



## Orchestra User Guide

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# Table of Contents

Introduction .....	iii
1. General information .....	1
1.1. Nova Orchestra Overview .....	1
1.2. Features list .....	1
1.3. Restrictions .....	2
1.4. Tooling .....	3
2. Prerequisites .....	4
2.1. Hardware .....	4
2.2. Software .....	4
3. Installation guide .....	5
3.1. Installation .....	5
3.2. Database Management .....	5
3.3. Orchestra directory structure .....	6
4. Configuration and Services .....	8
4.1. Services Container .....	8
4.1.1. Environment.xml file .....	8
4.2. Services .....	9
4.2.1. Publisher .....	10
4.2.2. Invoker .....	10
4.2.3. Repository .....	10
4.2.4. Persistence .....	10
4.2.5. Journal and History .....	11
4.2.6. Querier .....	11
4.2.7. Timers .....	11
4.2.8. Finished instance handler (FIH) .....	12
5. User guide .....	13
5.1. Start and Stop Nova Orchestra .....	13
5.2. Deploying / undeploying a process .....	13
5.3. Other commands .....	13
5.4. Running the examples .....	14
5.5. Running the tests .....	14
5.6. Configuring Logger .....	14
6. Developer's guide .....	16
6.1. Nova Orchestra APIs .....	16
6.1.1. Getting started with Nova Orchestra APIs .....	16

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# Introduction

This documentation is targeted to Orchestra users. It presents the installation procedure and a quick user guide of Nova Orchestra features.

**Chapter 1, General information** describes the new version Orchestra v4 called Nova Orchestra

**Chapter 2, Prerequisites** describes the prerequisites to the installation of Nova Orchestra

**Chapter 3, Installation guide** describes how to install the Orchestra engine

**Chapter 4, Configuration and Services** describes main configuration features and default services

**Chapter 5, User Guide** This chapter will guide you through the discovery of the functionalities of Nova Orchestra.

**Chapter 6, Developer's Guide** guides you through APIs of Nova Orchestra.

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# Chapter 1. General information

## 1.1. Nova Orchestra Overview

Nova Orchestra is the name of new version of Orchestra.

“Nova” technology is based on the “Process Virtual Machine” conceptual model for processes. The Process Virtual Machine defines a generic process engine enabling support for multiple process languages (such BPEL, XPDL...).

On top of that, it leads to a pluggable and embeddable design of process engines that gives modeling freedom to the business analyst. Additionally, it enables the developer to leverage process technology embedded in a Java application.

For more information about the Process Virtual Machine, check Nova Orchestra FAQs [<http://wiki.orchestra.objectweb.org/xwiki/bin/view/Main/FAQ>] on the Orchestra web site [<http://orchestra.objectweb.org>].

## 1.2. Features list

Nova Orchestra is a Web Service Orchestration engine that provides BPEL 2.0 support. Business Process Execution Language (BPEL) is an XML language created by the Oasis Consortium. More information and the specifications can be found on Oasis web site [[www.oasis-open.org/committees/wsbpel/](http://www.oasis-open.org/committees/wsbpel/)]

Nova Orchestra provides partial BPEL 2.0 support. Hereafter, you can find the list of the activities supported :

- Scope
- Receive
- Reply
- Invoke
- Assign
- Empty
- Sequence
- Flow
- If
- Some static analysis
- wait
- while
- repeatUntil
- forEach

- pick

This version provides Web Service support using the Axis 1.4 framework.

Nova Orchestra is shipped with a complete test suite and a few examples.

Nova Orchestra is persistable. This means that all the data concerning your processes definition and instances execution is stored in a Database using a persistence framework (hibernates by default). The following database systems have been successfully tested :

- HSQL (default)
- Postgres (8.2)
- Oracle

## 1.3. Restrictions

Nova Orchestra comes out with an innovative architecture based on a generic and extensible engine, called "The Process Virtual Machine" and a powerful injection technology allowing services pluggability.

This new version of Orchestra is aimed at showing the power of its very innovative architecture by providing support for all the basic activities defined in the BPEL standard. As stated in the previous section, this version provides the possibility to persist the processes definition and execution. Future versions will continue to improve the standard coverage as well as other functionalities like other services. Check the roadmap [<http://wiki.orchestra.objectweb.org/xwiki/bin/view/Main/Roadmap>] for more information.

This version does not support the following features :

- No fault management
- Foreach successfulBranchOnly to true unsupported because no fault management
- Some restrictions in assign statement :
  - no extensionAssignOperation
  - to partnerlink not supported
  - validate not supported
- Some restrictions in scope statement
  - isolated not supported
  - exitOnStandardFault not supported
  - partnerlink : dynamic update of endpoints
  - handlers not supported
- The following BPEL 2.0 statements are not supported :
  - throw / rethrow
  - exit
  - compensate

- compensateScope
- validate
- extensionActivity
- import
- extensions

## 1.4. Tooling

For the new version, Nova Orchestra does not ship a graphical designer. Nova Orchestra engine has been tested with processes created using the Eclipse BPEL designer [[www.eclipse.org/bpel/](http://www.eclipse.org/bpel/)]. Download and installation instruction are available on the project web site.

This version of Nova Orchestra provides an new Web 2.0 administration console. This console will be improved in following releases to add monitoring capabilities.

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# Chapter 2. Prerequisites

## 2.1. Hardware

A 1GHz processor is recommended, with a minimum of 512 Mb of RAM. Windows users can avoid swap file adjustments and get improved performance by using 1Gb or more of RAM

## 2.2. Software

- Nova Orchestra requires Java Development Kit (JDK) 1.5 (also called JDK 5.0) but also runs with with next release.

The JDK software can be downloaded from <http://java.sun.com/j2se/1.5.0>

- Nova Orchestra requires Apache Ant 1.7 or higher

It can be downloaded from <http://ant.apache.org>

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# Chapter 3. Installation guide

## 3.1. Installation

Unzip the orchestra-axis distribution package.

```
>unzip orchestra-4.0.RC1.zip
```

A new directory `orchestra-4.0.RC` will be created. It contains an ant file to install and start Orchestra.

*Remark : Nova Orchestra runs in Apache Tomcat servlet container. Tomcat 5.5.25 is delivered with the Orchestra Package.*

To install Orchestra, go to orchestra directory and launch the install by running ant:

```
>cd orchestra-4.0.RC1
>ant install
```

The install script installs Tomcat and Nova Orchestra. The default installation activates the persistence using the HSQL Database.

### Important

*if your network is based on a proxy, please change the file `conf/conf.properties`. Set in this file the proxy host, port and non proxy hosts. Then run **ant configure** under the installation directory.*

## 3.2. Database Management

The default configuration of Nova Orchestra uses the Database persistence service and the HSQL Database. Nova Orchestra has also been tested with Oracle and Postgres database system. To change to postgres or Oracle, you need to put the corresponding JDBC driver in the directory `catalina_base/webapps/orchestra/WEB-INF/lib` and modify the `hibernate.properties` file : uncomment the corresponding lines :

```
# Hibernate configuration

# For using Orchestra with HSQL
# hibernate.dialect                org.hibernate.dialect.HSQLDialect
# hibernate.connection.driver_class org.hsqldb.jdbcDriver
# hibernate.connection.url         jdbc:hsqldb:file:db_orchestra
# hibernate.connection.username    sa
# hibernate.connection.password

# For using Orchestra with postgresQL
# hibernate.dialect                org.hibernate.dialect.PostgreSQLDialect
# hibernate.connection.driver_class org.postgresql.Driver
# hibernate.connection.url         jdbc:postgresql://server:port/db
# hibernate.connection.username    user
# hibernate.connection.password    pass

hibernate.dialect                org.hibernate.dialect.HSQLDialect
hibernate.connection.driver_class org.hsqldb.jdbcDriver
hibernate.connection.url         jdbc:hsqldb:file:db_orchestra
hibernate.connection.username    sa
hibernate.connection.password

hibernate.hbm2ddl.auto           update
hibernate.cache.use_second_level_cache true
hibernate.cache.provider_class   org.hibernate.cache.HashtableCacheProvider
hibernate.show_sql              false
hibernate.format_sql            false
```



```
hibernate.use_sql_comments      false
hibernate.bytecode.use_reflection_optimizer true
```

### 3.3. Orchestra directory structure

Hereafter is detailed the structure of Orchestra installation. The installation directory contains the following structure :

```
README
build.xml
install.xml
licence.txt
catalina_base/
catalina_home/
conf/
doc/
examples/
lib/
```

Let's present those items :

- README

This file gives the basic information related to Nova Orchestra

- build.xml

This file is an ant file that provides tasks to install and use Nova Orchestra. Just typing `ant` will result giving you the usage.

- install.xml

This file is an ant file that is called when you run `ant install` (no need to specify the use of this file)

- license.txt

The license of Nova Orchestra. All of Nova Orchestra is available under the LGPL license.

- conf/

This directory contains all the configuration files of Nova Orchestra.

#### Warning

The modifications made to the configuration files are only taken into account after running the `ant configure` command.

- catalina\_base/ & catalina\_home/

Those directories are the installation and configuration directories of Tomcat

- doc/

This directory contains the documentation of Nova Orchestra. It contains 2 directories :

- html/

For HTML documentation

- pdf/

For PDF documentation

- `html-single`

For HTML documentation in a single page

- `examples/`

This directory contains some examples provided with Nova Orchestra package. The 2 examples provided are :

- `loanApproval`

This is an example from the BPEL 2.0 standards

- `weather`

This example shows how to call a real world Web Service.

- `lib/`

This directory contains the libraries used in Nova Orchestra.

---

# Chapter 4. Configuration and Services

This chapter introduces the services configuration infrastructure provided by Nova Orchestra as well as main services included in this version.

## 4.1. Services Container

The Process Virtual Machine technology includes a services container allowing the injection of services and objects that will be leveraged during the process definition and execution. Objects and services used by the Orchestra engine are defined through a XML file. A dedicated parser and a wiring framework are in charge of creating those objects. Service invoker, publisher, persistence and timers are examples of pluggable services.

This services container (aka IoC container) can be configured through a configuration file. A default configuration file is included in the package under the /conf directory (environment.xml).

### 4.1.1. Environment.xml file

The default environment.xml file created during the installation of Nova Orchestra is set to use the database implementation of the persistence service. This file also sets the configuration of hibernate. Here is the environment.xml file generated :

```
<environment-definition>
  <application>
    <hibernate-session-factory table-prefix='NOVA_'>
      <properties resource='hibernate.properties' />
      <mapping resource='hibernate.definition.hbm.xml' />
      <mapping resource='hibernate.execution.hbm.xml' />
      <mapping resource='hibernate.job.hbm.xml' />
      <mapping resource='hibernate.queries.hbm.xml' />
      <mapping resource='hibernate.type.hbm.xml' />
      <mapping resource='hibernate.wire.hbm.xml' />
      <mapping resource='bpel.activities.hbm.xml' />
      <mapping resource='bpel.elements.hbm.xml' />
      <mapping resource='bpel.execution.hbm.xml' />
      <mapping resource='bpel.runtime.hbm.xml' />
      <mapping resource='bpel.services.hbm.xml' />
      <mapping resource='bpel.queries.hbm.xml' />
      <mapping resource='bpel.util.hbm.xml' />
      <mapping resource='bpel.wsdl.hbm.xml' />
      <mapping resource='bpel.lang.hbm.xml' />
      <cache-configuration resource='pvm.definition.cache.xml' usage='read-write' />
      <cache-configuration resource='bpel.cache.xml' usage='read-write' />
    </hibernate-session-factory>
    <standard-command-service>
      <retry-interceptor />
      <environment-interceptor />
      <transaction-interceptor />
    </standard-command-service>
    <job-executor threads='1' auto-start='false' />
    <repository class='org.ow2.orchestra.execution.services.db.DbRepository' />
    <publisher class='org.ow2.orchestra.axis.AxisPublisher' />
    <invoker class='org.ow2.orchestra.axis.AxisInvoker' />
  </application>
  <block>
    <timer-session />
    <standard-transaction />
    <job-session />
    <hibernate-session />
    <hibernate-bpel-persistence-service />
  </block>
</environment-definition>
```

Currently, following objects implementations can be injected in the environment:

- **publisher:** object intended for publishing services of the given bpel proces .Default implementation is based on axis web services framewrok through the default implementation (class `org.ow2.orchestra.axis.AxisPublisher`).
- **invoker:** object intended for external web services invocations. Default implementation is based on axis web services framewrok through the default implementation (class `org.ow2.orchestra.axis.AxisInvoker`).
- **repository:** data repository storing processes and instances... Db persistence (class `org.ow2.orchestra.execution.services.db.DbRepository`) implementation is included in this RC.
- **recorder:** object responsible of process execution logs. Default implementation handles process logs in the command line console (`org.ow2.orchestra.persistence.log.LoggerRecorder`). Recorder and Journal (see next) objects can be chained (new ones can be added as well on top of the recorder chainer). This give you a powerful mechanism to handle process execution data
- **journal:** object responsible for storing or retrieving process execution data. Db persistence (class `org.ow2.orchestra.persistence.db.DbJournal`) implementation is provided by default.
- **archiver:** object intended for process logs archiving. Default implementation handles logs on process data archiving through the default implementation (class `org.ow2.orchestra.persistence.log.LoggerArchiver`). Archiver and History (see next) objects can be chained (new ones can be added as well on top of the archiver chainer). This give you a powerful mechanism to handle process archived data
- **history:** object intended for storing or retrieving process archieved data. Default implementation is provided and available in the following class: `org.ow2.orchestra.persistence.db.DbHistory`.
- **queryList:** object intended to configure how the QueryRuntimeAPI will retrieve the process execution data. This retrieval could be configured to chain with the expected order into the journal and the history.
- **finished-instance-handler:** action to perform when a process instance is finished. This object could chain two distinct actions: for a given process instance, deleting the runtime object including its activities from the repository and then store data in the archive and remove data from journal. Default implementations are proposed for both chained actions.

\* Note 1: As explained before persistence objects are provided as default implementations in the environment. Notice that in a persistence configuration additional resources are required, i.e for hibernate persistence you can specify mapings, cache configuration...

\* Note 2: The environment is divided in two different contexts: application and block. Objects declared inside the application context are created once and reused while objects declared inside the block context are created for each operation.

## 4.2. Services

Services in Nova Orchestra is all about pluggability. To allow that, each service has been thought in terms of an interface with different possible implementations. In the following lines you will find a description of main services supported in Nova Orchestra.

The PVM includes a framework to allow the injection of services and objects that will be leveraged during the process definition and execution. Objects and services required in Orchestra are defined through an XML file. A dedicated parser and wiring framework in the PVM is in charge of creating those objects.

A default environment file (environment.xml) is provided in the installed package.

Currently, following objects are required for the execution environment :

- publisher
- invoker
- repository
- persistence
- timer
- journal and history
- querier

Example of implementation classes for these objects are embedded into the Orchestra jar and defined into the environment.xml file.

### 4.2.1. Publisher

The publisher service sets the way the services proposed by the BPEL processes will be published. The default implementation of this service uses the Axis Web Service Container.

### 4.2.2. Invoker

The invoker service sets the way the BPEL processes will call external services. The default implementation of this service uses the Axis Web Service Container.

### 4.2.3. Repository

The repository service sets the way the data will be handled by the engine. Nova Orchestra proposes one implementation managing data in the database.

### 4.2.4. Persistence

Persistence is one of key technical services injected into the services container. This service, as well as other major services in Nova Orchestra, is based on a service interface. That means that multiple persistence implementations can be plugged on top.

The Persistence service interface is responsible to save and load objects from a relational database. By default, a persistence implementation based on the Hibernate ORM framework is provided (JPA and JCR to come).

The Process Virtual Machine core definition and execution elements (processes, nodes, transitions, events, actions, variables and executions) as well as the BPEL extension ones (activities, conditions, variables...) are persisted through this service. Process Virtual Machine core elements are also cached by leveraging the default persistence service implementation (Hibernate based). Processes and instances are stored through this persistence service. Repository is the term used in Nova Orchestra to store those entities.

This service is only used if the repository service is set to database.

## 4.2.5. Journal and History

This module concerns the way in which the process data is stored during the process execution and archived when the execution is completed. This is indeed a crucial module in a process solution.

Nova Orchestra unifies journal data et history data as the underlying essence of both is to handle process data. For that to be done, we created the concept of process record. A record is a minimal set of attributes describing a process entity execution. That means that each process entity related to the execution has its own associated record.

Those records are recorded during the process execution and stored depending on the persistence service implementation (db, xml...). The Nova Orchestra API will retrieve record data from the records storage and sent them back to the users (meaning that records also acts as value objects in Nova Orchestra APIs).

As soon as a process instance is finished, a typical scenario would be (by default) to move instance related process data from the production environment to a history one. While the physical device and the data structure could changed from one process engine deployment to another (XML, BI database...), the internal format could remain the same (records). This is exactly what is happening in Nova Orchestra, when archiving data the engine just move execution records from the production to the history environment without data transformation in between.

Journal and history data are persisted in different database. Change `hibernate.properties` [`hibernate-history.properties`] file in `conf` directory to modify the journal [history] database

## 4.2.6. Querier

The querier is an API tool for getting process records corresponding to different criteria. It can get records from journal, from history or both. This possibility is defined in the environment. Several parameters will allow us to obtain this information by various criteria: their state (running or after delivery) or ID. Depending on the circumstances this request will return a record, a set of records or an empty table.

## 4.2.7. Timers

To handle activities deadlines, a timer service is required that can schedule timers to be executed in the future. Timers must have the ability to contain some contextual information and reference the program logic that needs to be executed when the timer expires.

This service, as well as any other asynchronous service in Nova Orchestra is based on the Process Virtual Machine Job executor framework. Job executor framework is responsible for handling jobs. A job could be a timer scheduling or an asynchronous message for instance. When a job is created and stored in the database, the job executor starts a new transaction, fetch the job from the database and perform the instructions contained in the message.

The timer service is used for the BPEL statements "wait" and "onAlarm".

The Database implementation uses the Job Executor module of the Process Virtual Machine for the management of the timers. Its definition in the environment is the following : `<timer-session />`

For the Job Executor, the administrator can set the number of thread that will manage the jobs. This information is also defined in the environment file with the following line :

```
<job-executor threads='1' auto-start='false' />
```

The default number of thread for the job executor is 1. It is advised to leave this value to avoid concurrency problems.

## 4.2.8. Finished instance handler (FIH)

FIH are executed after the instance finished. Orchestra provides following implementations in the package `org.ow2.orchestra.services.handlers.impl` :

- `NoOpFinishedInstanceHandler` : do nothing
- `CleanJournalFinishedInstanceHandler` : remove instance data from journal
- `ArchiveFinishedInstanceHandler` : remove instance data from journal and put it in history
- `DeleteFinishedInstanceHandler` : delete instance data from orchestra repository

---

# Chapter 5. User guide

## 5.1. Start and Stop Nova Orchestra

Nova Orchestra is a webapp that can be deployed on Tomcat. So starting Nova Orchestra in fact starts Tomcat with the correct environment. This can be performed from the installation directory with the following command line :

```
>cd orchestra-4.0.RC1
>ant start
```

Starting Orchestra will not be done in background. This means that the console starting Orchestra will be dedicated to the traces from Orchestra. To perform further actions, new consoles need to be opened.

To stop Nova Orchestra, type the following command line :

```
>cd orchestra-4.0.RC1
>ant stop
```

## 5.2. Deploying / undeploying a process

Once Nova Orchestra is started, it is then possible to deploy a new process on the engine :

```
>ant deploy -Dbpel=<process>.bpel -Dwsdl=<process>.wsdl -Dextwsdl=<wsdl1,wsdl2>
```

Nova Orchestra also provides the possibility to use an archive to deploy a process. This archive should be a zip file with the extension .bar. Here is the command line to deploy such an archive :

```
>ant deploy -Dbar=<process>.bar
```

Warning : The archive should be a zip file structured as described bellow :

```
/bar.properties
/<process>.bpel
/<process>.wsdl
/<files>.wsdl
```

The bar.properties file should have the following structure :

```
bpel=<process>.bpel
wsdl=<process>.wsdl
extwsdl=<file1>.wsdl,<file2>.wsdl,...
```

To undeploy a process, use the following command line :

```
>ant undeploy -Dprocess=<process_name>
```

Warning : the process name should be fully qualified. This means that it needs to contain to namespace. For instance :

```
{http://orchestra.ow2.org/weather}weather
```

## 5.3. Other commands

Nova Orchestra provides a set of other commands that can be useful

- A command to check the status of Nova Orchestra. This command tells if the engine is started and if so, gives the names of processes deployed on the engine :

```
>ant status
```



- A command to simulate a Web Service call. This command will simulate a WS call to interact with a deployed process :

```
>ant call -Dendpoint=<service_url> -Daction=<SOAP_action> -Dmessage=<message>
```

For example :

```
>ant call -Dendpoint=http://localhost:8080/orchestra/services
-Daction=http://orchestra.ow2.org/weatherArtifacts/process/weatherPT
-Dmessage="<weatherRequest xmlns='http://orchestra.ow2.org/weather'>
  <input>Grenoble,France</input>
</weatherRequest>"
```

## 5.4. Running the examples

The Nova Orchestra package contains two examples of BPEL processes:

- `loanApproval` : invokes two local web services. This example is taken from the BPEL 2.0 standard.
- `weather`: invokes a remote Web Service and returns the current weather.

A `build.xml` file is provided for each of those samples. Those ant scripts provide the same targets to deploy, launch and undeploy the sample. Go to the desired example and use the command lines :

```
>ant deploy
>ant launch
>ant undeploy
```

## 5.5. Running the tests

Nova Orchestra is delivered with a test suite to check if your installation is correct. There are 3 different tests available :

- *Core test suite*. This suite tests the core functionalities of the engine (e.g. BPEL activities, variables, etc...). To run this test suite, the server should not be started. This test suite can be launched with the following command :

```
>ant test
```

- *Axis test suite*. This suite gives the possibility to test the Axis Web Service stack deploying and launching real processes. This test suite can be launched with the following command (server should be started) :

```
>ant test-axis
```

- *Stress test suite*. This suite will launch a small stress test. This test suite can be launched with the following command line :

```
>ant test-stress
```

A command is also provided to launch those 3 test suites at once :

```
>ant test-all
```

The results of the tests are available under the directory `testresults`.

## 5.6. Configuring Logger

It is possible to activate the logs. To do so, the file `logging.properties` under the directory `$CATALINA_BASE/webapps/orchestra/WEB-INF/classes` can be edited. Here is the content of that file :

```
handlers= java.util.logging.ConsoleHandler
.level= SEVERE
java.util.logging.ConsoleHandler.level = FINEST
java.util.logging.ConsoleHandler.formatter = org.jbpm.util.JbpmFormatter

# For example, set the com.xyz.foo logger to only log SEVERE messages:
# com.xyz.foo.level = SEVERE

#org.jbpm.pvm.level=INFO
#org.ow2.orchestra.level=FINEST
#org.jbpm.pvm.Execution.level=FINEST
#org.jbpm.wire.level=FINEST
```

Uncomment the last lines to activate the logs.

---

# Chapter 6. Developer's guide

This chapter describes how to start playing with Nova Orchestra:

- How to develop a simple application by leveraging Orchestra APIs

## 6.1. Nova Orchestra APIs

### 6.1.1. Getting started with Nova Orchestra APIs

Actually, one API is developed in Nova Orchestra RC7. Others APIs will be available in the future versions of Nova Orchestra. APIs are included in a Maven module. To include this module you have to add following Maven dependency :

```
<dependency>
  <groupId>org.ow2.orchestra</groupId>
  <artifactId>orchestra-api</artifactId>
  <version>4.0.RC7</version>
</dependency>
```

If you do not want / can't use Maven, you can create a Maven module which depends only on this dependency and create an assembly. Then copy created jar to your project.

- **QueryRuntimeAPI**: to get recorded/runtime informations for instances and activities. It allows also to get activities per state. Then operations in this API applies to process instances and activity instances.

Hereafter you will find an example on how to access to the QueryRuntimeAPI from your client application:

```
QuerierRuntimeAPI querierRuntimeAPI = AccessorUtil.getQueryRuntimeAPI(String, String);
```

The method `getQueryRuntimeAPI` takes two arguments of type `String`. The first argument is the URL of the JMX service. The second is the name of the object JMX. In case we use the default configuration, two constants can be used which are: `AccessorUtil.SERVICE_URL` and `AccessorUtil.OBJECT_NAME`.

For a detailed insight on Nova Orchestra APIs, please take a look to the Nova Orchestra javadoc APIs (available under `/javadoc` directory)