Restcomm SIP Servlets User Guide

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This user guide will help you get a better understanding of Restcomm SIP servlets and how the container can be used in an enterprise context. The guide will cover how to how to quickly get started with Restcomm SIP servlets either on top of JBoss or Apache Tomcat containers. There are sample applications included for those who want to grasp how to build SIP applications. You will also learn how to use advanced features like High Availability through Clustering and Failover. Finally, monitoring and security will be explained.

Chapter 1. Introduction

1.1. Overview of Restcomm SIP Servlets within the Telecommunications Industry

The Restcomm Communication Platform is the best architecture to create, deploy and manage services and applications integrating voice, video and data across a range of IP and legacy communications networks. It drives convergence with the following key enablers:

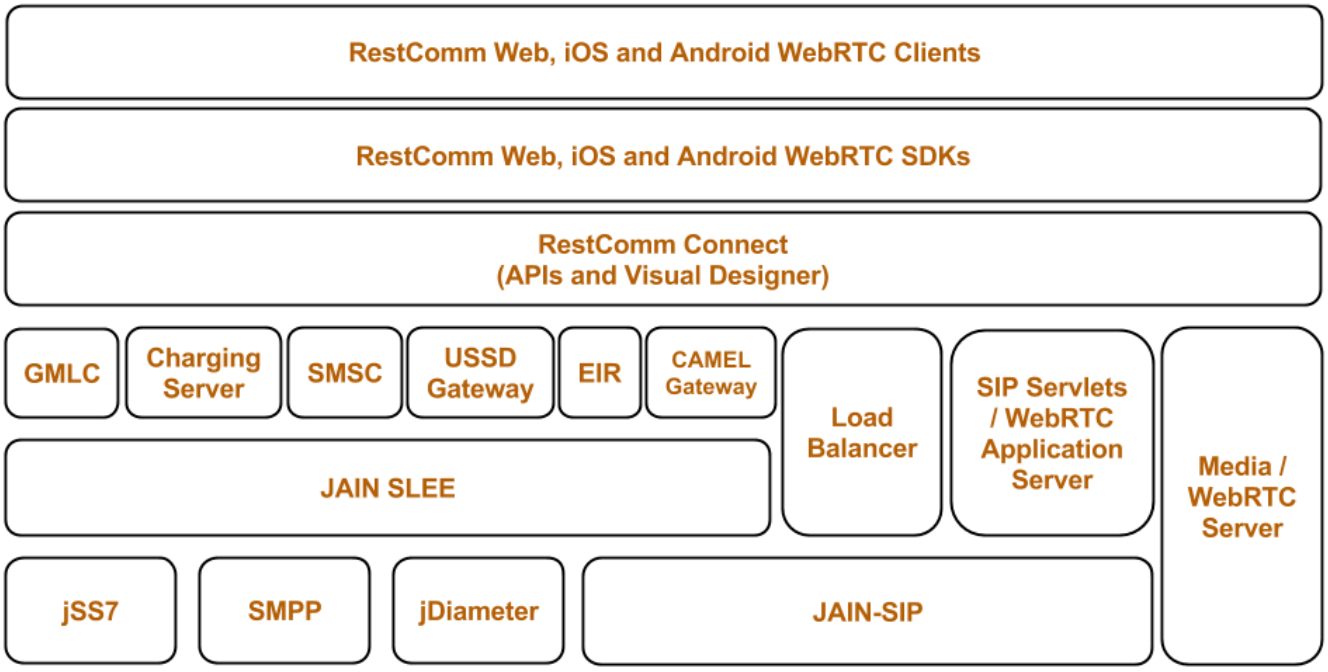

Figure 1. Restcomm Architecture Overview

1.2. Overview of SIP Servlets Server

Restcomm SIP Servlets is a modern communications middleware platform. RestcommSIP Servlets facilitates the shift towards Cloud Communications by enabling deployment and autoscaling of real time SIP Servlets apps across all major IaaS (Infrastructure as a Service) providers and also brings realtime communications (voice and video) to your Browser using HTML5 WebRTC and SIP Over WebSockets !

The link: HTML5 WebRTC Client allows you to make video calls from and to any Web Browser supporting WebRTC , (only Google Chrome supports it so far but all major browsers should support it in the next 6 months) as well as SIP Endpoints.

Restcomm SIP Servlets enables turnkey SaaS offerings such as RestComm .

Restcomm SIP Servlets implements the latest SIP Servlet v1.1 (JSR 289) standard. It can be plugged into any Application Server container (currently 7.X and JBoss 7.X) and also offers High Availability and Failover.

Restcomm SIP Servlets is lead by TeleStax, Inc . and developed collaboratively by a community of individual and enterprise contributors.

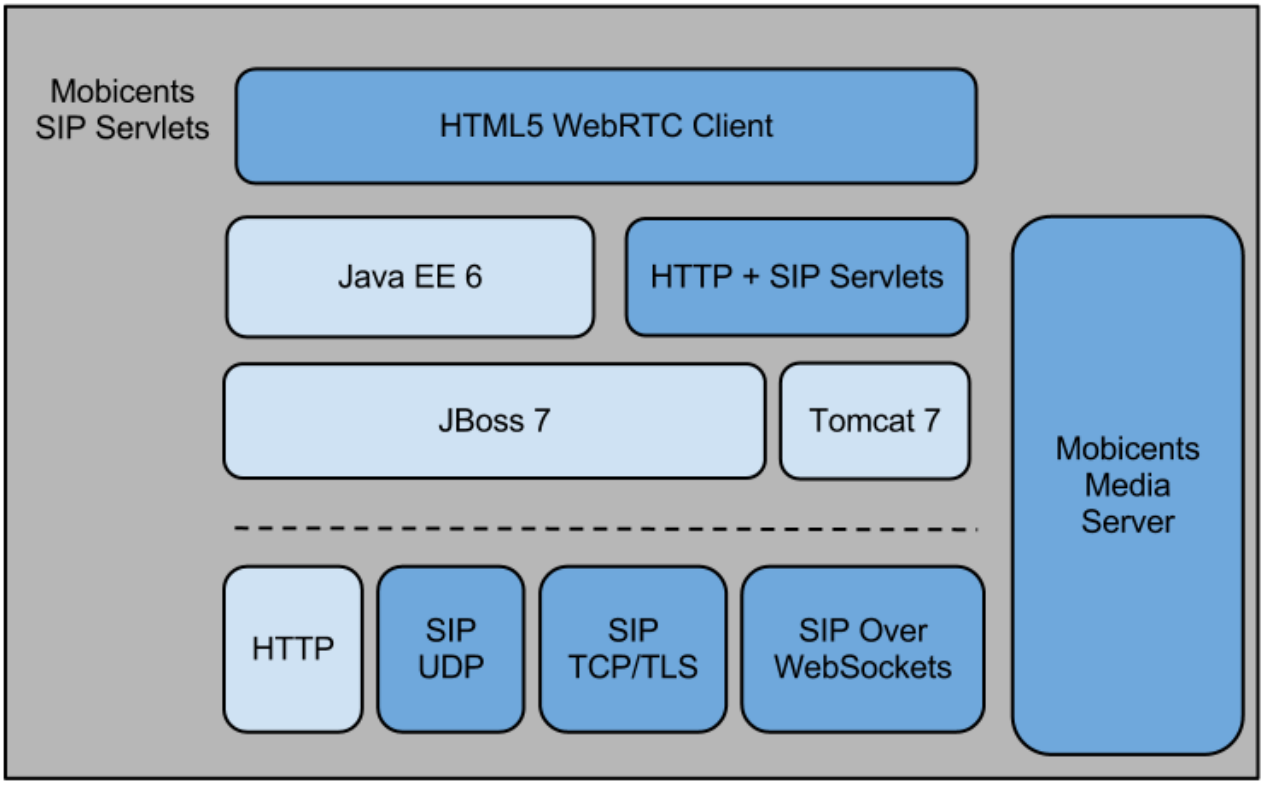

Figure 2. Restcomm WebRTC SIP Stack

Chapter 2. SIP Servlets Server-Installing, Configuring and Running

2.1. Getting Started with Restcomm for JBoss AS7

Features not yet available on Restcomm for JBoss AS7

- SIP Failover
- SNMP
- Jopr Monitoring

Some of the features mentioned above will likely be added in the future. As of the time of this writing, they are not available. Even though Jopr monitoring is not available, there is a Command Line Interface (CLI), which will be discussed further down. As the features become available, this guide will be updated to reflect the changes.

2.1.1. Downloading and Starting Restcomm SIP Servlets for JBoss AS7

If you have been working with JBoss for some time, you will quickly notice that the JBoss AS7 iteration has gone through a lot of changes. This guide will help you understand how you can quickly get started with JBoss AS7 within the Restcomm framework.

You can go to the link below to download the latest Restcomm SIP Servlets for JBoss AS7: link: Download Latest Version of Restcomm SIP Servlets for JBoss AS7

You will need to extract the content of the file into a directory on your local system. The root directory of the Restcomm SIP Servlets for JBoss AS7 that you downloaded will be referred to in this guide as $JBOSS_HOME.

If this is your first time working with Restcomm SIP Servlets for JBoss, you will need to make sure you have Java Run Time or JDK installed on your computer. You will also need to have the environment variables set. See the links below to learn how to get JRE or JDK setup on your system.

Installing and Configuring JDK

Setting Environment Variables

1. Starting Restcomm SIP Servlets for JBoss AS7 To start the server do the following:

```
$JBOSS_HOME/bin/standalone.sh
```

During the startup process, you will notice that the final part of the log output will be similar to the truncated output below. Notice that the Admin Console interface can be accessed at http://172.0.0.1:9990. This will be explained later.

```
14:28:43,972 INFO  [org.jboss.as] (Controller Boot Thread) JBAS015951: Admin console
listening on http://127.0.0.1:9990
14:28:43,974 INFO  [org.jboss.as] (Controller Boot Thread) JBAS015874: JBoss AS
7.1.2.Final "Steropes"
started in 22148ms - Started 222 of 306 services (83 services are passive or on-
demand)
```

You will notice that the startup is very fast. The reason for this is that JBoss was rewritten from the ground up for speed with services being started concurrently and non critical services remain passive until first use. This provides better system resource management. With the simple startup above, you will be able to enter the default web interface of the application server by going to this url http://127.0.0.1:8080. The result will show a screenshot similar to the one below.

Figure 3. JBoss Application Server 7 Welcome Page

With the standard startup script, you will not have access to any SIP functionalities. This is because of the modular approach implemented in JBoss AS7. There is a configuration file that needs to be used to activate additional functionalities like SIP and High Availability.

In order to start the Restcomm SIP Servlets for JBoss AS7 with SIP functionalities, you need to append the startup script with the SIP configuration file. The configuration files are located in the $JBOSS_HOME/standalone/configuration directory. You can see the content of the directory below

```
application-roles.properties  mgmt-users.properties     standalone-ha.xml
application-users.properties  mss-sip-stack.properties  standalone-sip.xml
dars                          standalone-full-ha.xml     standalone.xml
logging.properties            standalone-full.xml        standalone_xml_history
```

Starting Restcomm SIP Servlets for JBoss AS7 with SIP

If you want to start Restcomm SIP Servlets with SIP services activated, you need to go to the $JBOSS_HOME/bin directory. Type the following command:

```
./standalone.sh -c standalone-sip.xml
```

1. You will see a message similar to the one below once the server is successfully started

```
20:43:21,487 INFO  [org.jboss.as.server] (ServerService Thread Pool -- 37) JBAS018559:
Deployed "click2call.war"
20:43:21,489 INFO  [org.jboss.as.server] (ServerService Thread Pool -- 37) JBAS018559:
Deployed "sip-servlets-management.war"
20:43:21,647 INFO  [org.jboss.as] (Controller Boot Thread) JBAS015951: Admin console
listening on http://127.0.0.1:9990
20:43:21,648 INFO  [org.jboss.as] (Controller Boot Thread) JBAS015874: JBoss AS
7.1.2.Final "Steropes" started in 26560ms - Started 232 of 321 services (88 services
are passive or on-demand)
```

The click2call SIP sample application bundled with Restcomm SIP Servlets will become available at this url http://127.0.0.1:8080/click2call. You can configure multiple SIP softphones to use the sample application. See the section below for how to configure and test the SIP sample application.

2.1.2. Testing Click2Call with Restcomm SIP Servlets for JBOSS AS7

Once the server is started as stated in the previous section, you can configure multiple instances of any SIP softphone you prefer. In this example, Linphone will be used.

```
(configuring two instances of Linphone)

start Linphone
go to the Options menu

On the Network Settings tab,
    SIP (UDP) port to 5061. (leave the rest as default)
On the Manage SIP Accounts tab,
    click the add button
    Your SIP identity: = sip:linphone@127.0.0.1:5080
    SIP Proxy address: = sip 127.0.0.1:5080

Leave the rest of the settings as default.


Configuring Linphone (on the second shell)

go to the Options menu

On the Network Settings tab,
    SIP (UDP) port to 5062. (leave the rest as default)
On the Manage SIP Accounts tab,
    click the add button
    Your SIP identity: = sip:linphone2@127.0.0.1:5080
    SIP Proxy address: = sip 127.0.0.1:5080

Leave the rest of the settings as default.
```

A correctly configured Linphone will look like the screenshot below.

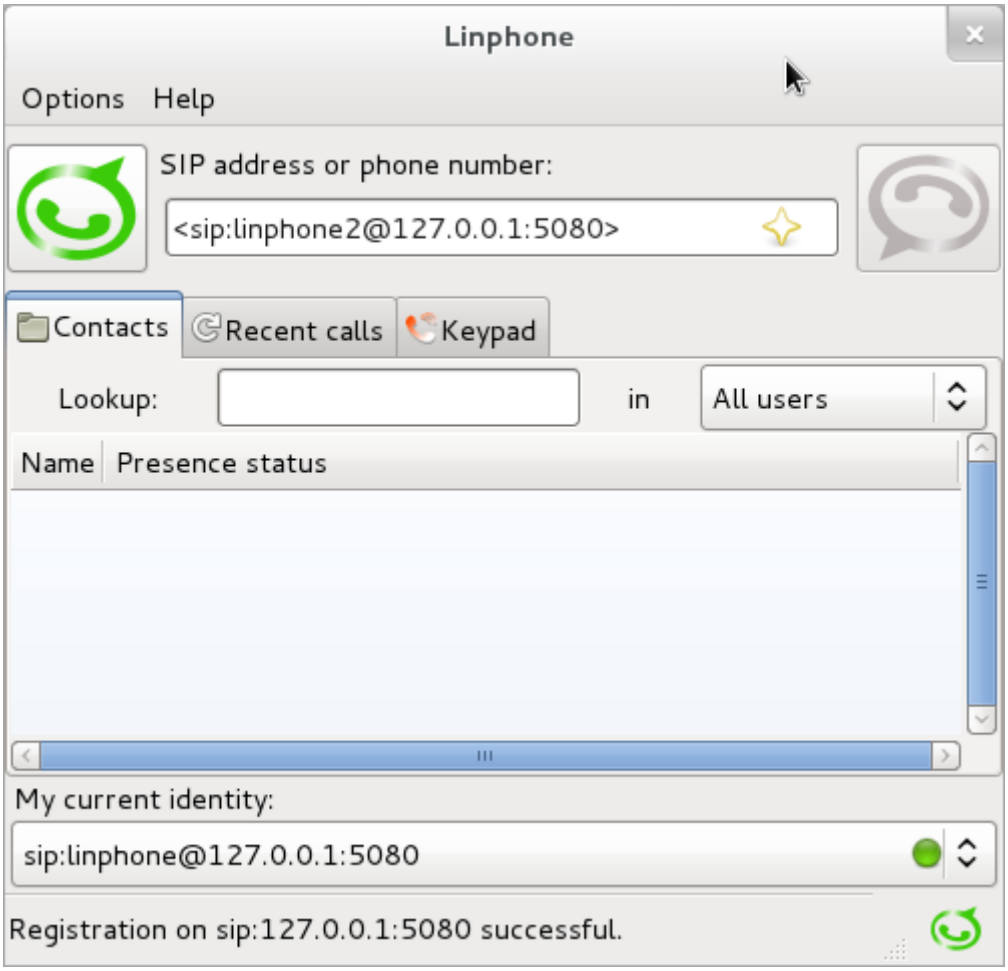

Figure 4. Successfully Configured Linphone

Once the phones are successfully registered with the Restcomm SIP Servlets for JBoss AS7 server, you can check the result in the sample SIP application at this url, http://127.0.0.1:8080/click2call

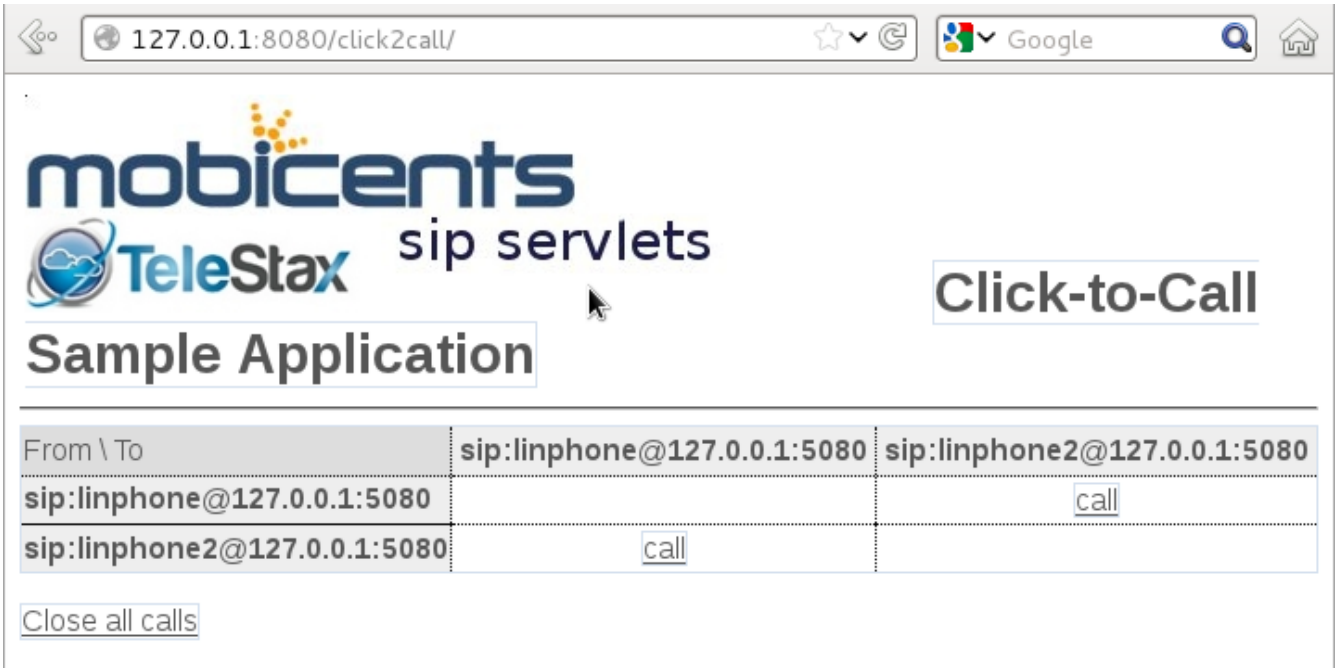

Figure 5. Click2call SIP Registered Softphones

You can make calls from the sample click2call application and see the logs in the shell terminal you used to start the Restcomm SIP Servlets for JBoss AS7 server.

2.1.3. Command Line Interface for Restcomm SIP Servlets JBoss AS7

Part of the task of any administrator who has to manage a JBoss server will be to monitor services offered to clients. There is a command line interface bundled with JBoss AS7 which can be accessed by going to the $JBOSS_HOME/bin directory.

You need to make sure that the JBoss server is running on your system and listening on port 9999. The section below will work you through steps to familiarize yourself with the CLI.

There are so many features available with the Restcomm SIP Servlets for JBoss AS7 CLI. The example below will concentrate on getting data from the SIP you started using the [path]_ ./standalone.sh -c standalone-sip.xml _ script.

In the $JBOSS_HOME/bin directory, type

```
./jboss-cli.sh
```

(This will show the message below)

```
You are disconnected at the moment.
Type 'connect' to connect to the server or
'help' for the list of supported commands.
```

At the [disconnected /] command prompt, type

```
connect
```

When you see the [standalone@localhost:9999 /] at the prompt, you are successfully connected to the server.

Navigating the CLI

Moving around the Restcomm SIP Servlets for JBoss AS7 CLI is similar to normal file system with a few exceptions. You can use commands like, (ls, cd, cd..) to navigate around the CLI

Follow the steps below to access SIP information from the CLI

```
At the prompt type (ls)

[standalone@localhost:9999 /] ls
core-service                  deployment                    extension
interface                     path                          socket-binding-group
subsystem                     system-property               launch-type=STANDALONE
management-major-version=1    management-minor-version=2    name=linux-fedora
namespaces=[]                 process-type=Server           product-name=undefined
product-version=undefined     profile-name=undefined        release-codename=Steropes
```

```
release-version=7.1.2.Final   running-mode=NORMAL           schema-locations=[]
server-state=running

[standalone@localhost:9999 /] cd deployment

[standalone@localhost:9999 deployment] ls
click2call.war                sip-servlets-management.war

[standalone@localhost:9999 deployment] cd click2call.war

[standalone@localhost:9999 deployment=click2call.war] ls
subdeployment
subsystem
content=[{"path" => "deployments/click2call.war","relative-to" =>
"jboss.server.base.dir","archive" => true}]
enabled=true
name=click2call.war
persistent=false
runtime-name=click2call.war
status=OK

[standalone@localhost:9999 deployment=click2call.war] cd subsystem

[standalone@localhost:9999 subsystem] ls
sip   web

[standalone@localhost:9999 subsystem] cd sip


[standalone@localhost:9999 subsystem=sip] ls
servlet
active-sip-application-sessions=7
active-sip-sessions=8
app-name=org.mobicents.servlet.sip.example.SimpleApplication
expired-sip-application-sessions=25
expired-sip-sessions=26
max-active-sip-sessions=-1
rejected-sip-application-sessions=0
rejected-sip-sessions=0
sip-application-session-avg-alive-time=180
sip-application-session-max-alive-time=230
sip-application-sessions-created=32
sip-application-sessions-per-sec=0.0
sip-session-avg-alive-time=162
sip-session-max-alive-time=180
sip-sessions-created=34
sip-sessions-per-sec=0.0
```

No SIP data on the CLI

The data from the SIP subsystem are only available if you have the click2call sample application running and your softphones are connected to the server.

1. SIP Servlets Management Console There is also a SIP servlets management console that is available at this url http://127.0.0.1:8080/sip-servlets-management. The resulting page will be similar to the screenshot below. More information will be provided about the SIP servlets management console in later chapters of this guide.

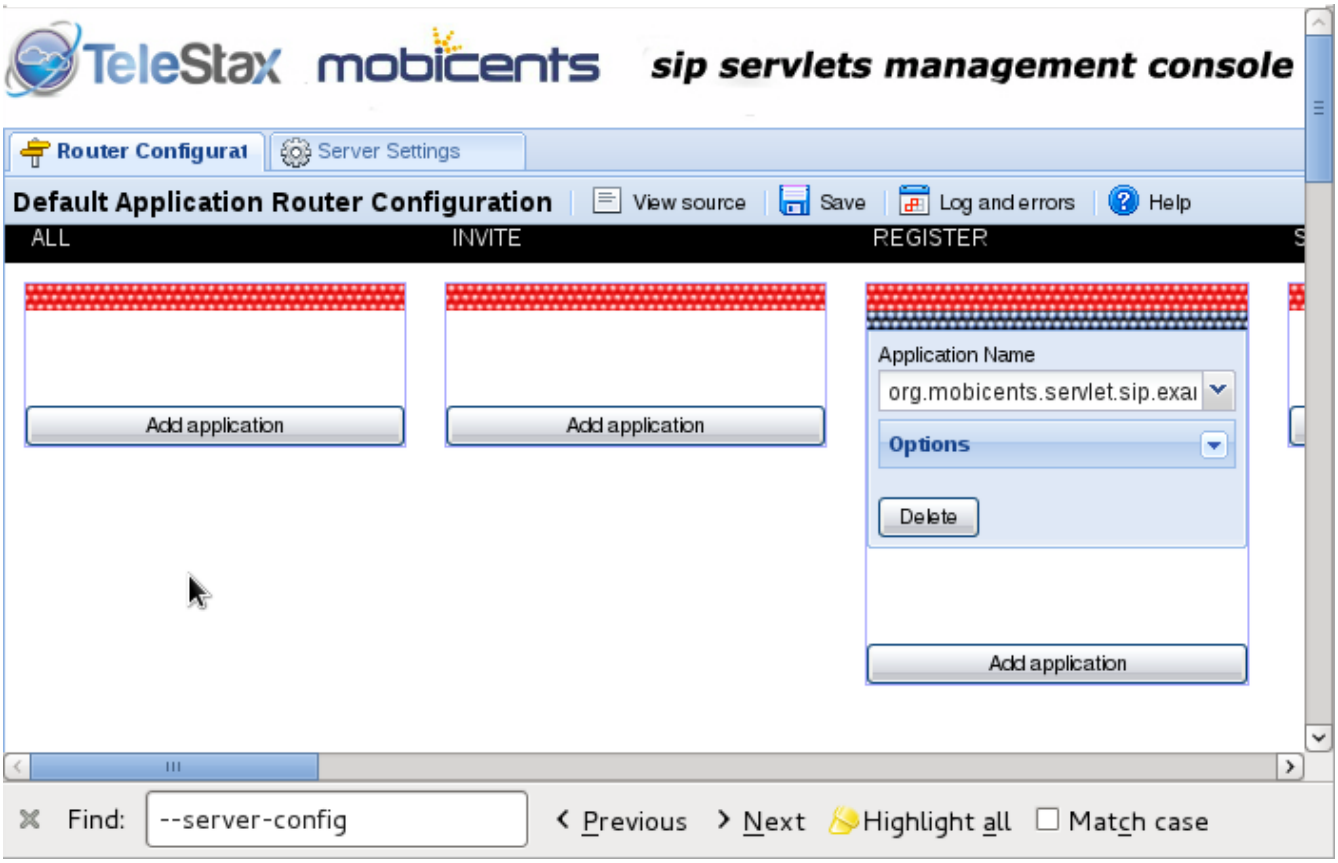

Figure 6. JBoss Application Server 7 Management Console

2.1.4. Accessing Management Console

Restcomm SIP Servlets for JBoss AS7 provides a management console that can be useful for accessing vital information about your server. In the welcome page that appears when you access http://127.0.0.1:8080, there is a link that points to the Administration Console.

If you don't have a user account for the management console, you will see a screenshot like the one below. It contains instructions about how to create a user account.

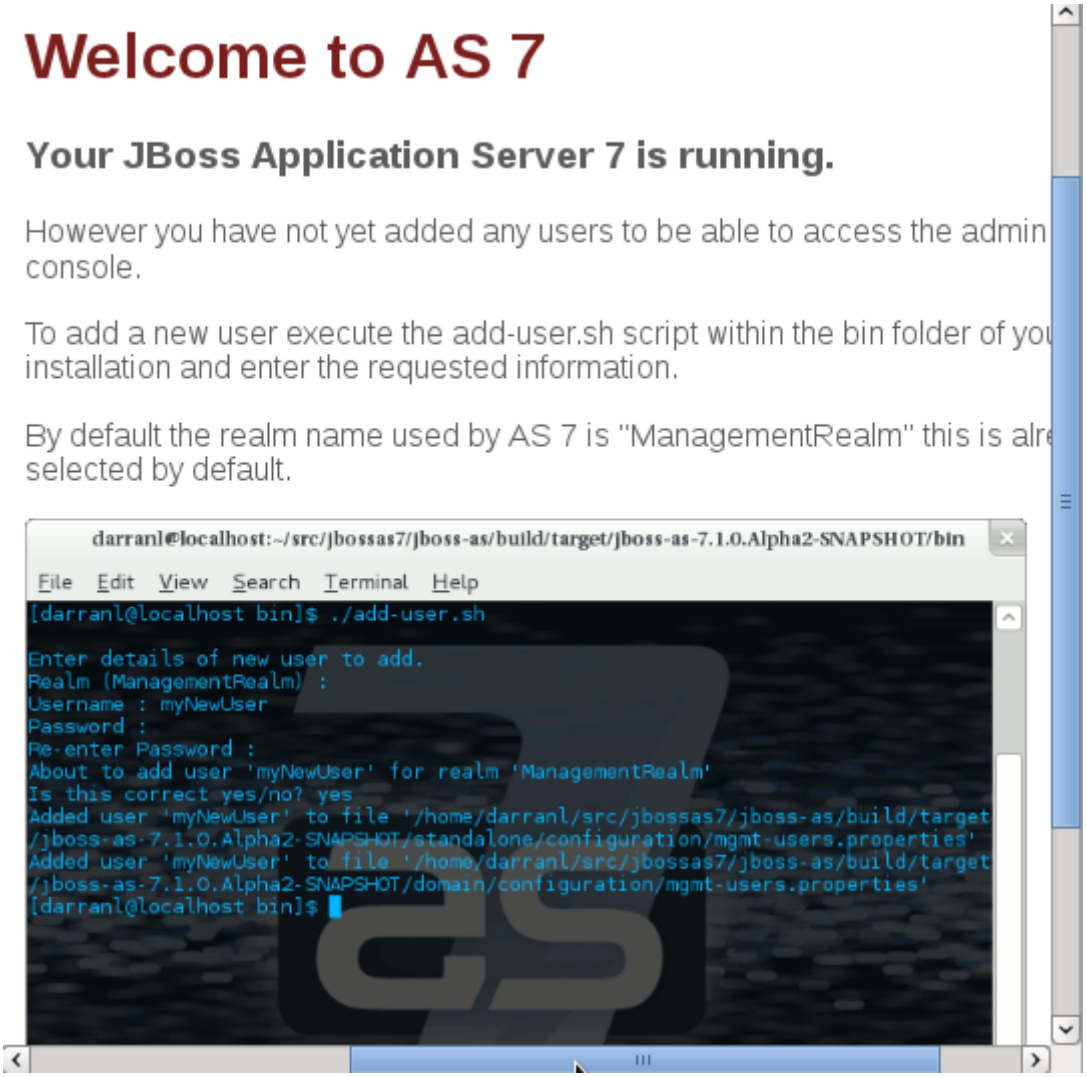

Figure 7. Administration Console Error Page

1. Creating a User Account Go to the $JBoss_HOME/bin directory and run the ./add-user.sh script. You can follow the interactive user mode to create an account for the Administration Console.

Once the user account has been created, you can access the Administration Console at this address http://127.0.0.1:9990/console/

The screenshot below shows you what the Administration Console looks like.

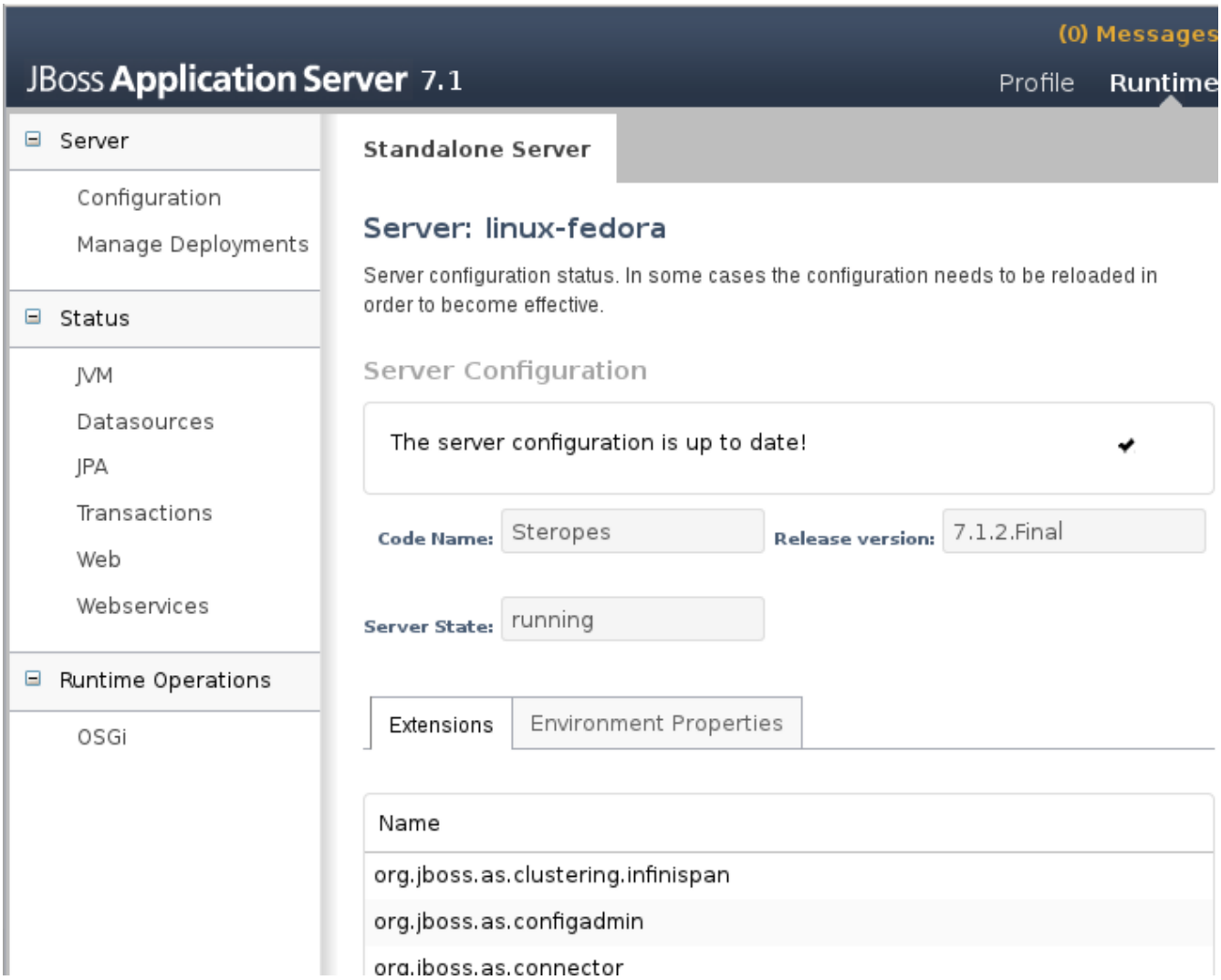

Figure 8. Administration Console

Deleting Administration Console User Account

Deleting the user account isn't very intuitive. In the event that you will need to remove an account and create another one, you can remove the account from the mgmt-users.properties file. It is located in the $Restcomm_JBoss_HOME/standalone/configuration directory. If you are running in the domain mode, you will need to check the corresponding configuration directory.

Installing the Restcomm for JBoss Binary Distribution on

For this procedure, it is assumed that the downloaded archive is saved in the *My Downloads* folder. . Create a directory in *My Downloads* to extract the zip file's contents into. For ease of identification, it is recommended that the version number of the binary is included in the folder name. For example, *-jboss-<version>*. . Extract the contents of the archive, specifying the destination folder as the one created in the previous step. You can either use Winzip or the opensource tool called 7-Zip to extract the content of the donwloaded Restcomm SIP Servlets for JBoss AS7 file . It is recommended that the folder holding the Restcomm SIP Servlets for JBoss files (in this example, the folder named *-jboss-<version>*) is moved to a user-defined location for storing executable programs. For example, the *Program Files* folder.

Procedure: Running Restcomm SIP Servlets for JBoss on

There are several ways to start Restcomm SIP Servlets for JBoss on Windows. All of the following methods accomplish the same task.

1. Using Windows Explorer, navigate to the *bin* subdirectory in the installation directory.
2. The preferred way to start Restcomm SIP Servlets for JBoss from the Command Prompt. The command line interface displays details of the startup process, including any problems encountered during the startup process.

   Open the Command Prompt via the Start menu and navigate to the correct folder:

   ```
   C:\Users\<user>My Downloads> cd "-jboss-<version>"
   ```

3. Start the JBoss Application Server by executing one of the following files:
   - *run.bat* batch file:

     ```
     C:\Users\<user>My Downloads\-jboss-<version>>bin\run.bat
     ```

   - *run.jar* executable Java archive:

     ```
     C:\Users\<user>My Downloads\-jboss-<version>>java -jar bin\run.jar
     ```

2.2. Getting Started with Restcomm SIP Servlets for Tomcat 7

You can download the latest Restcomm SIP Servlets for Tomcat 7 link: Download Latest Version of for Tomcat 7

The content of the downloaded file can be extracted to any location you prefer on your computer. The root directory to which the content of the download is extracted will be referred to as $CATALINA_HOME.

The content of the $CATALINA_HOME/bin is similar to the output below.

```
bootstrap.jar                commpappend.bat      startup.bat
catalina.bat                 daemon.sh            startup.sh
catalina.sh                  digest.bat           tomcat-juli.jar
catalina-tasks.xml           digest.sh            tomcat-native.tar.gz
commons-daemon.jar           setclasspath.bat     tool-wrapper.bat
commons-daemon-native.tar.gz setclasspath.sh      tool-wrapper.sh
configtest.bat               shutdown.bat         version.bat
configtest.sh                shutdown.sh          version.sh
```

You can start Restcomm SIP Servlets for Tomcat 7 by going to $CATALINA_HOME/bin directory and typing the following:

```
sudo ./catalina.sh run
```

The startup process is slightly different from Restcomm SIP Servlets for JBoss AS7. If you see an output like the one below, you know that Tomcat is correctly started. This is a truncated log from the startup process.

```
2012-08-21 22:23:41,025 INFO  [SipApplicationDispatcherImpl] (main)
SipApplicationDispatcher Started
2012-08-21 22:23:41,025 INFO  [SipStandardService] (main) SIP Standard Service
Started.
Aug 21, 2012 10:23:41 PM org.apache.catalina.startup.Catalina start
INFO: Server startup in 3608 ms
```

If you get an error message about environment variables or Java, make sure you have the CATALINA environment variables set.

Setting Environment Variables - JAVA and CATALINA

2.2.1. Testing Click2CallAsync with Restcomm for Tomcat 7

If Restcomm SIP Servlets for Tomcat 7 is started and running, you should be able to use your web browser to access the welcome page at this url http://127.0.0.1:8080/ This will show you a screenshot similar to the one below.

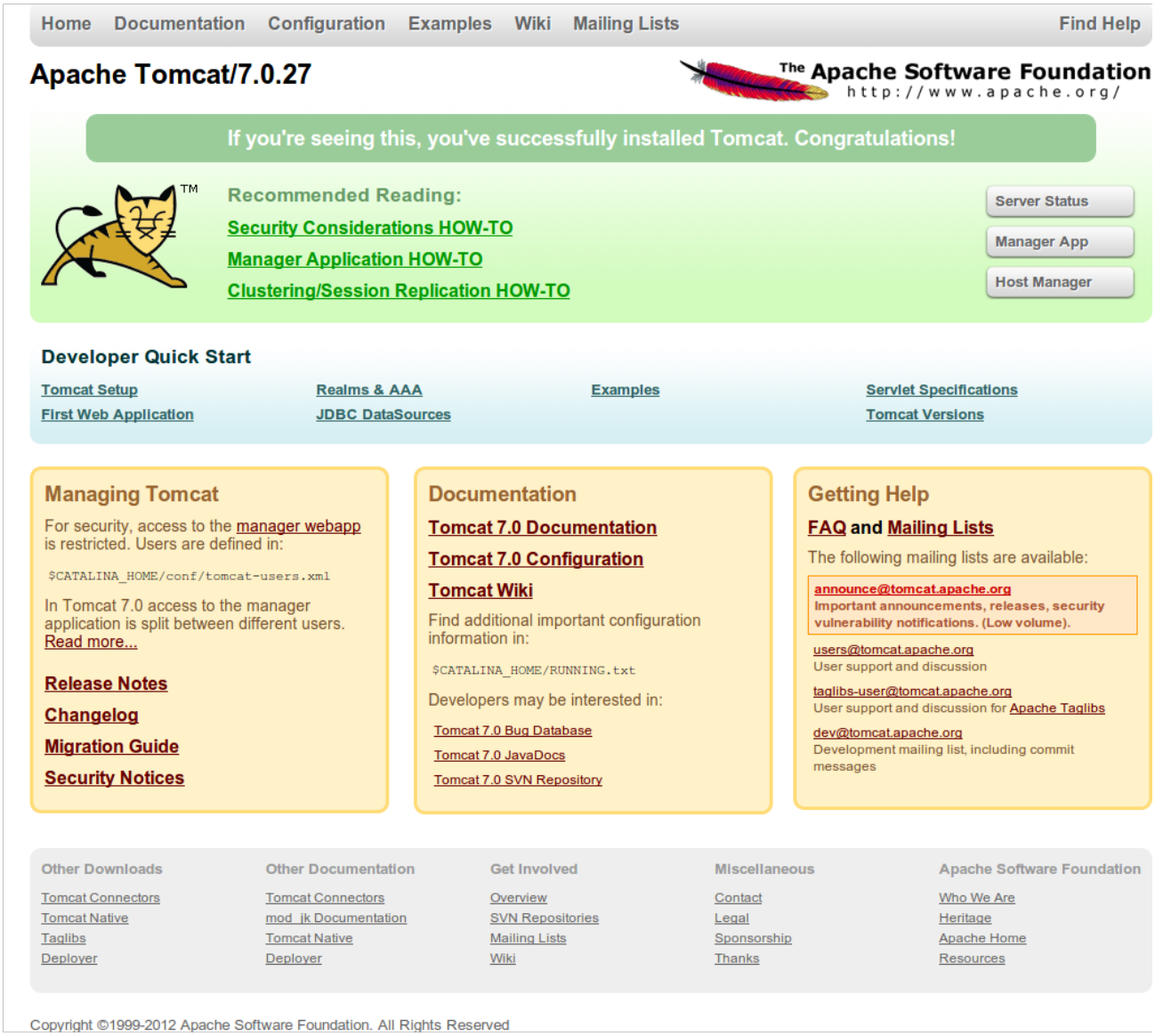

Figure 9. JBoss Application Server 7 Welcome Page

Deploying your application once the server is running is simple. You need to copy your .War files to the $CATALINA_HOME/webapps directory.

There is a pre-installed sample SIP application that you can use to test your Restcomm SIP Servlets Tomcat 7 configuration. The application is also located in the $CATALINA_HOME/webapps directory

Start your web browser and go to the link, http://127.0.0.1:8080/Click2CallAsync/

Sample Application Name

Note that the application name is case-sensitive and will not work if you try to access it as http://127.0.0.1:8080/click2callasync/

The sample SIP application page will be similar to the screenshot below.

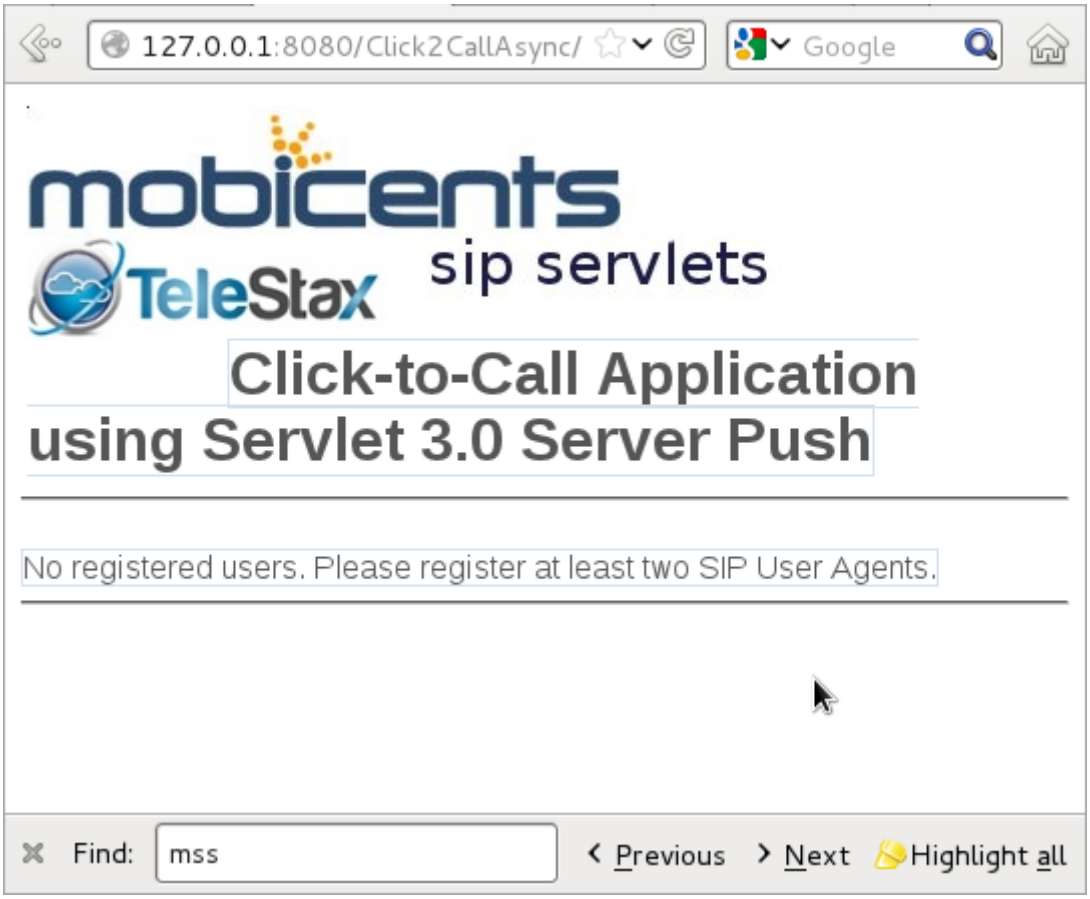

Figure 10. SIP Sample Click2CallAsync Application

In order to use the application, you can download a softphone and start multiple instances of the phone on a single server. In this guide, the softphone that will be used is Linphone. The configuration is as follows:

Multiple Instances of Linphone

On some Linux systems, you might need to use a different user profile in order to start a second instance of Linphone. Ex. sudo linphone

```
(configuring two instances of Linphone)

start Linphone
go to the Options menu

On the Network Settings tab,
        SIP (UDP) port to 5061. (leave the rest as default)
On the Manage SIP Accounts tab,
        click the add button
        Your SIP identity: = sip:linphone@127.0.0.1:5080
        SIP Proxy address: = sip 127.0.0.1:5080

Leave the rest of the settings as default.


Configuring Linphone (on the second shell)

go to the Options menu

On the Network Settings tab,
        SIP (UDP) port to 5062. (leave the rest as default)
On the Manage SIP Accounts tab,
        click the add button
        Your SIP identity: = sip:linphone2@127.0.0.1:5080
        SIP Proxy address: = sip 127.0.0.1:5080

Leave the rest of the settings as default.
```

Once the softphones are configured and are successfully registered with the Restcomm SIP Servlets for Tomcat 7 server, you will see a screenshot like the one below in the web browser at this url http://127.0.0.1:8080/Click2CallAsync/

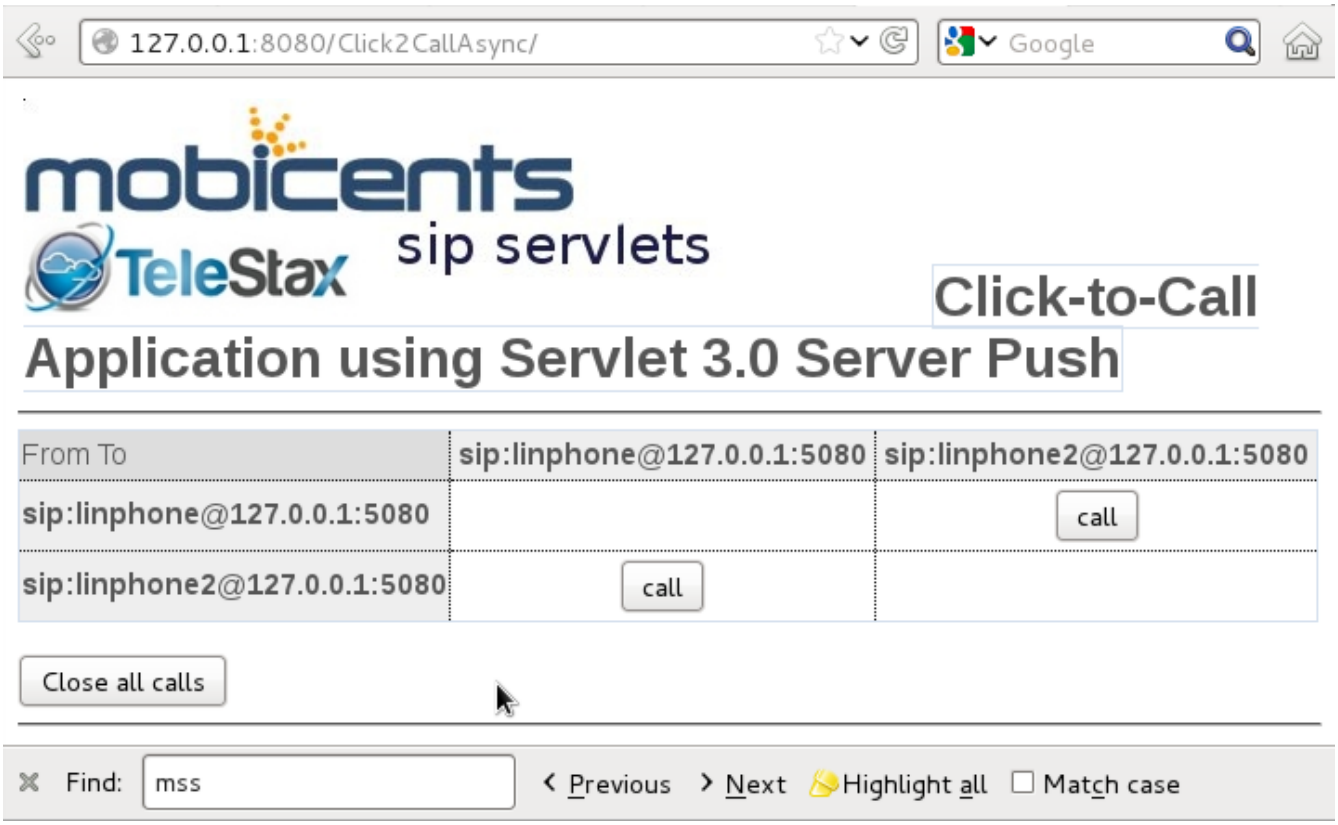

Figure 11. SIP Click2CallAsync with Registers Clients

You can make calls using the application and the softphones you configured will start ringing. It is important to start Restcomm SIP Servlets for Tomcat 7 in a terminal using the (./catalina.sh run) script. It will help with troubleshooting SIP calls. The logs you see on the terminal will let you know when a softphone registers with the Tomcat server and you will also be able to see the status of call setup and shutdown.

Stopping Restcomm SIP Servlets for Tomcat 7

The best way to stop a server is using the CTRL-D on the terminal in which the server was started. If you started the Restcomm SIP Servlets for Tomcat 7 server using the $CATALINA_HOME/bin/startup.sh, you can stop the server using $CATALINA_HOME/bin/shutdown.sh

2.2.2. Tomcat for Windows

Installing the Restcomm SIP Servlets for Tomcat 7 Binary Distribution on Windows

1. For this example, we'll assume that you downloaded the binary distribution zip file to the *My Downloads* folder. First, using Windows Explorer, create a subdirectory in *My Downloads* to extract the zip file's contents into. When you name this folder, it is good practice to include the version number; if you do so, remember to correctly match it with the version of the Restcomm SIP Servlets for Tomcat binary distribution you downloaded. In these instructions, we will refer to this folder as *-tomcat-<version>*.
2. Double-click the downloaded zip file, selecting as the destination folder the one you just created to hold the zip file's contents.
    a. Alternatively, it is also possible to use Java's `jar -xvf` command to extract the binary distribution files from the zip archive. To use this method instead, first move the

downloaded zip file from *My Downloads* to the folder that you just created to hold the SIP Servlets Server files.

b. Then, open the Windows Command Prompt and navigate to the folder holding the archive using the `cd` command.

Opening the Command Prompt from Windows Explorer

If you are using Windows Vista®, you can open the Command Prompt directly from Explorer. Hold down the `Shift` key and right-click on either a folder, the desktop, or inside a folder. This will cause an context menu item to appear, which can be used to open the Command Prompt with the current working directory set to either the folder you opened, or opened it from.

c. Finally, use the `jar -xvf` command to extract the archive contents into the current folder.

```
C:\Users\Me\My Downloads\-tomcat-<version>>jar -xvf ""
```

3. At this point, you may want to move the folder holding the Restcomm SIP Servlets for Tomcat binary files (in this example, the folder named *-tomcat-<version>*) to another location. This step is not strictly necessary, but it is probably a good idea to move the installation folder from *My Downloads* to a user-defined location for storing runnable programs. Any location will suffice, however.
4. You may want to delete the zip file after extracting its contents in order to free disk space:

```
C:\Users\Me\My Downloads\-tomcat-<version>>delete ""
```

Configuring

Configuring Restcomm SIP Servlets for Tomcat consists in setting the `CATALINA_HOME` environment variable and then, optionally, customizing your Restcomm SIP Servlets for Tomcat container by adding SIP Connectors, configuring the application router, and configuring logging. See Sip Connectors to learn what and how to configure Restcomm SIP Servlets for Tomcat.

Alternatively, you can simply run your Restcomm SIP Servlets for Tomcat container now and return to this section to configure it later.

Running

Once installed, you can run the Tomcat Servlet Container by executing the one of the startup scripts in the *bin* directory (on Linux or Windows), or by double-clicking the *run.bat* executable batch file in that same directory (on Windows only). However, we suggest always starting Tomcat using the terminal or Command Prompt because you are then able to read—and act upon—any startup messages, and possibly debug any problems that may arise. In the Linux terminal or Command Prompt, you will be able to tell that the container started successfully if the last line of output is similar to the following:

```
Using CATALINA_BASE:   /home/user/temp/apps/sip_servlets_server/
Using CATALINA_HOME:   /home/user/temp/apps/sip_servlets_server/
Using CATALINA_TMPDIR: /home/user/temp/apps/sip_servlets_server/temp
Using JRE_HOME:       /etc/java-config-2/current-system-vm
```

Detailed instructions are given below, arranged by platform.

Procedure: Running Restcomm SIP Servlets for Tomcat on Windows

1. There are several different ways to start the Tomcat Servlet Container on Windows. All of the following methods accomplish the same task.

   Using Windows Explorer, change your folder to the one in which you unzipped the downloaded zip file, and then to the *bin* subdirectory.

2. Although not the preferred way (see below), it is possible to start the Tomcat Servlet Container by double-clicking on the *startup.bat* executable batch file.

   a. As mentioned above, the best way to start the Tomcat Servlet Container is by using the Command Prompt. Doing it this way will allow you to view all of the server startup details, which will enable you to easily determine whether any problems were encountered during the startup process. You can open the Command Prompt directly from the <*topmost_directory*>|*bin* folder in Windows Explorer, or you can open the Command Prompt via the Start menu and navigate to the correct folder:

   ```
   C:\Users\Me\My Downloads> cd "-tomcat-<version>"
   ```

   b. Start the Tomcat Servlet Container by running the executable *startup.bat* batch file:

   ```
   C:\Users\Me\My Downloads\-tomcat-<version>>bin\startup.bat
   ```

Stopping

Detailed instructions for stopping the Tomcat Servlet Container are given below, arranged by platform. Note that if you properly stop the server, you will see the following three lines as the last output in the Linux terminal or Command Prompt (both running and stopping the Tomcat Servlet Container produces the same output):

```
Using CATALINA_BASE:   /home/user/temp/apps/sip_servlets_server
Using CATALINA_HOME:   /home/user/temp/apps/sip_servlets_server
Using CATALINA_TMPDIR: /home/user/temp/apps/sip_servlets_server/temp
Using JRE_HOME:       /etc/java-config-2/current-system-vm
```

Procedure: Stopping Restcomm SIP Servlets for Tomcat on Windows

1. Stopping the Tomcat Servlet Container on Windows consists in executing the *shutdown.bat*

executable batch script in the *bin* subdirectory of the SIP Servlets-customized Tomcat binary distribution:

```
C:\Users\Me\My Downloads\-tomcat-<version>>bin\shutdown.bat
```

2.3. Sip Connectors

Restcomm SIP Servlets comes with default settings that are designed to get your system up and running without the need to know about all the detailed configurations. That said, there are situations in which you might like to fine-tune your setttings to adapt it to your needs. That is what the following section will help you achieve. You will get a better understand of SIP connectors and how to make them work for you.

2.3.1. Configuring SIP Connectors and Bindings

There are two important configuration files that you might need to modifying depending on your system needs. The standalone-sip.xml file in Restcomm SIP Servlets for JBoss AS7 and the server.xml file in Restcomm SIP Servlets for Tomcat. The extracts below will give you a snapshot of default configurations.

For JBoss

Changing the ports and other configuration for the SIP connector can be done in the standalone-sip.xml file. Below is an extract :

Example 1. Adding a SIP Connector to $JBOSS_HOME/standalone/configuration/standalone-sip.xml

```
 <socket-binding-group name="standard-sockets" default-interface="public" port-
offset="${jboss.socket.binding.port-offset:0}">
        <socket-binding name="management-native" interface="management"
port="${jboss.management.native.port:9999}"/>
        <socket-binding name="management-http" interface="management"
port="${jboss.management.http.port:9990}"/>
        <socket-binding name="management-https" interface="management"
port="${jboss.management.https.port:9443}"/>
        <socket-binding name="ajp" port="8009"/>
        <socket-binding name="http" port="8080"/>
        <socket-binding name="https" port="8443"/>
        <socket-binding name="sip-udp" port="5080"/>
        <socket-binding name="sip-tcp" port="5080"/>
        <socket-binding name="sip-tls" port="5081"/>
    <socket-binding name="sip-ws" port="5082"/>
        <socket-binding name="osgi-http" interface="management" port="8090"/>
        <socket-binding name="remoting" port="4447"/>
        <socket-binding name="txn-recovery-environment" port="4712"/>
        <socket-binding name="txn-status-manager" port="4713"/>
        <outbound-socket-binding name="mail-smtp">
            <remote-destination host="localhost" port="25"/>
        </outbound-socket-binding>
    </socket-binding-group>
```

If you need to add a connector for the same protocol, a new socket-binding should be created. A naming convention should be followed for the name attribute of the new socket-binding. The convention is <name>-sip-<protocol>. By example,

```
    <socket-binding name="second-sip-udp" port="5080"/>
```

SIP <connector> Attributes

port (defined at the socket-binding element)

The port number on which the container will be able to receive SIP messages.

protocol

Specifies the connector is a SIP Connector and not an HTTP Connector. There is no need to change this property.

signalingTransport (use socket-binding element)

Specifies the transport on which the container will be able to receive SIP messages. Supported Values are "udp", "tcp", "tls" and "ws".

use-load-balancer

Enable to specify if that particular connector will be using the Load Balancer for outbound

traffic. The Load Balancer to be used is defined by the next `load-balancer` attributes below

load-balancer-address

Specifies the Load Balancer address used to route outbound traffic for this SIP Connector.

load-balancer-rmi-port

Specifies the RMI Port used to connect to the Load Balancer for this SIP Connector. This enables the connector to advertise to the Load Balancer the IP and Port it is listening on so that the Load Balancer can route traffic to that connector as well.

load-balancer-sip-port

Specifies the SIP Port of the Load Balancer to use for outbound traffic for this SIP Connector. This enables the connector to choose to which Load Balancer it sends outbound traffic. This is particularly useful for supporting different Load Balancers over different network interfaces

use-stun

Enables Session Traversal Utilities for NAT (STUN) support for this Connector. The attribute defaults to "false". If set to "true", ensure that the `ipAddress` attribute is *not* set to `127.0.0.1`. Refer to Restcomm SIP Servlets [_mssstun__stun] for more information about STUN.

stun-server-address

Specifies the STUN server address used to discover the public IP address of the SIP Connector. This attribute is only required if the `useStun` attribute is set to "true". Refer to Restcomm SIP Servlets [_mssstun__stun] for more information about STUN and public STUN servers.

stun-server-port

Specifies the STUN server port of the STUN server used in the `stunServerAddress` attribute. You should rarely need to change this attribute; also, it is only needed if the `useStun` attribute is set to "true". Refer to Restcomm SIP Servlets [_mssstun__stun] for more information about STUN.

use-static-address

Specifies whether the settings in staticServerAddress and staticServerPort are activated. The default value is "false" (deactivated).

static-server-address

Specifies what load-balancer server address is inserted in Contact/Via headers for server-created requests. This parameter is useful for cluster configurations where requests should be bound to a load-balancer address, rather than a specific node address.

static-server-port

Specifies the port of the load-balancer specified in staticServerAddress. This parameter is useful in cluster configurations where requests should be bound to a load-balancer address rather than a specific node address.

http-follow-sip

Makes the application server aware of how the SIP Load Balancers assign request affinity, and stores this information in the application session.

For Tomcat

Changing the ports and other configuration for the SIP connector can be done in the server.xml file. Below is an extract.

Example 2. Adding a SIP Connector to $CATALINA_HOME/conf/server.xml

```
  <Connector port="5080"
ipAddress="127.0.0.1"
 protocol="org.mobicents.servlet.sip.startup.SipProtocolHandler"
 signalingTransport="udp"
 useStun="false"
 stunServerAddress="stun01.sipphone.com"
 stunServerPort="3478"
 staticServerAddress="122.122.122.122"
 staticServerPort="44"
 useStaticAddress="true"
 httpFollowsSip="false"/>
```

SIP <connector> Attributes

port

The port number on which the container will be able to receive SIP messages.

ipAddress

The IP address at which the container will be able to receive SIP messages. The container can be configured to listen to all available IP addresses by setting `ipAddress` to `0.0.0.0 <sipPathName>`.

protocol

Specifies the connector is a SIP Connector and not an HTTP Connector. There is no need to change this property.

signalingTransport

Specifies the transport on which the container will be able to receive SIP messages. For example, "udp".

useLoadBalancer

Enable to specify if that particular connector will be using the Load Balancer for outbound traffic. The Load Balancer to be used is defined by the next `loadBalancer` attributes below

loadBalancerAddress

Specifies the Load Balancer address used to route outbound traffic for this SIP Connector.

loadBalancerRmiPort

Specifies the RMI Port used to connect to the Load Balancer for this SIP Connector. This enables the connector to advertise to the Load Balancer the IP and Port it is listening on so that the Load Balancer can route traffic to that connector as well.

loadBalancerSipPort

Specifies the SIP Port of the Load Balancer to use for outbound traffic for this SIP Connector. This enables the connector to choose to which Load Balancer it sends outbound traffic. This is particularly useful for supporting different Load Balancers over different network interfaces

useStun

Enables Session Traversal Utilities for NAT (STUN) support for this Connector. The attribute defaults to "false". If set to "true", ensure that the `ipAddress` attribute is *not* set to `127.0.0.1`. Refer to Restcomm SIP Servlets [_mssstun__stun] for more information about STUN.

stunServerAddress

Specifies the STUN server address used to discover the public IP address of the SIP Connector. This attribute is only required if the `useStun` attribute is set to "true". Refer to Restcomm SIP Servlets [_mssstun__stun] for more information about STUN and public STUN servers.

stunServerPort

Specifies the STUN server port of the STUN server used in the `stunServerAddress` attribute. You should rarely need to change this attribute; also, it is only needed if the `useStun` attribute is set to "true". Refer to Restcomm SIP Servlets [_mssstun__stun] for more information about STUN.

useStaticAddress

Specifies whether the settings in staticServerAddress and staticServerPort are activated. The default value is "false" (deactivated).

staticServerAddress

Specifies what load-balancer server address is inserted in Contact/Via headers for server-created requests. This parameter is useful for cluster configurations where requests should be bound to a load-balancer address, rather than a specific node address.

staticServerPort

Specifies the port of the load-balancer specified in staticServerAddress. This parameter is useful in cluster configurations where requests should be bound to a load-balancer address rather than a specific node address.

httpFollowsSip

Makes the application server aware of how the SIP Load Balancers assign request affinity, and stores this information in the application session.

A comprehensive list of implementing classes for the SIP Stack is available from the Class SipStackImpl page on nist.gov.

2.3.2. Application Routing and Service Configuration

The application router is called by the container to select a SIP Servlet application to service an initial request. It embodies the logic used to choose which applications to invoke. An application router is required for a container to function, but it is a separate logical entity from the container.

The application router is responsible for application selection and must not implement application

logic. For example, the application router cannot modify a request or send a response.

For more information about the application router, refer to the following sections of the JSR 289 specification: Application Router Packaging and Deployment, Application Selection Process, and Appendix C.

.

See the example chapters for more information about the Application Router Configuration for SIP Restcomm SIP Servlets for JBoss AS7

Operating the Example Applications

In order to configure the application router for Tomcat, you should edit the `Service` element in the container's *server.xml* configuration file

Example 3. Configuring the Service Element in the Container's server.xml

```
  <Service name="Sip-Servlets"
 className="org.mobicents.servlet.sip.startup.SipStandardService"
 sipApplicationDispatcherClassName="org.mobicents.servlet.sip.core.SipApplicationD
ispatcherImpl"
 usePrettyEncoding="false"
 additionalParameterableHeaders="Header1,Header2"
 bypassResponseExecutor="false"
 bypassRequestExecutor="false"
 baseTimerInterval="500"
 t2Interval="4000"
 t4Interval="5000"
 timerDInterval="32000"
 dispatcherThreadPoolSize="4"
 darConfigurationFileLocation="file:///home/user/workspaces/sip-servlets/
 sip-servlets-examples/reinvite-demo/reinvite-dar.properties"
 sipStackPropertiesFile="conf/mss-sip-stack.properties"
 dialogPendingRequestChecking="false"
 callIdMaxLength="32"
 tagHashMaxLength="10"
 canceledTimerTasksPurgePeriod="1">
```

For Restcomm SIP Servlets for JBoss AS7 this is located in standalone-sip.xml file :

Example 4. Configuring the Mobicents SubSystem Element in the Container's standalone.xml

```
  <subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0" application-
router="dars/mobicents-dar.properties" stack-properties="mss-sip-stack.properties"
path-name="gov.nist" app-dispatcher-
class="org.mobicents.servlet.sip.core.SipApplicationDispatcherImpl" concurrency-
control-mode="SipApplicationSession" congestion-control-interval="-1">
            <connector name="sip-udp" protocol="SIP/2.0" scheme="sip" socket-
binding="sip-udp"/>
            <connector name="sip-tcp" protocol="SIP/2.0" scheme="sip" socket-
binding="sip-tcp"/>
            <connector name="sip-tls" protocol="SIP/2.0" scheme="sip" socket-
binding="sip-tls"/>
        </subsystem>
```

SIP Service element attributes

className

This attribute specifies that the servlet container is a *converged* (i.e. SIP + HTTP) servlet container.

sipApplicationDispatcherClassName (Tomcat) - app-dispatcher-class (JBoss/EAP)

This attribute specifies the class name of the `org.mobicents.servlet.sip.core.SipApplicationDispatcher` implementation to use. The routing algorithm and application selection process is performed in that class.

darConfigurationFileLocation (Tomcat) - application-router (JBoss/EAP)

The default application router file location. This is used by the default application router to determine the application selection logic. Refer to Appendix C of the JSR 289 specification for more details.

sipStackPropertiesFile (Tomcat) - stack-properties (JBoss/EAP)

Specifies the location of the file containing key value pairs corresponding to the SIP Stack configuration properties. This attribute is used to further tune the JAIN SIP Stack. If this property is omitted, the following default values are assumed:

usePrettyEncoding (Tomcat) - use-pretty-encoding (JBoss/EAP)

Allows Via, Route, and RecordRoute header field information to be split into multiple lines, rather than each header field being separating with a comma. The attribute defaults to "true". Leaving this attribute at the default setting may assist in debugging non-RFC3261 compliant SIP servers.

additionalParameterableHeaders (Tomcat) - additional-parameterable-headers (JBoss/EAP)

Comma separated list of header names that are treated as parameterable by the container. The specified headers are classed as valid, in addition to the standard parameterable headers defined in the Sip Servlets 1.1 Specification.

baseTimerInterval (Tomcat) - base-timer-interval (JBoss/EAP)

Specifies the `T1` Base Timer Interval, which allows the SIP Servlets container to adjust its timers depending on network conditions. The default interval is 500 (milliseconds).

t2Interval (Tomcat) - t2-interval (JBoss/EAP)

Specifies the `T2` Interval, which allows the SIP Servlets container to adjust its timers depending on network conditions. The default interval is 4000 (milliseconds).

t4Interval (Tomcat) - t4-interval (JBoss/EAP)

Specifies the `T4` Interval, which allows the SIP Servlets container to adjust its timers depending on network conditions. The default interval is 5000 (milliseconds).

timerDInterval (Tomcat) - timerD-interval (JBoss/EAP)

Specifies the `Timer D` Interval, which allows the SIP Servlets container to adjust its timers depending on network conditions. The default interval is 32000 (milliseconds).

dialogPendingRequestChecking (Tomcat) - dialog-pending-request-checking (JBoss/EAP)

This property enables and disables error checking when SIP transactions overlap. If within a single dialog an INVITE request arrives while there is antoher transaction proceeding, the container will send a 491 error response. The default value is false.

callIdMaxLength (Tomcat) - call-id-max-length (JBoss/EAP)

This property allows to shorten the size of Call-ID Header. This is useful when integrating with Lync (which has a limit of 32 in size) or older SIP Servers

tagHashMaxLength (Tomcat) - tag-hash-max-length (JBoss/EAP)

This property allows to shorten the size of tags in From and To Header. This is useful when integrating with Lync (which has a limit of 10 in size) or older SIP Servers

dnsServerLocatorClass (Tomcat) - dns-server-locator-class (JBoss/EAP)

Specifies the `org.mobicents.ext.javax.sip.dns.DNSServerLocator` implementation class that will be used by the container to perform DNS lookups compliant with RFC 3263 : Locating SIP Servers and E.164 NUmber Mapping. The default class used by the container is `org.mobicents.ext.javax.sip.dns.DefaultDNSServerLocator`, but any class implementing the `org.mobicents.ext.javax.sip.dns.DNSServerLocator` interface. To disable DNS lookups, this attribute should be left empty.

dnsResolverClass (Tomcat) - dns-resolver-class (JBoss/EAP)

Specifies the `org.mobicents.javax.servlet.sip.dns.DNSResolver` implementation class that will be used by the container to perform DNS lookups compliant with RFC 3263 : Locating SIP Servers and E.164 NUmber Mapping. The default class used by the container is `org.mobicents.servlet.sip.dns.MobicentsDNSResolver`, but any class implementing the `org.mobicents.servlet.sip.dns.DNSResolver` interface. To disable DNS lookups, this attribute should be left empty.

addressResolverClass (Tomcat) - address-resolver-class (JBoss/EAP)

Specifies the `gov.nist.core.net.AddressResolver` implementation class that will be used by the container to perform DNS lookups. The default class used by the container is

`org.mobicents.servlet.sip.core.DNSAddressResolver`, but any class implementing the `gov.nist.core.net.AddressResolver` NIST SIP Stack interface and having a constructor with a `org.mobicents.servlet.sip.core.SipApplicationDispatcher` parameter can be used. To disable DNS lookups, this attribute should be left empty.

canceledTimerTasksPurgePeriod (Tomcat) - canceled-timer-tasks-purge-period (JBoss/EAP)

Defines a period to due a purge in the container timer schedulers. The purge may prevent excessive memory usage for apps that cancel most of the timers it sets.

2.3.3. SIP Servlets Server Logging

Logging is an important part of working with Restcomm SIP Servlets. There are a few files that you need to be familiar with in order to successfully troubleshoot and adapt Restcomm SIP Servlets server monitoring and logging to your environment.

Logging Files for Restcomm SIP Servlets for JBoss AS7

$JBOSS/standalone/configuration/logging.properties

$JBOSS/standalone/configuration/mss-sip-stack.properties

$JBOSS/standalone/configuration/standalone-sip.xml

Example 5. Setting the log file name in $JBOSS/standalone/configuration/standalone-sip.xml

```
 </formatter>
<file relative-to="jboss.server.log.dir" path="server.log"/>
<suffix value=".yyyy-MM-dd"/>
<append value="true"/>
```

The configuration above produces SIP logs that can be found in the $JBOSS_HOME/standalone/log directory. Below is an extract of the log files.

```
                      server.log.2012-08-14  server.log.2012-08-24
server.log            server.log.2012-08-16  server.log.2012-08-25
server.log.2012-08-07 server.log.2012-08-21  server.log.2012-08-26
server.log.2012-08-13 server.log.2012-08-22
```

Logging Files for Restcomm SIP Servlets for Tomcat

If you are working with Tomcat, the log configuration files are located in the $CATALINA_HOME/conf/ directory. The log4j configuration file is located in $CATALINA_HOME/lib/ directory

$CATALINA_HOME/conf/logging.properties

$CATALINA_HOME/conf/mss-sip-stack.properties

$CATALINA_HOME/conf/server.xml

$CATALINA_HOME/lib/log4j.xml

Example 6. Setting the log file name $CATALINA_HOME/conf/server.xml

```
<Valve className="org.apache.catalina.valves.AccessLogValve" directory="logs"
               prefix="localhost_access_log." suffix=".txt"
               pattern="%h %l %u %t &amp;quot;%r&amp;quot; %s %b" resolveHosts="false"/>
```

Example 7. Configuring the log file name $CATALINA_HOME/lib/log4j.xml

```
<log4j:configuration xmlns:log4j="http://jakarta.apache.org/log4j/">
  <appender name="rolling-file" class="org.apache.log4j.RollingFileAppender">
    <param name="file" value="${catalina.home}/logs/sip-server.log"/>
    <param name="MaxFileSize" value="1000KB"/>
```

The result of the extracted configuration above that is taken from the log4j.xml file and can be found in the $CATALINA_HOME/logs directory.

JAIN-SIP Stack Logging

There are two separate levels of logging:

- Logging at the container level, which can be configured using the *log4j.xml* or *standalone-sip.xml* configuration file seen above
- Logging of the JAIN SIP stack, which is configured through the container logging and the SIP stack properties themselves

You can setup the logging so that the JAIN SIP Stack will log into the container logs.

To use LOG4J in JAIN SIP Stack in Tomcat, you need to define a category in *CATALINE_HOME/lib/jboss-log4j.xml* and set it to `DEBUG`.

Example 8. Configuring the JAIN SIP Stack to log into the Tomcat Container's logs

```
                    <category name="gov.nist">
                    <priority value="DEBUG"/>
                    </category>
```

To use LOG4J in JAIN SIP Stack in JBoss, you need to define a logger in *JBOSS_HOME/standalone/configuration/standalone-sip.xml* and set it to `DEBUG`.

Example 9. Configuring the JAIN SIP Stack to log into the JBoss Container's logs

```
                    <logger category="gov.nist">
                    <level name="DEBUG"/>
                </logger>
```

For this category to be used in Restcomm SIP Servlets, you need to specify it in *JBOSS_HOME/standalone/configuration/mss-sip-stack.properties* or *CATALINE_HOME/conf/mss-sip-stack.properties*, add the `gov.nist.javax.sip.LOG4J_LOGGER_NAME=gov.nist` property, and set the `gov.nist.javax.sip.TRACE_LEVEL=LOG4J` property.

Chapter 3. Application Router

Application Routing is performed within the Restcomm Sip Servlets container by the Default Application Router. The following sections describe the Default Application Router, and how other JSR 289 compliant Application Router implementations can be installed.

3.1. Default Application Router

The Application Router is called by the container to select a SIP Servlet application to service an initial request. It embodies the logic used to choose which applications to invoke.

3.1.1. Role of the Application Router

An Application Router is required for a container to function, but it is a separate logical entity from the container. The Application Router is responsible for application selection and does not implement application logic. For example, the Application Router cannot modify a request or send a response.

There is no direct interaction between the Application Router and applications, only between the SIP Servlets Container and the Application Router.

The SIP Servlets container is responsible for passing the required information to the Application Router within the initial request so the Application Router can make informed routing decisions. The Application Router is free to make use of any information or data stores, except for the information passed by the container. It is up to the individual implementation how the Application Router makes use of the information or data stores.

The deployer in a SIP Servlet environment controls application composition by defining and deploying the Application Router implementation. Giving the deployer control over application composition is desirable because the deployer is solely responsible for the services available to subscribers.

Furthermore, the SIP Servlets specification intentionally allows the Application Router implementation to consult arbitrary information or data stores. This is because the deployer maintains subscriber information and this information is often private and valuable.

3.1.2. Restcomm Default Application Router

Restcomm SIP Servlets provides an implementation of the Default Application Router (DAR) as defined in the SIP Servlets 1.1 specification, Appendix C.

The DAR Configuration File

The Default Application Router (DAR) obtains its operational parameters from a configuration text file that is modeled as a Java properties file. The configuration file contains the information needed by the Application Router to select which SIP Servlet application will handle an incoming initial request.

In the case of Restcomm SIP Servlets, it is also possible to configure the DAR through the *server.xml* configuration file (see [_bsssc_configuring_the_service_element_in_the_containers_server.xml] and [_wwtssmc_working_with_the_sip_servlets_management_console]).

The properties file has the following characteristics and requirements:

- It must be made available to the DAR.
- It must allow the contents and file structure to be accessible from a hierarchical URI supplied as a system property *javax.servlet.sip.ar.dar.configuration*.
- It is first read by the container when it loads up and is refreshed each time an application is deployed and undeployed.
- It has a simple format in which the name of the property is the SIP method and the value is a comma-separated string value for the `SipApplicationRouterInfo` object.

```
INVITE: (sip-router-info-1), (sip-router-info-2)..
SUBSCRIBE: (sip-router-info-3), (sip-router-info-4)..
ALL: (sip-router-info-5), (sip-router-info-6)..
```

  Restcomm SIP Servlets defines a new keyword called `ALL`. The keyword allows mapping between the sip-router-info data, and all methods supported by the container (for example, INVITE, REGISTER, SUBSCRIBE). This mapping can save time when configuring an application that listens to all incoming methods.

If `ALL`, and a specific method are defined in the DAR file, the specific method takes precedence over `ALL`. When the specific method no longer has applications to serve, `ALL` is enabled again.

The sip-router-info data specified in the properties file is a string value version of the `SipApplicationRouterInfo` object. It consists of the following information:

- The name of the application as known to the container. The application name can be obtained from the element of the *sip.xml* deployment descriptor of the application, or the `@SipApplication` annotation.
- The identity of the subscriber that the DAR returns. The DAR can return any header in the SIP request using the DAR directive `DAR:SIP_HEADER`. For example, `DAR:From` would return the SIP URI in the `From` header. The DAR can alternatively return any string from the SIP request.
- The routing region, which consists of one of the following strings: `ORIGINATING`, `TERMINATING` or `NEUTRAL`. This information is not currently used by the DAR to make routing decisions.
- A SIP URI indicating the route as returned by the Application Router, which can be used to route the request externally. The value may be an empty string.
- A route modifier, which consists of one of the following strings: `ROUTE`, `ROUTE_BACK` or `NO_ROUTE`. The route modifier is used in conjunction with the route information to route a request externally.
- A string representing the order in which applications must be invoked (starts at 0). The string

is removed later on in the routing process, and substituted with the order positions of sip-router-info data.

- An optional string that contains Restcomm -specific parameters. Currently, only the `DIRECTION` and `REGEX` parameters are supported.

The field can contain unsupported `key=value` properties that may be supported in future releases. The unsupported properties will be ignored during parsing, until support for the attributes is provided.

The syntax is demonstrated in [_example_dar_direction_example].

- The `DIRECTION` parameter specifies whether an application serves external(INBOUND) requests or initiates (OUTBOUND) requests.

  If an application is marked `DIRECTION=INBOUND`, it will not be called for requests initiated by applications behaving as UAC. To mark an application as UAC, specify `DIRECTION=INBOUND` in the optional parameters in the DAR.

  Applications that do not exist in the DAR list for the container are assumed to be `OUTBOUND`. Because undefined applications are incapable of serving external requests, they must have self-initiated the request. The Sip Servlets Management Console can be used to specify the `DIRECTION` parameter.

  If an application is marked `DIRECTION=UAC_ROUTE_BACK`, the Application that acted as UAC will be called back if it present in the list of applications to be called for that particular message SIP method.

- The `REGEX` parameter specifies a regular expression to be matched against the initial request passed to the Application Router.

  If the regular expression matches a part of the initial request, the application is called. If it does not, it is skipped.

  For example, in the following sip-router-info data:

```
INVITE - ("org.mobicents.servlet.sip.testsuite.SimpleApplication", "DAR:From",
"ORIGINATING", "", "NO_ROUTE", "0", "REGEX=From:.*sip:.*@sip-servlets\.com")
```

only incoming initial requests with a From Header with a SIP URI that belongs to the sip-servlets.com domain will be passed to the SimpleApplication.

Example 10. DIRECTION Example

In this example, two applications are declared for the `INVITE` request. The `LocationServiceApplication` is called for requests coming from outside the container, but it will not be called for the requests initiated by the UAC application `Click2DialApplication`.

```
INVITE: ("org.mobicents.servlet.sip.testsuite.Click2DialApplication", "DAR:From",
"ORIGINATING", "", "NO_ROUTE", "0", "DIRECTION=OUTBOUND"), \
("org.mobicents.servlet.sip.testsuite.LocationServiceApplication", "DAR\:From",
"ORIGINATING", "", "NO_ROUTE", "0", "DIRECTION=INBOUND")
```

This type of configuration is useful in cases where different application must be responsible for both requests initiated by the container, and external requests received by the container.

Example 11. ORIGINATING/TERMINATING DAR Example

In this example, the DAR is configured to invoke two applications on receipt of an INVITE request; one each in the originating and the terminating halves. The applications are identified by their application deployment descriptor names.

```
INVITE: ("OriginatingCallWaiting", "DAR:From", "ORIGINATING", "", "NO_ROUTE",
"0"), ("CallForwarding", "DAR:To", "TERMINATING", "","NO_ROUTE", "1")
```

For this example, the returned subscriber identity is the URI from each application's `From` and `To` headers respectively. The DAR does not return any route to the container, and maintains the invocation state in the `stateInfo` as the index of the last application in the list.

Routing of SIP Messages to Applications

Initial Requests and Application Selection Process

Initial Requests are those that can essentially be dialog creating (such as, `INVITE`, `SUBSCRIBE` and `NOTIFY`), and not part of an already existing dialog.

Initial requests are routed to applications deployed in the container according to the SIP Servlets 1.1 specification, Section 15.4.1 Procedure for Routing an Initial Request.

There are some other corner cases that apply to initial requests. Refer to Appendix B, Definition of an Initial Request in the SIP Servlets 1.1 specification.

Example 12. INVITE Routing

The following example describes how the DAR routes an INVITE to two applications deployed in a container. The applications in this example are a Location Service and a Call Blocking application.

In the example, the assumption of a request coming to the server is described. However, applications can act as a UAC, and generate initial requests on their own. For routing purposes, it is not necessary for the specified application initiating the request to have an entry in the DAR file.

The DAR file contains the required information for the two applications to be invoked in the correct order.

```
INVITE: ("LocationService", "DAR:From", "ORIGINATING", "", "NO_ROUTE", "0"),
("CallBlocking", "DAR:To", "TERMINATING", "","NO_ROUTE", "1")
```

Processing occurs in the following order:

1. A new `INVITE` (not a re-INVITE) arrives at the container.

   The `INVITE` is a dialog creating request, and is not part of any dialog.

2. The Application Router is called.

   From the `INVITE` information, the first application to invoke is the Location Service.

3. The Application Router returns the application invocation order information to the container (along with the rest of the sip-router-info data) so the container knows which application to invoke.
4. The container invokes the LocationService that proxies the `INVITE`.

   The proxied `INVITE` is considered as a new `INVITE` to the known IP Address of the registered user for the Request URI

   For further information regarding `INVITE` handling, refer to "Section 15.2.2 Sending an Initial Request" in the SIP Servlets 1.1 Specification.

5. Because the `INVITE` has been proxied, the container invokes the Application Router for the proxied `INVITE` to see if any more applications are interested in the event.
6. From the proxied invite, the Application Router determines that the second application to invoke is the Call Blocking application.
7. The Application Router returns information regarding the Call Blocking application to the container (along with the rest of the sip-router-info data) so the container knows which application to invoke.
8. The container routes the `INVITE` for the Call Blocking application to the next application in the chain.
9. The Call Blocking application determines that the user that initiated the call is black listed. The application rejects the call with a "Forbidden" response.
10. Because the Call Blocking application acts as a UAS, the Application Selection Process is stopped for the original `INVITE`.

The path the `INVITE` has taken (that is, LocationService to CallBlocking) is called the

application path. The routing of the responses will now occur as explained in the next section.

Response Routing

Responses always follow the reverse of the path taken by the corresponding request. In our case, the Forbidden response will first go back to the LocationService, and then back to the caller. This is true for responses to both initial and subsequent requests. The application path is a logical concept and as such may or may not be explicitly represented within containers.

Another possible outcome could have been that the Call Blocking application, instead of sending a Forbidden response, allowed the call and proxied the INVITE to the same Request URI chosen by the Location Service. Then when the callee sends back the 200 OK Response, this response goes back the same way through the application path (so in the present case Call Blocking, then Location Service, then back to the caller).

The Call Blocking application cannot just do nothing with the request and expect the container to route the request in its place (either to a next application in chain if another one is present or to the outside world if none is present). The Application has to do something with request (either proxy it or act as a UAS).

Subsequent Requests

Subsequent requests are all requests that are not Initial.

The second scenario, where the Call Blocking application allowed the call, will be used in this section to showcase subsequent requests. The caller has received the 200 OK response back. Now, according to the SIP specification (RFC 3261), it sends an ACK. The ACK arrives at the container, and is not a dialog creating request and is already part of an ongoing dialog (early dialog) so the request is detected as a Subsequent request and will follow the application path created by the initial request. The ACK will go through Location Service, Call Blocking, and finally to the callee.

3.1.3. Limitations of the Default Application Router

The DAR is a minimalist Application Router implementation that is part of the reference implementation. While it could be used instead of a production Application Router, it offers no processing logic except for the declaration of the application order.

In real world deployments, the Application Router plays an extremely important role in application orchestration and composition. It is likely that the Application Router would make use of complex rules and diverse data repositories in future implementations.

3.2. DFC Application Router

3.2.1. Description of DFC Application Router

Instead of using the Restcomm Default Application Router, any SIP Servlets 1.1 compliant Application Router can be used, including the eCharts DFC Application Router.

3.2.2. Installing the DFC Application Router

Detailed instructions are available from the eCharts website. The following procedure describe how to install the eCharts DFC Application Router (DFCAR) on a variety of SIP Servlet Server platforms.

Procedure: Installing DFCAR on Tomcat

1. Deploy the DFCAR

   Drop the *dfcar.jar* from the ECharts distribution package in the `TOMCAT_HOME/lib` directory.

2. Remove the DAR

   Remove the Restcomm Default Application Router located in `TOMCAT_HOME/lib/sip-servlets-application-router-*.jar`.

Please see the following link to learn how to deploy jar files in Restcomm for JBoss AS7.

Procedure: Installing DFCAR on JBoss AS7

1. Deploy the DFCAR

   Create a directory under `JBOSS_HOME/modules/system/layers/base/org/echarts/`

   Drop the *dfcar.jar* from the ECharts distribution package in the `JBOSS_HOME/modules/system/layers/base/org/echarts/` directory.

   Create a `module.xml` file under the same directory with the following contents

   ```
   <module xmlns="urn:jboss:module:1.1" name="org.echarts">
   <resources>
   <resource-root path="dfcar.jar"/>
   </resources>
   <dependencies>
   <module name="org.apache.log4j"/>
   <module name="org.mobicents.javax.servlet.sip"/>
   </dependencies>
   </module>
   ```

2. Remove the DAR

   Remove the Restcomm Default Application Router located in `JBOSS_HOME/modules/system/layers/base/org/mobicents/dar`.

3. Use the DFC DAR

   In `JBOSS_HOME/modules/system/layers/base/org/jboss/as/web/main/module.xml`, replace the following line

   ```
   <module name="org.mobicents.dar" export="true"/>
   ```

by this one

```
<module name="org.echarts" export="true"/>
```

Chapter 4. SIP Servlet Example Applications

The SIP Servlet Server has a selection of examples that demonstrate particular capabilities of the server. Available Examples lists the available examples, their location, and a brief description about the functionality each example demonstrates. The examples can also provide a useful starting point for developing SIP Applications, therefore it is encouraged to experiment and adapt the base examples. Each example is available in both binary and source formats.

Table 1. Available Examples

Example	Description
Call Blocking	Demonstrates how to block calls by specifying that the INVITE SIP Extension checks the From address to see if it is specified in the block list. If the blocked SIP address matches, the Call Blocking application send a FORBIDDEN response.
Call Forwarding	Demonstrates how to forward calls by specifying that the INVITE SIP Extension checks the To address to see if it is specified in the forward list. If the SIP address matches, the application acts as a back-to-back user agent (B2BUA).
Call Controller	Call Blocking and Call Forwarding are merged to create a new service.
Speed Dial	Demonstrates how to implement speed dialing for SIP addresses. The demonstration uses a static list of speed dial numbers. The numbers are translated into a complete address based on prior configuration. The SIP addresses are proxied without record-routing, or supervised mode.
Location Service	Demonstrates a location service that performs a lookup based on the request URI, into a hard-coded list of addresses. The request is proxied to the set of destination addresses associated with that URI.
Composed Speed Dial and Location	Speed Dial and Location are merged to create a new service. Speed Dial proxies the speed dial number to a SIP address, then Location Service proxies the call to the actual location of the call recipient.
Click to Call	Demonstrates how SIP Servlets can be used along with HTTP servlets as a converged application to place calls from a web portal. The example is a modified version of the click to dial example from the Sailfin project, but has been reworked to comply with JSR 289.

Example	Description
Chat Server	Demonstrates MESSAGE SIP Extension support. This example is based on the chatroom server demonstration from the BEA dev2dev project, and has been modified to meet JSR 289 requirements.
Media JSR 309 Example	Demonstrates how the Sip Servlets Application Developers can leverage the JSR-309 API, which provides to application developers multimedia capabilities with a generic media server (MS) abstraction interface. This example is only compatible with JBoss AS5. The solution is know to work with Twinkle and linphone SIP soft-phones.
Shopping	Demonstrates integration with Seam and Java Enterprise Edition (JEE), and JSR 309 Media integration with text to speech (TTS) and dual-tone multi-frequency (DTMF) tones. The demonstration builds on the Converged Demo example, and adds support for the SIP Servlets v1.1 specification.
Diameter Event Charging Service	Demonstrates how the Diameter Event Charging, and the Location service, can be used to perform fixed-rated charging of calls (event charging). When a call is initiated, a debit of ten euros is applied to the A Party account. If the call is rejected by the B Party, or A Party hangs up before B Party can answer the call, the ten euro charge is credited to the A Party account.
Diameter Sh OpenIMS Integration	Demonstrates the integration between RestComm and OpenIMS, using the Diameter Sh interface to receive profile updates and SIP.
Diameter Ro/Rf IIntegration	A Diameter Ro/Rf service that performs online call charging.
Conference	Demonstrates the capabilities of the Media Server, such as endpoint composition and conferencing, as well as proving that SIP Servlets are capable of working seamlessly with any third-party web framework, without repackaging or modifying the deployment descriptors. The demonstration uses Google’s GWT Ajax framework with server-push updates to provide a desktop-like user interface experience and JSR 309 for Media Control.

Example	Description
Alerting Application	This application was developed so that the JBoss RHQ/Jopr Enterprise Management Solution would be able to notify system administrators when a monitoring alert is fired by Jopr/RHQ.
SIP Presence Client Application	A Call Blocking application interoperating with the PLATFORM_NAME; SIP Presence Service (Technology Preview) to fetch the blocked contacts through XCAP.

4.1. Operating the Example Applications

Important Information

Before trying out the examples in this section, you must have installed, configured and have Restcomm for JBoss or Restcomm for Tomcat AS7 running on your system.

See the chapters below for detailed instructions.

Getting Started with Restcomm for JBoss AS7

Getting Started with Restcomm SIP Servlets for Tomcat 7

4.1.1. The Location Service

The Restcomm Location Service contains a list of mappings of request URIs to destination addresses. When the Location Service receives a request, it performs a lookup on that mapping and proxies the request simultaneously to the destination address (or addresses) associated with that URI.

The Location Service Mappings Cannot Currently Be Configured

The Location Service currently performs a lookup on a hard-coded list of addresses. This model is evolving toward the eventual use of a database.

Regardless of whether you are using the JBoss Application Server or the Tomcat Servlet Container as the Servlets Server, the application, container and Location Service perform the following steps:

- A user—let us call her Alice—makes a call to `sip:receiver@sip-servlets.com`. The `INVITE` is received by the servlet container, which then starts the Location Service.
- The Location Service, using non-SIP means, determines that the callee (i.e. the receiver) is registered at two locations, identified by the two SIP URIs, `sip:receiver@127.0.0.1:5090` and `sip:receiver@127.0.0.1:6090`.
- The Location Service proxies to those two destinations in parallel, without record-routing, and without making use of supervised mode.
- One of the destinations returns a `200 OK` status code; the second proxy is then canceled.

- The `200 OK` is forwarded to Alice, and call setup is completed as usual.

Here is the current list of hard-coded contacts and their location URIs:

- .sip:receiver@sip-servlets.com `sip:receiver@127.0.0.1:5090`
- `sip:receiver@127.0.0.1:6090`

Downloading

The Location Service is comprised of two archive files, a Web Archive (WAR) and a Default Application Router (DAR) configuration file, which you need to add to your installed SIP Servlets Server. For more information about WAR files, refer to the JBoss Application Server Administration and Development Guide. For more information about DAR files, refer to the JSR 289 spec, Appendix C.

Download the Location Service’s WAR file from here: &VERSION;&VERSION;<a href="https://oss.sonatype.org/content/groups/public/org/mobicents/servlet/sip/examples/location-service//location-service-.war" class="bare">https://oss.sonatype.org/content/groups/public/org/mobicents/servlet/sip/examples/location-service//location-service-.war</a>.

Download the Location Service's DAR file from here: https://sipservlets.googlecode.com/git/sip-servlets-examples/location-service/locationservice-dar.properties.

Installing

Both the *location-service-.war* WAR file and the *locationservice-dar.properties* DAR file that you downloaded should be placed into different directories in your SIP Servlet Server installation hierarchy. Which directory depends on whether you are using the Location Service with Restcomm for JBoss or with Restcomm for Tomcat:

Restcomm for JBoss AS7

Place *location-service-.war* into the *$JBOSS_HOME/standalone/deployments/* directory, and *locationservice-dar.properties* into the [path]_$JBOSS_HOME/standalone/configuration/dars/ _ directory.

Restcomm for Tomcat AS7

Place *location-service-.war* into the *$CATALINA_HOME/webapps/* directory, and *locationservice-dar.properties* into the *$CATALINA_HOME/conf/dars/* directory.

Configuration

Restcomm for JBoss

Open the $JBOSS_HOME/standalone/configuration/standalone-sip.xml configuration file and find the mobicents subsystem element.

Example 13. Editing MSS for JBoss's standalone-sip.xml for the Location Service

In the $JBOSS_HOME/standalone/configuration/standalone-sip.xml file search for the line

```
 <subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/mobicents-dar.properties"
```

and replace it with the line below

```
<subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/locationservice-dar.properties"
```

Restcomm for Tomcat

Open the *$CATALINA_HOME/conf/server.xml* configuration file and find the `Service` element. Add an attribute to it called `darConfigurationFileLocation`, and set it to `conf/dars/locationservice-dar.properties`:

Example 14. Editing MSS for Tomcat's server.xml for the Location Service

In the $JBOSS_HOME/standalone/configuration/standalone-sip.xml file search for the line

```
 <subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/mobicents-dar.properties"
```

and replace it with the line below

```
<subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/locationservice-dar.properties"
```

Running

Once the WAR and DAR files have been placed in the right directories, and the JBoss Application Server or Tomcat Servlet Container knows where to find them (which you specified in the *standalone-sip.xml* and *server.xml* file), then you should go ahead and run the SIP Servlets Server.

Testing

The following procedure shows how to test the Location Service.

Procedure:

1. Start two SIP soft-phones. The first phone should be set up as `sip:receiver@sip-servlets.com` at the IP address `127.0.0.1` on port `5090`. The second phone can be set up in any way you like. Note that the SIP phones do not have to be registered.
2. Using the second phone, make a call to `sip:receiver@sip-servlets.com`. If the Location Service

has been set up correctly and is running, the first phone—as the receiver or callee—should now be ringing.

4.1.2. The Diameter Event-Changing Service

The Diameter Event-Changing Service is based on the Location Service, which performs call-charging at a fixed rate. Upon the initiation of a call, a debit of €10.00 occurs. In the cases of a call being rejected or the caller disconnecting (hanging up) before an answer is received, the caller's account is refunded.

Note that an Restcomm for JBoss installation is required to run this example; it will not work with Restcomm for Tomcat.

Provided here is a step-by-step description of the procedure as performed by the application and container:

Procedure: Diameter Event-Changing Service Step-By-Step

1. A user, Alice, makes a call to `sip:receiver@sip-servlets.com`. The `INVITE` is received by the servlet container, which sends a request to debit Alice's account to the Charging Server. The servlet container then invokes the location service.
2. The Location Service determines, without using the SIP protocol itself, where the callee—or receiver—is registered. The callee may be registered at two locations identified by two SIP URIs: `sip:receiver@127.0.0.1:5090` and `sip:receiver@127.0.0.1:6090`.
3. The Location Service proxies to those two destinations simultaneously, without record-routing and without using the supervised mode.
4. One of the destinations returns `200 (OK)`, and so the container cancels the other.
5. The `200 (OK)` is forwarded upstream to Alice, and the call setup is carried out as usual.
6. If none of the registered destinations accepts the call, a Diameter Accounting-Request for refund is sent to the Diameter Charging Server in order to debit the already-credited €10.00

Diameter Event-Changing Service: Installing, Configuring and Running

Preparing your Restcomm for JBoss server to run the Diameter Event-Changing example requires downloading a WAR archive, a DAR archive, the Ericsson Charging Emulator, setting an attribute in JBoss's *standalone-sip.xml* configuration file, and then running JBoss AS. Detailed instructions in the section below.

Pre-Install Requirements and Prerequisites

The following requirements must be met before installation can begin.

Software Prerequisites

One Restcomm for JBoss Installation

Before proceeding, you should follow the instructions for installing, configuring, running and testing Restcomm for JBoss from the binary distribution.

Downloading

The following procedure describes how to download the required files.

1. First, download the latest Web Application Archive () file corresponding to this example, the current version of which is named diameter-event-charging-*.war, from &VERSION;&VERSION;<a href="https://oss.sonatype.org/content/groups/public/org/mobicents/servlet/sip/examples/diameter-event-charging//diameter-event-charging-.war" class="bare">https://oss.sonatype.org/content/groups/public/org/mobicents/servlet/sip/examples/diameter-event-charging//diameter-event-charging-.war</a>.
2. Secondly, download the corresponding Disk Archive () configuration file here: https://sipservlets.googlecode.com/git/sip-servlets-examples/diameter-event-charging/diametereventcharging-dar.properties.
3. Finally, you will need to download the Ericsson Charging Emulator, version 1.0, from http://mobicents.googlecode.com/files/ChargingSDK-1_0_D31E.zip.

Installing

The following procedure describes how to install the downloaded files.

1. Place the *diameter-event-charging-.war* WAR archive into the *$JBOSS_HOME/standalone/deployments/* directory.
2. Place the *diametereventcharging-dar.properties* DAR file in your $JBOSS_HOME/standalone/configuration/dars/ directory.
3. Finally, open the terminal, move into the directory to which you downloaded the Ericsson Charging SDK (for the sake of this example, we will call this directory *charging_sdk*), and then unzip the downloaded zip file (you can use Java's `jar -xvf` command for this:

```
~]$ cd charging_sdk
charging_sdk]$ jar -xvf ChargingSDK-1_0_D31E.zip
```

Alternatively, you can use Linux's `unzip` command to do the dirty work:

```
charging_sdk]$ unzip ChargingSDK-1_0_D31E.zip
```

Configuration

Restcomm for JBoss

Open the $JBOSS_HOME/standalone/configuration/standalone-sip.xml configuration file and find the mobicents subsystem element.

Example 15. Editing the standalone-sip.xml for the Diameter Event-Changer Service

In the $JBOSS_HOME/standalone/configuration/standalone-sip.xml file search for the line

```
 <subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/mobicents-dar.properties"
```

and replace it with the line below

```
<subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/diametereventcharging-dar.properties"
```

Running

The following procedure describes how to run the Diameter Event-Changing Service.

Procedure: Diameter Event-Changing Service

1. Then, run the Ericsson Charging Emulator. Open a terminal, change the working directory to the location of the unzipped Charging Emulator files (in *ChargingSDK-1_0_D31E* or a similarly-named directory), and run it with the `java -jar PPSDiamEmul.jar` command:

   ```
   ~]$ java -jar PPSDiamEmul.jar
   ```

Using

Using the Event-Changing service means, firstly, inserting some parameters into the Charging Emulator, and then, by using two SIP (soft)phones, calling one with the other. The following sequential instructions show you how.

SIP (Soft)Phone? Which?

The Restcomm team recommends one of the following SIP phones, and has found that they work well: the 3CX Phone, the SJ Phone or the WengoPhone.

Procedure: Using the Diameter Event-Changing Service

1. Configure the Ericsson SDK Charging Emulator

   Once you have started the Charging Emulator, you should configure it exactly as portrayed in [_figure_mss_chargingemulatorconfig].

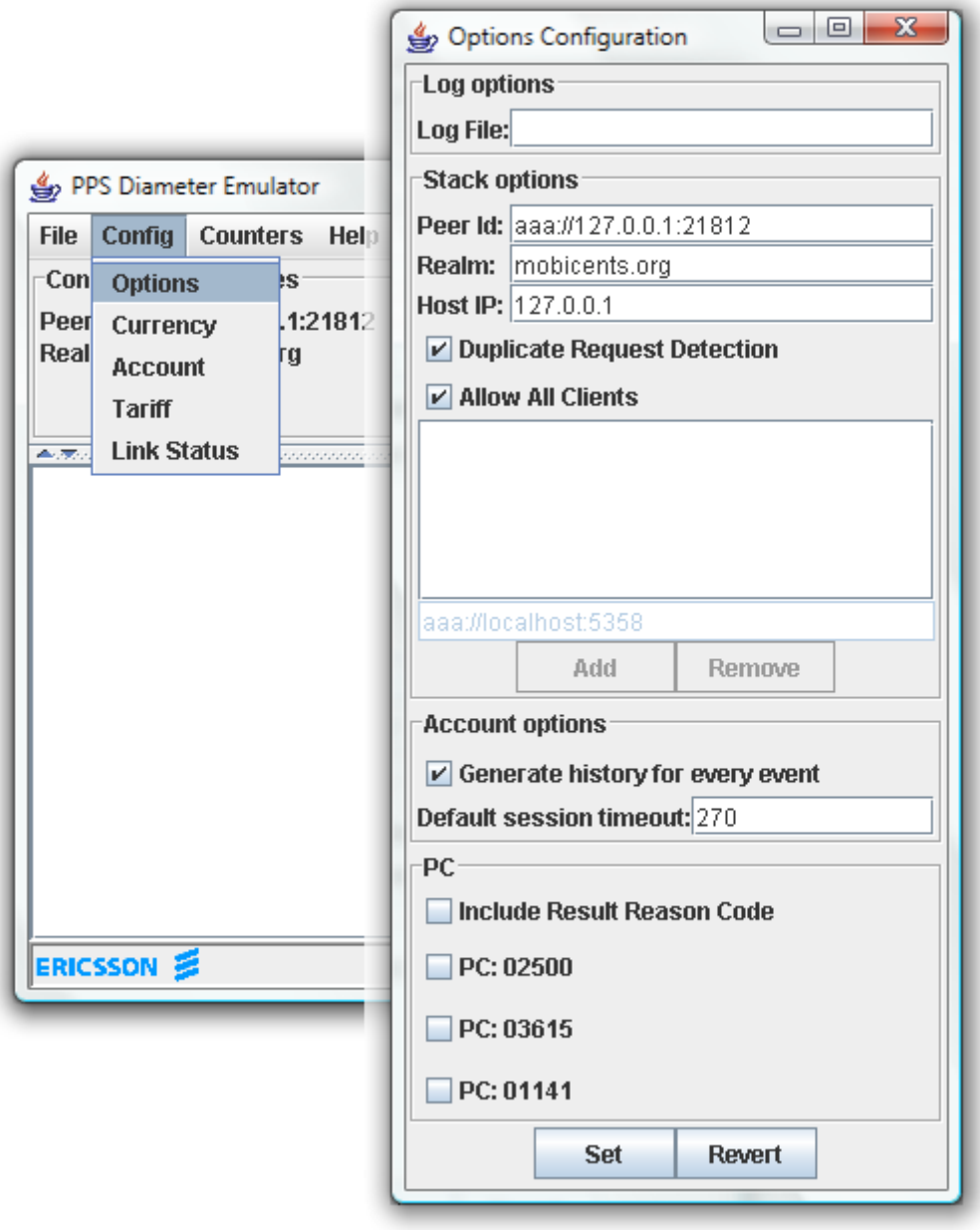

Figure 12. Configuring the Charging Emulator

2. Set the `Peer ID` to: `aaa://127.0.0.1:21812`
3. Set the `Realm` to: `mobicents.org`
4. Set the `Host IP` to: `127.0.0.1`
5. Start two SIP (soft)phones. You should set the first phone up with the following parameters: `sip:receiver@sip-servlets` on IP address `127.0.0.1` on port `5090`. The other phone can be set up any way you like.
6. Before making a call, open the **Config** | **Options** dialog window, as shown in the image.

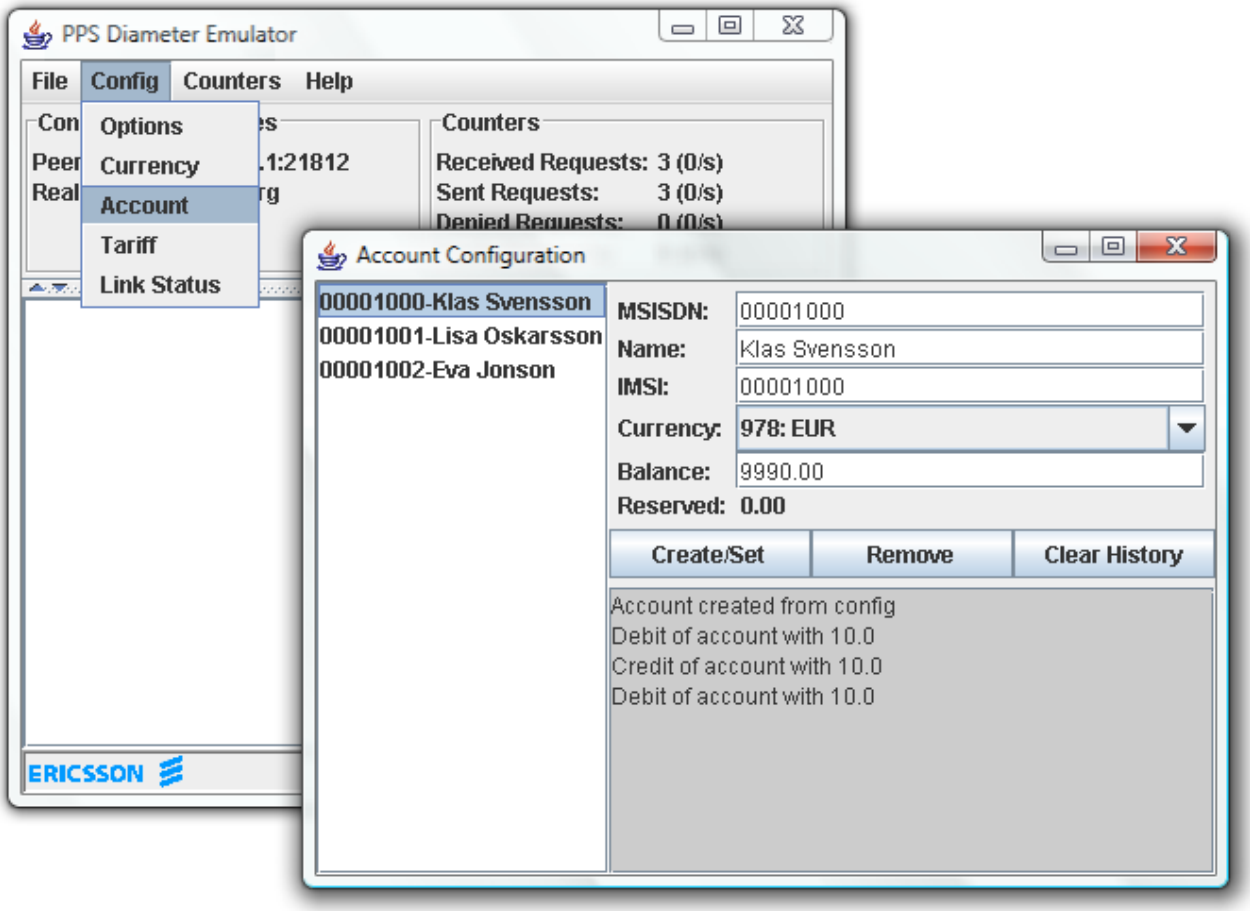

Figure 13. Configuring Accounts in the Charging Emulator

In the Account Configuration window of the Charging Emulator, you can see the user's balances. Select a user to watch the balance. You can also stretch the window lengthwise to view the user's transaction history.

7. Time to call! From the second, "any-configuration" phone, make a call to `sip:receiver@sip-servlets.com`. Upon doing so, the other phone should ring or signal that it is being contacted .
8. You should be able to see a request—immediately following the invite and before the other party (i.e. you) accepts or rejects the call—sent to the Charging Emulator. That is when the debit of the user's account is made. In the case that the call is rejected, or the caller gives up, a second, new Diameter request is sent to refund the initial amount charged by the call. On the other hand, if the call is accepted, nothing else related to Diameter happens, and no second request takes place.

   Please note that this is not the correct way to do charging, as Diameter provides other means, such as unit reservation. However, for the purpose of a demonstration it is sufficient to show the debit and follow-up credit working. Also, this is a fixed-price call, regardless of the duration. Charging can, of course, be configured so that it is time-based.

4.1.3. The Call-Blocking Service

The Restcomm Call-Blocking Service, upon receiving an `INVITE` request, checks to see whether the sender's address is a blocked contact. If so, it returns a `FORBIDDEN` reply; otherwise, call setup proceeds as normal.

Blocked Contacts Cannot Currently Be Configured

Blocked contacts are currently hard-coded addresses. This model is evolving towards the eventual use of a database.

Here is the current hard-coded list of blocked contacts:

- `sip:blocked-sender@sip-servlets.com`
- `sip:blocked-sender@127.0.0.1`

The Call-Blocking Service: Installing, Configuring and Running

Software Prerequisites

Either an Restcomm for JBoss or an Restcomm for Tomcat Installation

The Call-Blocking Service requires either an Restcomm for JBoss or an Restcomm for Tomcat binary installation.

Downloading

The Call-Blocking Service is comprised of two archive files, a Web Archive (WAR) and a Default Application Router (DAR) configuration file, which you need to add to your installed SIP Servlets Server. For more information about WAR files, refer to the JBoss Application Server Administration and Development Guide. For more information about DAR files, refer to the JSR 289 spec, Appendix C.

Download the Call-Blocking Service’s WAR file from here: &VERSION;&VERSION;<a href="https://oss.sonatype.org/content/groups/public/org/mobicents/servlet/sip/examples/call-blocking//call-blocking-.war" class="bare">https://oss.sonatype.org/content/groups/public/org/mobicents/servlet/sip/examples/call-blocking//call-blocking-.war</a>.

Download the Call-Blocking Service's DAR file from here: https://sipservlets.googlecode.com/git/sip-servlets-examples/call-blocking/call-blocking-servlet-dar.properties.

Installing

Both the *call-blocking-.war* WAR file and the *call-blocking-servlet-dar.properties* DAR file that you downloaded should be placed into different directories in your SIP Servlet Server installation hierarchy. Which directory depends on whether you are using the Call-Blocking Service with Restcomm for JBoss or with Restcomm for Tomcat:

Restcomm for JBoss

Place *call-blocking-.war* into the *$JBOSS_HOME/standalone/deployments/* directory, and *call-blocking-servlet-dar.properties* into the *$JBOSS_HOME/standalone/configuration/dars/* directory.

Restcomm for Tomcat

Place *call-blocking-servlet-dar.properties* into the *$CATALINA_HOME/webapps/* directory, and *call-blocking-servlet-dar.properties* into the *$CATALINA_HOME/conf/dars/* directory.

Configuring

Restcomm for JBoss

Open the $JBOSS_HOME/standalone/configuration/standalone-sip.xml configuration file and find the mobicents subsystem element.

Example 16. Editing MSS for JBoss's standalone-sip.xml for the Location Service

In the $JBOSS_HOME/standalone/configuration/standalone-sip.xml file search for the line

```
 <subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/mobicents-dar.properties"
```

and replace it with the line below

```
<subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/call-blocking-servlet-dar.properties"
```

Restcomm for Tomcat

Open the *$CATALINA_HOME/conf/server.xml* configuration file and find the `Service` element. Add an attribute to it called `darConfigurationFileLocation`, and set it to `conf/dars/call-blocking-servlet-dar.properties`:

Example 17. Editing MSS for Tomcat's server.xml for the Location Service

In the $JBOSS_HOME/standalone/configuration/standalone-sip.xml file search for the line

```
 <subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/mobicents-dar.properties"
```

and replace it with the line below

```
<subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/call-blocking-servlet-dar.properties"
```

Running

Once the WAR and DAR files have been placed in the right directories, and the JBoss Application Server or Tomcat Servlet Container knows where to find them (which you specified in a *server.xml* and the *standalone-sip.xml* files), then you should go ahead and run the SIP Servlets Server.

Testing

The following procedure shows how to test the Call-Blocking Service.

Procedure: Testing the Call Blocking Service

1. Start a SIP softphone of your choice. The account name should be `blocked-sender`. The `From Header` should list one of the following addresses: `sip:blocked-sender@sip-servlets.com` or `sip:blocked-sender@127.0.0.1`. The SIP softphone does not need to be registered.
2. Make a call to any address, and you should receive a `FORBIDDEN` response.

4.1.4. The Call-Forwarding Service

The Restcomm Call-Forwarding Service, upon receiving an `INVITE` request, checks to see whether the sender's address is among those in a list of addresses which need to be forwarded. If so, then the Call-Forwarding Service acts as a Back-to-Back User Agent (B2BUA), and creates a new call leg to the destination. When the response is received from the new call leg, it sends it an acknowledgment (`ACK`) and then responds to the original caller. If, on the other hand, the server does not receive an `ACK`, then it tears down the new call leg with a `BYE`. Once the `BYE` is received, then it answers `OK` directly and sends the `BYE` to the new call leg.

Contacts to Forward Cannot Currently Be Configured

Contacts to forward are currently hard-coded addresses. This model is evolving toward the eventual use of a database.

Here is the current hard-coded list of contacts to forward:

- `sip:receiver@sip-servlets.com`
- `sip:receiver@127.0.0.1`

The Call-Forwarding Service: Installing, Configuring and Running

Pre-Install Requirements and Prerequisites

The following requirements must be met before installation can begin.

Downloading

The Call-Forwarding Service is comprised of two archive files, a Web Archive (WAR) and a Data Archive (DAR), which you need to add to your installed SIP Servlets Server. For more information about WAR and DAR files, refer to the JBoss Application Server Administration and Development Guide.

Download the Call-Forwarding Service’s WAR file from here: &VERSION;&VERSION;<a href="https://oss.sonatype.org/content/groups/public/org/mobicents/servlet/sip/examples/call-forwarding//call-forwarding-.war" class="bare">https://oss.sonatype.org/content/groups/public/org/mobicents/servlet/sip/examples/call-forwarding//call-forwarding-.war</a>.

Download the Call-Forwarding Service's DAR file from here: https://sipservlets.googlecode.com/git/sip-servlets-examples/call-forwarding/call-forwarding-b2bua-servlet-dar.properties.

Installing

Both the *call-forwarding-.war* WAR file and the *call-forwarding-servlet-dar.properties* DAR file that you downloaded should be placed into different directories in your SIP Servlet Server installation hierarchy. Which directory depends on whether you are using the Call-Forwarding Service with Restcomm for JBoss or with Restcomm for Tomcat:

Restcomm for JBoss

Place *call-forwarding-.war* into the *$JBOSS_HOME/standalone/deployments/* directory, and *call-forwarding-servlet-dar.properties* into the *$JBOSS_HOME/standalone/configuration/dars/* directory.

Restcomm for Tomcat

Place *call-forwarding-.war* into the *$CATALINA_HOME/webapps/* directory, and *call-forwarding-servlet-dar.properties* into the *$CATALINA_HOME/conf/dars/* directory.

Configuring

Restcomm for JBoss

Open the $JBOSS_HOME/standalone/configuration/standalone-sip.xml configuration file and find the mobicents subsystem element.

Example 18. Editing MSS for JBoss's standalone-sip.xml for the Location Service

In the $JBOSS_HOME/standalone/configuration/standalone-sip.xml file search for the line

```
 <subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/mobicents-dar.properties"
```

and replace it with the line below

```
<subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/call-forwarding-b2bua-servlet.properties"
```

Restcomm for Tomcat

Open the *$CATALINA_HOME/conf/server.xml* configuration file and find the `Service` element. Add an attribute to it called `darConfigurationFileLocation`, and set it to `conf/dars/call-forwarding-b2bua-servlet-dar.properties`:

Example 19. Editing MSS for Tomcat's server.xml for the Location Service

In the $JBOSS_HOME/standalone/configuration/standalone-sip.xml file search for the line

```
 <subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/mobicents-dar.properties"
```

and replace it with the line below

```
<subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/call-forwarding-b2bua-servlet-dar.properties"
```

Running

Once the WAR and DAR files have been placed in the right directories, and the JBoss Application Server or Tomcat Servlet Container knows where to find them (which you specified in a *standalone-sip.xml* and *server.xml* files), then you should go ahead and run the SIP Servlets Server.

Testing

The following procedure shows how to test the Call-Forwarding Service.

Procedure:

1. Start two SIP soft-phones of your choice. Set the account settings of the first SIP softphone to:
   - Account name: `forward-receiver`
   - IP address: `127.0.0.1`
   - Port: `5090`

   Neither of the SIP soft-phones needs to be registered.

2. From the second phone, make a call to `sip:receiver@sip-servlets.com`. The first phone, "forward-receiver", should now be ringing.

4.1.5. The Call-Controller Service

The Call-Controller service is a composition of two other services: Call-Blocking and Call-Forwarding. Essentially, it performs the services of both call-forwarding and call-blocking.

- To learn about how the Call-Blocking service works, refer to The Call-Blocking Service.
- To learn about how the Call-Forwarding service works, refer to The Call-Forwarding Service.

Blocked Contacts and Contacts to Forward Cannot Currently Be Configured

Both the list of blocked contacts and the list of contacts to forward are currently both hard-coded. However, both of those models are evolving toward the eventual use of databases.

The Call-Controller Service: Installing, Configuring and Running

The Call-Controller service requires the two WAR files for the Call-Blocking and Call-Forwarding services to be placed in the correct directory inside your Restcomm SIP Servlets Server binary installation. However, the Call-Controller service does *not* require their corresponding DAR files: you need only to download and install a DAR file customized for the Call-Controller service. The instructions below show you how to do precisely this; there is no need, therefore, to first install either the Call-Blocking or the Call-Forwarding services, though it is helpful to at least be familiar with them.

Pre-Install Requirements and Prerequisites

The following requirements must be met before installation can begin.

Downloading

The Call-Controller Service is comprised of two WAR files, one for the Call-Forwarding service and one for Call-Blocking, and a customized Call-Controller DAR file. You do not need to install the DAR files for the Call-Forwarding or the Call-Blocking services. For more information about WAR files, refer to the JBoss Application Server Administration and Development Guide. For more information about DAR files, refer to the JSR 289 spec, Appendix C

Download the Call-Blocking Service’s WAR file from here: &VERSION;&VERSION;<a href="https://oss.sonatype.org/content/groups/public/org/mobicents/servlet/sip/examples/call-blocking//call-blocking-.war" class="bare">https://oss.sonatype.org/content/groups/public/org/mobicents/servlet/sip/examples/call-blocking//call-blocking-.war</a>.

Download the Call-Forwarding Service’s WAR file from here: &VERSION;&VERSION;<a href="https://oss.sonatype.org/content/groups/public/org/mobicents/servlet/sip/examples/call-forwarding//call-forwarding-.war" class="bare">https://oss.sonatype.org/content/groups/public/org/mobicents/servlet/sip/examples/call-forwarding//call-forwarding-.war</a>.

Download the Call-Controller Service's DAR file from here: https://sipservlets.googlecode.com/git/sip-servlets-examples/call-blocking/call-controller-servlet-dar.properties.

Installing

The *call-blocking-.war*, *call-forwarding-.war* and *call-controller-servlet-dar.properties* archive files that you downloaded should be placed into different directories in your SIP Servlet Server installation hierarchy. Which directory depends on whether you are using the Call-Controller Service with Restcomm for JBoss or with Restcomm for Tomcat:

Restcomm for JBoss

Place *call-blocking-.war* and *call-forwarding-.war* into the *$JBOSS_HOME/standalone/deployments/* directory, and *call-controller-servlet-dar.properties* into the *$JBOSS_HOME/standalone/configuration/dars/* directory.

Restcomm for Tomcat

Place *call-blocking-.war* and *call-forwarding-.war* into the *$CATALINA_HOME/webapps/* directory,

and *call-controller-servlet-dar.properties* into the *$CATALINA_HOME/conf/dars/* directory.

Configuring

RRestcomm for JBoss

Open the $JBOSS_HOME/standalone/configuration/standalone-sip.xml configuration file and find the mobicents subsystem element.

Example 20. Editing MSS for JBoss's standalone-sip.xml for the Location Service

In the $JBOSS_HOME/standalone/configuration/standalone-sip.xml file search for the line

```
 <subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/mobicents-dar.properties"
```

and replace it with the line below

```
<subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/call-forwarding-b2bua-servlet.properties"
```

Restcomm for Tomcat

Open the *$CATALINA_HOME/conf/server.xml* configuration file and find the `Service` element. Add an attribute to it called `darConfigurationFileLocation`, and set it to `conf/dars/call-controller-servlet-dar.properties`:

Example 21. Editing MSS for Tomcat's server.xml for the Location Service

In the $JBOSS_HOME/standalone/configuration/standalone-sip.xml file search for the line

```
 <subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/mobicents-dar.properties"
```

and replace it with the line below

```
<subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0"
application-router="dars/call-controller-servlet-dar.properties"
```

Running

Once the WAR and DAR files have been placed in the right directories, and the JBoss Application Server or Tomcat Servlet Container knows where to find them (which you specified in a *server.xml* file), then you should go ahead and run the SIP Servlets Server.

Testing

Two use-cases can be distinguished for the Call-Controller service: one in which a call is blocked,

and another in which a call is forwarded. Therefore, we have two cases for which we can test the Call-Controller.

Procedure: Blocking a Call with Call-Controller

1. Start two SIP soft-phones of your choice. Set the account settings of the SIP soft-phones to:
   - .Relevant First Softphone SettingsAccount name: `forward-receiver`
   - IP address: `127.0.0.1`
   - Port: `5090`
   - .Relevant Second Softphone SettingsAccount name: `blocked-sender`

   Neither of the SIP soft-phones needs to be registered.

2. From the second phone, `blocked-sender`, make a call to `sip:receiver@sip-servlets.com`. You should receive a `FORBIDDEN` response.

Procedure: Forwarding a Call with Call-Controller

1. Start two SIP soft-phones of your choice. Set the account settings of the SIP soft-phones to:
   - .Relevant First Softphone SettingsAccount name: `forward-receiver`
   - IP address: `127.0.0.1`
   - Port: `5090`
   - .Relevant Second Softphone SettingsAccount name: `forward-sender`

   Neither of the SIP soft-phones needs to be registered.

2. From the second softphone, `forward-sender`, make a call to `sip:receiver@sip-servlets.com`. The first phone, `forward-receiver`, should now be ringing.

SIP Servlet Example Applications provides more information about other service examples available.

Click To Call

Chapter 5. Understanding Restcomm High Availabilty

High Availability in Restcomm for JBoss AS7

Clustering and Failover features as described below are not yet implemented in Restcomm for JBoss AS7. This guide will be updated when the feature becomes available.

High Availability

Is a term used to describe software and hardware based strategies that are implemented to ensure optimal performance and continuous system operation in case of failure. High availability encompasses, clustering, failover and load balancing

Clustering

Is a technique used to ensure continuous service availability by having two or more servers communicate with each other and share configuration and application data (replication) on fixed, predetermined intervals. This produces two or more application servers with identical setup. There is often a primary server within a clustered cloud from which data is replicated to the secondary. The application servers within a clustered environment will use what is called a heartbeat to ensure that all servers within are alive and functioning. In the case of failure, another server (secondary) will take over the task of responding to client's requests without impacting user experience. In some clustered ecosystem, load balancing is used as explained below.

Load Balancing

This is ultimately about performance. All request from clients are evenly distributed by the (load balancer) to multiple application servers that are running similar configurations.This type of setup often includes fault tolerance or failover. When one of the nodes, application server instance is not available, all traffic will be directed to the remaining servers. This ensures continuity albeit performance can degrade. Load balancing allows a single point of entry for multiple clients.

Failover

Failover is a way to provide continuous service to clients connecting to an application server in case of system, software or hardware failure. Connections to an unresponsive server is directed (failed over) to a backup server. This is often done within the scope of a clustered configuration aided by a load balancer.

It is important to note that clustering is also a way to provide failover and enhance server performance. The same can be said of load balancing. The idea behind all the above mentioned techniques is to provide high availability to connecting clients connecting to applications running on Restcomm . In a nutshell, high availability englobes all the above mentioned techniques.

5.1. Load Balancer

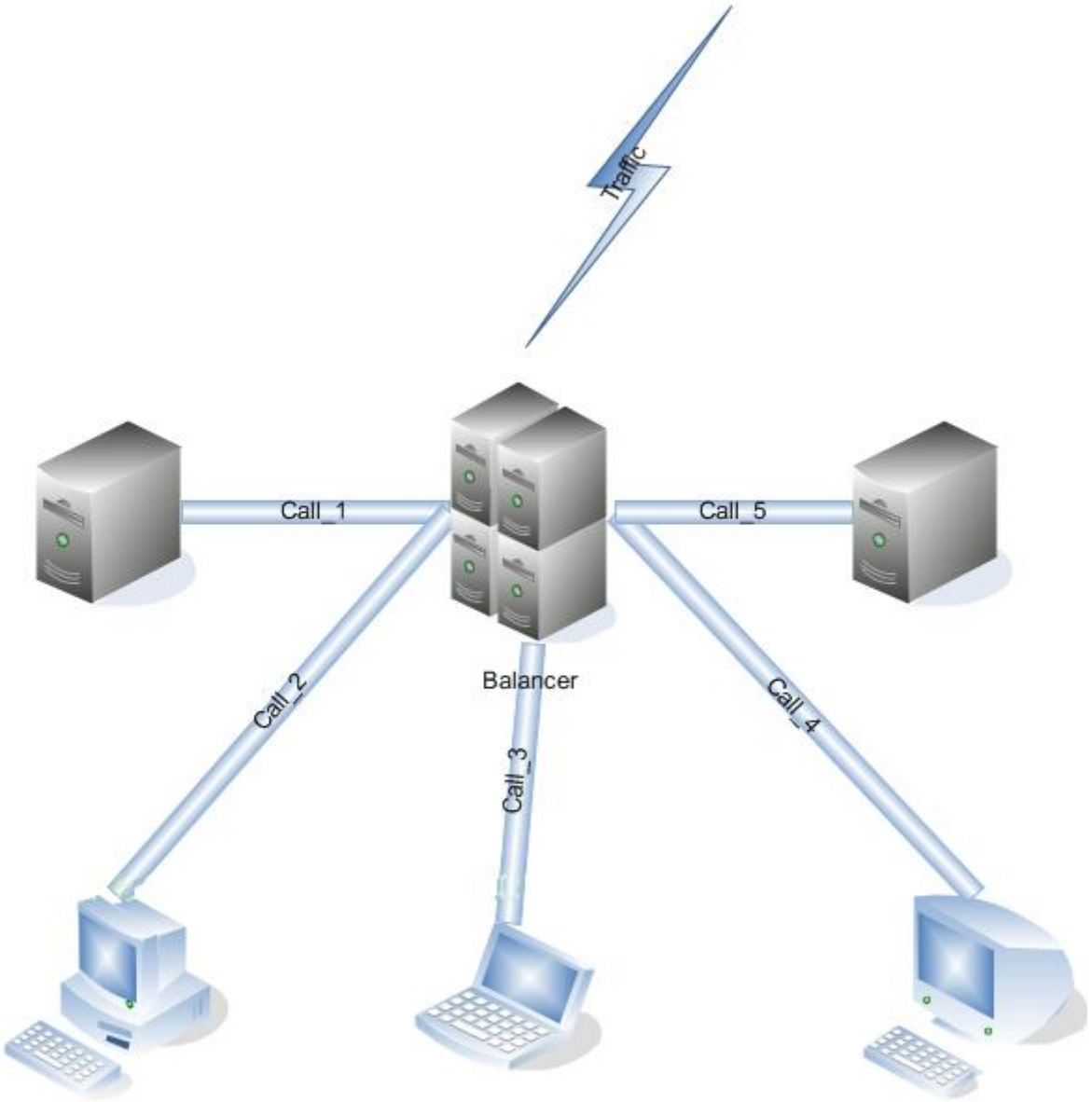

Figure 14. Star Cluster Topology.

The SIP Load Balancer is used to balance the load of SIP service requests and responses between nodes in a SIP Servlets Server cluster. Both Restcomm for JBoss and Restcomm for Tomcat servers can be used in conjunction with the SIP Load Balancer to increase the performance and availability of SIP services and applications.

In terms of functionality, the SIP Load Balancer is a simple stateless proxy server that intelligently forwards SIP session requests and responses between User Agents (UAs) on a Wide Area Network (WAN), and SIP Servlets Server nodes, which are almost always located on a Local Area Network (LAN). All SIP requests and responses pass through the SIP Load Balancer.

5.1.1. SIP Load Balancer: Installing, Configuring and Running

Pre-Install Requirements and Prerequisites

Software Prerequisites

A JAIN SIP HA-enabled application server such as Restcomm JAIN SLEE or Restcomm SIP Servlets is required.

Running the SIP Load Balancer requires at least two instances of the application server as cluster nodes nodes. Therefore, before configuring the SIP Load Balancer, we should make sure we've installed a the SIP application server first. The Restcomm SIP load balancer will work with a SIP Servlets-enabled JBoss Application Server *or* a JAIN SLEE application server with SIP RA.

Downloading

The load balancer is located in the *sip-balancer* top-level directory of the Restcomm distribution. You will find the following files in the directory:

SIP load balancer executable JAR file

This is the binary file with all dependencies

SIP load balancer Configuration Properties file

This is the properties files with various settings

Installing

The SIP load balancer executable JAR file can be extracted anywhere in the file system. It is recommended that the file is placed in the directory containing other JAR executables, so it can be easily located in the future.

Configuring

Configuring the SIP load balancer and the two SIP Servlets-enabled Server nodes is described in Procedure: Configuring the Restcomm SIP Load Balancer and SIP Server Nodes.

Procedure: Configuring the Restcomm SIP Load Balancer and SIP Server Nodes

1. Configure lb.properties Configuration Properties File

   Configure the SIP Load Balancer's Configuration Properties file by substituting valid values for your personal setup. Complete Sample lb.properties File shows a sample *lb.properties* file, with key element descriptions provided after the example. The lines beginning with the pound sign are comments.

   Example 22. Complete Sample lb.properties File

```
#  Load Balancer Settings
# For an overview of the   Load Balancer visit
# http://docs.google.com/present/view?id=dc5jp5vx_89cxdvtxcm
# The Load balancer will listen for both TCP and UDP connections



# The binding address of the load balancer. This also specifies the
# default value for both internalHost and externalHost if not specified
separately.
```

```
host=127.0.0.1

# The binding address of the load balancer where clients should connect (if the
host property is not specified)
#externalHost=127.0.0.1

# The SIP port from where servers will receive messages
# delete if you want to use only one port for both inbound and outbound)
internalPort=5065

# The SIP port used where clients should connect
externalPort=5060

# The binding address of the load balancer where SIP application servers should
connect (if the host property is not specified)
#internalHost=127.0.0.1

# The RMI port used for heartbeat signals
rmiRegistryPort=2000

# The HTTP port for HTTP forwarding
# if you like to activate the integrated HTTP load balancer, this is the entry
point
httpPort=2080
#If no nodes are active the LB can redirect the traffic to the unavailableHost
specified in this property,
#otherwise, it will return 503 Service Unavailable
#unavailableHost=google.com

# If you are using IP load balancer, put the IP address and port here
#externalIpLoadBalancerAddress=127.0.0.1
#externalIpLoadBalancerPort=111

# Requests initited from the App Servers can route to this address (if you are
using 2 IP load balancers for bidirectional SIP LB)
#internalIpLoadBalancerAddress=127.0.0.1
#internalIpLoadBalancerPort=111

# The addresses in the SIP LB Via headers can be either the real addresses or
those specified in the external and internal IP LB addresses
useIpLoadBalancerAddressInViaHeaders=false

# Designate extra IP addresses as serer nodes
#extraServerNodes=222.221.21.12:21,45.6.6.7:9003,33.5.6.7,33.9.9.2

# Call-ID affinity algortihm settings. This algorithm is the default. No need
to uncomment it.
#algorithmClass=org.mobicents.tools.sip.balancer.CallIDAffinityBalancerAlgorith
m
# This property specifies how much time to keep an association before being
evitcted.
```

```
# It is needed to avoid memory leaks on dead calls. The time is in seconds.
#callIdAffinityMaxTimeInCache=500
#The following attribute specified the policy after failover. If set to true
all calls from the failed node
#will go to a new healthy node (all calls to the same node). If set to false
the calls will go to random new nodes.
#callIdAffinityGroupFailover=false

# Uncomment to enable the consistent hash based on Call-ID algorithm.
#algorithmClass=org.mobicents.tools.sip.balancer.HeaderConsistentHashBalancerAl
gorithm
# This property is not required, it defaults to Call-ID if not set, cna be
"from.user" or "to.user" when you want the SIP URI username
#sipHeaderAffinityKey=Call-ID
#specify the GET HTTP parameter to be used as hash key
#httpAffinityKey=appsession

# Uncomment to enable the persistent consistent hash based on Call-ID
algorithm.
#algorithmClass=org.mobicents.tools.sip.balancer.PersistentConsistentHashBalanc
erAlgorithm
# This property is not required, it defaults to Call-ID if not set
#sipHeaderAffinityKey=Call-ID
#specify the GET HTTP parameter to be used as hash key
#httpAffinityKey=appsession

#This is the JBoss Cache 3.1 configuration file (with jgroups), if not
specified it will use default
#persistentConsistentHashCacheConfiguration=/home/config.xml

# Call-ID affinity algortihm settings. This algorithm is the default. No need
to uncomment it.
#algorithmClass=org.mobicents.tools.sip.balancer.CallIDAffinityBalancerAlgorith
m
# This property specifies how much time to keep an association before being
evitcted.
# It is needed to avoid memory leaks on dead calls. The time is in seconds.
#callIdAffinityMaxTimeInCache=500

# Uncomment to enable the consistent hash based on Call-ID algorithm.
#algorithmClass=org.mobicents.tools.sip.balancer.HeaderConsistentHashBalancerAl
gorithm
# This property is not required, it defaults to Call-ID if not set, cna be
"from.user" or "to.user" when you want the SIP URI username
#sipHeaderAffinityKey=Call-ID
#specify the GET HTTP parameter to be used as hash key
#httpAffinityKey=appsession

# Uncomment to enable the persistent consistent hash based on Call-ID
algorithm.
#algorithmClass=org.mobicents.tools.sip.balancer.PersistentConsistentHashBalanc
```

```
erAlgorithm
# This property is not required, it defaults to Call-ID if not set
#sipHeaderAffinityKey=Call-ID
#specify the GET HTTP parameter to be used as hash key
#httpAffinityKey=appsession

#This is the JBoss Cache 3.1 configuration file (with jgroups), if not
specified it will use default
#persistentConsistentHashCacheConfiguration=/home/config.xml


#If a node doesnt check in within that time (in ms), it is considered dead
nodeTimeout=5100
#The consistency of the above condition is checked every heartbeatInterval
milliseconds
heartbeatInterval=150


#JSIP stack configuration.....
javax.sip.STACK_NAME = SipBalancerForwarder
javax.sip.AUTOMATIC_DIALOG_SUPPORT = off
# You need 16 for logging traces. 32 for debug + traces.
# Your code will limp at 32 but it is best for debugging.
gov.nist.javax.sip.TRACE_LEVEL = 0

// Specify if message contents should be logged.
gov.nist.javax.sip.LOG_MESSAGE_CONTENT=false

gov.nist.javax.sip.DEBUG_LOG = logs/sipbalancerforwarderdebug.txt
gov.nist.javax.sip.SERVER_LOG = logs/sipbalancerforwarder.xml
gov.nist.javax.sip.THREAD_POOL_SIZE = 64
gov.nist.javax.sip.REENTRANT_LISTENER = true
```

host

Local IP address, or interface, on which the SIP load balancer will listen for incoming requests.

externalPort

Port on which the SIP load balancer listens for incoming requests from SIP User Agents.

internalPort

Port on which the SIP load balancer forwards incoming requests to available, and healthy, SIP Server cluster nodes.

rmiRegistryPort

Port on which the SIP load balancer will establish the RMI heartbeat connection to the application servers. When this connection fails or a disconnection instruction is received, an application server node is removed and handling of requests continues without it by redirecting the load to the lie nodes.

httpPort

Port on which the SIP load balancer will accept HTTP requests to be distributed across the nodes.

internalTransport

Transport protocol for the internal SIP connections associated with the internal SIP port of the load balancer. Possible choices are `UDP`, `TCP` and `TLS`.

externalTransport

Transport protocol for the external SIP connections associated with the external SIP port of the load balancer. Possible choices are `UDP`, `TCP` and `TLS`. It must match the transport of the internal port.

externalIpLoadBalancerAddress

Address of the IP load balancer (if any) used for incoming requests to be distributed in the direction of the application server nodes. This address may be used by the SIP load balancer to be put in SIP headers where the external address of the SIP load balancer is needed.

externalIpLoadBalancerPort

The port of the external IP load balancer. Any messages arriving at this port should be distributed across the external SIP ports of a set of SIP load balancers.

internalIpLoadBalancerAddresst

Address of the IP load balancer (if any) used for outgoing requests (requests initiated from the servers) to be distributed in the direction of the clients. This address may be used by the SIP load balancer to be put in SIP headers where the internal address of the SIP load balancer is needed.

internalIpLoadBalancerPort

The port of the internal IP load balancer. Any messages arriving at this port should be distributed across the internal SIP ports of a set of SIP load balancers.

extraServerNodes

Comma-separated list of hosts that are server nodes. You can put here alternative names of the application servers here and they will be recognized. Names are important, because they might be used for direction-analysis. Requests coming from these server will go in the direction of the clients and will not be routed back to the cluster.

algorithmClass

The fully-qualified Java class name of the balancing algorithm to be used. There are three algorithms to choose from and you can write your own to implement more complex routing behaviour. Refer to the sample configuration file for details about the available options for each algorithm. Each algorithm can have algorithm-specific properties for fine-grained configuration.

nodeTimeout

In milliseonds. Default value is 5100. If a server node doesnt check in within this time (in ms), it is considered dead.

heartbeatInterval

In milliseconds. Default value is 150 milliseonds. The hearbeat interval must be much smaller than the interval specified in the JAIN SIP property on the server machines - `org.mobicents.ha.javax.sip.HEARTBEAT_INTERVAL`

The remaining keys and properties in the configuration properties file can be used to tune the JAIN SIP stack, but are not specifically required for load balancing. To assist with tuning, a comprehensive list of implementing classes for the SIP Stack is available from the Interface SIP Stack. For a comprehensive list of properties associated with the SIP Stack implementation, refer to Class SipStackImpl.

2. Configure logging

   The SIP load balancer uses Log4J as a logging mechanism. You can configure it through the typical log4j xml configuration file and specify the path as follows `-DlogConfigFile=./log4j.xml`. Please refer to Log4J documentation for more information on how to configure the logging. A shortcut exists if you want to switch between INFO/DEBUG/WARN logging levels. The JVM option `-DlogLevel=DEBUG` will allow you to switch all loggig categories to the specified log level.

3. Configure the container configuration file

   Ensure the following attributes are configured for the `<service>` element in *server.xml* for Tomcat or in the mobicents `subsystem` element for JBoss AS7.

   - The `sipPathName` attribute must contain the following value `org.mobicents.ha.balancing.only` to indicate that the server will be using the Restcomm JAIN SIP HA SIP Stack which is an extension of the JAIN SIP Stack offering integration with the Mobicents Load Balancer and transparent replication.

4. Configure the *mss-sip-stack.properties* configuration file

   - The `org.mobicents.ha.javax.sip.cache.MobicentsSipCache.cacheName` property must contain the name of the cache that will be responsible for holding the replicated data of the SIP Stack layer (namely the established SIP dialog data). The value has to be one of the cache name present in the jboss-cache-manager-jboss-beans.xml file of the jboss-cache-manager JBoss Service of the container. The default value is `standard-session-cache`
   - The `org.mobicents.ha.javax.sip.BALANCERS` property must be configured with the list of load balancer IP address and internal ports. As an example, suppose a single &THIS.PLATFORM; SIP Load Balancer is running with IP `192.168.0.1` and internal port `5065`, the property would be set with value `192.168.0.1:5065`. To specify multiple balancers use `;` as separator. If this property is used the balancers attribute located in server.xml should not be used as it is a replacement for it.
   - The `org.mobicents.ha.javax.sip.LoadBalancerHeartBeatingServiceClassName` property is optional, it defines the class name of the HeartBeating service implementation, currently the only one available is `org.mobicents.ha.javax.sip.LoadBalancerHeartBeatingServiceImpl`
   - The `org.mobicents.ha.javax.sip.LoadBalancerElector` property is optional, it defines the class of the load balancer elector from JAIN SIP HA Stack. The elector is used to define which load

balancer will receive outgoing requests, which are out of dialog or in dialog with null state. Currently only one elector implementation is available, `org.mobicents.ha.javax.sip.RoundRobinLoadBalancerElector`, which, as the class name says, uses round robin algorythm to select the balancer.

Configuration File Locations

On Restcomm for Tomcat server installations, *server.xml* is located in *<install_directory>/conf*.

On Restcomm for JBoss server installations, the default *standalone-sip.xml* configuration file is located in *standalone/configuration* or the default *domain-sip.xml* configuration file located in *domain/configuration* for cluster configurations

Easy Node Configuration with JMX

Both SIP Servlet-enabled JBoss and Tomcat have (Java Management Extensions) interfaces that allow for easy server configuration. The JMX Console is available once the server has been started by navigating to http://localhost:8080/jmx-console/.

Both the `balancers` and `heartBeatInterval` attribute values are available under `name=-SIP-Servlets,type=load-balancer-heartbeat-service` in the JMX Console.

balancers

Host names of the SIP load balancer(s) with corresponding `addBalancerAddress` and `removeBalancerAddress` methods.

heartBeatInterval

Interval at which each heartbeat is sent to the SIP load balancer(s).

Converged Load Balancing

Apache HTTP Load Balancer

The Restcomm SIP Load Balancer can work in concert with HTTP load balancers such as `mod_jk`. Whenever an HTTP session is bound to a particular node, an instruction is sent to the SIP Load Balancer to direct the SIP calls from the same application session to the same node.

It is sufficient to configure `mod_jk` to work for HTTP in JBoss in order to enable cooperative load balancing. Restcomm will read the configuration and will use it without any extra configuration. You can read more about configuring `mod_jk` with JBoss in your JBoss Application Server documentation.

Alternatively you may disable this behaviour and make the HTTP load balancer follow the decisions made by the SIP load balancer with the httpFollowsSip flag. This is achieved by changing the jvmRoute part of the session ID cookie used internally by `mod_jk`.

The httpFollowsSip flag

The `httpFollowsSip` flag in the service configuration makes the application server aware of how different mod_jk and SIP load balancers have assigned request affinity for each application session. The application servers assign exactly one node to each Sip Servlets application session and this node is the node where the last SIP request associated with the application session has landed (decised by the SIP load balancer). Then the application server will actively update the session ID cookie (the jvmRoute part) of any HTTP request that arrives at the wrong node. The application server will do so with a specially composed HTTP redirect response or with a HTML refresh hint. As a backup strategy, if the request is bound to seek non-existing node forever and it will let the request be served by a new node. This avoids having a client stuck reloading the same page over and over.

One problem with this flag is that if you have two or more SIP sessions associated with the same application session and the load balancer has decided to send SIP requests to different nodes, which might happend if you use Call-ID based affinity, then the application server will have to change the jvmRoute very often for every SIP request resulting in significant overhead. It is generally not adviced to enable this flag if you have more than 1 SIP session per application session and the means to guarantee all SIP sessions from the application session will land on the same node.

This is an example how to enable the option. It is disabled by default.

```
<Connector port="5080"
     ipAddress = "${jboss.bind.address}"
     ...
     httpFollowsSip="true" />
```

Integrated HTTP Load Balancer

To use the integrated HTTP Load Balancer, no extra configuration is needed. If a unique `jvmRoute` is specified and enabled in each application server, it will behave exactly as the apache balancer. If `jvmRoute` is not present, it will use the session ID as a hash value and attempt to create a sticky session. The integrated balancer can be used together with the apache balancer at the same time.

In addition to the apache behavior, there is a consistent hash balancer algorithm that can be enabled for both HTTP and SIP messages. For both HTTP and SIP messages, there is a configurable affinity key, which is evaluated and hashed against each unassigned request. All requests with the same hash value will always be routed to the same application server node. For example, the SIP affinity key could be the callee user name and the HTTP affinity key could the “appsession” HTTP GET parameter of the request. If the desired behaviour group these requests, we can just make sure the affinity values (user name and GET parameter) are the same.

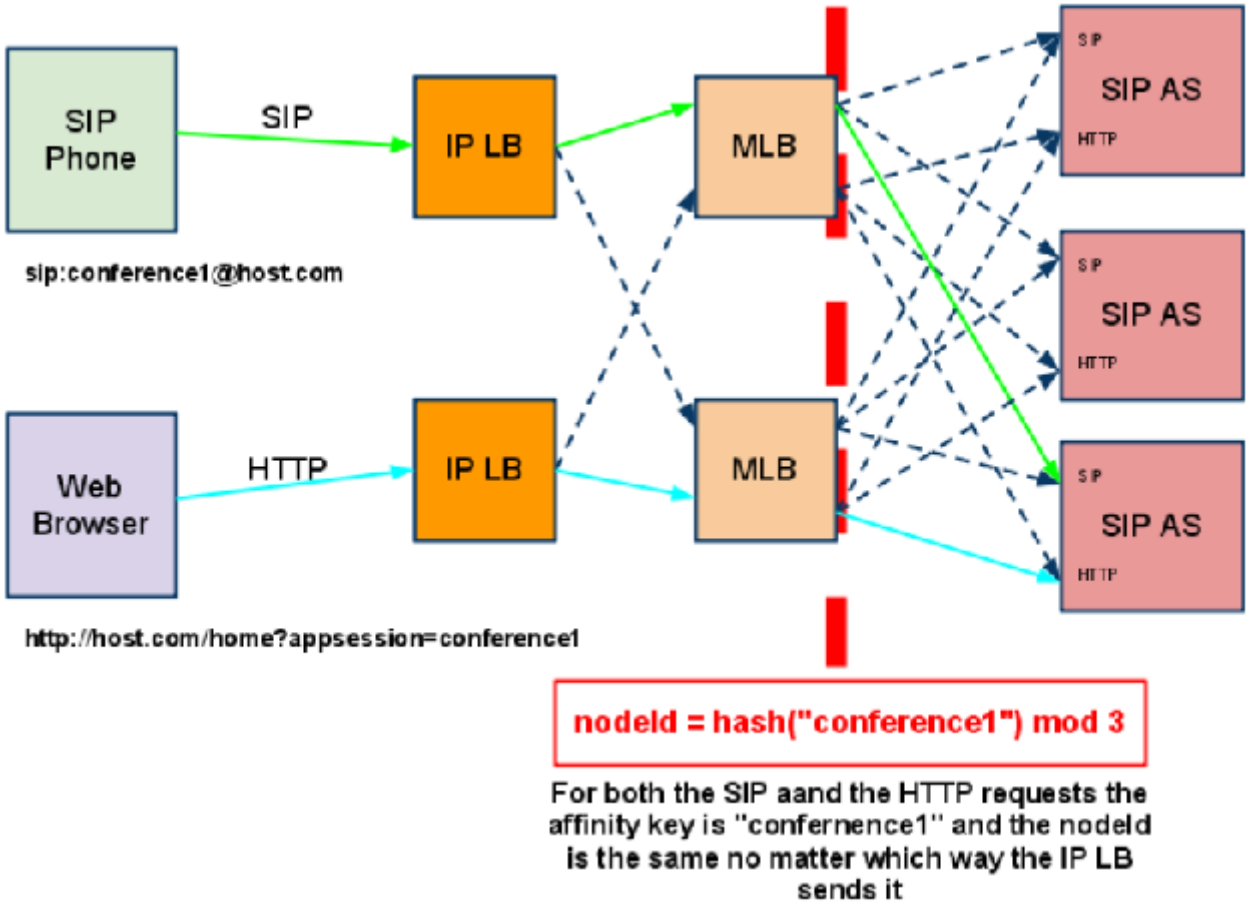

Figure 15. Ensuring SIP and HTTP requests are being grouped by common affinity value.

Running

Procedure: Running the SIP Load Balancer and SIP Server Nodes

1. Start the SIP Load Balancer

   Start the SIP load balancer, ensuring the Configuration Properties file (*lb.properties* in this example) is specified. In the Linux terminal, or using the Windows Command Prompt, the SIP Load Balancer is started by issuing a command similar to this one:

   ```
   java -jar sip-balancer-jar-with-dependencies.jar lb-configuration.properties
   ```

   Executing the SIP load balancer produces output similar to the following example:

```
home]$ java -jar sip-balancer-jar-with-dependencies.jar lb-configuration.properties
Oct 21, 2008 1:10:58 AM org.mobicents.tools.sip.balancer.SIPBalancerForwarder start
INFO: Sip Balancer started on address 127.0.0.1, external port : 5060, port : 5065
Oct 21, 2008 1:10:59 AM org.mobicents.tools.sip.balancer.NodeRegisterImpl
startServer
INFO: Node registry starting...
Oct 21, 2008 1:10:59 AM org.mobicents.tools.sip.balancer.NodeRegisterImpl
startServer
INFO: Node expiration task created
Oct 21, 2008 1:10:59 AM org.mobicents.tools.sip.balancer.NodeRegisterImpl
startServer
INFO: Node registry started
```

The output shows the IP address on which the SIP Load Balancer is listening, as well as the external and internal listener ports.

2. Configure SIP Server Nodes

   SIP Servlets Server nodes can run on the JBoss Application Server, or the Tomcat Servlet Container. The SIP Servlets Server binary distributions define the type of SIP Servlets Server nodes used, and should already be installed from [_sslb_binary_sip_load_balancer_software_prerequisites].

   The Tomcat's *server.xml* or JBoss's *standalone-sip.xml* file specifies the nodes used. Because there is more then one client node specified, unique listener ports must be specified for each node to monitor HTTP and/or SIP connections. Configuring SIP Connectors and Bindings describes the affected element in the configuration file.

3. Start Load Balancer Client Nodes

   Start all SIP load balancer client nodes.

Testing

To test load balancing, the same application must be deployed manually on each node, and two SIP Softphones must be installed.

Procedure: Testing Load Balancing

1. Deploy an Application

   Ensure that for each node, the DAR file is the same.

   Deploy the Location service manually on both nodes.

2. Start the "Sender" SIP softphone

   Start a SIP softphone client with the SIP address of `sip:sender@sip-servlets-com`, listening on port 5055. The outbound proxy must be specified as the sip-balancer (http://127.0.0.1:5060)

3. Start the "Receiver" SIP softphone

Start a SIP softphone client with the SIP address of `sip:receiver-failover@sip-servlets-com`, listening on port 5090.

4. Initiate two calls from "Sender" SIP softphone

   Initiate one call from `sip:sender@sip-servlets-com` to `sip:receiver-failover@sip-servlets-com`. Tear down the call once completed.

   Initiate a second call using the same SIP address, and tear down the call once completed. Notice that the call is handled by the second node.

Stopping

Assuming that you started the JBoss Application Server as a foreground process in the Linux terminal, the easiest way to stop it is by pressing the key combination in the same terminal in which you started it.

This should produce similar output to the following:

```
^COct 21, 2008 1:11:57 AM org.mobicents.tools.sip.balancer.SipBalancerShutdownHook run
INFO: Stopping the sip forwarder
```

Uninstalling

To uninstall the SIP load balancer, delete the JAR file you installed.

5.1.2. IP Load Balancing

IP Load Balancers

An IP load-balancer is a network appliance that distributes traffic to an application server (or actual servers) using a load-balancing algorithm. IP load-balancing is often used when the other load-balancers' capacity is exceeded and can not scale further without hardware upgrades.

Routing decisions are made based on OSI Layer 2, 3 or 4 data. This type of load balancer only examines low-level TCP, UDP or ethernet packet structures including MAC addresses, IP addresses, ports, and protocol types (TCP or UDP or other).

An IP load balancer never reads the payload of the TCP/IP packets and therefore never parses SIP or HTTP (or any protocol above OSI Layer 4). Because an IP load balancing device is not SIP or HTTP aware in any way, it is much more performant than `mod_jk` or the Restcomm SIP load-balancer.

Technical overview

In its simplest form, the IP load-balancer usually "owns" the public-facing IP address (known as a VIP). The traffic is routed to actual servers in it's private network similar to NAT. It is also possible to not change the IP address and just work on the MAC address by assuming that all actual servers are configured to accept packets for the VIP address. The features offered by the IP load balancer

depend largely on the vendor.

Some examples of Linux-based software load balancers include Red Hat Cluster Suite (RHCS) and Linux Virtual Server (LVS). There are many hardware vendors as well.

One main drawback relating to IP load balancers is that they can not make routing decisions based on SIP messages and (with some exceptions) they can not work cooperatively with HTTP or other load balancers.

Configuring Restcomm Cluster for pure IP Load Balancing

Pure IP load balancing is not a recommented option. It is advised to use a distributed load balancer instead. Proper operation with pure IP load balancing depends on the ability of the IP load balancer to establish request affinity based on IP addresses and ports.

First you need to remove the SIP load balancers from any configuration in Restcomm . In particular the `org.mobicents.ha.javax.sip.BALANCERS` attribute in *mss-sip-stack.properties*. You should remove the balancers attribute from the Service tag of jboss.web service. This simply removes the default load balancer from the system and the traffic bypasses the SIP load-balancer. Next you must configure Restcomm to put the IP load balancer IP address in the `Via`, `Contact` and other system headers where the IP address of the server machine is required. This will ensure that any responses or subsequent SIP requests follow the same path, but always hit the load balancer instead of particular cluster node that may fail. To specify the IP load balancer address in Restcomm your should edit this file on Tomcat *CATALINA_HOME/conf/server.xml* and specify `staticServerAddress` such as:

```
<Connector port="5080"
     ipAddress = "${jboss.bind.address}"
     ...
staticServerAddress="122.122.122.122" staticServerPort="44"
useStaticAddress="true"/>
```

and edit this file on JBoss *JBOSS_HOME/standalone/configuration/standalone-sip.xml* and specify `staticServerAddress` such as:

```
<socket-binding name="sip-udp" port="5080"
     ...
staticServerAddress="122.122.122.122" staticServerPort="44"
useStaticAddress="true"/>
```

Depending on your reliability requirements you can omit the configuration described in this section and let the servers use their own IP address in the SIP messages.

5.1.3. SIP Load Balancing Basics

All User Agents send SIP messages, such as `INVITE` and `MESSAGE`, to the same SIP URI (the IP address and port number of the SIP Load Balancer on the WAN). The Load Balancer then parses, alters, and forwards those messages to an available node in the cluster. If the message was sent as a part of an existing SIP session, it will be forwarded to the cluster node which processed that User Agent's original transaction request.

The SIP Server that receives the message acts upon it and sends a response back to the SIP Load Balancer. The SIP Load Balancer reparses, alters and forwards the message back to the original User Agent. This entire proxying and provisioning process is carried out independent of the User Agent, which is only concerned with the SIP service or application it is using.

By using the Load Balancer, SIP traffic is balanced across a pool of available SIP Servers, increasing the overall throughput of the SIP service or application running on either individual nodes of the cluster. In the case of a Restcomm server with `</distributed>` capabilities, load balancing advantages are applied across the entire cluster.

The SIP Load Balancer is also able to failover requests mid-call from unavailable nodes to available ones, thus increasing the reliability of the SIP service or application. The Load Balancer increases throughput and reliability by dynamically provisioning SIP service requests and responses across responsive nodes in a cluster. This enables SIP applications to meet the real-time demand for SIP services.

5.1.4. HTTP Load Balancing Basics

In addition to the SIP load balancing, there are several options for coordinated or cooperative load balancing with other protocols such as HTTP.

Typically, a JBoss Application Server will use apache HTTP server with mod_jk, mod_proxy, mod_cluster or similar extension installed as an HTTP load balancer. This apache-based load balancer will parse incoming HTTP requests and will look for the session ID of those requests in order to ensure all requests from the same session arrive at the same application server.

By default, this is done by examining the `jsessionid` HTTP cookie or GET parameter and looking for the `jvmRoute` assigned to the session. The typical `jsessionid` value is of the form `<sessionId>.<jvmRoute>`. The very first request for each new HTTP session does not have a session ID assigned; the apache routes the request to a random application server node.

When the node responds it assigns a session ID and `jvmRoute` to the response of the request in a HTTP cookie. This response goes back to the client through apache, which keeps track of which node owns each `jvmRoute`. Once the very first request is served this way, the subsequent requests from this session will carry the assigned cookie, and the apache load balancer will always route the requests to the node, which advertised itself as the `jvmRoute` owner.

Instead of using apache, an integrated HTTP Load Balancer is also available. The SIP Load Balancer has a HTTP port where you can direct all incoming HTTP requests. The integrated HTTP load balancer behaves exactly like apache by default, but this behavior is extensible and can be overridden completely with the pluggable balancer algorithms. The integrated HTTP load balancer is much easier to configure and generally requires no effort, because it reuses most SIP settings and

assumes reasonable default values.

Unlike the native apache, the integrated HTTP Load Balancer is written completely in Java, thus a performance penalty should be expected when using it. However, the integrated HTTP Balancer has an advantage when related SIP and HTTP requests must stick to the same node.

5.1.5. Pluggable balancer algorithms

The SIP/HTTP Load Balancer exposes an interface to allow users to customize the routing decision making for special purposes. By default there are three built-in algorithms. Only one algorithm is active at any time and it is specified with the `algorithmClass` property in the configuration file.

It is up to the algorithm how and whether to support distributed architecture or how to store the information needed for session affinity. The algorithms will be called for every SIP and HTTP request and other significant events to make more informed decisions.

Users must be aware that by default requests explicitly addressed to a live server node passing through the load balancer will be forwarded directly to the server node. This allows for pre-specified routing use-cases, where the target node is known by the SIP client through other means. If the target node is dead, then the node selection algorithm is used to route the request to an available node.

The following is a list of the built-in algorithms:

org.mobicents.tools.sip.balancer.CallIDAffinityBalancerAlgorithm

This algorithm is not distributable. It selects nodes randomly to serve a give Call-ID extracted from the requests and responses. It keeps a map with `Call-ID → nodeId` associations and this map is not shared with other load balancers which will cause them to make different decisions. For HTTP it behaves like apache.

org.mobicents.tools.sip.balancer.HeaderConsistentHashBalancerAlgorithm

This algorithm is distributable and can be used in distributed load balancer configurations. It extracts the hash value of specific headers from SIP and HTTP messages to decide which application server node will handle the request. Information about the options in this algorithms is available in the balancer configuration file comments.

org.mobicents.tools.sip.balancer.PersistentConsistentHashBalancerAlgorithm

This algorithm is distributable and is similar to the previous algorithm, but it attempts to keep session affinity even when the cluster nodes are removed or added, which would normally cause hash values to point to different nodes.

org.mobicents.tools.sip.balancer.ClusterSubdomainAffinityAlgorithm

This algorithm is not distributable, but supports grouping server nodes to act as a subcluster. Any call of a node that belongs to a cluster group will be preferentially failed over to a node from the same group. To configure a group you can just add the `subclusterMap` property in the load balancer properties and listing the IP addresses of the nodes. The nodes specified in a group do not have to alive and nodes that are not specified are still allowed to join the cluster. Otherwise the algorthim behaves exactly as the default Call-ID affinity algorthim. The groups are

enclosed in parentheses and the IP addresses are separate by commas as follows:

```
  subclusterMap=( 192.168.1.1, 192.168.1.2 ) ( 10.10.10.10,  20.20.20.20,
30.30.30.30)
```

5.1.6. Distributed load balancing

When the capacity of a single load balancer is exceeded, multiple load balancers can be used. With the help of an IP load balancer the traffic can be distributed between all SIP/HTTP load balancers based on some IP rules or round-robin. With consistent hash and `jvmRoute`-based balancer algorithms it doesn't matter which SIP/HTTP load balancer will process the request, because they would all make the same decisions based on information in the requests (headers, parameters or cookies) and the list of available nodes. With consistent hash algorithms there is no state to be preserved in the SIP/HTTP balancers.

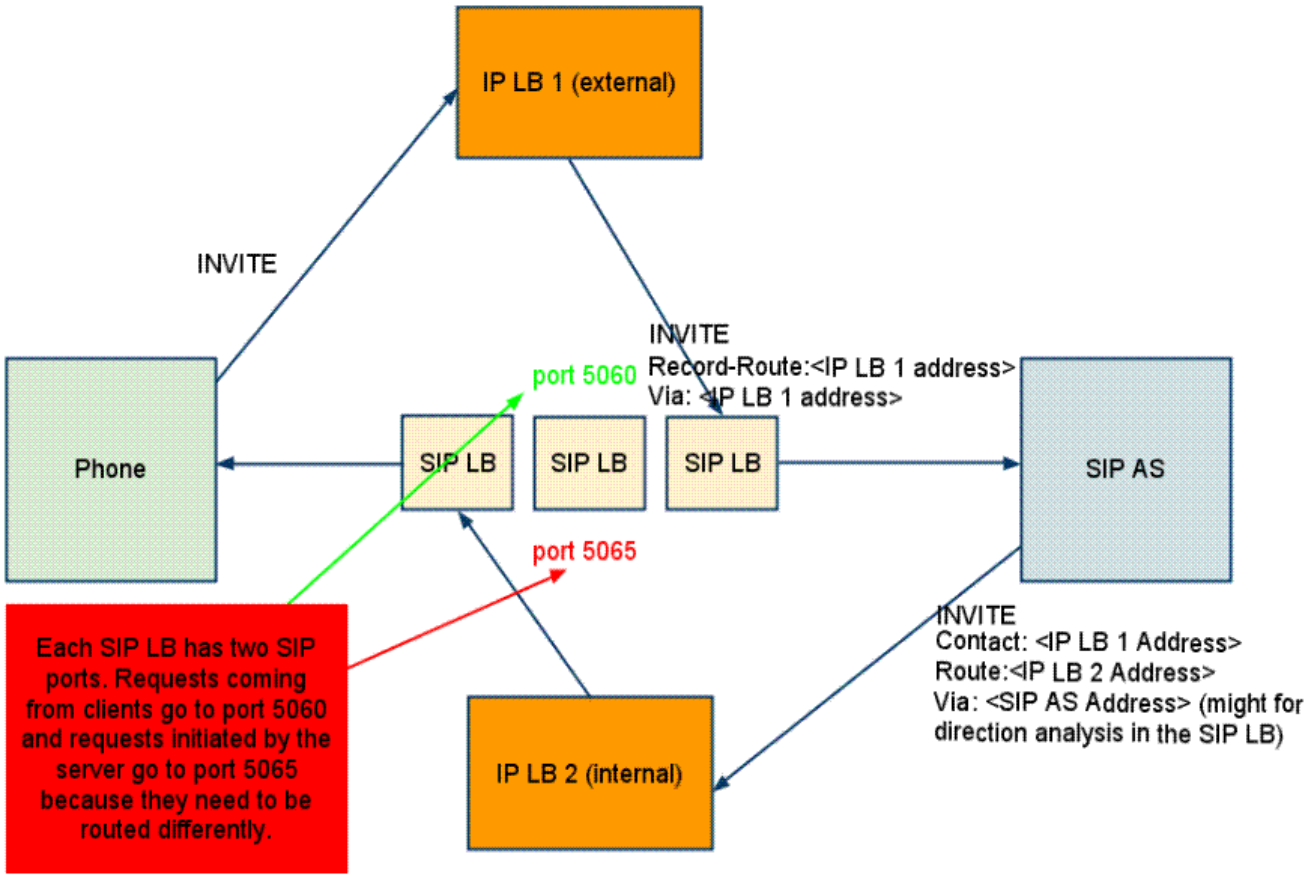

Figure 16. Example deployment: IP load balancers serving both directions for incoming/outgoing requests in a cluster

5.1.7. Implementation of the Restcomm Load Balancer

Each individual Restcomm SIP Server in the cluster is responsible for contacting the SIP load balancer and relaying its health status and regular "heartbeats".

From these health status reports and heartbeats, the SIP Load Balancer creates and maintains a list of all available and healthy nodes in the cluster. The Load Balancer forwards SIP requests between these cluster nodes, providing that the provisioning algorithm reports that each node is healthy and

is still sending heartbeats.

If an abnormality is detected, the SIP Load Balancer removes the unhealthy or unresponsive node from the list of available nodes. In addition, mid-session and mid-call messages are failed over to a healthy node.

The SIP Load Balancer first receives SIP requests from endpoints on a port that is specified in its Configuration Properties configuration file. The SIP Load Balancer, using a round-robin algorithm, then selects a node to which it forwards the SIP requests. The Load Balancer forwards all same-session requests to the first node selected to initiate the session, providing that the node is healthy and available.

5.1.8. SIP Message Flow

The SIP Load Balancer appends itself to the `Via` header of each request, so that returned responses are sent to the SIP Balancer before they are sent to the originating endpoint.

The Load Balancer also adds itself to the path of subsequent requests by adding Record-Route headers. It can subsequently handle mid-call failover by forwarding requests to a different node in the cluster if the node that originally handled the request fails or becomes unavailable. The SIP load balancer immediately fails over if it receives an unhealthy status, or irregular heartbeats from a node.

In advanced configurations, it is possible to run more than one SIP Load Balancer. Simply edit the balancers connection string in your SIP Server - the list is separated with semi-colon.

Basic IP and Port Cluster Configuration describes a basic IP and Port Cluster Configuration. In the diagram, the SIP Load balancer is the server with the IP address of `192.168.1.1`.

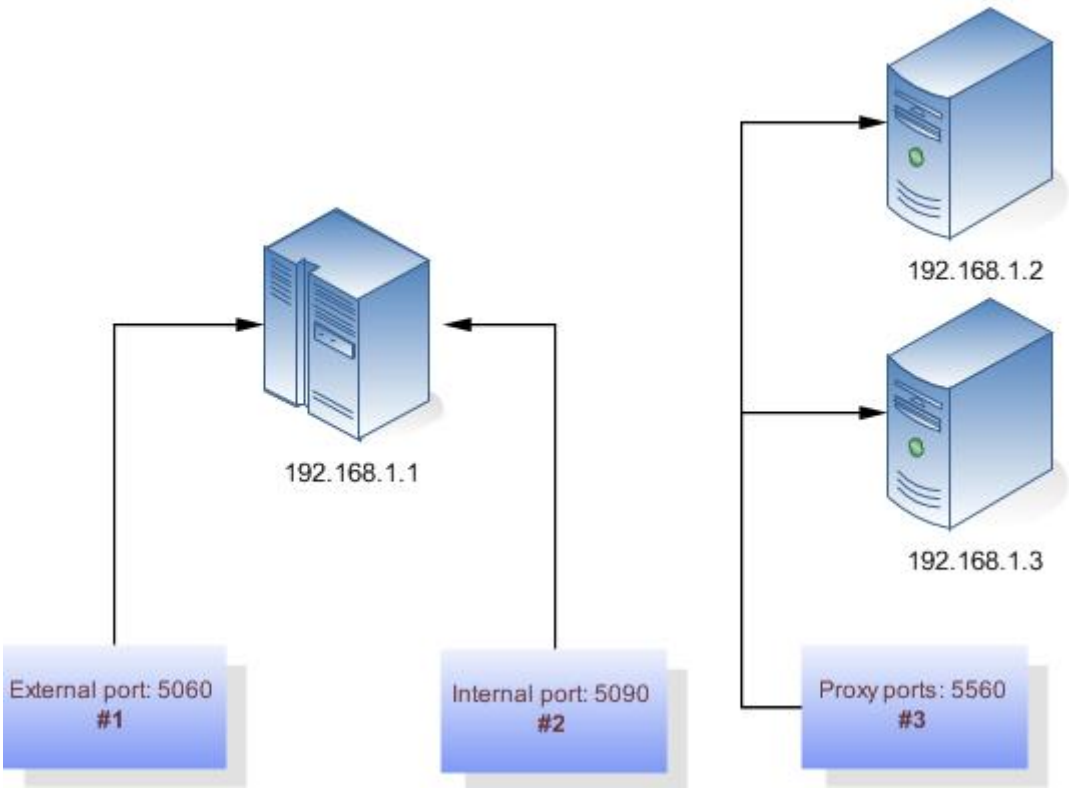

Figure 17. Basic IP and Port Cluster Configuration

5.2. Restcomm Graceful Shutdown

Graceful shutdown of a server or SIP/Web Applications is when existing request/connections/sessions are allowed to gracefully complete while no new requests and/or connections and/or sessions are accepted. SIP Servlets Container or Applications can be gracefully shutdown through the Management Console, JMX or CLI as described below

As soon as the shutdown command is given, the container will stop the applications so that they do not accept any more inbound connections. It will inform also load balancers that the server is no longer part of the cluster if the command is given on the container and not an individual application. The Applications are closed so that they do not accept any more requests, but the requests currently inside the container will drain out and the Server instance will shutdown after the grace period expires.

5.2.1. Graceful Shutdown through Restcomm SIP Servlets Management Console

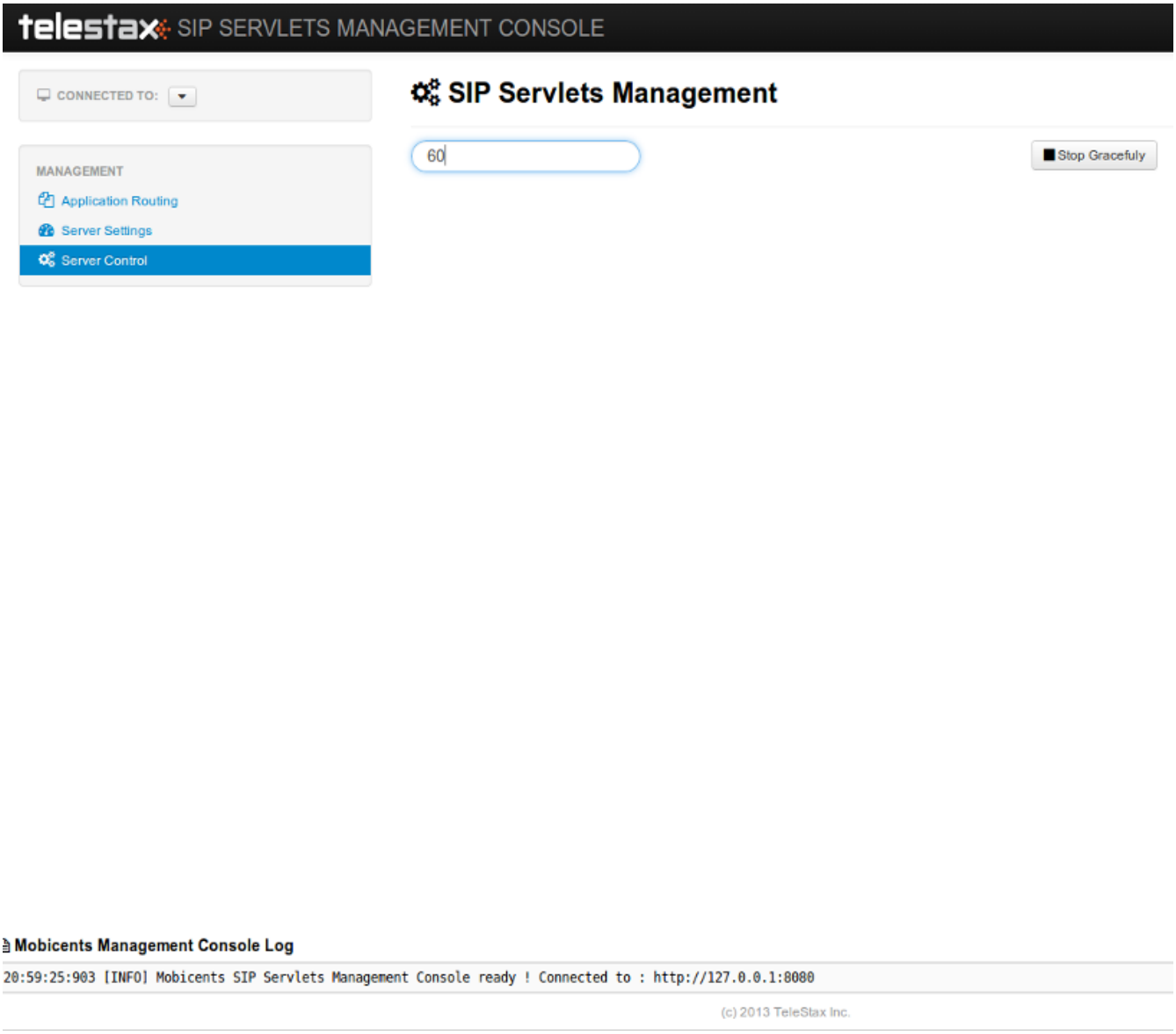

Figure 18. Graceful Shutdown of Container through Restcomm SIP Servlets Management Console

5.2.2. Graceful Shutdown of Container or Applications through Restcomm JBoss AS/EAP Command Line Interface

`To Gracefully shutdown an Application through the CLI `, use the following command

```
sh bin/jboss-cli.sh --connect
/subsystem=sip:contextGracefulShutdown\(timeToWait=30000,sipApp=appNameFromDeploymentD
escriptor)
```

`To Gracefully shutdown an Application through the CLI `, use the following command

```
sh bin/jboss-cli.sh --connect  /subsystem=sip:gracefulShutdown\(timeToWait=30000\)
```

5.2.3. Graceful Shutdown of Container or Applications through Restcomm SIP Servlets JMX Console

`To Gracefully shutdown an Application through the JMX Console, Find the 'SipManager' MBean corresponding to your application and go to the 'stopGracefully' operation, Fill out the 'Time To Wait' Field and click 'Invoke' Button `

`To Gracefully shutdown the Container through the JMX Console, Find the 'jboss.web:type=SipApplicationDispatcher' MBean and go to the 'stopGracefully' operation, Fill out the 'Time To Wait' Field and click 'Invoke' Button `

Chapter 6. Enterprise Monitoring and Management

There is two ways of monitoring Restcomm Sip Servlets :

- Through JMX
- Through the industry standard Simple Network Management Protocol - SNMP
- Through the Restcomm Sip Servlets Management Console.

6.1. JMX Monitoring

The default mechanism for monitoring Restcomm Sip Servlets is using the Java Management Extensions (JMX) technology. The Oracle website includes the list of options and how to configure JMX Remote on Java 7 http://docs.oracle.com/javase/7/docs/technotes/guides/management/agent.html

Please find below, the list of SIP Specific metrics that can be monitored through JMX

6.1.1. SIP Stack Monitoring Metrics

JMX Name `Domain=org.mobicents.jain.sip,name=Mobicents-SIP-Servlets,type=sip-stack` provides the following metrics :

- `NumberOfClientTransactions` : Active number of SIP Client Transactions.
- `NumberOfServerTransactions` : Active number of SIP Server Transactions.
- `NumberOfDialogTransactions` : Active number of SIP Dialogs.
- `LocalMode` : whether the stack is using replication or not.

6.1.2. Container SIP Core Router (SipApplicationDispatcher) Monitoring Metrics

JMX Name `Domain=<server_name>,type=SipApplicationDispatcher` provides the following metrics :

- `RequestsProcessedByMethod` : Number of incoming SIP requests that have been processed by SIP Method name (INVITE, BYE, INFO, ...).
- `ResponsesProcessedByStatusCode` : Number of incoming SIP responses that have been processed by status code (1xx, 2xx, 3xx, ...).
- `RequestsSentByMethod` : Number of outgoing SIP requests that have been sent by SIP Method name (INVITE, BYE, INFO, ...).
- `ResponsesSentByStatusCode` : Number of outgoing SIP responses that have been sent by status code (1xx, 2xx, 3xx, ...).

6.1.3. Application Level Monitoring Metrics

JMX Name `Domain=<server_name>,path=<application_context_name>,type=SipManager,host=<host_name>` provides the following metrics :

- `expiredSipSessions` : Number of SIP sessions that have expired
- `expiredSipApplicationSessions` : Number of SIP Application sessions that have expired
- `sipSessionAverageAliveTime` : the average time (in seconds) that expired SIP sessions had been alive.
- `sipApplicationSessionAverageAliveTime` : the average time (in seconds) that expired SIP Application sessions had been alive.
- `sipSessionCounter` : Number of SIP Sessions created.
- `sipApplicationSessionCounter` : Number of SIP Application Sessions created.
- `activeSipSessions` : Number of currently active SIP Sessions.
- `activeSipApplicationSessions` : Number of currently active SIP Application Sessions.
- `rejectedSipSessions` : Number of SIP session creations that failed due to maxActiveSipSessions.
- `rejectedSipApplicationSessions` : Number of SIP Application session creations that failed due to maxActiveSipApplicationSessions.
- `numberOfSipSessionCreationPerSecond` : Number of SIP sessions per second that have been created.
- `numberOfSipApplicationSessionCreationPerSecond` : Number of SIP Application sessions per second that have been created.

6.1.4. JMX Monitoring for Restcomm for JBoss AS7/EAP6

Follow the link To Connect JConsole to JMX on AS7/EAP6.

SNMP Monitoring for Restcomm for JBoss AS7

The SNMP feature is not yet implemented in Restcomm for JBoss AS7. This guide will be updated when SNMP monitoring feature become available. In the meantime, see the chapter below for information about the CLI.

Getting Started with Restcomm SIP Servlets for AS7 CLI

6.1.5. JMX Monitoring for Restcomm for Tomcat 7

Follow the link To Connect JConsole to JMX on Tomcat 7.

SNMP Monitoring for Restcomm for Tomcat 7

The SNMP feature is not yet implemented in Restcomm for Tomcat 7. This guide will be updated when SNMP monitoring feature become available.

Chapter 7. Security

The information present in SIP requests often contains sensitive user information. To protect user information, SIP Security can be enabled on the server, and within the SIP application to mitigate the risk of unauthorised access to the information.

There are essentially two levels of security that can be enabled on the server, the communication between the server and other SIP entities and securing the application and its content.

7.1. SIP Servlets Application Security

Application security varies depending on the server type used. The following procedures describe how to configure the JBoss AS7 and Tomcat servers to enable Security.

Procedure: Enable SIP Application Security in JBoss AS7

1. Add Security Policy to Server Configuraton
    a. Open the configuration file located in `$JBOSS_HOME/standalone/configuration/standalone-sip.xml`
    b. Append a security domain to the under the `<security-domains>`:

```
<security-domain name="sip-servlets">
    <authentication>
        <login-module code="UsersRoles" flag="required">
            <module-option name="usersProperties"
value="${jboss.server.config.dir}/sip-servlets-users.properties"/>
            <module-option name="rolesProperties"
value="${jboss.server.config.dir}/sip-servlets-roles.properties"/>
            <module-option name="hashAlgorithm" value="MD5"/>
            <module-option name="hashEncoding" value="RFC2617"/>
            <module-option name="hashUserPassword" value="false"/>
            <module-option name="hashStorePassword" value="true"/>
            <module-option name="passwordIsA1Hash" value="true"/>
            <module-option name="storeDigestCallback"
value="org.jboss.security.auth.callback.RFC2617Digest"/>
        </login-module>
    </authentication>
</security-domain>
```

2. Create SIP Server User Properties File
    a. Open a terminal and navigate to the `$JBOSS_HOME/standalone/configuration` directory:

```
home]$ cd standalone/configuration
```

    b. Create and open a `sip-servlets-users.properties` file and append the user lines to the file:

```
# A sample users.properties file, this line creates user "admin" with
# password "admin" for "sip-servlets-realm"
admin=<A1_cryptographic_string>
```

c. To create <A1_cryptographic_string>, execute the following command in a terminal:

```
home]$ java -cp ../../modules/system/layers/base/org/picketbox/main/picketbox-
4.0.15.Final.jar org.jboss.security.auth.callback.RFC2617Digest admin sip-
servlets <password>
```

d. Copy the A1 hash, and paste it into the admin parameter in the previous step.

e. Save and close `sip-servlets-users.properties`.

3. Create the SIP Server Roles File

a. Create and open `sip-servlets-roles.properties` (using your preferred editor) and append the following information to the file:

```
# A sample roles.properties file for use with some roles
# Each line in this file assigns roles to the users defined in
# sip-servlets-users.properties
admin=caller,role1,role2,..
```

4. Add the Security Domain to the SIP Application

a. Open the `jboss-web.xml` file for the SIP application to which security is required.

b. Add the element as a child of the element:

```
<jboss-web>
      <security-domain>sip-servlets</security-domain>
</jboss-web>
```

5. Add Security Constraints to the SIP Application

a. Open the `sip.xml` file for the SIP application.

b. Add the element as a child of the element:

```
<security-constraint>
    <display-name>REGISTER Method Security Constraint</display-name>
    <resource-collection>
        <resource-name>SimpleSipServlet</resource-name>
        <description>Require authenticated REGSITER requests</description>
        <servlet-name>SimpleSipServlet</servlet-name>
        <sip-method>REGISTER</sip-method>
    </resource-collection>
    <auth-constraint>
        <role-name>caller</role-name>
    </auth-constraint>
</security-constraint>

<login-config>
    <auth-method>DIGEST</auth-method>
    <realm-name>sip-servlets</realm-name>
 </login-config>
```

Procedure: Enable SIP Application Security in Tomcat Server

1. Activate the Memory Realm in Catalina:
   a. Open a terminal and navigate to the */conf* directory:

```
home]$ cd server/default/<tomcat_home>/conf/
```

   b. Open `server.xml` and uncomment the following line:

```
<!--<Realm className="org.apache.catalina.realm.MemoryRealm"/>-->
```

2. Update SIP Server User Properties File
   a. In the */conf* directory, open `tomcat-users.xml` (using your preferred editor) and append the following child element:

```
<user name="user" password="password" roles="caller"/>
```

3. Add Security Constraints to the SIP Application
   a. Open the `sip.xml` file for the SIP application to which security is required.
   b. Add the child element to the element:

```
<security-constraint>
  <display-name>REGISTER Method Security Constraint</display-name>
  <resource-collection>
    <resource-name>SimpleSipServlet</resource-name>
    <description>Require authenticated REGISTER requests</description>
    <servlet-name>SimpleSipServlet</servlet-name>
    <sip-method>REGISTER</sip-method>
  </resource-collection>
  <auth-constraint>
    <role-name>caller</role-name>
  </auth-constraint>
</security-constraint>
<login-config>
  <auth-method>DIGEST</auth-method>
  <realm-name>sip-servlets-realm</realm-name>
</login-config>
```

7.2. TLS

In order to configure TLS you will have to obtain a public/private key, a X.509 certificate, add those to the Java keystore and optionally add certificates from a known CA (certicate authority). The entire process can be confusing but in order to get a basic setup for testing purposes up and running with minimal effort, this section starts off with a simple quick start. However, for production environment you need to obtain an officially signed certificate from a known CA and that process is outlined in section Production Setup.

7.2.1. Quick Start

This section shows how to create a self signed certificate, how to add that to the Java keystore and how to configure the SIP Servlet Container to make use of this configuration. Note, this section should only be used in a development environment and the main reason for this quickstart section is to get you going right away as well as get you comfortable with generating keys and certificates and adding them to the Java keystore.

Procedure: Server Side Authentication

At a high-level, we will execute the following three steps:

1. Generate a public/private key pair and a self signed certificate and add those to the Java keystore.
2. Configure the SIP Servlet Container to load our certificate from the keystore.
3. Test!

Let's follow each step in order:

1. Generate certificate

Generating a new key-pair and a certificate can be done in a few different ways with a few different tools but here we will just use the java keytool that comes with the JDK. Simple issue the following command, which will generate a new public and private key, generate a self-signed certificate and add it all to the Java keystore:

```
keytool -genkeypair -alias myserver -keyalg RSA -keysize 1024 -keypass secret
-validity 365 -storetype jks -keystore myserver.jks -storepass secret -v -dname
"CN=James Smith, OU=Engineering, O=My Company, L=My City, S=My State, C=US"
```

-keystore specifies which keystore we should use/update. If the keystore doesn't exist, a new one will be created for one. In the above example, we named the keystore `myserver.jks` and it will be saved in the current directory

-keypass and -storepass should be chosen wisely since with bad passwords you won't have much protection anyway. Also, normally you should never passwords on the command prompt, it is too easy for other people to steal. If you leave these two options out, the keytool command will ask you for it.

-keyalg specifies which algorithm to use when generating the keys and the keysize how long those keys should be.

Note: the command -genkeypair is new in JDK 6 and was previously named -genkey. The keytool in JDK 6 has some improvements over the previous versions so it is recommended to use it instead.

See more about the Java keytool here: http://docs.oracle.com/javase/6/docs/technotes/tools/solaris/keytool.html

2. Configure the SIP Servlet Container

The SIP Servlet Container relies on the JAIN SIP stack to support it with TLS capabilities. As such, it is the JAIN SIP stack that we need to configure to have it read our certificate we added to the key store. The various configuration options are described in the javadoc of the SipStackImpl class but for this quickstart, we will be using the following ones:

- `javax.net.ssl.keyStore` – the filename and location of the keystore to use.
- `javax.net.ssl.keyStorePassword` – the password to the keystore.
- `javax.net.ssl.trustStore` – the filename and location of the truststore to use.
- `javax.net.ssl.trustStorePassword` – the password to the truststore.
- `gov.nist.javax.sip.TLS_CLIENT_AUTH_TYPE` – which type of authentication we will require of the client (for now, the client authentication type will be set to Disabled).

  The configuration options are JVM parameters and you will have to add these to the command line when you start the server:

```
./bin/run.sh -Djavax.net.ssl.keyStorePassword=mysecret
-Dgov.nist.javax.sip.TLS_CLIENT_AUTH_TYPE=Disabled
-Djavax.net.ssl.keyStore=/path/to/your/keystore/myserver.jks
-Djavax.net.ssl.trustStorePassword=mysecret
-Djavax.net.ssl.trustStore=/path/to/your/keystore/myserver.jks
```

Once the server is up, we are ready to verify that we can get a TLS connection using the certificate we previously added in the first step.

for this first part of the quickstart we will not require a certificate from the client since this involves more configuration. This is controlled by the `gov.nist.javax.sip.TLS_CLIENT_AUTH_TYPE parameter`.

3. Test!

To verify your setup there are a few different tools that you can use.

- openssl is an open source SSL toolkit and contains a generic SSL/TLS test client
- SIPp – an open source SIP load testing tool that is capable of using TLS. However, it requires some additional steps that we have not addressed in the first parf of this quickstart so therefore we willl not be using SIPp.
- Using your favorite SIP client. Most SIP clients out there are capable of establishing a TLS connection but you will have to consult its documentation of how to configure TLS.

Using openssl:

Assuming that your server is running on localhost and is listening for TLS on port 5081 the command would be:

```
openssl s_client -host 127.0.0.1 -port 5081
```

If you are successful you should see an output from openssl displaying information about the server certificate (which should be the one we generated in Step 1). If there are any issues with the setup, openssl is pretty good about giving out information about what it thinks is wrong.

Tip: if you add the following JVM parameter as well you will get a lot of useful debug information: `-Djavax.net.debug=ssl`

Procedure: Server Side Authentication

In the first part of this quickstart we generated a public and private key along with a self-signed certificate and added them all into the Java keystore. The server was then configured to use this information and when a client connected, our certificate was served up to the client. However, normally, the client and the server would like to verify each others certificate to make sure they both trust each other and if not, either of them will terminate the connection. In the first part of the

quickstart, the server did not require the client to present a certificate when connecting (remember that we set the `gov.nist.javax.sip.TLS_CLIENT_AUTH_TYPE` to disabled) so let's do that now.

At a high-level, these are the tasks we need to execute:

1. Generate a public/private key pair for the client along with a certificate.
2. The server need to add the client certificate to its keystore as a trusted certificate.
3. Start the server with client authenticating enabled.

Let's follow each step in order:

1. Generate Client Certificate

   We will use the Java keytool for this step in the same we did for for the server side in the previous quikstart. The command is exactly the same and the only difference is that we store the information in a new keystore called `myclient.jks`.

   ```
   keytool -genkeypair -alias myclient -keyalg RSA -keysize 1024 -keypass secret
   -validity 365 -storetype jks -keystore myclient.jks -storepass secret -v -dname
   "CN=John Doe, OU=Engineering, O=Some Work, L=Some City, S=Some State, C=US"
   ```

   We have now generated a new keystore containing the clients authentication information. However, the server needs to import the client certificate into its trusted keystore so we need to extract the certificate out of the client key store. This can also be done using the Java keytool.

   ```
   keytool -exportcert -alias myclient -file client.cert -keystore myclient.jks
   -storepass secret -rfc
   ```

   The certificate is saved in file 'client.cert' and we will use this file in the next step.

2. Re-configure the server

   Simply change the `gov.nist.javax.sip.TLS_CLIENT_AUTH_TYPE` from 'Disabled' to 'Enabled' and start the server again.

3. Test

   We will once again use openssl to verify our setup but now that the client will be forced to present a certificate as well, we do need the certificate's private key as well. The private key is embedded into the keystore and was generated when we issued the 'kenkeypair' keytool-command. Unfortunately, the keytool does not have an option for exporting the private key so we will have to write a small java program to extract it for us. Luckily, it is not a lot of code:

```
import java.io.FileInputStream;
    import java.security.Key;
    import java.security.KeyStore;
    import sun.misc.BASE64Encoder;

    /**
     * Code originally posted on Sun's developer forums but
     * can now only be found at stackoverflow:
     * http://stackoverflow.com/questions/150167/how-do-i-list-export-private-keys-
from-a-keystore
     */
    public class DumpPrivateKey {

        static public void main(String[] args)
        throws Exception {
            if(args.length < 3) {
            throw new IllegalArgumentException("expected args: Keystore filename,
Keystore password, alias, <key password: default same than keystore");
            }
            final String keystoreName = args[0];
            final String keystorePassword = args[1];
            final String alias = args[2];
            final String keyPassword = getKeyPassword(args,keystorePassword);
            KeyStore ks = KeyStore.getInstance("jks");
            ks.load(new FileInputStream(keystoreName),
keystorePassword.toCharArray());
            Key key = ks.getKey(alias, keyPassword.toCharArray());
            String b64 = new BASE64Encoder().encode(key.getEncoded());
            System.out.println("-----BEGIN PRIVATE KEY-----");
            System.out.println(b64);
            System.out.println("-----END PRIVATE KEY-----");
        }

        private static String getKeyPassword(final String[] args, final String
keystorePassword)
        {
        String keyPassword = keystorePassword; // default case
        if(args.length == 4) {
            keyPassword = args[3];
        }
        return keyPassword;
        }
        }
```

Copy and paste the above code into a file call DumpPrivateKey.java and then compile it:

```
javac DumpPrivateKey.java
```

and then use it to extract the private key:

```
java DumpPrivateKey myclient.jks secret myclient > clientprivate.key
```

Now that we have the private key of the client we can use openssl to verify the setup again:

```
openssl s_client -host 127.0.0.1 -port 5081 -cert client.cert -certform PEM -key
clientprivate.key
```

If all goes well you should successfully establish a connection and openssl will dump information about the certificate exchange.

7.2.2. Production Setup

In a production environment it is important that you run with an officially signed certificate from a known CA. It is this certificate that you will load into your keystore and the process is very similar to the one outlined in the quick start.

1. Generate a PKCS#12 Storage

   Assuming that you already have a private key and a signed certificate from a known CA you first have to wrap these two into a pkcs#12 storage (pkcs#12 is a file format for storing X.509 public certificates along with the private key), and then load that into the Java keystore. To create a pkcs#12 storage you can use the openssl pkcs12 command:

   ```
   openssl pkcs12 -inkey myprivate.key -in mycertificate.pem -export -out
   mystorage.pkcs12 -passout mysecret
   ```

   where myprivate.key is the private key, `mycertificate.pem` is the X.509 certificate. The password for the storage is 'mysecret' and the name of the storage file is `mystorage.pkcs12`.

2. Generate the Java Keystore

   Once the pkcs#12 has been created, use the Java keytool to load the pkcs12 storage and convert it into a java keystore.

   ```
   keytool -importkeystore -srckeystore mystorage.pkcs12 -srcstoretype PKCS12
   -destkeystore myserver.jks -deststorepass mysecret -srcstorepass mysecret
   ```

   A few things to point out:

   -srcstoretype is important and tells the Java keytool which format the key store that we are importing is in. In the previous step, we generated a pkcs#12 store so in this example, the store type must be PKCS12.

   -srcstorepass is the password for the pkcs#12 storage and in the above example it is the same as

the destination key store (-deststorepass) but most likely they will be different.

3. Re-configure and Test

   Now that we have a java keystore the server configuration is exactly the same as described in the quick start, i.e., simply set the java properties `javax.net.ssl.keyStore` and `javax.net.ssl.trustStore` to point to this key keystore file and then set the password through the property `javax.net.ssl.keyStorePassword` and `javax.net.ssl.trustStorePassword`. Once the server has been re-started you can use openssl to verify the setup.

7.2.3. Production Setup

In addition to securing your SIP TLS, you may want to secure your HTTPS and SIP Over WebSockets Connectors too.

1. Secure HTTPS on JBoss 7/EAP 6

   Assuming that you already followed the previous steps, you now have a private key and a self signed certificate. You will need to configure your `$JBOSS_HOME/standalone/configuration/standalone-sip.xml` to enable HTTPS connector:

```
            <subsystem xmlns="urn:jboss:domain:web:1.4" default-virtual-
server="default-host" native="false">
            <connector name="http" protocol="HTTP/1.1" scheme="http" socket-
binding="http"/>
        <connector name="https" protocol="HTTP/1.1" scheme="https" socket-
binding="https" secure="true">
        <ssl protocol="TLSv1,TLSv1.1,TLSv1.2" certificate-key-
file="/path/to/myserver.jks" certificate-file="/path/to/myserver.jks"
password="secret"/>
        </connector>
```

2. Add SIP Over WebSockets Secure Connector

   Make sure the following connector is present in `$JBOSS_HOME/standalone/configuration/standalone-sip.xml`

```
<connector name="sip-wss" protocol="SIP/2.0" scheme="sip" socket-binding="sip-
wss"/>
```

   Make sure the following socket-binding is present in `$JBOSS_HOME/standalone/configuration/standalone-sip.xml`

```
<socket-binding name="sip-wss" port="5083"/>.
```

3. For self-signed certificates, import the pkcs file to your Browser

To make that the WebSockets connection is not refused with a self-signed certificate, you need to import the pkcs file generated in 7.2.2 to Google Chrome (Settings ⇒ Show Advanced Settings ⇒ Manage Certificates Button, then import your mystorage.pkcs12 file) or Firefox.

4. Test!

   Go to your WebRTC favorite example through https://localhost:8443/webrtc/, and use wss://localhost:5083 to connect over Secure SIP Over WebSockets.

Chapter 8. Advanced Features of the SIP Servlets Server

The advanced features of SIP Servlets include Concurrency and Congestion Control, load balancing and clustering support with the Restcomm Load Balancer.

8.1. Media Support

Restcomm SIP Servlets provides support for applications to set up calls through SIP by implementing the SIP Servlets 1.1 Specification.

As most Telco services have the need for managing and controlling media (for example, to play announcements, mix calls and recognize DTMF), Restcomm SIP Servlets allows applications to control media through JSR 309.

8.1.1. JSR 309: Media Server Control API

This specification is a protocol agnostic API for Media Server Control. It provides a portable interface to create media rich applications with IVR, Conferencing, Speech Recognition, and similar features.

Restcomm Media Server provides an implementation of the JSR 309 specification using the MGCP protocol, to allow any Media Server (located in the same Virtual Machine or on a remote server) supporting MGCP to be controlled.

The following examples demonstrate its usage:

- Media Example : a SIP Servlet application showing how to use media capabilities (Media playback, Recording, Text to Speech with FreeTTS and DTMF detection).
- Conference Demo : a Conference Media Server demo application built on GWT with server-push updates.
- Shopping Example : a Converged JEE Application showing SEAM integration, JEE, Media integration with TTS and DTMF support.

8.2. Concurrency and Congestion Control

Concurrency and Congestion control refer to settings that define the way in which messages are processed under heavy load. The way Restcomm SIP Servlets Server processes messages in a production environment is crucial to ensure quality of service for customers.

Concurrency control mode tuning affects the way in which the SIP Servlets Server processes messages, whereas Congestion Control tuning affects the point at which the server begins rejecting new requests. Both of these parameters can be set using the following methods:

- Through the SIP Servlets Management Console.
- Editing the server's *server.xml* or *standalone-sip.xml* configuration file.

- From the `dispatcher` MBean.
- From the Embedded Jopr integrated management platform.

Concurrency Control

The JSR 289 expert group does not specify how concurrency control should be implemented.

Restcomm SIP Servlets for JBoss and Restcomm SIP Servlets for Tomcat have concurrency control implemented as a configurable mode, which defines the way in which the SIP Servlets Server processes messages.

It has to be noted that this concurrency control mechanism is not cluster aware and will work per node only, it is not a cluster wide lock.

The following modes are provided, and cater for the particular setup required in an implementation:

None

All SIP messages are processed as soon as possible in a thread from the global thread pool.

Transaction

Bypass the SIP Servlets request/response executors, and utilize the JAIN SIP built-in Transaction serialization to manage race conditions on the same transaction.

SipSession

SIP messages are processed as soon as possible except for messages originating from the same `SipSession`. These messages are excluded from any simultaneous processing.

SipApplicationSession

SIP messages are processed as soon as possible, with the guarantee that no two messages from the same `SipSession` *or* from the same `SipApplicationSession` will ever be processed simultaneously. Of all the available methods, this mode is the best choice for guaranteed thread-safety.

Congestion Control

Restcomm Sip Servlets currently provides the following congestion control mechanisms:

Changing Congestion Control Settings

All the settings and congifurations starting with gov.nist.javax.sip are located in the $JBOSS-HOME/standalone/configuration/mss-sip-stack.properties file. The section below will provide further details.

- Congestion control is largely application-specific and it is implemented in a pipeline. First messages arrive in the JAIN SIP message queue where they will wait on the locks needed before they can be processed. To avoid keeping too many messages in the queue and potentially running out of memory, older messages are discarded without any error indication. This prevents spam and flood DoS attacks to accumulate large backlog and render the server unresponsive. It also guranatees flood recovery time of 20 seconds or less, in the mean time retransmissions are already queuing so that normal SIP calls can continue without dropping

them. After the request has passed the first queue it enters the SIP transaction layer where there is a customizable optional congestion control logic. There is one packaged congestion control algorithm which can be enabled by setting the following property `gov.nist.javax.sip.SIP_MESSAGE_VALVE=gov.nist.javax.sip.stack.CongestionControlMessageValve`. For this algorithm you can set the limit value by the following property `gov.nist.javax.sip.MAX_SERVER_TRANSACTIONS=2000`. You can also implement your own algorithm and change the class name in `gov.nist.javax.sip.SIP_MESSAGE_VALVE` to activate it.

There is also another optional legacy congestion control stage with another queue where messages can be discarded based on dynamic parameters such as available JVM heap memory or number of messages in the queue. This method will be deprecated and is not recommended. All SIP messages which cannot be processed immediately are put into a queue, and wait for either a free thread or for the lock on their session to be released. The size of the SIP message queue is a tunable parameter, which defaults to `1500`.

- If the SIP Message queue becomes full, the container immediately begins rejecting new SIP requests until the queue clears. This is achieved by using one of the following methods:
  - Sending a `503` SIP error code to the originating application.
  - Dropping incoming messages (according to the specified congestion control policy).
- If the container exceeds the configurable memory threshold (90% by default), new SIP requests are rejected until the memory usage falls below the specified memory threshold. This is achieved by using one of the following methods:
  - Sending a `503` SIP error code to the originating application.
  - Dropping incoming messages (according to the specified congestion control policy).

A background task gathers information about the current server congestion. The data collection interval can be adjusted, and congestion control deactivated, by setting the interval to 0 or a negative value.

The congestion control policy defines how an incoming message is handled when the server is overloaded. The following parameters are configurable:

- DropMessage - drop any incoming message
- ErrorResponse - send a 503 - Service Unavailable response to any incoming request (Default).

Configuring the Concurrency and Congestion Control Settings

The concurrency and congestion control settings can be configured through the SIP Servlets Management Console, using the following methods:

- Through the SIP Servlets Management Console.
- Editing the server's *server.xml* or the *standalone-sip.xml* configuration file.
- From the `dispatcher` MBean.
- From the Embedded Jopr integrated management platform.

Tuning Parameters with the SIP Servlets Management Console

The easiest way to configure the SIP Message Queue Size and Concurrency Control Mode tunable parameters is to open the `SIP Servlets Management Console` in your browser (by going to http://localhost:8080/sip-servlets-management), making your changes, and then clicking button **Apply**.

Figure 19. SIP Servlets Management Console Concurrency and Congestion Control Tuning Parameters

Concurrency and congestion control settings altered through the SIP Servlets Management Console are not saved to the server.xml on Tomcat, only on JBoss AS7 through the standalone-sip.xmlconfiguration file. To make settings persistent, append the settings to the server.xml file directly.

Making your changes permanent in standalone-sip.xml or server.xml by manual editing

Alternatively, you can edit your server's *standalone-sip.xml* or *server.xml* configuration file, which has the benefit of making your chosen settings changes permanent for Tomcat. Instructions follow, grouped by the SIP Servlets Server you are running:

Procedure: Tuning RestComm SIP Servlets for JBoss Server Settings for Concurrency and Congestion Control

1. Open standalone-sip.xml File

   Open the $JBOSS_HOME/standalone/configuration/standalone-sip.xml configuration file in a text editor.

2. Extract from stanalone-sip.xml file with conccurency configuration

```
<subsystem xmlns="urn:org.mobicents:sip-servlets-as7:1.0" application-
router="dars/mobicents-dar.properties" stack-properties="mss-sip-stack.properties"
path-name="gov.nist" app-dispatcher-
class="org.mobicents.servlet.sip.core.SipApplicationDispatcherImpl" concurrency-
control-mode="SipApplicationSession" congestion-control-interval="-1">
    <connector name="sip-udp" protocol="SIP/2.0" scheme="sip" socket-binding="sip-
udp"/>
    <connector name="sip-tcp" protocol="SIP/2.0" scheme="sip" socket-binding="sip-
tcp"/>
    <connector name="sip-tls" protocol="SIP/2.0" scheme="sip" socket-binding="sip-
tls"/>
    <connector name="sip-tls" protocol="SIP/2.0" scheme="sip" socket-binding="sip-
ws"/>
    <connector name="sip-tls" protocol="SIP/2.0" scheme="sip" socket-binding="sip-
wss"/>
</subsystem>
```

Procedure: Tuning RestComm SIP Servlets for Tomcat Server Settings for Concurrency and Congestion Control

1. Open server.xml File

   Open the $CATALINA_HOME/conf/server.xml configuration file in your text editor.

2. Add Parameters to <service> Element

   Locate the <service> element, and add the concurrencyControlMode and/or sipMessageQueueSize attributes.

   Possible values for the concurrencyControlMode attribute include: None, SipSession or SipApplicationSession. SipSession is the value of this attribute when it is not present—and overridden—in server.xml.

3. Define the Correct Attribute Values

   The following default values for the concurrency and congestion control parameters are used regardless of whether the attributes are defined in the server.xml file:

   - sipMessageQueueSize="1500"
   - backToNormalSipMessageQueueSize="1300"
   - congestionControlCheckingInterval="30000" (30 seconds, in milliseconds)
   - memoryThreshold="95" (in percentage)
   - backToNormalMemoryThreshold="90" (in percentage)
   - congestionControlPolicy="ErrorResponse"

     Experimentation is required for these tuning parameters depending on the operating system and server.

Tuning Parameters from the dispatcher MBean

Navigate to the `dispatcher` MBean from Restcomm SIP Servlets for JBoss's JMX console.

All changes performed at run time are effective immediately, but do not persist across reboots for Tomcat, only on JBoss AS7. the server.xml must be appended with the settings in order to make the configuration persistent.

When editing the dispatcher MBean from RestComm SIP Servlets for JBoss's JMX console, values allowed for the concurrency control mode are **None**, **SipSession** or **SipApplicationSession**.

8.3. STUN Support

The Session Traversal Utilities for NAT (STUN) prococol is used in Network Address Translation (NAT) traversal for real-time voice, video, messaging, and related interactive IP application communications. This light-weight, client-server protocol allows applications passing through a NAT to obtain the public IP address for the UDP connections the application uses to connect to remote hosts.

STUN support is provided at the SIP connector level, using the STUN for Java project. The STUN for Java project provides a Java implementation of the STUN Protocol (RFC 3489), which allows each SIP connector to select whether it should use STUN to discover a public IP address, and then use this address in the SIP messages sent through the connector.

To make a SIP connector STUN-enabled, three attributes must be appended to the child element in the *server.xml* or child element in *standalone-sip.xml* file. The properties are:

- useStun="true"

  Enables STUN support for this connector. Ensure that the `ipAddress` attribute is not set to `127.0.0.1`.

- stunServerAddress="<Public_STUN_Server>"

  STUN server address used to discover the public IP address of this SIP Connector. See Public STUN Servers for a suggested list of public STUN servers.

- stunServerPort="3478"

  STUN server port of the STUN server used in the `stunServerAddress` attribute. Both TCP and UDP protocols communicate with STUN servers using this port only.

A complete list of available SIP connector attributes and their descriptions is located in the Configuring SIP Connectors and Bindings section of this guide.

A number of public STUN servers are available, and can be specified in the `stunServerAddress`. Depending on the router firmware used, the STUN reply packets' MAPPED_ADDRESS may be changed to the router's WAN port. To alleviate this problem, certain public STUN servers provide

XOR_MAPPED_ADDRESS support. Public STUN Servers provides a selection of public STUN servers.

Table 2. Public STUN Servers

Server Address	XOR Support	DNS SRV Record
stun.ekiga.net	Yes	Yes
stun.fwdnet.net	No	Yes
stun.ideasip.com	No	Yes
stun01.sipphone.com	Yes	No
stun.softjoys.com	No	No
stun.voipbuster.com	No	No
stun.voxgratia.org	No	No
stun.xten.com	Yes	Yes
stunserver.org	Yes	Yes

For more information about NAT traversal best practices, refer to NAT Traversal..

8.4. Restcomm vendor-specific Extensions to JSR 289

Restcomm provide Extensions for applications or external systems to interact with the Restcomm SIP Servlets container as well as Extensions not defined in the specification in the JSR 289 specification that can prove useful and might be proposed for inclusion in a next release of the SIP Servlets specification

Javadoc for JSR 289 Extensions

8.5. CDI Telco Framework

CDI is the Java standard for dependency injection and contextual lifecycle management, led by Gavin King for Red Hat, Inc. and is a Java Community Process(JCP) specification that integrates cleanly with the Java EE platform. Any Java EE 6-compliant application server provides support for JSR-299 (even the web profile). It seemed a natural fit create a new framework based on CDI for the Telco world.

CDI-Telco-Framework (CTF) from Restcomm brings the power and productivity benefits of CDI into the Restcomm Sip Servlets platform providing dependency injection and contextual lifecycle management for converged HTTP/SIP applications. This new framework is intended to become a replacement for our previous Seam Telco Framework.

CTF mission statement is to simplify SipServlets development by introducing a component based programming model, ease of development by making available SIP utilities out of the box, and finally providing dependency injection and contextual lifecycle management to the SipServlets.

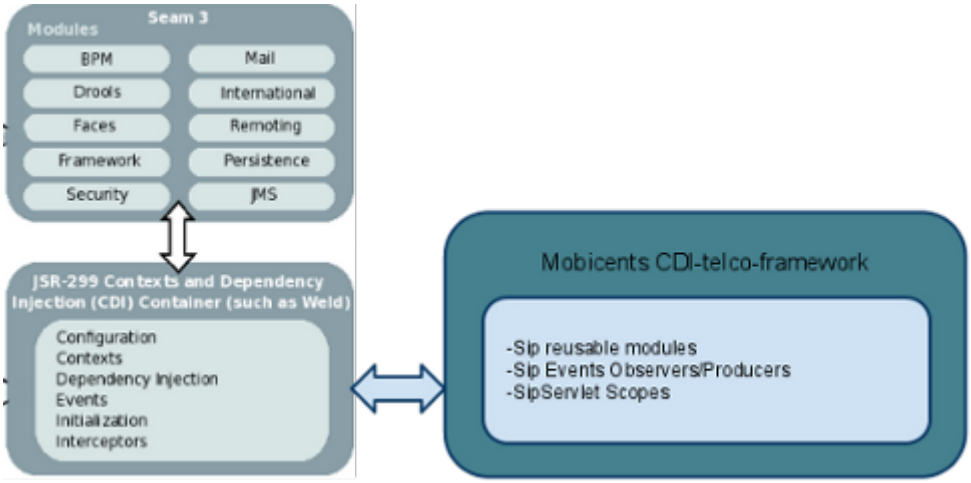

Figure 20. CDI Telco Framework Extension

More information about the CTF can be found on the CDI Telco Framework Documentation.

8.6. Diameter Support

The Diameter Protocol (RFC 3588) is a computer networking protocol for Authentication, Authorization, and Accounting (AAA). The Diameter version included in Restcomm SIP Servlets currently support Base, Sh, Ro and Rf.

For more information regarding Diameter support, refer to the Diameter Home Page. For a list of Diameter examples, refer to SIP Servlet Example Applications.

8.7. SIP and IMS Extensions

SIP Extensions in the SIP Servlets Server are based on the Internet Engineering Task Force's (IETF) Request for Comments (RFC) protocol recommendations. Supported SIP Extensions lists the supported RFCs for the SIP Servlets Server.

Table 3. Supported SIP Extensions

Extension	RFC Number	Description
DNS	RFC 3263	SIP: Locating SIP Servers
ENUM	RFC 2916	E.164 number and DNS
INFO	RFC 2976	The SIP INFO Method
IPv6	RFC 2460	Internet Protocol, Version 6 (IPv6) Specification
JOIN	RFC 3911	The SIP "Join" Header
MESSAGE	RFC 3428	SIP Extension for Instant Messaging
PATH	RFC 3327	SIP Extension Header Field for Registering Non-Adjacent Contacts

Extension	RFC Number	Description
PRACK	RFC 3262	Reliability of Provisional Responses in the SIP
PUBLISH	RFC 3903	SIP Extension for Event State Publication
REASON	RFC 3326	The Reason Header Field for the Session Initiation Protocol (SIP)
REFER	RFC 3515	The SIP Refer Method
REPLACES	RFC 3891	The SIP "Replaces" Header
STUN	RFC 3489	STUN - Simple Traversal of User Datagram Protocol (UDP) through Network Address Translators (NATs)
SUBSCRIBE/NOTIFY	RFC 3265	SIP-specific Event Notification
Symmetric Response Routing	RFC 3581	An Extension to the Session Initiation Protocol (SIP) for Symmetric Response Routing
Multipart type	RFC 4662	A Session Initiation Protocol (SIP) Event Notification
To/From Header Modification	RFC 4916	Connected Identity in the Session Initiation Protocol (SIP)

IMS Private Header (P-Header) Extensions are provided according to the recommendations of the 3rd Generation Partnering Project (3GPP) and the IETF. P-Header extensions are primarily used to store information about the networks a call traverses, including security or call charging details.

IMS P-Header Extensions describes the list of supported P-Headers, including links to the relevant ITEF memorandum where available.

Table 4. IMS P-Header Extensions

AuthorizationHeaderIMS	**Defines a new auth-param for the Authorization header used in REGISTER requests.**
PAccessNetworkInfoHeader	Contains information regarding the access network the User Agent (UA) uses to connect to the SIP Proxy. The information contained in this header may be sensitive, such as the cell ID, so it is important to secure all SIP application that interface with this header.
PAssertedIdentityHeader	Contains an identity resulting from an authentication process, derived from a SIP network intermediary. The identity may be based on SIP Digest authentication.

AuthorizationHeaderIMS	Defines a new auth-param for the Authorization header used in REGISTER requests.
PAssertedServiceHeader	Contains information used by "trust domains", according to Spec(T) specifications detailed in RFC 3324.
PAssociatedURIHeader	Contains a list of URIs that are allocated to the user. The header is defined in the 200 OK response to a REGISTER request. It allows the User Agent Client (UAC) to determine the URIs the service provider has associated to the user's address-of-record URI.
PathHeader	SIP Extension header, with syntax similar to the RecordRoute header. Used in conjunction with SIP REGISTER requests and 200 class messages in response to REGISTER responses.
PCalledPartyIDHeader	Typically inserted en-route into an INVITE request by the proxy, the header is populated with the Request_URI received by the proxy in the request. The header allows the User Agent Server (UAS) to identify which address-of-record the invitation was sent to, and can be used to render distinctive audio-visual alert notes based on the URI.
PChargingFunctionAddressesHeader	Contains a list of one or more of the Charging Collection Function (CCF) and the Event Charging Function (ECF) addresses. The CCF and ECF addresses may be passed during the establishment of a dialog, or in a standalone transaction.
PChargingVectorHeader	Contains a unique charging identifier and correlation information, which is used by network operators to correctly charge for routing events through their networks.
PMediaAuthorizationHeader	Contains one or more session-specific media authorization tokens, which are used for QoS of the media streams.
PPreferredIdentityHeader	Contains a SIP URI and an optional display-name. For example, "James May" <sip:james@domain.com>. This header is used by trusted proxy servers to identify the user to other trusted proxies, and can be used to select the correct SIP URI in the case of multiple user identities.

AuthorizationHeaderIMS	Defines a new auth-param for the Authorization header used in REGISTER requests.
PPreferredServiceHeader	Used by the PAssertedService Header to determine the preferred user service. Multiple PPreferreedService headers may be present in a single request.
PProfileKeyHeader	Contains a key used by a proxy to query the user database for a given profile. The key may contain wildcards that are used as part of the query into the database.
PrivacyHeader	Contains values that determine whether particular header information is deemed as private by the UA for requests and responses.
PServedUserHeader	Contains an identity of the user that represents the served user. The header is added to the initial requests for a dialog or standalone request, which are then routed between nodes in a trusted domain.
PUserDatabaseHeader	Contains the address of the HSS handling the user that generated the request. The header field is added to request routed from an Interrogating Call Session Control Function (I-CSCF) to a Serving Call Session Control Function (S-CSCF).
PVisitedNetworkIDHeader	Contains the identifier of a visited network. The identifier is a text string or token than it known by both the registrar or the home proxy at the home network, and the proxies in the visited network.
SecurityClientHeader, SecurityServerHeader, SecurityVerifyHeader	Contains information used to negotiate the security mechanisms between a UAC, and other SIP entities including UAS, proxy and registrar.
ServiceRouteHeader	Contains a route vector that will direct requests through a specified sequence of proxies. The header may be included by a registrar in response to a REGISTER request.
WWWAuthenticateHeaderIms	Extends the WWWAuthenticateResponse header functionality by defining an additional authorization parameter (auth-param).

8.8. SIP Servlets - JAIN SLEE Interoperability

JAIN SLEE is a more complex specification than SIP Servlets, and it has been know as heavyweight and with a steep learning curve. However JAIN SLEE has standardized a high performing event driven application server, an execution environment with a good concurrency model and powerful

protocol agnostic capabilities thus covering a variety of Telco protocols.

SIP Servlets on the other hand is much simpler and easier to get started with. Its focus is on extending the HTTP Servlets and Java EE hosting environments with SIP capabilities. SIP Servlets is more of a SIP programming framework, while JSLEE is a complete, self sufficient application platform. The fact that SIP Servlets is focused on SIP and Java EE makes it a natural fit to build JEE converged applications.

Table 5. SIP Servlets / JAIN SLEE Comparison Table

SIP Servlets	**JAIN SLEE**
Application Architecture	
Based on HTTP Servlets. Unit of logic is the SIP Servlets	Component based, Object Orientated architecture. Unit of logic is the Service Building Block
Composition through Application Router	Composition through parent-child relationship
Application State	
Servlets are stateless	SBBs may be stateful
Shared state stored in a session and visible to all Servlets with access to the session	SBB state is transacted and a property of the SBB itself. Shared state may be stored in a separate ActivityContext via a type safe interface
Concurrency Control	
Application managed: use of Java monitors	System Managed: isolation of concurrent transactions
Facilities (Utilities for Applications)	
Timer, Listeners	Timer, Trace, Alarm, Statistics, Profiles.
Protocol Support	
SIP, HTTP and Media (JSR 309)Protocol agnostic.	Consistent event model, regardless of protocol/resource
Availability Mechanisms	
Container managed state (session object) that can be replicated	Container managed state (SBB CMP, Facility, ActivityContext) that can be replicated
No transaction context for SIP message processing	Transaction context for event delivery
Non transacted state operations	Container managed state operations are transacted
Facilities are non transacted	Facilities, timers, are transacted
No defined failure model	Well defined and understood failure model via transactions
Management	

SIP Servlets	JAIN SLEE
No standard management mechanisms defined	JMX Interface for managing applications, life cycle, upgrades, ...

JSLEE and SIP Servlets target different audiences with different needs, but they can be complementary in a number of real world cases.

SIP Servlets focuses on SIP and its integration with Java EE. It is also more of a SIP framework within Java EE. JSLEE is an event driven application server with protocol agnostic architecture, spanning any legacy or potential future protocols. SIP Servlets applications are generally simpler to implement and accelerate time to market for Web and SIP deployment scenarios. JSLEE has a steeper learning curve and covers a wider set of target deployment environments.

As JBoss is the only vendor to implement both specifications through Restcomm , this makes it a natural fit to build converged and interoperable JSLEE/SIP Servlets applications that are able to comply with standards in a portable manner. We built an application that could leverage standards all the way without resorting to vendor proprietary extensions by making SIP Servlets and JSLEE work together. Our "JSLEE and SIP-Servlets Interoperability with Mobicents Communication Platform" paper describes our approach and the possible different approaches we have identified to achieve the goal of interoperability between SIP Servlets and JSLEE.

You can also use our JSLEE/SIP Servlets interoperability example, showcasing our approach.

8.9. Eclipse IDE Tools

The SIP Servlets Eclipse tools assist developers in creating JSR-289 applications with Restcomm. You can use the Dynamic Web Project wizard for converged applications to get started with an empty project, and then test your application with a real SIP Phone right from the IDE.

Figure 21. SIP Servlets Eclipse IDE Tools

8.9.1. Pre-Install requirements

Eclipse 3.4 is required.

8.9.2. Installation

The standard Eclipse update site installation mechanism is leveraged. The Restcomm Update Site is at the following location: http://mobicents.googlecode.com/svn/downloads/sip-servlets-eclipse-update-site. After adding this update site to Eclipse you can proceed with the regular Eclipse Plug-in Installation. If you need help, the process is demonstrated in this video.

8.9.3. SIP Servlets Core Plug-in

This plug-in allows you to create Dynamic Web Projects with the SIP Facet. There are a number of new Dynamic Web Project configurations for Converged applications. It is best to use the ones marked as "recommended". After you complete the wizard, a complete converged project skeleton will be generated. Working with this type of project is similar to working with normal Web projects. You can see a demo here.

8.9.4. SIP Phone Plug-in

The SIP Phone plug-in integrates a SIP phone inside your Eclipse IDE. You can use the phone to test your SIP or Media applications. The phone uses the microphone and speakers on your computer and allows you to simulate real-world scenarios.

Chapter 9. Best Practices

This chapter discusses Best Practices related to Restcomm SIP Servlets usage in real world deployments.

9.1. Restcomm SIP Servlets Performance Tips

Because the default profile of Restcomm SIP Servlets is targeted at a development environment, some tuning is required to make the server performance suitable for a production environment.

A useful presentation from OKI Japan

9.1.1. Tuning JBoss

To ensure the server is finely tuned for a production envirionment, certain configuration must be changed. Visit the JBoss Application Server Tuning wiki page to learn about optimization techniques.

While it is preferable to have a fast Application Server, most of the information doesn't apply to Restcomm . In summary, the most important optimization technique is to remove logs, leaving only what is required.

Check the log configuration file in the following location and review the information.

SIP Servlets Server Logging

9.1.2. Tuning Restcomm SIP Servlets

- *Congestion Control*: It is recommended that this feature is enabled to avoid overload of the server and that the *sipMessageQueueSize* and *memoryThreshold* parameters are tuned according to Concurrency and Congestion Control.
- *Concurrency* : *Default Value: None.* For better performance, it is recommended to leave this value set to `None`.

9.1.3. Tuning The JAIN SIP Stack

The stack can be fine-tuned by altering the SIP stack properties, defined in the external properties file specified by the *sipStackPropertiesFile* attribute as described in Configuring SIP Connectors and Bindings.

- *gov.nist.javax.sip.THREAD_POOL_SIZE*

  Default value: 64

  This thread pool is responsible for parsing SIP messages received from socket messages into objects.

  A smaller value will make the stack less responsive, since new messages have to wait in a queue for free threads. In UDP, this can lead to more retransmissions.

Large thread pool sizes result in allocating resources that are otherwise not required.

- *gov.nist.javax.sip.REENTRANT_LISTENER*

  Default value: true

  This flag indicates whether the SIP stack listener is executed by a single thread, or concurrently by the threads that parse the messages.

  Restcomm SIP Servlets expects this flag to be set to `true`, therefore do not change the value.

- *gov.nist.javax.sip.LOG_MESSAGE_CONTENT*

  Default value: true

  Set the parameter to `false` to disable message logging.

- *gov.nist.javax.sip.TRACE_LEVEL=0*

  Default value: 32.

  Set the parameter to `0` to disable JAIN SIP stack logging.

- *gov.nist.javax.sip.RECEIVE_UDP_BUFFER_SIZE=65536* *and* *gov.nist.javax.sip.SEND_UDP_BUFFER_SIZE=65536*

  Default value: 65536.

  Those properties control the size of the UDP buffer used for SIP messages. Under load, if the buffer capacity is overflown the messages are dropped causing retransmissions, further increasing the load and causing even more retransmissions.

- *gov.nist.javax.sip.MAX_MESSAGE_SIZE=10000*

  Default value: 10000.

  This property controls the maximum size of content that can be read for a SIP Message on UDP. The default is 65536. The average UDP message size is quite lower than this so reducing this property will benefit memory usage since a byte buffer of this size is created for every message received.

  It also defines the maximum size of content that a TCP connection can read. Must be at least 4K. Default is "infinity" — ie. no limit. This is to prevent DOS attacks launched by writing to a TCP connection until the server chokes.

- *gov.nist.javax.sip.TCP_POST_PARSING_THREAD_POOL_SIZE=30*

  Default value: 30.

  Use 0 or do not set this option to disable it. When using TCP, your phones/clients usually connect independently, creating their own TCP sockets. Sometimes however SIP devices are allowed to tunnel multiple calls over a single socket. This can also be simulated with SIPP by running "sipp

-t t1".

In the stack, each TCP socket has it's own thread. When all calls are using the same socket they all use a single thread, which leads to severe performance penalty, especially on multi-core machines. This option instructs the SIP stack to use a thread pool and split the CPU load between many threads. The number of the threads is specified in this parameter.

The processing is split immediately after the parsing of the message. It cannot be split before the parsing because in TCP the SIP message size is in the Content-Length header of the message and the access to the TCP network stream has to be synchronized.

Additionally, in TCP the message size can be larger. This causes most of the parsing for all calls to occur in a single thread, which may have impact on the performance in trivial applications using a single socket for all calls. In most applications it doesn't have performance impact. If the phones/clients use separate TCP sockets for each call, this option doesn't have much impact, except the slightly increased memory footprint caused by the thread pool. It is recommended to disable this option in this case by setting it 0 or not setting it at all. You can simulate multi-socket mode with "sipp -t t0". With this option also we avoid closing the TCP socket when something fails, because we must keep processing other messages for other calls. Note: This option relies on accurate Content-Length headers in the SIP messages. It cannot recover once a malformed message is processed, because the stream iterator will not be aligned any more. Eventually the connection will be closed.

The full list of JAIN SIP stack properties is available from the SIP Stack Properties Home Page and the full list of implementation specific properties are available from the SIP Stack Implementation Home Page.

9.1.4. Tuning The JVM

The following tuning information applies to Sun JDK 1.6, however the information should also apply to Sun JDK 1.5.

For more information on tuning Restcomm SIP Servlets performance, refer to the OKI Japan Presentation.

For more information on performance, refer to the Performance White Paper.

To pass arguments to the JVM, change *$JBOSS_HOME/bin/standalone.conf* (Linux) or *$JBOSS_HOME/bin/standalone.bat* (Windows).

- *Garbage Collection*

  JVM ergonomics automatically attempt to select the best garbage collector. The default behaviour is to select the throughput collector, however a disadvantage of the throughput collector is that it can have long pauses times, which ultimately blocks JVM processing.

  For low-load implementations, consider using the incremental, low-pause, garbage collector (activated by specifying `*-XX:+UseConcMarkSweepGC -XX:+CMSIncrementalMode*`). Many SIP applications can benefit from this garbage collector type because it reduces the retransmission

amount.

For more information please read: Garbage Collector Tuning

- *Heap Size*

  Heap size is an important consideration for garbage collection. Having an unnecessarily large heap can stop the JVM for seconds, to perform garbage collection.

  Small heap sizes are not recommended either, because they put unnecessary pressure on the garbage collection system.

9.1.5. Tuning The Operating System

The following tuning information is provided for Red Hat Enterprise Linux (RHEL) servers that are running high-load configurations. The tuning information should also apply to other Linux distributions.

After you have configured RHEL with the tuning information, you must restart the operating system. You should see improvements in I/O response times. With SIP, the performance improvement can be as high as 20%.

- *Large Memory Pages*

  Setting large memory pages can reduce CPU utilization by up to 5%.

  Ensure that the option `*-XX:+UseLargePages*` is passed and ensure that the following Java HotSpot™ Server VM warning does not occur:

  `Failed to reserve shared memory (errno = 22)" when starting JBoss.` It means that the number of pages at OS level is still not enough.

  To learn more about large memory pages, and how to configure them, refer to Java Support for Large Memory Pages and Andrig's Miller blog post.

- *Network buffers*

  You can increase the network buffers size by adding the following lines to your */etc/sysctl.conf* file:

- `net.core.rmem_max = 16777216`
- `net.core.wmem_max = 16777216`
- `net.ipv4.tcp_rmem = 4096 87380 16777216`
- `net.ipv4.tcp_wmem = 4096 65536 16777216`
- `net.core.netdev_max_backlog = 300000`
- Execute the following command to set the network interface address:

```
sudo ifconfig [eth0] txqueuelen 1000 #
```

Replace [eth0] with the correct name of the actual network interface you are setting up.

9.2. NAT Traversal

In a production environment, it is common to see SIP and Media data passing through different kinds of Network Address Translation (NAT) to reach the required endpoints. Because NAT Traversal is a complex topic, refer to the following information to help determine the most effective method to handle NAT issues.

9.2.1. STUN

STUN (Session Traversal Utilities for NAT) is not generally considered a viable solution for enterprises because STUN cannot be used with symmetric NATs.

Most enterprise-grade firewalls are symmetric, therefore STUN support must be provided in the SIP Clients themselves.

Most of the proxy and media gateways installed by VoIP providers recognize the public IP address the packets have originated from. When both SIP end points are behind a NAT, they can act as gateways to clients behind NAT.

9.2.2. TURN

TURN (Traversal Using Relay NAT) is an IETF standard, which implements media relays for SIP end-points. The standard overcomes the problems of clients behind symmetric NATs which cannot rely on STUN to solve NAT traversal.

TURN connects clients behind a NAT to a single peer, providing the same protection offered by symmetric NATs and firewalls. The TURN server acts as a relay; any data received is forwarded.

This type of implementation is not ideal. It assumes the clients have a trust relationship with a TURN server, and a request session allocation based on shared credentials.

This can result in scalability issues, and requires changes in the SIP clients. It is also impossible to determine when a direct, or TURN, connection is appropriate.

9.2.3. ICE

ICE (Interactive Connection Establishment) leverages both STUN and TURN to solve the NAT traversal issues.

It allows devices to probe for multiple paths of communication, by attempting to use different port numbers and STUN techniques. If ICE support is present in both devices, it is quite possible that the devices can initiate and maintain communication end-to-end, without any intermediary media relay.

Additionally, ICE can detect cases where direct communication is impossible and automatically initiate fall-back to a media relay.

ICE is not currently in widespread use in SIP devices, because ICE capability must be embedded within the SIP devices.

Depending on the negotiated connection, a reINVITE may be required during a session, which adds more load to the SIP network and more latency to the call.

If the initiating ICE client attempts to call a non-ICE client, then the call setup-process will revert to a conventional SIP call requiring NAT traversal to be solved by other means.

9.2.4. Other Approaches

While the above is a good solution to circumvent NAT issues. There might be cases where it is not possible to use those solutions at all.

Other approaches include using proxy and media that can act as gateways, Session Border Controllers, enhanced Firewall with Application Layer Gateway (ALG) and Tunnelling.

Here is more information on Session Border Controllers and how they can resolve NAT issues when above solutions are not possible

Chapter 10. Apendix

10.1. Java Development Kit (): Installing, Configuring and Running

The [app]` Platform` is written in Java; therefore, before running any server, you must have a working Java Runtime Environment () or Java Development Kit () installed on your system. In addition, the JRE or JDK you are using to run [app] must be version 5 or higher [1: At this point in time, it is possible to run most servers, such as the JAIN SLEE Server, using a Java 6 JRE or JDK. Be aware, however, that presently the XML Document Management Server does not run on Java 6. We suggest checking the web site, forums or discussion pages if you need to inquire about the status of running the XML Document Management Server with Java 6.].

10.1.1. JRE versus JDK - 32-Bit versus 64-Bit

Should I Install the JRE or JDK?

Although you can run servers using the Java Runtime Environment, we assume that most users are developers interested in developing Java-based, [app]-driven solutions. Therefore, in this guide we take the tact of showing how to install the full Java Development Kit.

Should I Install the 32-Bit or the 64-Bit JDK, and Does It Matter?

Briefly stated: if you are running on a 64-Bit Linux or Windows platform, you should consider installing and running the 64-bit JDK over the 32-bit one. Here are some heuristics for determining whether you would rather run the 64-bit Java Virtual Machine (JVM) over its 32-bit cousin for your application:

- Wider datapath: the pipe between RAM and CPU is doubled, which improves the performance of memory-bound applications when using a 64-bit JVM.
- 64-bit memory addressing gives virtually unlimited (1 exabyte) heap allocation. However large heaps affect garbage collection.
- Applications that run with more than 1.5 GB of RAM (including free space for garbage collection optimization) should utilize the 64-bit JVM.
- Applications that run on a 32-bit JVM and do not require more than minimal heap sizes will gain nothing from a 64-bit JVM. Barring memory issues, 64-bit hardware with the same relative clock speed and architecture is not likely to run Java applications faster than their 32-bit cousin.

Note that the following instructions detail how to download and install the 32-bit JDK, although the steps are nearly identical for installing the 64-bit version.

10.1.2. Downloading JDK

You can download the Sun JDK 5.0 (Java 2 Development Kit) from Sun's website: http://java.sun.com/javase/downloads/index_jdk5.jsp. Click on the Download link next to "JDK 5.0 Update <x>`" (where [replaceable]<x>` is the latest minor version release number). On the next page, select your language and platform (both architecture—whether 32- or 64-bit—and operating

system), read and agree to the Java Development Kit 5.0 License Agreement, and proceed to the download page.

The Sun website will present two download alternatives to you: one is an RPM inside a self-extracting file (for example, *jdk-1_5_0_16-linux-i586-rpm.bin*), and the other is merely a self-extracting file (e.g. *jdk-1_5_0_16-linux-i586.bin*). If you are installing the JDK on Red Hat Enterprise Linux, Fedora, or another RPM-based Linux system, we suggest that you download the self-extracting file containing the RPM package, which will set up and use the SysV service scripts in addition to installing the JDK. We also suggest installing the self-extracting RPM file if you will be running [app]`` in a production environment.

Installing

The following procedures detail how to install the Java Development Kit on both Linux and Windows.

Procedure: Installing the JDK on Linux

1. Regardless of which file you downloaded, you can install it on Linux by simply making sure the file is executable and then running it:

```
~]$ chmod +x "jdk-1_5_0_<minor_version>-linux-<architecture>-rpm.bin"
~]$ ./"jdk-1_5_0_<minor_version>-linux-<architecture>-rpm.bin"
```

Moving from Non-RPM Installer to SysV Service Scripts

If you download the non-RPM self-extracting file (and installed it), and you are running on an RPM-based system, you can still set up the SysV service scripts by downloading and installing one of the `-compat` packages from the JPackage project. Remember to download the `-compat` package which corresponds correctly to the minor release number of the JDK you installed. The compat packages are available from link:ftp://jpackage.hmdc.harvard.edu/JPackage/1.7/generic/RPMS.non-free/.

You do not need to install a `-compat` package in addition to the JDK if you installed the self-extracting RPM file! The `-compat` package merely performs the same SysV service script set up that the RPM version of the JDK installer does.

10.1.3. Installing JDK on Windows

1. Using Explorer, simply double-click the downloaded self-extracting installer and follow the instructions to install the JDK.

Configuring

Configuring your system for the JDK consists in two tasks: setting the `JAVA_HOME` environment variable, and ensuring that the system is using the proper JDK (or JRE) using the `alternatives` command. Setting `JAVA_HOME` usually overrides the values for `java`, `javac` and `java_sdk_1.5.0` in `alternatives`, but we will set them all just to be safe and consistent.

10.1.4. Setting Linux JAVA_HOME Environment Variables

Setting the JAVA_HOME Environment Variable on Generic Linux

After installing the JDK, you must ensure that the JAVA_HOME environment variable exists and points to the location of your JDK installation.

10.1.5. Setting the Correct Java Version

Setting java, javac and java_sdk_1.5.0 Using the alternatives command

As the root user, call /usr/sbin/alternatives with the --config java option to select between JDKs and JREs installed on your system:

10.1.6. Setting JAVA_HOME Environment Variables on Windows

Setting the JAVA_HOME Environment Variable on Windows

For information on how to set environment variables in Windows, refer to http://support.microsoft.com/kb/931715.

10.1.7. Uninstalling JDK on Linux and Windows

Uninstalling

There is usually no reason (other than space concerns) to remove a particular JDK from your system, given that you can switch between JDKs and JREs easily using alternatives, and/or by setting JAVA_HOME.

Uninstalling the JDK on Linux

On RPM-based systems, you can uninstall the JDK using the `yum remove <jdk_rpm_name> ` command.

Uninstalling the JDK on Windows

On Windows systems, check the JDK entry in the Start menu for an uninstall command, or use Add/Remove Programs.

10.1.8. Setting the JBOSS_HOME Environment Variable

The [app]` Platform` (`) is built on top of the [app]`JBoss Application Server (JBoss AS). You do not need to set the JBOSS_HOME environment variable to run any of the [app]` Platform` servers *unless* JBOSS_HOME is *already* set.

The best way to know for sure whether JBOSS_HOME was set previously or not is to perform a simple check which may save you time and frustration.

Checking to See If JBOSS_HOME is Set on Unix

At the command line, echo $JBOSS_HOME to see if it is currently defined in your environment:

```
~]$ echo $JBOSS_HOME
```

The [app]` Platform` and most &PLATFORM_NAME; servers are built on top of the JBoss Application Server (JBoss AS). When the [app]` Platform` or &PLATFORM_NAME; servers are built *from source*, then JBOSS_HOME *must* be set, because the &PLATFORM_NAME; files are installed into (or "over top of" if you prefer) a clean JBoss AS installation, and the build process assumes that the location pointed to by the JBOSS_HOME environment variable at the time of building is the JBoss AS installation into which you want it to install the &PLATFORM_NAME; files.

This guide does not detail building the [app]` Platform` or any &PLATFORM_NAME; servers from source. It is nevertheless useful to understand the role played by JBoss AS and JBOSS_HOME in the &PLATFORM_NAME; ecosystem.

The immediately-following section considers whether you need to set JBOSS_HOME at all and, if so, when. The subsequent sections detail how to set JBOSS_HOME on Unix and Windows

Even if you fall into the category below of *not needing* to set JBOSS_HOME, you may want to for various reasons anyway. Also, even if you are instructed that you do *not need* to set JBOSS_HOME, it is good practice nonetheless to check and make sure that JBOSS_HOME actually *isn't* set or defined on your system for some reason. This can save you both time and frustration.

You *DO NOT NEED* to set JBOSS_HOME if…

- …you have installed the [app]` Platform` binary distribution.
- …you have installed a &PLATFORM_NAME;server binary distribution *which bundles* JBoss AS.

You *MUST* set JBOSS_HOME if…

- …you are installing the [app]` Platform` or any of the &PLATFORM_NAME; servers *from source*.
- …you are installing the [app]` Platform` binary distribution, or one of the &PLATFORM_NAME; server binary distributions, which *do not* bundle JBoss AS.

Naturally, if you installed the [app]` Platform` or one of the &PLATFORM_NAME; server binary releases which *do not* bundle JBoss AS, yet requires it to run, then you should install JBoss AS before setting JBOSS_HOME or proceeding with anything else.

Setting the JBOSS_HOME Environment Variable on Unix

The JBOSS_HOME environment variable must point to the directory which contains all of the files for the [app]` Platform` or individual &PLATFORM_NAME; server that you installed. As another hint, this topmost directory contains a *bin* subdirectory.

Setting JBOSS_HOME in your personal *~/.bashrc* startup script carries the advantage of retaining effect over reboots. Each time you log in, the environment variable is sure to be set for you, as a user. On Unix, it is possible to set JBOSS_HOME as a system-wide environment variable, by defining it in */etc/bashrc*, but this method is neither recommended nor detailed in these instructions.

Procedure: To Set JBOSS_HOME on Unix…

1. Open the *~/.bashrc* startup script, which is a hidden file in your home directory, in a text editor, and insert the following line on its own line while substituting for the actual install location on

your system:

```
export JBOSS_HOME="/home/<username>/<path>/<to>/<install_directory>"
```

2. Save and close the *.bashrc* startup script.
3. You should `source` the *.bashrc* script to force your change to take effect, so that `JBOSS_HOME` becomes set for the current session [2: Note that any other terminals which were opened prior to your having altered .bashrc will need to source ~/.bashrc as well should they require access to JBOSS_HOME.].

```
~]$ source ~/.bashrc
```

4. Finally, ensure that `JBOSS_HOME` is set in the current session, and actually points to the correct location:

The command line usage below is based upon a binary installation of the [app]` Platform`. In this sample output, `JBOSS_HOME` has been set correctly to the `topmost_directory` of the `installation. Note that if you are installing one of the standalone [app]` servers (with `JBoss AS` bundled!), then `JBOSS_HOME` would point to the `topmost_directory` of your server installation.

```
~]$ echo $JBOSS_HOME
/home/silas/
```

Setting the JBOSS_HOME Environment Variable on Windows

The `JBOSS_HOME` environment variable must point to the directory which contains all of the files for the &PLATFORM_NAME;Platform or individual &PLATFORM_NAME;server that you installed. As another hint, this topmost directory contains a *bin* subdirectory.

For information on how to set environment variables in recent versions of Windows, refer to http://support.microsoft.com/kb/931715.

10.1.9. Setting CATALINA_HOME on Linux and Windows

Procedure: Setting the `CATALINA_HOME` Environment Variable on Linux

1. The `CATALINA_HOME` environment variable must point to the location of your Tomcat installation. Any &PLATFORM_NAME; server which runs on top of the Tomcat servlet container has a topmost directory, i.e. the directory in which you unzipped the zip file to install the server, and underneath that directory, a *bin* directory. `CATALINA_HOME` must be set to the topmost directory of your &PLATFORM_NAME; server installation.

   Setting this variable in your personal *~/.bashrc* file has the advantage that it will always be set (for you, as a user) each time you log in or reboot the system. To do so, open *~/.bashrc* in a text editor (or create the file if it doesn't already exist) and insert the following line anywhere in the

file, taking care to substitute *<sip_server>* for the topmost directory of the &PLATFORM_NAME; server you installed:

```
export CATALINA_HOME="/home/<username>/<path>/<to>/<sip_server>"
```

Save and close *.bashrc*.

2. You can—and should--`source` your *.bashrc* file to make your change take effect (so that `CATALINA_HOME` is set) for the current session:

```
~]$ source ~/.bashrc
```

3. Finally, make sure that `CATALINA_HOME` has been set correctly (that it leads to the right directory), and has taken effect in the current session.

   The following command will show the path to the directory pointed to by `CATALINA_HOME`:

```
~]$ echo $CATALINA_HOME
```

   To be absolutely sure, change your directory to the one pointed to by `CATALINA_HOME`:

```
~]$ cd $CATALINA_HOME && pwd
```

Procedure: Setting the `CATALINA_HOME` Environment Variable on Windows

1. The `CATALINA_HOME` environment variable must point to the location of your Tomcat installation. Any &PLATFORM_NAME; server which runs on top of the Tomcat servlet container has a topmost directory, i.e. the directory in which you unzipped the zip file to install the server, and underneath that directory, a *bin* directory. `CATALINA_HOME` must be set to the topmost directory of your &PLATFORM_NAME; server installation.

   If you are planning on running the Tomcat container as the Administrator, then you should, of course, set the `CATALINA_HOME` environment variable *as the administrator*, and if you planning to run Tomcat as a normal user, then set `CATALINA_HOME` as a user environment variable.

   For information on how to set environment variables in Windows, refer to http://support.microsoft.com/kb/931715.

Chapter 11. JSR 289 Errata

This chapter discusses deviations from the JSR 289 specification by Restcomm SIP Servlets after feedback on usage in real world deployments and from the community.

11.1. Restcomm SIP Servlets Deviations from JSR 289

- _Correlation of Responses to Proxy Branches _: It seems the javadoc for Speed Dial contains an error, SipServlet.doBranchResponse() shouldn't be included as it contradicts the last sentence from the spec 10.2.4.2 Correlating responses to proxy branches : "Note that if the doBranchResponse() is not overridden then doResponse() method will be invoked only for the best final response as before", If SipServlet.doBranchResponse() handling is done in SipServlet.doResponse() and the servlet overrides SipServlet.doResponse() then it will receive intermediate final responses as well as the best final response which is not the desired behavior, so the doBranchResponse() handling is done in SipServlet.doService() method allowing applications not overriding doResponse or doService to receive both intermediate final responses on the doBranchResponse as well as the best final response on doResponse but this fixes the issue of intermediate final responses being delivered to doResponse in case the servlet overrides it.
- *SipServletResponse typo* : _ SipServletResponse.SC_TEMPORARLY_UNAVAILABLE_ should be replaced by SC_TEMPORARILY_UNAVAILABLE.