Tuning: Overview

In SAS Viya, you can tune your environment for performance and scalability. This document includes tuning methodologies and parameters for:

- Apache HTTP Server
- Java Runtime Environment (JRE)
- Java Database Connectivity (JDBC) connection pool
- Lightweight Directory Access Protocol (LDAP) connection pool
- Operating system
- SAS servers and services

Performance requirements are usually identified in terms of transaction response time, number of transactions per second, throughput, resource utilization, total cost per transaction, availability, and more. Scalability often refers to the ability of a component to adapt readily to a greater or lesser intensity of use, volume, or demand, while meeting integral business objectives. The common objective of scaling a component or system is to increase the capacity for growth, increase the speed of the component, improve the efficiency, or shift or reduce the load on the component.

Tuning: Apache HTTP Server

Overview

You can improve the performance of the Apache HTTP Server by configuring other aspects of the web server. For example, to improve performance, rotate log files and configure the Multi-Processing Modules (MPMs).

For more information about MPMs, see [http://httpd.apache.org/docs/2.4/mpm.html](http://httpd.apache.org/docs/2.4/mpm.html).

Recommendations

Linux

1. For sites with upward of 400 users, it is recommended that you enable the following Apache HTTP modules:
   - Apache 2.2: `worker`
     In `/etc/sysconfig/httpd`, uncomment the following line:
     ```
     HTTPD=/usr/sbin/httpd.worker
     ```
   - Apache 2.4: `mod_mpm_worker.so`
In `/etc/httpd/conf.modules.d/00-mpm.conf`, comment the line ending in `mod_mpm_prefork.so`, and uncomment the line ending in `mod_mpm_worker.so`:

```bash
#LoadModule mpm_prefork_module modules/mod_mpm_prefork.so
LoadModule mpm_worker_module modules/mod_mpm_worker.so
#LoadModule mpm_event_module modules/mod_mpm_event.so
```

### Apache 2.4 on SUSE: **worker**

Verify that the worker MPM is installed. It can be installed with Zypper, using the following command:

```bash
zypper install apache2-worker
```

Then, edit the `/etc/sysconfig/apache2` file and define the `APACHE_MPM` property.

```bash
APACHE_MPM="worker"
```

2 Configure the Apache HTTP Server to use the worker MPM as follows:

- For Apache 2.2, modify the `/etc/httpd/conf/httpd.conf` file to adjust worker MPM properties. Add the `ServerLimit` property and change the value for the other properties that are highlighted in the sample file below:

  ```bash
  # worker MPM
  # StartServers: initial number of server processes to start
  # MaxClients: maximum number of simultaneous client connections
  # MinSpareThreads: minimum number of worker threads which are kept spare
  # MaxSpareThreads: maximum number of worker threads which are kept spare
  # ThreadsPerChild: constant number of worker threads in each server process
  # MaxRequestsPerChild: maximum number of requests a server process serves
  
  <IfModule worker.c>
    ServerLimit          32
    StartServers         10
    MaxClients           1024
    MinSpareThreads      25
    MaxSpareThreads      75
    ThreadsPerChild      32
    MaxRequestsPerChild  0
  </IfModule>
  ```

- For Apache 2.4, add the following configuration block to the existing configuration file. It is recommended that you modify either the `/etc/httpd/conf.modules.d/00-mpm.conf` file or the `/etc/httpd/conf/httpd.conf` file. On SUSE, edit the `/etc/apache2/httpd.conf` file.

  ```bash
  <IfModule mpm_worker_module>
    ServerLimit          32
    StartServers         10
    MaxRequestWorkers    1024
    MinSpareThreads      25
    MaxSpareThreads      75
    ThreadsPerChild      32
    MaxConnectionsPerChild  0
  </IfModule>
  ```

3 Identify a suitable log rotation strategy and modify the `/etc/httpd/conf/httpd.conf` file to configure the Apache `rotatelogs` tool to perform log rotation. For information about rotation strategies and configuration options, see [http://httpd.apache.org/docs/2.4/programs/rotatelogs.html](http://httpd.apache.org/docs/2.4/programs/rotatelogs.html).

The following are sample `httpd.conf` file entries for configuring daily log rotation:

```bash
#ErrorLog logs/error_log
ErrorLog "|/usr/sbin/rotatelogs logs/error_log 86400"
```
#CustomLog logs/access_log combined
CustomLog "|/usr/sbin/rotatelogs logs/access_log 86400" combined

Note: For SUSE, the ErrorLog property is defined in the /etc/apache2/httpd.conf file. The CustomLog property is defined in the /etc/sysconfig/apache2 file, as APACHE_ACCESS_LOG:

APACHE_ACCESS_LOG=""|/usr/sbin/rotatelogs /var/log/apache2/access_log 86400" combined"

4 Restart the Apache HTTP Server by running the following commands:

   apachectl stop
   apachectl start

Windows

For sites with upward of 400 users, it is recommended that you apply the following tuning changes to the configuration of the WinNT MPM:

1 Edit the conf\extra\httpd-mpm.conf file

2 Add the ThreadLimit directive and increase the ThreadsPerChild within the mpm_winnt_module conditional block as highlighted in the sample file below:

   # WinNT MPM
   # ThreadsPerChild: constant number of worker threads in the server process
   # MaxConnectionsPerChild: maximum number of connections a server process serves
   <IfModule mpm_winnt_module>
      ThreadLimit 3072
      ThreadsPerChild 3072
      MaxConnectionsPerChild 0
   </IfModule>

Tuning: Files Service

Overview

By default, the first 5 KB of text in an attachment is extracted and indexed. If you upload an attachment that contains more text, only the configured number of bytes of text are extracted and indexed.

There are three categories for file extraction that are based on the size and type of the file. The size and type are configurable and as an administrator, you can change the default settings. Currently, the default values of these properties are set based on a maximum heap size of 256 MB. The maximum heap size can also be changed. If you increase the file extraction limit, then you must also increase the maximum heap size.

Use SAS Environment Manager to change the value of how much of an attachment is extracted and indexed by editing the sas.files.extractionLimit setting. For details, see “Configuration Properties: How to Configure Services” in SAS Viya Administration: Configuration Properties.

Recommendations

Default Configuration Settings

The following table provides the default settings for the Files Service definition:
Table 1 Default Configuration Settings

<table>
<thead>
<tr>
<th>File Size</th>
<th>Default Limit</th>
<th>Details</th>
</tr>
</thead>
</table>
| Large     | 10 MB         | If a file is larger than 10 MB, only 10 MB of the file is sent for text extraction. The following properties define the file size and type: 
  * sas.files.extraction.largeFileSize: 10485760 
  * sas.files.extraction.largeFileTypes: application/vnd.ms-powerpoint,application/vnd.openxmlformats-officedocument.presentationml.presentation |
| Medium    | 5 MB          | If a file is larger than 5 MB, only 5 MB of the file is sent for text extraction. The following properties define the file size and type: 
  * sas.files.extraction.mediumFileSize: 5242880 
  * sas.files.extraction.mediumFileTypes: application/vnd.ms-excel,application/vnd.openxmlformats-officedocument.spreadsheetml.sheet,text/csv |
| Small     | 2.5 MB        | If a file is larger than 2.5 MB, only 2.5 MB of the file is sent for text extraction. The following properties define the file size and type: 
  * sas.files.extraction.smallFileSize: 2621440 
  * sas.files.extraction.smallFileTypes: application/msword,application/vnd.openxmlformats-officedocument.wordprocessingml.document,application/pdf |

Note: If the file size does not fall under any of the above size categories, the complete stream of the file is sent to Apache Tika for extraction.

Note: A limitation exists with Microsoft Word document files (and possibly Microsoft PowerPoint and Microsoft Excel files) where the partial extraction of content does not work. Word document files fall under the small category. If you send partial Word document files that are greater than 2.5 MB for extraction, Apache Tika does not return any extracted text.

Modify the File Extraction Properties
1. From SAS Environment Manager, navigate to the Definitions view.
2. In the Definitions list, select sas.files.extraction.
3. In the top right corner of the Files service window, click .
4. In the Edit sas.files.extraction Configuration dialog box, make the required changes to the appropriate file size and file type.
5. Click Save.

See Also
“Edit Configuration Instances” in SAS Viya Administration: Configuration Properties
### Tuning: Java Runtime Environment

**Overview**

*Note:* The Java Runtime Environment (JRE) is currently supported only on Linux deployments.

The goal of JRE tuning is to improve performance in the services, particularly in the area of memory usage and garbage collection cycles. The goal is to also maximize the number of clients that the SAS web applications can support.

**Recommendation**

The default JRE tuning options that are applied for each service should be sufficient. However, you might need to limit how much the native memory usage grows for each Java process. To limit the growth, add the following lines to the `Viya-installation-directory/etc/sysconfig/sas-javaesntl/sas-java-services` file:

```
# Limit the number of "malloc arenas" to 1 (default behavior is to use (# of cores * 8))
export MALLOC_ARENA_MAX=1
```

### Tuning: JDBC Connection Pool

**Overview**

*Note:* The Java Database Connectivity (JDBC) connection pool is currently supported only on Linux deployments.

In JDBC connection pooling, instead of creating connections every time they are requested, connections are reused. The JDBC connection pool is a collection of database connection objects that are available for reuse. It is maintained by a connection pooling module as a layer on top of the JDBC driver.

**Recommendations**

**Configure Deployment Size**

SAS Viya provides default JDBC connection pool settings for small, medium, and large deployments. By default, all services are configured to use the medium deployment settings.

To configure a different deployment size for a service, complete the following tasks:

1. From SAS Environment Manager, navigate to the Definitions view.
2. In the Definitions list, select jvm.
3. In the top right corner of the window, click New Configuration.
4. In the New jvm Configuration dialog box, complete the following tasks:
   a. Choose one or more services to which the new settings apply by clicking and selecting the services.
Override Default Property Values

To change the default property settings, complete the following tasks:

1. From SAS Environment Manager, navigate to the Definitions view.
2. In the Definitions list, select spring.
3. In the top right corner of the window, click New Configuration.
4. In the New spring Configuration dialog box, complete the following tasks:
   a. Choose one or more services to which the new settings apply by clicking and selecting the services.
      Note: Not all services use the default property settings. Instead, those services specify a scaling factor that enables them to have larger pool sizes, based on the deployment size that is specified in the sas.deployment.springdatasource.defaults property. For more information, see “Datasource Scaling Factor” on page 8.
   b. Click OK.
   c. Click .
   d. In the Name field, specify a property from the Property Settings Table on page 8.
   e. In the Value field, specify the new size that you want to set the property.
   f. Click Save.
5. Click Save.
Default Datasource Property Settings

The following table provides the default property settings for the JDBC connection pool, based on the deployment size:

<table>
<thead>
<tr>
<th>Property</th>
<th>Small Deployment</th>
<th>Medium Deployment</th>
<th>Large Deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>datasource.tomcat.initialSize</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>datasource.tomcat.maxActive</td>
<td>6</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>datasource.tomcat.maxIdle</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>datasource.tomcat.minIdle</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

A service can also provide default files for small, medium, and large deployments in the service resource directory.

Datasource Scaling Factor

Not all services use the default property settings. Instead, those services specify a scaling factor that enables them to have larger pool sizes, based on the deployment size that is specified in the sas.deployment.springdatasource.defaults property. For example, the Authorization Service specifies a scaling factor of 10. Therefore, its maxActive value is 60 for small, 100 for medium, and 200 for large deployments. For a list of the default property values, see Table 2 on page 8

Configure the Scaling Factor

To define a scaling factor for a service, complete the following tasks:

1. From SAS Environment Manager, navigate to the Definitions view.
2. In the Definitions list, select jvm.
3. In the top right corner of the window, click New Configuration.
4. In the New jvm Configuration dialog box, complete the following tasks:
   a. Choose one or more services to which the new settings apply by clicking ⬤ and selecting the services.
   b. Click OK.
   c. Click ⬤.
   d. In the Name field, specify the java_option_datasource_factor property.
   e. In the Value field, specify -Dsas.datasource.custom.factor=multiplier, where multiplier is the multiplier factor by which the property in the Property Settings Table on page 8 will be multiplied.
   f. Click Save.
5. Click Save.
6. Restart all SAS Viya services.
See Also

- “Edit Configuration Instances” in SAS Viya Administration: Configuration Properties
- “Start and Stop All Servers and Services” in SAS Viya Administration: General Servers and Services

Scaling Factor Example

You can specify a multiplier factor for a service by using the `sas.datasource.custom.factor` property. The default value for a property is multiplied by the value that you specify. For example, for a medium deployment, the default value for the `spring.datasource.tomcat.maxActive` property is 10. If you set the multiplier factor to 5, the new maxActive value is 50. The factor must be greater than 0. The resulting maxActive value will be no less than `spring.datasource.tomcat.initialsize` and no more than 200.

Tuning: LDAP Connection Pool

Overview

Note: The Lightweight Directory Access Protocol (LDAP) connection pool is currently supported only on Linux deployments.

The LDAP service provider supports connection pooling. In LDAP connection pooling, the service provider maintains a pool of previously used connections. When a connection is closed or goes to garbage collection, it goes back to the pool to be used again.

By default, no configuration is required for the LDAP service provider to use connection pooling. However, configuration is needed to customize the setting for optimal performance.

Recommendations

1. In SAS Environment Manager, edit the Identities service.
2. Navigate to the `sas.identities.providers.ldap.connection` configuration instance and configure the following:

   Table 3  Properties and Values

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pool.maxActive</td>
<td>30</td>
</tr>
<tr>
<td>pool.maxIdle</td>
<td>30</td>
</tr>
</tbody>
</table>

See Also

“Edit Configuration Instances” in SAS Viya Administration: Configuration Properties
Tuning: Operating System

Overview

There are a number of configuration changes and variables that you can set to tune SAS Viya for your performance and scalability needs. The following sections show how to configure the operating system settings that are relevant to SAS Viya post-deployment.

Linux

Recommendations

Tuning TCP/IP

For sites with upward of 400 users, it is recommended that you perform the following:

- Ensure that IPv6 is enabled.
- Permanently set the SAS recommended TCP/IP settings by using the following commands:

  /sbin/sysctl -w net.ipv4.tcp_fin_timeout=30
  /sbin/sysctl -w net.core.netdev_max_backlog=3000
  /sbin/sysctl -w net.core.somaxconn=3000
  /sbin/sysctl -w net.ipv4.tcp_keepalive_intvl=15
  /sbin/sysctl -w net.ipv4.tcp_keepalive_probes=5

Tuning for SAS Studio

The following options can be modified in the /etc/sysctl.conf file, when these conditions exist:

- For sites with upward of 40 concurrently logged-on users, who are running tasks that require rendering of graphs, the SEMMNI parameter should be increased to 4096.
- For sites with upward of 600 logged-on users, increase the PID_MAX parameter to 131072.

Windows

Recommendations

Update Windows Registry

The Windows registry must be updated. Microsoft recommends performing a system backup before editing the registry. To set the SAS recommended parameters, use the REGEDIT command as follows:

1. Access the HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\Tcpip\Parameters registry subkey. Add the DWORD value with a name of TcpTimedWaitDelay and a value of 30 (0x1e).
2. Access the HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\AFD\Parameters registry subkey. Add the following DWORD values:
### AFD Service Parameters

<table>
<thead>
<tr>
<th>Name</th>
<th>Recommended Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnableDynamicBacklog</td>
<td>1 decimal</td>
</tr>
<tr>
<td>MinimumDynamicBacklog</td>
<td>20 decimal</td>
</tr>
<tr>
<td>MaximumDynamicBacklog</td>
<td>1000 decimal</td>
</tr>
<tr>
<td>DynamicBacklogGrowthDelta</td>
<td>10 decimal</td>
</tr>
</tbody>
</table>

The recommended values specify the number of connections that you want to be available. These values request a minimum of 20 and a maximum of 1000 available connections. The number of available connections is increased by 10 each time there are fewer than the minimum number of available connections.

3 In addition, the user port range should be updated. From a command prompt, run the following commands, based on the version of your internet protocol:

```
netsh int ipvn set dynamicport tcp start=32768 num=32767
netsh int ipvn set dynamicport udp start=32768 num=32767
```

The value of $n$ indicates the version of your internet protocol and is either 4 or 6.

4 Restart Windows.

### Update System Configurations

The following list includes general recommendations for configuring Windows systems:

- Disable Windows indexing on any directories that are used by SAS software.
- Set Windows performance settings so that background processes are favored.
- Set the maximum power profile in the system BIOS for all systems, except Intel Sandy Bridge.
- Disable the C1E BIOS setting on Dell systems.

### Tuning: SAS Cache Server

#### Overview

By default, the SAS Cache Server uses overflow to disk. An Apache Geode Resource Manager runs inside the SAS Cache Server, monitoring the current heap usage against the current maximum heap that is available. If the SAS Cache Server is configured with different values of initial heap size and maximum heap size, the Resource Manager may detect a premature critical heap situation. To avoid this, it is recommended that you set the initial heap size and maximum heap size to the same value.

For more information about Geode Resource Manager, see Managing Heap and Off-heap Memory.
Recommendations

If you increase the initial heap size option (-Xms) for the SAS Cache Server, increase the value so that it is equal to that of the maximum heap size option (-Xmx). These values can be increased if there is enough demand, but ideally they should be set to the same value to avoid the overhead of expansion and contraction. The default is set to -Xms256m and -Xmx256m. Depending on the usage patterns observed and the number of users, you might decide to increase these values. For example, -Xms1024m and -Xmx1024m are reasonable values for a multi-tenant deployment with a large number of users.

Configure Initial Heap Size

1. From SAS Environment Manager, navigate to the All services view.
2. In the All services list, select Cache Server service.
3. At the top of the content pane, enter jvm in the Filter field, and then click ᵒ.
4. Click ᵒ.
5. In the Edit jvm Configuration window, click ▶.
6. In the Add Property window:
   a. In the Name field, specify java_option_xms.
   b. In the Value field, specify the new initial heap size as -Xmssize, where size is the number of bytes. Append k for kilobytes, m for megabytes, or g for gigabytes. For example, -Xms1024m.
      For more information, see Java Documentation.
7. Click Save.

See Also

- “Edit Configuration Instances” in SAS Viya Administration: Configuration Properties
- “Create Configuration Instances” in SAS Viya Administration: Configuration Properties

Configure Maximum Heap Size

1. In the Edit jvm Configuration window, update the java_option_xmx property with the new maximum heap size value.
   Important: For the SAS Cache Server, the maximum heap size should be the same as the value that you specified for the initial heap size.
2. Click Save.

Tuning: SAS Cloud Analytic Services

Overview

You can update the SAS Cloud Analytic Services configuration file options to optimize the CPU resources for the Apache HTTP Server.
Recommendation

A recommended value for `cas.CPUSHARES` for a SAS Viya full deployment on Windows is 70.

See Also

“Configuration File Options” in SAS Viya Administration: SAS Cloud Analytic Services

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**Tuning: SAS Infrastructure Data Server**

**Overview**

Note: SAS Infrastructure Data Server is not currently supported in a programming-only deployment.

SAS Infrastructure Data Server provides a transactional store that is used to support SAS Viya. The server is configured automatically during deployment. However, to optimize its performance, it is recommended that you perform the tuning recommendations in this section.

**Recommendations**

**Connection Settings**

In SAS Environment Manager, edit the **SAS Infrastructure Data Server** service and modify the following properties to change the number of connections available to client:

<table>
<thead>
<tr>
<th>Configuration Instance</th>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>sas.dataserver.conf: common</td>
<td>max_connections</td>
<td>1027</td>
</tr>
<tr>
<td></td>
<td>For more information, see <a href="http://www.postgresql.org/docs/9.1/static/runtime-config-connection.html#RUNTIME-CONFIG-CONNECTION-SETTINGS">here</a></td>
<td></td>
</tr>
<tr>
<td>sas.dataserver.conf: common</td>
<td>max_prepared_transactions</td>
<td>1027</td>
</tr>
<tr>
<td></td>
<td>For more information, see <a href="http://www.postgresql.org/docs/9.4/static/runtime-config-resource.html">here</a></td>
<td></td>
</tr>
<tr>
<td>sas.dataserver.pool: common</td>
<td>num_init_children</td>
<td>1024</td>
</tr>
<tr>
<td></td>
<td>For more information, see <a href="http://www.pgpool.net/docs/pgpool-II-3.5.4/doc/pgpool-en.html#NUM_INIT_CHILDREN">here</a></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Note:</em> This setting does not apply to a Windows deployment.</td>
<td></td>
</tr>
</tbody>
</table>

Note: The `max_connections` value should be slightly higher than the `num_init_children` value to allow for direct connections outside pgpool for administrative use, such as backup and recovery.
ulimit Settings

On Red Hat Linux deployments, there are recommended ulimit settings for the sas user. The settings reside in the `/etc/security/limits.conf` file.

```
sas soft nofile 150000
sas hard nofile 150000
sas soft nproc 100000
sas hard nproc 100000
sas soft stack 10240
sas hard stack 10240
```

**Note:** You might need to adjust additional Linux operating system settings in order to support these recommended ulimit settings.

Semaphore Settings

On Red Hat Linux and SUSE Linux deployments, there are recommended semaphore settings. The settings reside in the `/etc/sysctl.conf` file.

```
kernel.sem=512 32000 100 1024
net.core.somaxconn=2048
```

For more information, including formulas and minimum values, see [http://www.postgresql.org/docs/9.5/static/kernel-resources.html](http://www.postgresql.org/docs/9.5/static/kernel-resources.html).

**Note:** Changing Linux semaphore settings requires a machine reboot.

**Note:** You might need to adjust additional Linux operating system settings in order to support these recommended semaphore settings. To optimize your PostgreSQL resources, you should also scale the server's working memory settings in accordance with “Special Considerations” on page 14.

Special Considerations

Specialized solutions or use cases might require further configuration tuning. If you need to experiment with the parameters for your optimized system performance, the most important parameters are:

- **shared_buffers**
  specifies the amount of memory to be used for caching data. PostgreSQL also benefits from the file system cache, so `shared_buffers` should not be so large that they interfere with the file system cache. For a large database, set this parameter between 1 GB and up to 25% of the total system memory.

- **work_mem**
  specifies the amount of memory to be used for sorts, hashing, and materialization, before writing to temporary disk files. Several running sessions can perform operations concurrently. Therefore, the total memory used might be many times the value of `work_mem`. Keep this in mind when choosing the value for this parameter. Set this parameter between 16 MB and 64 MB or more, for a specialized use case (for example, frequent very large sorts).

- **maintenance_work_mem**
  specifies the maximum amount of memory to be used for vacuuming (reclaiming storage used by rows that are marked for deletion) and index builds. For a large database, set this parameter to 256 MB or more.

If your application can tolerate losing a transaction if the computer or storage crashes, you can set the `synchronous_commit` parameter to **Off** for faster updates.
Tuning: SAS Message Broker

Overview

SAS Message Broker, which is based on RabbitMQ, is an intermediary program that converts messages from the protocol of the sender of the message to the protocol of the receiver. The server is configured automatically during deployment. However, to optimize its performance, it is recommended that you perform the tuning recommendations in this section.

Recommendations

Modify Allocations

Memory Allocation

By default, SAS Message Broker is configured to use up to 40% of the physical RAM on the machine on which an instance runs. This value does not guarantee that more than 40% will be used, but it sets a threshold at which publishers are throttled (notified to slow down message sending). You must decide what percentage of memory to dedicate to the message broker.

For example, if your system has 250 GB and you want to dedicate 50 GB to SAS Message Broker, use the following calculation to begin throttling back at 40% of the dedicated memory:

\[
(0.4 \times 50 \text{ GB}) / 250 \text{ GB} = 0.08 - 0.10
\]

In the above example, you start throttling back the message broker when it has consumed more than 10% of the available memory. It is difficult to determine the value that the memory threshold, \texttt{vm\_memory\_high\_watermark}, should be set to on a system where SAS Message Broker is sharing resources with other services. When the threshold is reached, producers are blocked from sending additional messages until used memory falls below this threshold again. Alternatively, an absolute limit high watermark might be set. However, this value must be less than the amount of available RAM. Otherwise, the message broker will not start.

To set the memory threshold for SAS Message Broker, complete the following tasks:

1. **On Linux**, set the \texttt{vm\_memory\_high\_watermark} parameter by editing one of the following files:
   - If your environment is enabled for Transport Layer Security (TLS), edit the \texttt{/opt/sas/deploymentId/config/etc/rabbitmq-server/rabbitmq.config.ssl} file.
   - If your environment is not enabled for TLS, edit the \texttt{/opt/sas/deploymentId/config/etc/rabbitmq-server/rabbitmq.config.tcp} file.

   On Windows, set the \texttt{vm\_memory\_high\_watermark} parameter by editing the \texttt{C:\ProgramData\SAS\Viya\var\lib\rabbitmq-server\rabbitmq.conf} file.

2. Specify the following in the configuration file:

   \texttt{vm\_memory\_high\_watermark, percentRAM}

   For more information, see \textit{Configuring the Memory Threshold}.  

Disk Space Allocation

By default, SAS Message Broker requires at least 50 MB of free disk space to operate. If this threshold is reached, SAS Message Broker slows down message sending and blocks connections. Therefore, it is recommended that you set the minimum free disk size to the amount of memory that is installed on the machine, if it is available. By configuring a large amount of free disk space, a constrained system is more likely to recover under heavy usage scenarios by providing adequate space for paging considerations. By default, paging of transient messages, which are written to the disk under high memory consumption, starts when the system gets halfway to the `vm_memory_high_watermark`.

To set the free disk size, complete the following tasks:

1. On Linux, set the `disk_free_limit` parameter by editing one of the following files:
   - If your environment is enabled for Transport Layer Security (TLS), edit the `/opt/sas/deploymentId/config/etc/rabbitmq-server/rabbitmq.config.ssl` file.
   - If your environment is not enabled for TLS, edit the `/opt/sas/deploymentId/config/etc/rabbitmq-server/rabbitmq.config.tcp` file.

   On Windows, set the `disk_free_limit` parameter by editing the `C:\ProgramData\SAS\Viya\var\lib\rabbitmq-server\rabbitmq.conf` file.

2. Specify the following in the configuration file:
   ```
   disk_free_limit, {mem_relative, 1.0}
   ```
   For more information, see Configuring the Disk Free Space Limit.

   Note: Using a disk space setting that is relative to the memory size assumes that the available disk space is greater than the amount of available memory.

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Tuning: SAS Studio 5

Overview

SAS Studio is a development application for SAS that you access through your web browser. Heap size increases are recommended if you have more than 25 users accessing the SAS Studio 5 server.

Recommendations

It is recommended that you increase the initial heap size option `-Xms` and the maximum heap size option `-Xmx` for SAS Studio 5. The maximum heap size option also needs to be increased for SAS Compute Server.

Configure Initial Heap Size

1. From SAS Environment Manager, in the navigation bar, click `Configuration`.

2. Navigate to the `All services` view.

3. In the `All services` list, select `SAS Studio Viya`.

4. At the top of the content pane, click `New Configuration`.

5. In the Select Definition dialog box, select `jvm`.

6. In the New jvm Configuration window, click `+`. 

In the Add Property window:
   a In the Name field, specify `java_option_xms`.
   b In the Value field, specify the new initial heap size as `-Xms4096m`.

For more information, see Java Documentation.

See Also
- “Edit Configuration Instances” in SAS Viya Administration: Configuration Properties
- “Create Configuration Instances” in SAS Viya Administration: Configuration Properties

Configure Maximum Heap Size for SAS Studio 5
1 In the New jvm Configuration window, click `+`.
2 In the Add Property window:
   a In the Name field, specify `java_option_xmx`.
   b In the Value field, specify the new maximum heap size as `-Xmx4096m`.
   c Click Save.
3 In the New jvm Configuration window, click Save.
4 Restart SAS Studio 5.
   On Red Hat Enterprise Linux 6.x, run the following commands:
   ```
   sudo service sas-viya-sasstudiov-default stop
   sudo service sas-viya-sasstudiov-default start
   ```
   On Red Hat Enterprise Linux 7.x and SUSE Enterprise Linux Server 12, run the following command:
   ```
   sudo systemctl restart sas-viya-sasstudiov-default
   ```
   On Windows, in Windows Services Manager, right-click SAS Studio and select Restart.

Configure Maximum Heap Size for SAS Compute Server
1 In the All services list, select SAS Compute Service.
2 At the top of the content pane, click New Configuration.
3 In the Select Definition dialog box, select jvm.
4 In the New jvm Configuration window, click `+`.
5 In the Add Property window:
   a In the Name field, specify `java_option_xmx`.
   b In the Value field, specify the new maximum heap size as `-Xmx1024m`.
   c Click Save.
6 In the New jvm Configuration window, click Save.
7 Restart the SAS Compute Service.
On Red Hat Enterprise Linux 6.x, run the following commands:

```bash
sudo service sas-viya-compute-default stop
sudo service sas-viya-compute-default start
```

On Red Hat Enterprise Linux 7.x and SUSE Enterprise Linux Server 12, run the following command:

```bash
sudo systemctl restart sas-viya-compute-default
```

On Windows, in Windows Services Manager, right-click the **SAS Compute Service** and select **Restart**.