SAS Viya® 3.3 Administration: Monitoring

Monitoring: Overview

SAS Viya provides monitoring functions through several facilities. Use the monitoring system that matches your needs and your environment:

- The SAS Viya operations infrastructure collects metrics from SAS Viya applications and services. See “Operations Infrastructure: Overview” in SAS Viya Administration: Operations Infrastructure for more information. SAS Environment Manager uses the collected data to display metric information and status in these interfaces:
  - To quickly view the health and status of your SAS Viya environment, see “Use the SAS Environment Manager Dashboard for System Monitoring” on page 9.
  - To view metrics, status, and performance charts for the machines in your environment, see “Monitoring: How to (SAS Environment Manager)” on page 2.
  - To view detailed reports for the status and activity in your system, see “Use SAS Environment Manager Reports for System Monitoring” on page 3.

If you are using the SAS Viya programming-only interface, SAS Environment Manager is not deployed.

- CAS Server Monitor is a graphical web application that is embedded in the CAS server. It provides system-level monitoring for the machines and processes running under the CAS server.

To view detailed information about the load and performance for the machines and processes running under a CAS server, see “Monitoring: How to (CAS Server Monitor)” on page 10.

- Grid Monitor provides histograms to view CPU load, memory usage, disk usage, and network performance for each CAS node. Grid Monitor provides a greater level of detail than SAS Environment Manager or CAS Server Monitor. The information that is displayed in the application enables you to quickly identify the nodes that are overloaded compared to the other nodes in the CAS cluster. The application enables you to view detailed information about memory and disk usage and to monitor processes that run on the CAS cluster. See “Monitoring: How to (Grid Monitor)” on page 14.

- CAS start-up or session options can enable returning of performance metric information each time a CAS action runs. The data provided by the metrics enables you to monitor the CPU load on the CAS grid and to determine how efficiently the CAS grid is processing the actions. See “CAS Action Metrics” on page 20 for a list of the metrics that are returned.

The CAS options are available in the SAS Viya programming-only environment.
Monitoring: Concepts

A metric is a measurement that describes the performance of a component or a subsystem of SAS Viya. Because metrics are valuable only when they are regularly collected and evaluated, the operations infrastructure is dedicated to collecting data about the state of SAS Viya resources and services. A set of collector components from the infrastructure then publishes the data as a message to a RabbitMQ exchange, where a publisher sends it to ETL processes and a data mart. SAS Environment Manager uses the collected data from the data mart to display in various interfaces such as reports, tables, and availability indicators. See SAS Viya Administration: Operations Infrastructure for more information.

In a SAS Viya environment, CAS uses a controller node to distribute work to worker nodes. In this type of distributed environment, it is important to monitor the performance of each of the nodes in the environment, to ensure that nodes are not becoming overloaded and slowing down. You should also monitor session processes on the CAS nodes to ensure that individual processes are not consuming excessive resources.

Monitoring: How to (SAS Environment Manager)

Monitor Machines

Navigation

In SAS Environment Manager, select Machines from the left navigation menu to display the Machines page.

The Machines page displays a list of machines across the top of the page. An icon next to the machine name indicates the status of the machine (available, unavailable, or partially available). Select a machine from the list to display information about the machine on the charts and tables in the Machines page.

View the Status of a Machine

1. In SAS Environment Manager, select Machines from the left navigation menu to display the Machines page.

2. On the Machines page, select a machine name from the list at the top of the page. An icon beside the machine name indicates whether the services on the machine are available ☑, partially available ☑, or completely unavailable ☓.

3. By default, the chart on the Machines page displays the percentage of total CPU utilization over the last hour. Click Last hour to change the display to the last 6, 12, or 24 hours. Place your pointer on a line on the graph to view detailed information about the CPU utilization, divided into User, System, Wait, and Stolen usage. Place your pointer in the chart and use the control wheel on your mouse to zoom in to the chart.

   Note: The chart is updated every two minutes. The data that is displayed on the chart is updated every five minutes.

4. Click Memory above the chart to display the percentage of memory that is used over the selected time period. Place your pointer on a line on the graph to view detailed information about memory usage.

5. The Machine Checks table displays the results of these predefined system checks that are performed on the machine:

   Disk utilization of SAS Config filesystem
   
   The check passes if disk usage does not exceed 95%.


**Memory percent free**

The check passes if memory usage does not exceed 95%.

**Serf Health Status**

The check passes if the SAS Configuration Server is running.

The table is refreshed every 10 seconds.

6 The **Service Instances** table displays a list of the service instances that are running on the selected machine and the status, address, and port for each service instance. The data is refreshed every 10 seconds.

7 By default, the area on the right side of the Machines page displays the properties of the server. The **Properties** area displays information such as the machine address, operating system, uptime, and total memory.

8 To display the collected metrics for the server, click in the toolbar on the right side of the page. The **System Metrics** area displays detailed information about memory usage and availability.

9 To display the SAS packages that are installed on the machine, click in the toolbar on the right side of the page. The **SAS Packages** area displays the name and version number of the packages that are installed on the machine.

10 To display the system limits for the machine, click in the toolbar on the right side of the page. The **System Limits** area displays the resource limits for users on the machine.

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**Use SAS Environment Manager Reports for System Monitoring**

**Working with System Reports**

SAS Environment Manager provides a set of predefined reports that provide a view of the most important metrics for monitoring a SAS Viya deployment. The Dashboard displays a thumbnail of each report, which you can use to access the full report in SAS Report Viewer. You must be an administrator in order to view system reports.

To display the report thumbnails, on the SAS Environment Manager Dashboard, select **Show Reports**.

The report thumbnails are not live views of the full reports, but are snapshots of the report from the last time the thumbnail was generated. You must refresh the thumbnail in order to view the current state of the report. To refresh a report thumbnail, in the title bar for the report, select ![refresh icon] and then select **Refresh**.

To open a report, in the title bar for the thumbnail report, select ![open icon] and then select **Open**.

To return to SAS Environment Manager from the full view of a report, click your browser’s back button or select ![settings icon] and select **Manage Environment**.

**Monitor Application Activity**

The Application Activity report provides detailed information about SAS applications and services running on your system. See “Working with System Reports” on page 3 for information about accessing and opening reports.

When you open the report, the machines in your environment are listed along the top of the report. Select a machine for which to display the report.

Select the report page to view. The report pages are organized into these tabs:

**Main**

Displays a chart of memory usage of the 10 applications or services that are consuming the most memory. The report displays the metrics HeapUsedMax and NonHeapUsedMax.
**System Session History**
Displays a graph of the top 10 applications or services that have had the most active HTTP sessions over the previous eight hours.

**Application History**
Displays the thumbnails of detailed reports for a selected service or application. Use the menu in the upper left corner of the page to select the service or application whose reports you want to view. If you do not select a service or application, the thumbnails display aggregate data for all services and applications. Use the slider control at the top of the page to select the time range for the reports. Click \( \text{chart} \) in the upper right of any chart to view a full-size version of the chart, including legends and labels. Click \( \text{chart} \) in the upper right of the full-size chart to return to the thumbnail view.

Here are the available charts:

**Heap usage**
Displays the amount of heap memory that is used. The chart displays the metrics HeapCommitted, HeapUsed, NonHeapCommitted, and NonHeapUsed.

**HTTP sessions**
Displays the number of HTTP sessions that are used. The chart displays the metrics HTTPSessionsActive and HTTPSessionsMax.

**Class Usage**
Displays the number of classes that are used by the application or service. The chart displays the metrics Classes, ClassesLoaded, and ClassesUnloaded.

**DataSource Activity**
Displays the number of data sources that are used by the application or service. The chart displays the metrics DatasourcePrimaryActive and DatasourcePrimaryUsage.

**Garbage Collection Time**
Displays the amount of time that is used for garbage collection. The chart displays the metrics GcPsMarksweepTime and GcPsScavengeTime.

**Threads**
Displays the number of application threads that is used. The chart displays the metrics Threads, ThreadsDaemon, and ThreadsPeak.

**Uptime**
Displays the amount of time that the application or service has been running.

**Garbage Collection Count**
Displays the number of items that are collected during garbage collection. The chart displays the metrics GcPsMarksweepCount and GcPsScavengeCount.

**Data collection status**
Displays a chart of metric data points that are collected for each application.

**Monitor CAS Activity**
The CAS Activity report provides detailed information about CAS. See “Working with System Reports” on page 3 for information about accessing and opening reports.

When you open the report, the machines in your environment are listed along the top of the report. Select a machine for which to display the report.

Select the report page that you want to view. The report pages are organized into these tabs:

**Main**
Displays the **Memory Used**, **I/O**, and **Threads** charts.
CPU Load
Displays the CPU Load and CPU Usage charts. The CPU Usage chart displays the metrics SystemCPU and UserCPU.

System Info
Displays the thumbnails of detailed reports for the CAS servers. Use the slider control at the top of the page to select the time range for the reports. Click ⚫ in the upper right of any chart to view a full-size version of the chart, including legends and labels. Click ⚫ in the upper right of the full-size chart to return to the thumbnail view.
Here are the available charts:
- I/O Wait Time
- IRQ Time
- Open Files
- Free Memory

System Details
Displays a table of detailed metric information for the CAS servers, which are captured at one-minute intervals. The table includes data for load averages, free memory, idle time, and IRQ time.

Node Details
Displays a table of detailed information about the CPU load on the CAS server nodes, which are captured at one-minute intervals.

CAS Details
Displays a table of detailed metrics for the CAS servers, which are captured at one-minute intervals. The table includes metrics for memory used, CPU usage, and uptime.

Monitor Disk Space
The Disk Space report provides detailed information about disk space and usage. See “Working with System Reports” on page 3 for information about accessing and opening reports.

When you open the report, the machines in your environment are listed along the top of the report. Select a machine for which to display the report.
Select the report page to view. The report pages are organized into these tabs:

Main
Displays a chart of the top 10 filesystems on SAS Viya machines that have the least amount of free space.

Storage Dashboard
Displays a chart of the total percentage of free disk space on each machine in the system. It also displays a series of charts of the top 10 file storage locations that have the least amount of available space.

In the Bottom 10 paths by Percent available charts, the black line represents the available space. The background of the chart is color-coded to indicate whether the available space is in the acceptable zone (green), the warning zone (yellow), or the danger zone (red). For example, the disk corresponding to this graph has 18% free space, which is in the danger zone.

All disk usage over time
Displays a chart of the percentage of free space on all paths for each machine over the previous 48 hours.
Machine disk usage over time
Displays a chart of the total percentage of free disk space on each machine in the system. It also displays a chart of the percentage of free space on all paths for each machine over the previous 48 hours.

Disk usage forecast
Displays a chart of the percentage of free space for a selected machine and the path over the previous 24 hours. It also includes a projection of the free space that will be available over the next 48 hours. Select a machine from the list above the chart, and then select a path from the list below the machine list.

Storage Map
Displays a visual representation of the size and available free space of all disks in all machines. Each disk is represented by a color-coded block. The size of the block represents the size of the disk. The color of the block represents the amount of free space. The color shifts from blue to red as the disk space decreases. Place your pointer on a block to view the size and percentage of free space for the disk.

Details
Displays a table of the size and free space for a selected machine and path, and that is recorded at one-minute intervals. Select a machine from the list above the table, and then select a path from the list below the machine list.

When monitoring of CAS disk usage, understand that owned disk space is the space used by files that are created in SAS_DISK_CACHE directories from in-memory blocks. These files cannot be shared with other server processes or session processes. Shared disk space is the space that is used by existing SASHDAT files from a co-located data source (PATH, HDFS, or DNFS). These files can be shared with other server processes or session processes.

Monitor SAS Infrastructure Data Server Tables
The Infrastructure Data Server Tables report provides detailed information about the table size and usage on the SAS Infrastructure Data Server. See “Working with System Reports” on page 3 for information about accessing and opening reports.

Select the report page to view. The report pages are organized into these tabs:

Main
Displays a chart of the five largest tables in the SAS Infrastructure Data Server. The chart displays the metrics TableSize Max, IndexSize Max, and ToastSize Max for each table.

Table Usage Trend
Displays a graph of the total size of all SAS Infrastructure Data Server tables over the past 36 hours. The chart separately displays the metrics TableSize, IndexSize, and ToastSize for all tables.

Application Usage History
Displays an animated chart of the size of the largest SAS Infrastructure Data Server tables over the previous 36 hours. Click ▶ below the chart to start the animation. The chart displays the size of the tables at the time indicated on the slider control below the chart. You can use the slider control to view the size of the tables at a selected time. The chart separately displays the metrics TableSize, IndexSize, and ToastSize for each table.

Table Size History
Displays an animated chart of the size of the largest SAS Infrastructure Data Server tables over the previous five hours. Click ▶ below the chart to start the animation. The chart displays the size of the tables at the time indicated on the slider control below the chart. You can use the slider control to view the size of the tables at a selected time. The chart separately displays the metrics TableSize, IndexSize, and ToastSize for each table.

Monitor Message Queue Activity
The Message Queue Activity report provides detailed information about traffic and activity on the RabbitMQ message queues that used by the operations infrastructure to provide log messages, metric data, notifications,
and alerts to consumers such as SAS Environment Manager. See “Working with System Reports” on page 3 for information about accessing and opening reports.

Select the report page to view. The report pages are organized into these tabs:

**Main**
- Displays a chart of the total amount of data that is published to and from each message queue. The chart displays the PublishIn Max and PublishOut Max metrics for each message queue.

**Cumulative traffic**
- Displays a graph of the amount of data that is published to a selected message queue over the previous 48 hours. Select the queue name from the list at the top of the chart. The chart displays the PublishIn and PublishOut metrics.

**Activity over time**
- Displays an animated chart of the amount of data that is published to message queues over the previous 36 hours. Click ▶ below the chart to start the animation. The chart displays the amount of data that is published to the queue at the time indicated on the slider control below the chart. You can use the slider control to view the amount of data that is published at a selected time.

**System info**
- Displays charts illustrating the number of RunQueue instructions, the amount of data written to queues, and the amount of memory that is used over the previous 48 hours. The charts display the RunQueue, IoWriteBytes, and MemUsed metrics.

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**Monitor System Activity**

The System Activity report provides detailed information about CPU usage, memory usage, and network activity. See “Working with System Reports” on page 3 for information about accessing and opening reports.

When you open the report, the machines in your environment are listed along the top of the report. Select a machine to display the report for that machine.

Select the report page to view. The report pages are organized into these tabs:

**Main**
- Displays charts of the load average and memory usage for a selected machine over a selected time range. Select the machine from the list at the top of the chart. Select the time range using the slider control at the top of the chart.

**CPU history**
- Displays a chart of the CPU usage for a selected machine over a selected time range. Select the machine from the list at the top of the chart. Select the time range using the slider control at the top of the chart. The chart displays separate lines for the metrics System CPU% and User CPU%.

**Memory Usage history**
- Displays a chart of the free memory and the used memory for a selected machine over a selected time range. The orange area at the top of the chart represents the free memory, and the green area at the bottom of the chart represents the used memory. The two values together always add up to the total memory. Select the machine from the list at the top of the chart. Select the time range using the slider control at the top of the chart.

**Network Activity history**
- Displays charts of the network activity and the cumulative network I/O for a selected machine and an interface over a selected time range. Select the machine and the interface from the lists at the top of the chart. Select the time range using the slider control at the top of the chart. The Network Activity over time chart displays the TransmitBytes and ReceiveBytes metrics. The Cumulative Network I/O chart displays the TransmitBytes_cnt and ReceiveBytes_cnt metrics.

**Memory Animation**
- Displays an animated chart of the used memory and the free memory for all machines over the previous 36 hours. Click ▶ below the chart to start the animation. The chart displays the memory usage at the time...
indicated on the slider control below the chart. You can use the slider control to view the memory usage at a selected time. The chart separately displays the metrics Used Memory and Free Memory for each machine. The orange area at the top of the chart represents the free memory, and the green area at the bottom of the chart represents the used memory.

**CPU Details Animation**
Displays an animated chart of the CPU usage for all machines over the previous 36 hours. Click ▶ below the chart to start the animation. The chart displays the CPU usage at the time indicated on the slider control below the chart. You can use the slider control to view the CPU usage at a selected time. The chart separately displays the metrics UserCPU, WaitCPU, SystemCPU, and StolenCPU for each machine.

**Network Activity Animation**
Displays an animated chart of the network activity for all machines over the previous 36 hours. Click ▶ below the chart to start the animation. The chart displays the network activity at the time indicated on the slider control below the chart. You can use the slider control to view the activity at a selected time. The chart separately displays the metrics TransmitBytes_cnt and ReceiveBytes_cnt for each machine.

**System Details**
Displays a table of detailed system metrics for selected machines over a selected time period, which is captured at one-minute intervals. The table includes information about memory usage, CPU usage, and system load. Select a machine from the list at the top of the table. Select a time period by using the slider control at the top of the table.

**Network Details**
Displays a table of detailed network metrics for the selected machines and the interfaces over a selected time period, which is captured at one-minute intervals. The table includes information about received data, transmitted data, and transmit errors. Select a machine and an interface from the lists at the top of the table. Select a time period by using the slider control at the top of the table.

**Monitor User Activity**
The User Activity report provides a view of audit information. See “Working with System Reports” on page 3 for information about accessing and opening reports.

Select the report page to view. The report pages are organized into these tabs:

- **Main**
  
  Contains thumbnail graphs for the charts Most active users, Activity counts, Most active data, and User activity.

- **Most Active Users**
  
  Displays the Most Active Users and Activity Over Time charts, and a table of the audit records that are ordered by level of user activity. The table does not display audit records from SAS internal users. Select a bar in the Most Active Users chart to display the Activity Over Time chart for the selected user, and to list the audit records only for the selected user.

- **Application Usage**
  
  Displays the Most used Applications and Application Activity charts, and a table of the audit records that are ordered by level of application activity. Select a bar in the Most used Applications chart to display the Application Activity chart for the selected application, and to list the audit records only for the selected application.

- **Report Activity**
  
  Displays the Top Report Usage chart and a table of the audit records for report access. By default, the chart and the table display activity for all users. To view report usage and the audit records only for a specific user, select the user in the Users menu.

- **Data Plan Activity**
  
  Displays the Top Report Usage chart and a table of the audit records for data plan access. By default, the chart and the table display activity for all users. To view data plan usage and the audit records only for a specific user, select the user in the Users menu.
Data Activity
Displays the Top Report Usage chart and a table of the audit records for data table access. By default, the chart and the table display data table activity for all users. To view data table activity usage and the audit records only for a specific user, select the user in the Users menu.

Failures
Displays the Failed Requests per Application chart and the Failed Activities chart, and a table of the audit records only for failed requests. By default, the Failed Activities chart and the audit records table display failures for all applications. To view the Failed Activities chart and the audit records for a specific application, select the application’s bar in the Failed Requests per Application chart.

Details
Displays a table of audit records. By default, the table displays all audit records. To filter the table, use the menus at the top of the table to display only those records that match your selected criteria. You can filter by user, application, action, and state. You can also filter using multiple criteria.

Note: If the User Activity report is blank or displays the message Cannot find the requested data source, you must verify that the command-line interface (CLI) was deployed properly in your SAS Viya environment. See xisError - link not found - The element p049i0kijgyyipnh1wbb0n1ua0p2 was not found in the link database for more information.

Use the SAS Environment Manager Dashboard for System Monitoring

Monitor Availability of Machines and Services
The Availability tile displays grids of color-coded boxes, and each box displays the status of each machine, service, and service instance. A green box indicates that the item is available, a yellow box indicates that it is partially available, and a red box indicates that it is unavailable. The tile is updated every 10 seconds.

Selecting a box on one of the grids highlights the corresponding boxes on the other two grids. The box that you select is outlined with a solid line, and the associated boxes are outlined with a dashed line. Here are the associations between the selected boxes:

- When you click a box on the Machines grid, the services and the service instances that are running on that machine are highlighted on the Services grid and on the Service Instance grid.
- When you click a box on the Services grid, the machines on which that service is running are highlighted on the Machines grid, and the instances of the service are highlighted on the Service instances grid.
- When you click a box on the Service instances grid, the machines on which the service instance is running are highlighted on the Machines grid, and the service is highlighted on the Services grid.

Note: To deselect a box, hold down the Ctrl key and click the box. You can also hold down the Ctrl key and press the spacebar.

Place your cursor over a box to view the name of the machine, the service, or the service instance.

Double-click a box on the Machine grid to open the Services dialog box, which lists the services that are running on that machine and their availability. You can open the Machines page for the selected machine from this dialog box.

Click a box on the Service instances grid to view the machine address and the port where the instance is running.

Use the Filter field to display only certain machines, services, and service instances. As you enter characters in the Filter field, the boxes that are displayed in the Availability area dynamically change. The boxes that are displayed either match the characters that you type, or are associated with the boxes that are displayed. For example, entering laun in the Filter field might cause two Services boxes to be displayed (for the Launcher service and the Launcher server), only the Service instance boxes that are associated with the displayed services, and only the Machines boxes that are associated with the displayed services.
Evaluate CAS Nodes

The CAS System Health tile is used to display a pair of graphs that provide a quick view of the nodes that are either registered as a controller or are a worker node for the selected CAS server. Use the buttons at the top of the tile to select the graph that you want to view.

If your environment contains more than one CAS server, a menu above the graph enables you to select the server to view. When you display the dashboard, this functionality behind the tile attempts to connect to the default CAS server. If the default server cannot be found, the tile displays information for the first server to which it can connect. If it can connect to the default server, but the server does not respond within five seconds, the tile displays a message. You can then retry the server or choose another server. You define the default server in the default casServer property. This property is one of the sas.casmanagement.global properties for the CAS Management service. See “Introduction” in SAS Viya Administration: Configuration Properties for information about setting this property.

Here are the graphs displayed in the CAS System Health tile:

CPU Load
Displays a graph of the 1-minute CPU load average over the past five minutes for each node in your CAS cluster. The chart is updated every 10 seconds. Each node is represented by a separate line on the graph. The vertical scale of the graph changes, depending on the largest value that is displayed in the chart. Position your cursor over a line in the chart to identify both the node and the specific CPU load average value.

Node Memory Usage
Displays a bar chart, which displays the memory usage for each node in your CAS cluster. Each bar represents a separate node. Place your pointer over a bar on the graph to view the name of the node and its memory usage. The vertical scale of the graph changes to match the memory usage of the most heavily used node. The chart is updated every 10 seconds.

Monitoring: How to (CAS Server Monitor)

Access CAS Server Monitor
To log on to CAS Server Monitor, open a web browser and enter the following URL in the address field:

https://http-proxy-machine-name/cas-tenant-name-deployment-instance-name-http

You must have an active CAS Server session in order to access CAS Server Monitor.

For more information, see “Using CAS Server Monitor” in SAS Viya Administration: SAS Cloud Analytic Services.

Monitor CAS Process Performance
The CAS processes you can monitor with these steps correspond to SAS server processes. You can separately monitor each session that is started from the CAS server.

1. In CAS Server Monitor, beneath the Cloud Analytic Services banner, click .

2. Select Add View → CAS Process CPU Usage.

   The Process CPU Usage panel on the window displays a set of histograms. There is one histogram for each machine and the corresponding CAS server process. The histogram in the upper left is the CAS controller node. If you are not an administrator, only the histogram for the CAS controller node is displayed.
Each histogram displays the percentage of CPU usage, from 0 to 100%.

Use these histograms to note patterns of CPU usage among the CAS nodes.

3 Select Add View → CAS Process Metrics

The CAS Process Metrics panel on the window displays a set of histograms. There is one set of three histograms for each machine and the corresponding CAS server process. If you are not an administrator, only the set of histograms for the CAS controller node is displayed.

Each set of histograms displays the percentage of CPU used, amount of resident memory used, and amount of virtual memory used for the CAS process.

4 Click ▼ if you want to stop metric collection. Click ► to resume collection.

Monitor CPU Usage for a Session

1 In CAS Server Monitor, select ▶ on the left side of the window.

2 Select Add Session View and select a session.

The panel for the session displays a set of histograms, with one histogram for each machine in the grid. If you are not an administrator, only the histogram for the CAS controller node is displayed. The top half of the histogram displays the percentage of CPU load used by the session, and the bottom displays the amount of resident memory used for the session.

Monitor Host Performance

CAS Server Monitor displays histograms that enable you to view the CPU load and memory usage for all machines in your CAS server. Follow these steps:
1 In CAS Server Monitor, select 🔄 on the left side of the window.

2 To view the CPU load, select Add View ⇒ Host CPU Load Average. The Host CPU Load Average panel on the window displays a set of histograms. There is one histogram for each machine in the CAS grid. If you are not an administrator, only the histogram for the CAS controller node is displayed.

Each histogram displays the CPU load on the machine, using the same format as the Linux `xload` command. Each division on the histograms represents one load average point. The highest point on each histogram is displayed to the right of the histogram.

Use these histograms to note usage patterns among the CAS nodes. For example, if you notice that the load on a worker node machine is significantly and consistently higher than the load on other machines, you can use the Show Processes function to check for other running processes or defunct processes. See "Monitor Process Information" on page 12 for instructions on this function.

3 To view the memory usage, select Add View ⇒ Host Memory Usage. The Host Memory Usage panel on the window displays a set of histograms. There is one histogram for each machine in the CAS grid. If you are not an administrator, only the histogram for the CAS controller node is displayed.

Each histogram displays the percentage of memory used on the machine, from 0 to 100%. The percentage of memory used is displayed in green, at the top of the histogram. The percentage of virtual memory used is displayed in orange, at the bottom of the histogram.

Use these histograms to note patterns of memory usage among the CAS nodes. For example, if the memory usage is consistently high on a machine, its memory might need to be increased.

4 Click ▶ if you want to stop metric collection. Click ▶ to resume collection.

Monitor Process Information

1 Perform one of these actions in CAS Server Monitor:
   - Select 🔄 on the left side of the window and open one of the views from the Add View or Add Session View menus. Click ⏯️ to the right of a histogram. Select Show Processes.
   - Click 🔄 and select the Nodes tab. Click ⏯️ on the right side of a node’s row and select Show Processes.

2 The Processes window appears. The window displays this information:
- Metrics for the selected node, including uptime, number of processes, memory usage, CPU load, and file usage
- A histogram of the CPU load for the node
- A table containing the output from the `top` command for the selected node. The output includes metrics such as CPU usage, time, and threads for each process. If you are a SAS administrator, the window displays information about all processes. If you are not a SAS administrator, you can view information only about your own processes.

If you are the process owner, you can open a terminal window to terminate processes that are causing problems. See “Open a Terminal Window on a Node” on page 13 for information.

### Open a Terminal Window on a Node

After using the monitoring functions of CAS Server Monitor to identify problems with CAS nodes, you might want to issue commands to end processes on a node. If you are the process owner, you can launch a terminal window to manage processes on the node. Follow these steps.

1. Perform one of these actions in CAS Server Monitor:
   - Select ![icon] on the left side of the window and use the Add View menu to display the Host CPU Load Average, Host Memory Usage, CAS Process CPU Usage, or CAS Process Metrics views.
   - Click ![icon] on the right side of the histogram for a node. Select Launch Terminal. This option is available only if you are an administrator.
   - Click ![icon] and select the Nodes tab. Click ![icon] on the right side of a node’s row and select Launch Terminal.

2. A terminal window appears on the selected machine. Use the window to manage processes on the machine.

3. Type `exit` to close the terminal window.

### Change the Monitoring Display Options

When you are viewing the histograms in the Resource Monitor view in CAS Server Monitor, you can control how the histograms are displayed.

- To change how quickly the graph data is refreshed, move the slider next to the Speed label.
- To change the size of the histograms, move the slider next to the Size label.
- The default layout for a histogram view is a grid. To change to a single column, click the column icon ![icon] in the banner for a view. To return to a grid layout, click the grid icon ![icon].

To change the default view for the Resource Monitor view, select userid ⇒ Settings in the upper right of the CAS Server Monitor window. You can select a default monitor view and layout.
Monitoring: How to (Grid Monitor)

Start Grid Monitor
To start the Grid Monitor application, on the controller machine, run the script `/opt/sas/viya/home/SASFoundation/utilities/bin/gridmon.sh`. You must have authorization to log on to the controller machine, and you must have passwordless SSH for the host account that you use to log on.

Monitor Host Performance
The stand-alone Grid Monitor application displays histograms that enable you to view the CPU load, memory usage, and network performance for all machines on your CAS grid. You can also view the last 60 seconds of metric data that was collected for all machines or for a single machine. Follow these steps:

1. Start the Grid Monitor application. See “Monitoring: Overview” on page 1 for information.

2. The Grid Monitor window displays a set of histograms. There is one histogram for each machine on the grid. The histogram displays values for CPU usage (green bars, one for each CPU on the machine), network read speed (dark blue bar), network write speed (red bar), and memory usage (light blue bar).

Place your pointer over a node name to view the metric data that is represented by the bars in the chart. The metric data includes CPU usage values for each core in the machine.

3. To view average CPU and memory use for all nodes on the grid, select Menu ⇒ Show Grid History. A chart appears that shows the average CPU usage (marked by a green line) and the memory usage (marked by a blue line) for the last 60 seconds across all nodes on the grid.
4 To view metric data for a particular machine, right-click the histogram in the main Grid Monitor window and select **Show History Graph**. The chart that appears displays the average CPU usage for all the cores in the machine (green line), the CPU usage for each core (yellow lines), the percentage of memory used (light blue line), the percentage of maximum network read speed (dark blue line), and the percentage of maximum network write speed (red line). The histogram displays data for the last 60 seconds.

![CPU Histogram](image)

**Monitor Process Information**

1 In the Grid Monitor window, select **Menu ➰ Show Jobs on Grid**.

2 The Jobs window displays information about the servers and sessions that are running on the grid nodes.

![Process Information](image)

Entries that contain a value in the **Port** column represent server processes. Entries without a value in the **Port** column represent session processes.

The value in the **Owned Disk** column represents the space used by files created in CAS_DISK_CACHE directories from in-memory blocks.

The value in the **Shared Disk** column represents the space used by existing SASHDAT files from a co-located data source (PATH, HDFS, or DNFS). These files can be shared with other server processes or session processes. Access to physical memory that is backed by existing SASHDAT files can be shared with sessions.

3 Click the label of a column to sort the table by that column's values.

4 You can use the information in this window to identify processes that are consuming a large number of resources or that are defunct.

   - If users report poor performance, it might be an indication that the memory use is larger than the physical memory capacity of the machines.

   - If individual sessions by the same user have large **Owned Disk** values, you can encourage the user to promote tables to global scope in order to take advantage of memory sharing.

   - It is acceptable for the values in the **Owned Disk** and **Shared Disk** columns for a server to be larger than the physical memory capacity of the machines. However, if these values are significantly larger than the physical memory, then you should monitor the process for page faults. A large number of page faults
(combined with reports of poor performance) are an indicator that you need to add more physical memory if no other improvements are possible.

5 To remove defunct processes, select **Job Menu ➔ Kill Old Processes**. To manage other processes, open a terminal window on a selected node. Right-click the histogram for a CAS node and select **Xterm** from the menu.

### Monitor Memory and Disk Usage

You can use the Job View window to monitor the memory and disk space used by CAS processes. Because CAS uses file-backed memory mapping for in-memory tables in the majority of cases, monitoring memory and disk use are related.

1 In the Grid Monitor window, select **Menu ➔ Show Jobs on Grid** to open the Job View window.

2 Select **Job Menu ➔ Display Totals**. The total CPU and memory usage for all processes is displayed at the top of the table.

<table>
<thead>
<tr>
<th>CPU</th>
<th>Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.9 Gb</td>
<td>3.3 Gb</td>
</tr>
<tr>
<td>3.9 Gb</td>
<td>3.3 Gb</td>
</tr>
<tr>
<td>41.3 Gb</td>
<td>3.3 Gb</td>
</tr>
<tr>
<td>0.0%</td>
<td>41.3 Gb</td>
</tr>
</tbody>
</table>

Use these values to evaluate the total load on your system and the need for additional memory or disk capacity.

3 To evaluate memory usage for a particular session, locate a server process. Server processes contain a value in the **Port** column.

4 Note the value of the **Shared Disk** column. This value represents the space used by existing SASHDAT files from a co-located data source (PATH, HDFS, or DNFS). These files can be shared with other server processes or session processes. As other processes compete for memory, these tables are paged from disk to memory and then back from memory to disk. A high rate of paging can degrade performance.

5 Compare the values in the **Memory** and **Shared Disk** columns. If the **Shared Disk** value is lower than the **Memory** value, it indicates that sufficient memory is available for both the processes and the shared tables. In this case, performance problems are not caused by paging.

### Monitor Disk Usage

1 In the Grid Monitor window, select **Menu ➔ Show Disks**.

2 The Disks window appears. This window lists the disks used by your CAS environment. It is important that you know which file systems (and devices) are used for the CAS_DISK_CACHE directories. You should monitor these CAS_DISK_CACHE directories to ensure that there is enough room for the in-memory blocks that are written to them.
3 To view usage information for a disk on each machine in your CAS cluster, click the disk name in the Disks window.

4 A window with the name of the disk is displayed. This window displays a histogram for the disk usage on each node in the CAS cluster.

5 To view detailed metrics for disk use on a node, position your cursor on a histogram for a CAS node. The information includes the total space available on the disk and the space used by the selected node.
Monitor Ranks

When a server starts, a software process starts on each machine in the cluster. Each process is assigned a rank. You can monitor the processes for a server across all machines in the cluster, or for all the processes that are running on a specific machine.

To monitor processes for a server across all machines, follow these steps:

1. From the Grid Monitor window, select **Menu ⇒ Show Jobs on Grid** to display the Jobs window.

2. From the Jobs window, right-click a process and select **Show Ranks** from the pop-up menu to display the ranks for the selected session.

3. Place your pointer over a rank to display the CPU usage, memory usage, PID, and nice value for the rank on the machine.

4. If you are using cgroups, the information displayed also includes the memory usage and memory limit for the cgroup.
The **Cgroup Memory Limit** value specifies the physical memory limit on a host. For distributed servers, the limit applies to each host. Although more than the limit can be used through memory mapping, only physical memory up to the limit is used. The limit applies cumulatively to all sessions that are started on the server instance.

To monitor the processes on a single machine, follow these steps:

1. From the Grid Monitor window, right-click the histogram for a machine and select **Show Ranks on Node** from the pop-up menu. The **Ranks on machine_name** window appears.

2. Place your pointer over a rank to display the CPU usage, memory usage, ID, PID, and nice value for the rank.

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### Monitoring: How to (CAS Options)

#### View Performance Metrics for a CAS Action

To view metric performance data when you execute a CAS action, start the CAS server with the `-metrics` option, or set the `cas.metrics` configuration option to `true`.

To start displaying performance metrics for a running server, set the `metrics` session option to `true`.

If you enable metric collection, a standard set of metric data is returned to the log each time that a CAS action completes. The same data is displayed by both the server and the client, although the names of the metrics are different. See "CAS Action Metrics" on page 20 for a list of the metrics that are displayed.

Here is an example of the metrics that are displayed for a CAS action:

```plaintext
NOTE: Executing action 'tkimstat.summary'
```
Evaluate CPU Utilization for an Action

If you specify that performance metrics are collected when CAS actions are executed, you can use these metrics to evaluate the utilization of your CAS environment.

The server metric CPU time is displayed in both the number of seconds and a percentage. Here is an example:

```
cpu time    0.165974 seconds (664.19%)
```

The percentage is calculated as \( \frac{\text{cpuUserTime} + \text{cpuSystemTime}}{\text{elapsedTime}} \). On a single-threaded system, the maximum value for this metric is 100%. However, for a multi-core system, the maximum value is \( 100\% \times \text{number of cores} \). In this example, the system has 96 cores, so the maximum value is 9600%.

Monitoring: Troubleshooting

Why Can I Not See Machine Information in SAS Environment Manager?

If you are a tenant administrator, you do not have the permissions to look at machine health information or metric data. Your provider-level administrator can access this information.

Monitoring: Reference

CAS Action Metrics

If you enable metric collection for CAS actions, a standard set of metric data is returned each time that a CAS action completes. The same data is displayed by both the server and the client. Here is the data that is displayed:
<table>
<thead>
<tr>
<th>Server Metric Name</th>
<th>Client Metric Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>real time</td>
<td>elapsedTime</td>
<td>The number of seconds in actual time required to run the action.</td>
</tr>
<tr>
<td></td>
<td>cpuUserTime</td>
<td>The total number of seconds taken by the action in user mode across all cores that were used to run the action.</td>
</tr>
<tr>
<td></td>
<td>cpuSystemTime</td>
<td>The total number of seconds taken by the action in system mode across all cores that were used to run the action.</td>
</tr>
<tr>
<td>cpu time</td>
<td></td>
<td>CPU time is measured and displayed in these formats:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- cpuUserTime + cpuSystemTime, displayed in seconds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- (cpuUserTime + cpuSystemTime) / elapsedTime, displayed as a percentage.</td>
</tr>
<tr>
<td>total nodes</td>
<td>systemNodes</td>
<td>The number of nodes in the cluster (total nodes display both systemNodes and systemCores).</td>
</tr>
<tr>
<td>total nodes</td>
<td>systemCores</td>
<td>The number of cores in the cluster (total nodes display both systemNodes and systemCores).</td>
</tr>
<tr>
<td>total memory</td>
<td>systemTotalMemory</td>
<td>The total memory available to the system. Total memory is displayed in GB, and systemTotalMemory is displayed in bytes.</td>
</tr>
<tr>
<td>memory</td>
<td>memory</td>
<td>Memory used to execute the action.</td>
</tr>
<tr>
<td></td>
<td>memoryOS</td>
<td>Operating system used by the action.</td>
</tr>
<tr>
<td>contextVoluntary</td>
<td></td>
<td>The number of times a context switch occurred because a process relinquished its processor before its time slice had been completely used.</td>
</tr>
<tr>
<td>contextInvoluntary</td>
<td></td>
<td>The number of times a context switch occurred because a higher priority process was present or because the current process exceeded its time slice.</td>
</tr>
<tr>
<td>memoryQuota</td>
<td></td>
<td>The memory quota used by the action.</td>
</tr>
<tr>
<td>dataMovementTime</td>
<td></td>
<td>The amount of time, in seconds, taken by the data that moved between the memory and the processors.</td>
</tr>
<tr>
<td>Server Metric Name</td>
<td>Client Metric Name</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>dataMovementBytes</td>
<td>The number of bytes of data that moved between the memory and the processors.</td>
<td></td>
</tr>
</tbody>
</table>

See “View Performance Metrics for a CAS Action” on page 19 for information about displaying these metrics.