

# LEAP USER GUIDE

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The LEAP add-on, when combined with JADE, provides a modified run-time environment for enabling FIPA agents to execute on  
on lightweight devices running Java (Java version)  
on devices running Microsoft .NET Framework v1.1 (.NET version)

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## 1 Introduction

This document describes how to use the LEAP add-on to execute JADE agents on lightweight devices such as cell phones running Java and on devices running Microsoft .Net Framework.

The LEAP add-on was mainly developed within the scope of the LEAP IST project and is available for download from the JADE web site since March 2005.

### 1.1 Target audience

This document is intended for JADE users who are interested in developing multi-agent applications that have to be deployed on lightweight devices such as mobile phones and PDAs.

The reader is therefore assumed to be already familiar with

- JADE. For people new to JADE we recommend to read the JADE Programming Tutorial for beginners, and the JADE Administration Tutorial both available on the JADE web site (<http://jade.tilab.com>).
- The Micro Edition version of the Java platform and in particular (for the sections of this document dealing with MIDP) with the Java Micro Edition SDK (formerly called J2ME Wireless ToolKit). For people new to the Java Micro Edition we recommend to visit <http://java.sun.com> first.
- The Microsoft .NET framework (**only** for those programmers wishing to run JADE over .NET). For people new to .NET technology we recommend to visit <http://www.microsoft.com/> first.
- Android platform version 2.1 (or later). For people interested to develop JADE applications on the Android platform, we recommend to read the Jade-Android Programming Tutorial available on the JADE web site at (<http://jade.tilab.com/doc/tutorials/JadeAndroid-Programming-Tutorial.pdf>).

### 1.2 Rationale

As a consequence of the introduction of always-connected wireless networks (GPRS, UMTS, WLAN) and of the continuous growth in power and resources of handheld devices such as PDAs and cell phones, the wireless and wire-line environments are progressively integrating together. In this scenario the need of deploying applications distributed partly in the fixed network and partly on handheld devices is becoming more and more important.

JADE, unfortunately, cannot run, as it is, on small devices for the following reasons:

1. The complete JADE runtime environment has a memory footprint of some Mbytes that cannot fit the (often strong) limitations of handheld devices.
2. JADE requires Java 5 (or later) while the majority of handheld devices only support CDC, PersonalJava, or more typically MIDP.
3. Wireless links have different characteristics with respect to fixed network such as high latency, low bandwidth, intermittent connectivity and dynamic IP address assignment that must be taken into account properly.

The LEAP add-on was created to solve these problems and allows deploying JADE agents on handheld devices as described in the followings.

### **1.3 The JADE-LEAP runtime environment**

The LEAP add-on, when combined with JADE, replaces some parts of the JADE kernel forming a modified runtime environment that we will identify as JADE-LEAP (“JADE powered by LEAP”) and that can be deployed on a wide range of small devices. In order to achieve this, JADE-LEAP can be shaped in different ways corresponding to the two configurations (CDC and CLDC) of the Java Micro Edition and the Android Dalvik Java Virtual Machine. More in details

- **pjava:** to execute JADE-LEAP on handheld devices supporting J2ME CDC or PersonalJava such as most of today PDAs. *It should be noticed that in 2003 the Personal Java specification was declared obsolete and was substituted by the CDC configuration of the J2ME edition. From the point of view of running JADE-LEAP there are no differences however. Throughout this document therefore with the term “PersonalJava” we mean both the actual obsolete Personal Java specification and the J2ME CDC configuration.*
- **midp:** to execute JADE-LEAP on handheld devices supporting MIDP1.0 (or later) only, such as the great majority of Java enabled cell phones.
- **android:** to execute JADE-LEAP on devices supporting Android 2.1 (or later).

In addition a **dotnet** version of JADE-LEAP exists to execute JADE-LEAP on PC and servers in the fixed network running Microsoft .NET Framework version 1.1 or later. Though different internally, the three versions of JADE-LEAP provide the same set of API to developers thus offering a homogeneous layer over a diversity of devices and types of network as depicted in Figure 1.

Only a few features that are available in JADE as well as in JADE-LEAP for *pjava* and *dotnet* are not supported in JADE-LEAP for *midp* as they are intrinsically related to Java classes that are not supported in MIDP (see 5 for a summary of MIDP unsupported features).

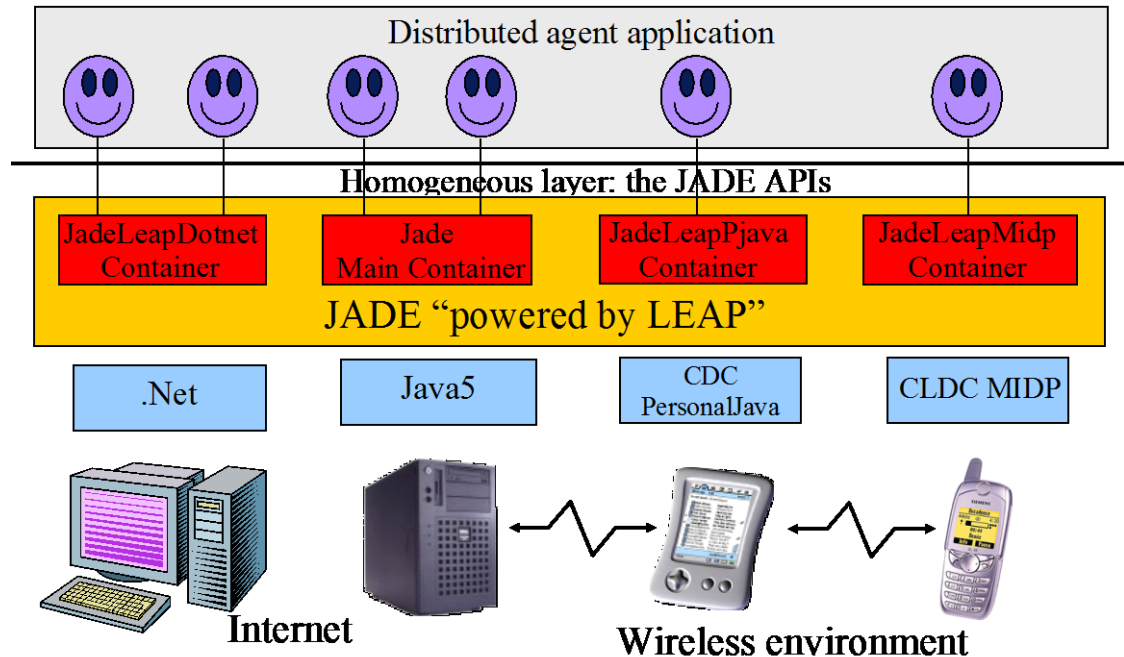


Figure 1. The JADE-LEAP runtime environment

**NOTE:** Until release 3.7, JADE-LEAP was a completely different platform with respect to JADE. It was not possible to attach a JADE-LEAP container to a JADE Main Container or vice-versa. As a consequence, besides the *pjava* and *midp* versions, also a *j2se* version existed to run JADE-LEAP on PC and Servers running the Java Standard Edition and. **Since release 4.0 JADE and JADE-LEAP became a single platform where JADE-LEAP for *pjava*, *midp* and *android* simply represent modified versions of JADE to run JADE agents on small devices.**

## 1.4 Downloading

JADE-LEAP for *pjava*, *midp*, *android* and *dotnet* can be directly downloaded in binary form from the "Download" area of the JADE web site (<http://jade.tilab.com>). People interested in modifying/compiling JADE-LEAP have to download (besides the JADE sources) the LEAP add-on from the "Add-ons" area of the JADE web site and follow the instructions included in chapter 4.

## 2 Using JADE-LEAP

### 2.1 The split execution mode

The JADE runtime environment can be executed in two different modes. The normal "Stand-alone" execution mode where a complete container is executed on the device/host where the JADE runtime is activated.

The “**Split**” execution mode where the container is split into a FrontEnd (actually running on the device/host where the JADE runtime is activated) and a BackEnd (running on a remote server) linked together by means of a permanent connection (see Figure 2).

The following table summarizes how the 2 execution modes are supported in the different environments targeted by JADE-LEAP. **Note that the split execution mode is mandatory in *midp* and strongly suggested in *pjava*.**

	<b>.NET</b>	<b>pjava</b>	<b>midp</b>	<b>Android</b>
<b>Stand-alone</b>	Suggested	Supported	Not supported	Supported
<b>Split</b>	Supported	Suggested	Mandatory	Supported

The split execution mode is particularly suited for resource-constrained and wireless devices since:

- The FrontEnd is definitely more lightweight than a complete container.
- The bootstrap phase is much faster since all communications with the Main container required to join the platform are performed by the Back End and therefore they are not carried out over the wireless link.
- The usage of the wireless link is optimized.

**It is important to remark that agent developers typically do not have to care in any way about the fact that their agents will run on a stand-alone container or on the FrontEnd of a split container as the APIs they provide are exactly the same.**

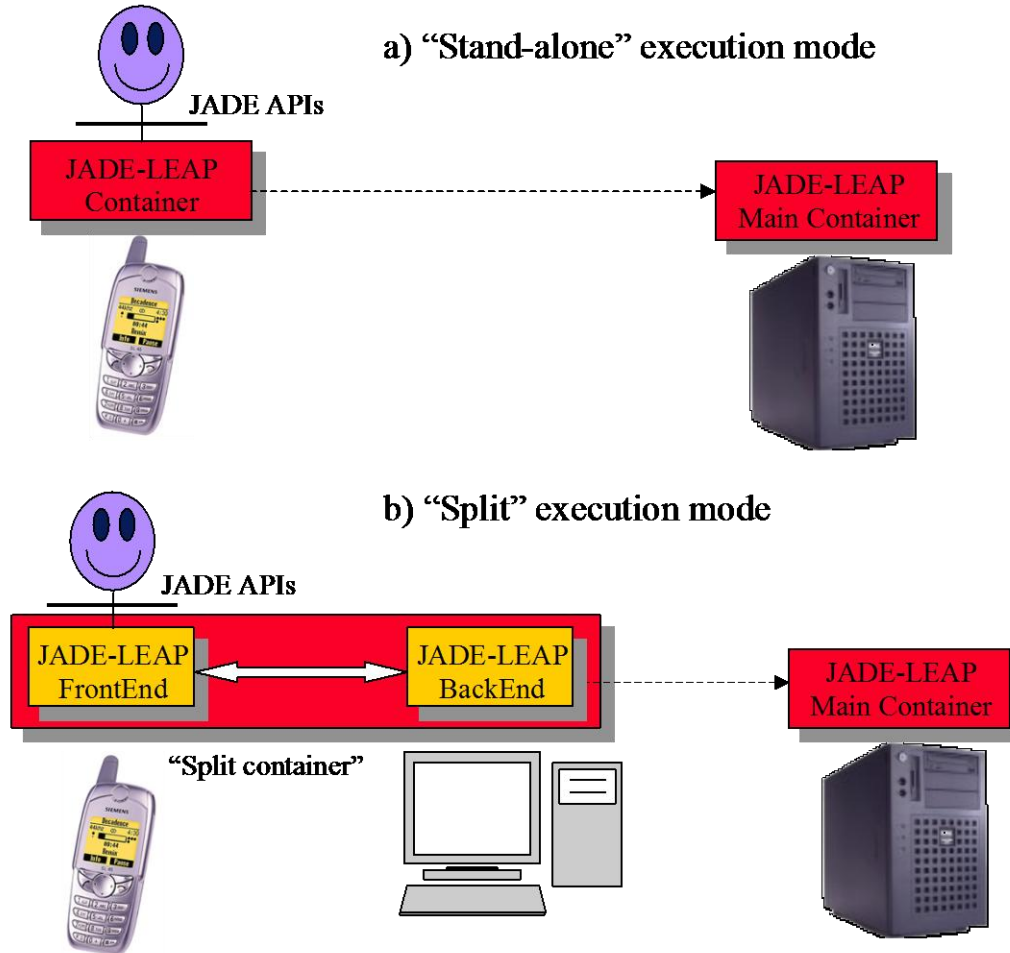


Figure 2. Execution modes

The following issues must be taken into account:

- When launching a split container, a JADE container (possibly, but NOT necessarily the Main Container) must already be active on the host where the BackEnd has to be created. In the followings we will refer to this container as **Mediator**.
- A Main Container cannot be split.
- Agent mobility and cloning is never supported on a split container.

**When running JADE-LEAP on a PersonalJava/CDC device and mobility features are needed, we recommend to try the split execution mode plus the dynamic behaviour loading mechanism supported by the `jade.core.behaviours.LoaderBehaviour` class first. Only if this does not fit your needs, then try the stand-alone execution mode.**

## 2.2 Executing JADE-LEAP on handheld devices

### 2.2.1 PDAs and smart-phones running J2ME CDC/PersonalJava

When working on PDAs and smart-phones running J2ME CDC or PersonalJava, the *pjava* version of JADE-LEAP must be used.

#### *Split execution*

A *pjava* split container is started by typing (assuming JADE-LEAP *pjava* classes are in the classpath):

```
java jade.MicroBoot [options]
```

Main options are:

- host <host-name/address> Indicates the host where the mediator container is running and the BackEnd will be created (Default = localhost).
- port <port-number> Indicates the port where the mediator container is listening for commands (Default = 1099).
- agents <agents specification> Activates the specified agents (see the JADE Administrator's guide to the format of agent specifications).
- exitwhenempty <true|false> When this option is set to true the container automatically exits as soon as there are no more agents living on it.
- conf <filename> Read the configuration properties from the specified file

It should be highlighted that, in the split execution mode, the `-host` and `-port` options specify the host and port of the Mediator container that may not be the Main Container.

#### *Stand-alone execution*

A *pjava* stand-alone container is started, exactly as for a normal JADE container, by typing (assuming JADE-LEAP *pjava* classes are in the classpath):

```
java jade.Boot [options] [agents specification]
```

where the same options and agents specification valid for JADE apply (see the JADE Administrator's Guide) except for the `-gui` option, since the JADE tools (including the RMA) require JAVA 5 or later to run, and the `-backupmain`, `-smhost` and `-smport` options since the MainReplicationService is not supported in PersonalJava/CDC .

In addition, in order to maintain backward compatibility with previous versions of JADE-LEAP, the old style command line

```
java jade.Boot <properties file name>
```

is still valid and is equivalent to

```
java jade.Boot -conf <properties file name>
```

### 2.2.2 Cell phones running MIDP

When working on cell-phones running MIDP1.0 (or higher), the *midp* version of JADE-LEAP must be used.

In order to be deployed on MIDP devices, JADE-LEAP for *midp* is configured as a MIDlet Suite including the following MIDlets:



`jade.MicroBoot`. Load this MIDlet to start a split container.  
`jade.util.leap.Config`. Load this MIDlet to manually edit configuration properties  
`jade.util.leap.OutputViewer`. Load this MIDlet to view the output printed out during the previous JADE-LEAP execution session.

As mentioned, when working with JADE-LEAP for *midp* only the split container execution mode is available. The `host`, `port`, `agents`, `exitwhenempty` and `conf` configuration options can be set in two ways:

- As properties set in the JAD or MANIFEST of the MIDlet suite.
- By means of the `jade.util.leap.Config` MIDlet.

### 2.2.2.1 Setting configuration options as properties in the JAD or MANIFEST

In order to make JADE-LEAP *midp* read configuration properties from the JAD or MANIFEST set the `LEAP-conf` key<sup>1</sup> in the JAD or MANIFEST to "jad" (default) and specify configuration options as  
`LEAP-<key>: <value>`

As an example the following lines in the JAD or MANIFEST would start (when `JADEsplit` is selected) a `FrontEnd` that tries to create its `BackEnd` on host `host1` and launches agents `Peter` of class `MyClass1` and `John` of class `MyClass2`.

```
MIDlet-1: JADEsplit, , jade.MicroBoot
...
LEAP-conf: jad
LEAP-host: host1
LEAP-agents: Peter:MyClass1;John:MyClass2
...
```

This way of setting configuration options is quite simple, but must be done before uploading a JADE-LEAP-based MIDlet on the cell phone and cannot be changed unless the MIDlet is uploaded again.

### 2.2.2.2 Setting configuration options using the Config MIDlet

In order to make JADE-LEAP read the configuration properties previously set through the Config MIDlet set the `LEAP-conf` key in the JAD or MANIFEST to "conf". Follow the process depicted in Figure 3 to specify configuration properties through the Config MIDlet.

---

<sup>1</sup> N.B.: Since JADE 3.4 (26/5/05) we changed the key name from `MIDlet-LEAP-conf` to `LEAP-conf`. In fact, Markus Becker reported that in JSR 118 it is not allowed to use attributes starting with `MIDlet-` even if not all devices enforce this rule.



**Figure 3. Setting properties through the Config MIDlet**

This way of setting configuration options is clearly more complex, but is also more flexible as configuration options can be changed without the need of uploading a JADE-LEAP-based MIDlet again.

In order to reset a configuration property, set its value to an empty string (“”).

### 2.2.2.3 The OutputViewer

Since a MIDP device in general does not allow you to view logging printouts produced by calls to `System.out.println`, in case of problems during JADE-LEAP execution, it is possible to review JADE-LEAP logging printouts by launching the `jade.util.leap.OutputViewer` MIDlet.

See 6.3 and the documentation of the `jade.util.Logger` class to know how to use this facility from your code too.

### 2.2.3 An example

Figure 4 depicts, as an example, a scenario including, among others, a stand-alone container running on a Personal Java PDA and a split container running on a MIDP phone and shows the configuration properties to execute each container. Note that in the depicted scenario the role of the Mediator container is not played by the Main Container, but by a peripheral container.

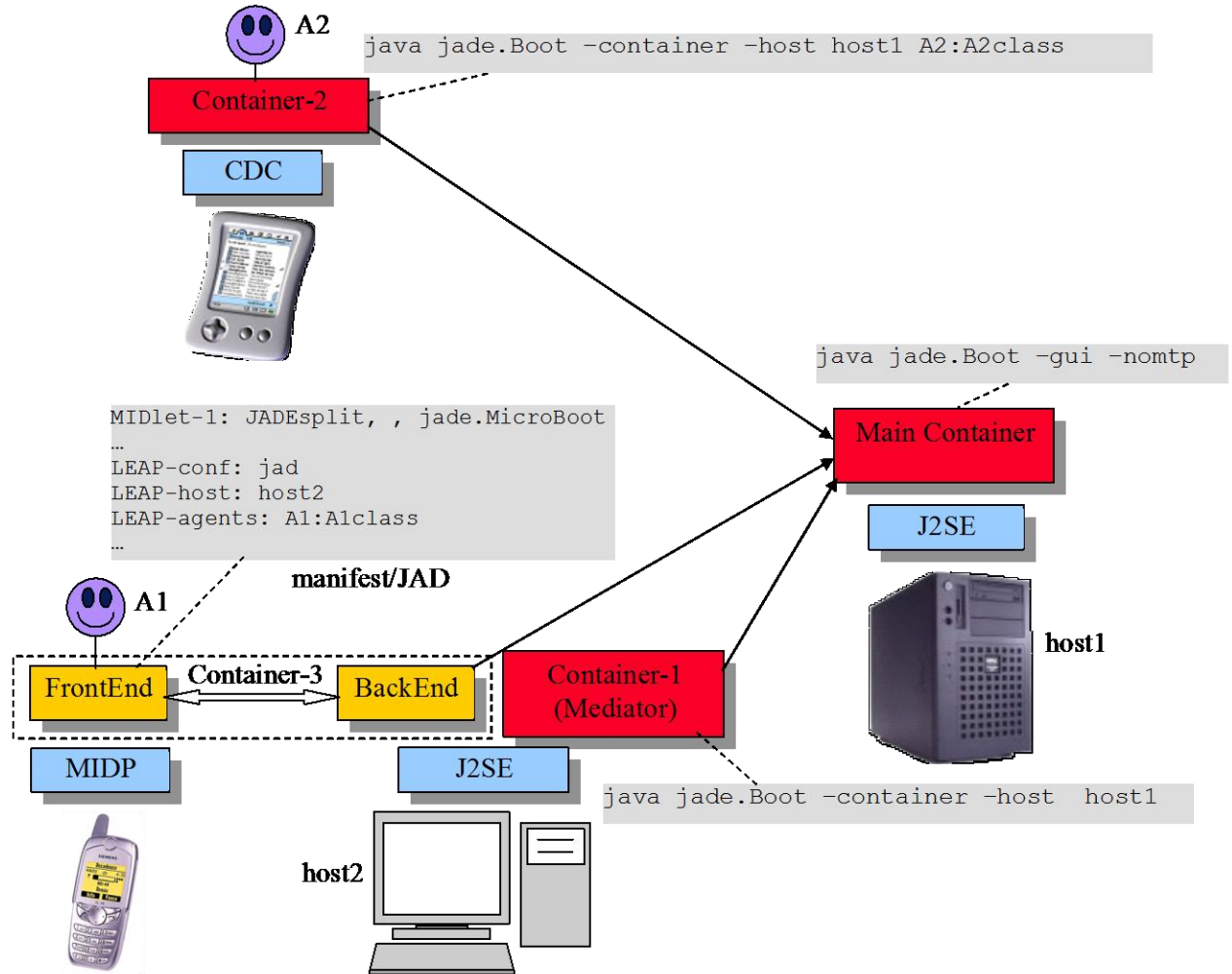


Figure 4. An example

### 2.3 Executing JADE-LEAP in Microsoft .NET environment

When working in a Microsoft .NET environment, the *dotnet* version of JADE-LEAP must be used. The only difference between using the *dotnet* version of JADE-LEAP and the standard JADE platform is that, being the former an executable, it must be launched typing

```
JADEBoot.exe [options] [agents specification]
```

## 3 Creating a JADE-LEAP based MIDlet

Unlike normal applications running on PC and servers that can load classes from several libraries (jar files), a MIDP application must be packaged into a single jar file. This means that, when packaging a JADE-LEAP based MIDP application, Jade classes and

application specific classes must be put in the same Jar file. The typical ANT build script to create a JADE-LEAP based MIDlet is therefore similar to that below.

```
<project name="JADE-based sample MIDlet">

  <!-- Where to find MIDP classes -->
  <property name="j2mewtk.home" value="Micro Edition SDK home dir"/>
  <property name="midplib" value="{j2mewtk.home}/lib"/>
  <property name="boot-midp-classes"
    value="{midplib}/midpapi10.jar;{midplib}/cldcapi10.jar"/>

  <!-- Where to find JADE-LEAP -->
  <property name="jadeMIDP" value="JADE-LEAP jar file for MIDP" />

  <!-- Local directories and files -->
  <property name="src" value="src" />
  <property name="classes" value="classes" />
  <property name="unverified" value="unverified" />
  <property name="lib" value="lib" />

  <property name="jar-file" value="{lib}/sample.jar" />
  <property name="manifest-file" value="sample.manifest" />
  <property name="jad-file" value="sample.jad" />

  <!-- Additional ANT tasks
    Require the StampysoftAntTasks.jar in the ANT lib directory -->
  <!-- Preverifier -->
  <taskdef name="preverify"
    classname="com.stampysoft.ant.j2me.PreverifyTask">
  </taskdef>
  <!-- Jad Updater -->
  <taskdef name="updatejad"
    classname="com.stampysoft.ant.j2me.UpdateJARSizeTask">
  </taskdef>

  <!-- Targets -->

  <target name="init">
    <tstamp />
    <mkdir dir="{classes}" />
    <mkdir dir="{unverified}" />
    <mkdir dir="{lib}" />
  </target>

  <!-- Compile application specific classes -->
  <target name="compile" depends="init">
    <javac srcdir="{src}"
      destdir="{unverified}"
      classpath="{jadeMIDP}"
      bootclasspath="{boot-midp-classes}"
      source="1.1"
      target="1.1"/>
  </target>
</project>
```

```

<!-- Create the MIDlet suite jar file including both JADE and
      application classes -->
<target name="jar" depends="compile">
  <!-- Mix JADE classes and application-specific classes -->
  <unjar src="{jadeMIDP}" dest="{unverified}" />

  <!-- Preverify the whole -->
  <preverify unverified="{unverified}" verified="{classes}" />

  <!-- Create the JAR -->
  <delete file="{jar-file}" quiet="true" />
  <jar jarfile="{jar-file}"
      basedir="{verified}"
      manifest="{manifest-file}" />

  <!-- Update the JAD -->
  <copy file="{manifest-file}"
      toFile="{jad-file}"
      overwrite="yes" />
  <manifest file="{jad-file}" mode="update">
    <attribute name="MIDlet-Jar-URL" value="{jar-fileMIDP}" />
  </manifest>
  <updatejad jad="{jad-file}" />
</target>
</project>

```

### 3.1 Minimization

Even in the *midp* version JADE-LEAP includes a lot of library classes that are useful only when the programmer actually uses them. For this reason a JADE-LEAP based MIDlet jar file produced by the ANT build script presented in previous section, is typically quite big even for very simple applications. In MIDP, however, it is desirable to remove all unused classes and reduce the size of the MIDlet suite jar file as much as possible. This can be done by means of the `minimize` target of the ANT build script included in the LEAP add-on (available for download from the JADE web site in the “Add-ons” area). This target prompts the user for

- The MIDlet suite jar file to be minimized.
- The `.dlc` file that specifies the dynamically loaded classes; these are used as starting point for the minimization process.
- The manifest file to be included in the minimized jar file

The result of the minimization process is a new jar file placed in the same directory of the original jar file and called as the original jar file plus the “-min” suffix. This new jar file will include only those classes that are referenced starting from the classes listed in the `.dlc` file.

The syntax of the `.dlc` file is just one fully qualified class name per line **with no blank lines and no comments**. Here follows an example:

```
jade.MicroBoot
```

```
jade.imtp.leap.JICP.BIFEDispatcher
sample.SampleAgent
```

The first two classes are required by JADE. Then, since agents are loaded dynamically, all application specific agent classes must be listed in the `.dlc` file.

## 4 Compiling JADE-LEAP

### 4.1 Getting the software

In order to compile JADE-LEAP for a given environment (see 1.3) it is necessary to download the JADE sources from the “Download” area of the JADE web site and the LEAP add-on from the “Add-ons” area of the JADE web site.

The LEAP add-on must be unzipped **in the JADE root directory**. Once this has been done your JADE directory structure should look like:

```
jade/
|
|-leap/
|   |- ...
|   |-demo/ includes a simple demo application
|   |-dotnet/ includes files required for dotnet version
|   |-resources/ includes build resources
|   |-src/ includes the leap add-on specific source files
|   |-android/ includes files required for android version
|- ...
|-src/ includes the JADE source files
```

Note that, unlike other add-ons that are un-packaged under the `jade/add-ons/` directory, the LEAP add-on must be un-packaged directly under the jade root directory. We will refer to the `jade/leap` directory as the “LEAP root directory” and we will indicate it simply as `leap/`.

### 4.2 Preliminary steps

As for JADE, building JADE-LEAP can be done using the program ‘**ant**’ (version **1.6** or later), a platform-independent version of make. ‘ant’ uses the file ‘`build.xml`’, which contains all the information about the files that have to be compiled, and that is located into the LEAP root directory `.`. The ‘ant’ program must be installed on your computer, and can be freely downloaded from the Jakarta Project at the Apache web site: <http://ant.apache.org>.

Using ant requires you to set the following environment variables (see the ant documentation for details).

- `JAVA_HOME` must point to your JDK installation.
- `ANT_HOME` must point to where you installed ant.

### 4.2.1 Extra preliminary steps for the .Net version only

Before you can build JADE-LEAP for *dotnet* you have to download and install the following software:

- .NET Framework SDK v1.1 from Microsoft [site](#) (it require the installation of .NET Framework 1.1 Redistributable also).
- Supplemental UI Library for Visual J# .NET v1.1 at this [page](#) (required to compatibility with Java Swing classes).

### 4.2.2 BuildLEAP.properties file (All versions)

Before building JADE-LEAP it is typically necessary to edit the `buildLEAP.properties` file included in the LEAP root directory. This property file includes the properties that depend on the local environment such as

- `j2me-wtk-home` property to point to the directory where the Sun Java Micro Edition SDK (formerly called J2ME Wireless Toolkit) is installed (required only to compile JADE-LEAP for *midp* and *pjava*).
- `dotnet-home` property to point to the directory where the Microsoft .Net Framework is installed (required only to compile JADE-LEAP for *dotnet*).
- `android-platform-home` property to point to the directory where the Android SDK(refer to downlaod <http://developer.android.com/index.html> ) is installed (required only to compile JADE-LEAP for *android*).

For example:**Android-platform-home** = `${env.ANDROID_SDK_HOME} / platforms/android-12`

## 4.3 Building JADE-LEAP

To build JADE-LEAP for a given environment (*pjava*, *midp*, *android* or *dotnet*) go in the LEAP root directory and type

```
ant <env> rebuild
```

where `<env>` indicates the environment you are compiling JADE-LEAP for.

For instance

```
ant midp rebuild
```

will build JADE-LEAP for *midp*.

Typing

```
ant all rebuild
```

will build JADE-LEAP for all environments.

As a result of the build process three new directories (one per environment) are created under the LEAP root directory. The produced JADE-LEAP jar files are named

```
leap/pjava/lib/JadeLeap.jar
```

```
leap/midp/lib/JadeLeap.jar
```

```
leap/dotnet/lib/JadeLeap.dll
```

```
leap/android/lib/JadeAndroid.jar
```

### 4.3.1 Build process details

This informative section provides some details about the build process. **You are not required to be aware of these details to build and use JADE-LEAP.**

Building JADE-LEAP for a given environment goes through the following steps.

**1) Initialization.** In this step the directory for the selected environment is deleted and re-created to ensure the build process starts from a clean situation. In particular the following directory structure is created:

```

leap/      (for Java versions)
|-<env>/
|         |-classes/
|         |-doc/
|         |-lib/
|         |-src/

```

```

leap/      (for .Net version)
|-<env>/
|         |-bin/
|         |-doc/
|         |-examples/
|         |-extras/
|         |-lib/
|         |-src/
|         |-VS2003S/

```

**2) Setup.** In this step the proper source files are copied from the JADE sources (directory `jade/src`) and the LEAP add-on sources (directory `leap/src`) into the `leap/<env>/src` directory. Then all copied files are preprocessed by means of the LEAP preprocessor. In order to adapt to different Java, hardware and network environments in facts, some JADE source files need to be modified “on the fly” before compilation. In order to achieve this we adopted an approach similar to the `#ifdef` directives of the C language. More in details both the JADE source files and the LEAP specific source files that require on-the-fly modifications include special Java comments that can be interpreted by the LEAP preprocessor. The piece of code below provides an example for this.

```

//#MIDP_EXCLUDE_BEGIN
// For some reason the local address or port may be in use
while (true) {
    try {
        sc = new Socket(ta.getHost(), Integer.parseInt(ta.getPort()));
        break;
    }
    catch (BindException be) {
        // Do nothing and try again
    }
}

```



```
//#MIDP_EXCLUDE_END

/*#MIDP_INCLUDE_BEGIN
String url = "socket://" + ta.getHost() + ":" + ta.getPort();
sc = (StreamConnection) Connector.open(url, Connector.READ_WRITE,
false);
#MIDP_INCLUDE_END*/
```

The lines such as `//#MIDP_EXCLUDE_BEGIN` and `/*#MIDP_INCLUDE_BEGIN` are just comments for the Java compiler, but are well defined directives for the LEAP preprocessor. Therefore, with reference to the example above, the same code after *midp* preprocessing would look like

```
String url = "socket://" + ta.getHost() + ":" + ta.getPort();
sc = (StreamConnection) Connector.open(url, Connector.READ_WRITE,
false);
```

Similar directives exist for *pjava* and *dotnet*.

**3a) Compilation (Only for Java versions).** In this step the preprocessed files are compiled to produce class files. When building JADE-LEAP for *midp*, compiled files are also pre-verified.

**4a) Jar (Only for Java versions).** In this step all compiled/pre-verified files are packaged into a single jar file called `JadeLeap.jar` and stored into the `leap/<env>/lib` directory.

**3b) Dll (Only for .Net version).** In this step the preprocessed files are compiled to produce dll file. When building JADE-LEAP for *dotnet*, an executable file, called *JADEBoot.exe*, is created and saved into the `leap/dotnet/bin` directory.

### 4.3.2 Create Visual Studio 2003 solution (Only .Net version)

This building process use the capability offered by Visual Studio 2003 to create the `JadeLeap.dll` file. The process has three steps: create the solution, register the dll into GAC and finally create the executable file. To obtain this type, in LEAP root directory, *ant dotnet solution*

**Note: this building option is to be used only if you have Visual Studio 2003 installed and you have prior compiled JADE-LEAP for dotnet version.**

**1) Initialization.** In this step a new directory is created under `leap/dotnet` branch:

```
leap/      (for .Net version)
|-<env>/
|   |-bin/
|   |-doc/
|   |-examples/
|   |-extras/
```

```

|      |-JadeLeap_Solution/  <- New directory created
|      |-lib/
|      |-src/
|      |-VS2003S/

```

**2) Setup.** In this step the source files are copied from the `leap/dotnet/src` directory into the `leap/dotnet/JadeLeap_Solution` directory.

**3) VS.** You can open Visual Studio 2003 by clicking on `leap/dotnet/JadeLeap_Solution/JadeLeapDotNet.vjsproj` file. Visual Studio 2003 splash screen will be appear. When the loading process will be ended, on the right you could see a column (called Solution Explorer) with all files listed in directories.

**4) Build type.** Before create the dll file, you have to choose which type of compile you prefer: if Debug compile or a Release compile. The first one is used if you want to looking for bugs inside JADE code. The second one is the common choice. Select one of these by clicking on the following combo box:



**5) Compile.** To compile and create the dll click on the compile button or press `Ctrl+Shift+B` buttons. At this point Visual Studio 2003 should ask you to save the solution file (\*.sln) into a directory. You can choose directly yes and continue with the building process. The result is the creation of `JadeLeap.dll` file. It will be placed in `leap/dotnet/lib/` directory .

**6) Registration.** Next step is register the dll into the Global Assembly Cache (called GAC) of you computer. Simply type from `/leap/dotnet/JadeLeap_Solution/bin/<build type>/` directory

**`gacutil.exe /i JadeLeap.dll`** (parameter `i` means install)

**7) Executable.** Now you have the dll registered and you can use it inside your projects. If you want to obtain an executable file to run the agent container like Java version you have to type:

***ant dotnet executable***

The above command will create the `JADEBoot.exe` file in `/leap/dotnet/bin` directory.

#### **4.4 The demo (Only Java versions)**

The LEAP add-on also includes a simple demonstrative application that allows you to try JADE-LEAP and that is located in the `leap/demo` directory. This demo is a simplified

chat application by means of which a group of participants exchange textual messages. Each message sent by a member of the group is received by all participants.

#### 4.4.1 Building the demo

In order to compile the demo go to the LEAP root directory and type

```
ant <env> demo
```

where <env>, as usual, indicates the environment you want to compile the demo for.

Note that in this case, besides the *pjava* and *midp* environment, also the *j2se* environment is present as the demo is available also for the JAVA Standard Edition.

Note also that the only part of the demo that depends on the environment is the GUI that is based on AWT for *j2se* and *pjava* and on the `javax.microedition.lcdui` package for *midp*.

Typing

```
ant all demo
```

compiles the demo for all environments.

As a result of the compilation three files are created (one per environment) into the

`leap/demo/lib` directory called

```
chatOntology.jar
```

```
chatStandard.jar
```

```
chatPjava.jar
```

```
chatMidp.jar
```

Also the Ontology library was created

```
chatOntology.jar
```

The `ant all demo` command compiles also the Android Chat Client into the `leap/android/demo/bin` folder; the discussion about the demo for this platform is delegated to the tutorial mentioned above.

Note that, unlike `chatStandard.jar` that only includes the demo classes, `chatPjava.jar`, `chatMidp.jar` include both the demo classes and the JADE-LEAP classes so that they are ready to be uploaded on a handheld device.

#### 4.4.2 Running the demo

In order to run the demo the following utility files are provided.

`startPlatform.bat` - Batch file to execute the platform plus the

`ChatManagerAgent`, i.e. the agent that acts as a presence server informing each participant when other participants join/leave the chat.

`startChatParticipant.bat` - Batch file to start a `ChatClientAgent` (i.e. the agent that allows a user to take part to the chat) on the PC. You can activate as many of these agents as you like.

`demo.jad` - JAD descriptor file to execute the demo on a MIDP device (refer to your MIDP device documentation to see how to upload this file plus the `demoMidp.jar` file to your MIDP device). Assuming the Java Wireless Toolkit is correctly installed on your

PC, double-clicking on this file should activate the wireless device emulator and load the demo MIDlet suite as shown in Figure 5.



**Figure 5. Starting the demo on the wireless emulator**

Selecting JADE-Chat activates a ChatClientAgent on the wireless emulator. Selecting View-output allows you to review logs (see 2.2.2.3) in case of problems.

## 5 APPENDIX 1 - Limitations in JADE-LEAP for pjava, midp and dotnet

This appendix provides a summary of JADE-LEAP limitations that you have to take into account when working in *pjava* and *midp* with respect to JADE.

### 5.1 PJAVA

- All JADE administration tools have GUIs based on Swing. As a consequence they cannot be executed on a *pjava* container. The same applies for the `jade.gui` package.
- It is not possible to “sniff” (by means of the Sniffer agent) or “introspect” (by means of the Introspector agent) an agent running on a *pjava* stand-alone container. Note that, on the other hand, it is possible to sniff an agent running on a *pjava* split container.
- The MainReplication and PersistentDelivery services are not supported.

### 5.2 MIDP

- The limitations described for *pjava* in the previous section also apply to *midp*.
- Agent mobility and cloning is not supported.
- The reflective introspectors (`jade.content.onto.ReflectiveIntrospector` and `jade.content.onto.BCReflectiveIntrospector`) are not supported in *midp* as they make use of Java reflection. The JADE support for content languages and ontologies can still be used by either working with abstract descriptors or using the `jade.content.onto.MicroIntrospector`.
- The `jade.wrapper` package and the methods of the `jade.core.Runtime` class that refer to classes in that package are not available in *midp*. A simplified in-process interface is still available through the `startUp()` and `shutDown()` methods of the `jade.core.Runtime` class (when executing a standalone container) and the `jade.core.MicroRuntime` class (when executing a split container).
- The Threaded behaviours are not supported.

### 5.3 .Net

- JADE-LEAP for *dotnet* is derived from JADE-LEAP *pjava* version and there isn't any graphical interface (except for Sniffer agent GUI).
- At the moment, it is not possible to “introspect” (by means of the Introspector agent) an agent running on a *dotnet* container.
- The MainReplication and PersistentDelivery services are not supported.
- The HTTPS service is not supported.
- The Mobility service is supported with the following limitation:
  - If you would transfer an agent with a GUI, the GUI have to be written in J# language using the Java Swing components available with the Supplementary UI packages from Microsoft (see 1.3)
- RMI is not supported.

- It is not possible to monitor .NET agents with Java RMA agent GUI.
- Communication between .NET agents and Java agents is possible using HTTP Message Transport Protocol.
- To use the *Sniffer* agent just type:  
**JADEBoot –agents sniffer0:jade.tools.sniffer.Sniffer**

## 6 APPENDIX 2. Hints for programmers

A part from the limitations described in 5, JADE-LEAP for *pjava* and *midp* provides the same APIs to applications developers with respect to JADE. As a consequence there is no need for a specific JADE-LEAP programmers guide or API documentation since those provided with JADE are still valid. When working on MIDP devices however there are issues that should be taken into account that are not covered in JADE documentation. This appendix provides proper hints to address these issues properly.

### 6.1 Ad-hoc startup (Only Java versions)

In some cases programmers might need to perform specific operations before starting up the JADE-LEAP runtime or, more in general, they might need to start the JADE-LEAP runtime from within another MIDlet. This can be done by means of the `jade.core.MicroRuntime` class that provide a minimal “in-process interface”. A possible (but not mandatory) approach is to create an ad-hoc startup class by extending `jade.MicroBoot` and redefining the `startApp()` method as needed. The MIDP part of the `chat.client.Start` class included in the chat demo provided with the LEAP add-on shows an example for this.

### 6.2 Agent GUI (Only Java versions)

Agents typically have GUIs to interact with a user. The base element for all MIDP GUIs is the `javax.microedition.lcdui.Displayable` class. In order to show whatever `Displayable` object it is necessary to have a reference to the current MIDlet. When starting JADE-LEAP for *midp* using the built-in startup class `jade.MicroBoot`, a pointer to the current MIDlet is made available by means of the public static variable `midlet` of the `jade.core.Agent` class. A code similar to that below can therefore be used (e.g. within the `setup()` method of an agent) to show a `Form` that acts as a GUI.

```
Form f = new Form("My Gui");
// Append proper items to the form
Display.getDisplay(Agent.midlet).setCurrent(f);
```

When starting JADE-LEAP by means of an ad-hoc startup class, as described in 6.1, programmers should take care that the `Agent.midlet` variable is properly set or make available to agents a pointer to the current MIDlet in a different way.

### 6.3 Printouts

In general a MIDP device does not show logging printouts produced by calls to `System.out.println()`. Especially during the development phase this can be quite inconvenient. To partially overcome this limitation the `println()` static method of the `jade.util.Logger` class can be used. When running on a *pjava* or *dotnet* environment this method just calls `System.out.println()`. When running on a *midp* environment, on the other hand, logging printouts written by means of this method are redirected so that they can later be viewed by means of the `jade.util.leap.OutputViewer` MIDlet.

### 6.4 Handling connection related events

As described in Figure 2, when using the split container execution mode a permanent connection is used to link the front end (running on the mobile terminal) with its back end (running on a server in the fixed network). This connection is completely managed by JADE that detects disconnections (e.g. due to lack of coverage) and restores it as soon as possible. In some cases however it is useful to properly react to connection related events such as a disconnection at the application level. This can be done by specifying a `ConnectionListener` among the configuration properties passed to the `MicroRuntime` in the `startJADE()` method. The `ConnectionListener` interface (included in the `jade.imtp.leap` package) provides a single method `handleConnectionEvent(int event)` that is called by the JADE runtime whenever a connection related event happens. Possible events are specified as `int` constants in the `ConnectionListener` interface; main events are listed below:

`DISCONNECTED`: the connection with the back end was lost due to some network problem.

`RECONNECTED`: the connection with the back end has been restored.

`RECONNECTION_FAILURE`: JADE detected that it is not possible to re-establish the connection with the back end.

### 6.5 JADE Gui and .Net

All JADE administration tools have GUIs based on Swing components. As a consequence they couldn't be executed on a *dotnet* container. The same limitation exists for the `jade.gui` package. If you use the Supplementary UI packages (see 3.2.1) you can use a large part of the Swing components inside *dotnet* code. But some element of Swing package cannot work anyway inside .NET such as `JTable` component. The only method to run it is rewrite missing classes in pure .NET technology (e.g. in C# language).

## 7 APPENDIX 3. Examples for .NET version

### 7.1 Compile all examples (J# and C#)

To compile all examples for .NET version start the command shell. Go to the leap directory and type

- *ant dotnet all-examples*, if you want to compile all the J# and C# examples for .NET;
- *ant dotnet J#-examples*, if you want to compile only J# examples for .NET;
- *ant dotnet C#-examples*, if you want to compile only C# examples for .NET;

At the end you'll find your .NET examples inside `leap/dotnet/examples` directory.

**Note: the J# examples are the same of those distributed with JADE-LEAP for Java.**

### 7.2 C# examples

In this section you can see some example made with C#.

#### 7.2.1 DummySender & DummyReceive

To compile this example just click on the

`leap/dotnet/examples/dummy/dummy.sln` file. Visual Studio 2003 will appear on the screen and than it will possible to compile and execute the example.

To start the demo you have two possibilities:

- start it within Visual Studio 2003: under *Project/Dummy* properties menu click on Configuration property and select Debugging. You should see many rows on the right of the little windows. Select the row called *Command Line Arguments* and type –  
**agents  
receiver:dotnet.examples.dummy.DummyReceiver;sender:dotnet.examples.dummy.DummySender(receiver)**

Now you can run the project clicking the run button or pressing *F5* button.

- start it from command shell. Go to the leap directory and type  
*ant dotnet C#-examples* (as say above)  
You should find in the `leap/dotnet/examples/dummy` directory a file called `Dummy.exe`

There are two different usage of this example: you can run it in the same computer or in a network. In the first case you can type **Dummy.exe –agents  
receiver:examples.dummy.DummyReceiver;sender:examples.dummy.DummySender(receiver)** and observe the result.

If you create two different agent container in two different pc you have to specify, for the *DummySender* agent, the name of the receiver's computer.



E.g. if you create container A on pc host1 with *DummyReceiver* agent and container B in pc host2 with *DummySender* you have to type the following commands in  
leap/examples/dotnet/dummy:

on pc A: **Dummy.exe –agents receiver:examples.dummy.DummyReceiver –mtp jade.mtp.http.MessageTransportProtocol**

on pc B: **Dummy.exe –agents sender:examples.dummy.DummySender(receiver,host1) –mtp jade.mtp.http.MessageTransportProtocol**

In this way you activate the communication on HTTP MessageTransportProtocol and specify to the *DummySender* agent where is the *DummyReceiver* agent.

## **8 APPENDIX 4. Running JADE-LEAP on a Windows Mobile 2003 device with the J9 Virtual Machine**

### **8.1 J9 Installation**

- Download from IBM web site (<http://www-306.ibm.com/software/wireless/wsdd/>)  
WebSphere Everyplace Micro Environment 5.7.2 - Personal Profile 1.0 for Windows Mobile 2003 2nd Ed.

- From the IBM web site: Follow these steps to install a runtime environment on your development computer:

1. Run the installer that is appropriate for your operating system:
  - \* weme-wm2003-arm-pro10-5.7.0.exe for a Windows environment
  - \* weme-wm2003-arm-pro10-5.7.0.bin for a Linux environment

Note: You must be logged in as "root" on a Linux system.

Result: The installer launches. The first window displays information about the installer package.

2. Click Next.

Result: The second installer window displays the license agreement.

3. Accept the license agreement and click Next.

Result: The third installer window prompts for the location to install the runtime files.

4. Accept the default location, or enter an alternate location, and click Next.

Result: The installer displays a verification prompt.

5. If the information is correct, click Next.

Result: A "successful installation" dialog box displays.

6. At this point, there are 2 different options to choose from:

\* If Finish is selected, it will display a verification that the program should exit. The runtime has been installed on the development machine. You will need to manually Active Sync the CAB files at a later time.

\* If Continue is selected, it will try to detect the Microsoft ActiveSync software to sync to your mobile device. If Microsoft ActiveSync software is not found, the dialog box displays instructions on finding the CAB files and performing the synchronization manually.

7. Click Next.

8. Click Finish to close the installer.

### Manually installing the runtime on your mobile device

If the CAB file was not automatically synchronized with your device, follow these steps to install the runtime environment:

Note: These instructions are for Windows only. Contact your mobile device manufacturer for Linux instructions.

1. To install the runtime environment:

\* On a Windows operating system, browse to the C:\Program Files\IBM\WEME\57\wm2003\arm\PPro10\cab directory.

\* On a Linux operating system, browse to the /opt/IBM/WEME/57/wm2003/PPro10/cab directory

2. Copy weme-ppro10-wm2003-arm\_22.CAB to your mobile device.

3. Click on the CAB file or, on the Settings tab, select Add/Remove Software to run the installer.

At this point try the example provided with the J9 runtime.

Pay attention: if Windows Mobile 2003 has been installed on the mobile device in a language different from English the J9 runtime might not work, in these cases create a "Program Files" folder at root level (at the same level of the "Windows" folder) and move the J9 folder, now the runtime and the example should work fine.

## **8.2 Running JADE-LEAP**

On your PC

-----

1- Compile JadeLeap for the *pjava* environment.

2- Start a JADE Main Container

On the mobile device

-----

1- Connect the mobile device with the PC using Microsoft Active Synchron

- 2- Create a folder i.e under "Program Files" called "JadeLeap" and copy the JadeLeap.jar file from pjava\lib.
3. Create the shortcut for the JadeLeap container: on you PC create a file called Leap.lnk. Since with Leap for pjava it is possible to start a normal container or a split container use the following lines:
  - 3.1 to start a normal container:

```
255#\Program Files\J9\PPRO10\bin\j9.exe" "-jcl:ppro10" "-cp" "\Program Files\JadeLeap\JadeLeap.jar" "jade.Boot" "-host" "<platform_ip_address_>" "-container"
```
  - 3.2 to start a split container:

```
255#\Program Files\J9\PPRO10\bin\j9.exe" "-jcl:ppro10" "-cp" "\Program Files\JadeLeap\JadeLeap.jar" "jade.MicroBoot" "-host" "<platform_ip_address_>"
```
- 4- Copy the file Leap.lnk in "Windows/Start Menu/Programs" on the device.
- 5- For the execution:
  - 5.1 Open a GPRS connection (of course the PC running the platform must have an IP address accessible over the net).
  - 5.2 From the Start menu, select Programs.
  - 5.3 Select the Leap icon. Result: a leap container joins the platform.

### **8.3 Running the JADELEAP Demo**

On the PC

-----

- 1- Compile the leap demo for j2se and pjava enviroment as specified in this Leap User guide
- 2- Start the platform using the batch file "demo\startPlatform.bat"
3. Start a chat participant using the batch file "demo\startChatParticipant.bat"

On the mobile device

-----

- 1- Connect the device with the PC using Microsoft Active Synch
- 2- Create a folder i.e. under "Program Files" called LeapDemo and copy the demoPjava.jar file.
- 3- Create the shortcut for the JadeDemo: on your PC create a file called LeapDemo.lnk and write the following line (according to your paths on the device):

```
255#\Program Files\J9\PPRO10\bin\j9.exe" "-jcl:ppro10" "-cp" "\Program Files\LeapDemo\demoPjava.jar" "chat.client.Start" "-host" "<platform_ip_address_>"
```

- 4- Copy the file LeapDemo.lnk on the device into "Windows/Start Menu/Programs".
- 5- To start the demo:
  - 5.1 Open a GPRS connection (of course the PC running the platform must have an IP address accessible over the net).
  - 5.2 From the Start menu, select Programs.
  - 5.3 Select the Leap Demo icon. Result: The LeapDemo application will run and you can chat with the other chat participant launched on your PC.