

IBM Cúram Social Program Management  
Version 7.0.0

*Cúram JMX Configuration Guide*



**Note**

Before using this information and the product it supports, read the information in “Notices” on page 13

**Edition**

This edition applies to IBM Cúram Social Program Management v7.0.0 and to all subsequent releases unless otherwise indicated in new editions.

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# Configuring Cúram JMX

Use this information to configure Cúram Java Management Extensions to allow operational data from a running Cúram application to be collected. This includes various invocation targets such as URLs, business methods, and SQL statements.

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## Introduction

### Purpose

The purpose of this guide is to describe the configuration options that are available for Cúram JMX (Java Management Extensions). These configuration options are managed by an administrator in the runtime administration application. There is no software development required to make these configuration changes.

### Audience

This guide is intended for application administrators interested in managing the operational data available via JMX.

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## Cúram JMX Configuration

### Introduction to Cúram JMX

Cúram JMX is the system that provides operational data from a running Cúram application. The following is a list of actions that an application administrator can perform that harness the capabilities of Cúram JMX:

- Enable the collection of statistics on various invocation targets: URLs, business methods and SQL statements - this can provide a long term view on the performance characteristics of individual invocation targets.
- Enable the collection of statistics on in-flight invocation targets: URLs, business methods and SQL statements - this is helpful in identifying long running or stuck invocation targets. It can also be used to derive a measure of the concurrent activity in the system.
- Enable the collection of aggregated transaction tracing information - this provides detailed aggregated statistics on all call flows executed in the application (from URLs to business methods to SQL statements). This data can be used to trace/profile poorly performing business transactions. In many cases such a snapshot provides enough information for an experienced developer to identify and fix the problem without much further investigations.
- Access statistics about all caches in a Cúram application, global and multi-instance - this can help with the fine tuning of application caches (custom or built-in).
- Enable the collection of end user statistics (at the moment these are just browser render times) - this can help in finding performance issues with the application user interface. For instance a custom widget can suddenly start to have performance problems due to inefficient rendering in the browser; using these statistics such a problem can be identified without contacting the affected users or even before they realize that a performance problem is slowly creeping in.
- Access statistics about runtime application configuration parameters.

- Download a compressed XML file with all the JMX statistics available in the application (custom or built-in) and its corresponding XSL style sheet.

## Configuration Parameters

The following is the core set of properties that control the JMX infrastructure in Cúram.

### **curam.jmx.monitoring\_enabled**

This is a boolean value that enables or disables the JMX monitoring infrastructure.

### **curam.jmx.configured\_mbeans\_ejb**

This is the list of configured MBeans in the EJB container. The syntax is described as follows:

```
Mbean_implementation_class_name1[#MBean_interface_class_name1][,
Mbean_implementation_class_name2[#MBean_interface_class_name2]...]
```

The parts in brackets are optional. If the class name for the interface is not specified it is assumed to be derivable from the implementation class name by appending MBean to it.

### **curam.jmx.configured\_mbeans\_web**

This is the list of configured MBeans in the Web container. The syntax is the same as for “curam.jmx.configured\_mbeans\_ejb.”

### **curam.jmx.per\_user\_statistics\_filter**

This is a regular expression to identify users for which individual statistics are to be collected. This property instructs Cúram MBeans to start aggregating statistics for the set of users that satisfies the regular expression. Custom MBeans may choose to follow the same rule.

Note that each user whose user name matches the regular expressions causes a separate set of statistics to be created in memory. Ensure that you have enough memory to store all statistics sets generated by this mechanism.

**Note:** If the filter used is not very selective ensure you have enough memory allocated in the JVM to store all the generated statistics sets

### **curam.jmx.transaction\_tracing\_enabled**

This is a boolean value that controls if transaction tracing is enabled in the application. When this is enabled, in flight data collection is enabled as well.

Transaction tracing can require large amounts of memory; ideally this feature should only be enabled for short period of times for troubleshooting problems. The mechanism can also be fine tuned to minimize the impact on the application using the other transaction tracing configuration parameters: curam.jmx.transaction\_tracing\_max\_recorded\_threads,curam.jmx.transaction\_tracing\_purge\_period,curam.jmx.transaction\_tracing\_max\_thread\_idle\_time

**Note:** Activate transaction tracing only when troubleshooting problems.

Transaction tracing data can be obtained from the JMX statistics. The data is in XML format; the schema is documented in XML Schema for Aggregated Transaction Tracing.

**curam.jmx.transaction\_tracing\_url\_filter**

This is a regular expression to identify URLs for which transaction tracing data is collected. This parameter does not impact the run-time aspects of the transaction tracing mechanism; the filter is only applied when the collected data is externalized.

**curam.jmx.transaction\_tracing\_max\_recorded\_threads**

The maximum number of threads for which transaction tracing data is collected. Note that at any one moment there could be more than this number of threads in the transaction tracing data but a significant amount of entries will only be preserved for this number of threads.

To preserve transaction tracing data for all threads in the application ensure the value of this parameter is equal to or greater than the total number of threads in your application

**curam.jmx.transaction\_tracing\_purge\_period**

The period of time, in seconds, between checks to ensure that only the number of threads specified in “curam.jmx.transaction\_tracing\_max\_recorded\_threads” are preserved in the transaction tracing data.

**curam.jmx.transaction\_tracing\_max\_thread\_idle\_time**

The maximum amount of time, in seconds, a thread is allowed to be idle before its transaction tracing data can be cleared. This parameter is used to trim data when there are more threads in the application than the value specified by curam.jmx.transaction\_tracing\_max\_recorded\_threads

**curam.jmx.download\_statistics\_username**

This is the username that is allowed to download the JMX statistics.

**curam.jmx.download\_statistics\_allowed**

When this is set to true, access to the JMX statistics is allowed.

**curam.jmx.in\_flight\_statistics\_enabled**

This is a boolean value that controls if statistics about in flight transactions are collected.

**curam.jmx.in\_flight\_statistics\_custom\_handler\_class**

The class name for the custom handler of in-flight statistics. The class must be an implementation of curam.util.jmx.inflight.InFlightDataCustomHandler

**curam.jmx.in\_flight\_statistics\_custom\_handler\_enabled**

Whether or not the custom handler for in-flight statistics is enabled. If this value is true and no value is specified in

curam.jmx.in\_flight\_statistics\_custom\_handler\_class then a built-in handler is activated that outputs the in-flight statistics to the file system. This built-in handler can be configured using the following application properties:

- curam.jmx.in\_flight\_statistics\_custom\_handler\_to\_file\_output\_folder - the output folder where the default custom handler writes data to files
- curam.jmx.in\_flight\_statistics\_custom\_handler\_to\_file\_max\_file\_size - the maximum file size; when it is reached a new file is created

**curam.jmx.in\_flight\_statistics\_custom\_handler\_batch\_size**

The number of in-flight data records buffered before being passed to the custom handler for processing.

**curam.jmx.in\_flight\_statistics\_custom\_handler\_enable\_data\_access\_stats**

When this value is false the in-flight statistics at the data access layer are not forwarded to the custom handler.

**curam.jmx.output\_statistics\_timer\_enabled**

Whether or not the timer that outputs the JMX statistics is enabled.

**curam.jmx.output\_statistics\_timer\_period**

The period at which JMX statistics are output by the timer.

**curam.jmx.output\_statistics\_timer\_use\_delta**

If true, the JMX timer resets the statistics after each cycle.

## Out of the Box Application Instrumentation

The out of the box Cúram application comes with a number of MBeans used to expose application statistics.

Some of these MBeans have their own dynamic configuration data which is accessible via the standard application configuration mechanism. Most of them also support gathering statistics for users selected using the `curam.jmx.per_user_statistics_filter` parameter. The availability of some of the data is affected by either Cúram JMX configuration parameters or the MBean's configuration parameters.

Each of these MBeans is described in the following sections.

### CuramServerCoreStatsMBean

This MBean exposes core statistics for code running in the server container.

**MBean Configuration Parameters:** This MBean has only one parameter:

- `curam.jmx.sql_statement_statistics_enabled` - set this parameter to true to enable the collection of SQL statement execution statistics

**MBean Statistics:** The following statistics are exposed by this MBean.

- Aggregated BPO method execution statistics - the following counters are available:
  - Username – the username that invoked this method. This is only valid when per user statistics are collected.
  - BPO Method – the name of the BPO method
  - Elapsed Time(ms) - the average response time in milliseconds for this BPO method
  - Min Elapsed Time(ms) - the minimum elapsed time in milliseconds
  - Max Elapsed Time(ms) - the maximum elapsed time in milliseconds
  - Std Deviation Elapsed Time(ms) - the standard deviation for the elapsed time
  - Invocations - the number of invocations of this method
  - Errors - the number of exceptions thrown by this method
- Aggregated SQL statement execution statistics - this data is available only if the MBean configuration parameter `curam.jmx.sql_statement_statistics_enabled` is set to true.
  - Username – the username that executed this SQL statement. This is only valid when per user statistics are collected.
  - SQL Text – the text of the SQL statement

- Executions – the total number of times this SQL statement was executed including database and query cache hits
- Elapsed Time(ms) – the average elapsed time in milliseconds to execute the statement. Only occurrences which hit the database are taken into account.
- Min Elapsed Time(ms) - the minimum elapsed time in milliseconds
- Max Elapsed Time(ms) - the maximum elapsed time in milliseconds
- Std Deviation Elapsed Time(ms) - the standard deviation for the elapsed time
- Rows Returned - the average number of rows returned by the statement
- Min Rows Returned - the minimum number of rows returned by the statement
- Max Rows Returned - the maximum number of rows returned by the statement
- Std Deviation Rows Returned - the standard deviation for the number of rows returned by the statement
- Query Cache Hit Ratio - the percentage of query cache hits
- Aggregated application exception statistics
  - Username – the username that invoked the operation that threw the exception. This is only valid when per user statistics are collected.
  - Catalog Entry – the catalog entry for the exception's message
  - Occurrences – the number of occurrences of this exception
- Aggregated SQL query cache statistics
  - Query cache type - the type of the query cache
  - Misses - the number of cache misses
  - Hits – the number of cache hits
- Data about in-flight BPO method and SQL statement invocations - this data is only collected when the Cúram JMX configuration parameter `curam.jmx.in_flight_statistics_enabled` is set to true.
  - BPO method data
    - UUID – the unique identifier of this transaction
    - Parent UUID – the unique identifier of this transaction's parent
    - Username – the username that initiated this transaction
    - Method – the method being executed
    - Elapsed Time(ms) - the time elapsed, in milliseconds, since this invocation has been initiated
  - SQL statement data
    - UUID – the unique identifier of this transaction
    - Parent UUID – the unique identifier of this transaction's parent
    - Username – the username that initiated this transaction
    - SQL – the SQL statement being executed
    - Elapsed Time(ms) - the time elapsed, in milliseconds, since this execution has been initiated
- Aggregated transaction tracing statistics - this data is only collected when Cúram JMX configuration parameter `curam.jmx.transaction_tracing_enabled` is set to true . The aggregated transaction data is exposed as XML. The XML schema is shown in “XML Schema for Aggregated Transaction Tracing” on page 11.

Tracing data is grouped by thread and the meaning of the C element attributes is detailed as follows:

- C – the application layer
- M - the invocation target, depending on the application layer it can be a URL, BPO method or an SQL statement
- EA - the average elapsed time for an invocation
- EMN –the minimum elapsed time for an invocation
- EMX – the maximum elapsed time for an invocation

**Availability of transaction tracing data:** Transaction tracing data is not collected outside JVM process boundaries. This means that full tracing through all application layers is only available when the client and server applications are collocated.

## CuramClientCoreStatsMBean

This MBean exposes core statistics for code running in the client container.

**MBean Statistics:** The following statistics are exposed by this MBean:

- Aggregated URL invocation data - the following counter are available:
  - Username – the username that invoked this URL. This is only valid when per user statistics are collected.
  - URL – the URL for which statistics have been collected
  - Invocations – the number of invocations of this URL
  - Elapsed Time(ms) - The average elapsed time per invocation in milliseconds
  - Min Elapsed Time(ms) - the minimum elapsed time in milliseconds
  - Max Elapsed Time(ms) - the maximum elapsed time in milliseconds
  - Std Deviation Elapsed Time(ms) - the standard deviation for the elapsed time
  - Errors - The number of times an exception is thrown when processing this URL
- Data about in-flight URL invocations - this data is only collected when the Cúram JMX configuration parameter `curam.jmx.in_flight_statistics_enabled` is set to true.
  - UUID – the unique identifier of this transaction
  - Parent UUID – the unique identifier of this transaction's parent
  - Username – the username that initiated this transaction
  - URL – the URL being invoked
  - Elapsed Time(ms) - the time elapsed, in milliseconds, since this request has been initiated
  - Client IP address - the IP address of the remote host connected to this application
  - Client port number - the port number of the remote host connected to this application
- Aggregated transaction tracing statistics - this data is only collected when the Cúram JMX configuration parameter `curam.jmx.transaction_tracing_enabled` is set to true . If a filter is specified using the configuration parameter `curam.jmx.transaction_tracing_url_filter` , data is collected only for activity originating from URLs matching the filter. The aggregation data has the same format as for “CuramServerCoreStatsMBean” on page 4.

## CuramCacheStatsMBean

This MBean exposes core statistics for Cúram Cache.

**MBean Statistics:** The following statistics are exposed by this MBean for each global cache:

- Cache group - the name of the cache group
- Cache - the name of the cache
- Layer - the name of the cache layer (memory, disk,...)
- Size - the number of items in the cache
- Hits - the number of requests to the cache that returned an item already loaded in the cache
- Misses - the number of requests to the cache that returned an item which had to be loaded in the cache
- Evictions - the number of times items that have been evicted from the cache
- Last access time - the timestamp of the last access to the cache
- Average get time(ns) - the average elapsed time, in nanoseconds, that takes for an item to be read from the cache. Note that some cache providers might only support millisecond resolution.
- Min get time(ns) - the minimum get time in nanoseconds
- Max get time(ns) - the maximum get time in nanoseconds
- Std deviation get time(ns) - the standard deviation for the get time

Multi-instance caches have three types of statistics. Some multi-instance caches offer also a statistics differentiator token which is used to differentiate further the cache instances for the purpose of calculating statistics. For transaction local caches this differentiator is the name of the business method currently being executed.

- Snapshot - these are statistics collected at the moment of the query from all caches alive at that moment
- Aggregated - these are statistics that are collected from all instances of caches that have been created. There are two types of aggregated statistics:
  - Without differentiator - aggregated statistics where the differentiator token provided by the cache instance is not taken into consideration
  - With differentiator - aggregated statistics where the differentiator token provided by the cache instance is taken into consideration

### **CuramEndUserStatsMBean**

This MBean exposes end user browser render time statistics.

- URL - the URL for which the statistics apply. The URL may have a list of widget IDs appended to it. These are the widgets that triggered loading events on the page at this URL.
- Invocations - the number of invocations to this URL
- RenderTime1(ms) - render time 1 in milliseconds - this is the time between the browser receiving the <head> tag and the browser receiving the </body> tag. It is an approximation of the time it takes to transfer the HTML document.
- RenderTime2(ms) - render time 2 in milliseconds - this is the time between render timestamp 1 and the time Dojo finished loading. This is an approximation of the time needed by Dojo initialization.
- RenderTime3(ms) - render time 3 in milliseconds - this is the time between render timestamp 2 and the time the last Dojo widget on the page finished loading

**Performance impact:** Enabling the collection of end user statistics may have an impact on the performance of the application.

**MBean Configuration Parameters:** The collection of end user statistics is controlled by the following application configuration parameters:

- `curam.jmx.end_user_statistics_enabled` - enables and disables the collection of end user statistics
- `curam.jmx.end_user_statistics_user_filter` - regular expression that selects the users for which end user statistics are collected
- `curam.jmx.end_user_statistics_display_enabled` - whether or not the end user statistics are displayed in the browser. If true, the statistics for the current page are displayed.
- `curam.jmx.end_user_statistics_upload_delay` - the delay in seconds between the page reporting being loaded and the moment the statistics are uploaded

### **CuramConfigurationStatsMBean**

This MBean exposes application configuration parameter statistics.

- **Parameter** - the name of the runtime configuration parameter
- **Type** - the type for the value of this parameter
- **Value** - the current value of this parameter
- **Access count** - the number of times the configuration parameter was accessed

### **ExtensionPointsStatsMBean**

This MBean exposes execution statistics for instrumented application extension points.

- **Extension point** - the name of the application extension point
- **Invocations** - the number of times the extension point was executed
- **Errors** - the number of times the execution of the extension point failed
- **Elapsed time(ms)** - the average elapsed time in milliseconds for an execution of the extension point
- **Min elapsed time(ms)** - the minimum elapsed time in milliseconds
- **Max elapsed time(ms)** - the maximum elapsed time in milliseconds
- **Std deviation elapsed time(ms)** - the standard deviation for the elapsed time

### **OperationalStatsMBean**

This MBean provides operational information.

**MBean Statistics:** The following statistics are provided by this MBean:

- **Last reset time** - the last time the JMX statistics were reset.
- **Last download time** - the last time the JMX statistics were downloaded
- **Application start up time** - the time when the application was started

### **RunAndRecordStatsMBean**

This MBean provides statistics for code instrumented with `CuramJMXUtil.runAndRecord` as described in Instrumenting Application Code

**MBean Statistics:** The following statistics are provided by this MBean:

- **Target** - the monitored target as provided to the call to `CuramJMXUtil.runAndRecord`
- **Invocations** - the number of invocations made to the monitored target
- **Elapsed time(ms)** - the average elapsed time in milliseconds for an invocation of the monitored target
- **Std deviation elapsed time(ms)** - the standard deviation of the elapsed time in milliseconds



- **Min elapsed time(ms)** - the minimum elapsed time in milliseconds
- **Max elapsed time(ms)** - the maximum elapsed time in milliseconds
- **Errors** - the number of times the invocation failed

### **CuramWebServicesOutboundPoolStatsMBean**

This MBean provides statistics for the pool of connection to external web services.

**MBean Statistics:** The following statistics are provided by this MBean:

- **Key** - a text representation of the external web service
- **Active** - the number of active connections in the pool
- **Size** - the total number of connections in the pool

### **CuramWebServicesOutboundStats**

This MBean provides statistics for the outbound web service calls.

**MBean Statistics:** The following statistics are provided by this MBean:

- **Target** - a text representation of the external web service
- **Invocations** - the number of invocations made to the monitored target
- **Elapsed time(ms)** - the average elapsed time in milliseconds for an invocation of the monitored target
- **Std deviation elapsed time(ms)** - the standard deviation of the elapsed time in milliseconds
- **Min elapsed time(ms)** - the minimum elapsed time in milliseconds
- **Max elapsed time(ms)** - the maximum elapsed time in milliseconds
- **Errors** - the number of times the invocation failed

## **Access to the JMX Statistics**

The JMX statistics can be obtained in several ways:

- Use a third party monitoring solution - there are enterprise class monitoring solutions with generic JMX support that can be used to visualize the application's statistics.
- Download the statistics as an XML file with an associated XSL file - this method collects the statistics from a single application server and provides a quick way of visualizing the statistics as an HTML page. The drawback is that it only works for application servers hosting the administration application.
- Use the JMX timer mechanism - this method works well in any environment, online or batch. For online applications statistics can be collected from every server in the environment.

### **Using the Administration Application**

The JMX statistics can be downloaded as a compressed XML file by accessing the URL `/Curam/JMXStats.do` or `/Curam/JMXStats.do?action=download`. The JMX statistics are only collected for the application server specified in the URL.

To reset the JMX statistics, invoke `/Curam/JMXStats.do?action=reset`. This invokes the reset method on all registered MBeans that define this method, resetting the statistics counters.

The JMX statistics are packaged as an XML file within a ZIP archive file. This archive contains the XML file with the JMX statistics (JMXStats.xml) and an associated XSL style sheet document (JMXStats.xsl). To visualize the statistics unzip

the two files on your file system and open the XML file with a browser that supports rendering XML files using XSL style sheets (any modern browser has this capability).

Access to the JMX statistics is controlled using two dynamic application properties:

- `curam.jmx.download_statistics_allowed` - when true, access to `/Curam/JMXStats.do` is allowed
- `curam.jmx.download_statistics_username` - this is the username that is allowed to access this URL. If a value is not set for this parameter, access to the JMX statistics is not allowed.

**Note for SAP NetWeaver:** The username specified for `curam.jmx.download_statistics_username` must be assigned the Administrator role in NetWeaver's User Management Engine.

**Note for IBM WebSphere:** The "ALL AUTHENTICATED" special subject must be assigned the "Monitor" and "Operator" roles in order to be able to collect and download Cúram JMX statistics. From the WebSphere administrative console click on the Users and Groups menu and from the Administrative group roles add the "Monitor" and "Operator" roles to the special subject "ALL AUTHENTICATED".

A more secure alternative is to assign the "Monitor" and "Operator" roles to the user configured to download the statistics. The drawback is that this user bypasses the Cúram login module and it has to be managed inside WebSphere's user registry. Assuming that the configured username is `sysadmin`, follow these steps:

1. Add the `sysadmin` user to the list of excluded usernames for the Cúram login module. For each resource configured with this login module (DEFAULT, RMI\_INBOUND and WEB\_INBOUND in Global security > JAAS - System logins) click on the `curam.util.security.CuramLoginModule` entry and add to the `exclude_usernames` list the `sysadmin` username.
2. Add the `sysadmin` user to the WebSphere's user registry and assign it the "Monitor" and "Operator" roles. In WebSphere administrative console navigate to Users and Groups > Manage Users and define the `sysadmin` user. Then from Users and Groups > Administrative user roles assign the "Monitor" and "Operator" roles to `sysadmin`.

To download the JMX statistics, ensure that `curam.jmx.download_statistics_allowed` is set to true, log in as the user specified in `curam.jmx.download_statistics_username` and visit the URL `<server>:<port>/Curam/JMXStats.do` or `<server>:<port>/Curam/JMXStats.do?action=download` where `<server>` is the host name of the application server whose JMX statistics are to be downloaded and `<port>` is the port number for your application.

## Using the JMX Timer

The JMX statistics can be obtained from any environment, online or batch, using the JMX timer. This mechanism writes the JMX statistics periodically at a file system location. The advantage of this mechanism is that it can be used for collecting statistics from every server in an environment.

The JMX timer is controlled by the following application properties:

`curam.jmx.output_statistics_timer_enabled`,  
`curam.jmx.output_statistics_timer_period` and  
`curam.jmx.output_statistics_timer_use_delta`.

---

## XML Schema for Aggregated Transaction Tracing

### XML Schema for Aggregated Transaction Tracing

```
<xsd:schema attributeFormDefault="unqualified"
  elementFormDefault="qualified" version="1.0"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <xsd:element name="CURAM_TRANSACTION_TRACE">
    <xsd:complexType>
      <xsd:sequence>
        <xsd:element maxOccurs="unbounded" name="THREAD">
          <xsd:complexType>
            <xsd:sequence>
              <xsd:element maxOccurs="unbounded" name="C">
                <xsd:complexType>
                  <xsd:sequence>
                    <xsd:element maxOccurs="unbounded" name="C">
                      <xsd:complexType>
                        <xsd:attribute name="C"
                          type="xsd:string" />
                        <xsd:attribute name="M"
                          type="xsd:string" />
                        <xsd:attribute name="EA"
                          type="xsd:decimal" />
                        <xsd:attribute name="EMN"
                          type="xsd:decimal" />
                        <xsd:attribute name="EMX"
                          type="xsd:decimal" />
                        <xsd:attribute name="CT"
                          type="xsd:int" />
                      </xsd:complexType>
                    </xsd:element>
                  </xsd:sequence>
                  <xsd:attribute name="C" type="xsd:string" />
                  <xsd:attribute name="M" type="xsd:string" />
                  <xsd:attribute name="EA" type="xsd:decimal" />
                  <xsd:attribute name="EMN" type="xsd:decimal" />
                  <xsd:attribute name="EMX" type="xsd:decimal" />
                  <xsd:attribute name="CT" type="xsd:int" />
                </xsd:complexType>
              </xsd:element>
            </xsd:sequence>
            <xsd:attribute name="ID" type="xsd:string" />
          </xsd:complexType>
        </xsd:element>
      </xsd:sequence>
    </xsd:complexType>
  </xsd:element>
</xsd:schema>
```



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