

IBM Cúram Social Program Management
8.0.2

Cúram Cache



Note

Before using this information and the product it supports, read the information in [“Notices” on page 8](#)

Edition

This edition applies to IBM® Cúram Social Program Management 8.0.0, 8.0.1, and 8.0.2.

Licensed Materials - Property of IBM.

© **Copyright International Business Machines Corporation 2012, 2022.**

US Government Users Restricted Rights – Use, duplication or disclosure restricted by GSA ADP Schedule Contract with IBM Corp.

© .

Contents

Figures.....	iv
Chapter 1. Developing with Cúram Cache.....	1
Overview.....	1
What is Cúram Cache.....	1
Configuration.....	1
Statistics.....	2
Shutting Down Cúram Cache.....	3
Global Caches.....	3
Global Cache Provider.....	3
Default Global Cache Group.....	3
Global Caches.....	3
Usage Recommendations.....	3
Configuration.....	4
Using Global Caches in a Transactional Context.....	4
Code Samples.....	5
Cache Loader.....	5
Cache Client.....	5
Cache Invalidation.....	5
Thread Local Caches.....	6
Configuration.....	6
Code Samples.....	6
Transaction Local Caches.....	7
Configuration.....	7
Code Samples.....	7
Notices.....	8
Privacy Policy considerations.....	9
Programming Interface Information.....	9
Trademarks.....	9

Figures

1. Configuring a cache.....	2
2. Configuring all caches in a group.....	2
3. Disabling a cache for a batch process.....	2
4. Configuring a global cache.....	4
5. Using CacheLoaderAdapter to implement a cache loader.....	5
6. Registering a cache loader and using the cache.....	5
7. Invalidating a cache entry in server code.....	6
8. Configuring a thread local cache with name curam.myproject.mycache.....	6
9. Setting up and using a thread local cache.....	6
10. Configuring a transaction local cache with name curam.myproject.mycache.....	7
11. Setting up and using a transaction local cache.....	7

Chapter 1. Developing with Cúram Cache

Use this information to configure the Cúram cache. Cúram cache is a generic caching service for short and long lived caches. The service is available in both the client and server containers of an application server environment and in a standard stand-alone Java™ process.

Overview

The aim of this document is to introduce Cúram Cache, a generic caching service that is designed to satisfy the requirement for short and long lived caches in the application.

This guide is intended for architects and developers who are interested in using Cúram Cache to satisfy their caching requirements.

What is Cúram Cache

Cúram Cache is a generic caching service that is designed to satisfy the requirement for short and long lived caches in the application. The service is available in both the client and server containers of an application server environment (online application) and in a standard stand-alone Java process (batch programs).

Cúram Cache allows the creation of three types of caches:

- Global - these are global (at JVM level) caches.
- Thread local - these are caches that live as long as the thread that owns them.
- Transaction local - these are caches that exist during the current transaction.

The last two types of caches are collectively referred to in this document as multi-instance caches because at any moment there might be more than one instance of a cache with a given name (one for each active transaction or thread).

Configuration

The configuration of all types of caches in Cúram Cache is entirely declarative and it is based on the configuration mechanism that is provided by the application. Cache configuration parameters must be added to the APP_CACHE property section.

In the current implementation, global caches support both size and time-based eviction policies while the multi-instance caches have support only for time-based eviction policy.

The following cache configuration parameters can be adjusted:

- Size – the maximum number of elements in memory. The default value is 200. The type is INT32.
- Eviction policy – the policy that is used for evicting items from memory when the maximum number of elements in memory is reached. The default value is LRU . The type is STRING . Valid values are:
 - LRU – least recently used
 - LFU – least frequently used
 - FIFO – first in first out
- Time to live - is the maximum number of seconds an item can remain in the cache regardless of use. Because the default implementation of Curam Cache is backed by Ehcache, the item expires at this limit and will no longer be returned from the cache (but may not be evicted yet).
- Time to idle - is the maximum number of seconds an item in the cache is allowed to be unused. Because the default implementation of Curam Cache is backed by Ehcache, the item expires at this limit and will no longer be returned from the cache (but may not be evicted yet).

All cache configuration properties must conform to this notation:

```
curam.cache.<cache_group_name>.<cache_name>.<parameter>
```

where:

- <cache_group_name> - is the name of the cache group the cache belongs to.
- <cache_name> - is the name of the cache. This might also be "*" and then, the configuration parameter is applied to all caches in this cache group.
- <parameter> - can be size, evictionPolicy, timeToIdle or timeToLive.

In the example below, the global cache `curam.myproject.mycache` in the default global cache group `curam-group` is configured with a size of 1000 items and an eviction policy of Least Recently Used.

```
curam.cache.curam-group.curam.myproject.mycache.size=1000
curam.cache.curam-group.curam.myproject.mycache.evictionPolicy=LRU
```

Figure 1. Configuring a cache

In this second example, the transaction local cache `curam.myproject.mycache` in the transaction local cache group `transaction-group` is configured with a time to idle of 10 seconds while all other transaction local caches are configured with a value of 5 seconds.

```
curam.cache.transaction-group.curam.myproject.mycache
                                     .timeToIdle=10
curam.cache.transaction-group.*.timeToIdle=5
```

Figure 2. Configuring all caches in a group

Cache configuration data that is stored in the application configuration repository can be overridden by passing the relevant values as JVM system properties. This might be of interest for batch processes where the application profile might be different than the online application.

The example here shows how to disable the global cache `curam.myproject.mycache` in the default global cache group for a batch process.

```
ant -f app_batchlauncher.xml
    -Dcuram.cache.curam-group.curam.myproject.mycache.size=0
    -Dbatch.userna...
```

Figure 3. Disabling a cache for a batch process

Statistics

All caches in Cúram Cache are instrumented for statistics and these are integrated with the Cúram JMX infrastructure.

The following minimum set of statistics are exposed by each type of cache through the `CuramCacheStats` MBean:

- 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 that is 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 are evicted from 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 support only millisecond resolution.

Multi-instance caches offer snapshot and aggregated statistics. Snapshot statistics are for all instances alive at the moment of the query and aggregated statistics are calculated from all instances that are created.

Shutting Down Cúram Cache

Cúram Cache requires orderly shutdown on JVM exit. Cúram Cache installs automatically a JVM shutdown hook to clear the cache as the last resort solution but it is recommended, where possible, the use of the explicit shutdown by starting `CacheManager.shutdown()` when the application is shut down.

Global Caches

Global caches are caches that exist in the scope of the JVM process or beyond. In the current version of Cúram Cache, global caches exist only in the scope of the JVM process. An entry that is stored in a global cache lives across transaction boundaries until it is removed explicitly, by the developer, or implicitly, as a result of the eviction policy associated with the cache.

It is important to note that because global caches are long lived, their data is prone to short periods of inconsistency when cached objects are updated. When an update is made in the application that affects a cached object, the associated cache entry is invalidated asynchronously. The caching infrastructure guarantees that the cache entry is, eventually, invalidated but it cannot guarantee a certain maximum time frame. Understanding this behavior is important when deciding if certain application data can be cached in a global cache.

Global Cache Provider

Cúram Cache implements large parts of the global caching infrastructure that uses third party caching solutions, which are referred to in this document as caching providers. The default provider is Ehcache, an open source, high performance, distributed caching infrastructure.

Default Global Cache Group

Global caches are grouped together based on common configuration requirements such as replication and disk storage. All caches in the application are created in the default cache group. The name of the default cache group is `curam-group`.

In the current implementation, the default cache group is not self-replicating and does not support disk overflow and disk persistence. Because self-replication is disabled, the cache operations are only visible to the JVM where the global cache is located. However, to keep all caches in the default cache group consistent throughout the application server cluster, an explicit cache invalidation mechanism is provided. The cache invalidation can be triggered only from the server code but it invalidates caches in both the server and the client containers across all JVMs in the application server cluster.

Global Caches

Global caches are created with a call to the `get()` method of the cache group. If a cache does not exist already, a cache is created and configuration data, if this data exists, is applied to the cache before being returned. Global caches are usually populated by using cache loaders that are registered by cache clients. This approach isolates the cache client from the management of concurrent access to the cache while the cache is loading.

However, Cúram Cache does not enforce the use of serializable objects in its API, certain features offered by the caching infrastructure are only available if the key or the cached object are serializable. For this reason, it is recommended that, whenever possible, serializable keys and values are used in Cúram Cache.

Usage of non-serializable keys: Cache entries that have non-serializable keys are only invalidated on the local JVM and not throughout the application server cluster.

Usage Recommendations

The following list is recommendations on how a global cache is used:

- Only cache immutable objects.
- Use serializable keys and values whenever possible. At the very least the keys should be serializable.

- Use a cache loader to populate the cache. This allows the cache to take advantage of the fine grain concurrency optimizations that are built into the cache provider and it does not require the user to be concerned with managing concurrent access to the cache.
- The loading of a cache without a loader (by using `get()` and `put()` calls) must be avoided for two main reasons:
 - Concurrency management - In this case the user is responsible for managing concurrent access to the cache while the cache is loading. The user has two choices:
 - Control concurrent access to the `get()` and `put()` block of code – this approach is not recommended in a performance sensitive part of the application but it offers the guarantee that on object is only loaded once.
 - Allow concurrent access to the `get()` and `put()` block of code – this approach supports higher concurrency but an object might be loaded more than once by different threads.
 - Efficient data management - without a cache loader, the cache must be pre-populated with all data. With a cache loader, only required data is pulled into the cache.
- Use cache names that are prefixed with a package name unique to your project. For instance `curam.cpm.myCache` would be a suitable name for a cache in the Curam Provider Management project.

Configuration

All global caches inherit default values for the configuration parameters.

Global caches inherit the following default configuration parameter values:

- `size` - 200
- `evictionPolicy` - LRU
- `timeToLive` - 0 (not active)
- `timeToIdle` - 0 (not active)

The **`timeToLive`** parameter is the maximum number of seconds that an item can remain in the cache regardless of use. Because the default implementation of Curam Cache is backed by Ehcache, the item expires at this limit and will no longer be returned from the cache. However, it cannot be evicted yet.

The **`timeToIdle`** parameter is the maximum number of seconds that an item in the cache is allowed to be unused. Because the default implementation of Curam Cache is backed by Ehcache, the item expires at this limit and will no longer be returned from the cache. However, it cannot be evicted yet.

The default values can be overridden for any global cache. In the following examples, `curam-group` is the name of the default cache group and `curam.myproject.mycache` is the name of the cache.

```
curam.cache.curam-group.curam.myproject.mycache.size=1000
curam.cache.curam-group.curam.myproject.mycache.evictionPolicy=LRU
curam.cache.curam-group.curam.myproject.mycache.timeToLive=3600
curam.cache.curam-group.curam.myproject.mycache.timeToIdle=300
```

Figure 4. Configuring a global cache

Using Global Caches in a Transactional Context

When a global cache is used in a transactional context, care must be taken to ensure that the cache maintains its consistency in case the current transaction is rolled back.

Cache invalidation in a transactional context: When modifying data that affects the content of a cache do not remove or update the cached element directly; instead, invoke the `CacheManagerEjb.postInvalidationMessage()` method to post an invalidation message that triggers the cache invalidation.

Code Samples

The section contains code samples that show how to write a cache loader, how to use the cache and how to invalidate a cache entry.

Cache Loader

The example shows how the `CacheLoaderAdapter` class is used to help in the implementation of `MyCacheLoader`.

```
...
public class MyCacheLoader extends
    CacheLoaderAdapter<Integer, ReadWorkQueueDetails> {
    /* (non-Javadoc)
     * @see curam.util.cache.CacheLoader#load(java.lang.Object)
     */
    public ReadWorkQueueDetails load(Integer workQueueID)
        throws ApplicationException, InformationalException {
        WorkAllocation wa = (WorkAllocation)WorkAllocationFactory
            .newInstance();
        ReadWorkQueueKey key = new ReadWorkQueueKey();
        key.key = new ReadWorkQueueKey();
        key.key.key = new WorkQueueKey();
        key.key.key.workQueueID = workQueueID;
        ReadWorkQueueDetails item = wa.readWorkQueue(key);
        if(item != null) {
            return item.dtls;
        }
        return null;
    }
}
...
```

Figure 5. Using `CacheLoaderAdapter` to implement a cache loader

Cache Client

The example shows the usual way of registering a cache loader and using the cache.

```
...
public class MyCacheClient {
    // keep a static reference to mycache
    private static Cache<Integer,
        ReadWorkQueueDetails> myCache;

    static {
        // retrieve a reference to mycache and register
        // the cache loader
        myCache = CacheManager.getDefaultCacheGroup()
            .getCache("mycache");
        myCache.registerCacheLoader(new MyCacheLoader());
    }

    public WorkAllocation() {
        ...
    }
}
...
// use the cache
ReadWorkQueueDetails wq = myCache.get(1);
...
```

Figure 6. Registering a cache loader and using the cache

Cache Invalidation

The example shows how to invalidate a cache entry in code running in a transactional context (server code).

As explained in “Default Global Cache Group” on page 3, cache invalidation for global caches in the default cache group can be triggered only by server code.

```

...
CacheManagerEjb.postInvalidationMessage(
    new CacheInvalidationMessage<Key>("mycache", 1));
...

```

Figure 7. Invalidating a cache entry in server code

Thread Local Caches

These caches are closely tied to the thread used to create them. No other thread can access data in these caches and caches are only deleted when the thread that created them is stopped. Thread local caches are specialized. They must be used only for small caches where the overhead of multi-threaded access control that exists for global cache cannot be tolerated.

Configuration

Thread local caches support only a time-based eviction policy.

The only two configuration parameters that can be used are

- `timeToLive` - this is the maximum number of seconds an item can remain in the cache regardless of use
- `timeToIdle` - this is the maximum number of seconds an item in the cache is allowed to be unused.

The default properties for the parameters are:

- `timeToLive` - 0 (not active)
- `timeToIdle` - 0 (not active)

The name of the group for thread local caches is `thread-group`. This name must be used to configure thread local cache as shown in the example.

```

curam.cache.thread-group.curam.myproject.mycache.timeToLive=60
curam.cache.thread-group.curam.myproject.mycache.timeToIdle=10

```

Figure 8. Configuring a thread local cache with name `curam.myproject.mycache`

Code Samples

Thread local caches are by accessed only where the correct context (thread) exists.

For instance, it is not recommended to set up a thread local cache in static block of code. Because that thread might not be the same as the thread using the cache later.

```

public void myMethod() {
    ...
    Cache<String, String> threadCache = CacheManager.
        getThreadLocalCacheGroup().getCache("mycache");
    String value = threadCache.get("key");
    if(value == null) {
        // perform expensive operation to calculate value - this
        // processing only happens once for each thread
        ...
        // and store the result
        threadCache.put("key", "value");
    }
    ...
}

```

Figure 9. Setting up and using a thread local cache

Transaction Local Caches

A transaction local cache is a cache that lives only during the current transaction. This type of cache is only available in the server application.

Configuration

Transaction local caches support only a time-based eviction policy.

Only the following two configuration parameters can be used:

- `timeToLive` - this is the maximum number of seconds an item can remain in the cache regardless of use
- `timeToIdle` - this is the maximum number of seconds an item in the cache is allowed to be unused.

The default properties for the parameters are:

- `timeToLive` - 0 (not active)
- `timeToIdle` -5

The name of the group for transaction local caches is `transaction-group`. This name must be used to configure transaction local caches as shown in the following example:

```
curam.cache.transaction-group.curam.myproject.mycache.timeToLive=60
curam.cache.transaction-group.curam.myproject.mycache.timeToIdle=10
```

Figure 10. Configuring a transaction local cache with name `curam.myproject.mycache`

Code Samples

Like thread local caches, transaction local caches are accessed only where the correct context (transaction) exists.

```
public void myMethod() {
    ...
    Cache<String, String> txnCache = CacheManagerEjb.
        getTransactionLocalCacheGroup().getCache("mycache");
    String value = txnCache.get("key");
    if(value == null) {
        // perform expensive operation to calculate value - this
        // processing only happens once per transaction
        ...
        // and store the result
        txnCache.put("key", "value");
    }
    ...
}
```

Figure 11. Setting up and using a transaction local cache

Notices

This information was developed for products and services offered in the United States.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not grant you any license to these patents. You can send license inquiries, in writing, to:

IBM Director of Licensing IBM Corporation North Castle Drive, MD-NC119 Armonk, NY 10504-1785 US

For license inquiries regarding double-byte character set (DBCS) information, contact the IBM Intellectual Property Department in your country or send inquiries, in writing, to:

Intellectual Property Licensing Legal and Intellectual Property Law IBM Japan Ltd. 19-21, Nihonbashi-Hakozakicho, Chuo-ku Tokyo 103-8510, Japan

INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some jurisdictions do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM websites are provided for convenience only and do not in any manner serve as an endorsement of those websites. The materials at those websites are not part of the materials for this IBM product and use of those websites is at your own risk.

IBM may use or distribute any of the information you provide in any way it believes appropriate without incurring any obligation to you.

Licensees of this program who wish to have information about it for the purpose of enabling: (i) the exchange of information between independently created programs and other programs (including this one) and (ii) the mutual use of the information which has been exchanged, should contact:

IBM Director of Licensing IBM Corporation North Castle Drive, MD-NC119 Armonk, NY 10504-1785 US

Such information may be available, subject to appropriate terms and conditions, including in some cases, payment of a fee.

The licensed program described in this document and all licensed material available for it are provided by IBM under terms of the IBM Customer Agreement, IBM International Program License Agreement or any equivalent agreement between us.

The performance data and client examples cited are presented for illustrative purposes only. Actual performance results may vary depending on specific configurations and operating conditions.

Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

Statements regarding IBM's future direction or intent are subject to change or withdrawal without notice, and represent goals and objectives only.

All IBM prices shown are IBM's suggested retail prices, are current and are subject to change without notice. Dealer prices may vary.

This information is for planning purposes only. The information herein is subject to change before the products described become available.

This information contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to actual people or business enterprises is entirely coincidental.

COPYRIGHT LICENSE:

This information contains sample application programs in source language, which illustrate programming techniques on various operating platforms. You may copy, modify, and distribute these sample programs in any form without payment to IBM, for the purposes of developing, using, marketing or distributing application programs conforming to the application programming interface for the operating platform for which the sample programs are written. These examples have not been thoroughly tested under all conditions. IBM, therefore, cannot guarantee or imply reliability, serviceability, or function of these programs. The sample programs are provided "AS IS", without warranty of any kind. IBM shall not be liable for any damages arising out of your use of the sample programs.

Privacy Policy considerations

IBM Software products, including software as a service solutions, (“Software Offerings”) may use cookies or other technologies to collect product usage information, to help improve the end user experience, to tailor interactions with the end user or for other purposes. In many cases no personally identifiable information is collected by the Software Offerings. Some of our Software Offerings can help enable you to collect personally identifiable information. If this Software Offering uses cookies to collect personally identifiable information, specific information about this offering’s use of cookies is set forth below.

Depending upon the configurations deployed, this Software Offering may use session cookies or other similar technologies that collect each user’s name, user name, password, and/or other personally identifiable information for purposes of session management, authentication, enhanced user usability, single sign-on configuration and/or other usage tracking and/or functional purposes. These cookies or other similar technologies cannot be disabled.

If the configurations deployed for this Software Offering provide you as customer the ability to collect personally identifiable information from end users via cookies and other technologies, you should seek your own legal advice about any laws applicable to such data collection, including any requirements for notice and consent.

For more information about the use of various technologies, including cookies, for these purposes, see IBM’s Privacy Policy at <http://www.ibm.com/privacy> and IBM’s Online Privacy Statement at <http://www.ibm.com/privacy/details> the section entitled “Cookies, Web Beacons and Other Technologies” and the “IBM Software Products and Software-as-a-Service Privacy Statement” at <http://www.ibm.com/software/info/product-privacy>.

Programming Interface Information

This publication documents intended programming interfaces that allow the customer to write programs to obtain the services of IBM Cúram Social Program Management.

Trademarks

IBM, the IBM logo, and [ibm.com](http://www.ibm.com) are trademarks or registered trademarks of International Business Machines Corp., registered in many jurisdictions worldwide. Other product and service names might be

trademarks of IBM or other companies. A current list of IBM trademarks is available on the Web at “ Copyright and trademark information ” at <http://www.ibm.com/legal/copytrade.shtml>.

Adobe, the Adobe logo, PostScript, and the PostScript logo are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States, and/or other countries.

Java and all Java-based trademarks and logos are trademarks or registered trademarks of Oracle and/or its affiliates.

The registered trademark Linux is used pursuant to a sublicense from the Linux Foundation, the exclusive licensee of Linus Torvalds, owner of the mark on a worldwide basis.

Microsoft, Windows, Windows NT, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.

UNIX is a registered trademark of The Open Group in the United States and other countries.

Other names may be trademarks of their respective owners. Other company, product, and service names may be trademarks or service marks of others.



Part Number:

(1P) P/N: