jPOS Extended Edition

Revision:

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Part I. Introduction

Chapter 1. Project Overview

1.1. Background

Back in the late nineties, our company was awarded the development of a jPOS-based application for our local VISANet [1] acquirer.

At that time, we thought that going for a J2EE solution was the way to go. We went with the great Orion application server and we called the application **jPOS-EE**, it was kind of a jPOS "Enterprise" Edition.

But we soon got to hit some of the major problems of running an early J2EE application in a demanding 7x24x365 environment, the deployment of new versions was both stressful and costly in terms of time (a one minute downtime can feel like a week when you are manning the telephones in a call center). So we designed a lightweight solution that we could deploy and redeploy quickly, without obscure RMI-IIOP related issues that could only be solved with an application server restart.

In addition, we started to see how O/R mapping tools such as Hibernate offered greater sophistication than EJB 2.1 could offer, and EJB 3.0 was not on the horizon yet.

So we decided to build our own tiny environment and began by building **Q2**, our JMX-based IoC micro kernel. [2]

We consider jPOS-EE as a **Meta-Project** where we encompass many other compatible (from a technical as well as license perspective) Open Source projects such as:

- Hibernate
- Jetty
- Velocity
- XStream
- JDOM
- JDBM
- Apache Commons
- Etcetera

In order to easily assemble different types of jPOS-EE applications whilst fostering code reuse as much as possible, we have developed a very simple, module-based jPOS-EE Software Development Kit (jPOS-EE SDK), now replaced by Gradle [3].

We kept the name jPOS-EE, but we replaced the first E from Enterprise to Extended. This document describes the **jPOS Extended Edition**.

We don't claim that using the jPOS-EE framework and our choice of supporting projects is the best way to write a jPOS application, people could argue that JEE is the way to go, or Spring is the way to go, or Pico/Nano container does better IoC, or that we should use JBoss/Jeronimo, Guice, OSGI, QI4J, you name it. In the same way, we choose to use Jetty but there's people that may say that Tomcat is the way to go.

jPOS-EE is just the way we at jPOS.org write our applications and we are sharing this "technology" on an as-is basis. You can use it, or you can write your jPOS application using whatever technology/framework you feel more comfortable with.

[1] Visanet/Uruguay **http://visanet.com.uy**
[2] Q2 is QSP version 2, described in the jPOS Programmer's Guide
[3] Gradle Project **http://gradle.org/**

1.2. About this document

This is the official jPOS-EE documentation that intends to aggregate everything related to jPOS-EE, including but no limited to: its objectives, specifications, schedule, priorities, organizational chart, road map, change log, coding conventions, core modules, optional modules, license information, etc.

It complements, but doesn't replace the **jPOS Programmer's Guide** [http://jpos.org/products/proguide]. It is not a user guide nor a tutorial, it is a development master workbook, written by developers for developers.

You're currently reading revision 2.0.10.

New versions of this document are regularly posted in **jpos.org/doc/jPOS-EE.pdf** [http://jpos.org/doc/jPOS-EE.pdf].

1.3. Objectives

Our main objective is to avoid repeating ourselves. **DRY** [4] is a good paradigm to keep in mind.

We at jPOS.org have a small company with very limited development resources and a large number of customers. Most of our end user applications are very specific, yet they share a large number of features.

jPOS-EE is all about code reuse. We developed a very simple SDK based on a pluggable module architecture that can be bundled together at compile time to create — as fast as possible — highly reliable jPOS applications.

The more we use jPOS-EE to create applications for our customers, the more we tend to make these modules smaller, with as few dependencies on each other as possible.

We expect developers using jPOS-EE to create their own modules based upon our public ones, and to interact with the jPOS-EE community in order to engage into the formal process of requesting changes to the jPOS-EE codebase whenever it is deemed necessary.

Local changes to the jPOS-EE code base may seem the easy way to solve a given requirement, but it forces you to apply the same change over and over as new jPOS-EE versions become available.

We encourage you to go the formal route and send us a pull request that can be included in jPOS-EE, reviewed by other jPOS-EE developers, tested in multiple platforms and disparate environments, properly documented and maintained in future releases.

1.4. Copyright and License

jPOS-EE is copyrighted code licensed under the GNU Affero General Public License version 3.

A copy of the copyright notice is available in every source file and can be found in link **Appendix A, *Copyright***.

A copy of the GNU Affero General Public License version 3 is also available in **Appendix B, *License***.

We strongly recommend you to review our license terms before using jPOS or jPOS-EE. You can find very useful information in the official Free Software Foundation GPL FAQ page (**www.fsf.org/licensing/licenses/gpl-faq.html** [http://www.fsf.org/licensing/licenses/gpl-faq.html]).

The AGPL covers applications that runs over the network (SaaS) such as most credit/debit card verification/ authorization systems like those deployed by most people using jPOS, meaning that you probably need a commercial license.

If in doubt, you can contact us using **jpos.org/contact** [http://jpos.org/contact?p=EECL]

1.5. Getting involved

jPOS-EE is a centralized open source project. jPOS.org retain full control of the release cycle because the code placed in the jposee repository is regularly checked out by our production customers.

[4] Do not repeat yourself

Whilst we have experimental modules, and a sandbox/incoming area where we can put alpha and even PoC code, there are fundamental modules that we use over and over at production sites. These modules may have been audited or even certified by third parties and we can't afford to modify them without being absolutely sure of their impact in the rest of the systems.

That said, we are very happy to accept contributions, and publish them for review by the jPOS-EE community.

We license jPOS-EE commercially, so companies or individuals willing to include code in the jPOS-EE distribution will need to sign a CLA (see **Appendix C, *Contributor License Agreement***) and if working for a company, a CCLA agreement (see **Appendix D, *Corporate CLA***) as well.

The best way to stay up-to-date with jPOS and jPOS-EE is to monitor the following resources:

- **The jPOS Blog** [http://feeds.feedburner.com/jpos]
- **jPOS and jPOS-EE commit notifications** [http://feeds.feedburner.com/jpos-commits]
- **jPOS users forum** [http://groups.google.com/group/jpos-users/feed/msgs.xml]
- **jPOS developers forum** [http://rss.gmane.org/gmane.comp.java.jpos.devel]
- **@jposcommits** [http://twitter.com/jposcommits]
- **Issue Tracker** [https://jpos.org/issues/issues/jPOS-EE]
- If tweeting about jPOS, please use the **#jPOS** [https://twitter.com/search?q=%23jPOS] hashtag

Resources Page

There is a handy **jpos.org/resources** [http://jpos.org/resources] page at our website.

Chapter 2. Contributing to the project

This project uses Fork & Pull collaborative development model as described in: **https://help.github.com/articles/using-pull-requests**.

The following sections provide the guidelines to follow before a contribution is made to the project.

2.1. GitHub Workflow

2.1.1. Quickfire Do's and Don't's

If you're familiar with git and GitHub, here's the short version of what you need to know. Once you fork and clone the jPOS-EE code:

- **Don't develop on the master branch**. Always create a development branch specific to the issue (see **https://jpos.org/issues/issues/jPOS-EE**) you're working on. Name it by issue # and description. For example, if you're working on Issue jPOS-EE-359, an aspect naming fix, your development branch should be called jPOS-EE-359-aspect-names. If you decide to work on another issue mid-stream, create a new branch for that issue—don't work on both in one branch.
- **Do not merge the upstream master with your development branch**; rebase your branch on top of the upstream master.
- **A single development branch should represent changes related to a single issue.** If you decide to work on another issue, create another branch.

Please note we use our own issue tracker system, YouTrack, hosted in jPOS.org. Please don't be confused with the excellent issue tracker provided by Github, we are currently not using that one.

2.1.2. Step-by-step (the short version)

- Fork on GitHub (click Fork button)
- Clone to computer (`$ git clone git@github.com:~you~/jPOS-EE.git`)
- Don't forget to cd into your repo: (`$ cd jPOS-EE/`)
- Set up remote upstream (`$ git remote add upstream git://github.com/jpos/jPOS-EE.git`)
- Create a branch for new issue (`$ git checkout -b 100-new-feature`, if you don't have a bug report no worries just skip the number)
- Develop on issue branch. [Time passes, the main jPOS repository accumulates new commits]
- Commit changes to issue branch. (`$ git add . ; git commit`)
- Fetch upstream (`$ git fetch upstream`)
- Update local master (`$ git checkout master; git pull upstream master`)
- Repeat steps 5-8 till dev is complete
- Rebase issue branch (`$ git checkout 100-new-feature; git rebase master`)
- Push branch to GitHub (`$ git push origin 100-new-feature`)
- Issue pull request (Click Pull Request button)

Extra reading material on forking can be found at : **http://gun.io/blog/how-to-github-fork-branch-and-pull-request/**

Item 11 (rebase) in the previous list is very often forgotten, but it's extremely important. Be kind with the rest of the team and do it. Read this **post by Git author Linus Torvalds** [http://www.mail-archive.com/dri-devel@lists.sourceforge.net/msg39091.html] to understand why.

2.1.3. Commit messages

Please read **http://tbaggery.com/2008/04/19/a-note-about-git-commit-messages.html** for guidelines in creating good commit messages.

2.2. Coding conventions

We adhere to standard **Sun's java ® coding conventions** [http://www.oracle.com/technetwork/java/codeconventions-150003.pdf] for the Java Language, that among other things it specifies: Four spaces should be used as the unit of indentation. The exact construction of the indentation (spaces vs. tabs) is unspecified. Tabs must be set exactly every 8 spaces (not 4).

Due to our revision control system, we also need that hard tabs (ASCII 0x09) are not used in source code and configuration files (in order for diff to work properly among platforms.

For *vi* users, we are using the following .vimrc:

```
set ts=8
set sts=4
set sw=4
set expandtab
```

For your Git commits and pull requests, we recommend you normalize your end of lines. This is specially important if you use a Windows platform.

```
git config --global core.autocrlf input
```

Eclipse users, go to Preferences -> Java -> Editor -> Typing and check the *Insert space for tabs* checkbox.

Part II. Modules

Chapter 3. Introduction to modules

In our traditional Ant based build system, the developer chooses which modules to use from the *opt* directory, and creates symbolic links to the *modules* directory. The build system merges them into a flat structure, and does some processing such as:

- Concatenate constants files from all modules into single addressable constant files.
- Create the hibernate configuration file from all the "mapping file" snippets from all the selected modules
- Resolve any property placeholders from all modules using property files

Compiled classes for all selected modules, static definitions for database connections, static constants file(s), etc. are then used to generate a jar archive (jposee.jar).

With the introduction of Gradle-based jPOS-EE project structure, we are also introducing a new module system, based on Maven type artifacts.

Some immediate benefits are:

- The SDK is built independently from your project.
- Your project just uses the modules as versioned dependencies. As a result your project's footprint is reduced, as now only need to track your code, not all the jPOS-EE dependencies in your version control system.
- The barrier to entry is greatly reduced, since a new developer could setup a jPOS-EE project in five minutes.
- No need to track module dependencies.
- Each module contains "sample" configurations used during project setup at runtime.

3.1. How do modules work?

A module is nothing more than a simple jar artifact with special features.

3.1.1. Hibernate Mappings

A Module defines a "module descriptor", stored in **/META-INF/org/jpos/ee/modules**. This descriptor contains the hibernate mapping entries for the persistent entities defined in this module.

Here is an example,

```
<module name="status">

    <mappings>
        <mapping resource="org/jpos/ee/status/Status.hbm.xml" />
        <mapping resource="org/jpos/ee/status/StatusTag.hbm.xml" />
    </mappings>

</module>
```

It is best practice to name the module descriptor the same as the module name suffixed with the ".xml" extension.

Instead of defining them statically in a central *hibernate.cfg.xml*, the persistent class mappings are resolved at runtime from all the module descriptors visible in the classpath.

3.1.2. Installables

There's a very special resource path, **/META-INF/org/jpos/ee/installs**. Any resource stored below that path, gets installed to the filesystem during the setup process (as shown in the tutorial).

So for example, if we have the *jposee-core* module as one of our dependencies, and the core modules has the following structure

```
META-INF
`-- org
    `-- jpos
        `-- ee
            `-- installs
                |-- cfg
                |   `-- README.txt
                |-- deploy
                |   |-- 00_logger.xml
                |   `-- 99_sysmon.xml
                `-- log
                    `-- q2.log
```

and we do:

```
$ java -jar q2.jar -cli
q2> setup .
```

We'd get the following structure copied to our current working directory:

```
.
|-- cfg
|   `-- README.txt
|-- deploy
|   |-- 00_logger.xml
|   `-- 99_sysmon.xml
`-- log
    `-- q2.log
```

If now we added the *jposee-db-mysql* module as one of our dependencies, which contains the following structure and ran setup again:

```
META-INF
`-- org
    `-- jpos
        `-- ee
            `-- installs
                `-- cfg
                    `-- db.properties
```

We'd end up with the following files in our filesystem:

```
.
|-- cfg
|   |-- README.txt
|   `-- db.properties
|-- deploy
|   |-- 00_logger.xml
|   `-- 99_sysmon.xml
`-- log
    `-- q2.log
```

Chapter 4. Core Modules

4.1. CORE

What	The core module contains all basic jPOS-EE functionality.
When	Available in all versions of jPOS-EE.
Who	The jPOS.org team.
Where	Directory modules/core available in git repository at github.
Why	This is a core module required in all jPOS-EE applications.
Status	Stable.
License	**GNU Affero General Public License version 3**

Maven Coordinates.

```
<dependency>
    <groupId>org.jpos.ee</groupId>
    <artifactId>jposee-core</artifactId>
    <version>${jposee.version}</version>
</dependency>
```

The core module serves two purposes:

- It includes all basic dependencies needed to run any jPOS-EE application.
- It contains base functionality shared by all jPOS-EE applications.

4.2. Transaction Support

What	The *txn* module contains **Transaction Manager** support code as well as common transaction manager participants.
When	Available in all versions of jPOS-EE.
Who	The jPOS.org team.
Where	Directory modules/txn available in git repository at github.
Why	This module if useful is your jPOS-EE application uses the **Transaction Manager**.
Status	Stable.
License	**GNU Affero General Public License version 3**

Maven Coordinates.

```
<dependency>
    <groupId>org.jpos.ee</groupId>
    <artifactId>jposee-txn</artifactId>
    <version>${jposee.version}</version>
</dependency>
```

There is nothing worse than re-inventing the wheel for every project. With this in mind, the jPOS team identified a series of activities that were common to almost every enterprise grade jPOS-EE based project, and created a module to provide the basis for building great TransactionManager participants that follow best practice patterns.

Instead of showing a boring table with a description of what every component does, I think an example Transaction Manager instance is in order:

```
<txnmgr name="txnmgr" logger="Q2" class="org.jpos.transaction.TransactionManager">
    <property name="space" value="transient:default"/>
    <property name="queue" value="TXN"/>
    <property name="max-sessions" value="10"/>

    <participant class="org.jpos.transaction.Open" logger="Q2" realm="open-db">      ❶
        <property name="checkpoint" value="db-open"/>
    </participant>

    <participant class="com.mydemo.DemoParticipant"                                  ❷
                 logger="Q2" realm="demo-participant"/>

    <participant class="org.jpos.transaction.Close" logger="Q2" realm="close-db">    ❸
        <property name="checkpoint" value="close"/>
    </participant>
</txnmgr>
```

❶ The *Open* Participant opens a new DB session and transaction.
❷ Our demo participant does some processing
❸ The *Close* Participant commits or rollbacks the existing transaction based on overall outcome, and closes the session.

In our demo scenario, the transaction manager will open a database session, execute our DemoParticipant and close the database session (although our DemoParticipant does not need a DB session!).

In case we wanted to add some debugging, we could definitely add to the end of the file:

```
    <participant class="org.jpos.transaction.ProtectDebugInfo"
                 logger="Q2" realm="protect-debug">                                  ❶
        <property name="checkpoint" value="protect-debug-info"/>
        <!-- Wipes entries from context -->
        <property name="wipe-entry" value="PAN"/>
        <property name="wipe-entry" value="EXP"/>
        <!-- Protects contents from any ISOMsg in context -->
        <property name="protect-ISOMsg" value="2"/>
        <property name="protect-ISOMsg" value="35"/>
        <property name="protect-ISOMsg" value="45"/>
        <!-- Wipes contents from any ISOMsg in context -->
        <property name="wipe-ISOMsg" value="48"/>
        <property name="wipe-ISOMsg" value="52"/>
    </participant>

    <participant class="org.jpos.transaction.Debug" logger="Q2" realm="debug">      ❷
        <property name="checkpoint" value="debug"/>
    </participant>
```

❶ The *ProtectDebugInfo* Participant protects sensitive material from logs.
❷ The *Debug* participant dumps the contents of the context to the log.

This would result in the contents of the context being dumped to the log, protecting sensitive material on the way.

In case you are wondering what the `DemoParticipant` might look like:

```
public class DemoParticipant extends TxnSupport implements MyConstants          ❶
{
    protected int doPrepare(long id, Context ctx) throws Exception               ❷
    {
        ISOMsg message = (ISOMsg) ctx.get(REQUEST);
        ISOSource source = (ISOSource) ctx.get(SOURCE);

        assertNotNull(message,"A valid 'REQUEST' is expected in the context");   ❸
        assertNotNull(source,"A valid 'SOURCE' is expected in the context");
        assertTrue(message.hasField(4),                                          ❹
            "The message needs to have an amount (ISOMsg:4)");

        message.setResponseMTI();

        Random random = new Random(System.currentTimeMillis());
        message.set (37, Integer.toString(Math.abs(random.nextInt()) % 1000000));
        message.set (38, Integer.toString(Math.abs(random.nextInt()) % 1000000));

        if ("000000009999".equals (message.getString (4)))
            message.set (39, "01");
        else
            message.set (39, "00");

        source.send (message);
        return PREPARED | NO_JOIN | READONLY;
    }
    public void commit(long id, Serializable context) { }
    public void abort(long id, Serializable context)  { }
}
```

❶ Our demo participant extends TxnSupport, the supporting class provided by this module.
❷ TxnSupport overrides the "prepare" method and delegates to *doPrepare*
❸ As you can see, not-null assertions are quite easy!
❹ So are boolean assertions.

If you are serious about jPOS-EE development involving Transaction Manager, we advise you to study the `TxnSupport` class further.

4.3. TxnId

The `txn` module has a handy `TxnId` class that can be used to generate ids in a distributed way.

The id is composed of:

- 1-digit century
- 2-digits year
- 3-digits day of year
- 5-digits second of day
- 3-digits node id
- 5-digits transaction id

A typical ID long value would look like this: `173000348000000001`, and the `toString()` method would show as `017-300-03480-000-00001`.

`TxnId` also has a handy `toRrn()` method that can be used to create (and parse) 12-characters strings suitable to be used as retrieval reference numbers.

`TxnId` can be used instead of UUIDs. It puts less pressure in the database index and provides chronological order.

The last two groups, `node-id` and `transaction-id` are supposed to be unique. transaction-id is easy to get from the transaction manager. `node-id` is a tricky one, use has to ensure each node has a unique `node-id` to avoid collisions.

4.4. QI Basics

4.4.1. Main XML

The main configuration is done on `00_qi.xml`

The main contents of this file are:

Title

Example: `<title>jPOS QI</title>`

Indicates the title for the app.

Locale

Indicates the available locales for the app, it can have more than one. The first one will be the default locale.

Examples:

```
<locale>en-US</locale>
```

```
<locale>es-UY</locale>
```

Messages

Indicates the names of the `.properties` files available. It can contain more than one.

Example:

```
<messages>qi-core-messages</messages>
```

```
<messages>qi-eeuser-messages</messages>
```

```
<messages>qi-sysconfig-messages</messages>
```

The naming convention for these files is: `packagename_locale.properties`

Menubar

A menubar represents the horizontal menu at the top of the app. It is represented with the `<menubar>` element. It contains "menus".

Menu

It represents the menu item. It has a `name`, an `icon`, a `style`, and an `action`.

Example:

```
<menu name="System" icon="COG" style="icon-cog" action="system" />
```

Sidebar

Represents the sidebar, it can contain **sections** and **options**. It is represented with the `sidebar` element. It can also be identified by an `id`. Example: `<sidebar id="info"> ... </sidebar>`

Section

Represents a section of the sidebar, represented with the `<section>` element. It has the following properties:

- `name`: String, required.

Example: `<section name="System"/>`

Option

Represents an option on the sidebar, represented with the `<option>` element. It has the following properties:

- `name` (string, required). The name that will be shown on the sidebar.
- `action` (string, required). What will be executed on click.
- `perm` (string, optional). The permission required to execute the action.

Example:

```
<option name="Exception log" action="exceptions"/>
```

View

Represents a view, it has the following properties:

- `route` (string, required). The `route` of the view to show.
- `class`
- `perm` (* means any perm).
- `sidebar` optional sidebar id. Indicates to which sidebar the view corresponds.

Example:

```
<view route="home" class="org.jpos.qi.views.DefaultView" perm="*" sidebar = "system"/>
```

Views can **can/will** contain different **properties** & **attributes**.

Properties

Represented with the `<property>` element. It has a `name` and a `value`. Some views require:

- `entityName` (string, required for entities). The name of the entity. For example, for `users`, it is `user`. It must be included like this: `<property name="entityName" value="aName"/>`
- `name` (string, required when extending a class). The name for the view. When extending a class (Ex: when extending from SysConfig), it is a required field. It must be included like this: `<property name="name" value="aName"/>`

Attribute

Represented with the `<attribute>` element. It has:

- `name` (string, required) The name of the attribute, it will be shown on the column, or field.
- `field` (boolean, optional) Boolean value indicating whether the attribute should be shown as a field, on the specific view.
- `column` (boolean, optional) Boolean value indicating whether the attribute should be shown as a columnn on the general view.
- `read-only` (boolean, optional) Boolean value indicating if the attribute should be editable

- `required` (boolean, optional) Indicates if the field is required. Default is false.
- `regex` (string, optional) A string indicating the regex used for validating the field.
- `length` (numeric,optional) A number, indicating the max length for the field value.
- `expand-ratio` (numeric,optional) A number, indicating if the field's expandRatio to be used. (Check link:https://vaadin.com/docs/-/part/framework/layout/layout-settings.html#layout.settings.size.expanding(Vaadin docs)[Vaadin Docs] for more info).
- `perm` (string, optional) The permission needed to access the field.

Example:

Different classes of views - TabView

If the view has a class of type `TabView`. It can contain views within the `<view>` elements. This views accept an additional property:

- `caption` Indicates the caption for the tab.

4.4.2. QI Permissions

- *sysadmin* : Needed to access `/roles`, `/permissions` and roles field in `/users`.
- *login* : Needed to login to **QI** and access `/about`, `/memory`, `/log`.
- *sysconfig* : Needed to access `/sysconfig`.
- *users.write*: Needed to access `/users`.
- *accounting*: Needed to access `/accounts` and `/transactions`.

Chapter 5. Database Support

Several jPOS-EE components rely on the `dbsupport` module to configure and access the underlying database (or databases) using Hibernate.

One of the most used class is `org.jpos.ee.DB` and its usage is straightforward:

```
    DB db = new DB();
    db.open();
    ...
    ...
    db.close();
```

If you want to update the database, your code may look like this:

```
    DB db = new DB();
    db.open();
    db.beginTransaction();
    ...
    ...
    db.commit();
    db.close();
```

The DB object implements the `Closeable` interface, so you can use the try-with-resources construct like this:

```
    try (DB db = new DB()) {
        db.open();
        db.beginTransaction();
        ...
        ...
        db.commit();
    }                                   ❶
```

❶ No need to call `db.close()` as `DB implements Closeable`.

Also, the `DB` object provides a couple of functional alternatives to the code above:

```
DB.exec ((db) -> {
    return db.session().get(YourObject.class, yourId);
});
```

or `execWithTransaction` that encloses your function within a `beginTransaction/commit` block.

```
DB.execWithTransaction((db) -> {
    db.session().save(obj);
    return obj;
});
```

Very often we find ourselves answering the question WHY (on earth) we have this `DB` object instead of just using Hibernate session factory and sessions directly. The answer comes from the history of jPOS-EE, which initially used an object-oriented database (ObjectStore). ObjectStore had a `DB` object that one had to instantiate to access the database, and we were used to it. Interesting enough, ObjectStore helped model JDO, which in term influenced the JPA we have today.

Once we moved away from the object-oriented database to Hibernate, we found it useful to keep that DB object around used by our code, slightly isolating us from Hibernate and providing some helper functionality, and that's the only reason there's a DB object in jPOS-EE.

5.1. DB Support configuration

Hibernate applications are usually configured by means of a single `hibernate.cfg.xml` file that looks like this:

```
<!DOCTYPE hibernate-configuration PUBLIC
    "-//Hibernate/Hibernate Configuration DTD 3.0//EN"
        "http://www.hibernate.org/dtd/hibernate-configuration-3.0.dtd">

<hibernate-configuration>
    <session-factory>
        ...
        ...
        <mapping class="org.jpos.ee.SysConfig"/>
        <mapping resource="org/jpos/ee/User.hbm.xml" />
        <mapping resource="org/jpos/ee/Consumer.hbm.xml" />
        <mapping resource="org/jpos/ee/Revision.hbm.xml" />
        <mapping resource="org/jpos/ee/Role.hbm.xml" />
        <mapping class="com.your.company.entity.YourEntity" />
        ...
        ...
    </session-factory>
</hibernate-configuration>
```

Besides standard configuration (c3p0, jdbc, transaction isolation), the `hibernate.cfg.xml` file has a collection of mappings for your application's entities, but jPOS-EE applications are built *à la carte* picking modules from the jPOS-EE modules offeering, as well as customer specific modules.

So if an application wants to use jPOS-EE DB support using say Postgresql backend, and wants to use the `sysconfig` module, and `eeuser` module, you would add the following dependencies:

```
   compile "org.jpos.ee:jposee-db-postgresql:${jposeeVersion}" ❶
   compile "org.jpos.ee:jposee-sysconfig:${jposeeVersion}"
   compile "org.jpos.ee:jposee-eeuser:${jposeeVersion}"
```

❶ the `db-postgresql` depends on `dbsupport` so no need to include it explicitly

But upon adding these modules as a dependency, the developer would have to manually add these mappings to the `hibernate.cfg.xml`.

In addition, as part of the edit work, you need to specify the Hibernate dialect to be used (i.e. `org.hibernate.dialect.MySQL5InnoDBDialect` for MySQL, or `PostgreSQLDialect` for Posgresql), JDBC URL, etc.

jPOS-EE uses a simple convention to dynamically create the Hibernate configuration file based on the following rules:

- It uses an initial **hibernate.cfg.xml** [https://github.com/jpos/jPOS-EE/blob/master/modules/dbsupport/src/main/resources/hibernate.cfg.xml] template available in the application's CLASSPATH as starting point.
- It scans the classpath looking for XML configuration files in each dependency jar inside the `META-INF/org/jpos/ee/modules`, for example, the `eeuser` module has the file:

```
<module name="eeuser">
    <mappings>
        <mapping resource="org/jpos/ee/User.hbm.xml" />
        <mapping resource="org/jpos/ee/Consumer.hbm.xml" />
        <mapping resource="org/jpos/ee/Revision.hbm.xml" />
        <mapping resource="org/jpos/ee/Role.hbm.xml" />
    </mappings>
</module>
```

So those mappings become part of the main Hibernate configuration. See **eeuser.xml** [https://github.com/jpos/jPOS-EE/blob/master/modules/eeuser/src/main/resources/META-INF/org/jpos/ee/modules/eeuser.xml]

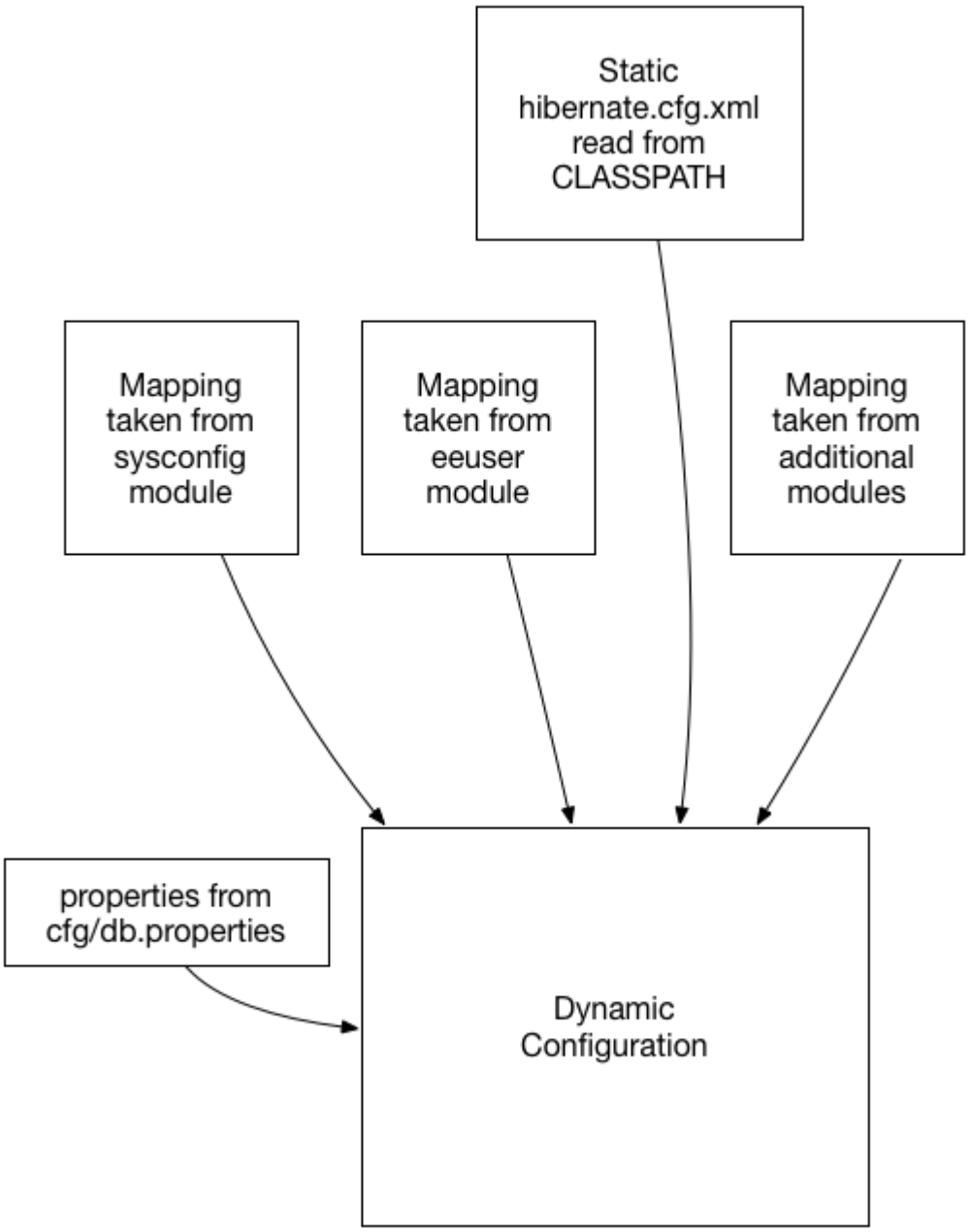
- Finally, it searchs for a `cfg/db.properties` file in the current working directory for additional configuration and overrides.

Here is a sample `db.properties`:

```
hibernate.connection.username=sa
hibernate.connection.password=password
hibernate.hbm2ddl.auto=validate
hibernate.connection.url=jdbc:postgresql://localhost:5432/jposee
hibernate.connection.driver_class=org.postgresql.Driver
hibernate.dialect=org.hibernate.dialect.PostgreSQLDialect
```

In addition to the XML module mapping file available in each module's classpath, the `db-*` set of modules (such as `db-mysql`, `db-postgresql`, etc.) has a sample `db.properties` file included in its `META-INF/q2/installs/cfg` directory, so a call to `gradle installResources` or the `install` CLI command (that you can invoke by calling `q2 --cli`) will export it to the operating system, where you can easily edit it.

So to recap, the following diagram shows how a dynamic `hibernate.cfg.xml` configuration is created when we call `DB db = new DB()` with no arguments:



remember, the `mapping` files are taken from the special `META-INF/org/jpos/ee/modules/*.xml`.

This configuration is suitable for situations where you have to connect to a single JDBC endpoint and access and map a unique set of entities. If that's not your case, read below for additional options.

5.1.1. Accessing a secondary/slave database

If you want to access an alternate database, you can use a modifier when instantiating your DB object, for example:

```
DB db = new DB ("slave");                    ❶
db.open();
db.session().setDefaultReadOnly(true);       ❷

...
...
```

❶ We call this constructor parameter a *config modifier*
❷ If this is a real `slave`, you may want to set the underlying Hibernate session to read-only mode.

In this case, jPOS-EE will operate in a very similar way as the one described in the previous section, but instead of reading properties from the `cfg/db.properties` file, it would read them from `cfg/slave:db.properties`.

The previous example works for situations where the set of entities mapped to tables in your secondary database are the same as the primary database. If that's not the case, in addition to read an alternate JDBC configuration from your `slave:db.properties` you want to map a different set of entities.

if your config modifier has actually two modifiers, separated by a colon (i.e. `slave:legacy`), then we'd read JDBC and optional properties from the `cfg/slave:db.properties`, but when we scan for mapping files, we use the following pattern `META-INF/org/jpos/ee/modules/legacy:*.xml`.

Finally, if this black magic feels confusing, you can always call

```
DB db = new DB("path/to/your/hibernate.cfg.xml");
```

The `DB` class uses an internal cache of sessions factories, so the first time you call it with no args or a given modifier, it will create a sessionFactory (an expensive operation that requires access to the database), but after that slow first time, creating new DB objects is a very cheap operation.

Database support is enabled by adding a database backend dependency module to your project.

For MySQL:

```
<dependency>
    <groupId>org.jpos.ee</groupId>
    <artifactId>jposee-db-mysql</artifactId>
    <version>${jposee.version}</version>
</dependency>
```

For PostgreSQL:

```
<dependency>
    <groupId>org.jpos.ee</groupId>
    <artifactId>jposee-db-postgresql</artifactId>
    <version>${jposee.version}</version>
</dependency>
```

For H2 Embedded database:

```
<dependency>
    <groupId>org.jpos.ee</groupId>
    <artifactId>jposee-db-h2</artifactId>
    <version>${jposee.version}</version>
</dependency>
```

For MS-SQL database:

```
    <dependency>
        <groupId>org.jpos.ee</groupId>
        <artifactId>jposee-db-mssql</artifactId>
        <version>${jposee.version}</version>
    </dependency>
```

Only one of these dependencies should defined in your project.

5.2. MySQL ® Support

What:	This module configures Hibernate to use MySQL as its back end.
When:	Available in all versions of jPOS-EE.
Who:	The jPOS.org team.
How:	Posted by the jPOS-EE team.
Where:	Directory modules/db-mysql available in the jPOS-EE GitHub repository.
Why:	An RDBMS back end is required by Hibernate.
Status:	Stable.
License:	The jPOS-EE code related to this module is licensed under the **GNU Affero General Public License version 3**. Hibernate ® itself is released under the GNU LGPL v2.1 license. See **Hibernate's License FAQ** [http://hibernate.org/356.html] for details and up-to-date information. The MySQL JDBC connector is licensed under the GNU GPL license. See **Connector/J page** [http://dev.mysql.com/downloads/connector/j/5.1.html].

Upon running *setup*, your runtime directory will contain a file: cfg/db.properties.

```
hibernate.connection.username=sa                                          ❶
hibernate.connection.password=password                                    ❷
hibernate.hbm2ddl.auto=update                                             ❸
#
hibernate.connection.url=jdbc:mysql://localhost/jposee?autoReconnect=true ❹
hibernate.connection.driver_class=com.mysql.jdbc.Driver
hibernate.dialect=org.hibernate.dialect.MySQL5InnoDBDialect
```

❶ Replace value with your database username
❷ Replace value with your database password
❸ Makes hibernate automatically update the contents of the DB to match the entities defined. This is good to keep during development, but should be set to **NONE** in a production environment.
❹ Replace the host and database (jposee) to match your database settings.

You want to change those defaults.

5.3. PostgreSQL ® support

What:	This module configures Hibernate to use PostgreSQL as its back end.
When:	Available starting in jPOS-EE v1r104.
Who:	The jPOS.org team.
How:	Posted by the jPOS-EE team.
Where:	Directory modules/db-postgresql available in the jPOS-EE GitHib repository.

Why:	An RDBMS back end is required by Hibernate.
Status:	Stable.
License:	The jPOS-EE code related to this module is licensed under the **GNU Affero General Public License version 3**. As of jPOS-EE v1r98, Hibernate ® itself is released under the GNU LGPL v2.1 license. See **Hibernate's License FAQ** [http://hibernate.org/356.html] for details and up-to-date information. The PostgreSQL JDBC connector is licensed under the BSD license. See **Postgresql.org** [http://jdbc.postgresql.org/license.html].

Upon running *setup*, your runtime directory will contain a file: cfg/db.properties.

```
hibernate.connection.username=sa                                    ❶
hibernate.connection.password=password                              ❷
hibernate.hbm2ddl.auto=update                                       ❸
hibernate.connection.url=jdbc:postgresql://localhost:5432/jposee    ❹
hibernate.connection.driver_class=org.postgresql.Driver
hibernate.dialect=org.hibernate.dialect.PostgreSQLDialect
```

❶ Replace value with your database username
❷ Replace value with your database password
❸ Makes hibernate automatically update the contents of the DB to match the entities defined. This is good to keep during development, but should be set to **NONE** in a production environment.
❹ Replace the host and database (jposee) to match your database settings.

You want to change those defaults.

5.4. H2 Embedded Database support

What:	This module configures Hibernate to use H2 as its back end.
When:	Available in all versions of jPOS-EE since v2.0.0.
Who:	The jPOS.org team.
How:	Posted by the jPOS-EE team.
Where:	Directory modules/db-h2 available in the jPOS-EE GitHib repository.
Why:	An RDBMS back end is required by Hibernate.
Status:	Stable.
License:	The jPOS-EE code related to this module is licensed under the **GNU Affero General Public License version 3**. As of jPOS-EE v1r98, Hibernate ® itself is released under the GNU LGPL v2.1 license. See **Hibernate's License FAQ** [http://hibernate.org/356.html] for details and up-to-date information. The H2 JDBC connector is licensed under the EPL license. See **h2database.com** [http://www.h2database.com/html/license.html].

Upon running *setup*, your runtime directory will contain a file: cfg/db.properties.

```
hibernate.connection.username=sa                                    ❶
hibernate.connection.password=                                      ❷
hibernate.hbm2ddl.auto=update                                       ❸
hibernate.connection.url=jdbc:h2:./data/jposee;LOCK_TIMEOUT=5000    ❹
hibernate.connection.driver_class=org.h2.Driver
hibernate.dialect=org.hibernate.dialect.H2Dialect
```

❶ Replace value with your database username
❷ Replace value with your database password
❸ Makes hibernate automatically update the contents of the DB to match the entities defined. This is good to keep during development, but should be set to **NONE** in a production environment.

❹ Replace the host and database (jposee) to match your database settings.

You want to change those defaults

5.5. MSSQL Database support

What:	This module configures Hibernate to use MS-SQL as its back end.
When:	Available since v2.2.4
Who:	The jPOS.org team.
How:	Posted by the jPOS-EE team.
Where:	Directory modules/db-mssql available in the jPOS-EE GitHib repository.
Why:	An RDBMS back end is required by Hibernate.
Status:	Stable.
License:	The jPOS-EE code related to this module is licensed under the **GNU Affero General Public License version 3**. As of jPOS-EE v1r98, Hibernate ® itself is released under the GNU LGPL v2.1 license. See **Hibernate's License FAQ** [http://hibernate.org/356.html] for details and up-to-date information. The H2 JDBC connector is licensed under the EPL license. See **h2database.com** [http://www.h2database.com/html/license.html].

Upon running *setup*, your runtime directory will contain a file: cfg/db.properties.

```
hibernate.connection.username=sa                                                    ❶
hibernate.connection.password=password                                              ❷
hibernate.hbm2ddl.auto=update                                                       ❸
hibernate.connection.url=jdbc:sqlserver://localhost:1433;databaseName=jposee        ❹
hibernate.connection.driver_class=com.microsoft.sqlserver.jdbc.SQLServerDriver
hibernate.dialect=org.hibernate.dialect.SQLServerDialect                            ❺
```

❶ Replace value with your database username
❷ Replace value with your database password
❸ Makes hibernate automatically update the contents of the DB to match the entities defined. This is good to keep during development, but should be set to **NONE** in a production environment.
❹ Replace the host and database (jposee) to match your database settings.
❺ `SQLServer2012Dialect` is also available.

You want to change those sample defaults

Chapter 6. Binary Log

6.1. BinLog

What	General purpose binary log
When	Implemented during 2.2.4
Who	The jPOS Software team.
Where	Directory modules/binlog
Why	Used by local Q2 nodes as audit trail or to SAF its transactions
Status	Experimental
License	**GNU Affero General Public License version 3**

Maven Coordinates.

```
        <dependency>
            <groupId>org.jpos.ee</groupId>
            <artifactId>jposee-binlog</artifactId>
            <version>${jposee.version}</version>
        </dependency>
```

The jPOS BinLog has the following features:

- multiple readers and writers can be used from the same JVM
- multiple readers and writers can be used from different JVMs

Make sure you read and understand the implementation notes at the end of this section before you attempt to use it.

Here is a sample Writer:

```
    File dir = new File("/tmp/binlog");
    try (BinLogWriter bl = new BinLogWriter(dir)) {                    ❶
        bl.add( ... ); // byte array
        bl.add( ... ); // byte array
        bl.add( ... ); // byte array
    }
```

❶ The BinLogWriter implements `AutoCloseable` so `try-with-resources` can be used

A reader would look like this:

```
    File dir = new File("/tmp/binlog");
    try (BinLogReader bl = new BinLogReader(dir)) {
        while (bl.hasNext()) {
            byte[] b = bl.next().get();
            // do something with the byte[]
        }
    }
```

The `BinLogReader` implements an `Iterator<BinLog.Entry>`. Each `BinLog.Entry` has two main methods:

- `BinLog.Rer ref()`
- `byte[] get()`

While iterating over a BinLog, it might make sense to persistently store its `BinLog.Ref` in order to be able to restart the iterator at a given point if required (this is useful if using the BinLog to implement a Store and Forward.

The `BinLogReader` has two constructors:

- `BinLogReader(File dir)`
- `BinLogReader(File dir, BinLog.Ref ref)`

the latter can be used to restart the iterator at a given reference point obtained from a previous run.

In addition to the standard `hasNext()` method required by the `Iterator` implementation, `BinLogReader` also has a `hasNext(long millis)` method that waits a given number of milliseconds once it reaches the end of the log, attempting to wait for a new entry to be available.

6.1.1. Implementation notes

The goal behind the BinLog implementation is to have a future proof file format easy to read from any language, 10 years down the road. We found that the Mastercard simple IPM file format, that's basically a two-byte message length followed by the message itself was suitable for that. The payload on each record can be ISO-8583 (like Mastercard), JSON, FSDMsg based, Protocol buffers or whatever format the user choose.

But that format isn't crash proof. If a system crashes while a record is being written to disk, the file can get easily corrupted. So we picked some ideas from Square's *tape* project that implements a highly crash proof on-disk persistent circular queue using a very small header. Tape is great and we encourage you to consider it instead of this binlog for some use cases, but we didn't want a circular queue, we wanted a place to securely store events for audit or store and forward purposes, and we also wanted to be able to access the same binlog from multiple JVMs with access to the same file-system, so we had to write our own.

The on-disk file format looks like this:

```
Format:
  256 bytes Header
  ... Data
  ... Data

Header format (256 bytes):
  4 bytes header length
  2 bytes version
  2 bytes Status (00=open, 01=closed)
  8 bytes Last element position
  4 bytes this log number
  4 bytes next log number
232 bytes reserved

Element:
  4 bytes Data length
  ...     Data
```

Each record has a length prefix (four bytes in network byte order) followed by its data. The header has a fixed length of 256 bytes but we found useful to make it look like a regular record too by providing its length at the very beginning. An implementation in any language reading a jPOS binlog can just be programmed to skip the first record.

At any given time (usually at end of day), a process can request a **cut-over** by calling the `BinLogWriter.cutover()` method in that case, all writers and readers will close the current file and move to the next one (Readers can choose to not-follow to the next file, for example while producing daily extracts).

In order to achieve file crash resilience, each write does the following:

- Lock the file
- Write the record's length and data
- Sync to disc
- Write the last element position to the header

- Sync to disc
- Unlock the file

In an MBP with SDRAM we've managed to achieve approximately 6000 writes per second. On an iMac with regular disk the numbers go down to approximately 1500 writes per second for regular ISO-8583 message lengths (500..1000 bytes per record).

Due to the fact that the header is small enough to fit in an operating system block, the second write where we place the last element position happens to be atomic. While this works OK for readers and writers reading the file from different JVMs, that's not the case for readers and writers running on the same JVM, even if they use a different file descriptor to open the file, the operating system stack has early access to the header that under high concurrency can lead to garbage values, that's the reason the code synchronizes on a `mutex` object at specific places.

6.1.2. Supporting CLI commands

The `binlog` CLI command is a subsystem that currently have two commands:

- monitor (to visually monitor a binlog)
- cutover (to force a cutover)
- exit (builtin command)

`binlog` accepts a parameter with the binlog's path, i.e: `binlog /tmp/binlog`

So a cutover can be triggered from cron using the following command:

```
q2 --command="binlog /tmp/binlog; cutover; exit; shutdown --force"
```

6.1.3. BinLog Quartz Support

The `binlog-quartz` provides support for automatic cutover, for example:

```
<cron class="org.jpos.q2.QuartzAdaptor" logger="Q2">
  <job id="1" class="org.jpos.binlog.cron.CutoverJob" when="59 59 23 * * ?"
       logger="Q2" realm="binlog-cutover">
    <property name="binlog" value="/tmp/binlog" />
  </job>
</cron>
```

Chapter 7. Rest Support

7.1. QRest

What	Lightweight REST server
When	Implemented during 2.2.5
Who	The jPOS Software team.
Where	Directory modules/qrest
Why	Used by local Q2 nodes as audit trail or to SAF its transactions
Status	Experimental
License	**GNU Affero General Public License version 3**

Maven Coordinates.

```
        <dependency>
            <groupId>org.jpos.ee</groupId>
            <artifactId>jposee-qrest</artifactId>
            <version>${jposee.version}</version>
        </dependency>
```

Traditionally, jPOS based REST applications use the Jetty module, Jersey, etc. as described in the **jPOS Tutorials** [http://jpos.org/tutorials]. But we have situations where we just need to provide a little `ok` response to say a `/health` endpoint on each Q2 running (for monitoring purposes).

Configuring Jetty/Jersey and deploying a `war` seems like overkill for these use cases so we've created a little **QRest** module that can be configured like this:

```
<qrest class='org.jpos.qrest.RestServer' logger='Q2'>
  <property name='port' value='8081' />                                          ❶
  <property name='queue' value='TXNMGR' />                                       ❷
  <property name="TLS" value="true" />                                           ❸
  <property name="server-auth" value="false" />                                  ❹
  <property name="client-auth" value="false" />                                  ❺
  <property name="keystore" value="cfg/keystore.jks" />                          ❻
  <property name="storepassword" value="jposjposjposjpos" />                     ❼
  <property name="keypassword"   value="jposjposjposjpos" />                     ❽
  <property name="enabled-cipher" value="TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA" /> ❾
  <property name="enabled-cipher" value="TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256" />
  <property name="enabled-cipher" value="TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384" />
  ...
  ...
</qrest>
```

❶ Listening port
❷ Transaction manager queue name
❸ `true` to enable TLS
❹ Set to `false` in order to allow self-signed certificates
❺ `true` requires client-side certificates
❻ Keystore location
❼ Store password
❽ Key password
❾ Enabled ciphers (optional, defaults to *all* if not present)

Once the server receives an HTTP request, it creates a `org.jpos.transaction.Context`, places a reference to the http request (under the Constant name `REQUEST` defined in the `org.jpos.qrest.Constants` enum), and to the session in the `SESSION` constant (so that a `SendResponse` participant can reply) and send it off to the TransactionManager for processing.

The TransactionManager is configured like this:

```
<txnmgr class="org.jpos.transaction.TransactionManager" logger="Q2">
  <property name="queue" value="TXNMGR"/>
  <property name="sessions" value="2"/>
  <property name="max-sessions" value="128"/>
  <property name="debug" value="true"/>

  <participant class="org.jpos.qrest.participant.Router">
    <route path="/jpos/myroute/{mypathparam}**" method="GET" name="mygroup1"/>
    <route path="/jpos/myroute/{mypathparam}**" method="POST" name="mygroup2"/>
    <route path="/jpos/fixedroute" method="POST" name="..."/>
    <route path="/q2**" method="GET" name="q2"/>                                    (1)
  </participant>

  <group name="q2">
    <participant class="org.jpos.qrest.participant.Q2Info" />
  </group>

  ..
  ..
  <group name="group1">
    ..
    ..
  </group>
  <group name="group2">
    ..
    ..
  </group>
  <participant class="org.jpos.qrest.SendResponse" logger="Q2"/>
</txnmgr>
```

(1) This route is special, see below, route processing gets delegated to the Q2Info class

This old **Blog Post** [http://jpos.org/blog/2013/10/eating-our-own-dogfood/] explained how the TransactionManager could be used to implement REST based APIs. The QRest service can be used to simplify a lot of Jetty/Server/Jersey boilerplate.

The `Router` participant is actually a `GroupSelector` (from the TransactionManager's standpoint) and takes care of parsing and placing in the Context both *Path Parameters* as well as *Query Parameters* (under the `PATHPARAMS` and `QUERYPARAMS` contants).

So if we define a route like this:

```
  <route path="/jpos/muxes/{muxname}" method="GET" name="muxes"/>
```

and we fire `curl localhost:8081/jpos/muxes/ABC`, we'll see that the Context will have a:

```
o.j.r.Constants.PATHPARAMS: {muxname=ABC}
```

If we add query parameters to the call, i.e.: `curl "localhost:8081/jpos/muxes/XYZ?a=1&b=2&c=3"`

the query parameters will be available under the `QUERYPARAMS` constant.

```
      o.j.r.Constants.QUERYPARAMS: {a=[1], b=[2], c=[3]}
      o.j.r.Constants.PATHPARAMS: {muxname=XYZ}
```

In addition to having the Router participant parse the route, one can define wildcard handlers for some routes. This is the case of the `Q2Info` participant that — although work in progress — intends to provide useful information about a running Q2 system.

So anything that starts with `/q2` (or whatever one choose to set in the XML configuration) will be handled by Q2Info.

Q2Info itself has its own routes, but those are hardcoded. So if we call `/q2/version`, we get output like this:

```
{
  "version" : "jPOS 2.1.2-SNAPSHOT master/0a14e5c (2018-04-30 22:34:16 UTC)"
}
```

`/q2/uptime` would give us:

```
{
  "uptime" : 601483
}
```

`/q2/diskspace`:

```
{
  "diskspace" : {
    "free" : 616271151104,
    "usable" : 616009007104
  }
}
```

Q2Info also provides now information about the MUXES, and we plan to expand it to provide information about other components (servers, transaction manager, space).

i.e.: `curl localhost:8081/q2/muxes`

```
  "muxes" : [ {
    "name" : "clientsimulator-mux",
    "type" : "QMUX",
    "connected" : true,
    "rx" : 21,
    "tx" : 21,
    "txExpired" : 0,
    "txPending" : 0,
    "rxExpired" : 0,
    "rxPending" : 0,
    "rxUnhandled" : 0,
    "rxForwarded" : 0,
    "metrics" : {
      "all" : {
        "autoResize" : false,
        "highestTrackableValue" : 60000,
        "lowestDiscernibleValue" : 1,
        "numberOfSignificantValueDigits" : 2,
        "tag" : null,
        "maxValue" : 18,
        "minNonZeroValue" : 3,
        "totalCount" : 21,
        "estimatedFootprintInBytes" : 10752,
        "startTimeStamp" : 9223372036854775807,
        "endTimeStamp" : 0,
        "maxValueAsDouble" : 18.0,
        "mean" : 6.190476190476191,
        "stdDeviation" : 3.141413809994408,
        "neededByteBufferCapacity" : 11560,
        "minValue" : 3
      },
      "ok" : {
        "autoResize" : false,
        "highestTrackableValue" : 60000,
        "lowestDiscernibleValue" : 1,
        "numberOfSignificantValueDigits" : 2,
        "tag" : null,
        "maxValue" : 18,
        "minNonZeroValue" : 3,
        "totalCount" : 21,
        "estimatedFootprintInBytes" : 10752,
        "startTimeStamp" : 9223372036854775807,
        "endTimeStamp" : 0,
        "maxValueAsDouble" : 18.0,
        "mean" : 6.190476190476191,
        "stdDeviation" : 3.141413809994408,
        "neededByteBufferCapacity" : 11560,
        "minValue" : 3
      }
    },
    "last" : "2018-05-02 17:56:48",
    "idle" : 1306237
  } ]
}
```


If we use the mux name as part of the URI, we get information for a particular MUX, i.e.: `curl localhost:8081/q2/muxes/clientsimulator-mux`

Here is a copy of the internal Q2Info route configuration:

```
    private void initInternalRoutes() {
        routes.add(new Route<>("/q2/version**", "GET",
            (t,s) -> mapOf ("version", q2Version())));
        routes.add(new Route<>("/q2/applicationVersion**", "GET",
            (t,s) -> mapOf("applicationVersion", Q2.getAppVersionString())));
        routes.add(new Route<>("/q2/instanceId**", "GET",
            (t,s) -> mapOf("instanceId", q2.getInstanceId())));
        routes.add(new Route<>("/q2/uptime**", "GET",
            (t,s) -> mapOf("uptime", q2.getUptime())));
        routes.add(new Route<>("/q2/started**", "GET",
            (t,s) -> mapOf("started", new Date(System.currentTimeMillis() -
            q2.getUptime()))));
        routes.add(new Route<>("/q2/diskspace**", "GET",
            (t,s) -> diskspace()));
        routes.add(new Route<>("/q2/muxes/{muxname}**", "GET",
            (t,s) -> muxInfo(t,s)));
        routes.add(new Route<>("/q2/muxes**", "GET",
            (t,s) -> muxes()));
    }
```

If we just call `/q2`, it will output them all.

Chapter 8. Tools

8.1. Freemarker Decorator

What	This module contains a text processor which decorates deployable descriptors for Q2.
When	Available in all versions of jPOS-EE since v2.0.0.
Who	The jPOS.org team.
Where	Directory modules/freemarker-decorator available in git repository at github.
Why	Install this module to better parameterize your applications.
Status	Stable.
License	The jPOS-EE code related to this module is licensed under the **GNU Affero General Public License version 3**. FreeMarker ® itself is released under the BSD license. See **http://freemarker.sourceforge.net/docs/app_license.html** for details and up-to-date information.

Maven Coordinates.

```
        <dependency>
            <groupId>org.jpos.ee</groupId>
            <artifactId>jposee-freemarker-decorator</artifactId>
            <version>${jposee.version}</version>
        </dependency>
```

8.1.1. Activation steps

This module remains dormant unless it finds its configuration resource.

In order to activate this module, you need to create a resource in your project residing at *META-INF/org/jpos/config/Q2-decorator.properties* of your classpath (not the filesystem!).

This file should contain two properties:

```
config-decorator-class=org.jpos.q2.freemarker.FreemarkerDecorationProvider    ❶
config-files=cfg/config.properties                                            ❷
```

❶ This property tells Q2 to use the FreemarkerDecoratorProvider as its decorator.
❷ This property defines a comma separated list of files which will be used as configuration files.

8.1.2. Introduction

A typical jPOS-EE application has this standard directory structure:

```
.
|-- cfg
|   |-- README.txt
|   `-- db.properties
|-- deploy
|   |-- 00_logger.xml
|   `-- 99_sysmon.xml
|-- lib
|-- log
|   `-- q2.log
`-- q2.jar
```

Whatever descriptor you install inside the *deploy* directory gets immediately deployed. Once this descriptor is removed, it gets undeployed.

Many of these descriptors require information specific to the target environment, such as hostnames, ports, ports to listen to, etc. Wouldn't it be great if you could define all of these in a single location?

The FrameMarker decorator processes **ANY** descriptor in memory giving Q2 the resulting text after processing. This opens a myriad of opportunities, such as declaring macros, and executing them :)

Let's see an example! Let's assume you have a file *cfg/config.properties* in your runtime directory that looks like this:

```
###### GENERAL INFO
NODE = NODE001
######  Environment
env=DEV
######  Ports we listens to
server_listen_port = 9999
######  Target host information
myBankHostPrimary=app.yourbank.com
myBankPortPrimary=2000
###### DEBUG STUFF
debugParticipant=true
```

and we had a deployable file: *deploy/10_mybank_channel.xml*

```
<channel-adaptor
      name="mybank-channel-adaptor-pri"
      class="org.jpos.q2.iso.ChannelAdaptor" logger="Q2">

    <channel
          name="mybank-channel-pri"
          packager="org.jpos.iso.packager.GenericPackager"
          class="org.jpos.iso.channel.CSChannel" logger="Q2"
          realm="channel.mybank">

        <property name="timeout" value="3600000"/>
        <property name="host" value="${mybankHostPrimary}"/>
        <property name="port" value="${mybankPortPrimary}"/>
        <property name="packager-config" value="cfg/packager/mybank.xml" />
        <property name="keep-alive" value="true" />
    </channel>

    <in>from-mybank-pri</in>
    <out>to-mybank-pri</out>
    <reconnect-delay>5000</reconnect-delay>
</channel-adaptor>
```

As you can see, we externalized the deployable's configurable over to a central location.

If you change the settings in the configuration file, you still need to redeploy the deployable (touch it).

But wait, there's more! FreeMarker being a macro processor, brings a lot of nice things for things like TransactionManager descriptors:

For example, ever wanted to have conditional participants?

```
    [#if debugParticipant == 'true']
    <participant class="org.jpos.transaction.Debug" logger="Q2" realm="debug">
        <property name="checkpoint" value="debug"/>
    </participant>
    [/#if]
```

Or maybe define a macro for things you'll use over and over?

```
[#macro OutputToSyslog msg]
<participant class="com.mycorp.txn.OutputToSyslog"
    logger="Q2" realm="output-to-syslog">
    <property name="node" value="${NODE}"/>
    <property name="message" value="${msg}"/>
</participant>
[/#macro]

<!-- And then invoke it -->
<group name="myGroup">
    [@OutputToSyslog msg="This is a test"/]
    .... Do some other stuff
</group>
```

8.2. Groovy Support

What	Add Groovy support.
When	Since 2.2.1.
Who	The jPOS.org team.
Where	Directory modules/groovy.
Why	Allows seamless integration with Groovy from Q2 applications.
Status	Experimental.
License	**GNU Affero General Public License version 3**

Maven Coordinates.

```
<dependency>
    <groupId>org.jpos.ee</groupId>
    <artifactId>jposee-groovy</artifactId>
    <version>${jposee.version}</version>
</dependency>
```

Although not strictly required by this particular QBean Groovy adaptor, the `jposee-groovy` module also includes the handy `groovy-sql` dependency.

8.2.1. Groovy QBean

In jPOS 2.0.7 (and later), `QFactory.properties` maps the `groovy` keyword to `org.jpos.q2.qbean.Groovy` so one can use a simple configuration like this:

```
<groovy logger='Q2' src='deploy/test.groovy' />
```

or

```
<groovy logger='Q2'><![CDATA[
  // ... your groovy code here
]]></groovy>
```

The following variables are automatically exposed:

- `log` has a refererence to the QBean's `Log` object
- `qbean` has a reference to the running QBean
- `cfg` has a reference to the QBean's configuration

8.2.2. GroovyParticipant

The module provides a `org.jpos.transaction.participant.GroovyParticipant` class, which allows the writing TransactionManager `TransactionParticipant`'s in Groovy.

Separate scripts can be specified for the `prepare`, `prepare-for-abort`, `commit`, and `abort` phases of the participant.

The `prepare` and `prepare-for-abort` methods are expected to return an `Integer` object with the TransactionManager standard result values (`PREPARED`, `ABORTED`, etc.).

The Groovy script code can be placed as part of the element's content (a CDATA section is recommended), or in an external file pointed to by the `src` attribute. We also recommend adding a `realm` attribute to identify errors in the logs, especially if you have several instances of `GroovyParticipant` in your transaction manager.

The following variables will be bound to each Groovy script's `Binding`:

- **id** - the transaction `int id` passed to the participant's method
- **ctx** - the transaction `Serializable ctx` passed to the participant's method
- **log** - a reference to `this` instance (since this class extends `org.jpos.util.Log`)
- **cfg** - this `TransactionParticipant`'s `Configuration` properties
- **tm**- a reference to the `TransactionManager`'s executing this transaction

By default, scripts are pre-compiled by a `GroovyClassLoader`. If you want the script to be evaluated each time, then set the `compiled` property to `false`.

Add a transaction participant like this:

```
<participant class="org.jpos.transaction.participant.GroovyParticipant"
             logger="Q2" realm="groovy-test">
  <prepare src="deploy/prepare.groovy" />
  <commit src="deploy/commit.groovy" />
  <abort>
    <![CDATA[
        import static org.jpos.transaction.TransactionConstants.*
        // ... embedded script
        return PREPARED
    ]]>
  </abort>
</participant>
```

8.2.3. GroovyRequestListener

The module provides a `org.jpos.groovy.GroovyRequestListener` class, which allows the writing of `org.jpos.iso.ISORequestListener`'s in Groovy.

The script's return value will be used as the return value from the `process` method. A non-null return value is interpreted to be *true-ish*. An explicit `null` return is interpreted to be `false`. A `boolean/Boolean` value will be returned as such.

The Groovy script code can be given as text within the `<script>` element (a `CDATA` section is recommended), or in an external file pointed to by the `src` attribute. The `src` path attribute will override the text /`CDATA` script (to avoid confusion, only one of the options should be used).

By default, scripts are pre-compiled by a `GroovyClassLoader`. If you want the script to be evaluated each time, then set the `compiled` property to `false`.

As a convenience, a comma-separated list of *ISO-8583* MTI's can be given in the `whitelist` property. If given, the script will be called *only* for requests having those MTI's. For requests not in the whitelist, the `ISORequestListener#process(ISOSource, ISOMsg)` method will return `false`, so the request can be handled by another `ISORequestListener` down the line.

The following variables will be bound to the Groovy script's `Binding`:

- **message** - the `ISOMsg` for this request

- **source** - the `ISOSource` for message
- **log** - a reference to `this` instance (since this class extends `org.jpos.util.Log`)
- **cfg** - this `ISORequestListener's` `Configuration` properties
- **xmlCfg** - this `ISORequestListener's` configuration `Element`

We also recommend adding a `realm` attribute to the `<request-listener>` element, to identify errors in the logs.

Examples:

A Groovy script given as embedded text in a `CDATA` section. The script will be pre-compiled, and called only for requests of the MTI's given in the `whitelist` property.

```
<request-listener class="org.jpos.transaction.participant.GroovyRequestListener"
                  logger="Q2" realm="groovy-test-one">
  <property name="whitelist" value="0100, 0420" />
  <script>
    <![CDATA[
        // ... embedded script
    ]]>
  </script>
</request-listener>
```

A Groovy script given in an external file. The `compiled` property is set to `false`, so the script will be interpreted and evaluated for each request. The script will be called for *all* MTI's.

```
<request-listener class="org.jpos.transaction.participant.GroovyRequestListener"
                  logger="Q2" realm="groovy-test-two">
  <property name="compiled" value="false" />
  <script src="../cfg/reqlistener2.groovy" />
</request-listener>
```

8.3. Crypto Service

The `cryptoservice` module uses AES-256 to encrypt sensitive data, such as primary account numbers and protects the encryption key using PGP.

At start-up time, and at regular intervals, the crypto service generates a new AES-256 key, encrypts it using PGP using one or more recipient ids (custodians), and stores the resulting encrypted message in the sysconfig table, using the "key." prefix, and a unique key UUID, i.e.:

```
id: key.f55fe6ec-ed9e-47a1-a0fe-c63dcbf128cb
value:
-----BEGIN PGP MESSAGE-----
Version: BCPG v1.56

hQEMA6Nw6GrTY6BpAQgAs1pUIK3n2FkMyNmfxSZgpPMNFKz39TcfExiwDRtuw+Zg
wRgFw86SJiL1BB+IE+mPAeCz4hrUkzliiu/760NiXHQysIasWEvUZZqFRA+ecNrk
zARgB8vgGTNgxPHoYPafVD5TrxY9LdRpJcO//Wm2fEVw0xc4Q7vxbH7e9gDQfiuA
gcNYk96rVCdbZFKxyMC8fpM9ng6M4V9lxp5TXihzJQEKHWavctIrU2rBolE1WCY2
Oobs1hELW4rfMpVwfGQDtxcFSNDYkd9IO/WnFTtTAxGHs0u1/miRVxNHadLINdke
wXx6au9vq12tqlYaJY+BAEtJaAInwwT5/irHj5dlwtJ0AW2wO3Mwh+A+pGJvSd2T
xyep1pNtm7tMbisZyms0TiGz+6BX6F5ZKCG5UuvsIvTHd/VLp2uajE5NVPe92Y1F
lLbbMyUfxzBwNhwhdfOEWwRAmrt7AbMyAQHUCZAXgwXn7SXsdh8TTzLMsssViD9+
h7lfP9w=
=YyZk
-----END PGP MESSAGE-----
```

The key is used to encrypt subsequent data for a given period of time (defaults to one day) until a new key is automatically generated.

Here is a sample usage:

```
   private void encryptCardData (TLCapture tl, Card card)      ❶
      throws Exception {
        Map<String,String> m = new HashMap<>();
        m.put ("P", card.getPan());
        m.put ("E", card.getExp());
        SecureData sd = getCryptoService().aesEncrypt(        ❷
           Serializer.serializeStringMap(m)
        );
        tl.setKid(sd.getId());                                ❸
        tl.setSecureData(sd.getEncoded());                    ❹
    }
```

❶ TLCapture in this example is a general purpose capture table.
❷ `getCryptoService()` just locates the `CryptoService` using the `NameRegistrar`
❸ `kid` stands for Key ID, we store the key UUID here
❹ `secureData` is a general purpose blob

The crypto service can be configured using a QBean descriptor like this:

```
<crypto-service class='org.jpos.crypto.CryptoService' logger='Q2'>
    <property name="custodian" value='demo@jpos.org' />              ❶
    <property name="pubkeyring" value='cfg/keyring.pub' />           ❷
    <property name="privkeyring" value='cfg/keyring.priv' />         ❸
    <property name="lazy" value="false" />                           ❹
    <property name="keylength" value="256" />                        ❺
    <property name="duration" value="86400000" />                    ❻
    <property name="ttl" value="3600000" />                          ❼
</crypto-service>
```

❶ custodian PGP id, there can be many `custodian` entries.
❷ path to the public keyring.
❸ path to the password-protected private keyring.
❹ if lazy=true, a key is generated the first time we call `aesEncrypt`, otherwise, a new one is created at service start.
❺ key length defaults to 256. Can be reduced if AES-256 is not supported by the JVM due to export restrictions.
❻ key duration
❼ internal key cache time-to-live (in millis).

This allows jPOS nodes to encrypt data securely without storing the encryption key to disk.

The transient encryption key is still in memory, so core dumps and swap should be disabled at the operating system level. This approach is still more secure than obfuscating encryption keys.

Decryption — that can of course run in a different node, at a different time — requires access to the private keyring, with its optional password. Said password can be entered manually, obtained from a remote service or HSM, etc. and it's a two step process.

First the key has to be *loaded* into memory, using the `loadKey` method. Once the key is loaded, the `aesDecrypt` can be called.

These are the method's signatures:

```
public void loadKey (String jobId, String keyId, char[] password) throws Exception;
public byte[] aesDecrypt (String jobId, String keyId, byte[] encoded) throws Exception;
```

Here `keyId`, `password`, and `encoded` cryptogram don't require too much explanation, but `jobId` does and here is the rationale. We could have a one-shot `aesDecrypt` method accepting the private key password, but decrypting the AES-256 key using PGP is an expensive operation. In situations where you have extract a daily file, probably encrypted by just a handful keys, you don't want to decrypt the key on every `aesDecrypt` call. We don't want to expose the key to the caller either, so the CryptoService keeps it in a private field. In order to do that, `loadKey`

caches the key (until it's unloaded), so it's cheap to call `loadKey` followed by `aesDecrypt`, after the first call where the key is actually decrypted, subsequent calls will be pretty fast.

In order to protect different clients from accessing keys loaded by other ones, we use a `jobId` that can be something as simple as a `UUID` or any nonce, only known to the caller. That `jobId` can then be used to `unload` those keys, using the `unloadKey` and `unloadAll` methods:

```
    public boolean unloadKey (String jobId, String keyId);
    public void unloadAll(String jobId);
```

There's also a no-args `unloadAll()` that unloads all keys, and should be used with care.

For some use cases (i.e. long running crypto-service based micro-service), it is possible to "UNLOCK" the system by calling

```
    public boolean unlock (char[] password);
```

For completeness, there's also a `lock()` method.

In order to simplify development and testing, and eventually to troubleshoot problems, we've also created a couple of CLI commands: `encrypt`, `decrypt`, `lock` and `unlock` in the `crypto` CLI subsystem.

If you're accessing the CLI using the command line `q2 --cli`, remember that the default `deployDir` is `deploy-cli` instead of `deploy`. You need a copy (or symlink) of `25_cryptoservice.xml` in that directory.

If you `ssh` to a running Q2 to reach the CLI, then you can ignore this tip.

For testing purposes, it is possible to set the `unlock-password` property in the crypto service configuration QBean, i.e.:

```
<property name="unlock-password" value="demo" />
```

This is of course highly insecure, the whole PGP based crypto service scheme makes no sense at all when unlocking the private key in such a way.

8.3.1. Using GnuPG to generate keys

- Generate key

```
gpg --full-generate-key
```

- Export custodian public keys into keyring.pub

```
gpg --armor --export xxx@domain.com yyy@domain.com > cfg/keyring.pub
```

- Export custodian private keys into keyring.priv

```
gpg --armor --export-secret-keys xxx@domain.com yyy@domain.com > cfg/keyring.priv
```

8.4. Crypto Server

The `cryptoserver` module offers a REST (qrest based) API to encrypt and decrypt using the `cryptoservice`.

It supports the following operations

8.4.1. encrypt

- Path: `/encrypt`
- Body:

```
{
  "text" : "The quick brown fox jumps over the lazy dog 0123456789"
}
```

Sample response:

```
{
    "kid": "d7e82270-7041-4434-8cf9-c4d0f26f620d",
    "cryptogram": "rp5uz7QMjRaEqPIbXzOZNI6bLuWYcdP0sH3I0FSKpRk...."
}
```

8.4.2. decrypt

- Path: `/decrypt`
- Body:

```
{
    "kid": "d7e82270-7041-4434-8cf9-c4d0f26f620d",
    "cryptogram": "rp5uz7QMjRaEqPIbXzOZNI6bLuWYcdP0sH3I0FSKpRk...."
}
```

```
{
  "text" : "The quick brown fox jumps over the lazy dog 0123456789"
}
```

The node running `cryptoserver` has to be `unlocked` (see **Section 8.3, “Crypto Service”** module).

Chapter 9. Simulators

9.1. Server Simulator

What:	The Server Simulator is an extremely simple, BSH-based simulator that can be used to test ISO-8583 based client software. It listens to port (default 10000), and forwards all incoming requests to a BeanShell based script that can be customized to meet your needs.
When:	Available in all versions of jPOS-EE.
Who:	The jPOS.org team.
How:	Posted by the jPOS-EE team.
Where:	Directory modules/server-simulator available in the repository at GitHub.
Why:	When writing ISO-8583 based client applications the ability to easily simulate a server is usually very useful.
Status:	Stable.
Dependencies:	module jpos
License:	**GNU Affero General Public License version 3**

The server simulator is a simple QServer with a BSHRequestListener that handle incoming messages and provide suitable responses.

The default configuration uses an XMLChannel along with an XMLPackager, but you are free to use any channel/packager combination.

The BSHRequestListener (documented in jPOS programmer's guide) exposes two objects: message (the incoming ISOMsg) and source (the ISOSource).

Here is the default configuration (05_serversimulator.xml):

```
<server class="org.jpos.q2.iso.QServer" logger="Q2" name="simulator_10000">
<attr name="port" type="java.lang.Integer">10000</attr>
<channel class="org.jpos.iso.channel.XMLChannel"
       logger="Q2" packager="org.jpos.iso.packager.XMLPackager">
</channel>
<request-listener class="org.jpos.bsh.BSHRequestListener" logger="Q2">
 <property name="source" value="cfg/serversimulator.bsh" />
</request-listener>
</server>
```

And the BSH script looks like this:

```
message.setResponseMTI ();                                          ❶

Random random = new Random (System.currentTimeMillis());
message.set (37, Integer.toString(Math.abs(random.nextInt()) % 1000000));
message.set (38, Integer.toString(Math.abs(random.nextInt()) % 1000000));

if ("000000009999".equals (message.getString (4)))                  ❷
    message.set (39, "01");
else
    message.set (39, "00");

source.send (message);
```

❶ Sets the response MTI (i.e: 0800/0810, 1201/1220…)
❷ We use the special amount value $99.99 to decline the transaction

Never ever use this simulator even close to a production environment, or you may end up blindly authorizing transactions.

9.2. Client Simulator

What:	The Client Simulator can be used to fire a suite of unit tests against an ISO-8583 server. The suite is defined by a set of XML files representing messages to be sent and their expected responses.
When:	Available in all versions of jPOS-EE.
Who:	The jPOS.org team.
How:	Posted by the jPOS-EE team.
Where:	Directory `modules/client-simulator` available in the repository at GitHub.
Why:	When writing ISO-8583 based server applications the ability to easily simulate a client is usually very useful. We at jPOS.org use it as a high level self test for our applications.
Status:	Stable.
Dependencies:	module jpos
License:	**GNU Affero General Public License version 3**

In order to simulate complex ISO-8583 interchanges, the client simulator uses BSH scripting support to customize the content of ISO-8583 fields at runtime. This can be used to specify constant values, such as terminal IDs, merchant IDs, card numbers, as well as dynamic values such as trace numbers, retrieval reference numbers, pinblocks, key exchange related stuff, etc.

Let's have a look at the simulator's QBean configuration:

```
<qbean name="clientSimulator" logger="Q2" realm="client-simulator"
      class="org.jpos.simulator.TestRunner">

 <property name="mux"     value="clientsimulator-mux" />
 <property name="timeout" value="30000" />
 <property name="sessions" value="1" />
```

We specify a mux (that's the name of a QMUX running on the same JVM) and a timeout to wait for a given response. Then we define an initialization block, i.e:

```
 <init>
    import org.jpos.space.*;
    int cnt = 1;
    String terminal = "29110001";
    String merchant = "000000001001";
    String pinblk   = "0123456789ABCDEF";
    Space sp = SpaceFactory.getSpace();
 </init>
```

The initialization block is basically a BSH script. You can do whatever you want there, such as defining constants for later use, references to jPOS objects (such as Space instances, Security module, etc.).

And then the test suite:

```
    <test-suite>
     <path>cfg/</path>
     <test file="echo" count="10" continue="yes" name="Simple Echo Test" />
     <test file="echo" count="20" continue="yes" name="Simple Echo Test 2">
      <init>
       // optional init script
       // the variable 'testcase'references  _this_ testcase instance
       // the variable 'request' references the ISOMsg that is to be sent
      </init>
      <post>
       // optional post script
       // the variable 'testcase' references  _this_ testcase instance
       // the variable 'response' references the received message
      </post>
     </test>

     <path>cfg/anotherpath</path>
     <test file="mytest">MyTest</test>
     ...
     ...
    </test-suite>
  </qbean>
```

The suite can be separated in different paths, in the previous example, we assume that there exist two template files named: `cfg/echo_s` and `cfg/echo_r`.

The letter **s** in `cfg/echo_s` stands for **send** and the **r** in `cfg/echo_r` stands for **receive**.

`cfg/echo_s`:

```
  <isomsg>
   <field id="0" value="1800" />
   <field id="7" value="1025080500" />
   <field id="11" value="000001" />
   <field id="41" value="29110001" />
  </isomsg>
```

`cfg/echo_r`:

```
  <isomsg>
   <field id="0" value="1810" />
   <field id="39" value="00" />
  </isomsg>
```

If the response template file (i.e. `echo_r` in the previous example) is not present, client simulator blindly sends the message to the server, ignoring the response. A *response ignored* note is added to the test log.

In the previous example, we send a 1800 message with some fixed data, and we expect to receive a 1810 message, with a 00 content in field 39.

While using fixed content may be okay for most fields and test cases, there are situations where you want to use dynamic content.

Our simulator supports BSH scripts at the field level. Everything that starts with a bang character (**!**) is considered a script and evaluated as such, so you can write:

```
  <isomsg>
   <field id="0" value="1800" />
   <field id="7" value="ISODate.getANSIDate (new Date())" />
   <field id="11" value="! System.currentTimeMillis() % 1000000" />
   <field id="41" value="! terminal" />
   <field id="52" value="@ pinblk" />
  </isomsg>
```

Please note that in our example terminal is a runtime script variable that we've defined in our block. The **@** characters operates in a similar way as the **!** character, but the resulting value, which is supposed to be

an hexadecimal string, is converted to `byte[]` using `ISOUtil.hex2byte(String)` in order to produce an `ISOBinaryField`.

The same thing happens at receive time, when we are trying to simulate voids, reversals, we usually need information received in previous transactions, such as retrieval reference numbers, audit numbers, etc. so we can save that information for later use using a receive-time script:

```
<isomsg>
 <field id="0" value="1810" />
 <field id="11" value="! previousTrace=value" />
 <field id="37" value="! rrn=value" />
 <field id="39" value="00" />
</isomsg>
```

There's a special variable name called `value` where we put the received content, so in the previous example, the received retrieval reference number (field 37), is stored in the variable named `rrn` for later use.

The receive script may optionally return true or false, so we can write code like this:

```
<isomsg>
 <field id='39' value='! return value.equals(EXPECTED_RETVALUE)' />
</isomsg>
```

where `EXPECTED_RETVALUE` is initialized in a previous init block.

In fact, the previous example is equivalent to the following:

```
<isomsg>
 <field id='39' value='! EXPECTED_RETVALUE' />
</isomsg>
```

where the string value of EXPECTED_RETVALUE is used (unless it is a boolean).

There is a special string ***E** to test for echo. To ensure that the received content of a field is the same as the content we sent, we can write code like this:

```
<isomsg>
 <field id='4' value='*E' />
</isomsg>
```

The special string ***M** can be used to check for mandatory field presence, regardless its content. Likewise, ***E** can be used to check for mandatory echo, and ***O** can be used to check for optional echo. You can also use ***A** to check for mandatory *absence* of a field.

Test cases supports a count attribute that can be used to fire the same test n times.

It also supports a continue attribute. If continue="yes" then the test runner would just log an exception if something goes wrong, and it would continue with the next test.

The default timeout is 60 seconds, but one can specify a different timeout using the timeout attribute of the testcase element.

At the end, you get a ticket with the test results.

```
<log realm="org.jpos.simulator.TestRunner" at="......">
  <results>
    Simple Echo Test        [OK] 58ms.
    Simple Echo Test        [OK] 38ms.
    Simple Echo Test        [OK] 70ms.
    Simple Echo Test        [OK] 23ms.
    Simple Echo Test        [OK] 56ms.
    Simple Echo Test        [OK] 24ms.
    Simple Echo Test        [OK] 73ms.
    Simple Echo Test        [OK] 107ms.
    Simple Echo Test        [OK] 20ms.
    Simple Echo Test        [OK] 50ms.
    Simple Echo Test        [OK] 23ms.
    Simple Echo Test        [OK] 24ms.
    Simple Echo Test        [OK] 86ms.
    Simple Echo Test        [OK] 24ms.
    Simple Echo Test        [OK] 24ms.
    Simple Echo Test        [OK] 23ms.
    Simple Echo Test        [OK] 26ms.
    Simple Echo Test        [OK] 21ms.
    Simple Echo Test        [OK] 22ms.
    Simple Echo Test        [OK] 79ms.
    Simple Echo Test 2      [OK] 22ms.
    elapsed server=893ms(62%),
    simulator=526ms(37%), total=1419ms
  </results>
</log>
```

Chapter 10. Operation services

10.1. SSHD

What	The SSHD let's you establish an ssh connection to a running Q2 instance.
When	Available in all versions of jPOS-EE since v2.0.0.
Who	The jPOS.org team.
Where	Directory modules/sshd available in git repository at github.
Why	Remote secure login is an often desired featured in production systems.
Status	Stable.
License	**GNU Affero General Public License version 3**

Maven Coordinates.

```
        <dependency>
            <groupId>org.jpos.ee</groupId>
            <artifactId>jposee-sshd</artifactId>
            <version>${jposee.version}</version>
        </dependency>
```

The SSHD module provides remote secure logic to a running Q2 instance. It features:

- Simple configuration
- Authentication by username/public key.
- Allows for CLI customization through alternate command stores.

The `setup` process will create a default deployment descriptor in *deploy/05_sshd.xml*:

```
<sshd name="sshd" class="org.jpos.ee.cli.SshCLI">
    <port>2222</port>                                                    ❶
    <auth-username>admin</auth-username>                                 ❷
    <authorized-keys-file>cfg/authorized_keys</authorized-keys-file>     ❸
</sshd>
```

❶ The SSHD server will listen on this port.
❷ The username the ssh client will use to connect to the SSHD server.
❸ Points to a file containing public keys for every user who will be able to login

If you have not setup a personal public/private key pair, now it's the time to do this. The instructions we will provide here are for OpenSSH on a Unix system, but we'll provide some links for Windows systems as well.

To generate your key pair:

```
$ ssh-keygen -t rsa                                                  ❶
Generating public/private rsa key pair.
Enter file in which to save the key (/home/myuser/.ssh/id_rsa):
Enter passphrase (empty for no passphrase):                          ❷
Enter same passphrase again:
Your identification has been saved in /home/myuser/.ssh/id_rsa.      ❸
Your public key has been saved in /home/myuser/.ssh/id_rsa.pub.      ❹
The key fingerprint is:
f6:61:a8:27:35:cf:4c:6d:13:22:70:cf:4c:c8:a0:23 myuser@nexus
```

❶ The command `ssh-keygen -t rsa` initiated the creation of the key pair.
❷ No passphrase was entered (Enter key was pressed instead).
❸ The private key was saved in .ssh/id_rsa.

❹ The public key is saved in .ssh/id_rsa.pub.

In this case, the content of file id_rsa.pub is:

```
ssh-rsa AAAAB3NzaC1yc2EAAAABIwAAAIEArkwv9X8eTVK4F7pMlSt45pWoiakFkZMw
G9BjydOJPGH0RFNAy1QqIWBGWv7vS5K2tr+EEO+F8WL2Y/jK4ZkUoQgoi+n7DWQVOHsR
ijcS3LvtO+50Np4yjXYWJKh29JL6GHcp8o7+YKEyVUMB2CSDOP99eF9g5Q0d+1U2WVdB
WQM= myuser@nexus
```

It is one line in length.

Its content is then copied to cfg/authorized_keys of your Q2 instance.

If all is well, you should be able to run your Q2 instance and type:

```
ssh -p 2222 admin@localhost
```

And you should be given access to Q2 Remote CLI.

Windows Users can use Putty and use this **link** [http://www.ualberta.ca/CNS/RESEARCH/LinuxClusters/pka-putty.html] as a guide to get the contents for the *authorized_keys* file.

Chapter 11. Contributed modules

11.1. FSDMsgX

What:	This field/message packager can be used to wire a message parser with java code. Its a utility library that enables you to parse grammar, usually used by text (can be binary as well) messages that are field separator delimited, fixed length, branching based on data parsed, looking ahead in the stream for a specific byte and base future parsing decisions. Provides out of the box PCI compliance and ability to add java objects to meet you compliance needs.
When:	Available as of jPOS-EE 2.0.9
Who:	The jPOS.org team (contributed by @chhil)
How:	Posted by the jPOS-EE team.
Where:	Directory modules/fsdpackager available in the jPOS-EE main git repository
Why:	When schema based FSD does not meet your parsing needs to write more complex parsing rules.
Status:	Production grade
Dependencies:	module jpos
License:	**GNU Affero General Public License version 3**

11.1.1. Introduction to using the packagers

FixedFieldPackager

Consider a specification that states field 1 is a fixed field of 6 and field 2 is a fixed stream of 2 bytes. Stream of bytes=123456AB If the specification is followed: Field1 = 123456 Field2 = AB

Example 11.1. FixedFieldPackager Usage [unpacking raw bytes]

```
FSDMsgX msg = new FSDMsgX("Example1");
FixedFieldPackager field1 = new FixedFieldPackager("Field1", 6, AsciiInterpreter.INSTANCE);
FixedFieldPackager field2 = new FixedFieldPackager("Field2", 2, AsciiInterpreter.INSTANCE);
```

```
msg.add(field1);
msg.add(field2);
```

```
String s = "123456ABEXTRA";// there are EXTRA bytes in the stream
```

```
int offset = msg.unpack(s.getBytes());
System.out.println("Offset="+offset);
System.out.println("Field1="+msg.get("Field1"));
System.out.println("Field2="+msg.get("Field2"));
System.out.println(msg.dump("dump> "));
System.out.println(msg.getParserTree("tree> "));
System.out.println(msg.hexDump(""));
```

Output

```
Offset=8
Field1=123456
Field2=AB
dump> <fsdmsgX name="Example1">
dump>   <field id="Field1" value="123456"/>
dump>   <field id="Field2" value="AB"/>
dump> </fsdmsgX>
tree> [Example1]
tree> Field [Field1] : Fixed [6] : 123456
tree> Field [Field2] : Fixed [2] : AB
0000  31 32 33 34 35 36 41 42                           123456AB
```

- Create the main container object FSDMsgX.
- Create the individual field packagers for field1 and field2.
- Add the individual field packagers to the container.
- Call the unpack method on the input bytes to parse the stream.
- The unpack method returns the offset in the stream where the parser has reached, we parsed a total of 8 bytes, the offset is 8 (its 0 based so its at the 9^{th} position.
- Notice the fields are accessible via the containers get method.
- The containers dump method, provides a pretty xml (the prefix of "dump" to identify it in the output.
- The container has a getParseTree method that display your composite packager. This will help once you get into complex composite packager. The use of of the prefix "tree" is used to identify its output.
- The container has a hexdump method that dumps the hex equivalent of the unpacked stream. Notice EXTRA is not there as there was no rule to unpack it.
- If the input string was s = "123456" then an ISOException would be thrown telling you precisely what was wrong. org.jpos.iso.ISOException: Field [Field2] at offset [6]:Expecting 2 bytes found 0

Example 11.2. FixedFieldPackager Usage [packing object into bytes]

```
FSDMsgX msg = new FSDMsgX("Example1");
FixedFieldPackager field1 = new FixedFieldPackager("Field1", 6, AsciiInterpreter.INSTANCE);
FixedFieldPackager field2 = new FixedFieldPackager("Field2", 2, AsciiInterpreter.INSTANCE);
```

```
msg.add(field1);
msg.add(field2);
```

```
msg.set("Field1", "ABCDEF");
msg.set("Field2", "12");
```

```
byte[] outStream = msg.pack();
```

```
System.out.println(msg.dump("dump"));
System.out.println(msg.getParserTree("tree>"));
System.out.println(msg.hexDump(""));
System.out.println(ISOUtil.hexdump(outStream));
```

Output

```
dump<fsdmsgX name="Example1">
dump  <field id="Field1" value="ABCDEF"/>
dump  <field id="Field2" value="12"/>
dump</fsdmsgX>
tree>[Example1]
tree>Field [Field1] : Fixed [6] : ABCDEF
tree>Field [Field2] : Fixed [2] : 12
0000  41 42 43 44 45 46 31 32                           ABCDEF12
0000  41 42 43 44 45 46 31 32                           ABCDEF12
```

- Set the fields in the container.
- Call the unpack method on the container to serialize the object into a byte array.
- You can verify that data looks accurate in dump method.
- You can verify that the parser parsed it correctly.
- You can verify the hexdump of the actual packed vyte array outstream is the same as the hexdump of the container.

VariableFieldPackager

Used when the size of the field is variable and needs a delimiter to indicate the end of the field.

Consider a specification that indicates a field FirstName can have a maximum of 20 characters and will be terminate/delimited by a semi colon followed by a Lastname with a maximum of 10 characters terminated by a period. The delimiter is important because one could have a name Tom, Tommy, Thomas to indicate the end of a name a delimiter is needed. If I did bot have a FirstName, a semi colon would be needed to indicate there is no first name.

Example 11.3. VariableFieldPackager Usage

```
@Test
public void unpackTest02() throws ISOException {
```

```
VariableFieldPackager f1 = new VariableFieldPackager("F1", 20, new Byte((byte) 0x1c),
    AsciiInterpreter.INSTANCE);
VariableFieldPackager f2 = new VariableFieldPackager(
  "F2", 5, new Byte((byte) 0x1d),
  AsciiInterpreter.INSTANCE
);
```

```
FSDMsgX msg = new FSDMsgX("Test1");
msg.add("F1", f1);
msg.add("F2", f2);
```

```
String inStream = "123456" + (char) 0x1c + "ABC" + (char) 0x1d;
msg.unpack(inStream.getBytes());
```

```
assertEquals("123456", msg.get("F1"));
assertEquals("ABC", msg.get("F2"));
```

```
FSDMsgX msg2 = new FSDMsgX("Test2");
msg2.add("F1", f1);
msg2.add("F2", f2);
byte[] outStream = msg2.pack();
```

```
  System.out.println(msg2.getParserTree("Msg2"));
  assertArrayEquals(inStream.getBytes(), outStream);
  System.out.println(msg2.hexDump(""));
  System.out.println(msg.hexDump(""));
}
```

Output

```
Msg2[TestPack]
Msg2Field [F1] : VAR[0..20] delimiter[0x1C] or EOM  : 123456
Msg2Field [F2] : VAR[0..5] delimiter[0x1D] or EOM  : ABC
0000  31 32 33 34 35 36 1C 41  42 43 1D                 123456.ABC.
0000  31 32 33 34 35 36 1C 41  42 43 1D                 123456.ABC.
```

- Create a variable length field F1 that can be a max of 20 wide terminated by a 0x1C.

- Create a variable length field F2 that can be a max of 5 wide terminated by a 0x1D.
- Add them to the Test1 container.
- Use raw input to test unpacking.
- Expect F1 to be 123456 and F2 to be ABC.
- Create a new container Test2 to test packing of the same fields to get byte array. The packing process will add the delimiter, you dont set it.
- Expect the packed array to be identical to the raw input used for unpacking.
- See the hexdumps are identical for both the containers,operations show equivalence.

BranchFieldPackager

Consider a specification where you need to parse fields differently based on a particular field. Typically you will see a pattern where, if the value of the field is X the fields following it are Y1,Y2..Yn.

As an example: There is a field F1 which is fixed. There is a fixed field F2 that can have values 01 or 02. If the value is 01, 2 fields following it are Fixed 3 and Fixed 3. If the value is 02, 2 fields following it are Fixed 4 and Fixed 4. .BranchFieldPackager Usage

```
@Test
public void unpackTest06() throws ISOException{
```

```
AFSDFieldPackager f1 = new FixedFieldPackager("F1", 5, AsciiInterpreter.INSTANCE);
AFSDFieldPackager f2 = new FixedFieldPackager("F2", 2, AsciiInterpreter.INSTANCE);
```

```
FSDMsgX innerFSDCase01 = new FSDMsgX("inner-1");
AFSDFieldPackager f7 = new FixedFieldPackager("F7", 3, AsciiInterpreter.INSTANCE);
AFSDFieldPackager f6 = new FixedFieldPackager("F6", 3, AsciiInterpreter.INSTANCE);
innerFSDCase01.add("F7",f7);
innerFSDCase01.add("F6",f6);
```

```
FSDMsgX innerFSDCase02 = new FSDMsgX("inner-2");
AFSDFieldPackager f8 = new FixedFieldPackager("F8", 4, AsciiInterpreter.INSTANCE);
AFSDFieldPackager f9 = new FixedFieldPackager("F9", 4, AsciiInterpreter.INSTANCE);
innerFSDCase02.add("F8",f8);
innerFSDCase02.add("F9",f9);
```

```
Map<String, AFSDFieldPackager> caseMap = new HashMap<String, AFSDFieldPackager>();
caseMap.put("01", innerFSDCase01);
caseMap.put("02", innerFSDCase02);
AFSDFieldPackager f3 = new BranchFieldPackager("F3", "F2", caseMap, null);
```

```
FSDMsgX msg = new FSDMsgX("Test");
msg.add("F1", f1);
msg.add("F2", f2);
msg.add("F3", f3);
```

```
System.out.println(msg.getParserTree(""));
```

```
msg.unpack("ABCDE0244445555".getBytes());
System.out.println(msg.dump(""));
assertEquals("ABCDE", msg.get("F1"));
assertEquals("02", msg.get("F2"));
```

```
assertEquals("4444", msg.get("F8"));
assertEquals("5555", msg.get("F9"));
```

```
}
```

Output

```
 [Test]
Field [F1] : Fixed [5]
Field [F2] : Fixed [2]
Field [F3] : [Branch]
  switch (F2)
    01:
      [inner-1]
      Field [F7] : Fixed [3]
      Field [F6] : Fixed [3]
    02:
      [inner-1]
      Field [F8] : Fixed [4]
      Field [F9] : Fixed [4]
    default:
      [Not Set]
<fsdmsgX name="Test">
  <field id="F1" value="ABCDE"/>
  <field id="F2" value="02"/>
  <fsdmsgX name="inner-1">
    <field id="F8" value="4444"/>
    <field id="F9" value="5555"/>
  </fsdmsgX>
</fsdmsgX>
```

- Define Fixed F1.
- Define Fixed F2.
- Set up the individual case formatters for cases 01 and 02 based on value in F2 (inner-1 and inner-2)
- Add the cases to a map where the key is the values F2 can hold and the maps value is the packager it should follow.
- Set up the branchfield packager field F3. the constructor takes the existing fields name, the name of the field whose value we will make the branching decision off [F2], the map that has the value to packager map, the last one is the default packager to use if the value of F2 is not in the map, here we have chosen null as we dont want a default path.
- Add the F1,F2 and F3 to the container. You dont add the other packagers as the those are basically used indirectly by F3. So once the container unpacks F1, then F2 and then when it unpacks F3, it will follow the packagers in container F3.
- The output shows you the parsetree based on how you have setup your parser, you can see f1,F2 as fixed and the branch showing you the switch on F2 and the cases wit their packagers.
- You can try tpo change the input stream and use ABCDE01222333 to see case 01 gets used.
- When you do a pack, it will check to see what value is set in F2 and pick the packagers to follow accordingly.

Part III. Appendices

Appendix A. Copyright

Appendix B. License

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Version 3, 19 November 2007

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d. Convey the object code by offering access from a designated place (gratis or for a charge), and offer equivalent access to the Corresponding Source in the same way through the same place at no further charge. You need not require recipients to copy the Corresponding Source along with the object code. If the place to copy the object code is a network server, the Corresponding Source may be on a different server (operated by you or a third party) that supports equivalent copying facilities, provided you maintain clear directions next to the object code saying where to find the Corresponding Source. Regardless of what server hosts the Corresponding Source, you remain obligated to ensure that it is available for as long as needed to satisfy these requirements.

e. Convey the object code using peer-to-peer transmission, provided you inform other peers where the object code and Corresponding Source of the work are being offered to the general public at no charge under subsection 6d.

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