Monitoring: Overview

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

- **SAS Environment Manager** is a graphical enterprise web application that provides functions for monitoring the nodes and microservices in a SAS Viya environment. It provides two interfaces for monitoring your environment.
  - To quickly view the health and status of your SAS Viya environment, see Use the SAS Environment Manager Dashboard for System Monitoring on page 2.
  - To view detailed metrics for the machines and services in your environment, see Monitoring: How to (SAS Environment Manager) on page 2.

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 7.

CAS Server Monitor is available in both the SAS Viya programming and visual environments.

- **Grid Monitor** provides histograms to view CPU load, memory usage, disk usage, and network performance for each CAS node. Grid Monitor provides a higher 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 remaining 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 10.

Grid Monitor is available in both the SAS Viya programming and visual environments.

- **CAS start-up or session options** return 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 18 for a list of the metrics that are returned.

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

A metric is a measurement that describes the performance of some component or subsystem of SAS Viya. Metrics are valuable only when they are regularly collected and evaluated, which is a task performed by the Monitoring service. This service manages the collection of metric data and sends the data to be surfaced in SAS Environment Manager and other locations.

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.

For the 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 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.

**Monitoring: How to (SAS Environment Manager)**

**Use the SAS Environment Manager Dashboard for System Monitoring**

**Navigation**

In the side menu (≡), under SAS Environment Manager, select Dashboard.

**Evaluate CAS Nodes**

The CAS System Health tile is used to display a pair of graphs that provide a quick view of the nodes in your SAS Viya cluster. 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 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. See "Architecture" in SAS Cloud Analytic Services: Fundamentals for more information about CAS servers. You define the default server in the defaultCAServer property. This property is one of the sas.casmanagement.global properties for the CAS Management service. See "Configure Services" in SAS Viya Administration: Configuration Properties for information about setting this property.

**CPU Load Average**

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

**Node Memory Usage**

Displays a bar chart, displaying 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 ten seconds.

**View Server Status**

The **Servers** tile is used to display a table of CAS servers, associated controller node hosts, and the current status of the server. The server host is listed in the form `host-name:port_number`. If you have sufficient authorization, you can use the **Servers** view on the Data page to view detailed information about servers. Click on the **Servers** tile to access this page and corresponding view. This tile is updated every ten seconds.

**View Services Status**

The **Services** tile is used to display a table of service categories and their availability. Place your pointer over an availability icon in the table to view a description of its value.

If you have sufficient authorization, you can use the **Services** view on the Machines and Services page to view detailed information about the services. Click on the **Services** tile to access this page and corresponding view.

For example, if the **Services** tile indicates that some of the **Application** services are not available, use the **Services** view on the Machines and Services page to determine which services are not running. You can then check the logs for the services to isolate the problem and to restart the services if necessary.

**Note:** If you are using a clustered SAS Infrastructure Data Server, the **System** services are always listed as partially available. Because the standby servers are not actively responding, their availability is unknown.

**View Table Size**

The **Top 10 Tables: SAS Infrastructure Data Server** tile is used to display a graph of the ten largest tables in the system’s SAS Infrastructure Data Server database. The SAS Infrastructure Data Server tables contain information that defines your system. Because SAS Viya manages these tables, you do not need to be concerned with the contents of the tables. Place your pointer over a bar in the graph to display the name of the table and its size. The vertical scale of the graph changes, depending on the largest value being displayed in the chart.

If you have sufficient authorization, you can use the **Services** view for the SAS Infrastructure Data Server on the Machines and Services page to view detailed information about the tables. Click on the tile to access this page and corresponding view.

This tile is updated whenever the Dashboard is reloaded.

**Monitor Machines**

**Navigation**

Open the **Machines** view of the Machines and Services page:

1. In the side menu (…) under **SAS Environment Manager**, select **Resources** → **Machines and Services**.

2. SAS Environment Manager displays the Machines and Services page. In the **View** field, select **Machines**.

**View Machine Properties**

1. Open the **Machines** view of the Machines and Services page.
The page displays the name, address, and description for all of the machines in your environment.

2 To view the properties for a machine, right-click the entry for the machine and select Properties from the pop-up menu. As an alternative, select the machine and click the Properties icon in the toolbar.

The Properties dialog box displays the name, ID, address, category, and description for the machine.

**List Service Instances on a Machine**

1 Open the **Machines** view of the Machines and Services page.

2 Right-click an entry and select **Service Instances** or select the machine and click the Open icon on the toolbar. You can also double-click the machine entry.

The Machines and Services page displays a list of all the service instances that are running on the selected machine. In addition to information about the service instances, icons indicate whether the service instances are available, are not running, or have an unknown status. An unknown status appears when SAS Environment Manager cannot receive a response from the server. Possible reasons for an unknown status are that the monitoring service might not be running, the monitoring service’s cache has been cleared, or the server cannot communicate with the service.

**Monitor Services**

**Navigation**

Open the **Services** view of the Machines and Services page:

1 In the side menu, under **SAS Environment Manager**, select **Resources → Machines and Services**.

2 SAS Environment Manager displays the Machines and Services page. In the **View** field, select **Services**.

**View Service Properties**

1 Open the **Services** view of the Machines and Services page.

By default, the page displays the service name, availability, type, and description for all the services in your environment.

2 To view the properties for a service, right-click the entry for the service and select **Properties** from the pop-up menu. As an alternative, select the service and click the Properties icon in the toolbar.

The Properties dialog box displays the name, instance availability, ID, category, type, and description of the service.

**View Metric Data for a Service Instance**

1 Open the **Services** view of the Machines and Services page.

2 Right-click the entry for the service and select **Service Instances** or select the service and click the **Service Instances** icon in the toolbar. You can also double-click the service name.

3 Right-click the entry for a service instance and select **Metrics** from the pop-up menu or select the service instance and click the Metrics icon in the toolbar.
The table displays the name, value, and description of the metrics of the selected service instance. See Application Service Metrics on page 17 for information about the metrics listed on this page.

View Properties for a Service Instance
1. Open the Services view of the Machines and Services page.
2. Right-click the entry for a service and select Service Instances or select the service and click in the toolbar.
3. Right-click the entry for a service instance and select Properties from the pop-up menu or select the service instance and click in the toolbar.

The Properties dialog box displays information such as the name, machine address, and ID of the selected service instance.

Work with an Unavailable Microservice
A problem with SAS Viya might be due to an issue with one of the SAS Viya microservices. Use these steps to locate and handle problems with SAS Viya microservices.
1. Use the Services tile on the SAS Environment Manager Dashboard page to verify that the microservices are running. The Total column in the pane indicates the total number of microservices and how many are running.
2. To identify the microservice that is not running, click from the Services tile.
3. Locate the microservice that is unavailable. SAS Viya microservices have a value of application in the Type column.
4. After you have identified the name of the microservice that is not running, check the log for the microservice to determine the issue that caused it to stop. Each microservice produces a separate log in the directory /opt/sas/deployment_name/config/var/log/sas-microservice_name/default. See “Locate Microservice and Web Application Logs” in SAS Viya Administration: Logging for more information.
5. After you correct the issues identified in the log file, restart the service. See “General Servers and Services: Operate” in SAS Viya Administration: General Servers and Services for information.

Updating and Refreshing Service Properties
SAS Environment Manager reads service properties and status from a cache file. This file is updated at two different intervals, and you use two different methods to update the displayed information.
- Any changes to service properties are written to the cache once an hour. Select to immediately update the cache with resource property changes.
- Any changes to the status of the service status are written to the cache every 30 seconds. Select to immediately update the cache with the status changes.

Because the cache obtains the property information and the status information in separate steps, if you select to update the service properties, the cache might take several seconds to display the current information. If this happens, the icon in the Availability column changes to , indicating that the status is unknown. Click after you update the properties to obtain the current status.
Monitor Sessions

View Session Information
1. Open the Services view of the Machines and Services page.
2. Select CAS in the Category menu to view a list of all cas services.
3. Right-click an entry for a cas service and select Service Instances from the pop-up menu. You can also select the cas service and click 🔄 in the toolbar.
4. In the table of cas service instances, right-click a cas service instance and select Sessions. The cas service instance must be available (☑️ in the Availability column).
5. The page displays a list of sessions for the cas service instance. The status, owner, session ID, and session name are displayed for each session. To view the session threads that run on each node, double-click a session.
6. The table lists the session threads, including the name and PID. Select ☑️ in the table header to select additional information to display for each session, including the system CPU time, total CPU time, and user CPU time for each session.
7. Click 🔄 to refresh the session information. Refreshing the displayed information ensures that you are viewing the current information, rather than cached information. For example, if you change the port for a session, that change is not displayed until the cache is cleared. The cache is cleared every 30 minutes. If you refresh the view, the changed port is displayed immediately.

View Metrics for the SAS Infrastructure Data Server
Follow these steps to view detailed metric data for your SAS Infrastructure Data Server database.
1. In the side (بوابة) menu, under SAS Environment Manager, select Resources ⇒ Machines and Services.
2. Open the Services view in the Machines and Services page. Select System in the Category field.
3. Right-click the entry for the SAS Infrastructure Data Server service and select Service Instances from the menu.
4. In the list of service instances, right-click an instance and select Metrics from the menu.
   There are two types of SAS Infrastructure Data Server service instances: pgpool and datanode. The Metrics menu item is available only for a datanode service instance.
5. The page lists these available metric categories for the SAS Infrastructure Data Server database.
   - **databaseLock**
     Metric data for records in the database that have been locked.
   - **databaseSize**
     Metric data for the total size of the SAS Infrastructure Data Server database.
   - **autovacuum**
     Metric data for disk space that has been recovered by the automatic vacuum process.
topNtable
Metric data for the ten largest tables in the database. This information is displayed in the Top 10 SAS Infrastructure Data Server Tables chart on the SAS Environment Manager dashboard.

6 To view the metrics in any metric category, right-click the name of the metric category and select Metrics from the menu.

7 To view the data for any metric, right-click the metric name and select Metrics from the menu.

---

**Monitoring: How to (CAS Server Monitor)**

**Access CAS Server Monitor**

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


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

For more information, see “Access the Monitor” in SAS Viya Administration: Using CAS Server Monitor.

**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%.

   ![Histogram of CPU Usage](image)

   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.

![Histogram Example]

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.

![Session Histogram Example]

Note: The session view remains displayed even if the session is terminated. A session view is displayed until you close it.

**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 9 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 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. This option is available only if you are an administrator.
- 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 the process owner, the window displays information about all processes. If you are not the process owner, you can view information 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 Grid Node on page 10 for information.
Open a Terminal Window on a Grid 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 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 on the right side of the histogram for a node. Select Launch Terminal. This option is available only if you are an administrator.
   - Click and select the Grid Nodes tab. Click 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 Grid 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 in the banner for a view. To return to a grid layout, click the grid icon.

To change the default view for the Grid 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.

Monitor Process Information

1 In the Grid Monitor window, select Menu ⇒ Show Jobs on Grid.
The Jobs window displays information about the servers and sessions that are running on the grid nodes. 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.

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

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.

To remove defunct processes, select Job Menu \(\Rightarrow\) 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 \(\Rightarrow\) Show Jobs on Grid to open the Job View window.

2. Select Job Menu \(\Rightarrow\) Display Totals. The total CPU and memory usage for all processes is displayed at the top of the 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.
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.

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.
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 18 for a list of the metrics that are displayed.

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

```ruby
NOTE: Executing action 'tkimstat.summary'
NOTE: Action 'tkimstat.summary' used (Total process time):
NOTE:       real time               0.024989 seconds
NOTE:       cpu time                0.165974 seconds (664.19%)
NOTE:       total nodes             4 (96 cores)
NOTE:       total memory            377.85G
NOTE:       memory                  22.53M (0.01%)
{   disposition = { ... },
    messages = { ... },
    results = { ... },
    performance = {
        elapsedTime = 0.024989,
        cpuUserTime = 0.132979,
        systemCores = 96,
        systemTotalMemory = 405711519744,
        cpuSystemTime = 0.032995,
        memoryOS = 45793280,
        memory = 23621664,
        memoryQuota = 47366144,
        systemNodes = 4,
```
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 \((\text{cpuUserTime} + \text{cpuSystemTime})/\text{elapsedTime}\). 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: Reference

CAS Service Metrics

These metrics are displayed in SAS Environment Manager for each CAS server service. See View Metric Data for a Service Instance on page 4 for information about accessing these metrics.

<table>
<thead>
<tr>
<th>Metric Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cpuUserTime</td>
<td>The user CPU time used by the service instance.</td>
</tr>
<tr>
<td>memoryOS</td>
<td>The operating system memory used by the service instance.</td>
</tr>
<tr>
<td>memory</td>
<td>The total memory used by the service instance.</td>
</tr>
<tr>
<td>systemTotalMemory</td>
<td>The total memory available to the system.</td>
</tr>
<tr>
<td>systemCores</td>
<td>The number of cores available.</td>
</tr>
<tr>
<td>cpuSystemTime</td>
<td>The system CPU time used by the service instance.</td>
</tr>
<tr>
<td>memorySystem</td>
<td>The system memory used by the service instance.</td>
</tr>
<tr>
<td>memoryQuota</td>
<td>The memory quota used by the service instance.</td>
</tr>
<tr>
<td>elapsedTime</td>
<td>The real time taken to perform the action.</td>
</tr>
<tr>
<td>systemNodes</td>
<td>The total nodes in the cluster.</td>
</tr>
</tbody>
</table>

Application Service Metrics

These metrics are displayed in SAS Environment Manager for each application service. The data in each metric refers to the machine on which the service is running.
### 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>
</tbody>
</table>

**cpu time**

CPU time is measured and displayed in these formats:
- \( \text{cpuUserTime} + \text{cpuSystemTime} \), displayed in seconds.
- \( \frac{(\text{cpuUserTime} + \text{cpuSystemTime})}{\text{elapsedTime}} \), displayed as a percentage.
<table>
<thead>
<tr>
<th>Server Metric Name</th>
<th>Client Metric Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<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>dataMovementBytes</td>
<td></td>
<td>The number of bytes of data that moved between the memory and the processors.</td>
</tr>
</tbody>
</table>

See View Performance Metrics for a CAS Action on page 16 for information about displaying these metrics.