Monitoring Storage RAID

eG Innovations Product Documentation

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Total Performance Visibility

Table of Contents

Table of Figures

Chapter 1: Introduction

SMI-S, or the Storage Management Initiative – Specification, is a storage standard developed and maintained by the Storage Networking Industry Association (SNIA). It has also been ratified as an ISO standard. SMI-S is based upon the Common Information Model and the Web-Based Enterprise Management standards defined by the Distributed Management Task Force, which define management functionality via HTTP. The most recent approved version of SMI-S is available at the SNIA.

The main objective of SMI-S is to enable broad interoperable management of heterogeneous storage vendor systems. The current version is SMI-S V1.6.0. Over 75 software products and over 800 hardware products are certified as conformant to SMI-S.

At a very basic level, SMI-S entities are divided into two categories:

- **Clients** are management software applications that can reside virtually anywhere within a network, provided they have a communications link (either within the data path or outside the data path) to providers. Using the "provider" (the actual software library), a management application (SMI-S Client) doesn't require knowledge of the specific architecture or infrastructure requirements of the particular storage platform.
- **Servers** are the devices under management. Servers can be disk arrays, virtualization engines, host bus adapters, switches, tape drives, etc.

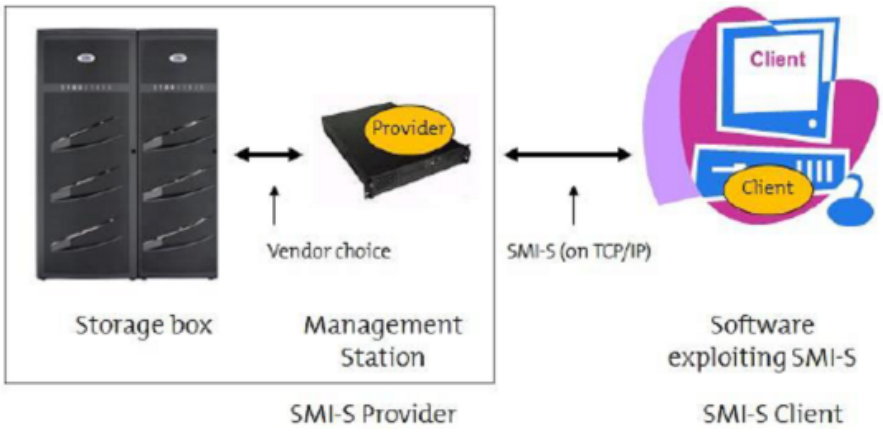

Figure 1.1: How to manage a storage system using SMI-S?

Chapter 2: How does eG Enterprise Monitor a Generic SMI-S Compliant Storage Device?

Storage Raid is an “agentless” monitoring model, which requires that an eG agent to be deployed on a remote host in the environment. Once configured, this eG agent will poll the **SMI-S Provider of the target storage system** at set intervals and collect the required performance metrics. To know where to install this eG agent and how to configure the agent to interact with the SMI-S Provider, follow the guidelines discussed below:

- **Know how the SMI-S Provider has been implemented in the storage system to be monitored**

  SMI-S defines CIM management profiles for storage systems. A profile describes the behavioral aspects of an autonomous, self-contained management domain. SMI-S includes profiles for Arrays, Switches, Storage Virtualizers, Volume Management and many other domains. In DMTF parlance, a provider is an implementation for a specific profile. Using the "provider" (the actual software library), a management application (SMI-S Client) doesn't require knowledge of the specific architecture or infrastructure requirements of the particular storage platform.

  SMI-S providers can be implemented either as proxies to the devices or as embedded software within the actual storage platform.

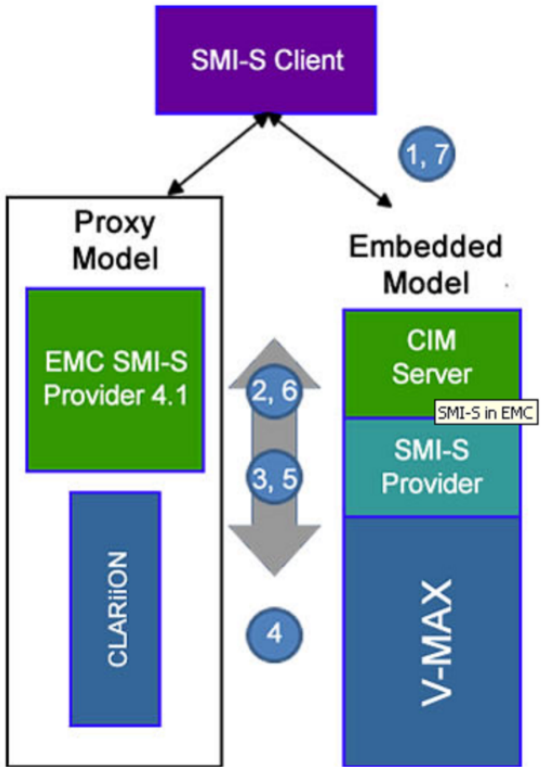

Figure 2.1: Implementation options for SMI-S Providers

Most legacy storage platforms have implemented their SMI-S providers as proxies. The proxies are software libraries external from the storage platforms that accept SMI-S queries and commands, and translate them into vendor specific commands which they send to the storage platforms.

As the name implies, the embedded SMI-S providers are included on the storage platforms and do not require the installation or maintenance of a separate software package to provide an SMI-S interface to the storage platform. The trend for the newer platforms is to embed the SMI-S providers within the storage system as evidenced by the latest IBM DS8000 platforms and the EMC V-Max platforms.

Before deploying the eG agent, know how the SMI-S provider of the target storage system has been implemented – as a proxy? or as an embedded software?.

- **Choose the host for eG agent deployment based on how the SMI-S Provider has been implemented in the storage system.**

If the SMI-S provider has been implemented as a proxy, then the eG agent should be deployed on the same host as the SMI-S provider. On the other hand, if the provider has been embedded in the storage platform, the eG agent can be deployed on any remote Windows host in the environment. However, in the case of the latter, make sure that the Windows host is able to connect to the SMI-S provider and pull out metrics related to the storage system.

- **Ensure that the SMI-S Provider is enabled and started on the storage system.**
- **Manage the target storage system using the eG administrative interface**

  You need to provide a **Host IP** when managing the storage system using the eG admin interface. This **Host IP** specification varies according to the SMI-S Provider implementation. If the provider is an embedded software, then specify the IP address of the storage system as the **Host IP**. If the provider is a proxy, then enter the IP address of the host on which the SMI-S Provider software has been installed as the **Host IP**.

- **Configure tests for the storage raid that has been managed**

  When configuring tests, you need to configure the eG agent with the following:

  - Whether the SMI-S Provider has been implemented as a proxy or as an embedded software.
  - The **SERIAL NUMBER** of the storage device to be monitored, in case the SMI-S Provider has been implemented as a proxy

    This is because, the proxy implementation of the provider can manage multiple devices at the same time. The **SERIAL NUMBER** is the unique identifier that will enable the eG agent to collect metrics from the right storage device.

  - Credentials of an SMI-S provider CIM user who has the right to access the storage device, execute API commands on it and pull out the desired metrics

    The exact role that is to be assigned to such a user will differ from one device to another – for instance, when monitoring 3PAR, you will have to provide the credentials of a user who has been assigned the **Monitor** role.

  - The namespace that uniquely identifies the profiles specific to the SMI-S provider in use.

2.1 Managing the Storage RAID

The eG Enterprise cannot automatically discover the Storage RAID so that you need to manually add the component for monitoring. Remember that the eG Enterprise automatically manages the components that are added manually. To manage a Storage RAID component, do the following:

1. Log into the eG administrative interface.
2. Follow the Components -> Add/Modify menu sequence in the **Infrastructure** tile of the **Admin** menu.
3. In the **COMPONENT** page that appears next, select *Storage RAID* as the **Component type**. Then, click the **Add New Component** button. This will invoke Figure 2.2.

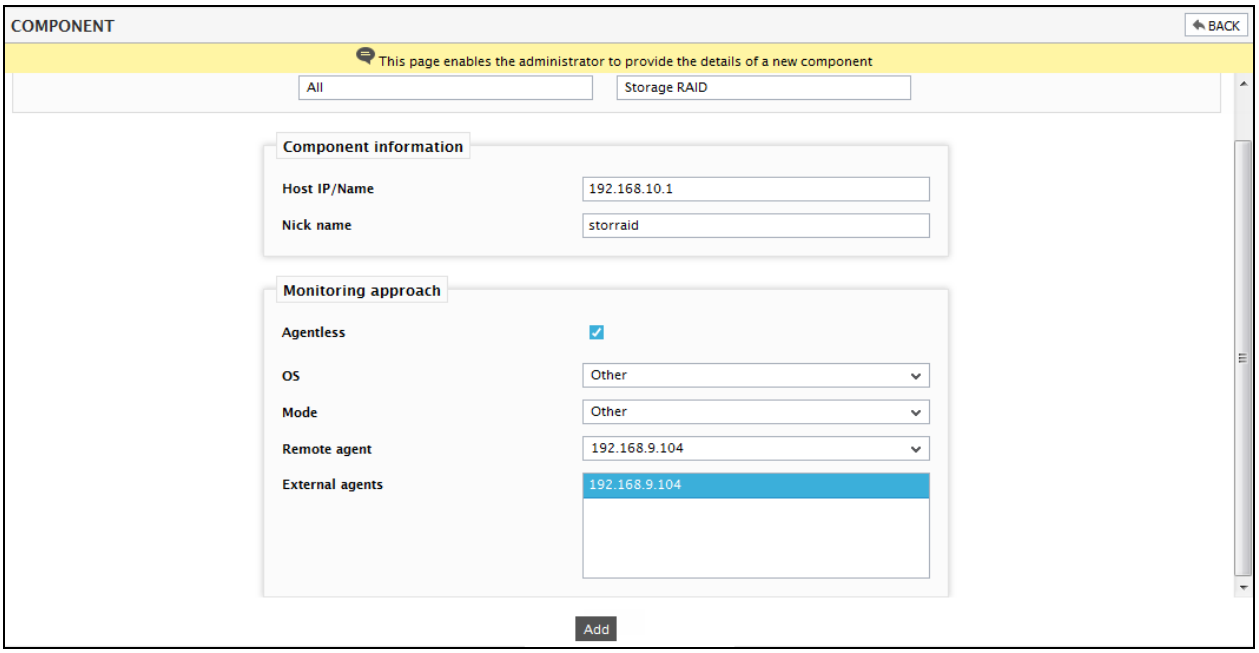

Figure 2.2: Adding a Storage RAID

4. Specify the **Host IP** and the **Nick name** of the Storage RAID in Figure 2.2. Also set the **Agentless** flag to **Yes**, select **Other** as the **OS** and **Other** as the **Mode**. Then, click the **Add** button to register the changes.
5. When you attempt to sign out, a list of unconfigured tests will appear as shown in Figure 2.3.

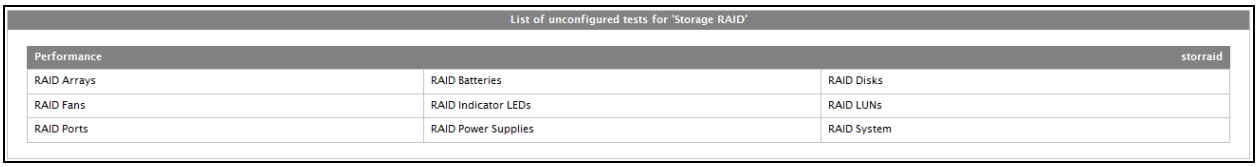

Figure 2.3: List of Unconfigured tests to be configured for the Storage RAID

6. Click on any test in the list of unconfigured tests. To know the details on configuring these tests, refer to the **Monitoring the Storage RAIDMonitoring the Storage RAID** chapter.
7. Finally, signout of the eG administrative interface.

Chapter 3: Monitoring the Storage RAID

eG Enterprise provides a dedicated monitoring model for monitoring the Storage RAID.

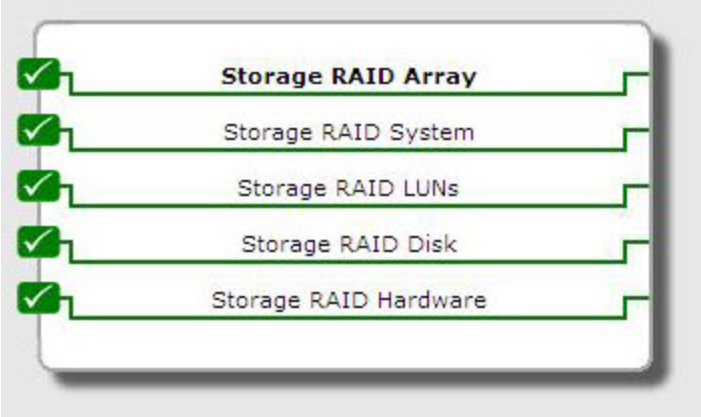

Figure 3.1: The generic Storage Raid model

Every layer of this 'agentless' model is mapped to a set of tests that monitors every aspect of storage performance – from the health of the hardware (batteries, LED sensors, power supply units etc.) to the health of core components of the storage device – e.g., disks, LUNs, RAID ports, controllers – is monitored in an agentless manner. Failures, error conditions, high load situations, load balancing irregularities and hot-spots are detected and alerted to administrators so they can initiate corrective actions.

Using the metrics reported by this model, administrators can find quick and accurate answers to the following performance queries:

- Has any hardware component of the storage RAID failed? If so, what is it - is it a fan? a PSU? a battery? or an indicator LED? What could have caused this failure?
- Is any disk in an abnormal state?
- Is any disk overloaded with I/O requests?
- Has any LUN experienced any failures? If so, which LUN is it?
- Is I/O load uniformly distributed across all LUNs or is any LUN overloaded?
- Is any LUN experiencing any slowdown when processing I/O requests?
- Have any non-recoverable errors been detected on a storage processor?
- Is I/O load uniformly distributed across all storage processors?
- Is any storage processor experiencing any slowdown when processing I/O requests?

- Is any port experiencing abnormal I/O activity?
- Is any storage array in a degraded state currently?
- Is any storage array overloaded with I/O requests?
- Is the storage system effectively utilizing its cache to service I/O requests?

3.1 The Storage RAID Hardware Layer

The tests mapped to this layer report on the overall health of the hardware supporting the SMI-S compliant storage system.

Figure 3.2: The tests mapped to the Hardware layer

3.1.1 RAID Fans Test

If the fan suddenly stops running, then the temperature of the storage system hardware will soar, causing serious damage to the core components of the device. This is why, its good practice to keep track of the fan status using the raid Fans test. For each fan available on the storage system, this test reports how healthy the fan is and what is its current operational state.

Every aspect of storage performance – from the health of the hardware (batteries, LED sensors, power supply units etc.) to the health of core components of the storage device – e.g., disks, LUNs, RAID ports, controllers – is monitored in an agentless manner. Failures, error conditions, high load situations, load balancing irregularities and hot-spots are detected and alerted to administrators so they can initiate corrective actions.

Target of the test : An SMI-S compliant storage device

Agent deploying the test : A remote agent

Outputs of the test : One set of results for each fan on the storage system.

Configurable parameters for the test

Parameter	Description
Test period	How often should the test be executed
Host	The IP address of the storage device.
Port	The port number at which the storage device listens to. By default, this is *NULL*.
User and Password	Specify the credentials of a user who has the right to execute API commands on the storage device and pull out metrics. The exact role that is to be assigned to such a user will differ from one device to another – for instance, when monitoring 3PAR, you will have to provide the credentials of a user who has been assigned the **Monitor** role, here.
Confirm Password	Confirm the password by retyping it here.
SSL	Set this flag to **Yes**, if the storage device being monitored is SSL-enabled.
IsEmbedded	If this flag is set to **True**, it indicates that the SMI-S provider is embedded on the storage platform. On the other hand, if this flag is set to **False**, it indicates that the SMI-S provider has been implemented as a proxy.
SerialNumber	If the SMI-S provider has been implemented as a proxy, then such a provider can be configured to manage multiple storage devices. This is why, if the IsEmbedded flag is set to **False**, you will have to explicitly specify which storage system you want the eG agent to monitor. Since each storage system is uniquely identified by a SerialNumber, specify the same here. The format of this number and where you can find it will differ from one storage system to another. You are hence advised to contact the storage administrator to know what to enter against SerialNumber. For example, the serial number for an EMC CLARiiON device will be of the format, **FCNMM094900059**.
NameSpace	Specify the namespace that uniquely identifies the profiles specific to the provider in use.

Measurements made by the test

Measurement	Description	Measurement Unit	Interpretation
Health state	Indicates how healthy this fan currently is.		The values that this measure can report and their corresponding numeric values are discussed in the table below:

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>OK</td></tr>
<tr><td>1</td><td>Unknown</td></tr>
<tr><td>2</td><td>Degraded/Warning</td></tr>
<tr><td>3</td><td>Minor failure</td></tr>
<tr><td>4</td><td>Major failure</td></tr>
<tr><td>5</td><td>Critical failure</td></tr>
<tr><td>6</td><td>Non-recoverable error</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the state of a fan. The graph of this measure however, represents the state of the fans using the numeric equivalents only.
</td></tr>
<tr><td>Operational status</td><td>Indicates the current operational state of this fan.</td><td></td><td>The values that this measure can report and their corresponding numeric values are discussed in the table below:
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>OK</td></tr>
<tr><td>1</td><td>In Service</td></tr>
<tr><td>2</td><td>Power Mode</td></tr>
<tr><td>3</td><td>Completed</td></tr>
<tr><td>4</td><td>Starting</td></tr>
<tr><td>5</td><td>Dormat</td></tr>
<tr><td>6</td><td>Other</td></tr>
<tr><td>7</td><td>Unknown</td></tr>
<tr><td>8</td><td>Stopping</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>9</td><td>Stressed</td></tr>
<tr><td>10</td><td>Stopped</td></tr>
<tr><td>11</td><td>Supporting Entity in Error</td></tr>
<tr><td>12</td><td>Degraded or Predicted Failure</td></tr>
<tr><td>13</td><td>Predictive Failure</td></tr>
<tr><td>14</td><td>Lost Communication</td></tr>
<tr><td>15</td><td>No Contact</td></tr>
<tr><td>16</td><td>Aborted</td></tr>
<tr><td>17</td><td>Error</td></tr>
<tr><td>18</td><td>Non-Recoverable Error</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the operational state of a fan. In the graph of this measure however, operational states are represented using the numeric equivalents only.
</td></tr>
<tr><td>Detailed operational state</td><td>Describes the current operational state of this fan.</td><td></td><td>This measure will be reported only if the API provides a detailed operational state.
Typically, the detailed state will describe why the fan is in a particular operational state. For instance, if the Operational status measure reports the value Stopping for a fan, then this measure will explain why the fan is being stopped.
The values that this measure can report and their corresponding numeric values are discussed in the table below:</td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>Online</td></tr>
<tr><td>1</td><td>Success</td></tr>
<tr><td>2</td><td>Power Saving Mode</td></tr>
<tr><td>3</td><td>Write Protected</td></tr>
<tr><td>4</td><td>Write Disabled</td></tr>
<tr><td>5</td><td>Not Ready</td></tr>
<tr><td>6</td><td>Removed</td></tr>
<tr><td>7</td><td>Rebooting</td></tr>
<tr><td>8</td><td>Offline</td></tr>
<tr><td>9</td><td>Failure</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the detailed operational state of a fan. In the graph of this measure however, detailed operational states are represented using the numeric equivalents only.
</td></tr>
</table>

3.1.2 RAID Power Supplies Test

The sudden failure of the power supply units of a storage device can cause the device to crash, leading to critical loss of data. To avoid this, you need to keep an eye on the state of each power supply unit of the storage system. This can be achieved using the **RAID Power Supplies** test. This test auto-discovers the power supply units of the storage system and reports the overall health and operational state of each unit.

Target of the test : An SMI-S compliant storage device

Agent deploying the test : A remote agent

Outputs of the test : One set of results for each power supply unit on the storage system.

Configurable parameters for the test

Parameter	Description
Test period	How often should the test be executed
Host	The IP address of the storage device.
Port	The port number at which the storage device listens to. By default, this is *NULL*.
User and Password	Specify the credentials of a user who has the right to execute API commands on the storage device and pull out metrics. The exact role that is to be assigned to such a user will differ from one device to another – for instance, when monitoring 3PAR, you will have to provide the credentials of a user who has been assigned the **Monitor** role, here.
Confirm Password	Confirm the password by retyping it here.
SSL	Set this flag to **Yes**, if the storage device being monitored is SSL-enabled.
IsEmbedded	If this flag is set to **True**, it indicates that the SMI-S provider is embedded on the storage platform. On the other hand, if this flag is set to **False**, it indicates that the SMI-S provider has been implemented as a proxy.
SerialNumber	If the SMI-S provider has been implemented as a proxy, then such a provider can be configured to manage multiple storage devices. This is why, if the IsEmbedded flag is set to **False**, you will have to explicitly specify which storage system you want the eG agent to monitor. Since each storage system is uniquely identified by a SerialNumber, specify the same here. The format of this number and where you can find it will differ from one storage system to another. You are hence advised to contact the storage administrator to know what to enter against SerialNumber. For example, the serial number for an EMC CLARiiON device will be of the format, **FCNMM094900059**.
NameSpace	Specify the namespace that uniquely identifies the profiles specific to the provider in use.

Measurements made by the test

Measurement	Description	Measurement Unit	Interpretation
Health state	Indicates how healthy this power supply unit currently is.		The values that this measure can report and their corresponding numeric values are discussed in the table below:

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>OK</td></tr>
<tr><td>1</td><td>Unknown</td></tr>
<tr><td>2</td><td>Degraded/Warning</td></tr>
<tr><td>3</td><td>Minor failure</td></tr>
<tr><td>4</td><td>Major failure</td></tr>
<tr><td>5</td><td>Critical failure</td></tr>
<tr><td>6</td><td>Non-recoverable error</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the state of a power supply unit. The graph of this measure however, represents the state of the power supplies using the numeric equivalents only.
</td></tr>
<tr><td>Operational status</td><td>Indicates the current operational state of this power supply unit.</td><td></td><td>
The values that this measure can report and their corresponding numeric values are discussed in the table below:
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>OK</td></tr>
<tr><td>1</td><td>In Service</td></tr>
<tr><td>2</td><td>Power Mode</td></tr>
<tr><td>3</td><td>Completed</td></tr>
<tr><td>4</td><td>Starting</td></tr>
<tr><td>5</td><td>Dormat</td></tr>
<tr><td>6</td><td>Other</td></tr>
<tr><td>7</td><td>Unknown</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>8</td><td>Stopping</td></tr>
<tr><td>9</td><td>Stressed</td></tr>
<tr><td>10</td><td>Stopped</td></tr>
<tr><td>11</td><td>Supporting Entity in Error</td></tr>
<tr><td>12</td><td>Degraded or Predicted Failure</td></tr>
<tr><td>13</td><td>Predictive Failure</td></tr>
<tr><td>14</td><td>Lost Communication</td></tr>
<tr><td>15</td><td>No Contact</td></tr>
<tr><td>16</td><td>Aborted</td></tr>
<tr><td>17</td><td>Error</td></tr>
<tr><td>18</td><td>Non-Recoverable Error</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the operational state of a power supply unit. In the graph of this measure however, operational states are represented using the numeric equivalents only.
</td></tr>
<tr><td>Detailed operational state</td><td>Describes the current operational state of this power supply unit.</td><td></td><td>This measure will be reported only if the API provides a detailed operational state.
Typically, the detailed state will describe why the power supply unit is in a particular operational state. For instance, if the Operational status measure reports the value Stopping for a power supply unit, then this measure will explain why the power supply is being stopped.</td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>The values that this measure can report and their corresponding numeric values are discussed in the table below:

<table><tr><th>Numeric Value</th><th>Measure Value</th></tr><tr><td>0</td><td>Online</td></tr><tr><td>1</td><td>Success</td></tr><tr><td>2</td><td>Power Saving Mode</td></tr><tr><td>3</td><td>Write Protected</td></tr><tr><td>4</td><td>Write Disabled</td></tr><tr><td>5</td><td>Not Ready</td></tr><tr><td>6</td><td>Removed</td></tr><tr><td>7</td><td>Rebooting</td></tr><tr><td>8</td><td>Offline</td></tr><tr><td>9</td><td>Failure</td></tr></table>
Note:

By default, this measure reports the Measure Values discussed above to indicate the detailed operational state of a PSU. In the graph of this measure however, detailed operational states are represented using the numeric equivalents only.</td></tr>
</table>

3.1.3 Storage RAID Batteries Test

A defective battery or a battery that is left with no charge can render the storage device unusable, denying users access to critical data! To prevent such eventualities, the health of the batteries used by the storage system should be periodically checked, and problem conditions promptly brought to the attention of administrators. This can be achieved using the **Storage RAID Batteries** test. This test reports the operational state and overall health of each of the batteries used by the storage system, proactively alerts administrators to potential abnormalities related to battery performance, and enables administrators to initiate pre-emptive action to avoid total battery failure.

Target of the test : An SMI-S compliant storage device

Agent deploying the test : A remote agent

Outputs of the test : One set of results for each battery on the storage system.

Configurable parameters for the test

Parameter	Description
Test period	How often should the test be executed
Host	The IP address of the storage device.
Port	The port number at which the storage device listens to. By default, this is *NULL*.
User and Password	Specify the credentials of a user who has the right to execute API commands on the storage device and pull out metrics. The exact role that is to be assigned to such a user will differ from one device to another – for instance, when monitoring 3PAR, you will have to provide the credentials of a user who has been assigned the **Monitor** role, here.
Confirm Password	Confirm the password by retyping it here.
SSL	Set this flag to **Yes**, if the storage device being monitored is SSL-enabled.
IsEmbedded	If this flag is set to **True**, it indicates that the SMI-S provider is embedded on the storage platform. On the other hand, if this flag is set to **False**, it indicates that the SMI-S provider has been implemented as a proxy.
SerialNumber	If the SMI-S provider has been implemented as a proxy, then such a provider can be configured to manage multiple storage devices. This is why, if the IsEmbedded flag is set to **False**, you will have to explicitly specify which storage system you want the eG agent to monitor. Since each storage system is uniquely identified by a SerialNumber, specify the same here. The format of this number and where you can find it will differ from one storage system to another. You are hence advised to contact the storage administrator to know what to enter against SerialNumber. For example, the serial number for an EMC CLARiiON device will be of the format, **FCNMM094900059**.
NameSpace	Specify the namespace that uniquely identifies the profiles specific to the provider in use.

Measurements made by the test

Measurement	Description	Measurement Unit	Interpretation
Health state	Indicates how healthy the battery currently is.		The values that this measure can report and their corresponding numeric values

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>are discussed in the table below:
<table><tr><th>Numeric Value</th><th>Measure Value</th></tr><tr><td>0</td><td>OK</td></tr><tr><td>1</td><td>Unknown</td></tr><tr><td>2</td><td>Degraded/Warning</td></tr><tr><td>3</td><td>Minor failure</td></tr><tr><td>4</td><td>Major failure</td></tr><tr><td>5</td><td>Critical failure</td></tr><tr><td>6</td><td>Non-recoverable error</td></tr></table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the state of a battery. The graph of this measure however, represents the state of the batteries using the numeric equivalents only.</td></tr>
<tr><td>Operational status</td><td>Indicates the current operational state of this battery.</td><td></td><td>The values that this measure can report and their corresponding numeric values are discussed in the table below:
<table><tr><th>Numeric Value</th><th>Measure Value</th></tr><tr><td>0</td><td>OK</td></tr><tr><td>1</td><td>In Service</td></tr><tr><td>2</td><td>Power Mode</td></tr><tr><td>3</td><td>Completed</td></tr><tr><td>4</td><td>Starting</td></tr><tr><td>5</td><td>Dormant</td></tr><tr><td>6</td><td>Other</td></tr><tr><td>7</td><td>Unknown</td></tr></table></td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>8</td><td>Stopping</td></tr>
<tr><td>9</td><td>Stressed</td></tr>
<tr><td>10</td><td>Stopped</td></tr>
<tr><td>11</td><td>Supporting Entity in Error</td></tr>
<tr><td>12</td><td>Degraded or Predicted Failure</td></tr>
<tr><td>13</td><td>Predictive Failure</td></tr>
<tr><td>14</td><td>Lost Communication</td></tr>
<tr><td>15</td><td>No Contact</td></tr>
<tr><td>16</td><td>Aborted</td></tr>
<tr><td>17</td><td>Error</td></tr>
<tr><td>18</td><td>Non-Recoverable Error</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the operational state of a battery. In the graph of this measure however, operational states are represented using the numeric equivalents only.
</td></tr>
<tr><td>Detailed operational state</td><td>Describes the current operational state of this battery.</td><td></td><td>This measure will be reported only if the API provides a detailed operational state.
Typically, the detailed state will describe why the battery is in a particular operational state. For instance, if the Operational status measure reports the value Stopping for a battery, then this measure will explain why the battery is being stopped.</td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>The values that this measure can report and their corresponding numeric values are discussed in the table below:

<table><tr><th>Numeric Value</th><th>Measure Value</th></tr><tr><td>0</td><td>Online</td></tr><tr><td>1</td><td>Success</td></tr><tr><td>2</td><td>Power Saving Mode</td></tr><tr><td>3</td><td>Write Protected</td></tr><tr><td>4</td><td>Write Disabled</td></tr><tr><td>5</td><td>Not Ready</td></tr><tr><td>6</td><td>Removed</td></tr><tr><td>7</td><td>Rebooting</td></tr><tr><td>8</td><td>Offline</td></tr><tr><td>9</td><td>Failure</td></tr></table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the detailed operational state of a battery. In the graph of this measure however, detailed operational states are represented using the numeric equivalents only.</td></tr>
<tr><td>Battery state</td><td>Indicates the current battery state.</td><td></td><td>The values that this measure can report and their corresponding numeric values are discussed in the table below:

<table><tr><th>Numeric Value</th><th>Measure Value</th></tr><tr><td>1</td><td>Other</td></tr><tr><td>2</td><td>Unknown</td></tr><tr><td>3</td><td>Fully Charged</td></tr></table></td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>4</td><td>Partially Charged</td></tr>
<tr><td>5</td><td>Charging</td></tr>
<tr><td>6</td><td>Charging and High</td></tr>
<tr><td>7</td><td>Charging and Low</td></tr>
<tr><td>8</td><td>Charging and Critical</td></tr>
<tr><td>9</td><td>Overcharged</td></tr>
<tr><td>10</td><td>Low</td></tr>
<tr><td>11</td><td>Critical</td></tr>
<tr><td>12</td><td>Undefined</td></tr>
<tr><td>13</td><td>Learning</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the battery state. In the graph of this measure however, battery states are represented using the numeric equivalents only.
</td></tr>
</table>

3.1.4 RAID Indicator LEDs Test

LED Indicators on a storage system accurately point to the health of the various components of the system. To enable administrators sitting in remote locations to quickly recognize that something is wrong with the storage device / some of its components, the raid Indicator LEDs test reports the current color of the indicator LEDs.

Target of the test : An SMI-S compliant storage device

Agent deploying the test : A remote agent

Outputs of the test : One set of results for each indicator LED on the storage system.

Configurable parameters for the test

Parameter	Description
Test period	How often should the test be executed
Host	The IP address of the storage device.
Port	The port number at which the storage device listens to. By default, this is *NULL*.
User and Password	Specify the credentials of a user who has the right to execute API commands on the storage device and pull out metrics. The exact role that is to be assigned to such a user will differ from one device to another – for instance, when monitoring 3PAR, you will have to provide the credentials of a user who has been assigned the **Monitor** role, here.
Confirm Password	Confirm the password by retyping it here.
SSL	Set this flag to **Yes**, if the storage device being monitored is SSL-enabled.
IsEmbedded	If this flag is set to **True**, it indicates that the SMI-S provider is embedded on the storage platform. On the other hand, if this flag is set to **False**, it indicates that the SMI-S provider has been implemented as a proxy.
SerialNumber	If the SMI-S provider has been implemented as a proxy, then such a provider can be configured to manage multiple storage devices. This is why, if the IsEmbedded flag is set to **False**, you will have to explicitly specify which storage system you want the eG agent to monitor. Since each storage system is uniquely identified by a SerialNumber, specify the same here. The format of this number and where you can find it will differ from one storage system to another. You are hence advised to contact the storage administrator to know what to enter against SerialNumber. For example, the serial number for an EMC CLARiiON device will be of the format, **FCNMM094900059**.
NameSpace	Specify the namespace that uniquely identifies the profiles specific to the provider in use.

Measurements made by the test

Measurement	Description	Measurement Unit	Interpretation
Color	Indicates the current color of this LED.		The values that this measure can report and their corresponding numeric values are discussed in the table below:

Measurement	Description	Measurement Unit	Interpretation
			<table><tr><th>Numeric Value</th><th>Measure Value</th></tr><tr><td>0</td><td>Unknown</td></tr><tr><td>1</td><td>Other</td></tr><tr><td>2</td><td>Not Applicable</td></tr><tr><td>3</td><td>White</td></tr><tr><td>4</td><td>Red</td></tr><tr><td>5</td><td>Green</td></tr><tr><td>6</td><td>Blue</td></tr><tr><td>7</td><td>Orange</td></tr><tr><td>8</td><td>Yellow</td></tr><tr><td>9</td><td>Black</td></tr></table> **Note:** By default, this measure reports the **Measure Value**s discussed above to indicate the color of an LED. The graph of this measure however, represents the same using the numeric equivalents only.

3.2 The Storage RAID Disk Layer

This layer monitors the RAID disks and reports how healthy each disk is and how well the storage system balances I/O load across disks.

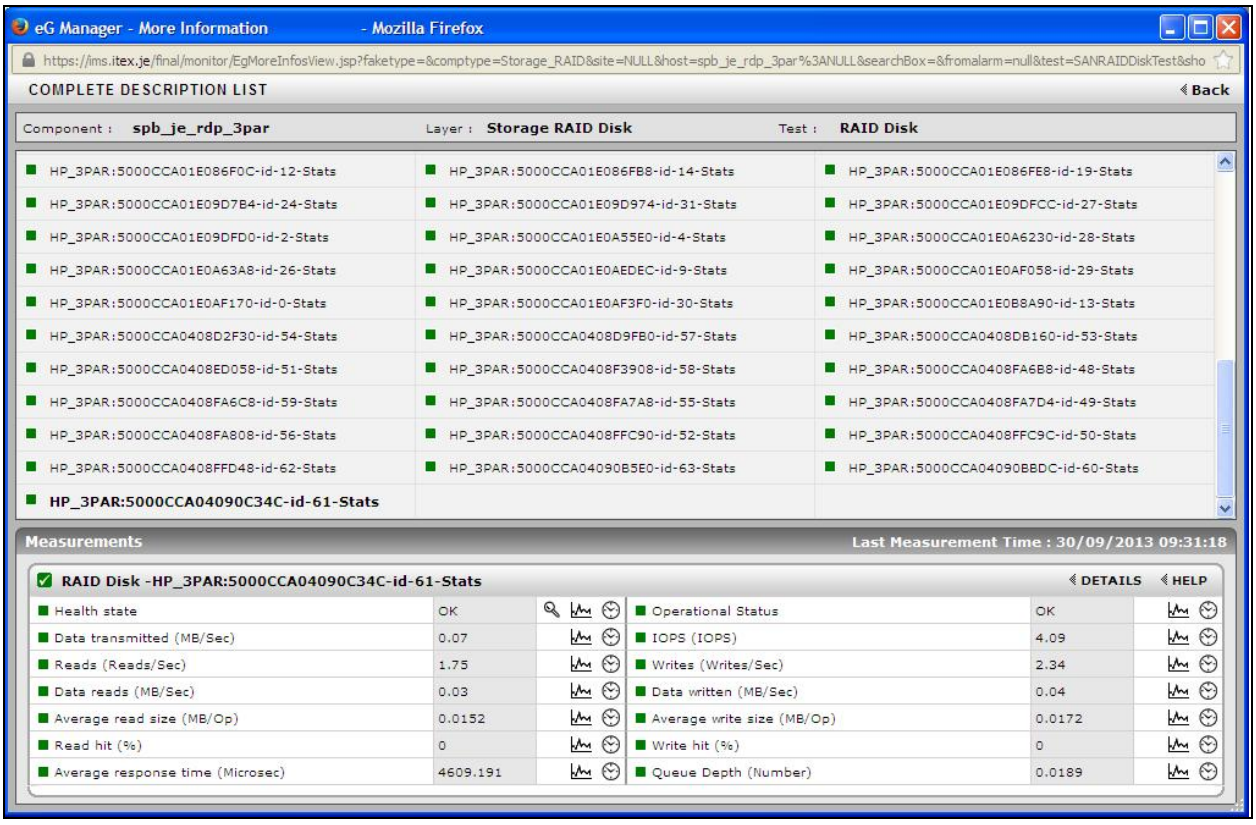

Figure 3.3: he test mapped to the Storage RAID Disk layer

3.2.1 RAID Disks Test

This test monitors the current state, overall health, and the load-balancing capability of each disk in the storage system. With the help of this test, administrators can not only identify failed disks, but can also predict the potential failure of a disk, so that efforts can be undertaken to avert the same. In addition, the test also points administrators to disks that are handling more I/O requests than the rest, thus shedding light on irregularities in the distribution of I/O load across disks and prompting administrators to fine-tune the load-balancing algorithm. In addition, the test also proactively alerts administrators to probable slowdowns in I/O processing by specific disks, thereby enabling administrators to initiate pre-emptive actions.

Target of the test : An SMI-S compliant storage device

Agent deploying the test : A remote agent

Outputs of the test : One set of results for each disk on the storage system.

Configurable parameters for the test

Parameter	Description
Test period	How often should the test be executed
Host	The IP address of the storage device.
Port	The port number at which the storage device listens to. By default, this is *NULL*.
User and Password	Specify the credentials of a user who has the right to execute API commands on the storage device and pull out metrics. The exact role that is to be assigned to such a user will differ from one device to another – for instance, when monitoring 3PAR, you will have to provide the credentials of a user who has been assigned the **Monitor** role, here.
Confirm Password	Confirm the password by retyping it here.
SSL	Set this flag to **Yes**, if the storage device being monitored is SSL-enabled.
IsEmbedded	If this flag is set to **True**, it indicates that the SMI-S provider is embedded on the storage platform. On the other hand, if this flag is set to **False**, it indicates that the SMI-S provider has been implemented as a proxy.
SerialNumber	If the SMI-S provider has been implemented as a proxy, then such a provider can be configured to manage multiple storage devices. This is why, if the IsEmbedded flag is set to **False**, you will have to explicitly specify which storage system you want the eG agent to monitor. Since each storage system is uniquely identified by a SerialNumber, specify the same here. The format of this number and where you can find it will differ from one storage system to another. You are hence advised to contact the storage administrator to know what to enter against SerialNumber. For example, the serial number for an EMC CLARiiON device will be of the format, **FCNMM094900059**.
NameSpace	Specify the namespace that uniquely identifies the profiles specific to the provider in use.

Measurements made by the test

Measurement	Description	Measurement Unit	Interpretation
Health state	Indicates how healthy this disk currently is.		The values that this measure can report and their corresponding numeric values are discussed in the table below:

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>OK</td></tr>
<tr><td>1</td><td>Unknown</td></tr>
<tr><td>2</td><td>Degraded/Warning</td></tr>
<tr><td>3</td><td>Minor failure</td></tr>
<tr><td>4</td><td>Major failure</td></tr>
<tr><td>5</td><td>Critical failure</td></tr>
<tr><td>6</td><td>Non-recoverable error</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the state of a disk. In the graph of this measure however, states are represented using the numeric equivalents only.
</td></tr>
<tr><td>Operational status</td><td>Indicates the current operational state of this disk.</td><td></td><td>The values that this measure can report and their corresponding numeric values are discussed in the table below:
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>OK</td></tr>
<tr><td>1</td><td>In Service</td></tr>
<tr><td>2</td><td>Power Mode</td></tr>
<tr><td>3</td><td>Completed</td></tr>
<tr><td>4</td><td>Starting</td></tr>
<tr><td>5</td><td>Dormant</td></tr>
<tr><td>6</td><td>Other</td></tr>
<tr><td>7</td><td>Unknown</td></tr>
<tr><td>8</td><td>Stopping</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>9</td><td>Stressed</td></tr>
<tr><td>10</td><td>Stopped</td></tr>
<tr><td>11</td><td>Supporting Entity in Error</td></tr>
<tr><td>12</td><td>Degraded or Predicted Failure</td></tr>
<tr><td>13</td><td>Predictive Failure</td></tr>
<tr><td>14</td><td>Lost Communication</td></tr>
<tr><td>15</td><td>No Contact</td></tr>
<tr><td>16</td><td>Aborted</td></tr>
<tr><td>17</td><td>Error</td></tr>
<tr><td>18</td><td>Non-Recoverable Error</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the operational state of a disk. In the graph of this measure however, operational states are represented using the numeric equivalents only.
</td></tr>
<tr><td>Detailed operational state</td><td>Describes the current operational state of this disk.</td><td></td><td>This measure will be reported only if the API provides a detailed operational state.
Typically, the detailed state will describe why the disk is in a particular operational state. For instance, if the Operational status measure reports the value Stopping for a disk, then this measure will explain why that disk is being stopped.
The values that this measure can report and their corresponding numeric values are discussed in the table below:</td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>Online</td></tr>
<tr><td>1</td><td>Success</td></tr>
<tr><td>2</td><td>Power Saving Mode</td></tr>
<tr><td>3</td><td>Write Protected</td></tr>
<tr><td>4</td><td>Write Disabled</td></tr>
<tr><td>5</td><td>Not Ready</td></tr>
<tr><td>6</td><td>Removed</td></tr>
<tr><td>7</td><td>Rebooting</td></tr>
<tr><td>8</td><td>Offline</td></tr>
<tr><td>9</td><td>Failure</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the detailed operational state of a disk. In the graph of this measure however, detailed operational states are represented using the numeric equivalents only.
</td></tr>
<tr><td>Data transmitted</td><td>Indicates the rate at which data was transmitted by this disk.</td><td>MB/Sec</td><td></td></tr>
<tr><td>IOPS</td><td>Indicates the rate at which I/O operations were performed on this disk.</td><td>IOPS</td><td>Compare the value of this measure across disks to know which disk handled the maximum number of I/O requests and which handled the least. If the gap between the two is very high, then it indicates serious irregularities in load-balancing across disks.
You may then want to take a look at the Reads and Writes measure to understand what to fine-tune – the load-balancing algorithm for read requests or</td></tr>
</table>

Measurement	Description	Measurement Unit	Interpretation
			that of the write requests.
Reads	Indicates the rate at which read operations were performed on this disk.	Reads/Sec	Compare the value of this measure across disks to know which disk handled the maximum number of read requests and which handled the least. If the gap between the two is very high, then it indicates serious irregularities in load-balancing across disks.
Writes	Indicates the rate at which write operations were performed on this disk.	Writes/Sec	Compare the value of this measure across disks to know which disk handled the maximum number of write requests and which handled the least. If the gap between the two is very high, then it indicates serious irregularities in load-balancing across disks.
Data reads	Indicates the rate at which data is read from this disk.	MB/Sec	Compare the value of these measures across disks to identify the slowest disk in terms of servicing read and write requests (respectively).
Data writes	Indicates the rate at which data is written to this disk.	MB/Sec	
Disk busy	Indicates the percentage of time this disk was busy processing requests.	Percent	Compare the value of this measure across disks to know which disk was the busiest and which disk was not. If the gap between the two is very high, then it indicates serious irregularities in load-balancing across disks.
Average read size	Indicates the amount of data read from this disk per I/O operation	MB/Op	Compare the value of these measures across disks to identify the slowest disk in terms of servicing read and write requests (respectively).
Average write size	Indicates the amount of data written to this disk per I/O operation.	MB/Op	
Read hit	Indicates the percentage of read requests that were serviced by the	Percent	A high value is desired for this measure. A very low value is a cause for concern, as it indicates that cache usage is very

Measurement	Description	Measurement Unit	Interpretation
	cache of this disk.		poor; this in turn implies that direct disk accesses, which are expensive operations, are high.
Write hit	Indicates the percentage of write requests that were serviced by the cache of this disk.	Percent	A high value is desired for this measure. A very low value is a cause for concern, as it indicates that cache usage is very poor; this in turn implies that direct disk accesses, which are expensive operations, are high.
Average response time	Indicates the time taken by this disk to respond to I/O requests.	Microsecs	Ideally, this value should be low. If not, it implies that the disk is slow.
Queue depth	Indicates the number of requests that are in queue for this disk.	Number	A consistent increase in this value indicates a potential processing bottleneck with the disk.

3.3 The Storage RAID LUNs Layer

This layer monitors the LUNs and reports how healthy each LUN is and how well the storage system balances I/O load across LUNs.

Figure 3.4: The test mapped to the Storage RAID LUNs layer

3.3.1 RAID LUNs Test

A logical unit number (LUN) is a unique identifier used to designate individual or collections of hard disk devices for address by a protocol associated with a SCSI, iSCSI, Fibre Channel (FC) or similar interface. LUNs are central to the management of storage arrays shared over a storage area network (SAN). LUN errors, poor LUN cache usage, and abnormal I/O activity on the LUNs, if not promptly detected and resolved, can hence significantly degrade the performance of the storage array. This is why, it is important that LUN performance is continuously monitored. This can be achieved using the **RAID LUNs** test. This test auto-discovers the LUNs in the storage system and reports the current state of each LUN, captures LUN errors, and measures the level of I/O activity on every LUN, so that administrators are notified of LUN-related problems well before they impact storage system performance.

Target of the test : An SMI-S compliant storage device

Agent deploying the test : A remote agent

Outputs of the test : One set of results for each LUN on the storage system.

Configurable parameters for the test

Parameter	Description
Test period	How often should the test be executed
Host	The IP address of the storage device.
Port	The port number at which the storage device listens to. By default, this is *NULL*.
User and Password	Specify the credentials of a user who has the right to execute API commands on the storage device and pull out metrics. The exact role that is to be assigned to such a user will differ from one device to another – for instance, when monitoring 3PAR, you will have to provide the credentials of a user who has been assigned the **Monitor** role, here.
Confirm Password	Confirm the password by retyping it here.
SSL	Set this flag to **Yes**, if the storage device being monitored is SSL-enabled.
IsEmbedded	If this flag is set to **True**, it indicates that the SMI-S provider is embedded on the storage platform. On the other hand, if this flag is set to **False**, it indicates that the SMI-S provider has been implemented as a proxy.
SerialNumber	If the SMI-S provider has been implemented as a proxy, then such a provider can be configured to manage multiple storage devices. This is why, if the IsEmbedded flag is

Parameter	Description
	set to **False**, you will have to explicitly specify which storage system you want the eG agent to monitor. Since each storage system is uniquely identified by a SerialNumber, specify the same here. The format of this number and where you can find it will differ from one storage system to another. You are hence advised to contact the storage administrator to know what to enter against SerialNumber. For example, the serial number for an EMC CLARiiON device will be of the format, **FCNMM094900059**.
NameSpace	Specify the namespace that uniquely identifies the profiles specific to the provider in use.

Measurements made by the test

Measurement	Description	Measurement Unit	Interpretation
Health state	Indicates how healthy this LUN currently is.		The values that this measure can report and their corresponding numeric values are discussed in the table below: Numeric Value / Measure Value 0 / OK 1 / Unknown 2 / Degraded/Warning 3 / Minor failure 4 / Major failure 5 / Critical failure 6 / Non-recoverable error **Note:** By default, this measure reports the **Measure Value**s discussed above to indicate the state of a LUN In the graph of this measure however, states are represented using the numeric equivalents only.
Operational status	Indicates the current operational state of this		The values that this measure can report and their corresponding numeric values

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td>LUN.</td><td></td><td>are discussed in the table below:

<table><tr><th>Numeric Value</th><th>Measure Value</th></tr><tr><td>0</td><td>OK</td></tr><tr><td>1</td><td>In Service</td></tr><tr><td>2</td><td>Power Mode</td></tr><tr><td>3</td><td>Completed</td></tr><tr><td>4</td><td>Starting</td></tr><tr><td>5</td><td>Dormant</td></tr><tr><td>6</td><td>Other</td></tr><tr><td>7</td><td>Unknown</td></tr><tr><td>8</td><td>Stopping</td></tr><tr><td>9</td><td>Stressed</td></tr><tr><td>10</td><td>Stopped</td></tr><tr><td>11</td><td>Supporting Entity in Error</td></tr><tr><td>12</td><td>Degraded or Predicted Failure</td></tr><tr><td>13</td><td>Predictive Failure</td></tr><tr><td>14</td><td>Lost Communication</td></tr><tr><td>15</td><td>No Contact</td></tr><tr><td>16</td><td>Aborted</td></tr><tr><td>17</td><td>Error</td></tr><tr><td>18</td><td>Non-Recoverable Error</td></tr></table>
Note:

By default, this measure reports the Measure Values discussed above to indicate the operational state of a LUN. In the graph of this measure however, operational states are represented using the numeric equivalents only.</td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td>Detailed operational state</td><td>Describes the current operational state of this LUN.</td><td></td><td>This measure will be reported only if the API provides a detailed operational state.

Typically, the detailed state will describe why the LUN is in a particular operational state. For instance, if the Operational status measure reports the value Stopping for a LUN, then this measure will explain why that LUN is being stopped.

The values that this measure can report and their corresponding numeric values are discussed in the table below:

<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>Online</td></tr>
<tr><td>1</td><td>Success</td></tr>
<tr><td>2</td><td>Power Saving Mode</td></tr>
<tr><td>3</td><td>Write Protected</td></tr>
<tr><td>4</td><td>Write Disabled</td></tr>
<tr><td>5</td><td>Not Ready</td></tr>
<tr><td>6</td><td>Removed</td></tr>
<tr><td>7</td><td>Rebooting</td></tr>
<tr><td>8</td><td>Offline</td></tr>
<tr><td>9</td><td>Failure</td></tr>
</table>

Note:

By default, this measure reports the Measure Values discussed above to indicate the detailed operational state of a LUN. In the graph of this measure however, detailed operational states are represented using the numeric equivalents only.</td></tr>
<tr><td>Data transmitted</td><td>Indicates the rate at</td><td>MB/Sec</td><td></td></tr>
</table>

Measurement	Description	Measurement Unit	Interpretation
	which data was transmitted by this LUN.		
IOPS	Indicates the rate at which I/O operations were performed on this LUN.	IOPS	Compare the value of this measure across LUNs to know which LUN handled the maximum number of I/O requests and which handled the least. If the gap between the two is very high, then it indicates serious irregularities in load-balancing across LUNs. You may then want to take a look at the Reads and Writes measures to understand what to fine-tune – the load-balancing algorithm for read requests or that of the write requests.
Reads	Indicates the rate at which read operations were performed on this LUN.	Reads/Sec	Compare the value of this measure across LUNs to know which LUN handled the maximum number of read requests and which handled the least.
Writes	Indicates the rate at which write operations were performed on this LUN.	Writes/Sec	Compare the value of this measure across LUNs to know which LUN handled the maximum number of write requests and which handled the least.
Data reads	Indicates the rate at which data is read from this LUN.	MB/Sec	Compare the value of these measures across LUNs to identify the slowest LUN in terms of servicing read and write requests (respectively).
Data writes	Indicates the rate at which data is written to this LUN.	MB/Sec	
LUN busy	Indicates the percentage of time this LUN was busy processing requests.	Percent	Compare the value of this measure across LUNs to know which LUN was the busiest and which LUN was not. If the gap between the two is very high, then it indicates serious irregularities in load-balancing across LUNs.
Average read size	Indicates the amount of data read from this LUN	MB/Op	Compare the value of these measures across LUNs to identify the slowest LUN

Measurement	Description	Measurement Unit	Interpretation
	per I/O operation		in terms of servicing read and write requests (respectively).
Average write size	Indicates the amount of data written to this LUN per I/O operation.	MB/Op	
Read hit	Indicates the percentage of read requests that were serviced by the cache of this LUN.	Percent	A high value is desired for this measure. A very low value is a cause for concern, as it indicates that cache usage is very poor; this in turn implies that direct LUN accesses, which are expensive operations, are high.
Write hit	Indicates the percentage of write requests that were serviced by the cache of this LUN.	Percent	A high value is desired for this measure. A very low value is a cause for concern, as it indicates that cache usage is very poor; this in turn implies that direct LUN accesses, which are expensive operations, are high.
Average response time	Indicates the time taken by this LUN to respond to I/O requests.	Microsecs	Ideally, this value should be low. If not, it implies that the LUN is slow.
Queue depth	Indicates the number of requests that are in queue for this LUN.	Number	A consistent increase in this value indicates a potential processing bottleneck with the LUN.

3.4 The Storage RAID System Layer

This layer monitors the health of and I/O activity on the storage processors (SP) and SP ports of the storage system.

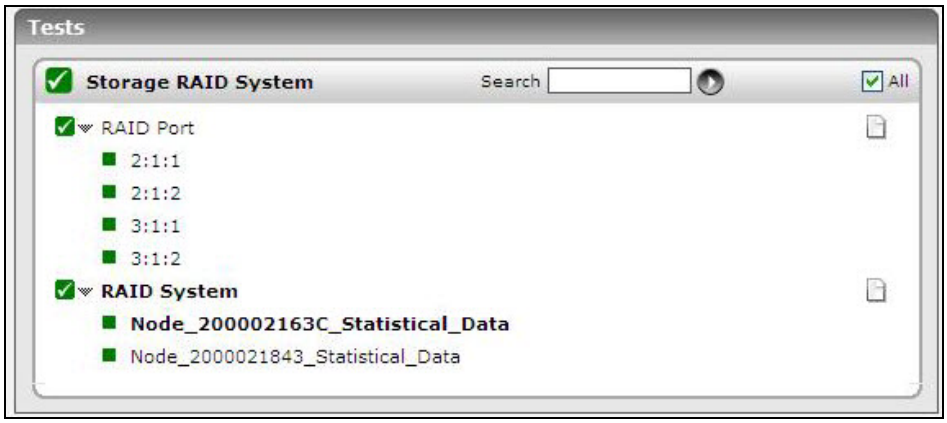

Figure 3.5: The tests mapped to the Storage RAID System layer

3.4.1 RAID System Test

The storage processor enables the administrator in serving the purpose of the following:

- creating raid groups
- binding LUNs
- execute CLI commands
- perform read/write operations from external server to SAN

Excessive usage of or heavy I/O load on a single storage processor can cause a marked deterioration in the overall performance of the storage sub-system, as it is indicative of severe deficiencies in the load-balancing algorithm that drives the storage processors. Using the **RAID System** test, administrators can easily monitor the current state, usage, and load on each of the storage processors on the storage system, quickly detect an overload condition, precisely point to the storage processor that is bearing its brunt, and promptly initiate measures to resolve the issue, so as to ensure the optimal performance of the storage system.

Target of the test : An SMI-S compliant storage device

Agent deploying the test : A remote agent

Outputs of the test : One set of results for each storage processor on the storage system.

Configurable parameters for the test

Parameter	Description
Test period	How often should the test be executed

Parameter	Description
Host	The IP address of the storage device.
Port	The port number at which the storage device listens to. By default, this is *NULL*.
User and Password	Specify the credentials of a user who has the right to execute API commands on the storage device and pull out metrics. The exact role that is to be assigned to such a user will differ from one device to another – for instance, when monitoring 3PAR, you will have to provide the credentials of a user who has been assigned the **Monitor** role, here.
Confirm Password	Confirm the password by retyping it here.
SSL	Set this flag to **Yes**, if the storage device being monitored is SSL-enabled.
IsEmbedded	If this flag is set to **True**, it indicates that the SMI-S provider is embedded on the storage platform. On the other hand, if this flag is set to **False**, it indicates that the SMI-S provider has been implemented as a proxy.
SerialNumber	If the SMI-S provider has been implemented as a proxy, then such a provider can be configured to manage multiple storage devices. This is why, if the IsEmbedded flag is set to **False**, you will have to explicitly specify which storage system you want the eG agent to monitor. Since each storage system is uniquely identified by a SerialNumber, specify the same here. The format of this number and where you can find it will differ from one storage system to another. You are hence advised to contact the storage administrator to know what to enter against SerialNumber. For example, the serial number for an EMC CLARiiON device will be of the format, **FCNMM094900059**.
NameSpace	Specify the namespace that uniquely identifies the profiles specific to the provider in use.

Measurements made by the test

Measurement	Description	Measurement Unit	Interpretation
Operational status	Indicates the current operational state of this storage processor.		The values that this measure can report and their corresponding numeric values are discussed in the table below: Numeric Value: 0 — Measure Value: OK

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>1</td><td>In Service</td></tr>
<tr><td>2</td><td>Power Mode</td></tr>
<tr><td>3</td><td>Completed</td></tr>
<tr><td>4</td><td>Starting</td></tr>
<tr><td>5</td><td>Dormant</td></tr>
<tr><td>6</td><td>Other</td></tr>
<tr><td>7</td><td>Unknown</td></tr>
<tr><td>8</td><td>Stopping</td></tr>
<tr><td>9</td><td>Stressed</td></tr>
<tr><td>10</td><td>Stopped</td></tr>
<tr><td>11</td><td>Supporting Entity in Error</td></tr>
<tr><td>12</td><td>Degraded or Predicted Failure</td></tr>
<tr><td>13</td><td>Predictive Failure</td></tr>
<tr><td>14</td><td>Lost Communication</td></tr>
<tr><td>15</td><td>No Contact</td></tr>
<tr><td>16</td><td>Aborted</td></tr>
<tr><td>17</td><td>Error</td></tr>
<tr><td>18</td><td>Non-Recoverable Error</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the operational state of a storage processor. In the graph of this measure however, operational states are represented using the numeric equivalents only.
</td></tr>
<tr><td>Detailed operational</td><td>Describes the current</td><td></td><td>This measure will be reported only if</td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td>state</td><td>operational state of this storage processor.</td><td></td><td>the API provides a detailed operational state.

Typically, the detailed state will describe why the storage processor is in a particular operational state. For instance, if the Operational status measure reports the value Stopping for a storage processor, then this measure will explain why that storage processor is being stopped.

The values that this measure can report and their corresponding numeric values are discussed in the table below:

<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>Online</td></tr>
<tr><td>1</td><td>Success</td></tr>
<tr><td>2</td><td>Power Saving Mode</td></tr>
<tr><td>3</td><td>Write Protected</td></tr>
<tr><td>4</td><td>Write Disabled</td></tr>
<tr><td>5</td><td>Not Ready</td></tr>
<tr><td>6</td><td>Removed</td></tr>
<tr><td>7</td><td>Rebooting</td></tr>
<tr><td>8</td><td>Offline</td></tr>
<tr><td>9</td><td>Failure</td></tr>
</table>

Note:

By default, this measure reports the Measure Values discussed above to indicate the detailed operational state of a storage processor. In the graph of this measure however, detailed operational states are represented using the numeric equivalents only.</td></tr>
</table>

Measurement	Description	Measurement Unit	Interpretation
Data transmitted	Indicates the rate at which data was transmitted by this storage processor.	MB/Sec	
IOPS	Indicates the rate at which I/O operations were performed on this storage processor.	IOPS	Compare the value of this measure across storage processors to know which storage processor handled the maximum number of I/O requests and which handled the least. If the gap between the two is very high, then it indicates serious irregularities in load-balancing across storage processors. You may then want to take a look at the Reads and Writes measures to understand what to fine-tune – the load-balancing algorithm for read requests or that of the write requests.
Reads	Indicates the rate at which read operations were performed on this storage processor.	Reads/Sec	Compare the value of this measure across storage processors to know which storage processor handled the maximum number of read requests and which handled the least.
Writes	Indicates the rate at which write operations were performed on this storage processor.	Writes/Sec	Compare the value of this measure across storage processors to know which storage processor handled the maximum number of write requests and which handled the least.
Data reads	Indicates the rate at which data is read from this storage processor.	MB/Sec	Compare the value of these measures across storage processors to identify the slowest storage processor in terms of servicing read and write requests (respectively).
Data writes	Indicates the rate at which data is written to this storage processor.	MB/Sec	
Average read size	Indicates the amount of data read from this storage processor per I/O operation	MB/Op	Compare the value of these measures across storage processors to identify the slowest storage processor in terms of servicing read and write requests

Measurement	Description	Measurement Unit	Interpretation
Average write size	Indicates the amount of data written to this storage processor per I/O operation.	MB/Op	(respectively).
Read hit	Indicates the percentage of read requests that were serviced by the cache of this storage processor.	Percent	A high value is desired for this measure. A very low value is a cause for concern, as it indicates that cache usage is very poor; this in turn implies that direct storage processor accesses, which are expensive operations, are high.
Write hit	Indicates the percentage of write requests that were serviced by the cache of this storage processor.	Percent	A high value is desired for this measure. A very low value is a cause for concern, as it indicates that cache usage is very poor; this in turn implies that direct storage processor accesses, which are expensive operations, are high.

3.4.2 RAID Ports Test

Storage ports help the storage processors receive and process I/O requests. By periodically checking port status and measuring the I/O load on the ports, you can identify overloaded ports and thus proactively detect potential/existing load-balancing irregularities and/or processing bottlenecks with the ports. The **RAID Ports** test facilitates this port check. For every port configured for the storage processors supported by the storage system, this test reports the port state, the I/O load on the ports, and the processing ability of the ports. In the process, the test not only points administrators to overloaded ports, but also puts a finger on ports that are slow when processing I/O requests.

Target of the test : An SMI-S compliant storage device

Agent deploying the test : A remote agent

Outputs of the test : One set of results for each storage port on the storage system.

Configurable parameters for the test

Parameter	Description
Test period	How often should the test be executed
Host	The IP address of the storage device.
Port	The port number at which the storage device listens to. By default, this is *NULL*.
User and Password	Specify the credentials of a user who has the right to execute API commands on the storage device and pull out metrics. The exact role that is to be assigned to such a user will differ from one device to another – for instance, when monitoring 3PAR, you will have to provide the credentials of a user who has been assigned the **Monitor** role, here.
Confirm Password	Confirm the password by retyping it here.
SSL	Set this flag to **Yes**, if the storage device being monitored is SSL-enabled.
IsEmbedded	If this flag is set to **True**, it indicates that the SMI-S provider is embedded on the storage platform. On the other hand, if this flag is set to **False**, it indicates that the SMI-S provider has been implemented as a proxy.
SerialNumber	If the SMI-S provider has been implemented as a proxy, then such a provider can be configured to manage multiple storage devices. This is why, if the IsEmbedded flag is set to **False**, you will have to explicitly specify which storage system you want the eG agent to monitor. Since each storage system is uniquely identified by a SerialNumber, specify the same here. The format of this number and where you can find it will differ from one storage system to another. You are hence advised to contact the storage administrator to know what to enter against SerialNumber. For example, the serial number for an EMC CLARiiON device will be of the format, **FCNMM094900059**.
NameSpace	Specify the namespace that uniquely identifies the profiles specific to the provider in use.

Measurements made by the test

Measurement	Description	Measurement Unit	Interpretation
Health state	Indicates how healthy this port currently is.		The values that this measure can report and their corresponding numeric values are discussed in the table below:

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>OK</td></tr>
<tr><td>1</td><td>Unknown</td></tr>
<tr><td>2</td><td>Degraded/Warning</td></tr>
<tr><td>3</td><td>Minor failure</td></tr>
<tr><td>4</td><td>Major failure</td></tr>
<tr><td>5</td><td>Critical failure</td></tr>
<tr><td>6</td><td>Non-recoverable error</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the state of a port. In the graph of this measure however, states are represented using the numeric equivalents only.
</td></tr>
<tr><td>Operational status</td><td>Indicates the current operational state of this port.</td><td></td><td>The values that this measure can report and their corresponding numeric values are discussed in the table below:
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>OK</td></tr>
<tr><td>1</td><td>In Service</td></tr>
<tr><td>2</td><td>Power Mode</td></tr>
<tr><td>3</td><td>Completed</td></tr>
<tr><td>4</td><td>Starting</td></tr>
<tr><td>5</td><td>Dormant</td></tr>
<tr><td>6</td><td>Other</td></tr>
<tr><td>7</td><td>Unknown</td></tr>
<tr><td>8</td><td>Stopping</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>9</td><td>Stressed</td></tr>
<tr><td>10</td><td>Stopped</td></tr>
<tr><td>11</td><td>Supporting Entity in Error</td></tr>
<tr><td>12</td><td>Degraded or Predicted Failure</td></tr>
<tr><td>13</td><td>Predictive Failure</td></tr>
<tr><td>14</td><td>Lost Communication</td></tr>
<tr><td>15</td><td>No Contact</td></tr>
<tr><td>16</td><td>Aborted</td></tr>
<tr><td>17</td><td>Error</td></tr>
<tr><td>18</td><td>Non-Recoverable Error</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the operational state of a port. In the graph of this measure however, operational states are represented using the numeric equivalents only.
</td></tr>
<tr><td>Detailed operational state</td><td>Describes the current operational state of this port.</td><td></td><td>This measure will be reported only if the API provides a detailed operational state.
Typically, the detailed state will describe why the port is in a particular operational state. For instance, if the Operational status measure reports the value Stopping for a port, then this measure will explain why that port is being stopped.
The values that this measure can report and their corresponding numeric values</td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>are discussed in the table below:
<table><tr><th>Numeric Value</th><th>Measure Value</th></tr><tr><td>0</td><td>Online</td></tr><tr><td>1</td><td>Success</td></tr><tr><td>2</td><td>Power Saving Mode</td></tr><tr><td>3</td><td>Write Protected</td></tr><tr><td>4</td><td>Write Disabled</td></tr><tr><td>5</td><td>Not Ready</td></tr><tr><td>6</td><td>Removed</td></tr><tr><td>7</td><td>Rebooting</td></tr><tr><td>8</td><td>Offline</td></tr><tr><td>9</td><td>Failure</td></tr></table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the detailed operational state of a port. In the graph of this measure however, detailed operational states are represented using the numeric equivalents only.</td></tr>
<tr><td>Data transmitted</td><td>Indicates the rate at which data was transmitted by this port.</td><td>MB/Sec</td><td></td></tr>
<tr><td>IOPS</td><td>Indicates the rate at which I/O operations were performed on this port.</td><td>IOPS</td><td>Compare the value of this measure across ports to know which port handled the maximum number of I/O requests and which handled the least. If the gap between the two is very high, then it indicates serious irregularities in load-balancing across ports.</td></tr>
</table>

3.5 The Storage RAID Array Layer

Using the test mapped to this layer, administrators can monitor the overall health, operational state, and I/O activity on the RAID arrays.

Figure 3.6: The test mapped to the Storage RAID Array layer

3.5.1 RAID Arrays Test

This test monitors the current state, overall health, and the load-balancing capability of each storage array in the storage system. With the help of this test, administrators can be proactively alerted to potential array failures / slowdowns / overload conditions. This way, irregularities in the distribution of I/O load across arrays comes to light, prompting administrators to fine-tune the load-balancing algorithm.

Target of the test : An SMI-S compliant storage device

Agent deploying the test : A remote agent

Outputs of the test : One set of results for each storage array on the storage system.

Configurable parameters for the test

Parameter	Description
Test period	How often should the test be executed.
Host	The IP address of the storage device.
Port	The port number at which the storage device listens to. By default, this is *NULL*.
User and Password	Specify the credentials of a user who has the right to execute API commands on the

Parameter	Description
	storage device and pull out metrics. The exact role that is to be assigned to such a user will differ from one device to another – for instance, when monitoring 3PAR, you will have to provide the credentials of a user who has been assigned the **Monitor** role, here.
Confirm Password	Confirm the password by retyping it here.
SSL	Set this flag to **Yes**, if the storage device being monitored is SSL-enabled.
IsEmbedded	If this flag is set to **True**, it indicates that the SMI-S provider is embedded on the storage platform. On the other hand, if this flag is set to **False**, it indicates that the SMI-S provider has been implemented as a proxy.
SerialNumber	If the SMI-S provider has been implemented as a proxy, then such a provider can be configured to manage multiple storage devices. This is why, if the IsEmbedded flag is set to **False**, you will have to explicitly specify which storage system you want the eG agent to monitor. Since each storage system is uniquely identified by a SerialNumber, specify the same here. The format of this number and where you can find it will differ from one storage system to another. You are hence advised to contact the storage administrator to know what to enter against SerialNumber. For example, the serial number for an EMC CLARiiON device will be of the format, **FCNMM094900059**.
NameSpace	Specify the namespace that uniquely identifies the profiles specific to the provider in use.

Measurements made by the test

Measurement	Description	Measurement Unit	Interpretation
Operational status	Indicates the current operational state of this storage array.		The values that this measure can report and their corresponding numeric values are discussed in the table below: Numeric Value / Measure Value 0 / OK 1 / In Service 2 / Power Mode 3 / Completed

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>4</td><td>Starting</td></tr>
<tr><td>5</td><td>Dormant</td></tr>
<tr><td>6</td><td>Other</td></tr>
<tr><td>7</td><td>Unknown</td></tr>
<tr><td>8</td><td>Stopping</td></tr>
<tr><td>9</td><td>Stressed</td></tr>
<tr><td>10</td><td>Stopped</td></tr>
<tr><td>11</td><td>Supporting Entity in Error</td></tr>
<tr><td>12</td><td>Degraded or Predicted Failure</td></tr>
<tr><td>13</td><td>Predictive Failure</td></tr>
<tr><td>14</td><td>Lost Communication</td></tr>
<tr><td>15</td><td>No Contact</td></tr>
<tr><td>16</td><td>Aborted</td></tr>
<tr><td>17</td><td>Error</td></tr>
<tr><td>18</td><td>Non-Recoverable Error</td></tr>
</table>
Note:
By default, this measure reports the Measure Values discussed above to indicate the operational state of a storage array. In the graph of this measure however, operational states are represented using the numeric equivalents only.
</td></tr>
<tr><td>Detailed operational state</td><td>Describes the current operational state of this storage array.</td><td></td><td>This measure will be reported only if the API provides a detailed operational state.
Typically, the detailed state will</td></tr>
</table>

<table>
<tr><th>Measurement</th><th>Description</th><th>Measurement Unit</th><th>Interpretation</th></tr>
<tr><td></td><td></td><td></td><td>describe why the storage array is in a particular operational state. For instance, if the Operational status measure reports the value Stopping for a storage array, then this measure will explain why that storage array is being stopped.

The values that this measure can report and their corresponding numeric values are discussed in the table below:

<table>
<tr><th>Numeric Value</th><th>Measure Value</th></tr>
<tr><td>0</td><td>Online</td></tr>
<tr><td>1</td><td>Success</td></tr>
<tr><td>2</td><td>Power Saving Mode</td></tr>
<tr><td>3</td><td>Write Protected</td></tr>
<tr><td>4</td><td>Write Disabled</td></tr>
<tr><td>5</td><td>Not Ready</td></tr>
<tr><td>6</td><td>Removed</td></tr>
<tr><td>7</td><td>Rebooting</td></tr>
<tr><td>8</td><td>Offline</td></tr>
<tr><td>9</td><td>Failure</td></tr>
</table>

Note:

By default, this measure reports the Measure Values discussed above to indicate the detailed operational state of an array. In the graph of this measure however, detailed operational states are represented using the numeric equivalents only.</td></tr>
<tr><td>Data transmitted</td><td>Indicates the rate at which data was transmitted by this storage array.</td><td>MB/Sec</td><td></td></tr>
</table>

Measurement	Description	Measurement Unit	Interpretation
IOPS	Indicates the rate at which I/O operations were performed on this storage array.	IOPS	Compare the value of this measure across storage arrays to know which storage array handled the maximum number of I/O requests and which handled the least. If the gap between the two is very high, then it indicates serious irregularities in load-balancing across storage arrays. You may then want to take a look at the Reads and Writes measures to understand what to fine-tune – the load-balancing algorithm for read requests or that of the write requests.
Reads	Indicates the rate at which read operations were performed on this storage array.	Reads/Sec	Compare the value of this measure across storage arrays to know which storage array handled the maximum number of read requests and which handled the least.
Writes	Indicates the rate at which write operations were performed on this storage array.	Writes/Sec	Compare the value of this measure across storage arrays to know which storage array handled the maximum number of write requests and which handled the least.
Data reads	Indicates the rate at which data is read from this storage array.	MB/Sec	Compare the value of these measures across storage arrays to identify the slowest storage array in terms of servicing read and write requests (respectively).
Data writes	Indicates the rate at which data is written to this storage array.	MB/Sec	
Read hit	Indicates the percentage of read requests that were serviced by the cache of this storage array.	Percent	A high value is desired for this measure. A very low value is a cause for concern, as it indicates that cache usage is very poor; this in turn implies that direct storage array accesses, which are expensive operations, are high.
Write hit	Indicates the percentage	Percent	A high value is desired for this measure.

Measurement	Description	Measurement Unit	Interpretation
	of write requests that were serviced by the cache of this storage array.		A very low value is a cause for concern, as it indicates that cache usage is very poor; this in turn implies that direct storage array accesses, which are resource-intensive operations, are high.

About eG Innovations

eG Innovations provides intelligent performance management solutions that automate and dramatically accelerate the discovery, diagnosis, and resolution of IT performance issues in on-premises, cloud and hybrid environments. Where traditional monitoring tools often fail to provide insight into the performance drivers of business services and user experience, eG Innovations provides total performance visibility across every layer and every tier of the IT infrastructure that supports the business service chain. From desktops to applications, from servers to network and storage, from virtualization to cloud, eG Innovations helps companies proactively discover, instantly diagnose, and rapidly resolve even the most challenging performance and user experience issues.

eG Innovations is dedicated to helping businesses across the globe transform IT service delivery into a competitive advantage and a center for productivity, growth and profit. Many of the world's largest businesses use eG Enterprise to enhance IT service performance, increase operational efficiency, ensure IT effectiveness and deliver on the ROI promise of transformational IT investments across physical, virtual and cloud environments.

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