignments.

- 3 To remove host assignments from ports, select the row check boxes for the ports and click Clear Host FQDN.
 - Clearing a user-resolved host makes the agent-resolved host active, if one exists.
 - Clearing an agent-resolved host adds the host FQDN to a list so that it does not get reassigned to the port in the future.

Running Dependency Processing Manually

If your environment has changed, you can update inferred-host-to-storage connections immediately rather than waiting for a scheduled processing.

NOTE: Edited host-port assignments are not affected by these actions.

On the Review Physical Host FQDNs dashboard, use one of the following options:

- **Refresh**—Runs the host-resolution analysis to identify inferred hosts for ports handling storage I/O.
- **Collect Zone Information**—Dependency processing automatically collects zone information on a nightly basis. If your environment has changed, use this button to collect updated zone information for FC switches in your environment and run the host-resolution analysis. The collection and analysis can take between five to ten minutes, possibly longer depending on the complexity of the environment.

Customizing Helper Strings for Dependency Processing

Zone names are set by the Storage Administrator and typically include the names of devices connected to ports. The dependency processing algorithm processes the zone name strings using various helper strings to identify the possible host names associated with a port. A DNS lookup is performed on the possible names to identify the most likely host FQDN. You can customize the helper stringers for your environment and improve the accuracy of the inferred hosts.

To customize helper strings for dependency processing:

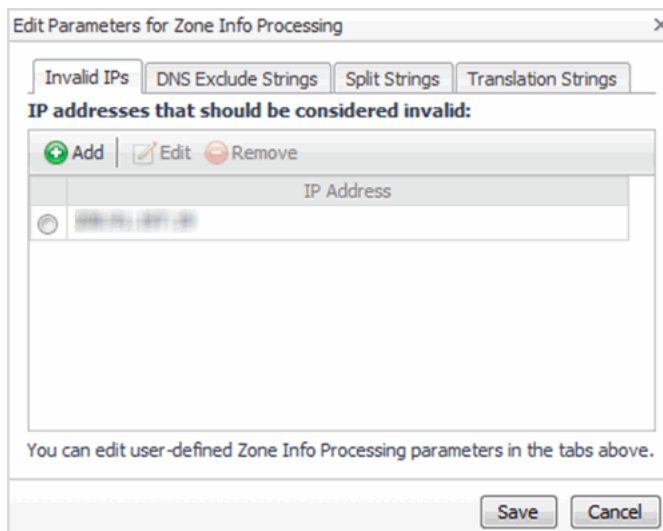
- 1 On the Storage Environment dashboard, in the Administration tab, click Review Physical Host FQDNs.
- 2 Click Change Zone Processing Params.

The Edit Parameters for Zone Info Processing dialog box opens.

- 3 To specify IP addresses to ignore during dependency processing, click Invalid IPs. Click Add, specify an IP address, and click Add.

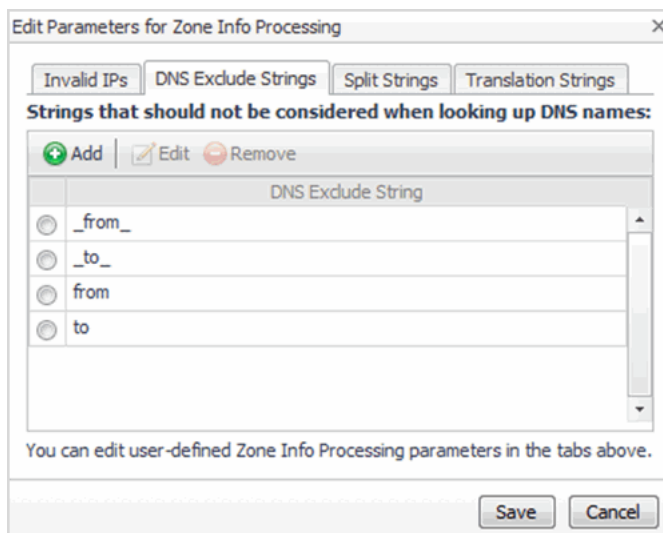
Some DNS setups *always* return a default IP address when a DNS lookup of a possible host name fails. If a DNS lookup of a host name returns an IP address listed in the Invalid IP table, the host name is considered invalid for dependency processing purposes.

Figure 6. Invalid IP table



- 4 To specify strings that may be included in the zone information, but are known not to be host names, click DNS Exclude Strings. Click Add, specify a string, and click Add.

Figure 7. DNS Exclude Strings



- 5 To specify strings used as separators for readability in the zone names, click Split Strings. Click Add, specify a string, and click Add.

- 6 To specify strings that you want to convert to other strings before performing a host name DNS lookup, click Translation Strings. Click Add, specify a string found in the zone information and the new string to use, and click Add.
- 7 When you are finished customizing parameters on all tabs, click Save.

Dependency processing begins. Zone information is collected using the changed parameters and host-resolution analysis is performed.

Reviewing Inferred Hosts

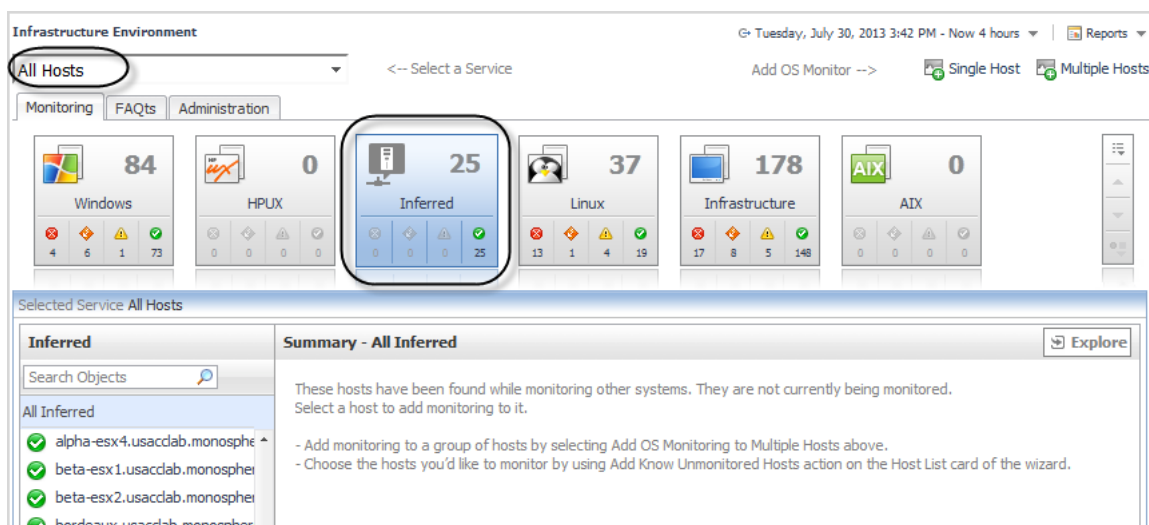
You can see a list of inferred hosts on the Infrastructure dashboard. From this dashboard, you can explore hosts and change their host port assignments if necessary. If you are interested in monitoring and collecting detailed data about an inferred host, you can set up an agent to monitor the host. This action moves the host from the inferred list to the appropriate monitored host list.

For more information about the Infrastructure dashboard, see the *Managing the Infrastructure Cartridge* section of the Foglight for Storage Management online help.

To review inferred hosts:

- 1 On the navigation panel, under Dashboards, click Infrastructure.
- 2 In the Select a Service list, select All Hosts.
- 3 In the Monitoring tab, click the Inferred tile.

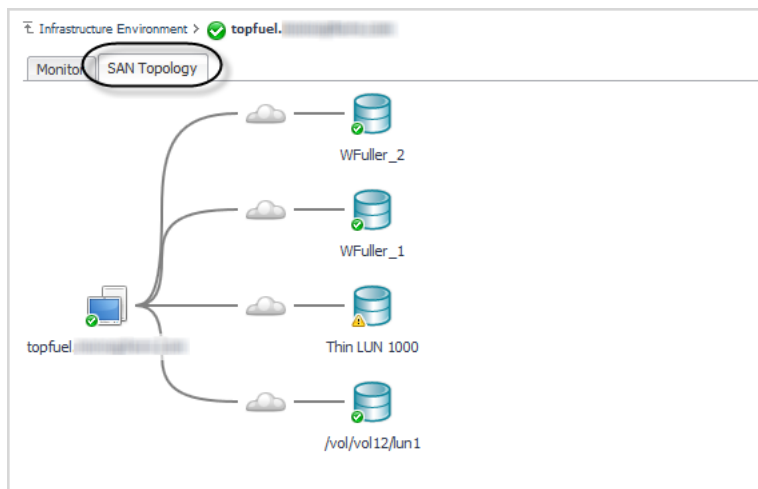
Figure 8. Inferred tile



- 4 In the quick view, click a host in the Inferred list and then click Explore.
- 5 Click the SAN Topology tab.

The SAN Topology tab displays the connections to the LUNs identified through dependency processing.

Figure 9. SAN topology




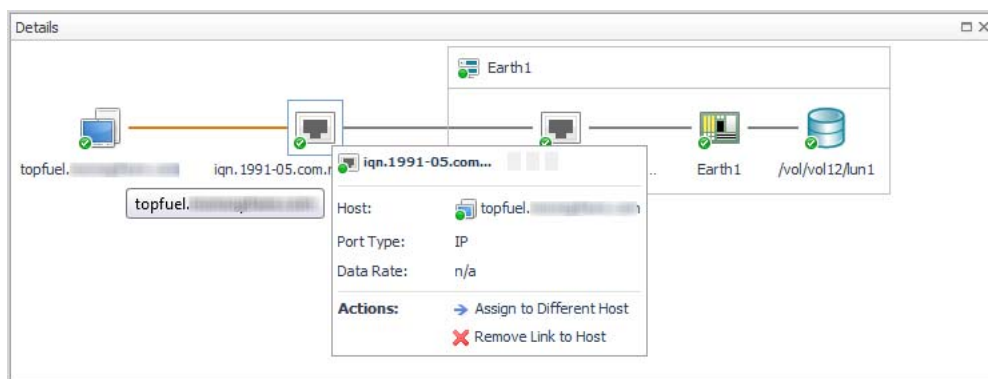

- 6 Click a Cloud  icon to show the connections through a port in a Details window. An orange line connecting a host to a port indicates that the host is an inferred host.

Figure 10. Inferred Host



- 7 If the assigned host is incorrect, click the Host Port  icon and select the desired action, such as Assign to Different Host or Remove Link to Host.
- 8 Close the Details window.
- 9 If you want to set up an agent to monitor this host, click the Monitor tab.

NOTE: If your user credentials do not include the role *Administrator*, you need to ask someone with this role to create an agent to monitor the host.

- 10 Click Configure Host Monitoring.
- 11 In the Add Monitored Host wizard, follow the online instructions to add the host.

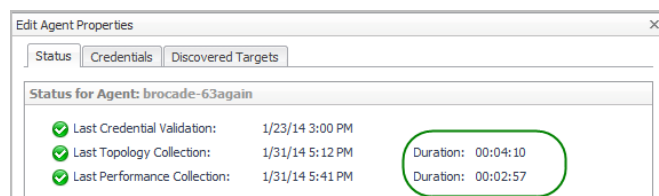
For help with the wizard, see “Adding a Monitored Host” in the *Managing the Infrastructure Cartridge* section of the Foglight for Storage Management online help.

Modifying Data Collection Schedules

Generally speaking, the default data collection schedules are suitable for most environments. If you notice that some agents take an extended time to collect topology data or performance data, and modifying your

monitoring environment is not a suitable solution, you may want to change the data collection schedules for the affected agents. You can find the current duration of collections in the Edit Agent Properties dialog box.

Figure 11. Edit Agent Properties



Understanding Data Collection Types and Schedules

Storage Collector agents perform two types of collections: topology collections and performance collections.

Topology collections

During topology collections, Foglight for Storage Management gathers basic information regarding each object and its child objects. For example, on an array object, LUN, disk, and children information is gathered. Foglight for Storage Management gathers various attributes and parameters (for example, size or capacity) as well as relationship data. This relationship data is the key to understanding the basic topology and interconnects, or paths, between objects (parent to parent, child to parent and, where appropriate, child to child). Without this relationship information performance analysis would not be possible.

Performance collections

During performance collections, Foglight for Storage Management gathers the following basic types of information:

- Performance metrics for each known object (an object is known if it has previously been collected during a topology collection).
- The performance collection enumerates objects and their children. This enumeration determines if there is any change in the topology (for example, a LUN has been created, a new ESX server has been added to a cluster, or a new VM has been created). As the collector recognizes changes in the environment (sometimes in conjunction with the server) it schedules topology collections to ensure that Foglight for Storage Management continually has an accurate understanding of the underlying topology. Not all topology changes can be detected by the performance collection. A scheduled topology collection will pick up any undetected changes.

Default data collection schedules

Storage Collector agents have a default schedule for topology and performance collections, as described in the following table.

Table 1. Default data collection schedules.

Type	Collection Interval	Notes
Topology collection	3 hours	<i>n/a</i>
Performance Collection for EMC SMI-S and Hitachi AMS only	15 minutes	Defines the collection interval for an agent that monitors a storage device using SMI-S or Hitachi AMS. The management hosts from which the Storage Collector agent collects performance data using SMI-S obtain performance data from the arrays every 15 minutes. Setting the agent to collect data more frequently is inefficient, because the same data is re-collected and discarded.
Performance Collection for all others	10 minutes	Defines the collection interval for an agent that uses a different method (than those listed above) to monitor a storage device.

For information about the technologies used by Storage Collector agents to monitor the different kinds of storage devices, see “Configuring Agents to Monitor Storage Devices” in the *Managing Storage in Virtual Environments Installation and Configuration* guide.

Modifying Data Collection Schedules for Storage Collector Agents

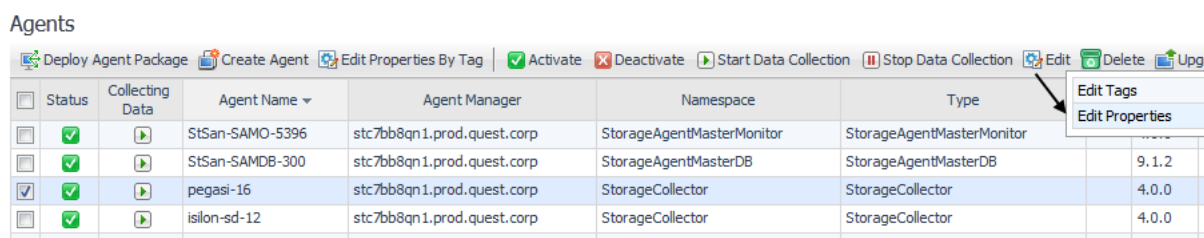
NOTE: You require the Foglight for Storage Management role *Administrator* to perform tasks that affect agents.

The collection interval can be increased to reduce the collection frequency impact in busy environments. It is not recommended to reduce the performance collection interval to less than five minutes. You can change the schedule for all agents by editing the default schedule, or clone the default schedule to create and select a specific schedule for a Storage Collector agent.

To modify storage collection schedules:

- 1 On the navigation panel, under Dashboards, click Administration > Agents.
- 2 Click Agent Status.
The Agent Status dashboard opens.
- 3 Select the agent whose schedule you want to change from the Agent Status view. You can select any Storage Collector agent if you are changing the default schedule.
- 4 Click Edit > Properties.

Figure 12. Edit > Properties



The Agent Status view displays.

- 5 Select Modify the properties for this agent only.

- 6 Scroll down to the Data Collection Scheduler section.

Figure 13. Data Collection Scheduler

The screenshot shows the 'Agent Status' page for a specific agent. The top section contains various configuration fields for the agent, including 'cliPath', 'useSecondaryCli' (set to False), 'aspVersion' (2), 'children' (a list of child targets), 'childrenVersion' (2), and 'Status Poll in Seconds' (60). Below this is the 'Data Collection Scheduler' section, which is highlighted with a rounded rectangle. It contains a 'Collector Config' dropdown menu with 'defaultSchedule' selected, and buttons for 'Edit', 'Clone', and 'Delete'. A warning icon and text state: 'Changing Secondary Property lists have global implications'. At the bottom of the page are buttons for 'Back To Agent Status', 'Cancel', and 'Save'.

From here you can perform the following agent editing tasks:

- To edit an existing schedule, continue with this procedure.
- To create a unique schedule for an agent using clone, see [Creating a unique schedule for an agent](#) on page 113.
- Assign a cloned schedule to another agent, see [Assigning a Cloned Schedule to Another Agent](#) on page 114.

- 7 From the Data Collection Scheduler drop-down, select the schedule you want to edit.

Figure 14. Data Collection Scheduler

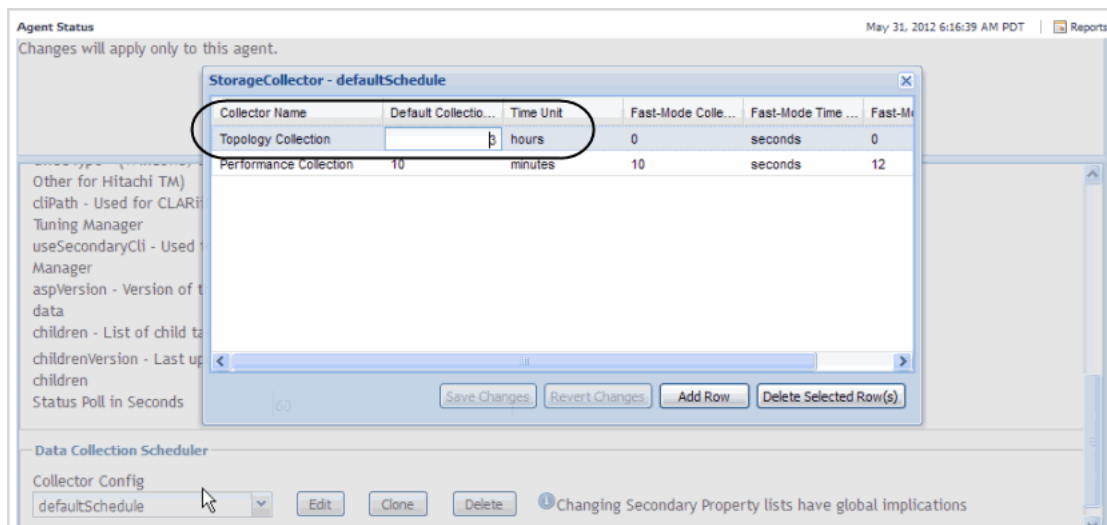
This screenshot is similar to Figure 13, showing the 'Agent Status' page. However, an arrow points from the 'Edit' button in the 'Data Collection Scheduler' section to the 'defaultSchedule' dropdown menu, indicating the next step in the process.

- 8 Click Edit.

The Storage Collector-<scheduleName> dialog box opens.

- 9 Click inside the field you want to edit and make the required changes.

Figure 15. Storage Collection Schedule changes



- 10 Click Save Changes.
- 11 Close the Storage Collector-*defaultSchedule* dialog box.
- 12 Click Back to Agent Status.

The edit is complete.

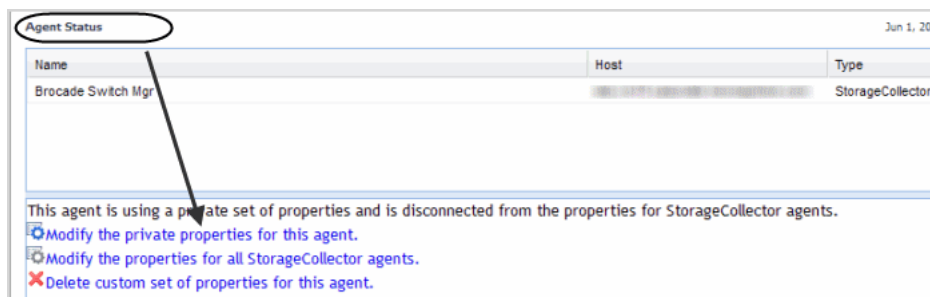
Creating a unique schedule for an agent

This procedure provides the steps required to create a unique schedule for a Storage Collector agent.

To create a unique schedule for an agent:

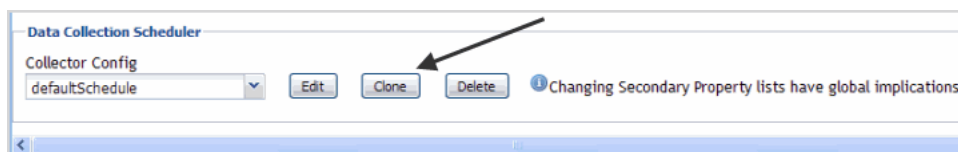
- 1 From the Agent Status view, click Modify the private properties for this agent.

Figure 16. Modify Private Properties



- 2 Scroll down to the Data Collection Scheduler section.
- 3 In the Data Collection Schedule section, click Clone.

Figure 17. Data Collection Schedule



The Clone defaultSchedule dialog box opens.

- 4 Enter a schedule name, and click OK.
The newly-cloned schedule appears in the Collector Config schedule selector.
- 5 Click Edit.
The Storage Collector edit dialog box opens.
- 6 Click inside the field(s) to be edited.
- 7 Click Save Changes to update the new schedule.
- 8 Close the Storage Collector-<name> dialog box.
- 9 Click Save to assign the new schedule to the agent.
- 10 Click Back to Agent Status.
The edit is complete.

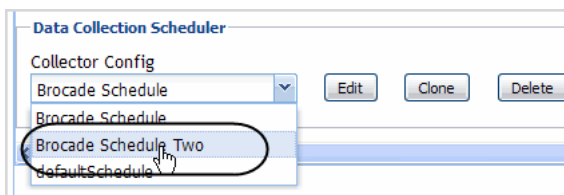
Assigning a Cloned Schedule to Another Agent

This procedure provides the steps required to clone a schedule to another Storage Collector agent.

To assign a cloned schedule to another agent:

- 1 From the Agent Status view, click Modify the private properties for this agent.
- 2 Scroll down to the Data Collection Scheduler section.
- 3 Click the Collector Config drop-down list.
- 4 Select the schedule you want to assign to this agent.

Figure 18. Select Schedule



- 5 Click Save to assign this new schedule to this agent.
- 6 Click Back to Agent Status.
The edit is complete.

Managing Foglight for Storage Management Rules

NOTE: You require the Foglight for Storage Management role *Administrator* to perform tasks that affect rules.

To see the list of Foglight for Storage Management rules, navigate to Administration > Rules & Notifications > Rule Management, and select StorageUI from the Cartridge list. For help with rules, open the online help from this dashboard.

All Foglight for Storage Management rule names start with *StSAN* and are organized into categories:

- **Essential**—*StSAN E*—Essential rules alert on latency issues, capacity issues, device failures, and errors.
- **Normal**—*StSAN N*—Normal rules alert on things like data traffic spikes.

- **Tuning—StSAN T**—Tuning rules are additional rules for situations that do not cause performance issues in most environment.

The Essential and Normal categories are enabled by default. The rules within each category can be enabled or disabled individually. By default, all rules in the Essential category are enabled, and all rules in the Normal category are disabled. You may want to review the Normal rules and enable the ones that suit your environment. Finally, you can control whether alarms are generated for rules in all categories or only some categories. For more information, see [Changing Alarm Sensitivity](#) on page 115.

You can and should modify rule conditions to better suit your storage environment. To change conditions, copy the rule and modify it. Then you can enable the new rule and disable the original rule. This approach allows you to refer back to the original rule if necessary, and also protects you from changes to the default rules that may occur during regular software updates. For more information, search for “Copying or deleting rules” in the online help.

For rules that reference registry variables for threshold values, you should modify the threshold in the registry variable, rather than modifying the rule. For help finding and editing registry variables, search for “Registry

NOTE: Rules that begin with StSANCar are rules used internally by the Storage cartridge, and do not generate alarms. Do not disable or alter these rules.

Variable” in the online help.

Managing Alarm Settings

You can control which type of rule generates alarms and also set up email notifications.

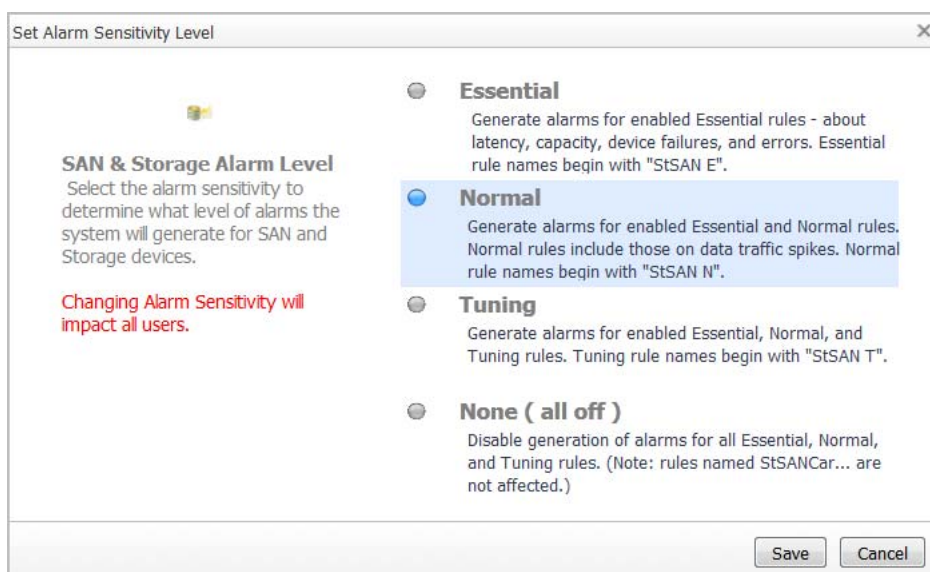
Changing Alarm Sensitivity

You can control which categories of StSAN rules generate alarms.

To set the alarm sensitivity:

- 1 On the navigation panel, under Dashboards, click **Storage & SAN > Storage Environment**.
- 2 Click the **Administration** tab.
- 3 Click **Change Alarm Sensitivity**.

Figure 19. Alarm Sensitivity



- 4 Select the category of rules that generate alarms or turn off alarms for all essential, normal, and tuning rules.

As noted in the option descriptions, each option includes the rule category that matches the name of the option plus the categories listed in the option above it, so selecting Tuning enables alarms for tuning, normal, and essential rules.

- 5 Click Save.

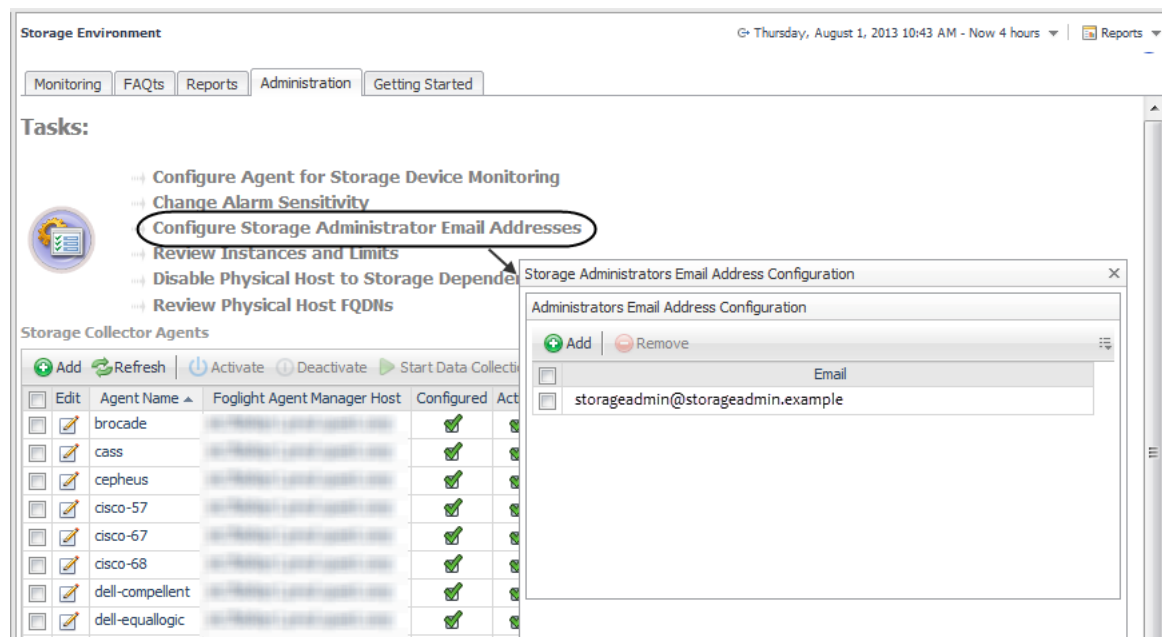
Configuring Email Notifications for Alarms

You can define a list of email addresses that receive a notification whenever an essential rule evaluates to a Critical or Fatal status. Email addresses are saved to the `StorageAdministrator` registry variable. An essential rule begins with `StorageAdministrator` and has the email action set automatically. For more information about rules, see [Managing Foglight for Storage Management Rules](#) on page 114.

To specify email addresses:

- 1 On the navigation panel, under Dashboards, click Storage & SAN > Storage Environment.
- 2 Click the Administration tab.
- 3 Click Configure Storage Administrator Email Addresses.
- 4 Click Add, type an email address, and click Add. Repeat to add additional email addresses.

Figure 20. Configure Storage Administrator Email Addresses



Troubleshooting Database Limits

Foglight for Storage Management sets limits on the number of instances of each object type that can exist in the Database Repository. On the Administration tab, the Review Instances and Limits task enables you to view a table containing a list of Foglight for Storage Management object types.

For each object type, the table displays the instance limit, the number of instances currently in the database, the utilization (count/limit), and a status based on utilization. While the utilization remains below 90%, the object type status is Normal. When utilization reaches 90%, the status becomes Critical; if you intend to

monitor new instances of this object type, you should take some steps to plan for the growth. At 100%, the status changes to Fatal and Foglight for Storage Management does not create anymore instances of the object type. For example, if the SanLUN object type is at 99% utilization, and you add an agent to monitor a new storage array that has 200 LUNs configured, the SanLUN instance limit will soon be reached and you will not see data for many of the new LUNs in the dashboards.

The limit on the number of instances per object type is a global default value, which is set in the registry variable called *foglight.limit.instances*. You can override the limit for selected topology types.

CAUTION: Before changing limits, you may want to consult with a Support Engineer to discuss alternatives. You want to ensure that the size of your database remains reasonable while still meeting your monitoring requirements.

To review the number of instances of each Storage object type in the Foglight for Storage Management database:

- 1 On the Storage Environment dashboard, in the Administration tab, click Review Instances and Limits.

Figure 21. Edit Registry Values

Edit Registry Variables				
Object Type	Instance Limit	Instance Count	Utilized ▾	Status
SanLinkDependency2	50,000	627	1.3 %	✓
SanPhysicalDisk	50,000	423	0.8 %	✓
SanFcSwitchPort	50,000	392	0.8 %	✓
SanLun	51,000	347	0.7 %	✓
SanFcAttachedPort	50,000	253	0.5 %	✓
SanVolumeExportName	50,000	179	0.4 %	✓
SanVolume	50,000	58	0.1 %	✓
SanPool	50,000	42	0.1 %	✓
SanStorageSupplierPortFC	50,000	36	0.1 %	✓
SanStorageSupplierPortISCSI	50,000	34	0.1 %	✓
SanLinks	50,000	18	0.0 %	✓
SanFcSwitch	50,000	17	0.0 %	✓
SanAgentMessage	50,000	16	0.0 %	✓
SanController	50,000	14	0.0 %	✓
SanStorageSupplierPortIB	50,000	13	0.0 %	✓
SanDirExportName	50,000	10	0.0 %	✓
SanVolumeDir	50,000	10	0.0 %	✓
SanMember	50,000	9	0.0 %	✓
SanStorageArray	50,000	8	0.0 %	✓
SanVsan	50,000	5	0.0 %	✓
SanISLLinks	50,000	5	0.0 %	✓
SanFabric	50,000	5	0.0 %	✓
SanFiler	50,000	4	0.0 %	✓
SanSole	50,000	0	0.0 %	✓

- 2 Review the Status column. If any of the icons are Critical or Fatal, consider either modifying how you monitor that type of object or extending the limit for that object type.
- 3 To increase or decrease a limit, click Edit Registry Variables and select *foglight.limit.instances*.

On the Edit Registry Variables dashboard, open the online help to learn how to add a registry variable for an object type and set its instance limit.

Understanding Metrics

This chapter defines the metrics displayed in the Storage & SAN dashboards. It also provides an overview of metrics in Foglight for Storage Management—you need this information if you intend to create new rules or custom dashboards.

Units of Measurement

Foglight for Storage Management uses the following units of measurement:

- B/s – Number of bytes per second. Frequently converted to KB/s or MB/s.
- ops/s – Number of operations per second.
- ms – Milliseconds. Frequently converted to μ s (microsecond).
- m – milli – Thousandth.
- ms/op – Milliseconds per operation.
- MB – Capacity metrics are captured in MB (megabytes), but are frequently displayed in GB (gigabytes) or TB (terabytes).

Performance Metrics

In general, performance is gauged in terms of rates (such as data rates, ops to disk rates, frame rates), latency, and utilization. The selection of performance metrics displayed in any given dashboard depends on the selected device type and the metrics available from the device vendor.

The following tables define each metric and shows the topology name for the metric. You need the topology name when referencing the metric in user-defined rules and dashboards.

Performance metrics are organized into the following categories:

- [Fabrics and FC Switches – Performance Metrics](#)
- [Storage Arrays and Filers – Disk I/O Performance Metrics](#)
- [Clustered Storage Arrays – Network Performance Metrics](#)

Fabrics and FC Switches – Performance Metrics

For fabrics and switches, performance is assessed in terms of send and receive values for the FC switch ports and is expressed as the average number of bytes per second or frames per second. Port errors are also an important indicator of port performance, because a higher number of errors correlates with lower send and receive values.

Table 1. Performance metrics

Display Name	Description	Topology Name
Baseline	A range of normal values, as determined by IntelliProfile by looking at historical data for the same time range. A baseline range displays after seven days of data collection.	<i>n/a</i>
Data Rate	Bytes per second sent and received through a port.	bytesTotal
Data Receive Rate	Average number of bytes per second received through a port. The data rate, compared against the Baseline of typical activity, indicates whether the current traffic is typical or out of the norm.	bytesRcvd
Data Send Rate	Also Data Xmit Rate Average number of bytes per second transmitted through a port. The data rate, compared against the Baseline of typical activity, indicates whether the current traffic is typical or out of the norm.	bytesXmit
Frame Rate	Average number of frames per second received and transmitted through a port.	framesTotal
Frame Receive Rate	Average number of frames per second received through a port.	framesRcvd
Frame Send Rate	Also Frame Xmit Rate Average number of frames per second transmitted through a port.	framesXmit
Link Error Rate	Average number of link errors <i>per second</i> on a port. Link errors are caused by or affect the link status of the connection. Link errors include: <ul style="list-style-type: none"> • Link resets • Loss of signal on the port • Loss of synchronization If an error rate value is very small, it may be displayed as 0.0. If a fabric or switch has an actual error rate of 0, it is not displayed.	errorsLink
Link Speed	Current speed of a port in Mb/second.	currentSpeedMb
Non-Link Error Rate	Average number of non-link errors <i>per frame</i> on a port. Non-link errors include: <ul style="list-style-type: none"> • Resource constraint that causes frames to be retried • CRC errors • Frame length errors • Address errors If an error rate value is very small, it may be displayed as 0.0. If a fabric or switch has an actual error rate of 0, it is not displayed.	nonLinkErrors
Rcvd Utilization	= Data Receive Rate / Link Speed , expressed as a percentage. Utilization values help you identify ports that may be overloaded.	bytesRcvd Utilization
Xmit Utilization	= Data Send Rate / Link Speed , expressed as a percentage. Utilization values help you identify ports that may be overloaded.	bytesXmit Utilization

Storage Arrays and Filers – Disk I/O Performance Metrics

Rate and latency metrics describe the performance of ports, controllers, pools, LUNs, disks, and NASVolumes. The selection of performance metrics displayed in any given dashboard depends on the selected device type and the metrics available from the device vendor.

NOTE: For controllers, the Date Rate, Latency, and Ops Rate sets of metrics include Block and File versions as well to track block and file operations separately. For example, Data Rate has Data Rate (File) and Data Rate (Block). These sets of metrics are not included in this table.

Table 2. Disk I/O Performance Metrics

Display Name	Description	Topology Name
% Busy	Also displayed as Pct Busy or Busiest Average percentage of time a component is busy doing I/O during the collection period.	busy
Average Queue Depth	Average number of outstanding I/O operations at the start of each new I/O request in a pool, LUN, or disk.	avgQueueDepth
Cache Hit Rate	Percentage of read operations that can be satisfied from the cache.	cacheHits
L1 Cache Hit Rate	Percentage of read operations that can be satisfied from this cache.	cacheHitRate_L1
L2 Cache Hit Rate	Percentage of read operations that can be satisfied from this cache.	cacheHitRate_L2
Data Rate	Bytes per second read and written.	bytesTotal
Data Read Rate	Bytes per second read.	bytesRead
Data Write Rate	Bytes per second written.	bytesWrite
Disk Latency	Average latency for read/write operations to the disks in a pool, calculated in milliseconds per operation. At the pool level, Avg Disk Latency reflects the average latency for I/O to the physical disks.	latencyTotalDisk
Latency (R/W Latency)	Average latency for read/write operations, calculated in milliseconds per operation. At the pool level, Latency reflects I/O to the pool only. If the block of data to be read is already in a cache, then the latency for that operation is very low, because no disk access needs to be performed. NOTE: Latency is <i>not</i> the sum of read latency and write latency. The number of read operations and write operations is different.	latencyTotal
Other Latency	Average latency for other operations	latencyOther
Read Latency	Average latency for read operations.	latencyRead
Write Latency	Average latency for write operations.	latencyWrite
Ops Rate	Average read and write operations per second.	opsTotal
Read Ops Rate	Read operations per second.	opsRead
Write Ops Rate	Write operations per second.	opsWrite
Other Ops Rate	Other operations per second.	opsOther

Clustered Storage Arrays – Network Performance Metrics

These metrics describe the performance of an EqualLogic array's network and an Isilon array's internal and external networks.

Table 3. Network Performance Metrics

Display Name	Description	Topology Name
Link Speed	Current operational speed of the port link.	currentSpeedMb
Max Port Speed	Rated maximum speed of the port	maxSpeedMb
Packet Errors %	Number of incorrectly received data packets divided by the total number of received packets, expressed as a percentage.	packetErrorPercent
Rcv Data Rate	Bytes per second received through a port or group of ports.	bytesWrite
Send Data Rate	Bytes per second sent through a port or group of ports.	bytesRead
Rcv Util	= Rcv Data Rate / Link Speed	bytesWrite Utilization
Send Util	= Send Data Rate / Link Speed	bytesRead Utilization
Rcv Util (% of max)	Also NW Rcv Util (% of max) = Rcv Data Rate / Max Port Speed	bytesWrite UtilizationMax
Send Util (% of max)	Also NW Send Util (% of max) = Send Data Rate / Max Port Speed	bytesRead UtilizationMax

Capacity Metrics

The selection of capacity metrics displayed in any given dashboard depends on the selected device type and the metrics available from the device vendor. The following tables define each metric and shows the topology name for the metric. You need the topology name when referencing the metric in user-defined rules and dashboards.

Capacity metrics are organized into the following categories:

- [Storage Arrays – Array, Member, and Pool Capacity Metrics](#)
- [Filers – Filer and Aggregate Capacity Metrics](#)
- [Storage Arrays and Filers – LUN, NASVolume, and Disk Capacity Metrics](#)

Storage Arrays – Array, Member, and Pool Capacity Metrics

The following table contains the capacity metrics you may see displayed for storage arrays, members/nodes, and pools.

- ① | **NOTE:** To view the metrics for EMC Isilon arrays (which are significantly different than other arrays), see [EMC Isilon Only Capacity Metrics](#).

Table 4. Array, Member, and Pool Capacity Metrics

Capacity Metric	Description	Member/Node			Topology Name
		Array	Member	Pool	
Total Advertised LUNs Size	Also Advertised LUNs Size Sum of the Advertised LUN Size for all LUNs in the entity.	✓		✓	conf_LunSize
Available Raw Capacity	Capacity available in the pool that has not been committed to data, snapshots, or thick-provisioned LUNs. Raw counts all the disk blocks available, before applying RAID.			✓	raw_available
Available Usable Capacity	Also Available Capacity Capacity available in the pool that has not been committed to data, snapshots, or thick-provisioned LUNs. <i>Usable</i> means after applying RAID.			✓	conf_available
Capacity Provisioned to LUNs	Also Provisioned to LUNs Capacity used for LUN data. Does not include capacity that is used for snapshots, reserves, etc. <ul style="list-style-type: none"> For thin-provisioned LUNs, this is the capacity used for data written to the LUNs. For thick-provisioned LUNs, this is the capacity allocated to the LUNs, and does not reflect data written <i>Formerly displayed as Consumed Capacity.</i>	✓		✓	Array: lun_usable_capacity Pool: conf_used
Overcommitment	= Total Advertised LUNs Size - Total Usable Capacity Overcommitment reflects the minimum additional capacity needed in the pool to support the advertised capacity promised to thin-provisioned LUNs. When the value of overcommitment is greater than zero, you run the risk of I/O writes failing because of insufficient physical storage to support the demand. Overcommitment is available only for arrays where the vendor provides the total usable capacity.	✓		✓	conf_LunOvercommitted
Total Disk Capacity	Sum of the sizes of the disks in the array. This includes spares.	✓			disk_capacity
Total Raw Capacity	Total capacity of the pool in raw terms. Raw counts all the disk blocks allocated to the pool, before applying RAID.			✓	raw_capacity

Table 4. Array, Member, and Pool Capacity Metrics

Capacity Metric	Description	Array Member/Node Pool			Topology Name
		Array	Member/Node	Pool	
Total Usable Capacity	Total capacity of the pool or member/node in usable terms. Pools that are defined with a specific RAID level have this metric. Pools that can support LUNs with different RAID levels do not have this metric.	✓	✓		conf_capacity
Used Capacity	= Total Usable Capacity - Available Usable Capacity.	✓			conf_used
% Used	= Used Capacity / Total Usable Capacity Percentage of the member/node's usable capacity that has been used.	✓			Calculated
% of Pool	<i>EqualLogic Pools-Members tab only.</i> Percentage of the pool storage capacity provided by a pool member.	✓			Calculated

EMC Isilon Only Capacity Metrics

Isilon arrays provide additional metrics to describe the Isilon OneFS file system (IFS) capacity in terms of hard disk drive (HDD) and solid state drive (SSD) capacity.

Table 5. EMC Isilon only Capacity Metrics

Capacity Metric	Description	Array Member/Node Pool			Topology Name
		Array	Member/Node	Pool	
Total HDD Capacity	Raw capacity of the hard drives in the array, as reported by the vendor.	✓			raw_capacity_HDD
Total SSD Capacity	Raw capacity of the solid-state drives in the array, as reported by the vendor.	✓			raw_capacity_SSD
IFS Capacity: Total	Total capacity of the Isilon File System.	✓		✓	Array: pool_capacity_conf Pool: conf_capacity
IFS Capacity	= Total HDD Capacity + Total SSD Capacity Capacity of the Isilon File System on a pool or member/node.		✓	✓	conf_capacity
IFS Capacity: Free	Also IFS Free Free capacity of Isilon File system.	✓	✓	✓	Array: pool_free_conf Pool and member: conf_available
IFS Capacity Used	= IFS Capacity - IFS Capacity: Free	✓	✓	✓	Calculated

Table 5. EMC Isilon only Capacity Metrics

Capacity Metric	Description	Array Member/Node			Topology Name
		Array	Member	Node	
IFS Capacity: HDD Total	Capacity of Isilon File System on hard disk drives in an array, pool, or node.	✓	✓	✓	conf_capacity_HDD
IFS Capacity: HDD Free	Free capacity of Isilon File System on hard disk drives in an array, pool, or node.	✓	✓	✓	conf_available_HDD
IFS Capacity: HDD Used	= IFS Capacity: HDD Total - IFS Capacity: HDD Free	✓	✓	✓	<i>Calculated</i>
IFS Capacity: SDD Total	Capacity of Isilon File System on solid state drives in an array, pool, or node.	✓	✓	✓	conf_capacity_SSD
IFS Capacity: SDD Free	Free capacity of Isilon File System on solid state drives in an array, pool, or node.	✓	✓	✓	conf_available_SSD
IFS Capacity: SDD Used	= IFS Capacity: SDD Total - IFS Capacity: SDD Free	✓	✓	✓	<i>Calculated</i>
HDD % Free	= IFS Capacity: HDD Free / IFS Capacity: HDD Total		✓	✓	conf_pct_available_HDD
SDD % Free	= IFS Capacity: SDD Free / IFS Capacity: SDD Total		✓	✓	conf_pct_available_SSD

Filers — Filer and Aggregate Capacity Metrics

Foglight for Storage Management supports NetApp filers (**F**). NetApp uses the word *aggregate* (**Ag**) instead of pool, but the metrics collected for aggregates are similar to the metrics collected for pools.

Table 6. Filer and Aggregate Capacity Metrics

Capacity Metric	Description	Filer	Aggregate	Topology Name
Advertised LUNs Size	Also Total Advertised LUNs Size or Adv LUNs Size Sum of the Advertised LUN Size for all LUNs in the entity.	✓		configured_lun_size
Advertised NASVolumes Size	Sum of the Advertised Size for all NASVolumes.	✓	✓	<i>Filer:</i> configured_vol_size <i>Aggregate:</i> conf_VolSize
Disk Capacity (Raw)	Also Total Disk Capacity Sum of the sizes of the disks in the filer. This includes spares.	✓		disk_capacity

Table 6. Filer and Aggregate Capacity Metrics

Capacity Metric	Description	Filer	Aggregate	Topology Name
Free Disk/Spares Capacity (Raw)	Amount of disk capacity that has not been committed to an aggregate. Disk capacity cylinder coloring and capacity alarms are defined in registry variables with the prefix: <i>StSAN.FilerDisks.PctUnallocatedCapacityThresh hold...</i>	✓		disk_free
Aggr Capacity (Usable) Total	Also Total Usable Aggr Capacity Sum of the Total Usable Capacity of all the aggregates in the filer. Aggregate capacity cylinder coloring and alarms are defined in registry variables with the prefix: <i>StSAN.FilerAggregates.PctUnallocatedCapacityThreshold...</i>	✓		pool_capacity_conf
Aggr Capacity (Usable) Free	Also Available Aggr Capacity Sum of the Available Usable Capacity in the aggregates. Usable means after applying RAID.	✓		pool_free_conf
Aggr Capacity (Raw) Total	Also displayed as Aggregate Capacity (Raw) Sum of the raw capacity of all the aggregates in the filer.	✓		pool_capacity_raw
Aggr Capacity (Raw) Free	Sum of the available raw capacity in all the aggregates.	✓		pool_free_raw
Overcommitment	= Advertised NASVolumes Size - Aggr Capacity (Usable) Total Overcommitment reflects the minimum additional capacity needed in the aggregate to support the advertised capacity promised to thin-provisioned volumes and LUNs. When the value of overcommitment is greater than zero, you run the risk of I/O writes failing because of insufficient physical storage to support the demand.		✓	conf_overcommitted
Total Usable Capacity	Total capacity of the aggregate in usable terms. Usable means after applying RAID.		✓	conf_capacity
Available Usable Capacity	Also displayed as Available Capacity Capacity available in the aggregate that has not been committed to data, snapshots, or thick-provisioned volumes and LUNs, in usable terms. Usable means after applying RAID.		✓	conf_available
Used Capacity	= Total Usable Capacity - Available Usable Capacity	✓		conf_used
% Available	Also % Free = Available Usable Capacity / Total Usable Capacity	✓		Calculated

Storage Arrays and Filers – LUN, NASVolume, and Disk Capacity Metrics


These metrics describe the capacity of LUNs , NASVolumes, and disks.

Table 7. LUN, NASVolume, and Disk Capacity Metrics

Capacity Metric	Description	LUN	NASVolume	Disk	Topology Name
Advertised LUN Size	Size of the LUN as advertised to the hosts connected to the LUN.	✓			advertisedSize
Provisioned Usable Capacity	Capacity provisioned for LUN data. In a thin-provisioned LUN, this is the capacity used for data written to the LUN. In a thick-provisioned LUN, this is the capacity allocated to the LUN, and does not reflect data written.	✓			size
Provisioned Raw Capacity	Capacity provisioned for LUN data in raw terms.	✓			rawCapacity
Advertised Size	Size of the NASVolume as advertised to the host mounting the volume.		✓		total_capacity
Free Capacity	Advertised Size - Used Capacity		✓		available_capacity
Used Capacity	Capacity in volume committed to data, snapshots, etc. in usable terms.		✓		used_capacity
% Used	= Used Capacity / Advertised Size		✓		percent_used
Disk Size	Size of the disk in MBs. Disk capacity cylinder coloring and capacity alarms are defined in registry variables with the prefix: <i>StSAN.FilerDisks.PctUnallocatedCapacityThreshold...</i>			✓	size

Overview of Metrics in Foglight for Storage Management

Metrics and data are saved in the Foglight for Storage Management database as properties of topology objects. Topology objects correspond to the types of storage devices and components being monitored in your storage environment.

 **TIP:** For in-depth information about the Foglight for Storage Management data model, see the *Foglight for Storage Management Data Model Guide*.

Summary of SAN Topology Objects

If you want to create new rules or custom dashboards, or if you want to browse the data directly instead of through the Storage & SAN dashboards, you need to know the names of devices, components, and metrics as they are stored in the Foglight for Storage Management Database Repository.

The following tables list the top-level storage devices and all child components, and identifies their topology object names. These lists are not comprehensive, rather they reflect the objects that you may need to reference if you are creating new rules or custom dashboards. For other objects, see the Data dashboard. For help navigating to the Data dashboard, see [Locating SAN Topology Objects in Foglight for Storage Management](#) on page 127.

Table 8. SAN Topology Objects

Device	Topology Object
Fabric	SanFabric
Fibre Channel Switch	SanFcSwitch
VSAN	SanVsan
Filer	SanFiler
Storage Array	SanStorageArray

Component	Topology Object
FC Switch Port	SanFcSwitchPort
FC Port (Arrays/Filers)	SanStorageSupplierPortFC
IP Port (Arrays/Filers)	SanStorageSupplierPortISCSI
InfiniBand Port (Arrays)	SanStorageSupplierPortIB
Controller	SanController
Disk	SanPhysicalDisk
LUN	SanLun
Member	SanMember
NASVolume	SanVolume
Pool or Aggregate	SanPool

Locating SAN Topology Objects in Foglight for Storage Management

NOTE: You require the Foglight for Storage Management role *Administrator* to access the Configuration > Data menu.

You can explore directly the metrics and data captured for monitored storage devices and their components. Data is displayed as a hierarchy of objects.

To locate storage topology objects:

- 1 On the navigation panel, under Dashboards, click Configuration > Data.
- 2 Expand the Storage & SAN branch.
- 3 Select a device type and then a device.
- 4 Select a metric to view details in the Property Viewer.

For example, the following image shows a selected FC Switch (brocade3900_3). The Data Rate metric, which is called `bytesRcvd`, is selected and displayed in the Property Viewer. The Property Viewer contains tables showing all collected values for the selected metric. For more information, see [Understanding Metric Data in Charts and Tables](#) on page 14.

Figure 1. Property Viewer

Value	Data Type
Administration	
Alarms	
Hosts	
Infrastructure	
Management Server	
Services	
Storage & SAN	
Fabrics	SanFabric
100000051E0F8BBA	SanFabric
Aggregate Alarms	List of Alarms
Aggregate Alarm State	AlarmStateObservation
Aggregate State Severity	AlarmSeverity
Alarms	List of Alarms
Current Aggregate Alarms	List of Alarms
Current Alarms	List of Alarms
fcSwitches	List of SanFcSwitchs
brocade3900_3	SanFcSwitch
Aggregate Alarms	List of Alarms
Aggregate Alarm State	AlarmStateObservation
Aggregate State Severity	AlarmSeverity
Alarms	List of Alarms
attachedSwitches	List of SanFcSwitchs
bytesRcvd	Metric
Current	MetricValue
History	List of MetricValues
Latest	MetricValue
Period	MetricValue
bytesTotal	Metric

Property Viewer (Foglight:Object) Wednesday, November 27, 2013 3:26 AM - 7:26 AM 4 hours

bytesRcvd (Metric)

Name	Value	Fetch Time
Name	bytesRcvd	0

Latest (MetricValue)

Start Time	End Time	Sampled Period	Count	Min	Max	Average	Sum	Sum Squares	Standard Deviation	Fetch Time
11/27/13 7:09 AM	11/27/13 7:19 AM	600,000 ms	610	3,427,976 B/s	3,427,976 B/s	3,427,976 B/s	2,091,065,176 B/s	7,168,120,607,016,248 B/s	0 B/s	

Current (MetricValue)

Start Time	End Time	Sampled Period	Count	Min	Max	Average	Sum	Sum Squares	Standard Deviation	Fetch Time
11/27/13 7:09 AM	11/27/13 7:19 AM	600,000 ms	610	3,427,976 B/s	3,427,976 B/s	3,427,976 B/s	2,091,065,176 B/s	7,168,120,607,016,248 B/s	0 B/s	

Period (MetricValue)

Start Time	End Time	Sampled Period	Count	Min	Max	Average	Sum	Sum Squares	Standard Deviation
11/27/13 3:19 AM	11/27/13 7:19 AM	72,000,000 ms	71,940	1,948,743 B/s	3,585,470 B/s	2,509,762 B/s	180,552,258,280 B/s	465,726,640,188,111,680 B/s	418 B/s

History (MetricValue)

Start Time	End Time	Sampled Period	Count	Min	Max	Average	Sum	Sum Squares	Standard Deviation
11/27/13 3:19 AM	11/27/13 3:29 AM	3,000,000 ms	3,005	2,363,276 B/s	2,363,276 B/s	2,363,276 B/s	7,101,645,440 B/s	16,783,150,733,934,376 B/s	0 B/s
11/27/13 3:28 AM	11/27/13 3:38 AM	3,000,000 ms	2,940	1,948,743 B/s	1,948,743 B/s	1,948,743 B/s	5,729,303,520 B/s	11,164,938,375,606,936 B/s	0 B/s
11/27/13 3:38 AM	11/27/13 3:48 AM	3,000,000 ms	3,000	2,015,800 B/s	2,015,800 B/s	2,015,800 B/s	6,047,401,460 B/s	12,190,354,806,136,710 B/s	0 B/s
11/27/13 3:48 AM	11/27/13 3:58 AM	3,000,000 ms	2,985	2,264,253 B/s	2,264,253 B/s	2,264,253 B/s	6,758,796,580 B/s	15,303,628,546,003,252 B/s	0 B/s

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