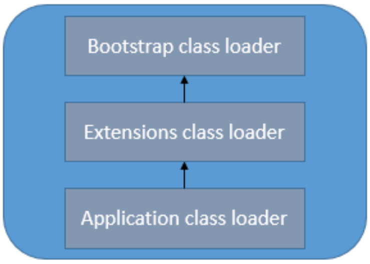
CHAPTER 11: CLASS LOADERS

Theory

With the help of the class loaders, WebSphere Application Server enables applications to access available class and resources. Having known the structure and the hierarchy of class loaders will help you to understand and troubleshoot advances environments against errors such as “ClassNotFoundException”.

Each Java class must be loaded by a class loader that locates and loads the required classes. During the startup of a JVM, following class loaders are used:

- The *bootstrap class loader*, loads the core Java libraries that are located under “<JAVA_HOME>/jre/lib”. This class loader is written in native code.
- The *extensions class loader*, loads the code in the extensions directories such as “<JAVA_HOME>/jre/lib/ext” or any other directory that is specified by the “java.ext.dirs” system property. This class loader is implemented by the “sun.misc.Launcher$ExtClassLoader” class.
- The *application class loader*, loads the code defined in the “java.class.path” that maps to the “CLASSPATH” environment variable. This is implemented by the “sun.misc.Launcher$AppClassLoader” class.

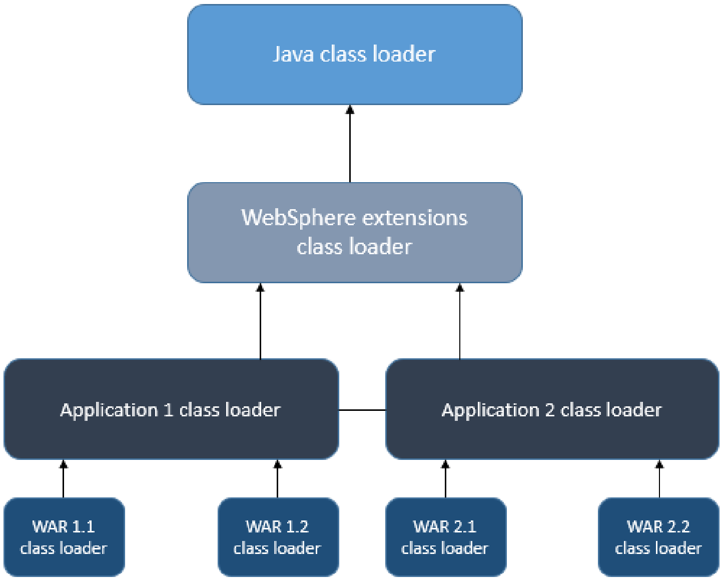


Java class loaders hierarchy

The *WebSphere extensions class loader* is where WebSphere Application Server itself is loaded. The class path that is used by the extensions class loader is retrieved from the “ws.ext.dirs” system property, which is initially derived from the “WAS_EXT_DIRS” environment variable set in the “setupCmdLine” script file. Each directory listed in the ws.ext.dirs environment variable is added to the WebSphere extensions class loaders class path, and every .jar file and .zip file in the directory is added to the class path.

Application or web module class loaders load elements of enterprise applications running on the server. These application elements can be:

- Web modules
- EJB modules
- Application client modules
- Resource adapter archives
- Utility JAR files



WebSphere class loaders hierarchy

Each class loader is a child of the previous class loader. WebSphere Application Server provides the ability to change the class loading behavior.

- **Application Server class loaders:** You can configure 2 types of class loader policies,
  - Single: In this case, applications are not isolated and uses a single application loader to load all of the modules, libraries and JAR files that are required by all the applications installed into the JVM.
  - Multiple: All applications are isolated and each of them has its own class loader to load EJB modules, libraries and etc.

  You can also configure the class loading mode as ***parent first*** that sets the loading of the classes to its parent class loader before attempting to load classes from its local path, or as ***parent last*** that starts loading classes from its local class path before asking its parent.

- **Application class loaders:** You can set the class loader order and WAR class loader policy within WebSphere Application Server.
  For class loader order you have 2 options:
    - *Classes loaded with parent class loader first*, sets the loading of classes to its parent class loader before attempting to load the class from its local class path.
    - *Classes loaded with application class loader first,* tells the class loader to start with loading classes from its local class path before asking its parent.

  For WAR class order policy, you have the following options:

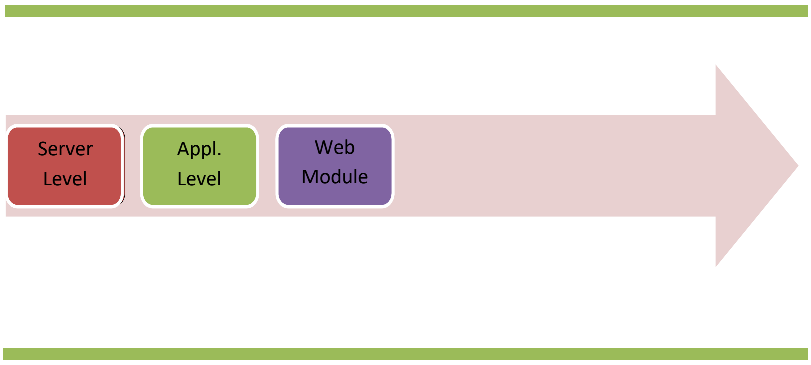
    - *Class loader for each WAR file in application* that creates a separate class loader is assigned to each WAR file.
    - *Single class loader for application* single class loader is assigned to all WAR files.
- **Web module class loaders:** You can set the class loader order that specifies the search order of the class whether to look first in the parent class loader or in the application class loader. You can set the order as following:
    - *Classes loaded with parent class loader first*, the class loader searches first the application class loader
    - *Classes loaded with application class loader first*, the class loader searches first in the WAR class loaders to load a class.

AIM

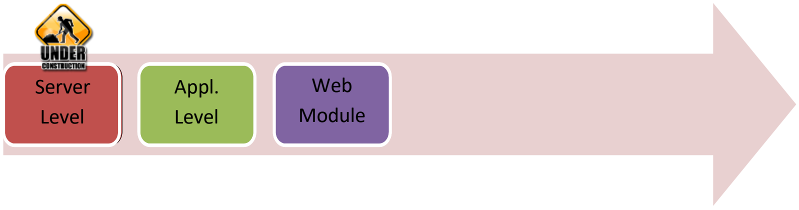
The aim of the lab exercise is to get familiar with class loader settings in different levels. In order to achieve this goal, you need to perform following tasks:

Task 1: Configure class loaders on server level
Task 2: Configure class loaders on application level
Task 3: Configure web module class loader

Lab Exercise 11: CLASS LOADERS

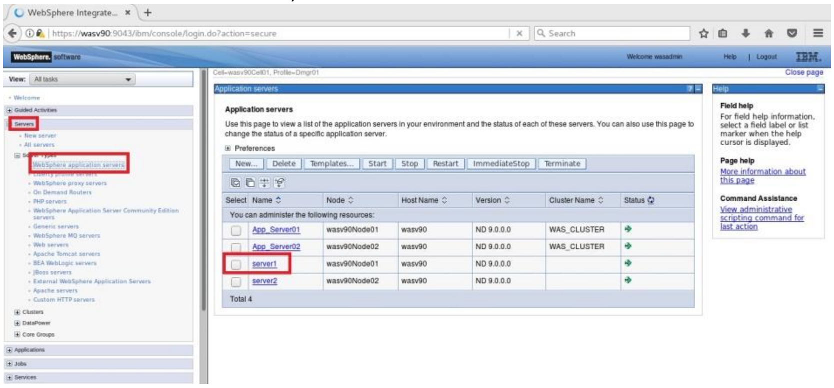


1. **Configure class loaders on server level**
2. **Configure class loaders on application level**
3. **Configure web module class loader**



Task 1: Configure class loaders on server level

Step 1: Navigate to “Servers>Server Types>WebSphere application servers” and then click on the server name, “server1”.



Application servers

Use this page to view a list of the application servers in your environment and the status of each of these servers. You can also use this page to change the status of a specific application server.

Preferences

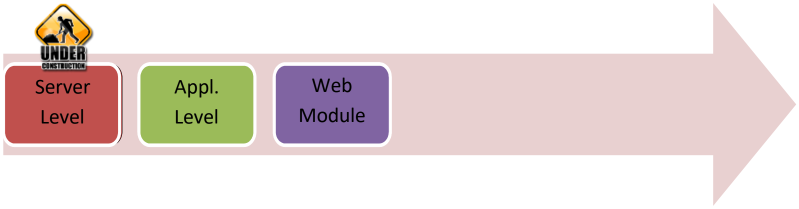
New... | Delete | Templates... | Start | Stop | Restart | ImmediateStop | Terminate

Select	Name	Node	Host Name	Version	Cluster Name	Status
You can administer the following resources:						
☐	App_Server01	wasv90Node01	wasv90	ND 9.0.0.0	WAS_CLUSTER	➜
☐	App_Server02	wasv90Node02	wasv90	ND 9.0.0.0	WAS_CLUSTER	➜
☐	server1	wasv90Node01	wasv90	ND 9.0.0.0		➜
☐	server2	wasv90Node02	wasv90	ND 9.0.0.0		➜
Total 4						

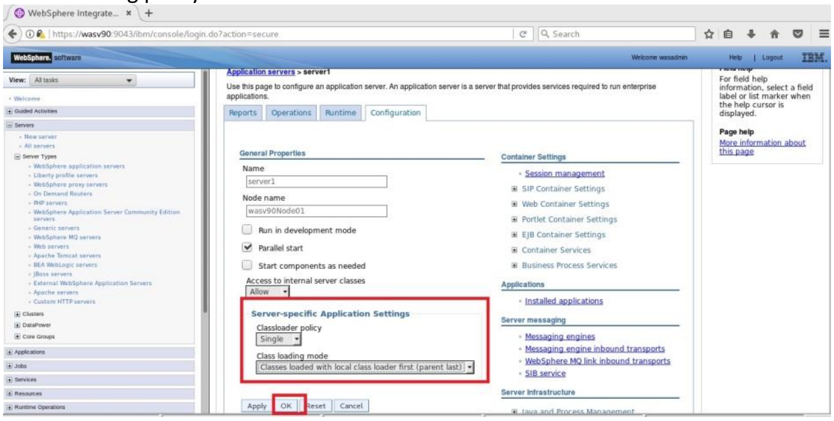
Field help
For field help information, select a field label or list marker when the help cursor is displayed.

Page help
More information about this page

Command Assistance
View administrative scripting command for last action



Step 2: Under the “Server-specific Application Settings”, select “Single” as “Classloader policy” and “Classes loaded with local class loader first (parent last)” as “Class loading policy” and then click “OK”.



Application servers > server1

Use this page to configure an application server. An application server is a server that provides services required to run enterprise applications.

General Properties

Name: server1

Node name: wasv90Node01

☐ Run in development mode

☑ Parallel start

☐ Start components as needed

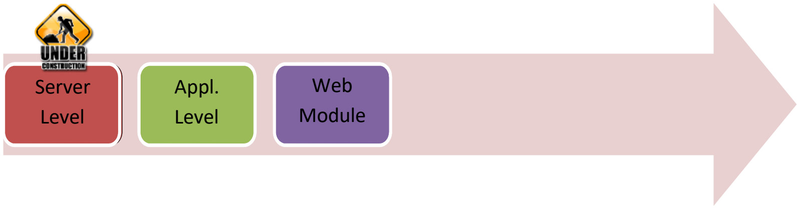
Access to internal server classes: Allow

Server-specific Application Settings

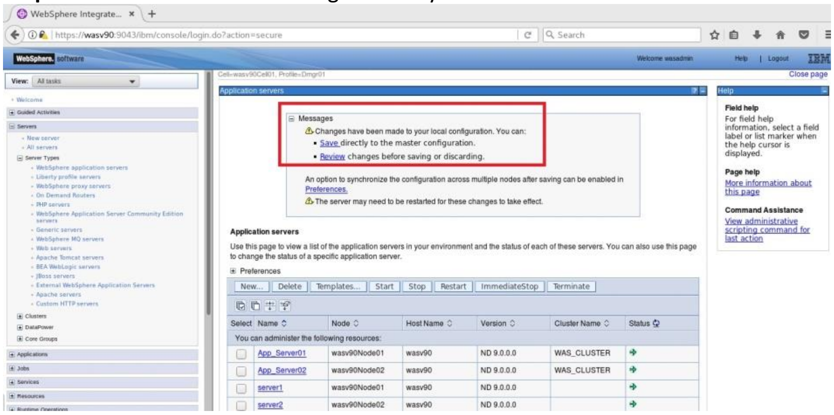
Classloader policy: Single

Class loading mode: Classes loaded with local class loader first (parent last)

For field help information, select a field label or list marker when the help cursor is displayed.



Step 3: Click "Save" to write changes directly.



Cell=wasv90Cell01, Profile=Dmgr01

Messages

⚠ Changes have been made to your local configuration. You can:

- Save directly to the master configuration.
- Review changes before saving or discarding.

An option to synchronize the configuration across multiple nodes after saving can be enabled in Preferences.

⚠ The server may need to be restarted for these changes to take effect.

Application servers

Use this page to view a list of the application servers in your environment and the status of each of these servers. You can also use this page to change the status of a specific application server.

Preferences

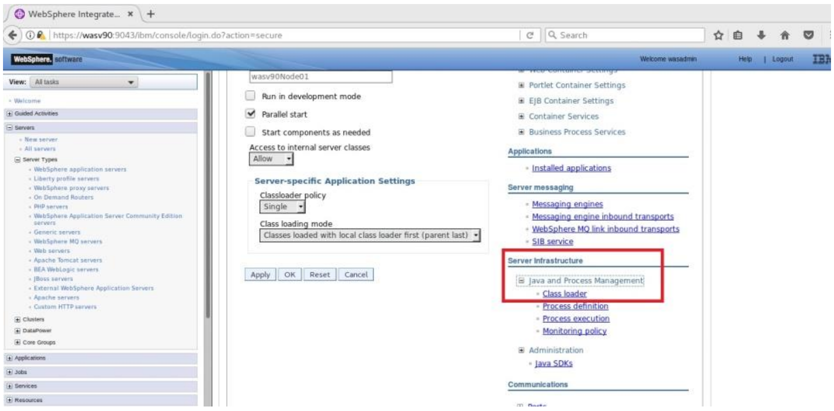
Select	Name	Node	Host Name	Version	Cluster Name	Status
You can administer the following resources:						
☐	App_Server01	wasv90Node01	wasv90	ND 9.0.0.0	WAS_CLUSTER	➔
☐	App_Server02	wasv90Node02	wasv90	ND 9.0.0.0	WAS_CLUSTER	➔
☐	server1	wasv90Node01	wasv90	ND 9.0.0.0		➔
☐	server2	wasv90Node02	wasv90	ND 9.0.0.0		➔

Field help
For field help information, select a field label or list marker when the help cursor is displayed.

Page help
More information about this page

Command Assistance
View administrative scripting command for last action

Step 4: Navigate to "Server Infrastructure>Java and Process Management>Class loader".



wasv90Node01

☐ Run in development mode

☑ Parallel start

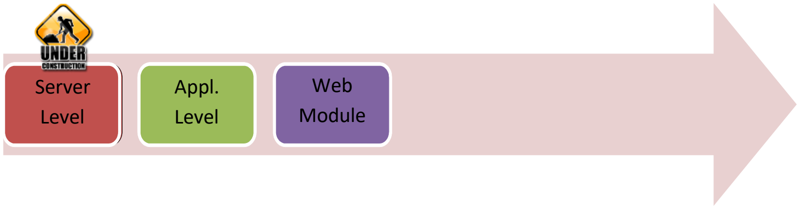
☐ Start components as needed

Access to internal server classes: Allow

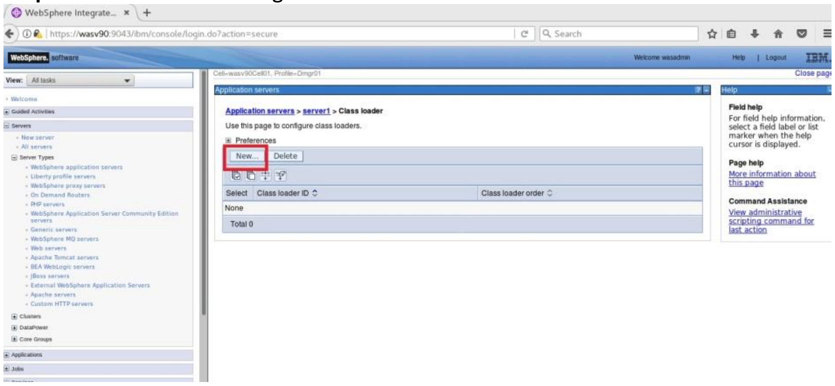
Server-specific Application Settings

Classloader policy: Single

Class loading mode: Classes loaded with local class loader first (parent last)



Step 5: Click “New” to configure new class loader.



Cell=wasv90Cell01, Profile=Dmgr01

Application servers

Application servers > server1 > Class loader

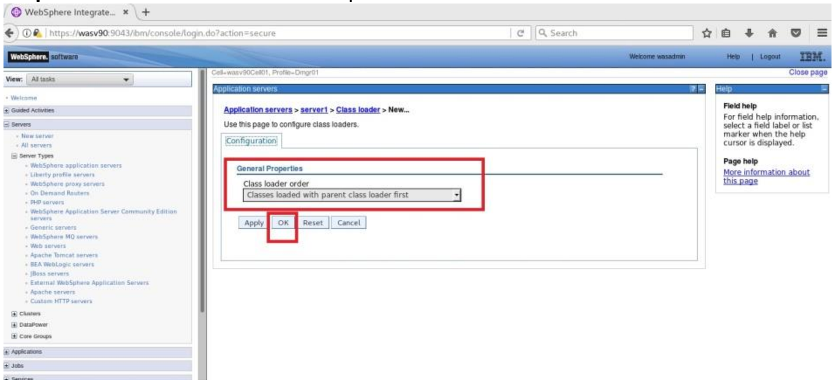
Use this page to configure class loaders.

Preferences

New... Delete

Select	Class loader ID	Class loader order
None		
Total 0		

Step 6: Select “Classes loaded with parent class loader first” then click “OK”.



Cell=wasv90Cell01, Profile=Dmgr01

Application servers

Application servers > server1 > Class loader > New...

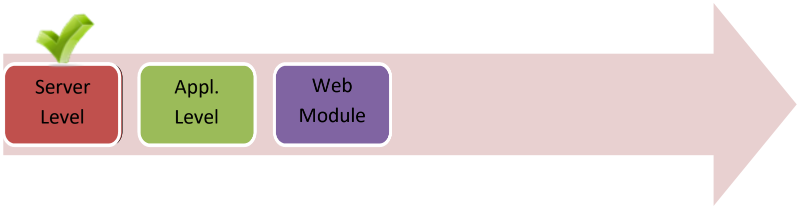
Use this page to configure class loaders.

Configuration

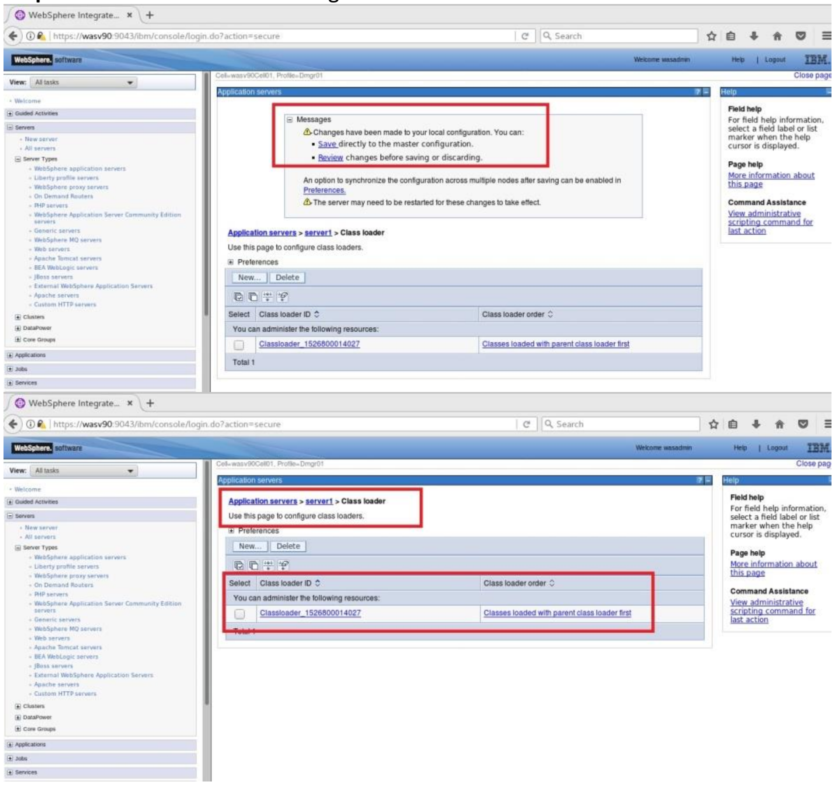
General Properties

Class loader order
Classes loaded with parent class loader first

Apply OK Reset Cancel



Step 7: Click “Save” to write changes to the master file.



Cell=wasv90Cell01, Profile=Dmgr01

Application servers

Messages

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Application servers > server1 > Class loader

Use this page to configure class loaders.

Preferences

Select	Class loader ID	Class loader order
You can administer the following resources:		
☐	Classloader_1526800014027	Classes loaded with parent class loader first
Total 1		

Help

Field help
For field help information, select a field label or list marker when the help cursor is displayed.

Page help
More information about this page

Command Assistance
View administrative scripting command for last action

Cell=wasv90Cell01, Profile=Dmgr01

Application servers

Application servers > server1 > Class loader

Use this page to configure class loaders.

Preferences

Select	Class loader ID	Class loader order
You can administer the following resources:		
☐	Classloader_1526800014027	Classes loaded with parent class loader first
Total 1		

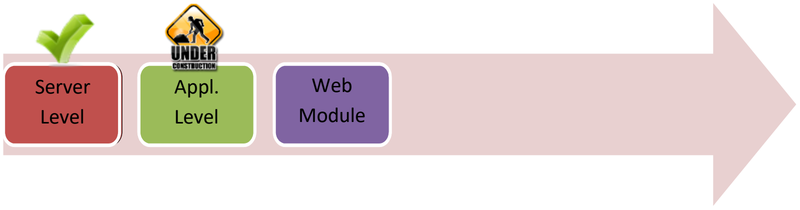
Help

Field help
For field help information, select a field label or list marker when the help cursor is displayed.

Page help
More information about this page

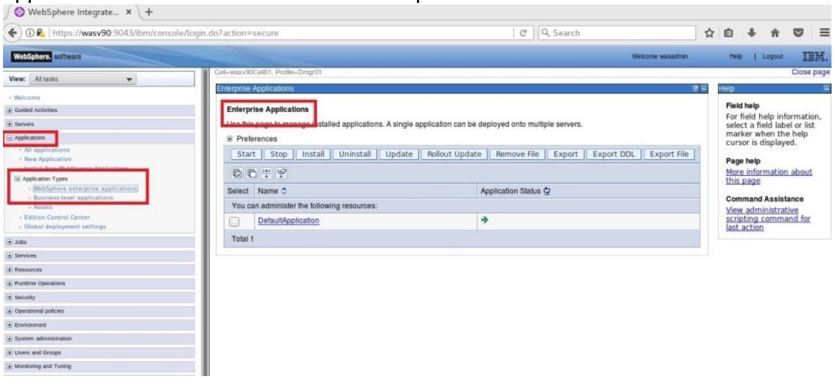
Command Assistance
View administrative scripting command for last action

Task 1 is complete!



Task 2: Configure class loaders on application level

Step 1: Navigate to “Applications>Application Types>WebSphere enterprise applications” and then click on “DefaultAPplication”.



Cell=wasv90Cell01, Profile=Dmgr01

Enterprise Applications

Enterprise Applications

Use this page to manage installed applications. A single application can be deployed onto multiple servers.

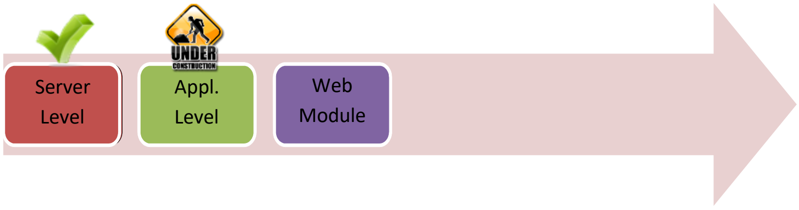
⊞ Preferences

Select	Name	Application Status
You can administer the following resources:		
☐	DefaultApplication	➜
Total 1		

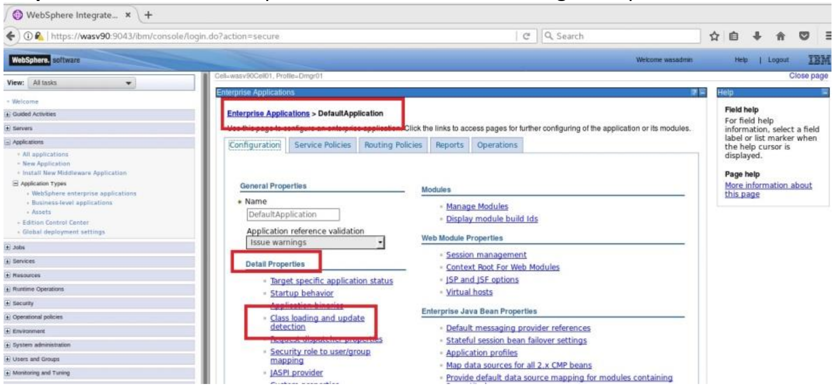
Field help
For field help information, select a field label or list marker when the help cursor is displayed.

Page help
More information about this page

Command Assistance
View administrative scripting command for last action



Step 2: Under “Default Properties”, click on “Class loading and update detection”.



Cell=wasv90Cell01, Profile=Dmgr01

Enterprise Applications

Enterprise Applications > DefaultApplication

~~Use this page to configure an enterprise application.~~ Click the links to access pages for further configuring of the application or its modules.

General Properties

* Name
  DefaultApplication

Application reference validation
Issue warnings

Detail Properties

- Target specific application status
- Startup behavior
- ~~Application binaries~~
- Class loading and update detection
- ~~Request dispatcher properties~~
- Security role to user/group mapping
- JASPI provider

Modules

- Manage Modules
- Display module build Ids

Web Module Properties

- Session management
- Context Root For Web Modules
- JSP and JSF options
- Virtual hosts

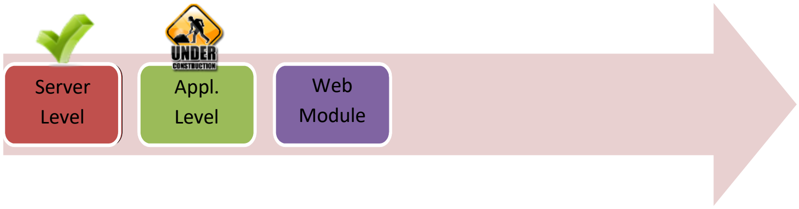
Enterprise Java Bean Properties

- Default messaging provider references
- Stateful session bean failover settings
- Application profiles
- Map data sources for all 2.x CMP beans
- Provide default data source mapping for modules containing

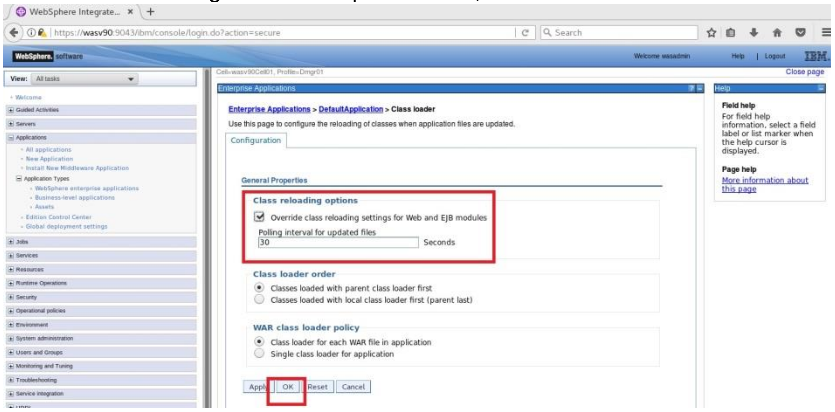
Help

Field help
For field help information, select a field label or list marker when the help cursor is displayed.

Page help
More information about this page



Step 3: Select “Override class reloading settings for the Web and EJB module” and enter “30” for “Polling interval for updated files”, then click “OK”.



Enterprise Applications > DefaultApplication > Class loader

Use this page to configure the reloading of classes when application files are updated.

Configuration

General Properties

Class reloading options

[✓] Override class reloading settings for Web and EJB modules

Polling interval for updated files: 30 Seconds

Class loader order

(●) Classes loaded with parent class loader first
( ) Classes loaded with local class loader first (parent last)

WAR class loader policy

(●) Class loader for each WAR file in application
( ) Single class loader for application

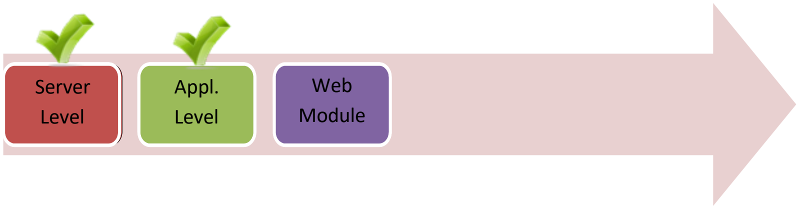
Apply | OK | Reset | Cancel

Field help

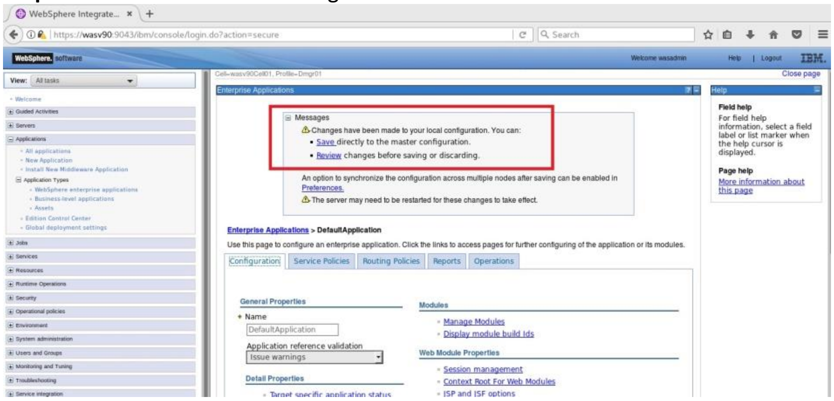
For field help information, select a field label or list marker when the help cursor is displayed.

Page help

More information about this page



Step 4: Click “Save” to write changes to master file.



Cell=wasv90Cell01, Profile=Dmgr01

Enterprise Applications

Messages

⚠ Changes have been made to your local configuration. You can:

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- Review changes before saving or discarding.

An option to synchronize the configuration across multiple nodes after saving can be enabled in Preferences.

⚠ The server may need to be restarted for these changes to take effect.

Enterprise Applications > DefaultApplication

Use this page to configure an enterprise application. Click the links to access pages for further configuring of the application or its modules.

General Properties

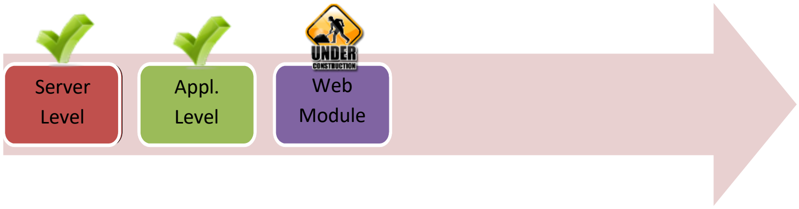
Name: DefaultApplication

Application reference validation: Issue warnings

Field help

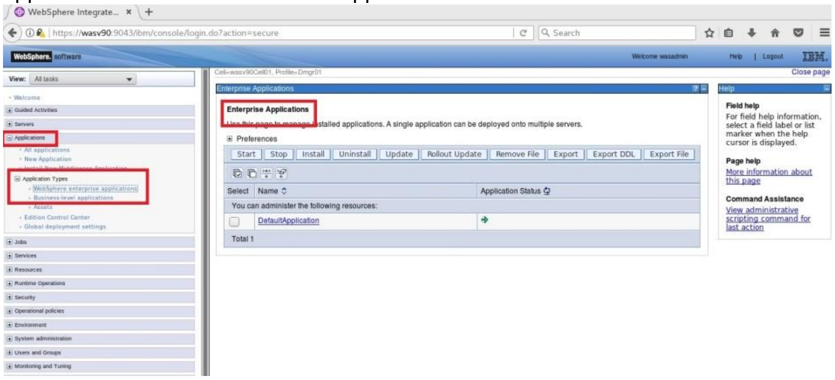
For field help information, select a field label or list marker when the help cursor is displayed.

Task 2 is complete!



Task 2: Configure web module class loader

Step 1: Navigate to “Applications>Application Types>WebSphere enterprise applications” and click on “DefaultApplication”.

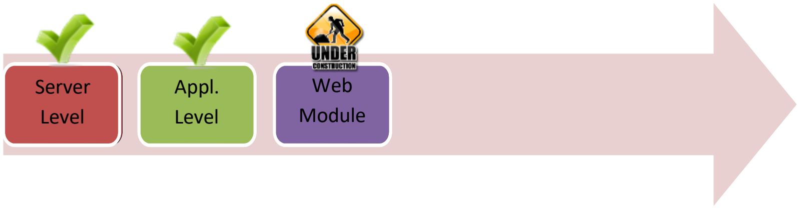


Enterprise Applications

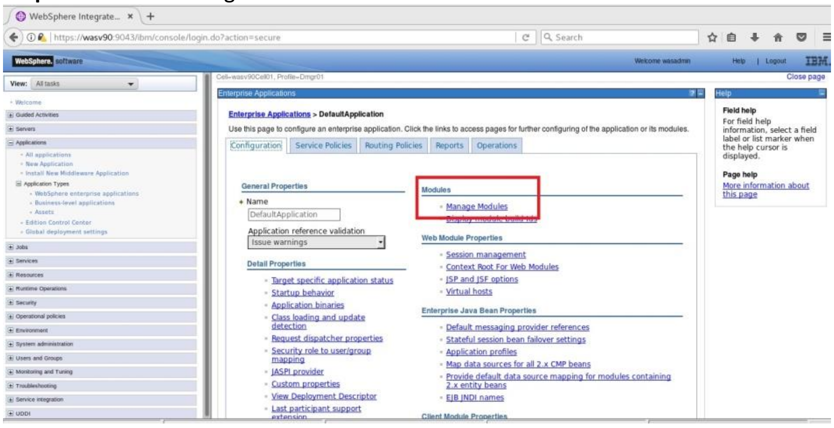
Use this page to manage installed applications. A single application can be deployed onto multiple servers.

Select	Name	Application Status
You can administer the following resources:		
☐	DefaultApplication	➜
Total 1		

For field help information, select a field label or list marker when the help cursor is displayed.



Step 2: Click on “Manage Modules” under “Modules”.



Cell=wasv90Cell01, Profile=Dmgr01

Enterprise Applications

Enterprise Applications > DefaultApplication

Use this page to configure an enterprise application. Click the links to access pages for further configuring of the application or its modules.

General Properties

* Name
DefaultApplication

Application reference validation
Issue warnings

Detail Properties

- Target specific application status
- Startup behavior
- Application binaries
- Class loading and update detection
- Request dispatcher properties
- Security role to user/group mapping
- JASPI provider
- Custom properties
- View Deployment Descriptor
- Last participant support extension

Modules

- Manage Modules
- ~~Display module build Ids~~

Web Module Properties

- Session management
- Context Root For Web Modules
- JSP and JSF options
- Virtual hosts

Enterprise Java Bean Properties

- Default messaging provider references
- Stateful session bean failover settings
- Application profiles
- Map data sources for all 2.x CMP beans
- Provide default data source mapping for modules containing 2.x entity beans
- EJB JNDI names

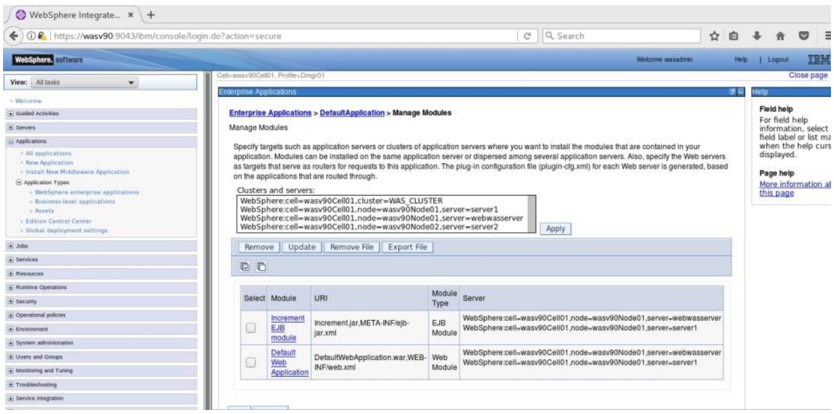
Client Module Properties

Help

Field help
For field help information, select a field label or list marker when the help cursor is displayed.

Page help
More information about this page

Step 3: Click on the web module name, “Default Web Application”.



Cell=wasv90Cell01, Profile=Dmgr01

Enterprise Applications

Enterprise Applications > DefaultApplication > Manage Modules

Manage Modules

Specify targets such as application servers or clusters of application servers where you want to install the modules that are contained in your application. Modules can be installed on the same application server or dispersed among several application servers. Also, specify the Web servers as targets that serve as routers for requests to this application. The plug-in configuration file (plugin-cfg.xml) for each Web server is generated, based on the applications that are routed through.

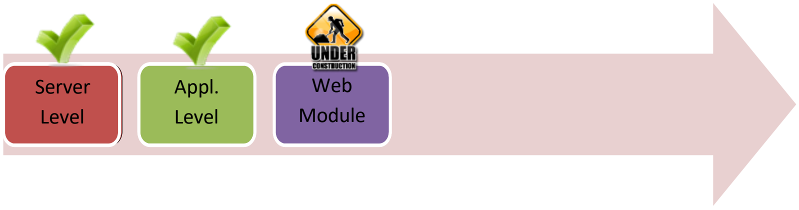
Clusters and servers:
WebSphere:cell=wasv90Cell01,cluster=WAS_CLUSTER
WebSphere:cell=wasv90Cell01,node=wasv90Node01,server=server1
WebSphere:cell=wasv90Cell01,node=wasv90Node01,server=webwasserver
WebSphere:cell=wasv90Cell01,node=wasv90Node02,server=server2

Select	Module	URI	Module Type	Server
☐	Increment EJB module	Increment.jar,META-INF/ejb-jar.xml	EJB Module	WebSphere:cell=wasv90Cell01,node=wasv90Node01,server=webwasserver WebSphere:cell=wasv90Cell01,node=wasv90Node01,server=server1
☐	Default Web Application	DefaultWebApplication.war,WEB-INF/web.xml	Web Module	WebSphere:cell=wasv90Cell01,node=wasv90Node01,server=webwasserver WebSphere:cell=wasv90Cell01,node=wasv90Node01,server=server1

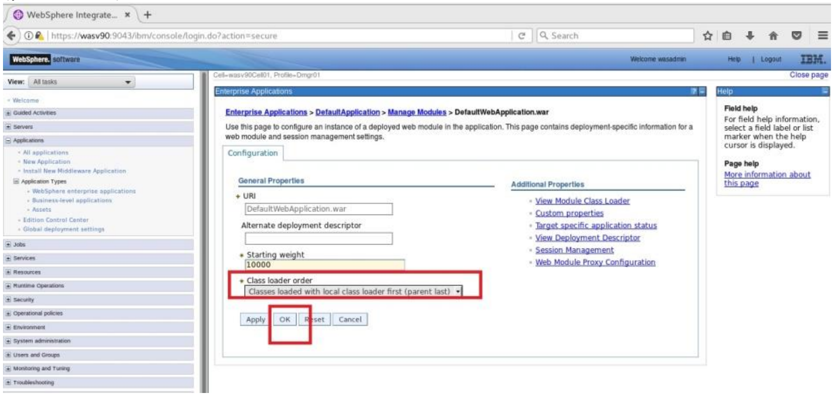
Help

Field help
For field help information, select field label or list ma when the help curs displayed.

Page help
More information a this page



Step 4: Change the class loader order, “Classes loaded with local class loader first (parent last)”.



Enterprise Applications > DefaultApplication > Manage Modules > DefaultWebApplication.war

Use this page to configure an instance of a deployed web module in the application. This page contains deployment-specific information for a web module and session management settings.

Configuration

General Properties

URI: DefaultWebApplication.war

Alternate deployment descriptor:

Starting weight: 10000

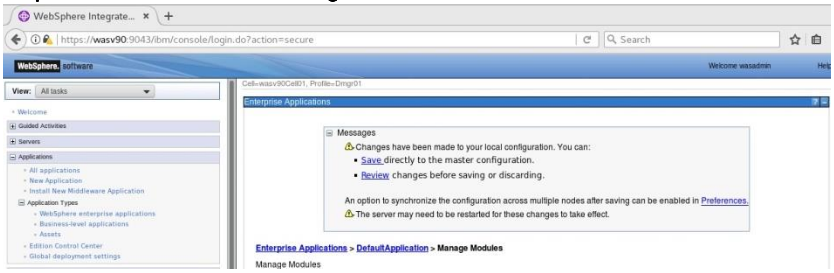
Class loader order: Classes loaded with local class loader first (parent last)

Additional Properties
- View Module Class Loader
- Custom properties
- Target specific application status
- View Deployment Descriptor
- Session Management
- Web Module Proxy Configuration

Field help: For field help information, select a field label or list marker when the help cursor is displayed.

Page help: More information about this page

Step 5: Click “Save” to write changes.



Messages

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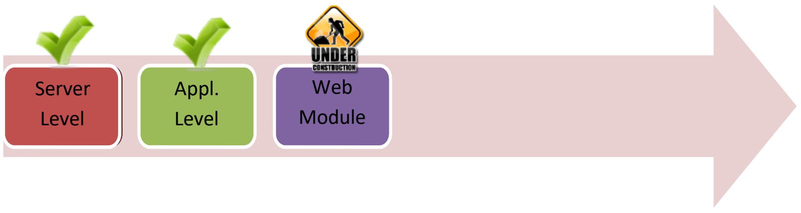
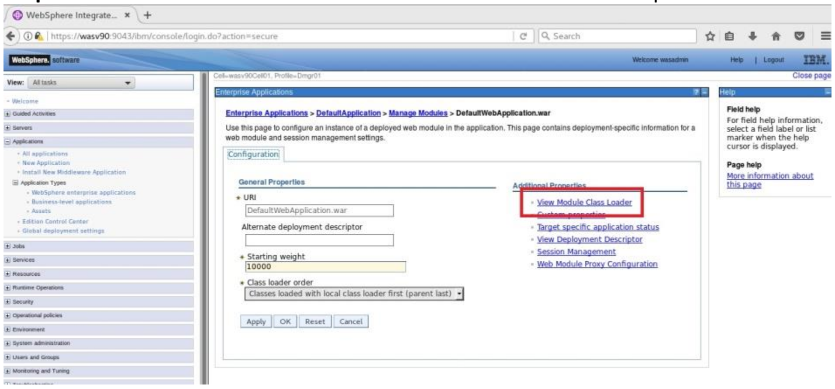
The server may need to be restarted for these changes to take effect.

Enterprise Applications > DefaultApplication > Manage Modules

Manage Modules



Step 6: Click on “View Module Class Loader” under “Additional Properties”.



Cell=wasv90Cell01, Profile=Dmgr01

Enterprise Applications > DefaultApplication > Manage Modules > DefaultWebApplication.war

Use this page to configure an instance of a deployed web module in the application. This page contains deployment-specific information for a web module and session management settings.

Configuration

General Properties

* URI: DefaultWebApplication.war

Alternate deployment descriptor:

* Starting weight: 10000

* Class loader order: Classes loaded with local class loader first (parent last)

Apply | OK | Reset | Cancel

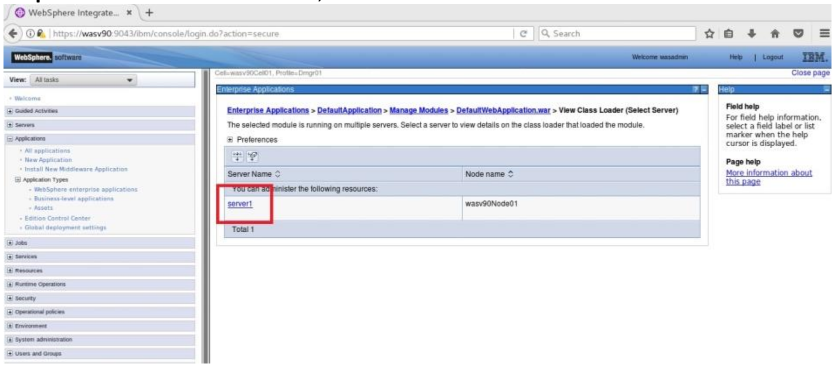
Additional Properties

- View Module Class Loader
- Custom properties
- Target specific application status
- View Deployment Descriptor
- Session Management
- Web Module Proxy Configuration

Field help
For field help information, select a field label or list marker when the help cursor is displayed.

Page help
More information about this page

Step 7: Click on the server name, “server1”.



Cell=wasv90Cell01, Profile=Dmgr01

Enterprise Applications > DefaultApplication > Manage Modules > DefaultWebApplication.war > View Class Loader (Select Server)

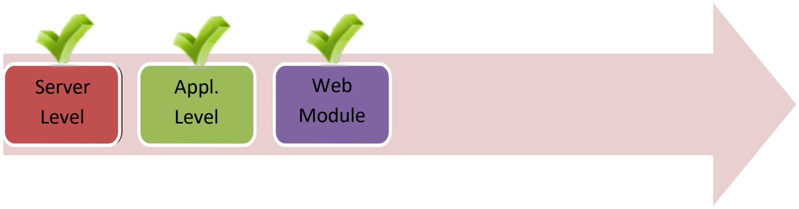
The selected module is running on multiple servers. Select a server to view details on the class loader that loaded the module.

Preferences

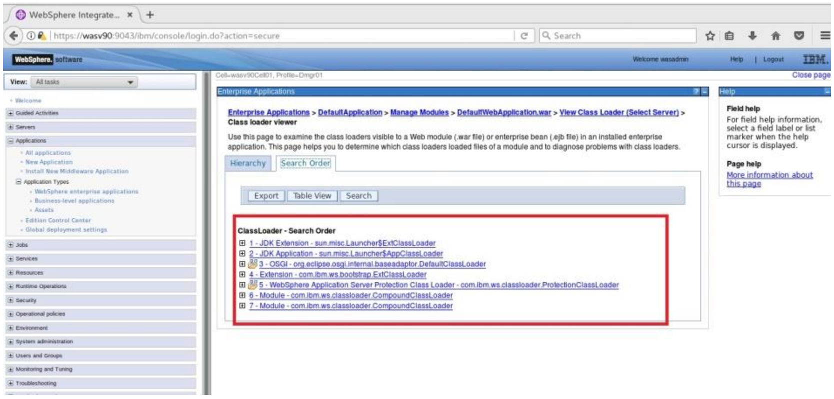
Server Name	Node name
You can administer the following resources:	
server1	wasv90Node01
Total 1	

Field help
For field help information, select a field label or list marker when the help cursor is displayed.

Page help
More information about this page



Step 8: You should see the class loaders loaded files of a module to debug problems with class loaders.



Enterprise Applications > DefaultApplication > Manage Modules > DefaultWebApplication.war > View Class Loader (Select Server) >
Class loader viewer

Use this page to examine the class loaders visible to a Web module (.war file) or enterprise bean (.ejb file) in an installed enterprise application. This page helps you to determine which class loaders loaded files of a module and to diagnose problems with class loaders.

ClassLoader - Search Order
- 1 - JDK Extension - sun.misc.Launcher$ExtClassLoader
- 2 - JDK Application - sun.misc.Launcher$AppClassLoader
- 3 - OSGI - org.eclipse.osgi.internal.baseadaptor.DefaultClassLoader
- 4 - Extension - com.ibm.ws.bootstrap.ExtClassLoader
- 5 - WebSphere Application Server Protection Class Loader - com.ibm.ws.classloader.ProtectionClassLoader
- 6 - Module - com.ibm.ws.classloader.CompoundClassLoader
- 7 - Module - com.ibm.ws.classloader.CompoundClassLoader

Field help
For field help information, select a field label or list marker when the help cursor is displayed.

Page help
More information about this page

Task 3 is complete!

SUMMARY

WebSphere Application Server enables applications to access available class and resources using class loaders. Understand the class loaders will help you to identify and solve the issues in an advanced WebSphere environment. WebSphere Application Server enables you to configure class loaders on server level, application level and web module level.

REFERENCES

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- http://pic.dhe.ibm.com/infocenter/wasinfo/v7r0/index.jsp?topic=%2Fcom.ibm.websphere.express.doc%2Finfo%2Fexp%2Fae%2Furun_rclassloader_inst.html
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