



HPE Service Activator

System Integrator's Overview

for Microsoft Windows Server 2012 R2®, and Red Hat Enterprise Linux 6.7 operating systems

Release: 8.0

March 14, 2016



Hewlett Packard
Enterprise

Notices

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Install Location Descriptors

The following names are used to define install locations throughout this guide.

Descriptor	What the Descriptor Represents
<code>\$ACTIVATOR_OPT</code>	The base install location of HPE Service Activator. The UNIX® location is <code>/opt/OV/ServiceActivator</code> The Windows® location is <code><install drive>:\HP\OpenView\ServiceActivator</code>
<code>\$ACTIVATOR_ETC</code>	The install location of specific HPE Service Activator files. The UNIX location is <code>/etc/opt/OV/ServiceActivator</code> The Windows location is <code><install drive>:\HP\OpenView\ServiceActivator\etc</code>
<code>\$ACTIVATOR_VAR</code>	The install location of specific HPE Service Activator files. The UNIX location is <code>/var/opt/OV/ServiceActivator</code> The Windows location is <code><install drive>:\HP\OpenView\ServiceActivator\var</code>
<code>\$ACTIVATOR_BIN</code>	The install location of specific HPE Service Activator files. The UNIX location is <code>/opt/OV/ServiceActivator/bin</code> The Windows location is <code><install drive>:\HP\OpenView\ServiceActivator\bin</code>
<code>\$JBOSS_HOME</code>	The install location for WildFly. The UNIX location is <code>/opt/HP/jboss</code> The Windows location is <code><install drive>:\HP\jboss</code>
<code>\$JBOSS_DEPLOY</code>	The install location of the HPE Service Activator JEE components. The UNIX location is <code>/opt/HP/jboss/server/standalone/deployments</code> The Windows location is <code><install drive>:\HP\jboss\server\standalone\deployments</code>
<code>\$JBOSS_EAR_LIB</code>	Location for libraries (Java *.jar files) to be executed by the HPESA engine (workflow manager and resource manager): <code>\$JBOSS_DEPLOY/hpsa.ear/lib</code>
<code>\$JBOSS_ACTIVATOR</code>	More specific location of HPE Service Activator UI components deployed in WildFly: <code>\$JBOSS_DEPLOY/hpsa.ear/activator.war</code>

Conventions

The following typographical conventions are used in this guide.

Font	What the Font Represents	Example
<i>Italic</i>	Book or manual titles, and manpage names	Refer to <i>HPE Service Activator, Workflows and the Workflow Manager</i> and the <i>Javadocs</i> for more information
	Provides emphasis, introduces a new term	You <i>must</i> follow these steps.
	Identifies a variable or parameter	Run the command: <code>InventoryBuilder <sourceFiles></code> The <i>assigned_criteria</i> parameter returns an ACSE response.
	Location descriptor	<code>\$JBOSS_DEPLOY</code>
Computer	Text and items on the computer screen	The system replies: <code>Press Enter</code>
	Command names	Use the <code>InventoryBuilder</code> command
	Method names	The <code>get_all_replies()</code> method does the following...
	File and directory names	Edit the file <code>\$ACTIVATOR_ETC/config/mwfm.xml</code>
	Window/dialog box names	In the <code>Test and Track</code> dialog...
Computer Bold	Text that you must type	At the prompt, type: <code>ls -l</code>
Keycap	Keyboard keys	Press Return
[Button]	Buttons on the user interface	Click [Delete]. Click the [Apply] button.
Menu Items	A menu name followed by a colon (:) means that you select the menu, then the item. When followed by an arrow (->), a cascading menu follows.	Select <code>Locate:Objects->by Comment</code>

In This Guide

This guide provides an overview of the HPE Service Activator product, including its architecture and components, and provides information to help plan and design Service Activator-based solutions.

Audience

The audience for this guide is the Solutions Integrator (SI) who will plan and deliver solutions, particularly SIs with architect roles. It is not intended for the end user. Implementors will need additional detail from manuals for the different components of tools within the HPE Service Activator product. The SI is expected to have some or all of the following background:

- Understanding and working knowledge of:
 - UNIX® commands
 - Windows® system administration
- Familiarity with Java™ and XML
- Understanding of security issues
- Understanding of the customer's problem domain

Chapter 1

Introducing HPE Service Activator

HPE Service Activator is a customizable product that performs tasks to activate services offered by providers of converged IT and network communications services. It can perform any activation task on elements of any infrastructure comprising network elements and IT servers, when the targets can be configured through command or request interfaces, whether they use command lines, web services, or any other protocol. The product is typically deployed to perform highly repetitive activations where automation brings a significant advantage in terms of cost saving, speedup and ensuring correct activation, but it is possible to use HPE Service Activator to automate any process that requires the execution of a sequence of automated command interactions.

The core of HPE Service Activator is a generic workflow engine. To build a solution for activation of services in a specific domain the core must be supplemented with customized data models, workflows and plug-ins for interaction with the elements in the provider's environment. Workflows must implement the activation processes needed to add, modify or terminate services for each of the provider's customers. The product includes tools to assist the SI in the customization process.

This overview manual introduces the way HPE Service Activator works in a deployed solution as well as the tool set and the customization process that the SI must go through in a solution delivery project.

1.1 Positioning an HPE ServiceActivator Solution

Described here is the positioning of HPE Service Activator for use as an activation system in fulfillment solutions. It should be noted that this positioning is not exclusive. Due to the flexibility of HPE Service Activator workflows and plug-ins, it is possible to customize solutions also for other domains, notably network configuration as well as test and diagnostics, also known as network troubleshooting applications.

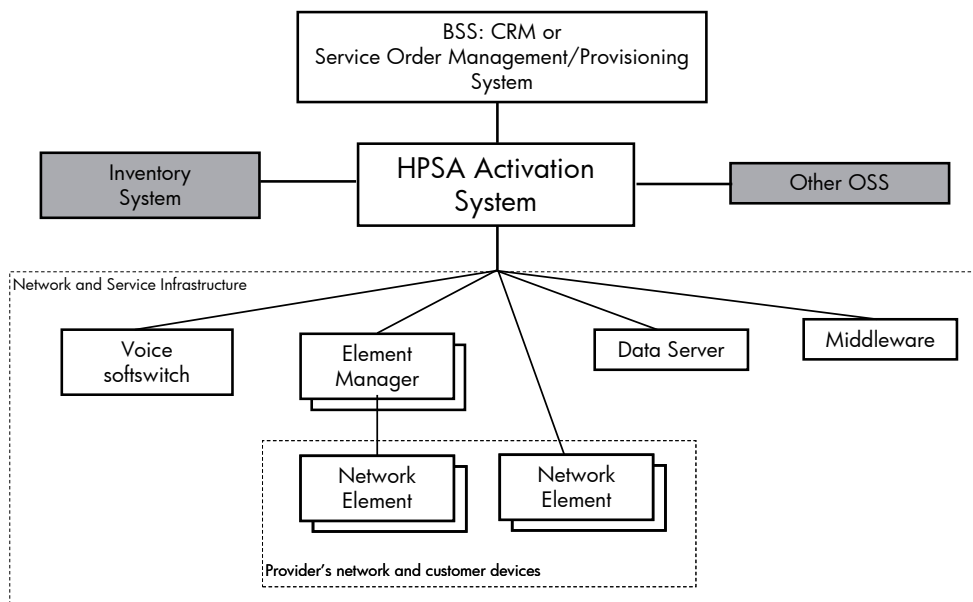
1.1.1 Positioning in the Provider's Environment

An activation system built with HPE Service Activator will typically be part of a complete service fulfillment solution driven by requests from a CRM (Customer Relationship Management) system. The fulfillment solution may comprise also order management (OM) and resource inventory, and it may be integrated with other Operation and Business Support Systems (OSS and BSS) outside of fulfillment.

The HPE Service Activator-based activation system typically has a built-in data repository commonly referred to as inventory: resource inventory, which is used to allocate resources in the network and keep data about devices which are activated, and service inventory which records services and their parameters as they are activated. Alternatively, if required, the activation system can access the inventory data in an external inventory system.

The positioning of the activation system between a BSS system, which drives it with requests for service activation, and the network and service infrastructure on which services are activated is shown in Figure 1-1. In this diagram the flow of control is from north to south. The network and service infrastructure may contain many different kinds of network elements and data servers. The latter can belong to a service infrastructure, for example GSM or IMS: HLR, HSS, servers for voice mail, SMS, MMS, etc. They can also be related to Internet data services: DHCP, RADIUS, email, etc. In general any server which needs to be activated with information about a new customer/subscriber can be part of the infrastructure that is known to the HPE Service Activator system.

Figure 1-1 Positioning of HPE Service Activator Activation System

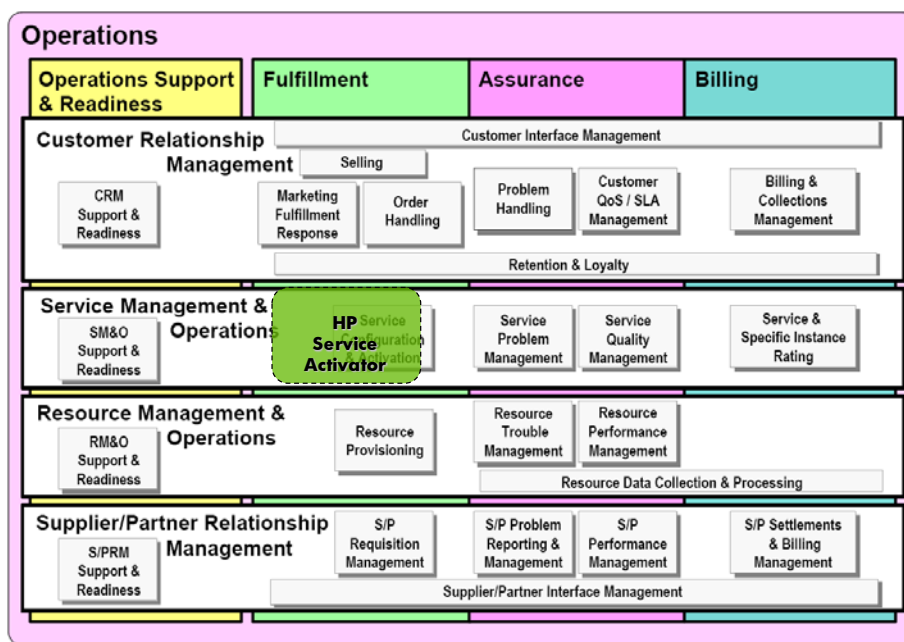


It is typical, but not mandatory that HPE Service Activator is driven by requests forwarded by an external BSS system, as discussed above. It is also possible to implement a stand-alone system where requests to start workflows are entered directly from the user interface on HPE Service Activator.

1.1.2 Positioning in the TMF NGOSS Maps

For the reader who is familiar with TMF's (NGOSS) eTOM map of the processes which are executed by a communications service provider to plan, deliver and maintain services, HPE Service Activator can be characterized by its position on the map as shown in Figure 1-2. HPE Service Activator helps to automate the processes designated in eTOM as 'Service Configuration & Activation'.

Figure 1-2 HPE Service Activator in the eTOM Map

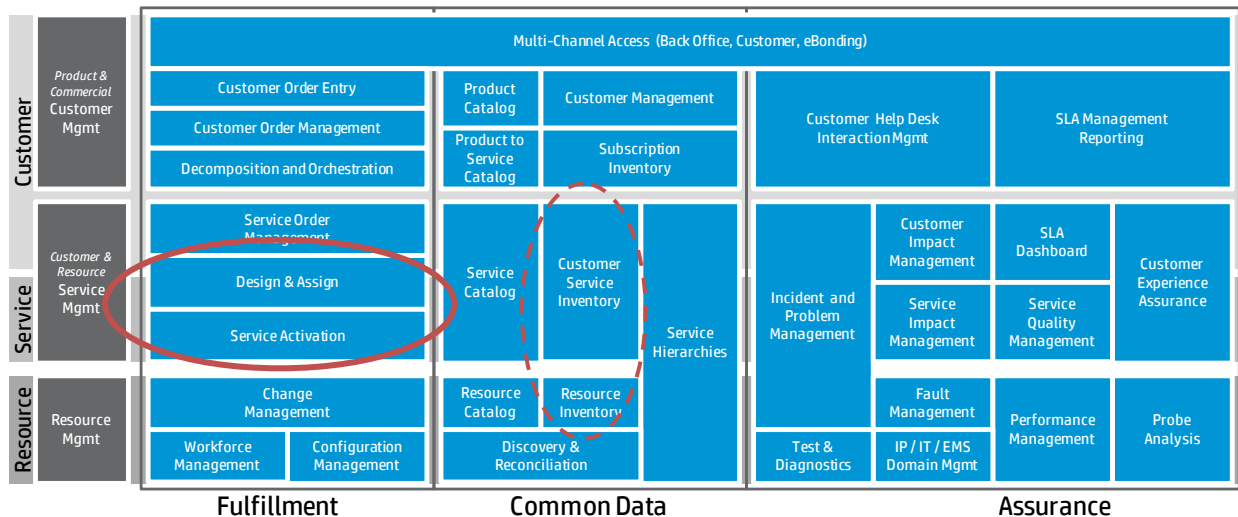


HPE Service Activator can also be positioned on TMF's emerging Telecom Application Map (TAM). TAM describes a number of so-called applications (with considerable overlap), grouped in domains and sub-domains, from which a complete OSS can be constructed. The functions of HPE Service Activator fall mainly in the sub-domains of Resource Inventory Management, Resource Order Management and Service Order Management.

1.1.3 Positioning in the HPE OSS Blueprint

HPE offers a range of OSS solutions, all derived from an overall blueprint, which is similar to the TM Framework maps, as shown in Figure 1-3.

Figure 1-3 HPE Service Activator in HPE NGOSS Solutions



Design & Assign, comprising the selection and reservation of resources for shared or exclusive use by a service instance, and Service Activation, comprising the interactions with network elements or systems in the provider's service infrastructure that are needed to activate a service instance, are identified in the blueprint as separate functional building blocks. HPE Service Activator is normally always used to implement Service Activation, and it is used to implement Design & Assign when that function is automated. It is recommended for solutions intended to be reusable to clearly separate the two functionalities, i.e. not combine them in the same workflows.

HPE Service Activator also has some capabilities in the Common Data column, identified as the Service Inventory and Resource Inventory functional building blocks. Generally these capabilities are not used to build master inventory systems, but primarily to build data models for internal purposes of the solution that is based on HPE Service Activator. Solutions may integrate and synchronize with external inventories.

1.2 HPE Service Activator Component Architecture

In Figure 1-1 there is a single box 'HPESA Activation System'. This box has a number of interfaces. Here we open the box and consider the components inside it. The various interfaces into the box are handled by different internal components. Figure 1-4 shows the major components: the workflow manager, the resource manager, and the web server, all of which run on the JEE platform WildFly. The web server is actually part of WildFly, whereas the other components are HPE Service Activator additions to the platform. For further discussion of the platform and how HPE Service Activator can scale by using a cluster of servers (Note: not based on WildFly clustering).

This section only scrapes the surface. For more information about the components and the associated development tools, read the next chapter and then go to the dedicated manuals as needed.

The workflow manager and the resource manager together make up the workflow engine of HPE Service Activator. The workflow engine does the process work of the activation system by executing workflow jobs.

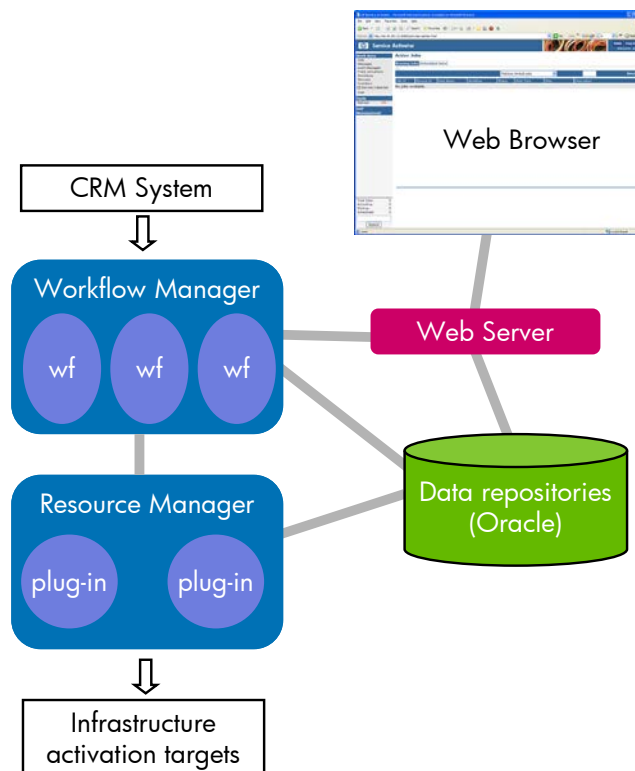
1.2.1 Workflows

A workflow is a definition of an executable process. The definition is at a detailed algorithmic level, suitable for control of interactions with activation targets. HPE Service Activator workflows should not be confused with business process workflows as supported by languages like BPEL. It is possible, however, to implement processes which interact with human operators as well as external system and have significant duration in HPE Service Activator. Workflows are composed from a set of action primitives known as workflow nodes. They are executed by the workflow manager, one node at a time. The crucial step in an activation workflow is the Activate node. This node executes an activation task which is where the actual interaction with activation targets take place.

1.2.2 Plugins and activation tasks

Activation tasks consist of one or more atomic tasks; each atomic task interacts with a specific activation target and is implemented as an element of the plug-in for that target, for example a specific type of network element (vendor and model) or IT server, for example LDAP, or a voice softswitch. A plug-in is a pluggable component which is managed by the resource manager. A task that consists of more than one atomic task is called a compound task. A compound task is executed as a transaction: the atomic tasks are executed sequentially, and if one of them fails, any atomic tasks that have already finished successfully will be undone by executing their “undo” parts, so that the net effect of the compound task will be nil. The undo part of each atomic task restores the state of the target as it was before the atomic task was executed.

Figure 1-4 HPE Service Activator Components and Interfaces



HPE Service Activator includes a few generic plug-ins, which are not for specific devices or target systems, but for a certain type of interface, such as a command line interface (CLI) or HTTP message exchange interface. When a generic plug-in is used, it will have pre-implemented atomic tasks which handle the communications protocol, but must be customized with additional control information that determines the specific commands or messages that are exchanged. In these cases a plug-in dedicated to a specific activation target comprises the generic plug-in plus the additional customization. Such plug-ins occur frequently.

To save time for connection establishment and session authentication it is often desirable to allow several successive activation dialogs with a target equipment, i.e. to activate different service instances, to occur within a single session between HPE Service Activator (a plug-in) and the equipment. This mode of operation is facilitated by supporting pools of reusable connections (preauthenticated sessions) within the resource manager.

Plug-ins may be reusable from one solution to another, and a list of plug-ins that have been built is maintained as a “plug-in library”. However, plug-ins are typically designed to fit the requirements of a particular provider’s solution. To limit the implementation effort they are not generally designed to be able to control all features of the target, and may therefore require additional work when reused for a different project.

1.2.3 Solution Data Repositories (Inventory)

It will often be necessary as steps of activation processes implemented with workflows to access data describing resources in the provider’s infrastructure as well as the services (instances) that have been activated. HPE Service Activator has the capability to model and maintain repositories of data that is needed by the solution, commonly referred to as resource and service inventory data. There is also a user interface for working with inventory data.

1.2.4 Northbound interface

The native northbound interface of the workflow manager is a Java RMI interface which supports a range of methods to inspect and control the state of the workflow manager. In particular it is possible to request the workflow manager to start a workflow job, specified by name and with parameters. The RMI is normally not used directly by an external requester, but all other NBIs are based on it.

1.3 Solution Packages

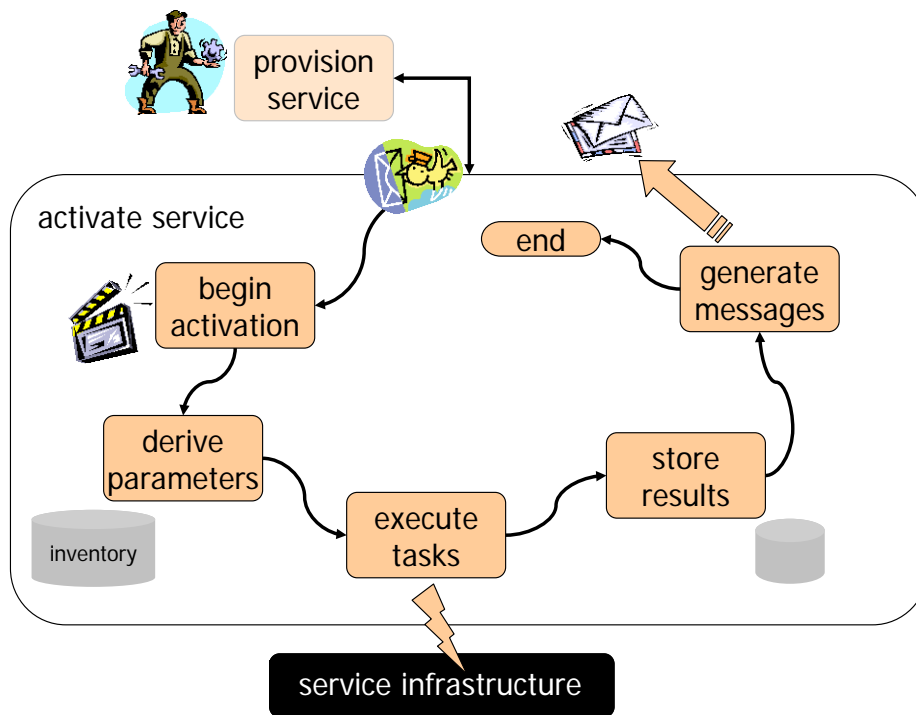
For frequently occurring types of activation solutions pre-customized packages of plug-ins, workflows and more, are maintained and made available for delivery projects. These packages allow rapid delivery of solutions. Depending on the provider’s environment some customization will still be required, to adapt to the provider’s specific network architecture, processes and service definitions, to develop any additional plug-ins needed for targets not already supported, and to integrate with other systems.

Solution packages exist for layer 2 (Metro Ethernet) and layer 3 (IP) VPN services and for residential services delivered over IP networks (Internet access, IPTV, etc.).

1.4 A Typical Workflow

Workflows for activation of services typically follow a pattern as depicted in Figure 1-5.

Figure 1-5 Typical Service Activation Workflow



In an actual workflow, each box as shown in Figure 1-5, will require several workflow nodes, the number depending on the complexity of the details of the process. At the high level, as shown, the process is typically as follows:

- A customer order is entered into a CRM system, where it is validated, approved and forwarded to the next level of processing. In a simple case it can go directly to Service Activation. In a more complex case, an order management process may be needed to decompose an order which is for a bundle of services and to separate the request for automatic activation, which can be handled by HPE Service Activator, from other tasks which must be performed manually or passed on to partners of the provider.
- The activation system based on HPE Service Activator receives the request for activation of a service, maps to the appropriate workflow and starts an instance of the workflow as a job.
- The workflow job inspects the parameter values from the request and calculates or gathers additional necessary parameter values.
 - For example, if a service type is specified as 'Gold' or 'Silver', the corresponding technical values for bandwidth and similar parameters will be looked up. For a complex technology, the derivation can also be complex.
 - Resources needed to satisfy the request, such as an access port, for example on a DSLAM, where customer premises equipment can be connected, are allocated from resource inventory. Resource identifiers will also be activation parameters. Allocated resources are recorded in resource inventory.
 - Parameter values, for example selection of a device or port, can also be obtained from a dialog with an operator.
- When all parameters are ready, the necessary activations are executed, ideally as a single task, which may be compound.
 - If an atomic task within a compound task fails, any preceding atomic tasks are automatically rolled back. This logic is not visible in the workflow.
- If the activation was successful, the newly activated service will be recorded in service inventory. If it failed, any reserved resources are again released.
- A summary of the action of the workflow, including service id, main parameter values, success or failure, is recorded in HPE Service Activator's audit trail.
- A response message to be returned to the requester is prepared. Success or failure indication and any relevant parameters that were derived by the workflow are included in the message. The message is forwarded according

to the protocol of the northbound interface. This may be done by a sender module or by the web service interface after the workflow terminates.

- The response message is processed by the order handling system or CRM system. This is outside the scope of the activation system

In actual implementations process logic is often divided over several workflows. A parent workflow can start instances of child workflows and synchronize with their completion. An architecture is recommended where the northbound communication to receive and respond to incoming request messages is separated from activation details that will differ for each type of request. This topic will be discussed in Chapter 5.

1.5 HPE Service Activator Documentation

This manual provides an introduction and overview:

- Chapter 2 describes in more detail each of the components of HPE Service Activator that were introduced above along with the tool(s) for customizing the corresponding part of a solution.
- Chapter 3 walks through a simple (not real) solution containing components of all the kinds introduced in the first chapters.
- Chapter 4 provides a brief guide for planning a solution delivery project and identifies the topics to be covered in the analysis phase which may be needed as a pre-sales activity to scope the delivery project.
- Chapter 5 discusses some design topics for the different components of a solution.
- Chapter 6 describes how HPE Service Activator can be deployed on a cluster of JBoss platforms for scalability and high availability.
- Chapter 7 describes the use of roles to control access and customize the user interface for different groups of users.
- Chapter 8 describes the Common Network Resource Model.
- Chapter 9 describes the Web Server Designer, a tool to generate a web service servlet dedicated to a solution.
- Chapter 11 describes the integration of HPE Service Activator and HPE NNMI.
- Chapter 12 describes the integration of HPE Service Activator and HPE Network Automation (NA).
- Chapter 13 gives some useful hints about testing and debugging.
- Chapter 14 gives advice about configuring an HPE Service Activator system.
- Chapter 15 gives an overview of the process of localizing an HPE Service Activator solution.

For further familiarization with HPE Service Activator it will be useful to study some of the example material that is provided as part of the installable kit. A simple example is introduced in Chapter 2. A more thorough example - using management of layer 2 VPN services as use case - complete with inventory data model, workflows and plug-in code is fully documented in a separate manual, *Putting HPE Service Activator to Work: A Sample Service Scenario for VPLS*.

For an actual customization and solution delivery project, detailed manuals are provided for installation on each supported operating system platform and for the major components of HPE Service Activator and the associated customization tools:

- *HPE Service Activator, Workflows and the Workflow Manager* provides all the information needed to understand workflows in detail, including descriptions of the workflow node and workflow manager module libraries, how to extend the libraries with new nodes and modules, and the workflow designer tool.
- *HPE Service Activator, Inventory Subsystem* explains how to customize a solution data repository model with definitions of each entity class (database table) and the user interface to present the data model. This manual also describes the Inventory Builder, the tool used to process inventory definitions.
- *HPE Service Activator, XMaps* explains how to customize a solution to use a graphical representation to model solution data. The manual also described the XMap Designer, a too used to configure XMaps.

- *HPE Service Activator, Developing Plug-Ins and Compound Tasks* explains the concepts of plug-ins, atomic tasks and compound tasks, and how to use the Service Builder tool to build plug-ins and customize compound tasks.
- *HPE Service Activator, Solution Separation and the Deployment Manager* explains how customized solutions can be managed on a target system: installed, inspected, removed. The Deployment Manager is the tool to use for managing solutions.

There is one manual describing the HPE Service Activator and its user interface in a generic way for users and system administrators: *HPE Service Activator, User's and Administrator's Guide*. You should read that manual as an introduction and to understand how you can supply solution specific information.

Chapter 2

Solution Component and Tools

In Chapter 1 the components of HPE Service Activator were introduced: workflow manager, resource manager, data repositories. Correspondingly, a customized solution will contain different components: workflows implementing activation processes, plug-ins implementing target interactions, and definitions for the required data model. On top of the workflows it will generally be necessary to add a northbound interface for receiving and responding to service activation requests. Depending on specific requirements it may also be necessary to integrate with other OSS/BSS systems.

HPE Service Activator comes with a set of tools which make the process of customization a joy. They will be introduced in this chapter and each one is thoroughly documented in one of the manuals listed at the end of Chapter 1. Here is an overview of this chapter:

- The first section, “Database Repositories”, describes the key role that is played by the prerequisite database to hold a number of repositories that are used by HPE Service Activator.
- The second section, “Solution Data Repositories”, introduces the capabilities of HPE Service Activator to manage repositories of resource and service data, also known as *inventory*, including the tree-structured inventory user interface. The tools in this area are the Inventory Builder and the Inventory Tree Designer
- The third section, “Plug-Ins and Activation Tasks”, introduces the concepts of HPE Service Activator plug-ins, including plug-ins that are developed as new Java source code by the solution integrator as well as generic plug-ins that can be customized. The tool in this area is the Service Builder.
- The fourth section, “Workflows”, explains the capabilities and architecture of the workflow manager and introduces the construction of workflows. The tool for building workflows is the Workflow Designer.
- The fifth section, “User Interface and Roles”, introduces the user interface of HPE Service Activator.
- The sixth section, “Interfaces for Integration”, describes how an HPE Service Activator solution is integrated with other OSS/BSS systems, primarily how to construct a northbound interface for receiving and responding to service activation requests. There is no tool dedicated to building NBIs.
- The seventh section, “Integration with Other HPE NGOSS Products: NNMi, NA, uCMDB”, introduces the components which are present in HPE Service Activator to enable integration with the mentioned products.
- The final section, “Solution Deployment”, describes how to organize, package and deploy all the components of a solution. The Deployment Manager is the tool that is used to deploy and manage one or more customized solutions on the HPE Service Activator platform

The next chapter, “An Example Solution: Intro_Example”, walks through a small example solution which does not activate devices in a real environment, but includes examples of all the solution components that have been discussed in sections of this chapter as material for study.

2.1 Database Repositories

HPE Service Activator uses several data repositories, all stored in tables of one or more databases, for different purposes. The first five repositories listed here are held in predefined tables that are created when HPE Service Activator is installed. These five repositories must all be store in the same database schema, known as the system database.

- Static Repository - customized items deployed on the system: workflows, plug-ins, compound tasks, inventory presentation tree definitions; the static repository for atomic and compound tasks is also called the task repository,
- Workflow Job Repository - state information about running workflow jobs and about cluster nodes
- Auxiliary Repository - temporary data for use under workflow control

- Audit and Message Repository - audit trail collected from running workflow jobs and modifications of inventory data, messages shown to operators
- SOR Messages – service order requests from external systems that might expect a response when the request is processed
- Statistics Repository - server usage and workflow job statistics
- Solution Data Repository (Inventory) - the data model defined by the SI, primarily intended but not restricted to store data pertaining to infrastructure resources (network elements, servers, applications, etc.).

The database product used to manage all the repositories is a prerequisite for installing and running HPE Service Activator. Two options exist for the database product to use: Oracle Database and Postgres Plus Advanced Server (PPAS) from EnterpriseDB. Both of these products are compatible with HPE Service Activator in terms of the SQL statements and responses that are exchanged over JDBC connections and both options are supported.

By default, all the repositories are held in the system database which is defined when HPE Service Activator is installed. The solution data (inventory) repository can be held in another databases, or even across multiple databases. To control the use of database servers and of physical disk space it is possible to organize the tables in different tablespaces.

The different components of HPE Service Activator all use JDBC database connections to the repositories that they need to access. Database connections are organized in pools, known as *data sources*. A base set of pools are configured with names and sizes when HPE Service Activator is configured at installation time. The standard configuration can be changed to accommodate additional needs in a solution (see “Data Sources” in Chapter 5).

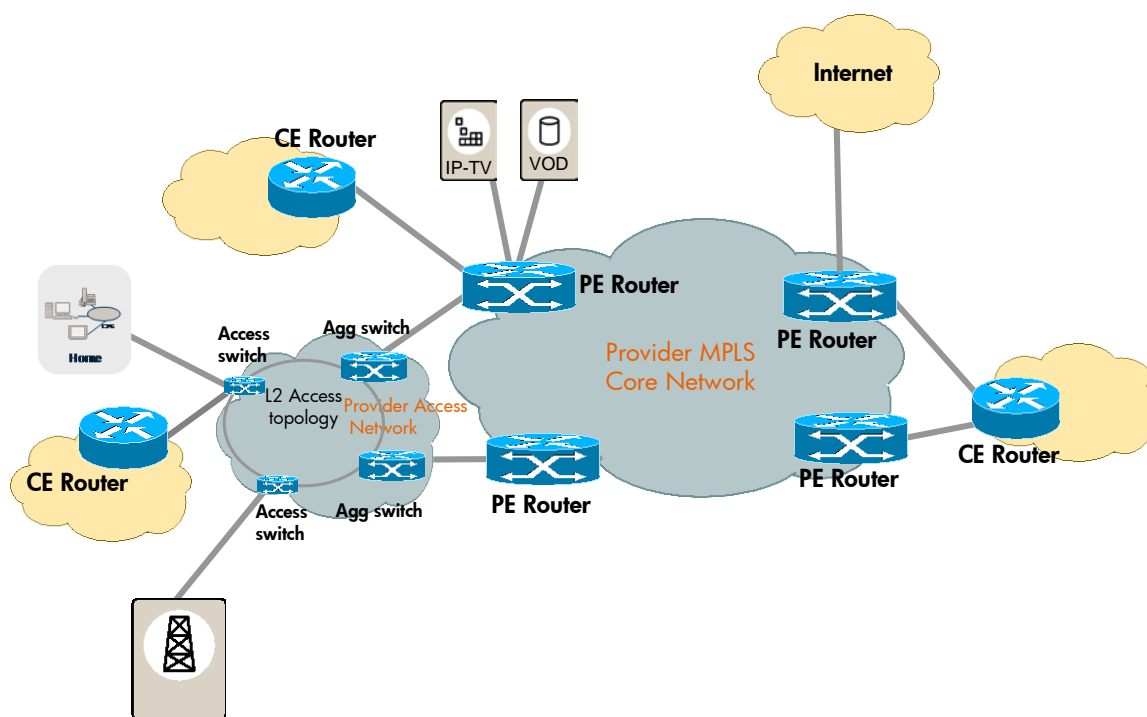
2.2 Solution Data Repositories (Inventory)

Repositories of data representing resources and services, or indeed anything that is needed, can be incorporated in an HPE Service Activator solution. Such repositories can be accessed from workflows as well as from the user interface. Data repositories are commonly referred to as resource inventory and service inventory, but these concepts and the distinction between them are not implied by the tools that are used.

The HPE Service Activator core product includes a Common Network Resource Model (CNRM) which is suitable for frequently managed new generation networks based on IP, Ethernet and MPLS technology. The network architecture that the CNRM is intended for is depicted in Figure 2-1.

Such networks may be used for a number of purposes, implying the CNRM can be used in several different activation solutions:

- to provide corporate VPN services;
- to carry the traffic between (residential and business) customer sites and provider platforms for a range of services: Internet access, VoIP, IPTV;
- to carry other provider traffic, for example between different platforms in the provider’s service network such as mobile backhaul from BST to BSC.
- to support a virtualization over different components and elements from the provider’s network.

Figure 2-1 Network Architecture Modelled by Common Network Resource Model

The CNRM can be used, possibly with extensions and adaptations, for solutions in the NGN space. For solutions in other spaces a different model must be built as needed. For example, a solution to activate mobile services will need to model the various servers involved, like HLR, etc., which must receive information about subscribers, but the solution has no need to know the radio and backbone transmission networks.

In general the data model must contain the entities that are needed by the activation processes. It must be defined in terms of entity classes. The solution designer may define any desired entity classes.

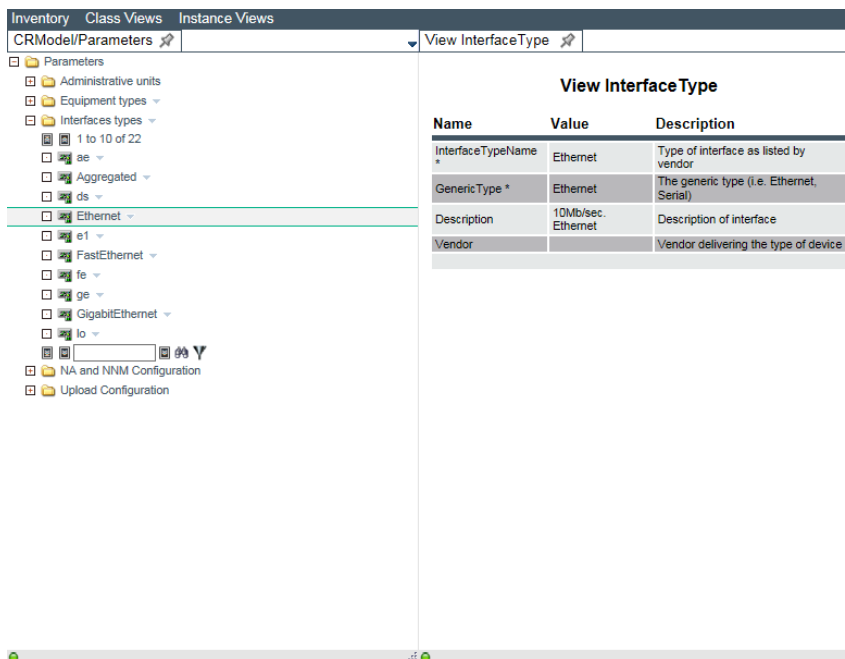
The data for each entity class will be stored in a separate table in the underlying database, and data entities can be accessed through Java bean objects from workflows. On the user interface different forms are used to create, display and edit entities of different classes.

Entity class definitions, known as “resource definitions” or “resource bean definitions” (the name does not imply that every entity must represent a resource), are given as compact XML-formatted files, one file per entity class. The definition format has a number of powerful features to allow the definition of fields, search keys, entity relationships, etc. Relationships between different entities are represented with foreign keys, i.e. inter-table pointers. Inheritance can be used to define an entity class which extends and modifies an existing entity class.

Deploying a data model from its definition in terms of entity classes is done with a tool, the Inventory Builder. The Inventory Builder reads the definitions and generates all the code that is needed for deployment: SQL statements that will create the database tables with indexes etc., Java code for beans to access the data for each entity class, and Java Server Pages (JSPs implemented with Struts) for forms to access the data from the user interface. The beans are used by the JSPs as well as by workflows. A number of workflow nodes are available in the built-in node library to create, query, reserve, release, update and delete repository data by means of the beans. The customizer will be aware that the beans and JSPs are created and deployed, but does not normally need to look into them.

HPE Service Activator’s user interface for accessing data in the repositories, known as the inventory user interface, is based on an explorer-style expandable tree structure where data entities are associated with branches of the tree. Entity relationships are used to define the child branches which appear when a branch is expanded. An example screenshot from the CNRM is shown in Figure 2-2. There is a graphical tool, the Inventory Tree Designer, to build tree definitions, branch by branch. A solution can include one or more tree definitions.

Figure 2-2 Inventory User Interface Screenshot



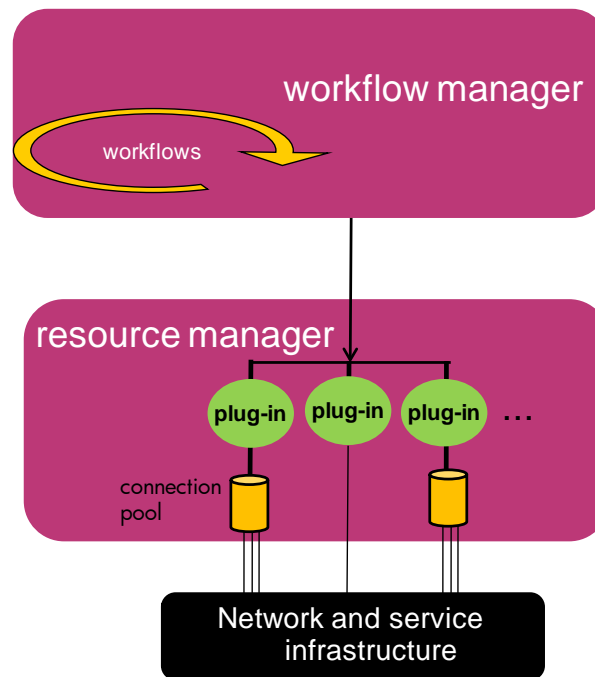
For a description of the inventory user interface, see the chapter “Inventory User Interface” in *HPE Service Activator, User’s and Administrator’s Guide*.

To build a working acquaintance with resource definitions, refer to example material introduced in Chapter 4. For a full description of the details of resource definitions, tree definitions and the tools to manage them, refer to *HPE Service Activator, Inventory Subsystem*.

For some solutions it may be necessary to integrate HPE Service Activator with an external inventory. Approaches to address such a requirement are discussed in Chapter 4.

2.3 Plug-Ins and Activation Tasks

In activation processes controlled by HPE Service Activator workflows, interactions with target devices or systems, possibly through element managers, take place in Activate nodes. Activate nodes execute activation tasks. Two components of HPE Service Activator are involved in the execution of an activation task: the workflow manager and the resource manager, as shown in Figure 2-3. Also shown are plug-ins and optional connection pools that exist within the resource manager.

Figure 2-3 Components Involved in Target Interactions

The task can be a single atomic task, or it can be a compound task, i.e. a list of atomic tasks. To execute an activation task the workflow manager will retrieve the definition of the task from the task repository and, if it is a compound task, control the sequencing of atomic tasks and rollback if a failure occurs. Parameters of a compound task are mapped to parameters for each atomic task. Each atomic task invocation with parameters is passed to the resource manager which will retrieve the corresponding plug-in Java class method from the task repository and execute it. During rollback, atomic tasks will be invoked in undo mode. Atomic tasks are responsible for communication with target devices or systems and pass to them for execution all appropriate commands or messages.

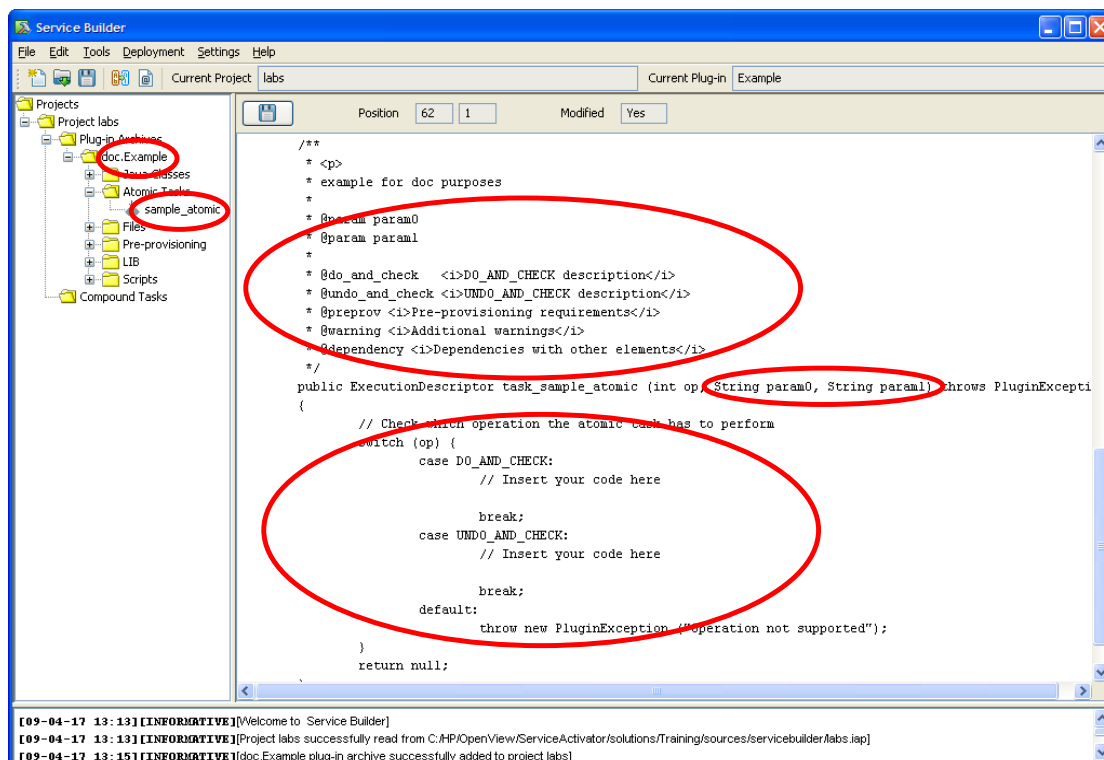
To execute an atomic task a plug-in will generally first setup an authenticated session with the target in question and then execute a command-response dialog with the target through the session. Authenticated sessions may be reused over multiple activation dialogs. In this case the plug-in will return the session to a connection pool after use, and for new dialogs reacquire a session from the connection pool. Connection pooling is a built-in capability of the resource manager. Connection pools can be set up statically, as a system administrative task, or they can be created dynamically, when needed by plug-ins.

For each solution one or more plug-ins will be needed depending on the set of targets on which services must be activated. In many cases it will be possible to use one of the generic plug-ins, in other cases it may be possible to reuse a dedicated plug-in from a previous solution. Otherwise it will be necessary to develop a new dedicated plug-in.

2.3.1 Plug-In Development

Development of a new plug-in entails the writing of the atomic tasks as Java methods. The Service Builder tool is a graphical development environment that supports this work. Figure 2-4 gives an idea of how the Service Builder works and what must be added to implement a plug-in. Before the time of the screenshot a new plug-in called `doc.Example` has been defined in a popup form, then an atomic task called `sample_atomic` has been initiated using another popup form. The code that is shown (including the prefix `task_` for the method name) has then been generated by Service Builder with placeholders for comments that will be used to generate plug-in documentation as Javadoc, and for the code to implement the actions of the atomic tasks in the do and undo modes, respectively. The `sample_atomic` task takes two parameters named `param0` and `param1` (thus defined in the popup screen, any names can be used), the runtime values for which must be supplied by the invoking Activate node in the workflow that initiates execution of the task.

Figure 2-4 Atomic Task in Service Builder



The do mode (case `DO_AND_CHECK`) of an atomic task must always be implemented with appropriate Java code. The undo mode must also be implemented if it shall be possible to use the atomic task in a compound task in any sequential position other than the very last one. If there is no such requirement, implementation of the undo case can be omitted.

An atomic task, when executed in the do mode, may fail, when for some reason it is not possible to complete the necessary interactions with the targets. If possible, the atomic task must fail cleanly, the target should be left in the same state as when execution of the task began. As Figure 2-4 shows, an atomic task must return an `ExecutionDescriptor`. The `ExecutionDescriptor` makes it possible to distinguish between success and failure, and between clean failure and “dirty” failure, i.e. the second order failure, when a change that was made to the target cannot be removed. The `ExecutionDescriptor` also includes a descriptive text field. The information collected from all atomic tasks that are executed in the forward path (do mode) of an activation task is passed back to the calling workflow and may subsequently be processed in the continuation of the workflow. Result information from atomic tasks executed in the rollback path (undo mode) is not made available to the workflow.

The Service Builder packages a plug-in as a single file in an archive format known as a plug-in archive identified by the file name suffix `.par`. To make use of existing Java libraries in a plug-in, the `.jar` files can be included in the `LIB` folder of the plug-in archive. Plug-in archives can be deployed into the task repository of an HPE Service Activator system.

Compound tasks do not belong to plug-ins. Typically a compound task will include atomic tasks from more than one plug-in. The Service Builder can also be used to build static compound tasks, i.e. compound tasks with fixed member atomic tasks. An XML-formatted file which describes the compound task is produced for distribution.

The Service Builder can also deploy plug-ins and compound tasks into HPE Service Activator’s task repository from the distribution files (`.par` and `.xml`, respectively).

2.3.2 Customizing Control Templates for Generic Plug-ins

Three generic plug-ins are supplied as part of the HPE Service Activator core product: the generic CLI plug-in, the generic HTTP plug-in and the LDAP plug-in. These plug-ins implement communication protocols for command line interface communication, for HTTP, and for LDAP respectively. But they do not include information about commands or HTTP messages to send or what to expect as responses. The controlling information must be prepared by the calling workflow and supplied in the form of task parameters.

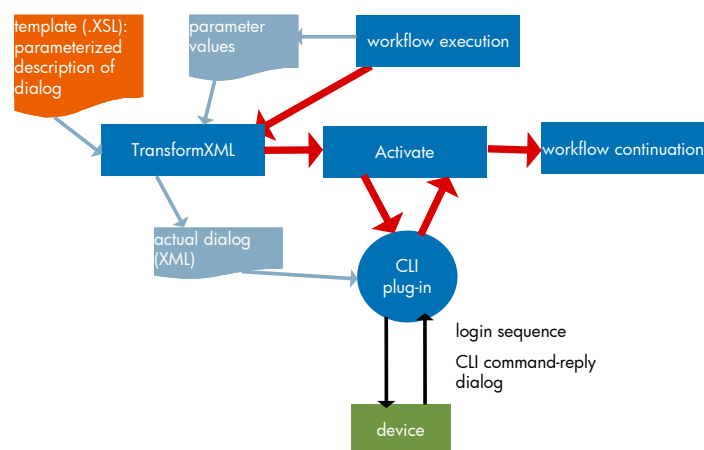
The CLI plug-in is controlled by an XML-formatted dialog control document. A dialog, for example with a complex router device, may comprise a large number of commands, and so the control document may be quite large. The control document will contain information about how to establish a session (log in) with the device, a sequence of command-response exchanges, and finally how to terminate the session. The specification for each command response exchange includes the exact command line to be sent, the expected response (next prompt) and patterns that allow recognition of possible error responses. Note that even a long dialog with many commands is executed as a single atomic task. In order to ensure clean failure of the task when an error response is received for a command, the CLI plug-in supports rollback of the command sequence (sub atomic task rollback). Command sequence rollback uses rollback commands that can be specified for each command-response exchange that is part of the sequence.

The HTTPPost atomic task supported by the generic HTTP plug-in makes a single HTTP Post call to a specified target. It supports features such as HTTPS with exchange of certificates and use of a proxy. The main parameter to achieve the intended effect is the HTTP Post message body, typically in SOAP format. This plug-in can be used when all necessary message formats are well known and simple enough that it is convenient to prepare templates for them and decode the responses by parsing XML in the workflow.

The LDAP plug-in can retrieve information from an LDAP directory and create, modify and delete entries. The dialog it performs with the directory service is also controlled by an XML-formatted dialog control document.

The generic CLI and HTTP plug-ins are quite different. But in both cases, there is a main parameter which takes the form of a document, the command sequence dialog control document and the HTTP message body, respectively. And in both cases the document will typically include a number of strings whose values must be sourced from variables of the workflow job that invokes the atomic task, representing items such as: user name and password for authentication of the session/request by the target, names of devices, ports, interfaces and other objects that exist and must be manipulated on the target. The way to handle this situation is to prepare a template document with replaceable placeholders for variable values, and to use a workflow node to substitute the actual values for the placeholders to obtain the final document to submit to the plug-in. The resulting workflow logic will be as shown in Figure 2-4, where the TransformXML node is used to achieve the parameter value substitution. For simple cases the ComposeMessage node can also be used.

Figure 2-5 Parameter Value Substitution for Generic Plug-in



In summary, when a generic plug-in is used, the target specific interaction control information will be found, not in the plug-in, but in the control document templates.

2.4 Workflows

Workflows are programs which define the activation processes of an HPE Service Activator solution. An execution of a workflow is called a job. The workflow manager is the operating system for workflow jobs: it starts new jobs when called upon to do it, it executes the workflow nodes of running jobs in the proper sequence, it persists and safeguards the states of running jobs, and it manages the sharing of a number of execution threads by all concurrent jobs. Refer to chapter Chapter 6 for a description of how the workflow engine can scale by deploying the workflow manager on a cluster of HPE Service Activator servers.

As programs, workflows consist of a number of directionally connected nodes. Each node performs a basic action. The workflow manager executes one node at a time:

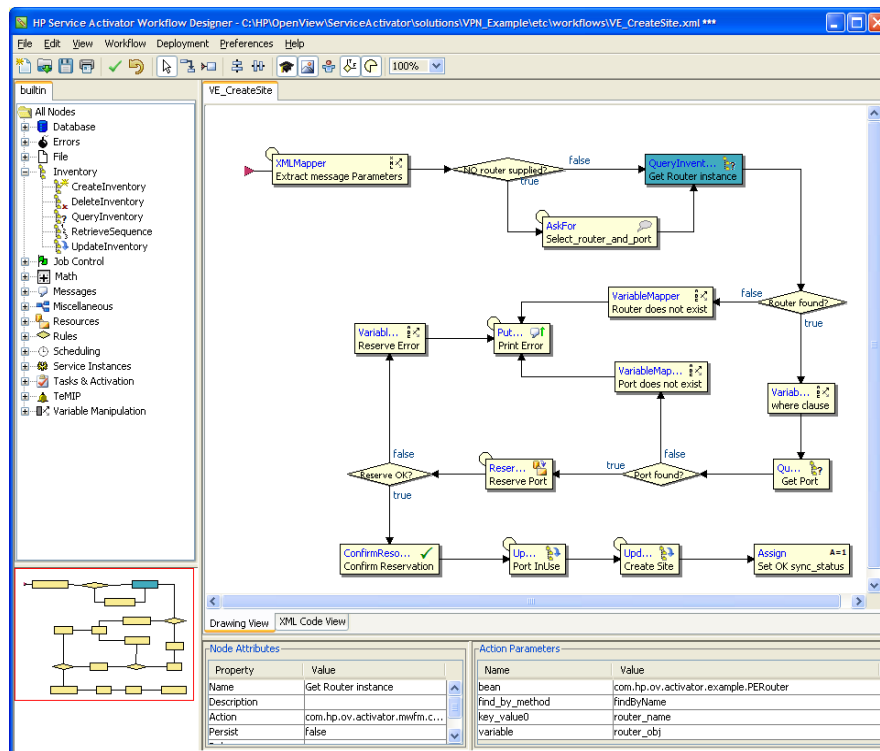
- select a ready job
- run the next node for the selected job
- save the state of the job to the workflow job repository

Persisting the states of workflow jobs between node executions makes the workflow engine robust. It allows HPE Service Activator to stop and restart at any time, whether intended or unintended, and workflow jobs will just continue from the point where they were persisted. In practice it is not necessary to persist the state after every single node, therefore it is possible per workflow node to disable saving of the job state to optimize on processing time.

The state of a workflow job consists primarily of its case packet: the values of a set of variables, some common ones are predefined for all workflows, others are added as part of the workflow definition.

A library of workflow nodes are available that can be used to compose workflows. Workflows are composed with the Workflow Designer, a tool with a user interface that displays a workflow as a directed graph, with nodes connected by arrows to represent their algorithmic sequence. Two special types of nodes allow the introduction of branching in the sequencing logic, based on values of variables: rule nodes, for two-way branches, and switch nodes, for n-way branches. Figure 2-6 is a snapshot of the Workflow Designer, with the library from which nodes can be picked on the left and the workflow chart with nodes, arrows and branches on the right.

Figure 2-6 Workflow Designer



The built-in node library covers the functions which are generally needed in activation workflows. Nodes range from very powerful ones which accomplish significant tasks, like transformations of XML documents, to simple ones, like comparison of two values or simple string manipulation. Functions accomplished with nodes include:

- inventory operations: create, query, update, delete repository data using beans
- reserve and release resources
- execute activation tasks
- spawn child workflow jobs
- wait to get data from outside the workflow job: from an operator through a popup dialog, from another workflow job, or from an external source via a programmatic interface
- send message (or email) to an external system
- receive service order requests, process them and eventually send a response to the external system, assuring that the same incoming message request will not be processed twice
- various transformations of documents, typically XML formatted, for parsing of incoming request messages and preparation of messages to be sent
- post messages to be shown to operators, process log entries for troubleshooting purposes and audit trail records
- liaison functions for integration with other relevant HPE products, (uCMDB).

Data manipulated by a workflow is held in variables that are passed to and from workflow nodes as input and output parameters. Typically, the request message whose receipt triggers execution of a workflow is passed into the workflow job in a preinitialized variable, the first nodes of the workflow will extract field values from the message into other, simpler variables. Some of these values will be used as keys for retrieving data from repositories, and retrieved data will be placed in further variables, etc., until all the parameters that are needed for the actual activation are held in a set of variables, from where they are passed to the activation task through an activation node.

A number of types are supported for variables, reflecting those of the underlying Java language: String, Boolean, Integer, Float, Object. Objects can be beans, maps, arrays and vectors.

The input and output parameters for each node in a workflow are specified as constants or mapped to workflow variables by means of the Workflow Designer.

2.4.1 Workflow Structure

Workflow jobs can spawn child jobs to execute other workflows. The parent may initialize variables of the child and may also synchronize with the child to retrieve result values back into its own variables. A single workflow job is restricted to a single string (thread) of node executions. Parallel algorithms can be realized by spawning multiple child jobs to work concurrently, for example to optimize activation of multiple independent devices.

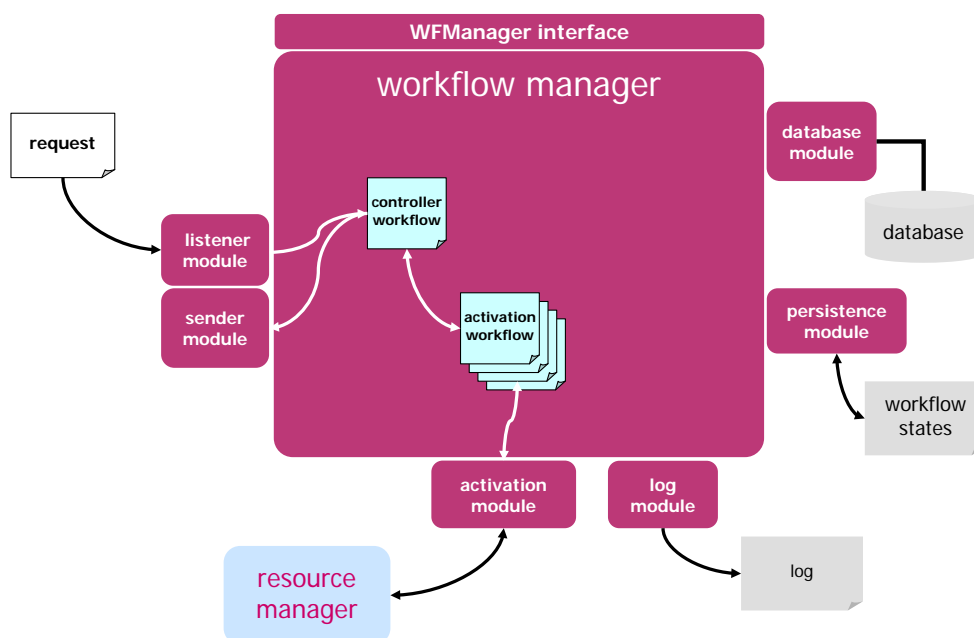
Multiple workflows working in parent-child relationships can also be used to architect complex processes in layers. A good practice is to use one workflow, designated as the *controller* workflow, to deal with northbound communication and process orchestration, and use dedicated workflows, spawned from the controller, to deal with service and device specific details.

2.4.2 Workflow Manager Architecture

The workflow manager has a core which is concerned with the execution of workflows, one node at a time, as described above. Other functions of the workflow manager are implemented as pluggable *workflow manager modules*. Modules are used for all functions which interface the workflow manager to its environment, like synchronizing with external sources of input, sending messages and emails, accessing the database, interacting with the transaction manager to execute activation tasks, etc., as illustrated in Figure 2-7. All tasks which involve wait points are generally performed by modules which run in separate threads from nodes of active jobs, to avoid depleting and potentially even deadlocking the power of the core engine.

Other examples of functions performed by workflow manager modules are management of scheduled workflows, authentication of users and RMI connections, writing of logs and audit trails, job distribution within a cluster (see Chapter 6), and collection of statistics.

Figure 2-7 Workflow Manager Architecture



Algorithms residing in workflow manager modules can easily be replaced, because modules are pluggable. In some cases, like authentication, several modules are provided in the product distribution, making the choice configurable.

Each workflow node is implemented as a Java class, extending a base node class with specializations for process nodes, rule nodes and switch nodes, and similarly with modules. As with nodes there is a built-in library of modules, providing a

wide range of generic capabilities. The libraries can be extended by adding new nodes and modules. Extensions can be provided in solution packages (see below), or they can be implemented as customizations for a delivery project.

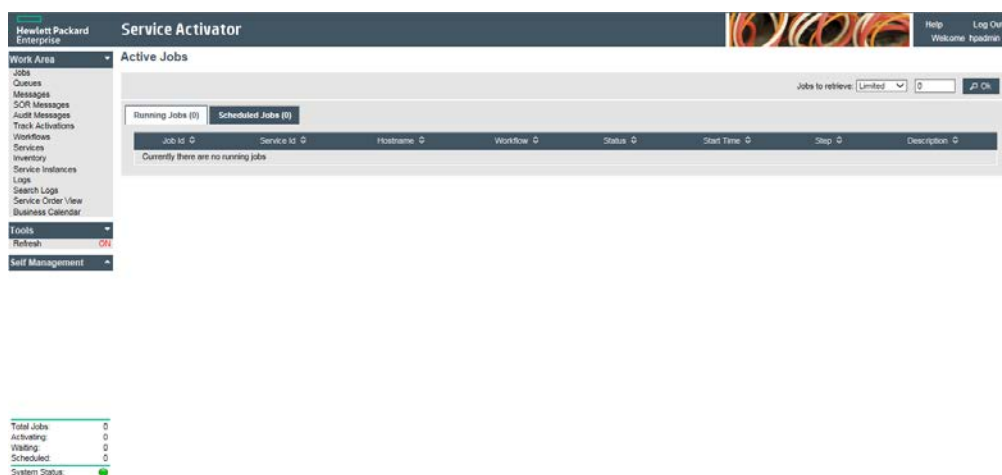
2.5 User Interface and Roles

HPE Service Activator supports a web browser based user interface, which does not rely on any components to be installed on the client side. It is implemented as a collection of web pages which are executed in the web server component of the HPE Service Activator platform. The pages are implemented in multiple technologies: plain HTML, Java Server Pages and Java Server Faces.

The inventory user interface that was mentioned under “Solution Data Repositories (Inventory)” above is launchable from the main window of the HPE Service Activator user interface as a separate window. A special feature that can be customized in the inventory UI is an operation to start a workflow job with input parameters that can be sourced from entities in the repository or entered by the user.

Other functions are available within the working area of the main window, selected from menus in the left hand side. Figure 2-8 shows the menu with the active jobs list (empty) selected and displayed in the working area. The Work Area and Tools menus can be customized; the ones shown here are the installation defaults.

Figure 2-8 User Interface Screenshot



The user interface allows operators to monitor activity within the workflow engine, including active activation transactions. Information about active jobs can be filtered by values of key characteristic variables of the job, such as order id (identifier of the request that triggered the job), service id (identifier of the service being activated) and type and state of the workflow.

Some HPE Service Activator solutions require operators to interact with workflow jobs through the user interface. There are also a number of housekeeping functions (Self Management) for the system administrator. The menu and other capabilities that each user gets via the user interface is controlled through roles that are established through log-in authentication. Only the admin role has access to the Self Management functions, other users may be specialized to interact with certain workflows, but not with others. The data that users may view and edit via the inventory user interface can also be controlled by roles.

The texts that are displayed on the user interface are organized as resource bundles and can be translated and localized by the system integrator.

For a general description of HPE Service Activator’s user interface, see *HPE Service Activator, User’s and Administrator’s Guide*.

2.6 Interfaces for Integration

The main integration of HPE Service Activator for a solution is normally the northbound integration to the CRM / Order Management system which is the source of activation requests. Northbound integration may be realized in different ways depending on the requirements.

The “classical” northbound interface for HPE Service Activator uses workflow manager modules for listening to request messages and sending response messages. This approach is illustrated in Figure 2-7. Listener and sender modules, which can receive and send messages in any format, are provided in the built-in workflow manager module library for TCP sockets and for JMS. With this approach, receiving and sending are done on separate connections and are asynchronous. Such decoupling is desired whenever workflow jobs can have non-negligible duration, to avoid occupying connection resources while workflows are running.

Sender and listener modules can also be used to implement peer interfaces to other OSS systems, with one-way notifications or two-way interactions as required.

An alternative to listener and sender modules is to use a web service interface, so that requests are received by the web server component of the platform and handled by a servlet which can start workflows. A tool is provided, the Web Service Designer, which can generate the servlet that will expose a collection of workflows as web service methods that allow them to be run conveniently by a client. A WSDL document defining the exposed interface for import to a client system can be generated.

The native generic RMI for the workflow manager is also available in a web service version. With this interface the method to start a workflow job can be called by forwarding a SOAP formatted request specifying the name of the workflow to run and initial values for workflow variables as parameters. A web service as described in the preceding paragraph is just a convenient specialization of the capabilities of this interface.

The section “Northbound Interface” in Chapter 5 elaborates on the two approaches to northbound integration that have been outlined here.

2.7 Integration with Other HPE NGOSS Products: NNMi, NA, uCMDB

An important aspect of HPE Service Activator is the support for solutions which include also HPE NGOSS products such as NNMi, NA and uCMDB, and where the products work seamlessly together and mutually enhance each other’s capabilities.

As of HPE Service Activator V5.1 support for interworking with NNMi V9.10, uCMDB V8.0 and NA V9.10 is included.

The HPE Service Activator product kit includes a number of components which serve to bind the products together, mostly in the form of hooks such as workflow nodes and plug-ins dedicated to interaction with the other products in order to allow the building of integrated solutions, but also readily usable capabilities such as UI crosslaunch with single sign-on and workflows which can load data into the Common Network Resource Model from NNMi.

Chapter 11 is about integration with NNMi, and Chapter 12 about integration with NA. These two chapters have similar organization, discussing the positioning of the product concerned to set the scene for integration, the potential benefits of integration, the integration capabilities that are available out-of-the-box, the components (hooks) that facilitate customized integration, and how to customize and configure an integrated solution.

There is not a chapter about integration with UCMDB. The components for UCMDB integration are a number of workflow nodes (Create/Delete/Query/Update UCMDBClSandRelations) which can be used to access data in a UCMDB data repository with similar power to those nodes which are used to access the native inventory of HPE Service Activator for the case where the inventory for a solution will consist of data managed with UCMDB.

2.8 Solution Deployment

An HPE Service Activator solution comprises different customized parts that are separate from and added on top of the core product framework: inventory data model, workflows, plug-ins, etc. All these parts have source files, mostly different XML documents, which are prepared using the appropriate specialized tools. To become operational on a running HPE Service Activator system, all the customized parts of a solution must be deployed into the static repository and file structures where they are accessed at runtime.

Deployment can be done with the specialized tools: the Workflow Designer can deploy workflows, the Inventory Builder can deploy resource definitions, etc. An entire solution can be deployed in a single operation with the *Deployment Manager*. The Deployment Manager is an umbrella for the specialized tools, it will use each one of them as needed.

In order to be managed with the Deployment Manager the source files for a solution must be arranged in a directory hierarchy which obeys a certain structure. The Deployment Manager can create the structure, and it can import entire solutions from zip or tar archives of the structure. You are not forced to keep your source files in a solution hierarchy, but it is strongly recommended to name and use a solution structure.

See Chapter 3 for illustrations of the solution directory structure and screenshots of the Deployment Manager.

It is possible to have multiple independent solutions on a single HPE Service Activator platform. All sources for each solution must include a short name of the solution, which is used to keep the deployed solutions separate, and must obey some naming conventions to avoid name clashes, for example of database tables. The Deployment Manager can deploy and undeploy each solution in turn.

The Deployment Manager is particularly useful with clustered platforms, where HPE Service Activator is running symmetrically on multiple servers. It will ensure that a solution is identically deployed on all servers within the cluster. The Deployment Manager can also manage versions of solutions, where some of the source files are updated.

Chapter 3

An Example Solution: Intro_Example

This section walks you briskly through a very simple example solution, too simple to be realistic, which has components of all the types that have been described. A larger example with more substance, yet still only an example for study, not activating real services, is described in a separate manual, *Putting HPE Service Activator to Work: A Sample Service Scenario for VPLS*. Both examples are found as zip files in the `$ACTIVATOR_OPT/examples` directory when HPE Service Activator has been installed, named `Intro_Example.zip` and `VPN_Example.zip`, respectively.

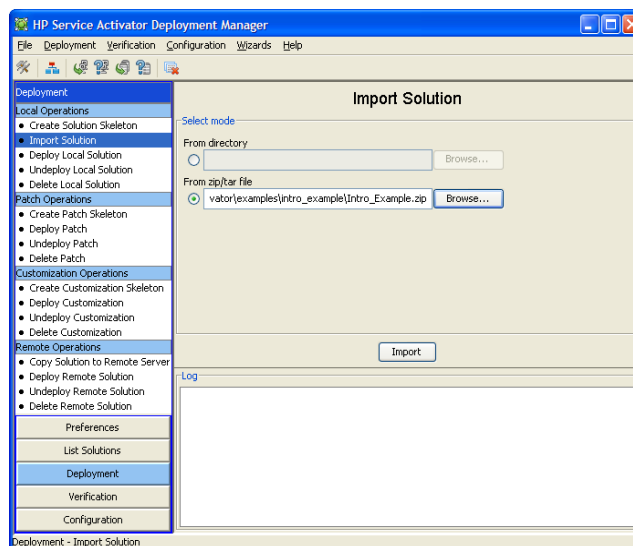
The `Intro_Example` is our subject here. The service that it activates is a point-to-point connection terminating on two switches assumed to be customer facing. The switches with the ports where the connections terminate are modelled as resources. There are workflows to create and delete connections, working through a plug-in that activates the service by configuring the endpoint switches. It doesn't really do that, it only writes some log entries. The `Intro_Example` uses the socket listener and sender modules to implement its northbound request interface. The listener module receives request messages and then starts the controller workflow.

Throughout this section you will be instructed to use the different HPE Service Activator tools to investigate the solution components. This assumes you have installed HPE Service Activator. After installation on a Windows platform you can launch the tools, the documentation and the user interface (in a browser) from the `start -> all programs -> HPE Service Activator` menu, or from desktop icons. For other platforms, consult the installation guide in question.

3.1 Contents of the Intro_Example

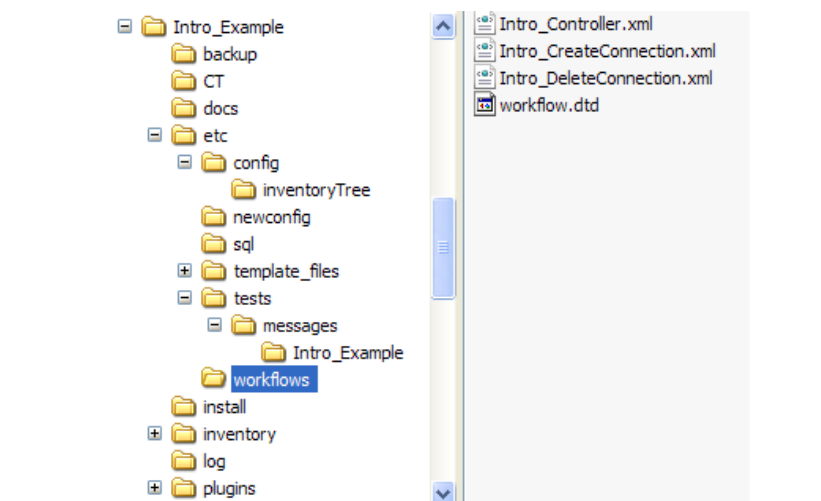
To access the source files of the `Intro_Example`, launch the Deployment Manager, select `Deployment -> Import solution`, and browse to the zip file, as shown in Figure 3-1. Click [`Import`].

Figure 3-1 Deployment Manager, Import Solution



The zip file contents will be unpacked into dedicated directories for the different solution components, according to the conventions of the Deployment Manager, under `$ACTIVATOR_OPT/solutions/Intro_Example`, see Figure 3-2. We will reference the component directories with their names relative to this solution root directory.

Figure 3-2 Intro_Example Solution Directories



Browsing the various component directories, you will find:

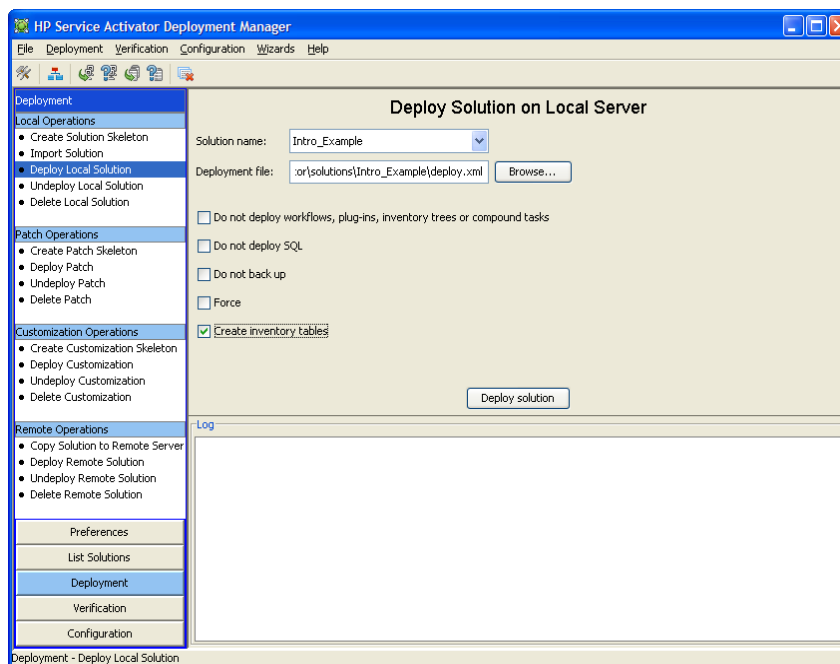
- In `plugins`, the plug-in archive file `Intro.Switch.par`. This is the plug-in for switch devices in deployable plug-in archive format. It has two atomic tasks:
 - `createConnectionEndPoint`, intended to create a unilateral connection from a customer facing port on one switch to a port on another switch; both switches and ports are identified by parameters
 - `deleteConnectionEndPoint`, intended to delete a unilateral connection from a customer facing port on one switch to a port on another switch; again both switches and ports are identified by parameters
- In `CT`, deployable definitions of two compound tasks that are invoked from the workflows: `Intro.CreateConnection` and `Intro.DeleteConnection`. Both tasks take parameters specifying two endpoints, each given by a switch and a port on that switch. The first task creates a bilateral connection as two unileateral connections between the two endpoints. The second task similarly deletes a bilateral connection.
- In `etc/workflows`, three workflows:
 - `Intro_Controller`, controller workflow which is started by the socket listener. It parses the request message, extracts the fields (tagged elements) of the message to variables, and uses the value of the `action` field as the name of a workflow to run as a child job; it must be one of the other two workflows.
 - `Intro_CreateConnection`, workflow for creating a connection, specified by variables initialized from the controller.
 - `Intro_DeleteConnection`, workflow for deleting a connection, similarly.
- In `inventory`, resource definitions for two resource data entity classes, `IntroSwitch` and `IntroPort`, where a port belongs to a switch identified by a foreign key on the port entity.
- In `etc/sql`, scripts to populate the resource inventory with a few switches and their ports.
- In `etc/config/inventoryTree/intro-tree.xml`, the definition of a simple tree in which switch and port data is made accessible on the inventory user interface.
- In `etc/tests/message/Intro_Example`, sample request messages (`intro-message-1.xml` and `intro-message-2.xml`) with format definition in `etc/config/intro-message.dtd`. You can use HPE Service Activator's regular user interface to select one of these messages and inject it for processing (send it to the port configured for the socket listener module). This feature must be enabled in the configuration file for the user interface (`$JBOSS_ACTIVATOR/WEB-INF/web.xml`) by setting the value of the parameter named `tests` to **true**. Do this before or after you deploy the `Intro_Example` solution, but before you start HPE Service Activator.
- In `etc/template_files/Intro_Example`, templates for response messages to be sent after processing of a request (`ERROR_intro.template` and `OK_intro.template`) and for an information pane to be shown to an operator.
- In `newconfig/mwfm.xml`, a fragment to be copied into the configuration file for the workflow manager (`$ACTIVATOR_ETC/mwfm.xml`) to configure the socket receiver and sender modules. Do this before or after you

deploy the Intro_Example solution (peruse the long configuration file in an editor to find a proper place for the fragment), but before you start HPE Service Activator.

3.2 Deploying the Example

Once you have unpacked the solution zip file as described above, use the Deployment Manager to deploy the complete solution. First you must configure the Deployment Manager to be able to access the system database; select **Preferences -> Configure Database Connection**, enter the username and password for your HPE Service Activator installation, and click [OK]. Then select **Deployment -> Deploy Local Solution** and then in the drop-down list labelled **solution name:**, which shows all undeployed solutions present (unpacked under \$ACTIVATOR_OPT/solutions) on the server, select **Intro_Example**. Check the **Create Inventory Tables** field and click [Deploy solution].

Figure 3-3 Deployment Manager, Deploy Solution



The Deployment Manager will then deploy all components of the solution into HPE Service Activator's internal directories and static repository (database tables).

Make sure you have changed the configuration files for the workflow manager (`mwfm.xml`) and for HPE Service Activator's user interface (`web.xml`) as described above under "Contents of the Intro_Example". In the workflow manager configuration file you should also enable the auditor module: search for `auditor`, uncomment the `<Module>` element for the `DBAuditModule`; set the parameter `store_audit` to have value "true". This module is used to write audit trail records, and the workflows in the example generate such records.

When this has been done, you must start HPE Service Activator (restart, if it is already running) to be able to run the solution.

3.3 Examining Components of the Intro_Example Solution

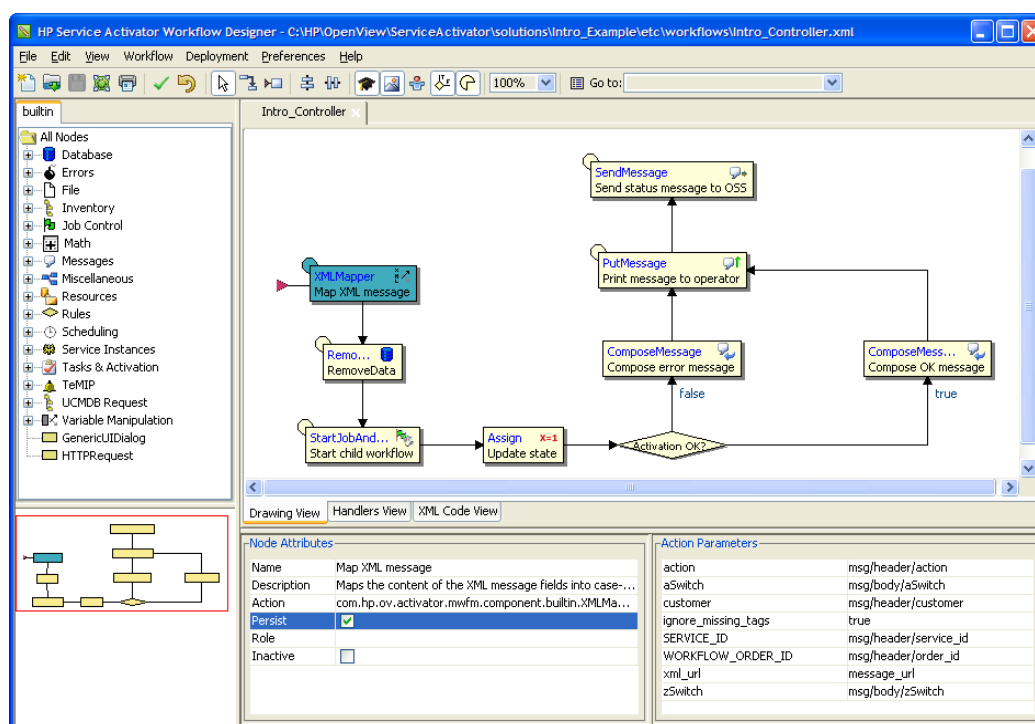
We will now take a closer look at the components of the Intro_Example solution.

The **plug-in** can be imported from the archive file `Intro.Switch.par` into the Service Builder and studied at the source code level, if desired. You will need to create a Service Builder project as a workspace to import the plug-in. We will not go into the details here, refer to *HPE Service Activator, Developing Plug-Ins and Compound Tasks*. The plug-in is documented with Javadoc, which you can study to understand the atomic tasks, their parameters and actions. To access the Javadoc you can extract the contents of the archive with Winzip, go to the `doc` directory, and double-click on the html file to open it in a browser.

The **compound task** definition files can also be imported and studied in the Service Builder which has dedicated functions for editing compound tasks. Alternatively, the xml files, which are quite straightforward, can be studied in a text editor. Be sure to understand the sequence of parameters of each compound task.

To study the **workflows**, launch the Workflow Designer, and open the workflow definition files. The initial location of the file open window will be `$ACTIVATOR_ETC/workflows`, you will need to navigate to the solution's workflow directory to open the files. With the `Intro_Controller` workflow open, the Workflow Designer appears as in Figure 3-4.

Figure 3-4 Intro_Controller Workflow in Workflow Designer



The workflows are simple. It is possible to understand the algorithms by inspecting them, node by node. Some clues are given here:

In Figure 3-4 the first node of the controller workflow, an XML mapper node, is selected. It extracts from the request message, which has been received by the listener module and passed to the workflow job, several values identified by XPath-like tag sequences to workflow variables. You can decipher this from the Action Parameters shown in the lower right corner (variable names in Name column, tag sequences in Value column). Take a closer look at one of the sample messages (in `etc/tests/messages/Intro_Example`) to understand how the tag sequences relate to the message format. You may note the use of the variables `WORKFLOW_ORDER_ID` and `SERVICE_ID` to hold the identifiers for the order and the service, respectively. These predefined variables are used by convention to make it possible in a general way to display information from running workflow jobs. The same is true for `WORKFLOW_STATE`, whose value is intended to give the observer an idea of how far the workflow job has progressed whenever it is inspected. The values of these predefined variables are automatically inherited to child workflows.

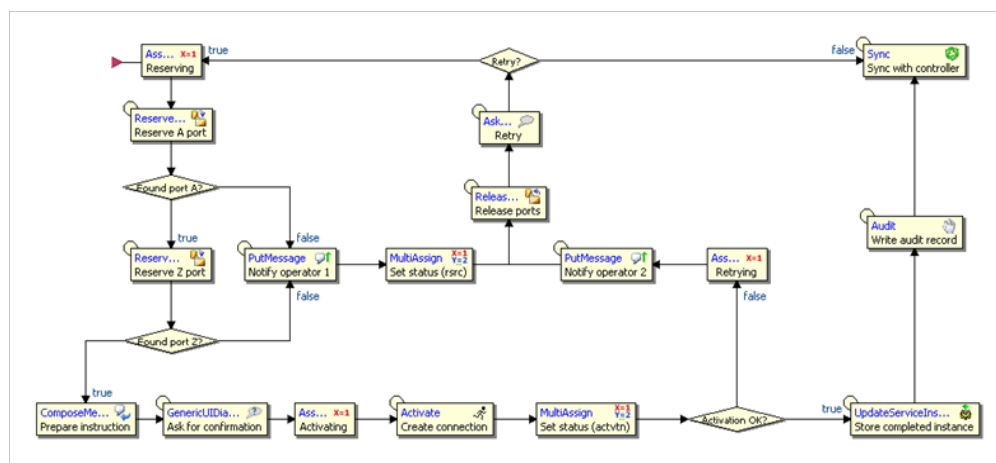
The controller workflow starts one of the other workflows to do the actual work that was requested. The name of the workflow is extracted literally from the request message. In a more complete implementation it would be appropriate to perform a database lookup to validate the request.

The child workflow in its final Sync node (true for both child workflows) returns a status that is inspected by the controller to determine if the child completed its task successfully.

The ComposeMessage nodes in the controller substitute variable values for placeholders in templates to create response messages which the controller will send back to the originator of the request. The PutMessage node posts the response message into the message area of the user interface, so you can easily see it when the workflow has run. Inspect the message template files (in `etc/template_files/Intro_Example`) to understand how the value substitution works.

The Intro_CreateConnection workflow (shown as screenshot in Figure 3-5) begins by allocating and reserving ports for the A and Z ends of the connection on switch devices which are specified by values that originate from the request message and have been passed from the controller workflow. This is done with ReserveResource nodes. Then follows the activation which invokes the compound task that will configure the switches. The workflow has looping logic to repeat the attempt after a failure. The GenericUIDialog and AskFor nodes synchronize with an operator; the one in the Retry loop will ask the operator to decide whether a retry is appropriate. The node labeled “Ask for confirmation” posts an information panel with a description of the connection that will be created, and waits for the operator to read the information and perform the required cabling before allowing the workflow to proceed, but does not take any input from the operator.

Figure 3-5 Intro_CreateConnection Workflow



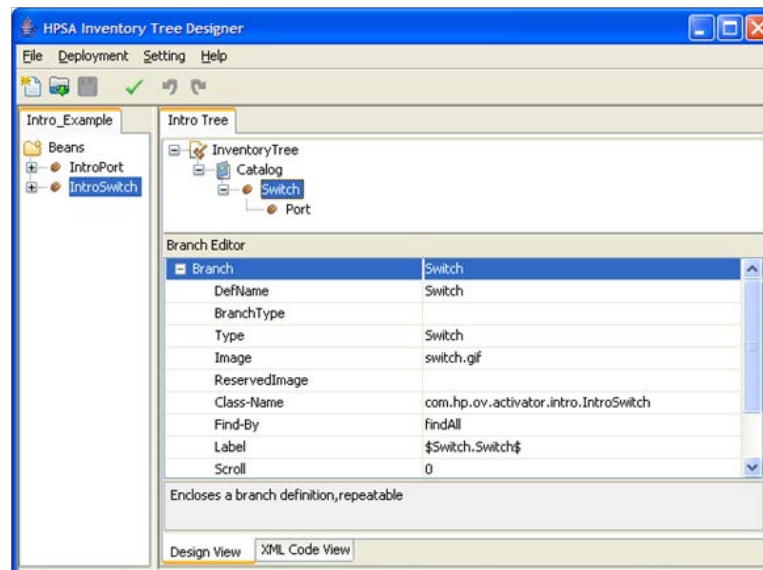
After a successful activation information about the newly created service is recorded as a simple service instance. Service instances are generic and predefined, the system integrator does not need to prepare a definition; they are stored in a database table that is created at installation time, not by the Inventory Builder. A service instance includes a unique identifier (database key) and contains the names and values of a number of additional variables, identified by name. This predefined capability can be used if services are simple and you have no special requirements for a service data repository, its structure or presentation. Finally, the sync node at the end of the workflow passes information back to the *operation_status* and *operation_description* variables of the controller workflow where they are used to determine the choice and contents of the response message.

When you have understood the process to create a service, the Intro_DeleteConnection workflow will be straightforward. It is supplied with the service identifier, retrieves all additional information about the service to be deleted from the service instance and unravels everything that was done during creation.

The **resource definitions** for resource data entity classes can be processed with the Inventory Builder. But to inspect these XML files you must use an editor. During deployment some instances of switch and port data were populated into

the tables defined by the resource definitions. After you have launched HPE Service Activator's main user interface (when you are running the solution, see below) you can view this data in the inventory user interface which is controlled by the **tree definition** that was also deployed, from file `/etc/config/inventoryTree/intro-Tree.xml`. The InventoryTreeDesigner tool can be used to inspect the tree definition itself as shown in Figure 3-6.

Figure 3-6 Intro Tree in Inventory Tree Designer



3.4 Running the Intro_Example Solution Workflows

With HPE Service Activator running, launch the user interface in a browser and log in; if you have not configured an authentication module, you will not need to type a password.

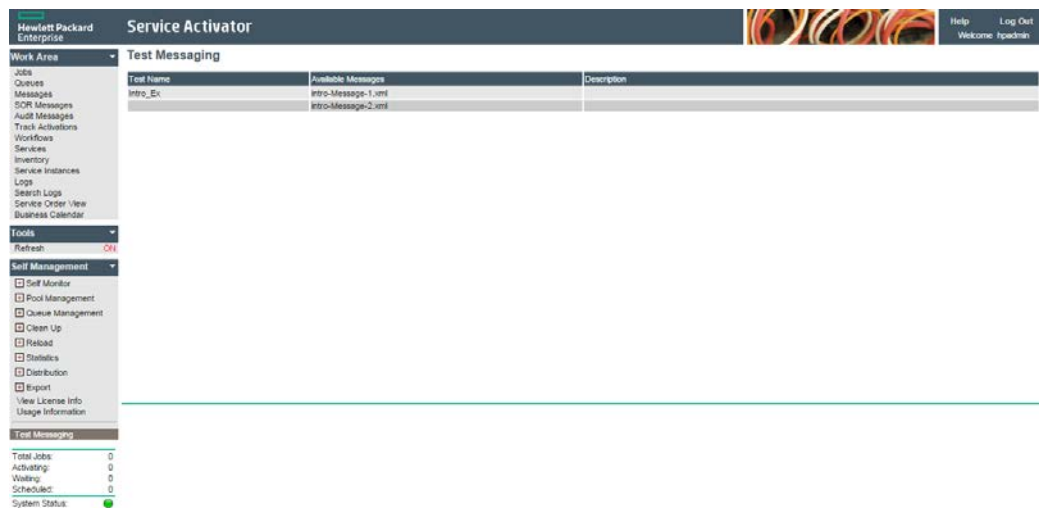
Inspect inventory. In the left hand menu of the main user interface window click `Inventory`, and the inventory user interface opens in a dedicated window. In this window select `Instance Views -> Intro Example/Intro Tree`. Then expand the tree and click in the sensitive area of a switch or port branch (or right-click to get an operations menu) to view the forms that display the field value data for the entity associated with the branch. Compare the data you see in the view forms to the fields defined in the resource definitions. If you inspect the tree after you have created a connection you will notice the ports that have been reserved for the activated service are marked with an `r`.

Make request to run workflow. You can select and inject one of the sample request messages to run the workflows. In the left hand menu, open the Self Management part at the bottom by clicking the little triangle. Then select `Test Messaging`. A list of the two sample messages will appear in the work area as shown in Figure 3-7. The first message contains a request to create a connection, the second message a request to delete the same.

Now right-click on one of the two message names, and then click `Start Test` in the single-item pop-up menu that appears. The message will be sent to the listener module, which will start the controller workflow. The resulting workflow job will read and process the message. The controller job will start a child job to do the requested work.

As you know from examining the workflows, they contain `AskFor` nodes that synchronize with an operator. To perform this interaction, select `Jobs` at the top of the left hand menu. In the job list that appears, select the tab labeled `Intro` (the tab label is specified by a parameter of the `AskFor` node). You will see a list of jobs waiting for interaction. Unless you have injected more than one request message, there will be just one job in the list. Right-click on it, and select `Interact with job` in the pop-up menu that appears. Study the pop-up window and click `[Submit]` to close it and signal to the workflow job to proceed.

Figure 3-7 User Interface with Test Messages



Inspect effects of workflow. The simplest way to study the result of running the workflow is to view the request response message. The sender module will attempt to send it, but since no application is waiting for it, the sending will fail. It is also posted in the message list on the user interface, and you can view it there. Select `Messages` in the left hand menu to see the message display. The posted messages will appear under the tab `Intro` (the tab is specified by a parameter of the `PutMessage` node in the controller workflow). Compare the message you see to the template from which it was generated.

When a request has been successfully it is documented with an audit record which you can inspect in the Audit Record view (select `Audit Messages` in the left hand menu).

When a service has been created you can inspect the service instance record that has been stored to hold information about it. In the left hand menu, click the '+' to expand `Service Instances`, then click `Open Instance`. A special window will then open; click the '+' to expand the list of service instances, and click on the service identifier of the branch line to view the details.

Another effect you can study is the warning messages written by the atomic tasks in the log of the resource manager. Select `Logs` in in the left hand menu, then select the `RESMGR` tab at the top of the work area, and then the `resmgr_active` file name at the bottom. Scroll down the file to see the yellow entries (these entries are written as warnings, hence the yellow color, so they will be easy to spot). If you study the Java source code of the plug-in you can find the statements that log the warnings. The other entries are written by the resource manager itself. Try to make out what they document. You can also view the log of the workflow manager (`Logs -> WWFM -> mwfm_active`); here you will see error entries in red color written by the sender module when it fails to send the request response message.

Finally you can inspect the inventory user interface to find the ports that are reserved and used when a connection service is created.

Chapter 4

Solution Planning and Analysis

This chapter gives an overview of the activities that must be undertaken in a project to build a solution based on HPE Service Activator and explains the aspects of a solution that must be analyzed early on to establish a solid base for scoping and planning a delivery project.

4.1 Activities in a Project to Build a Solution

Some solution delivery projects will start with a solution that exists more or less off the shelf, in the form of a solution package or a similar solution that has been delivered previously. Other projects will start from scratch or with very little in the form of reusable customization. Even when a rich solution package is used, it must generally be expected that the customer has requirements which are not met with the existing solution, so that the package must be enhanced or changed.

In general a solution delivery project can be broken into these phases, which are quite generic:

- **Analysis:** determine and understand all requirements in sufficient detail to develop a general description of the solution and plan the work to build it. The amount of work in the subsequent phases will depend heavily on the scope of the services that must be activated, the number of activation targets and complexity of the interfaces to control them, as well as the complexity of other process and integration requirements.

If a solution package or another existing solution is used as starting point, the analysis work will take the form of gap analysis, where the required capabilities are compared to what is already supported.

- **Design:** drawing board work to identify and determine full details of all components to be built, so that they can be described and the ideas for building each one developed. Components of a solution will include:
 - Northbound interface to receive orders from CRM system or other system which is the source of orders.
 - Workflows to execute the processes to configure and control activation of services.
 - Activation tasks to interact with target devices and systems for activation of services.
 - Operational model for resource repository. You can build a data model of the resources needed for the solution using HPE Service Activator's inventory capability. You will then need to design a way load data into the resource repository when the solution is installed and keep the repository regularly synchronized with the network; the source of the data can be an existing resource inventory system, or it can be the network devices directly. Alternatively, if there is a requirement to interface directly with an existing external inventory system and you are building a solution from scratch, then you can build such an interface using an API supported by that system.
 - Data model for resource and service data repositories.
- **Implementation and testing:** use HPE Service Activator tools to build all components according to design; test them as units and as a complete solution. In this phase the interworking of the components with external systems and devices must also be tested. Also latest in this phase documentation and plans for use of the solution must be prepared along with training of the user's of the solution.
- Install the solution in the production environment, perform appropriate tests to ensure it works properly, train the users, commission and hand over for production use.

4.2 Analysis

The following information must be collected, clarified, documented and understood as part of the analysis of an activation solution:

- Full definitions of the services to be activated including the underlying technology, the packaging and organization of the services, the detailed features, and the intended evolution of the services.
- The tasks involved in activating services. Understand all activation targets that are involved in each service, the protocols for interacting with them, and the command-response or message exchange interactions that must take place in the activation processes.

In order to fully understand activation tasks it may be necessary to study the network architecture to identify devices with different roles. This can be the background for understanding which devices need to be activated for a specific service. For example, when end customer's equipment is attached to the provider's network through some access device such as a DSLAM or access switch, where there is a port or interface dedicated to the customer then it will typically be necessary to reserve the port or interface in the resource data model and also to perform some action to enable the customer's traffic across the access port. Whether it will also be necessary to enable functions per customer on devices further towards the core of the network, such as aggregation devices and MPLS edge devices, will vary depending on the service and the network architecture.

- How activation processes are initiated. Normally these processes are triggered by XML messages received via a northbound interface from a an order management or CRM system. Various flavors of XML interfaces, including web services, are possible. Alternatively, in some solutions, there can be a requirement to support a user interface for entry of orders directly into HPE Service Activator.
- How the solution will fit into the provider's overall OSS/BSS environment, apart from order entry. Which other systems will it interface to, what data will be exchanged? At what point in the activation processes will there be interactions with other systems?
- Requirements for integrating with an external inventory system, initially or at a later stage. The provider may enforce as a policy that all data of a given type, for example resource inventory, is maintained in a single inventory system, and that other systems, including the activation system, must retrieve and update the data by interfacing to that inventory system. Such a requirement is fundamental to the way HPE Service Activator must be customized and must be made clear very early in the project.
- Requirements for maintaining resource and service data in HPE Service Activator's data repositories. Such a requirement may be explicitly stated, or it may be implicit that the data will be needed by activation processes. It is generally easier to customize HPE Service Activator to maintain resource and service data in its own repositories than to integrate with an external inventory system.
- A very important point to decide and understand is how data describing physical and logical resources that must be held in HPE Service Activator's resource data repository shall be loaded and kept synchronized with the actual state of the resources. One possible way is to include workflows that can upload device details from devices in the network. Another possible way is to refresh data from an external system that is already synchronized with the network.
- Volumes of activation orders to be processed and of data to be managed. Number of users performing web interactions with the solution and nature of interactions. This information is needed to determine the processing capacity that is needed.
- Requirements for the time allowed to process orders. The analysis of the implication of this requirement combined with volume of orders will involve the activation targets and their ability to execute the implied interactions in a timely fashion. HPE Service Activator is rarely the bottleneck in a solution.
- High availability requirement. This requirement together with transaction volume may justify / necessitate deployment of the solution on a cluster of servers.
- User interface requirements, for example: entering orders, monitoring activity, browsing/editing data in HPE Service Activator repositories. If several user functions shall be available, there may be requirements to use roles and privileges to differentiate between users.

A special aspect of user interface is localization of messages from English to local language.

- Audit trail requirement: what information is required to be stored as historical information about completed orders.

With all requirement information collected and organized it is possible to characterize the solution and to identify and estimate work items for the delivery project.

Chapter 5

Solution Design

This chapter provides information that is intended to help you as system integrator in the solution design phase, after you have collected complete information in the analysis, before you embark on implementation of the components of your solution using the HPE Service Activator tools. It is not a textbook on high level solution design, more collection of useful bits of information, for example it does not tell you how to design activation processes. You will also need to consult the manuals for the individual components and tools, as listed at the end of Chapter 1. When you consider tasks that require Java programming, you must consider in addition to the PDF-formatted manuals also the Javadoc which describes a range of interfaces and classes and can be accessed when HPE Service Activator has been installed by selecting (on Windows) `start -> all programs -> HPE Service Activator -> Docs -> JavaDoc`. On Unix systems the location is `/opt/OV/ServiceActivator/docs/javadoc`. An example page is shown in Figure 5-1.

We explain here some best practices, discuss some possible ways to solve common problems, and discuss some considerations that will have an impact on how the operating solution will be experienced by operators.

5.1 Solution Labelling

In order to be able to manage and keep separate different solutions, or parts of a large solution, it is strongly recommended that you use the source file organization supported by the Deployment Manager for all the source files of your solution(s) and that you use a well-chosen short string to uniquely label all the parts of the solution, as follows:

- As the name space part of the name of plug-ins and compound tasks.
- As the value of the `<Solution>` element in definitions of resource beans and inventory trees (required for deployment).
- As prefix for database table names for resource beans.
- As the solution name in the workflow settings of each workflow and also as prefix for the name of each workflow.

5.2 Queuing Sub-System

The queuing sub-system makes it possible to control how many jobs of a given type is running in parallel at the same time. By calling the rmi method `startQueueJob` instead of the standard `startJob` method the queuing sub-system will ensure only the configured number of jobs for this queue is running. If more jobs are tried to be started they will be waiting in the queue until there is free capacity.

What can be a type of a queue is up to the solution developer to select. It could be a given service type like at DSL service or a given target system.

There is no limitation about how many queues can be defined for a give solution. It makes sense to not have a very high number as you will then be splitting the capacity of HPE Service Activator in to small pieces. The full system capacity will not be possible to use unless the max capacity of all queues is used.

In future version it will be possible to configure listener module to call the `startQueueJob` method instead of the `startJob` method and in 7.0 the rmi interface can be used or the SOAP interface.

By using queuing it will be possible to ensure free capacity for high important tasks by defining dedicated queues. Also it would be possible to build the solution in such a way so it will be possible to stop activation of a certain activation types.

It is possible from the HPE Service Activator UI to lock a queue to accept new incoming request but still continue to process the already received requests. It is also possible to lock a queue to not process received request, but still continue to receive new incoming requests.

Request received in the queuing sub-system which have not yet been started as jobs in HPE Service Activator are saved in the database and will be picked up by the other cluster nodes in the system in case of a failover. A request will be deleted from the database when the job is started.

It is possible to configure a number of requests to stay in a cache. The reason for having a cache is to make it faster to start jobs. Also the queuing sub-system will ensure to read new request from the database so the queue threads can start jobs immediately when there is free capacity.

The queuing sub-system requires the queue and the queue persistence modules to be configured.

5.2.1 Configurable aspects of queues

A queue can be configured via the HPE Service Activator UI or by means of the `$ACTIVATOR_OPT/bin/queuetool`, which use an xml file as input. The xml file must follow the schema defined in `queues.xsd`. Apart from this then queues can also be configured as part of the deployment of a solution by defining the queues in an xml file and specify the file in the deployment descriptor.

A queue must be configured with the following parameters:

Solution name – the name of the solution this queue belongs to.

Name – the name of the queue.

Queue class – the class in the queuing system which should be used for this queue. Two different queues can be used; `com.hp.ov.activator.mwfm.engine.module.queuing.WeightedBlockingQueue` and `java.util.concurrent.PriorityBlockingQueue`.

Threads – how many threads in the queuing system should be created to start jobs based on the received requests.

Max jobs – how many jobs can be running in parallel per HPE Service Activator cluster node.

Cache – indicating how many of the received requests should stay in memory along with also being saved in the database.

Locked input– indicating if the queue should, when created, accept to receive requests or not.

Locked output– indicating if the queue should, when created, start to process requests or not.

TTL – how long time a request should be staying in the queue before it is deleted. The value must be provided in seconds and the default value is 0 indicating that it would stay forever.

Description – a text string which can be used to tell what is this queue used for.

5.3 Connection Pools

An introduction to connection pools was given in Chapter 2, through Figure 2-3 and its explanatory text. Connection pools can be used as the foundation for high performance deployments of the generic CLI plug-in. The basic mechanism is general and is described here as such. In future product versions connection pooling may be supported for additional plug-ins.

Connection pools are actually session pools, as the active connections in a pool will generally be authenticated sessions with the target equipment. Authentication does not happen by magic, the dialog to perform must be configured (or customized as part of dialog control documents) for each pool.

5.3.1 How pools work

Each connection pool is associated with a plug-in and contains sessions for use with a specific activation target. When the execution of an atomic task within the plug-in is requested (from a workflow job) it will refer to the pool rather than directly to target. The plug-in will then interact with the connection pool to acquire a session for the duration of the implied dialog with the target. Three scenarios are possible:

- if an unused session exists in the pool it will be allocated and used;
- otherwise, unless the maximum number of sessions for the pool has been reached, a new session will be created, initialized, allocated and used
- if the maximum number of sessions are already active, the new atomic task is queued until a session becomes available.

Once a session has been acquired by the plug-in it will use it directly, without pool management involvement, to conduct its dialog with the target.

After the dialog it is the responsibility of the plug-in to restore the session to its initial state (context, prompt level) before releasing it to the pool.

There is a special case for clustered platforms, where the resource manager may need to redirect an atomic task to be executed on the cluster node where the pool resides; see the description of unlimited pools below.

5.3.2 Configurable aspects of pools

A pool must be configured with instructions for initial and final actions after a connection has been created and before it is closed, as well as some timeout values and optionally a maximum number of connections that may exist in the pool. At runtime the resource manager will use the plug-in associated with the pool to execute the instructions for initial and final actions.

A pool consists of subpools, at least one. Some of the configurations belong to subpools. This means they can be different for different subpools.

A maximum time – the *Acquire timeout* – for an atomic task to wait to acquire a session can be configured; if it is exceeded the atomic task will fail.

A maximum time for the entire pool to be idle – the *Pool timeout* – can also be configured. When this timeout happens the pool will be cleaned out from memory. It will be instantiated when needed.

The following configurations belong to subpools.

Unused sessions are held for a configurable maximum time – the *Idle timeout* – then destroyed.

A maximum for the duration of an atomic task's dialog with the target – the *In use timeout* – can also be configured. If the timeout expires while a dialog is ongoing the atomic task will terminate with an error.

The maximum number of connections (sessions) for each subpool is configurable.

A multiline text parameter known as 'Session management' is also configurable per subpool. This text is actually processed by the plug-in, so its syntax and specific meaning will depend on the plug-in. For the CLI plug-in it must include the <Connect>, <Disconnect> and <Validate> elements of the dialog control document. The <Connect> element contains the target URL and the dialog to be executed to authenticate and initialize a session; this element must include any credentials required by the target. The <Disconnect> element contains any final dialog to be executed before the connection is destroyed. For more details refer to the Javadoc for the generic CLI plug-in.

Refer to *HPE Service Activator, User's and Administrator's Guide* for a description of how a system administrator configures pools and manages their states.

5.3.3 Pools and target locking

When you use a pool of connections to a target you will generally want to allow multiple sessions to be active in parallel. The standard behaviour of the resource manager, to lock the target during a session and not allow additional sessions (as described in the session below on Plug-Ins), will be undesirable. Instead, the size of the pool should put the limit on the number of parallel sessions. The Activate workflow node supports a parameter called `ignore_locking_argument`. Set this parameter to 'true' to disable the standard resource locking of the resource.

5.3.4 Design considerations for the use of pools

You should generally choose to use connection pools if your solution must satisfy performance requirements which render unacceptable the overhead of creating and authenticating a fresh connection for each atomic task. Then you have a couple of additional design decisions to make.

Each connection pool you use can be either static or dynamic:

- static pool The pool is created with complete configuration by a system administrator action before it is used.
- dynamic pool The pool is created as a side effect of the first atomic task that will need it; the configuration of the pool is included with the parameters for the atomic task. On subsequent atomic tasks, pool configuration parameters will be ignored.

Depending on its configuration a pool will be either limited to a maximum number of connections or not limited in this respect. The difference is important when the pool is deployed on a clustered platform (see Chapter 6 for a description of clusters):

- limited pool A limited pool will exist on only one server (cluster node); if a task that will use the pool is invoked on another cluster node, it will be redirected to the one where the pool resides; this will happen within the resource manager.
- unlimited pool An unlimited pool will be instantiated on every cluster node where a task needs to use it in accordance with configuration for load balancing; the total number of connections within the pool will be the sum over all nodes in the cluster.

5.4 Plug-Ins

5.4.1 Customized Use of Generic Plug-ins

As described in Chapter 2 if your activation target is controlled by a command line dialog you will not need to construct a new plug-in. Instead you will customize control document templates to be used with the generic CLI plug-in. Similarly if your activation target supports HTTP and it is convenient to prepare template files for each message you will need to send, then you can use the generic HTTP plug-in. In both of these cases you will need to read the documentation for the generic plug-in you are using. It will be found as Javadoc.

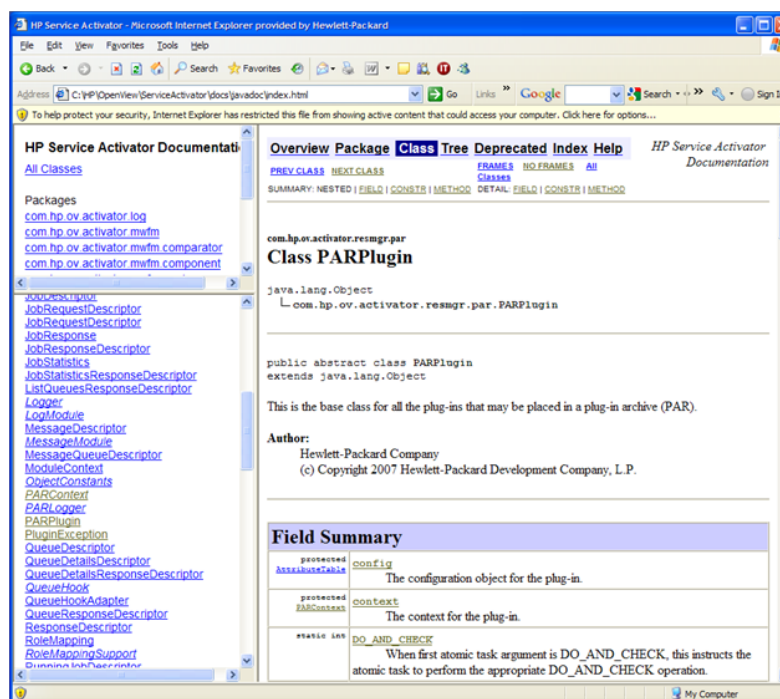
A question that will come up for command-line interfaces is how many commands to include in a single command document template, so that it is executed as an atomic task. Since there may be significant overhead in establishing a session and committing changes on the target device you should strive to accomplish the complete activation of all aspects of a service within a single atomic task. Combinations of multiple smaller files can be accomplished with include-files and the XSL call-template construct. The result may well be large control documents containing many commands.

5.4.2 Creating New Plug-ins

When the generic plug-ins are not sufficient, you will need to create your own plug-in(s). Then refer to *HPE Service Activator, Developing Plug-Ins and Compound Tasks* which gives you the details about plug-in programming using the Service Builder. Some general points relevant for plug-in design are briefly stated here:

All plug-ins extend a base class called PARPlugin. For detailed information, refer to the Javadoc (see Figure 5-1). From class PARPlugin all plug-ins have available a context field with a set of callable methods.

Figure 5-1 Javadoc for Class PARPlugin



In principle every atomic task must be implemented for both the do and undo modes. However, if you don't use compound tasks, the undo mode will never be used, so you can skip it. Even if compound tasks are used, this is also true

for an atomic task that will not be used in any compound task or only be in the last sequential position, because then the atomic task will never be called in the undo mode.

As you design the implementation of undo mode you may need information about the state of activation targets before the do mode of the atomic task was executed, so that you can restore it. Such information may have been passed as one or more parameters to the atomic task, or you may have retrieved it from the activation target before its state is changed (in do mode). You can use the methods of the `TransactionStateSaver` (or `AtomicTaskStateSaver`) interface which are inherited by the context to save the information for later retrieval, should the atomic task be called in the undo mode as part of unrolling the transaction. However, don't overdo it; it may not always be meaningful to attempt to do a perfect job in the undo mode: in a task intended to destroy a service a best effort approach may be the right one. When a service can only be partially destroyed, your best choice may be to design the destroy method to be idempotent, i.e. record the partially destroyed state and finish the job when the destroy method is called a second time.

If you write significant amounts of Java code, note that you can conveniently use the Service Builder in combination with a more powerful Java development environment, for example Eclipse.

5.4.3 Target Locking

A question you will confront when you create a new plug-in is target locking. Some targets will not be able to engage in multiple sessions concurrently, and even if the target does not have a problem, you may want to eliminate concurrency at the session level. The resource manager supports locking of a target. To determine when two calls to any atomic tasks in the plug-in address the same target, the resource manager looks at the first arguments (`param0`, `param1`, ...). You should think about this aspect when you define the arguments for the atomic tasks in your plug-in. You must define for the entire plug-in (not per atomic task) how many parameters to use for logging, with a minimum of one, and these parameters should then have the same meaning for all atomic tasks in the plug-in.

As an example, the first parameter may be the IP address/hostname of an element manager and the second parameter may identify a device in the communication with the element manager. If you will accept multiple concurrent sessions to the element manager, but you want to prevent two workflow jobs from configuring the same device concurrently, the number of locking arguments for the plug-in shall be two. It would then be natural to use the third argument to identify the function to perform and subsequent arguments to be function-specific.

As an alternative to locking on a set of argument values when one atomic task is actively using them, you can set a limit higher than one on the number of concurrent activations that you will allow.

5.4.4 Secure Communication with Targets

The resource manager has a general capability to use ssh, secure shell, to communicate with targets. It is used by the built-in NNMi plug-in (see Chapter 11) and optionally by the built-in generic CLI plug-in; it can also be used by plug-ins that you develop. To use it you must prepare and install keys for the secure communication and run the `ActivatorConfig` utility to configure the resource manager. These topics are covered in *HPE Service Activator, Installation Guide*.

5.4.5 Plug-ins for Web Services and Corba Interfaces

A frequently occurring case is an activation target which exposes a web service NBI described in WSDL form. The recommended approach to build a plug-in for such a target is to use the WildFly Web Service utility `WSConsume` which is available as part of the HPE Service Activator installation to generate from the WSDL a Java class where the web service methods are callable as stubs and then incorporate the generated class into the plug-in as an auxiliary Java class. The simplest approach to complete the plug-in is then to wrap each web service method as an atomic task method, but you may also want to call multiple methods, possibly with looping and branching, within a single atomic task.

A very similar process will apply to a Corba interface defined in the form of IDL. You can generate a class with stubs that can call the Corba methods and then wrap them as atomic task methods. Use this link for further information on Java IDL technology: <http://java.sun.com/j2se/1.5.0/docs/guide/idl/index.html>.

5.5 User Interface and Roles

The system integrator of an activation solution must understand the user community, how it can be divided into users with different roles, and the requirements each role has for viewing data, monitoring activity and interacting with processes. For more information on roles and what you can restrict and organize by means of them, see Chapter 7.

HPE Service Activator's main user interface window has functions to display information about ongoing activity as well as messages and audit trails produced by the workflow jobs and user activity in the past. Such information is shown in the various windows available in the Work Area menu. As system integrator you should be familiar with how these windows work, and you should plan how you intend your users will use them. Such a plan will guide you to decide the details of the information which you can control by customization. To become familiar with the user interface, read the pertinent chapters in *HPE Service Activator, User's and Administrator's Guide* and work the UI on a running system.

You can customize the items that appear in the Work Area and Tools parts of the left hand menu of the main UI window; see *HPE Service Activator, User's and Administrator's Guide* for more information.

Four common case-packet variables are present in all workflows intended to hold

- 1) an identifier of the order being processed (WORKFLOW_ORDER_ID),
- 2) an identifier of the service being activated (SERVICE_ID),
- 3) the type of the workflow (WORKFLOW_TYPE), and
- 4) the state of the workflow (WORKFLOW_STATE).

The values of these variables can be shown in several of the lists (jobs, messages, audit records, including the service order view) available on the user interface. They can also be used to search for jobs and other related items. You should use them properly in your workflows to ensure that meaningful information is shown in these UI views. Use the type to classify your workflows, first of all by solution, and within each solution as you see fit. When a workflow passes through several phases the state can be used to indicate how far along a job is, particular when it is waiting for something time consuming such as operator input, an activation task, or other external interaction. The values you assign to these variables can be chosen freely.

General recommendations are:

- Use messages shown in the Message window (generated by PutMessage nodes in workflows) for debugging during development, and when the solution is in operation only for well thought out diagnostic information that will make the user aware of problems that have occurred and point to causes that the user can repair.
- Use audit records generated explicitly using the Audit node in workflows to create an accurate audit trail. In addition to a number of standard fields of audit records you can add any needed information from case-packet variables, to properly document what has been accomplished by your workflow. Audit records should always be written at the end of a workflow.

All strings shown on the user interface are collected in resource bundles to allow localization. See Appendix A for more information.

5.5.1 UI Integration Using LWSSO or SPNEGO

Part of the integration of HPE Service Activator with other HPE NGOSS products such as NNMi and NA is GUI integration involving cross launching from the GUI of one application to that of another.

One way of GUI interworking is the use of HPE's Light Weight Single Sign On (LWSSO) to eliminate the need for the user to log in to each application; see the section "Light Weight Single Sign On" in Chapter 7.

NOTE NA does not support LWSSO and hence it is not possible to crosslaunch from NA to HPE Service Activator as described in this section.

A second way of GUI interworking is to use SPNEGO to provide the same function as LWSSO; see the section "SPNEGO" in Chapter 7

Another aspect is to configure one system to know the relevant URLs for contextual views of a launched application. In order to be able to set up cross launch capability from another application supporting LWSSO to HPE Service Activator views you will need to know the relevant URL formats. They are described here in the following.

The general format is

```
http://<hostname>:<port>/activator/<activator-subsystem>?<parameters>
```

where <hostname> must be an IP address or name of the server hosting HPE Service Activator, and <port> is the port number configured at system installation for access to HPE Service Activator's web server (default is 8080).

<activator-subsystem> defines the view you want to launch. Values are:

- views as shown in Work Area jsp/<jsp-file-name>
- Service Order View jsf/sov/serviceOrderView.jsf?<parameters>
- Inventory UI OpenInventoryFG.do?<parameters>

Look in the menu configuration file `$ACTIVATOR_ETC/config/menu.xml` for <jsp-file-name> for the Work Area views.

<parameters> take the standard form for a URL: <name>=<value>, with multiple occurrences separated by &

For service order view the following parameters can be used to specify the filter and the tab to select: jobId, serviceId, orderId, type, state, resultsTab (value shall be one of: jobsTab, messagesTab, auditTab, transactionsTab). Example:

```
http://<host-name>:<port>/activator/jsf/sov/serviceOrderView.jsf?
serviceId=site001&resultsTab=auditTab
```

For inventory UI the context must be specified as a specific instance branch to be selected using the following parameters; all are mandatory except operation:

- solution name of solution the tree belongs to
- view name of tree definition
- cl =true (to indicate cross launch)
- operation to invoke an operation on the branch
- branchPath sequence of branch names from tree definition leading to the desired branch, separated by '|' characters
- pk primary key of the instance to be selected

Example (from CNRM):

```
http://<host-name>:<port>/activator/OpenInventoryFG.do?
solution=CRModel&view=Equipment&cl=true&operation=view&
branchPath=Catalog|Region|Network|PEs|PE&pk=100
```

NOTE In the definition of the inventory tree all <Branch> elements in the branch path must include the <Parent-Find-By> child element. This is to allow the branch to be shown in its lineage (with all ancestors). Normally the <Parent-Find-By> element is not needed in tree definitions, so this is a significant extra requirement for the definition of an inventory tree.

5.5.2 UI Integration Without LWSSO

You may also want to cross-launch HPE Service Activator UI windows from external non-HPE applications which do not support HPE LWSSO. In this case, you can use the URL for logging in to HPE Service Activator, including credentials for authentication, with a redirect parameter to indicate the page you want to access:

```
http://<SA-host>:<SA-port>/activator/jsp/login.jsp?redirect=<page>
&hpsa_user=<username>&hpsa_password=<password>
```

where <page> is the path part of the URL for the page you want to display, i.e. /activator followed by the path of the page file relative to \$JBOSS_ACTIVATOR (i.e. the activator.war directory), for example activator/jsp/saRunningJobs.jsp for the page to display running jobs. This scheme will also work for pages in the UI part of a customized solution.

Note that the slash characters appearing in the <page> part must be escaped (because the slash character is a special delimiter in a URL) as the sequence %2F. So, if the SA-host is SAhost.mycompany.com, the SA-port is 8080, the username is foo and the password is bah, and you want to display running jobs, the complete URL will be:

```
http://SAhost.mycompany.com:8080/activator/jsp/login.jsp
?redirect=%2Factivator%2Fjsp%2FsaRunningJobs.jsp
&hpsa_user=foo&hpsa_password=bah
```

If you prefer to transfer the password in encrypted form, change the parameter name to HPEsa_encrypted_password and use the `crypt` utility in \$ACTIVATOR_OPT/bin to encrypt it.

5.5.3 A Note on Workflow Start Role Attribute

Most workflows do not get started from the workflows list on the user interface, but driven from an external message, for example through the socket listener, or as child jobs of other workflow jobs. To prevent users from accidentally starting such a workflow you can set the start (or default) role attribute in the workflow definition.

5.5.4 Viewing Jobs During Activation

Workflow jobs engaged in activation transactions (while executing an Activate node) will be visible on the activation queue in the Active Jobs view by users who have the 'internal' role. This role is normally not assigned to human users, but you can modify this behavior by setting the role attribute on the Activate node (using the Workflow Designer). The activation queue tab will then be visible to users with the specified role, and they will be able to select 'View Activation' from the right-click menu to launch the Transaction Details window.

You will not want users to be able to actually interact with a job during an activation transaction (that would allow the workflow job to continue as if the activation had completed). It can be prevented by configuring the user interface to hide the 'Interact with Job' item from the right-click menu of jobs on the activation queue.

5.6 Encrypted Passwords

One of the data items you may need to model for an activation target is a password that will be used to authenticate HPE Service Activator when it establishes a session with the target. You will want to avoid to store the password in clear text in resource inventory, log files, etc., so you will need to be able to encrypt the password after it is entered, for example on the inventory UI, using an encryption scheme that allows you to decrypt it again before transmission to the target, where it may be encrypted again using the key appropriate for that particular connection.

You can configure fields of resource beans for the inventory to be treated as passwords that must be encrypted upon entry. There are a number of ways to decrypt passwords (encrypted strings) when needed: by a workflow node (Decrypt), by a context method for use in workflow manager modules, by a context method for use in plug-ins, by an attribute in a control document for the CLI plug-in.

5.7 Data Models

To create a data model for resource and service inventory you must apply entity relationship analysis to the data you need to represent in order to determine entity classes and the foreign keys you need to represent relationships.

The inventory subsystem, i.e. the Inventory Builder and the beans and JSPs it generates, has many features that you should be aware of:

- a range of field data classes, including passwords as described above, with several control attributes
- inheritance, which lets you define resource superclasses and then subclasses by adding fields to a superclass
- flexible definition of keys that can be used to retrieve desired entity instances by resulting `findBy` methods, including foreign keys which represent relationships between different entity classes
- use of entity relationships to define keys comprising fields from inter-related entity classes (database joins)

For inventory trees and forms presented on the inventory UI there is also a rich set of features to control the structure and appearance of the trees and the operations that can be performed by users with different roles.

Consult the inventory manual, *HPE Service Activator, Inventory Subsystem*, for detailed information.

5.8 External Inventory Integration

You may need to integrate your solution with a preexisting inventory system.

If the inventory is held in a database with known table definitions, and the HPE Service Activator system can access the data at the SQL level, you can integrate by creating resource definitions that match the existing data, then use the resulting beans in your workflows to access the external inventory.

If the inventory is accessible only through a higher level API, one approach you can take is to design and build a number of workflow nodes to access the data in a way that will be convenient to use from your workflows: create, query, update,

etc., as needed. Such nodes will typically use a tailor-made workflow module to maintain a session with the external inventory.

A set of nodes providing a liaison to HPE's uCMDB product are available in the built-in library.

5.9 Workflow Processes

5.9.1 Controller Workflow Pattern

The section "A Typical Workflow" in Chapter 1 and the example in Chapter 2 give you some general ideas of what you can do with workflows. The pattern that you see in the Intro example with a controller workflow that handles the northbound communication and separate workflows to handle each type of request (in this case, create and delete service) is often useful. This pattern is a refinement of the single process that was described as "a typical workflow".

5.9.2 Activation Workflow Structure: Before - Activate - After

When you have complex activations involving several targets it is generally recommended to use compound tasks in order to simplify the error recovery logic in the workflow. A workflow with an activation task should have a clear before-and-after structure: before the activation only preparations, like retrieval, calculation and selection of parameters for the activation, possibly including resource reservations take place; after the activation come service inventory updates, output of informative messages, writing of audit records. If the activation fails, it should fail cleanly, and the updates that need to be undone or changed should be minimized.

5.9.3 Workflow States

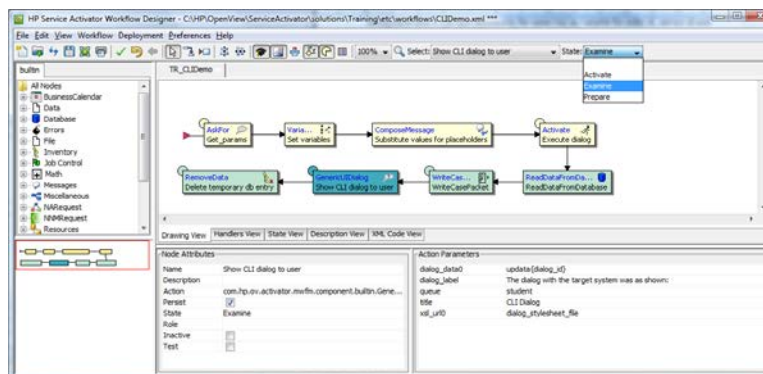
Depending on the logic, a workflow job may go through a sequence of states, for example "preparation", "activation", "data updating", as described in the preceding paragraph.

NOTE State, as discussed here, is the value of a single variable, and should not be confused with the complete state of a workflow job which comprises the values of its entire case-packet, as discussed in the section "Workflows" in Chapter 2.

All workflows have a common case-packet variable `WORKFLOW_STATE`, intended to reflect the current state of a workflow job. The value of this state variable is visible for monitoring on HPE Service Activator's web user interface in the same way as the variables for order id, service id and workflow type; see "User Interface and Roles" earlier in this chapter.

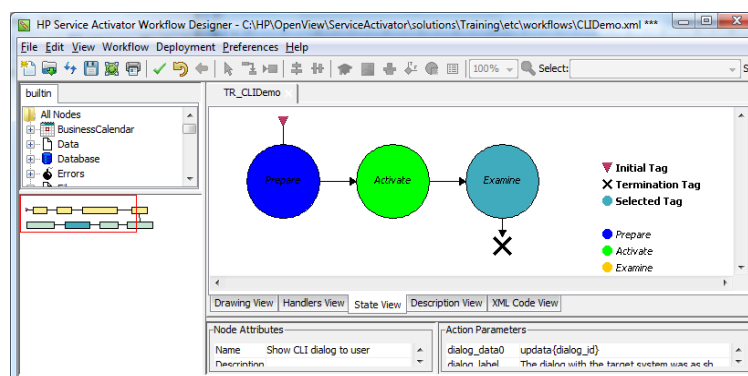
The `WORKFLOW_STATE` variable can be set in the same way as other variables in workflows, but there is also another feature that makes it easy to associate states with nodes of a workflow and view the association. A value can be set for each node as the attribute `State`; it will be automatically assigned to the `WORKFLOW_STATE` case-packet variable when the node is executed. When a node is selected, all other nodes which have the same `State` attribute value are highlighted (in light blue), as shown by the example in Figure 5-2.

Figure 5-2 Workflow in Designer with State



There is not a predefined set of values for the workflow state variable. The values can be freely chosen as part of solution design. In the example in Figure 5-2 three values were used as shown in the drop-down list that appears expanded from the tools bar. A reduced view of the workflow to show the possible state transitions as control passes through the nodes can be selected by the State View tab as shown in Figure 5-3 (for the workflow that was shown in Figure 5-2).

Figure 5-3 State View of Workflow in Designer



5.9.4 Business Processes

Although workflows are primarily intended to implement activations, it is also possible using interactions with operators and possibly external systems to implement business processes of some complexity and duration.

5.9.5 Using Cache with Inventory

Hint: frequent queries to very stable database tables may be optimized by using the Inventory Caching Module; it works together with the QueryInventory workflow node. Look for details in *HPE Service Activator, Workflows and the Workflow Manager*.

5.9.6 Starting Workflow from Inventory UI

Although it is generally expected that most workflow processes are initiated by receipt of request messages from a northbound system, it is also possible to start workflow jobs from the Inventory UI. You can use this feature for example if you have some processes which are not service oriented requests, for example device configuration or inventory maintenance. You can also provide an emergency route to initiate service activations, for situations where the northbound

system is out of operation. It is possible to initialize case-packet variables of the workflow job that is started with values that are sourced from inventory or entered by the user.

5.9.7 Interworking with NNMi and NA

Through the liaisons for NNMi and NA workflows can access devices and invoke actions on NA and NNMi to perform a number of functions. Refer to the dedicated chapters, Chapter 11 and Chapter 12.

5.9.8 Workflow Job Persistence

In a workflow definition you determine for each node whether the state of a job executing the workflow shall be stored (“persisted”) in the database after execution of the node. Should the workflow manager be restarted while the workflow is running, the job will be restarted at the last point of persistence. It is not necessary to persist after every single node; there is a performance cost associated with storing the data. Nodes which only change state internally in the workflow manager generally do not require persistence; they can be reexecuted after a restart, which will in reality happen very rarely, or never.

5.9.9 Business Calendars

A dedicated set of workflow nodes - `IsTimeIncluded`, `GetNextIncludedTime`, `GetBusinessHoursAfterDuration`, `GetTimeRangesOfBusinessDay`, `GetCalendarTimezone` - allows workflows to consult a business calendar defined for a solution with weekly working days and hours per day as well as annual holidays to avoid undesired activity outside of business hours. Business calendars are created and edited from the user interface. It is configurable whether the editor shows time of day in 12 hour (am/pm) or 24 hour format.

5.9.10 Considerations for Custom Workflow Nodes

You can extend the library of built-in workflow nodes by implementing custom nodes. The same is true for workflow manager modules. Information about these topics is found in *HPE Service Activator, Workflows and the Workflow Manager*.

There is a golden rule to observe: a workflow node must never occupy a workflow thread when it is waiting for an external event.

5.10 Solution Monitoring

In addition to monitoring the operation of HPE Service Activator on the UI it is also possible to use HPE OM (using OM notification messages) or any monitoring system that is based on receiving SNMP traps. HPE Service Activator includes a self-monitoring module, which can be configured on the workflow manager, to monitor a set of conditions and emit traps when they occur. The supported conditions are:

- JVM heap size exceeds configured threshold
- number of running job exceeds threshold
- cluster node is internally suspended, i.e. lost connectivity to system database
- cluster node is down

Alternatively, if there is no external system to monitor HPE Service Activator, the self monitoring module can be configured to write information into audit records or log messages. Refer to *HPE Service Activator, Workflows and the Workflow Manager* for detailed information about this module.

Additional traps or OM messages can be sent by workflows based on any condition that can be detected by the workflow logic. The typical reason to send such a message / trap would be an unusual negative response from an activation target. It is up to the solution designer how to use this capability.

5.10.1 OIDs for Traps Emitted from HPESA

You can use the workflow node SendSNMPTrap in conjunction with the workflow manager module SNMPSenderModule to send out SNMP traps. Traps will include one or more OIDs and a trap message.

The OID branch assigned to the HSPA product for sending traps is:

```
iso(1) org(3) dod(6) internet(1) private(4) enterprises(1) HP(11) nm(2) HPESA (52)
```

or in short: 1.3.6.1.4.1.11.2.52.

Some sub-branches of this branch are used for system generated traps (as described above). For solution generated traps you should select a value ≥ 100 for the next branch and build a further OID sub-tree as needed to distinguish between different traps from the solution.

5.11 Northbound Interface

In most cases an HPE Service Activator solution will need to be integrated northbound with an Order Management or CRM system which will be the originator of requests to create, modify or terminate services. The activation system will then respond to each request with one or more messages to acknowledge receipt and to indicate progress and completion of the requested process.

The general assumption is that the activation system is implemented as a collection of workflows that can accomplish a set of tasks which the originator or client system will request. In other words, each request from the client to perform a task can be translated to: run a specific workflow with some case-packet variables initialized with parameter values supplied by the client as values of elements in the message.

Two approaches to implementing the northbound integration were introduced in the section “Interfaces for Integration” in Chapter 2:

- using listener and sender modules of the workflow manager
- using web services implemented with servlets

The choice of which approach to take will depend on circumstances and specific requirements.

A description of how to configure secure communication on the northbound interface is included as an appendix in *HPE Service Activator, Installation Guide*.

5.11.1 Workflow Contract

When a workflow is invoked either on a northbound interface or internally by a parent workflow, we speak of the contract of the workflow as defining:

input	the set of case-packet variables which are expected to be initialized by the invoker, with some of them marked as mandatory; the request to start a workflow job will fail if values mandatory input values are missing (empty values, for example empty strings, are permitted)
-------	--

output the set of case-packet variables whose final values will be returned to the invoker; on the RMI interface of the Workflow Manager the case-packet is returned as a map containing the output variables (with the names as keys)

The workflow contract is defined by means of the Workflow Designer.

5.11.2 Using Listener and Sender Modules

Two pairs of listener and sender modules are available: the socket module pair and the JMS module pair. The interworking between modules and workflows follows the same pattern in both cases. An instance of the listener module is configured to listen at an access point of the underlying communication service for an incoming message and start a named workflow each time a message arrives. The message is stored in a temporary database entry, and access to it is provided to the workflow job through one initialized case-packet variable. In both cases, socket and JMS, a message is sent back to the client by using the SendMessage workflow node with two parameters: one identifying the sender module instance, another holding or identifying the message.

In the case of the socket listener and sender modules the underlying communication service is TCP. The access points are ports, and the messages are exchanged as raw TCP messages. In the JMS case the underlying communication service is a MOM (message-oriented middleware) supporting a JMS interface. The access point are JMS destinations, and messages are exchanged as MOM/JMS messages. See Appendix C for more information on using JMS.

With the listener/sender module approach parsing of incoming request messages is left to the workflow job that is started by the listener module. It is recommended to use a controller workflow to handle the parsing (at least of the general message fields such as order identifier, customer identifier, service identifier and request type which are not specific to the type of request) and determine the appropriate workflow to handle the specific request.

The Intro example described in Chapter 3 follows this recommendation with one controller workflow and a separate workflow for each request type. The example shows how to implement parsing of request messages with the XMLMapper node and how to use templates of response messages where values of case-packet variables are substituted for placeholders. This pattern represents a recommended best practice.

If you have multiple solutions with unrelated request message streams and formats, it is recommended to use a separate instance of the listener module for each solution, each one listening on a separate port.

5.11.3 Using Web Service Servlets

The second approach uses servlets deployed in WildFly, more specifically they are deployed with JBossWS which is part of the WildFly platform that HPE Service Activator runs on. The servlet for a service can be generated with the Web Service Designer tool which is provided as part of the HPE Service Activator core product. This tool and its use is described in Chapter 8. When the generated servlet has been deployed, a description of its interface in WSDL can be extracted from JBossWS on the running platform - see Chapter 8 for more detail - and imported in a client system to support generation or configuration of the necessary interface component on the client side.

In this approach a set of web service methods are exposed, where each method will run a specific workflow. Incoming messages will be parsed by the servlet and parameters of the method are assigned as initial values to case-packet variables of the workflow job.

The method may just start the workflow job and return the job identifier to the calling web service client, or it may wait for the job to complete, and return a response message including final values of case-packet variables. In the latter case the call-return communication synchronizes the caller with the activation system. In the former case the activation job may run asynchronously with continued activity on the client side, and will typically need to send one or more notification

messages to inform the client of progress and final status of the activation job. Such messages can be implemented according to the sender module approach as described above, or can be sent over HTTP using the generic HTTP plug-in.

Synchronous calls are not recommended when there may be many jobs with long or unpredictable duration. Servlets are not fault tolerant; the relationship between a running job and the client that requested it will be lost in the case of server host failure.

With this approach there is no obvious need for a controller workflow. Compared to the first approach the servlet takes on the role of the controller workflow.

5.11.4 Service Order Registry

HPE Service Activator comes with a Service Order Registry (SOR) in which request messages received from north-bound system may be stored. A module named `service_order_registry` *must* be configured in the Workflow Manager's configuration, also if the Service Order Registry is not used. The `service_order_registry` is enabled by default when installing HPE Service Activator.

In order to make use of the SOR, either the RMI method `receiveMessage()` or `receiveMessageAndWait()` must be used. The `receiveMessage()` and `receiveMessageAndWait()` methods are somewhat similar to the `startJob()` and `startAndWaitForJob()` methods, in the sense that they can be used to launch workflows – asynchronously or synchronously.

The RMI methods `receiveMessage()` or `receiveMessageAndWait()` both require that the `transactionId` and the `systemName` parameters are set. The combination of `transactionId` and `systemName` is used to uniquely identify the received message; if multiple messages carry the same `transactionId` and `systemName` they will be considered to be identical regardless of the content of the messages.

The Service Order Registry will, upon reception of a message, persist the message using (`transactionId`, `systemName`) as a unique identifier, and then it will launch the requested workflow in the Workflow Manager. In the synchronous case (when using the `receiveMessageAndWait()` method), the calling thread will be blocked until the execution of the requested workflow is finished. In the asynchronous case (when using the `receiveMessage()` method) the method will respond immediately *after* the message has been persisted *and* the workflow job has been started; the immediate response will contain a generated UUID as well as two counters that keep track of the number of times the same message has been resent.

NOTE Please study the Javadoc for the RMI methods `receiveMessage()` and `receiveMessageAndWait()` for more details about how to use these methods.

5.11.4.1 Modes of Operation

The two modes of operation – *synchronous* and *asynchronous* – are fundamentally different in the requirements that they pose on the solution developer. In general, using the asynchronous mode of operation require considerably more from the solution developer in order to operate as intended.

When using the *synchronous* mode of operation, `receiveMessageAndWait()`, the behavior of the Service Order Registry is as follows:

1. The message is persisted
2. The requested workflow is started and the SOR waits until the workflow is finished executing
3. The persisted message is updated with the workflow result (i.e. the workflow's case-packet is stored with the persisted message)

4. The `receiveMessageAndWait()` returns the workflow's case-packet

So, from the solution developer's point-of-view, the `receiveMessageAndWait()` method can be used almost identically to the `startAndWaitForJob()` method; they both block until the executed workflow is finished, and the result from the workflow job is returned in the format of a map containing all case-packet variables as key-value pairs.

When using the *asynchronous* mode of operation, `receiveMessage()`, the behavior of the Service Order Registry and the invoked workflow (developed by the solution developer) is as follows:

1. The message is persisted as a SOR entry
2. The requested workflow is started; an internal identifier that is used to identify the SOR entry is automatically written to the workflow's system case-packet variable named `SOR_ID`
3. The `receiveMessage()` method exits and returns a generated UUID
4. When the workflow has finished its task and calculated a result, the workflow must do the following:
 - a. The `SORSaveMessage` node or `SORSaveMessageHandler` must be executed to update the registry with the result; please read the description of the workflow node or the handler in the document *HPE Service Activator Workflows and the Workflow Manager*. Note, that it is possible to set the state of the SOR entry by setting the `sor_state` parameter (see section 5.11.4.4). Also, for correct operation the `sor_id` parameter must be set to `SOR_ID`. Finally, it is very important to remember to set the `send_workflow` parameter; this parameter is used to tell SOR which workflow to invoke *if* the same request message is received again. More details about this topic will be given in section 5.11.4.2.
 - b. The `SendMessage` node of `SendMessageHandler` must be executed to send back the asynchronous response to the caller. For correct operation, the parameter `use_sor_id` must be set to `true`. Currently, the *only* module shipped with HPE Service Activator that has the capabilities needed to support the asynchronous mode of operation is the `HTTPSenderModule`.

The solution developer must be very careful when implementing the functionality sketched in the steps 4a and 4b in the above description. Any deviation from these recommendations may cause the asynchronous mode of operation to malfunction.

5.11.4.2 Idempotency

In addition to serving as a registry for received messages, the Service Order Registry can be used to guarantee that for a given value of (`transactionId`, `systemName`) the requested workflow will only be invoked once even if the same request is received several times. Moreover, this mechanism can be used to secure that for a given request message the response will always be the same. This feature is known as *idempotency*.

The way to ensure that the system will always send back the same response for the same input data is different for the two modes of operation:

- *Synchronous* In this mode of operation idempotency is obtained automatically. If the Service Order Registry detects that the message is known, identified by (`transactionId`, `systemName`), then it will simply read the stored result in the SOR entry and immediately return that result to the calling thread.
- *Asynchronous* In this mode of operation the solution developer needs to design a "resend workflow"; i.e. the workflow to be invoked if the SOR sees the same request message again. The "resend workflow" that will be called is the one that was specified in the `SORSaveMessage` workflow node using the `send_workflow` parameter (see section 5.11.4.1). The Service Order Registry will set the value of the `SOR_ID` case-packet parameter in the "resend workflow" so that the SOR entry containing the result from the execution of the original request can be uniquely identified. This means that in the "resend workflow" the solution developer must use either

the `SendMessage` node of `SendMessageHandler` and set the parameter `use_sor_id` to `true` to trigger a re-send of the result to the caller.

5.11.4.3 Retention Policy

The Service Order Registry is not designed to keep received message indefinitely. SOR messages should be cleaned up on a regular basis, either automatically or manually from the web UI.

To enable automatic clean-up of SOR messages, the `service_order_registry` module in the `mwfm.xml` configuration file needs to have the parameters `time_window` and `sleep_interval` set. The `time_window` parameter specifies the number of hours for which to keep SOR message (from the current time and back), and the `sleep_interval` specifies how often to initiate a clean-up cycle. The `sleep_interval` parameter is also specified in hours.

The following example will lead to a daily clean-up cycle where all SOR messages older than one week will be deleted:

```
<Module>
  <Name>service_order_registry</Name>
  <Class-Name>
    com.hp.ov.activator.mwfm.engine.module.sor.ServiceOrderRegistryModule
  </Class-Name>
  <Param name="time_window" value="168" />
  <Param name="sleep_interval" value="24" />
</Module>
```

NOTE If the `time_window` and `sleep_interval` parameters are not specified, the SOR messages will never be automatically cleaned up.

5.11.4.4 Life-Cycle States

The Service Order Registry supports the following life-cycle state for SOR messages:

<i>Received</i>	Message request has been received but has not been yet processed
<i>Running</i>	Message request is being processed (the workflow is running)
<i>Responding</i>	Response message is being sent back to the north-bound system
<i>Finished</i>	Message request has been successfully processed
<i>Gave Up</i>	Message request has been processed but the response message could not be sent back and the number of retry attempts (if using retry) has been exceeded
<i>Incomplete</i>	Message request has resulted in an incomplete state
<i>Gave Up Incomplete</i>	Message request has finished in an incomplete state <i>and</i> the response message could not be sent back <i>and</i> the number of retry attempts (if using retry) has been exceeded

In case of no errors, the life-cycle states for a SOR message will be:

- *Received* → *Running* → *Responding* → *Finished*

Chapter 6

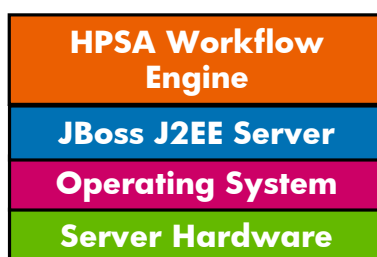
HPE Service Activator Platform

As described in chapter 1 the core component of an HPE Service Activator production system is a workflow engine. The workflow engine comprises the workflow and resource managers.

The workflow engine runs in the framework of WildFly (version 9.0.2). WildFly is a JEE platform which can run on a range of hardware and operating system platforms. HPE Service Activator is specifically supported on Red Hat Enterprise Linux on x86-64 processor, and on Windows 2012 R2 Servers on any hardware platform. In addition to WildFly, the operating system, and the processor hardware, HPE Service Activator requires access to a database server via JDBC connections.

The complete stack comprising the workflow engine on top of the required platform is shown in Figure 6-1.

Figure 6-1 HPE Service Activator Platform Stack



6.1 Cluster Platform

As described above, HPE Service Activator can be deployed on a range of different hardware, from small and inexpensive to large, very powerful processing systems. HPE Service Activator-based systems can also be deployed on clusters of separate servers, interconnected within a segment of a local area network. The term *cluster node* (or just *node*) is used to designate a server in a cluster.

Cluster configurations provide three important benefits:

- Extreme scalability: the workload of the HPE Service Activator solution can be distributed over all the nodes in a cluster; when a node is added, the total processing power is enhanced.
- High availability: if one of the nodes in a cluster suffers a failure and ceases to function or is taken out operation, all running workflow jobs will continue to run and are redistributed over the remaining nodes (one or more).
- Easy configuration of server nodes on standby sites for disaster recovery.

The unit of work for an HPE Service Activator system is a workflow job. A cluster node is selected to run a workflow job when the job is started. The job will remain on the selected node until it completes, except when a node failure occurs. All the processing of the workflow job, including activation transactions down to atomic tasks takes place on the same node. But when a job starts a child job, a different node may well be selected for the child job.

At any point in time when an HPE Service Activator production system is running, there will be a number of jobs running on each of the nodes. The distribution of work will change when jobs terminate, and when new jobs are started. The system administrator can view the running jobs and their assignment to cluster nodes.

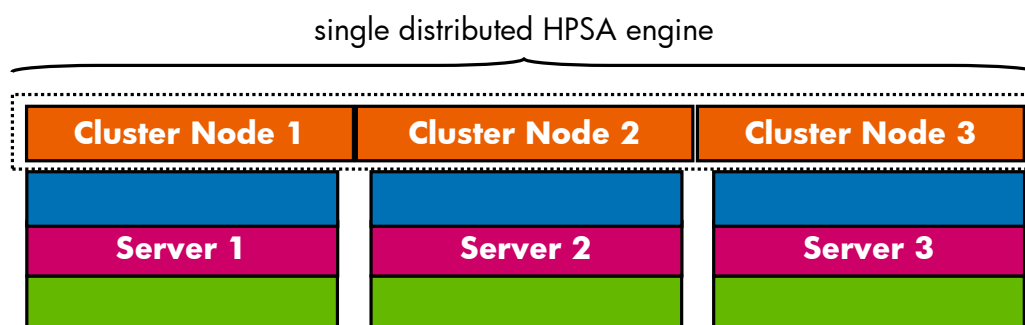
Workflow jobs are executed as a sequence of workflow nodes (note: a different meaning of the word node!) determined by the control logic of the workflow, with branching controlled by rule nodes. As the execution of each workflow node

completes, the state of the workflow job may be persisted, allowing execution of the job to be restarted from the next node. After a node which has no external impact, persistence may be omitted to enhance performance. Workflow nodes which have external impact are those which perform activation tasks, update the database (inventory or audit trail), post messages to queues, send messages to other systems, or perform any other action which causes something to change outside of the workflow engine itself. The persistence property as described here allows a workflow job to be restarted, if the cluster node it runs on suffers a failure or is halted, while the job is running. Restarting can take place without any startup costs on any node in the cluster.

To allow completely symmetric assignment of workflow jobs to cluster nodes, all the information that is needed to run a job is held in database repositories that can be accessed by all the nodes. This includes the static information: workflows, compound and atomic tasks (plug-ins), inventory tree definitions, as well as the dynamic states of workflow jobs, including values of case packet variables, and of active compound transactions, including locks on activation targets.

As a result of the symmetry and the single database, a cluster of workflow engines will appear and behave like a single distributed engine as illustrated in Figure 6-2 for a cluster comprising 3 nodes. Operators and external systems can interact with a running workflow through the web service interface of any node in the cluster.

Figure 6-2 HPE Service Activator Distributed Workflow Engine



Given the equal access to persisted workflows from all nodes in the cluster, it could be considered to monitor the relative loads on different nodes and migrate jobs between nodes to balance the load. There would be a performance penalty, since a job that remains on the same node benefits from having its state cached in the workflow engine. Assuming most workflows are short lived, the benefit would not be great. In HPE Service Activator workflow jobs only migrate upon node failure.

In the event of a node failure, it will be detected by the other nodes in the cluster. One of them will then automatically assume the role of redistribution manager. The redistribution manager will restart all workflow jobs that were active on the failed node. For each job a new cluster node is chosen to execute it. In this way the load of the failed node will be shared over all the remaining functional nodes.

Detection of cluster node failure is done by means of keep alive timers that are monitored by keep alive modules of the workflow managers on all active nodes in the cluster. The timers are also held in the shared database.

6.2 Cluster Installation and Setup

For details on how to install and configure an HPE Service Activator cluster, please refer to the Installation Guide. Only the main principles are mentioned here as part of the explanation of the clustering concept:

- HPE Service Activator must be installed on each node in the cluster. This will also install WildFly on each node. HPE Service Activator clustering does not build on WildFly clustering. The WildFly servers are independent and not aware of each other.

- When HPE Service Activator is installed on the first node, the database tables used by the workflow manager and other parts of the HPE Service Activator platform (as opposed to the tables belonging to the customized data model of a solution to be added on top) shall be created. When HPE Service Activator is installed on subsequent nodes, the same database user shall be specified, but the tables shall not be created again. An additional entry (row) will then be created in the table (CLUSTERNODELIST) that describes the nodes of the cluster.
- HPE Service Activator must be configured on each of the nodes in the cluster. For example, the workflow manager is configured in file mwfm.xml. The configuration shall normally be identical on all nodes of the cluster.
- Nodes can be installed on different sites. Each site is either a primary site or a standby site for disaster recovery. The name and type of the site must be given for each node where HPE Service Activator is installed.
- Except on a Windows server a virtual IP address can be defined for the server. The virtual address must be associated with an interface on the server. The virtual address is useful in the internal load balancing scenario described below.

6.3 Workflow Load Distribution

The important control decision that determines the distribution of load across the cluster is the selection of the node where each new workflow job is started.

Except for child workflows the initiative to start a workflow activity always originates outside of HPE Service Activator, typically in a CRM or Order Management system. The external component which makes requests for workflow jobs to be run can also be a catalog-driven workflow controller delivered by HPE as part of a solution. Service orders may also be entered into an order portal GUI, which can translate orders directly to requests to run workflows.

Once a workflow job has been started in response to an external request, it may spawn child jobs. The complexity of the workflows that are started by an external initiator will vary depending on the solution. In complex cases, the initial workflow will spawn many additional jobs.

Different mechanisms can be implemented to interface the external control component to HPE Service Activator's workflow manager, but in the end the request to run a workflow job is always made by a call on the API of the workflow manager: `startJob` (asynchronous mode) or `startAndWaitForJob` (synchronous mode).

NOTE The case when a user starts a workflow from the main UI or from the inventory UI is not special. The request is passed via the WildFly web server through a call on the workflow manager's API.

The actual API call may be implemented in different ways. It can be made directly by an external controlling component using either the RMI or SOAP version of the API. Alternatively it can be made by a workflow manager module, such as the socket listener, or by a web service NBI dedicated to an activation solution, i.e. a specific set of workflows exposed as web service methods.

Regardless of these technical variants, the more significant difference has to do with the selection of the cluster node where the job will run, as this is the decision that will affect load balancing in the cluster. The selection is made by a module of the workflow manager which receives the API call, known as the *distribution module*. Three different distribution modules implementing different selection algorithms (see below, Internal Load Balancing) are available in the HPE Service Activator kit; the workflow manager must be configured to know which distribution module to use. When the distribution module has selected the node to process a workflow job, it transfers the workflow job to that node.

The workflow manager can run in "stand-alone mode" (similar to versions prior to V5) with no active distribution module.

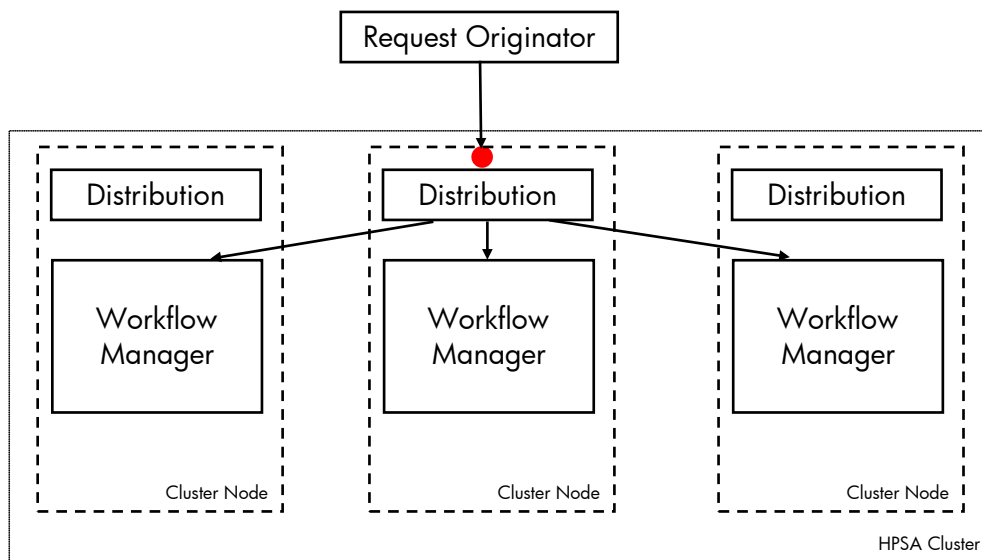
As for other workflow manager modules it is possible to extend HPE Service Activator with additional node selection algorithms by implementing new distribution modules.

All distribution modules allow the node selection algorithm to be bypassed for workflows that are started by a call on the external API.

6.3.1 Internal Load Balancing, Virtual IP Address

Internal load balancing is the intended normal distribution model, where HPE Service Activator itself takes care of load balancing. In this mode it does not matter which cluster node receives the request to start a workflow job. The originator of the request therefore does not require any load balancing capability. It is enough to know a single node which can receive all the calls and distribute them across the cluster, as illustrated in Figure 6-3.

Figure 6-3 Internal Load Balancing



HPE Service Activator supports the use of two IP addresses for each server in a cluster, the physical IP address and the virtual IP address. If a cluster node fails and goes out of operation, its physical IP address will become unreachable, whereas the virtual IP address will be taken over by one of the remaining servers in the cluster, the “failover” server. The fail over process may take up to a minute. After fail over requests sent to the virtual IP address of the failing cluster node will be transparently received by the failover server, which will initiate processing in the usual way.

By default the virtual IP address will automatically move back to the node it belongs when that node again becomes available. You can configure the keep alive workflow manager module to overrule this behaviour, if you prefer to manually decide from the UI when the virtual IP address shall move back.

The HPE Service Activator server address known by the request originator should be the virtual IP address of the node designated to receive the requests.

Four distribution modules, supporting different algorithms, are available as part of the HPE Service Activator standard product distribution. The workflow manager can be configured to use any one of these. The four algorithms are:

- Plain round robin.
- Weighted round robin, where each cluster node can be assigned a different weight according to its processing power.
- Selection of the node which has the shortest queue of workflow jobs waiting for a processing thread in the workflow manager (a measure of the load at the time when the decision is made).
- Selection is based on the value of a pre-initialized case-packet variable of the job to be started.

When a workflow job spawns a child job, the load balancing algorithm will again be applied, so a family of jobs with a common ancestor are not tied to the same cluster node.

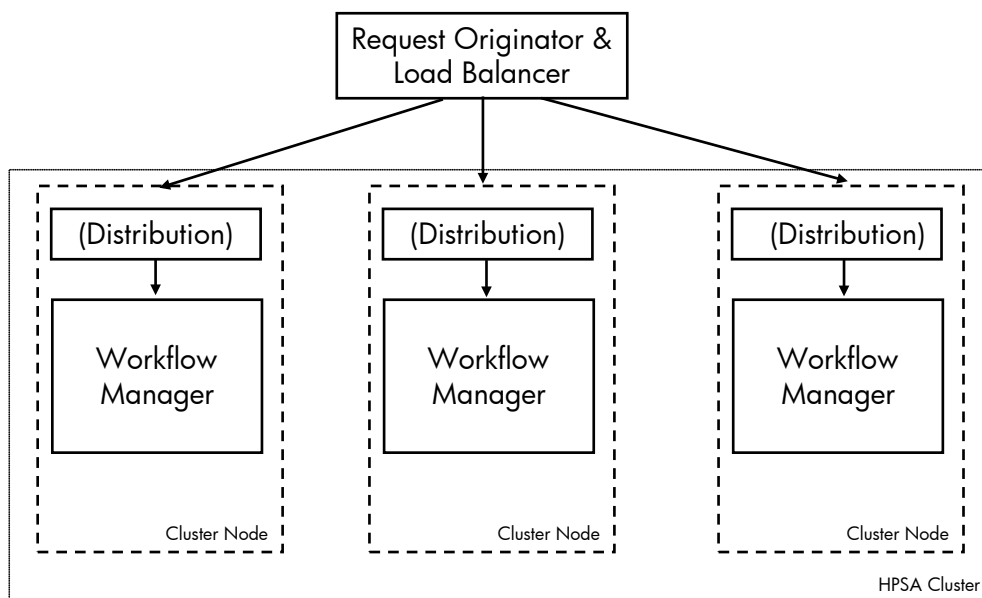
6.3.2 External Load Balancing

In the external load balancing model, the cluster node that receives the external API call to start a workflow job also runs the job. To achieve this behavior the active distribution module must be configured to run externally requested workflows locally, i.e. the node selection algorithm is not used. This means the external originator of the requests to run workflows will determine the distribution of processing across the cluster.

This mode of operation is supported to allow the use of request originating systems which already support a desired load balancing algorithm. Such systems will need to know all the cluster nodes and to maintain information about them, which requests have been dispatched to each one, etc., in order to make load balancing decisions.

When a job is started on a cluster node where the distribution function is disabled, any child jobs will run on the same cluster node. This is a logical consequence of the balancing logic being implemented externally. However, when jobs are redistributed after a node failure, they will still be distributed as opposed to all being executed by the node which acts as redistribution manager.

Figure 6-4 External Load Balancing



6.4 Standby Sites for Disaster Recovery

For the case of mission critical solutions where servers must be in standby mode at a secondary disaster protection site, HPE Service Activator cluster configuration allows cluster nodes to be associated with sites, and sites can be categorized as primary or standby. The category is actually a modifiable state of a site. Only the nodes at the primary site need to be running in normal operation, but the standby site(s) is also included in the installed and configured system and is visible from the user interface.

The database server that HPE Service Activator uses may also be configured with primary and standby sites and use a product from the database vendor to automatically maintain an up-to-date copy of the database at the standby site(s). Alternatively independent database servers can be used at the sites and backups of the database can be regularly transferred to the standby site(s).

In the event of a disaster, i.e. the servers at the primary site become unavailable, the server(s) at the disaster site must be started, the system administrator must connect to it (one of them) and change the state of the site from standby to primary. Northbound systems and users must then make sure to access the (a) new primary server. A configuration change may be needed, because the secondary site may have different host names and IP addresses from the original primary site.

The procedure for switchback to the original primary site must be similar. The secondary site must be deactivated, the original primary site restarted, the states of the sites must be swapped; this can be done from the system administrator user interface, and then the system will again be ready for normal operation.

6.5 Internet Protocol Versions (IPv4, IPv6)

HPE Service Activator will run in an IPv4 or an IPv6 environment. When deployed in a cluster and/or with a separate database server, all the machines which make up the platform, including database servers, must run the same version of Internet Protocol and use it for the interconnection of the cluster. All of the relevant setup is done during installation, for details see the installation guide.

For external communication, with activation targets as well as peer systems via liaisons, etc., HPE Service Activator can use any mix of IPv4 and IPv6, independently of the version that is used for internal cluster interconnection.

6.6 Managing an HPE Service Activator Cluster

6.6.1 User Interface Functions for Cluster Nodes

HPE Service Activator's system administrator interface (see *HPE Service Activator, User's and Administrator's Guide*) has features for managing a cluster:

- The operator can view how jobs currently running are distributed across the nodes of the cluster.
- The operator can set the state of a site to primary or standby.
- Statistics reports can be produced about the load of the nodes over a specified period of time.
- Nodes can be taken in and out of operation.

The last feature is known on the interface as locking and unlocking of a node. When a node is locked, it will no longer be a candidate to run new workflow jobs. The load on the node will then drain as current jobs run to completion. When there is no load left the node can be taken of operation for hardware or software maintenance.

Cluster nodes can also be suspended: all jobs are immediately suspended with saved state so they can be resumed later. Suspension is primarily intended to be applied to a complete cluster to allow backup of a frozen database. No use case is intended for suspending a single node.

6.6.2 Synchronizing Time on Cluster Nodes

In order to allow proper cooperation between the workflow engines in a cluster, the date and time on all the servers must be kept synchronized using a tool such as NTP (Network Time Protocol).

Chapter 7

Roles, Privileges and Authentication

Some HPE Service Activator solutions are black boxes with very few users. Others may have a larger user community. The inventory subsystem, in particular, may allow users to perform operations on many different types of entities. It is possible, therefore, to assign privileges to perform operations from the user interface with any desired granularity.

Privileges in HPE Service Activator are granted to roles. When a user logs in to HPE Service Activator, an authentication takes place based on user name and password, and a list of roles is established that the user will have during the session. The user is then permitted to perform any operation for which the privilege has been granted to one of the roles in the list.

NOTE Authentication must be configured for the workflow manager, otherwise it will not occur, and users will not get any roles. It is not enabled at installation time.

The user interface operations that may require privileges fall in four areas:

- Functions available as menu items in HPE Service Activator's main UI window. The menu falls in two parts, the Work Area and the Self Management menu. The Self Management menu as a whole is only available to users who have the - predefined - system administrator role, normally named 'admin'. For the work area a required role can be assigned to each menu item.
- Workflow related operations, also performed from the main UI window: starting and stopping workflow jobs, inspecting the state of a workflow job, interacting with a workflow job, viewing messages posted on queues by workflow jobs.
- Inventory operations performed from the inventory UI window: view a tree; expand a branch in a tree to see more branches; create, view, edit or delete a resource instance.
- Deploying plug-ins using the Service Builder tools. In this case the user does not log in to HPE Service Activator's web-based UI, but the Service Builder invokes methods to deploy plug-ins on the resource manager, and these methods may require authorization using the user's identity as established by the operating system.

As customizer of a HPE Service Activator solution you must define the roles that shall exist for the system, and you must assign to roles the privileges to perform specific operations. Typically you will then leave it to the system administrator to define users and assign roles to them. You must decide which operations shall require specific privileges. If it is not necessary to distinguish between different categories of users, you can simplify your task by leaving many operations available to any authenticated user. You generally do this by omitting to configure a privilege for each operation (for example to interact with a workflow or perform an operation on the inventory UI). You must also decide the granularity of the roles you define. If you make few large roles, each with wide privileges, you will simplify the task of the system administrator. If you make many small roles, each with limited privileges, you enable the system administrator to assign privileges to user groups with fine granularity.

The first section in this chapter introduces the system user and the predefined system administrator role.

The second section gives an overview, with references to additional information, of how the privileges to perform the operations in the four mentioned areas are assigned to roles. This is done in different ways, using different tools, for each of the four areas.

The third section gives an overview of the different modules you can choose from to authenticate users and establish their roles at log-in, and how to configure these modules.

The fourth section describes how users can be grouped in teams, and finally there is a section that describes HPE Service Activator's support for HPE's Light-Weight Single Sign On framework and SPNEGO.

Management of users, roles and privileges is done by the system administrator using the User Management view available from the Self Management menu area of HPE Service Activator's main UI, as described in *HPE Service Activator, User's and Administrator's Guide*.

7.1 System User and Predefined Roles

There are two predefined roles, 'admin' and 'internal'.

The 'admin' role, as described above, is the system administrator role with privileges to perform system administrator functions. It is possible, but not recommended to change the name of the role by editing the configuration file for the workflow manager, `mmfml.xml`, see "Setting the Workflow Manager Parameters" in *HPE Service Activator, Workflows and the Workflow Manager*.

The 'internal' role exists for technical implementation reasons. This role has the privilege to interwork with workflow jobs which are sleeping or waiting for activations or other software internal interactions. It is not intended to be assigned to human users.

One special user, the *system user*, is created with username and password during installation (system configuration) of HPE Service Activator. It exists primarily for technical implementation reasons and has all roles, including the predefined ones 'admin' and 'internal'. Software components (for example workflow manager modules) which need to perform 'internal' interactions with workflow jobs will take on the identity of the system user. When the workflow managers on separate cluster nodes interact, they also make use of the system user.

It is not possible from the user interface to change the name or password of the system user or to revoke any roles from it.

The system user is not intended to be used by a system administrator during normal operation, but must be used to create at least the first ordinary user once authentication has been enabled.

NOTE If a non-native authenticator module is used (see "Authentication and Assigning Roles to Users" below), the predefined roles and the system user are not automatically created during installation. They must then be explicitly created in the appropriate environment (operating system or LDAP) before authentication is configured. If this is not done, the system will malfunction.

7.2 Assigning Privileges to Roles

The privileges to perform operations related to workflows and inventory can be defined and assigned to roles with a fine granularity as part of the customization of workflows and inventory.

Roles and also their relationships to inventory UI privileges can be described in an XML-formatted file. The schema for the document is found in file `$ACTIVATOR_ETC/config/umData.xsd`. If you have defined the roles and relationships in the User Management view so that they are recorded in HPE Service Activator's static repository in the system database, you can use the UMMData script to export them to a file and include it in a solution to be deployed with the Deployment Manager. Refer to the manual for the Deployment Manager for information on how to include the roles file in a deployable solution.

For each of the four areas of potentially privileged operations, the information on how to define the operations with privileges and assign them to roles is found in different manuals, as outlined here:

7.2.1 User Interface

Privileges to view and select menu items in the work area of HPE Service Activator's main UI are assigned directly to roles. Configuration of the UI menu is described in *HPE Service Activator, User's and Administrator's Guide*.

7.2.2 Workflows

For operations related to workflows, privileges are also assigned directly to roles, see "Setting Roles" in *HPE Service Activator, Workflows and the Workflow Manager*. In the same manual, specifically for information about message and request queues, see "Queues", and for information about how to make these queues permanent using the <Permanent-Queue> tag, see "Setting the Workflow Manager Parameters".

7.2.3 Inventory

With respect to inventory operations, see "Inventory Tree Definitions" in *HPE Service Activator, Inventory Subsystem*, for information about defining the privileges, known as operation types, branch types and tree definitions. The assignment of these privileges to roles is done as part of User Management in HPE Service Activator's main UI.

7.2.4 Deploying Plug-ins

For deploying plug-ins, there is only one privilege, it is preassigned to a role named "deployer". The role is only required if you have enabled authentication of plug-in deployment. For more information, see "Configuring Authentication or Authorization" in *HPE Service Activator, Developing Plug-Ins and Compound Tasks*.

7.3 Authentication and Assigning Roles to Users

User authentication in HPE Service Activator is the process of validating that a supplied (user name, password) pair is valid, determining the identity of the user, and retrieving the list of the user's roles. It is done by a module of the workflow manager, known as an *authenticator module*.

On a virgin system, after installation of HPE Service Activator, authentication is disabled. You enable it, like other functions performed by workflow manager modules, by editing a specification of the module you want to use - its name, Java class, and configuration parameters, into the configuration file for the workflow manager, `mwfm.xml`.

You have four authenticator modules to choose from, HPE Service Activator's native recommended module, the `DatabaseAdvancedAuthModule`, one for each of the four supported operating systems, Windows, and Red Hat Linux, and finally an authenticator module that uses LDAP to access a directory service. For special requirements it is possible to build additional authenticator modules.

NOTE If you configure a non-native authenticator module remember to define the system user and predefined roles (with the same name and password that was defined at system installation time) within the data that is the foundation for authentication (i.e. OS users and groups or LDAP).

7.3.1 Native Authenticator Module

With the native authenticator module the user information is held in HPE Service Activator's own database, and all user administration functions are done through the User Management view of HPE Service Activator's main UI.

7.3.2 OS-based Authenticator Modules

The OS-based authenticator modules delegate authentication to the operating system, validating HPE Service Activator user credentials against the same database that the operating system uses for its own users. These modules then retrieve all user groups that the validated user belongs to and maps them to roles using the role mapping file. By default, the role mapping file is absent, and each group name is taken directly as a role name.

When you use one of the operating system based authenticator modules, you manage HPE Service Activator users by the same tools that you use to manage users of the operating system, including the creation of dedicated groups to implement the roles you have defined for HPE Service Activator.

7.3.3 Role Mapping

You will understand how to construct role mappings from the following example, which shows the contents of a role mapping file that maps the two groups `activ_users` and `activ_oper` to the same HPE Service Activator role, `operator`, and a third group `root` to the `admin` role.

```
<?xml version="1.0" encoding="utf-8" ?>
<!DOCTYPE RoleMappings SYSTEM "role_mappings.dtd">
<RoleMappings>
  <Role>
    <Name>operator</Name>
    <Mapping>activ_users</Mapping>
    <Mapping>activ_oper</Mapping>
  </Role>
  <Role>
    <Name>admin</Name>
    <Mapping>root</Mapping>
  </Role>
</RoleMappings>
```

The role mapping file must be named and placed as: `$ACTIVATOR_ETC/config/role_mappings.xml`. After you create or change it, reload the configuration from the Self Management menu of HPE Service Activator's main UI to allow it to take effect.

NOTE If you write your own authenticator module - see "Writing New Authenticator Module" in *HPE Service Activator, Workflows and the Workflow Manager* - you must consider if your module needs to support role mapping.

7.3.4 LDAP Authenticator Module

The LDAP-based authenticator module assumes that information about users and their roles is held in a directory which exposes an LDAP service interface where a client can authenticate users and look up their roles.

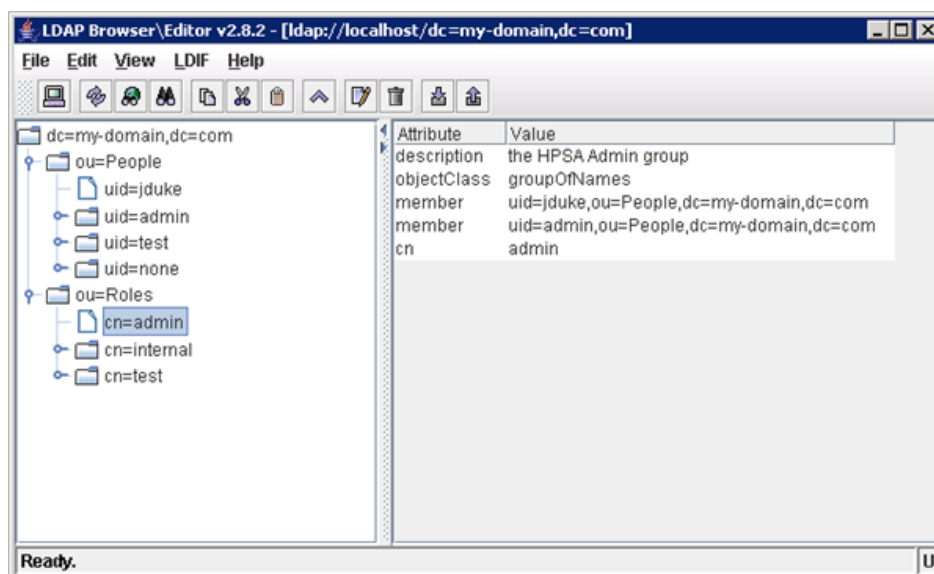
The LDAP authenticator module is based on the following assumptions about entries in the directory tree:

- There is a root entry used to authenticate the module (HPESA) as a client of the directory service when it binds to the service.

- HPESA users are represented by entries which are children of a single entry (the user parent), typically an organizationUnit entry with ou=People.
- All user entries must have an attribute whose value is the HPESA username. The name of of this attribute is configurable.
- User entries also contain the HPESA password for the user.
- Similarly HPESA roles are represented as entries which are children of a single entry (the role parent), typically an organizationUnit entry with ou=Roles.
- All role entries must have an attribute whose value is the HPESA role name. The name of of this attribute is also configurable.
- Each role entry has a multi-valued attribute (its name is configurable) with a value for each user who has the role. The value equals the distinguished name of the user entry.

To illustrate these points, Figure 7-1 is a screenshot from a directory browser showing a directory that meets the assumptions.

Figure 7-1 LDAP Directory Tree



You cannot create the entries in the directory from HPESA. It is possible to use an existing directory where user entries already exist. Even the role entries may be reused, if a role concept is already implemented in the directory in a way that is compatible with the assumptions. Otherwise, the system administrator must, using the user interface provided directly by the directory, create the entries that can be used to authenticate HPESA users and map each user's name to the appropriate set of roles.

To configure the LDAP authenticator module you need to provide: host and port where the directory service is running; username and password for authentication of the session from the module (as client on HPESA) to the server; complete distinguished names for the user and role parent entries; configurable attribute names (see the assumptions); a specification of whether you want to use SSL to access the directory service.

If the role names held in the directory are not the actual names as used in HPESA, you can use role mapping in the same way as for the OS-based authenticator module.

7.3.5 Role Mapping

If you use OS-based authentication and you want to use HPESA role names which are different from the user group names that have been configured on the OS, you can use role mapping.

You will understand how to construct role mappings from the following example, which shows the contents of a role mapping file that maps the two groups `activ_users` and `activ_oper` to the same HPE Service Activator role, `operator`, and a third group `root` to the `admin` role.

```
<?xml version="1.0" encoding="utf-8" ?>
<!DOCTYPE RoleMappings SYSTEM "role_mappings.dtd">
<RoleMappings>
  <Role>
    <Name>operator</Name>
    <Mapping>activ_users</Mapping>
    <Mapping>activ_oper</Mapping>
  </Role>
  <Role>
    <Name>admin</Name>
    <Mapping>root</Mapping>
  </Role>
</RoleMappings>
```

The role mapping file must be named and placed as: `$ACTIVATOR_ETC/config/role_mappings.xml`. After you create or change it, reload the configuration from the Self Management menu of HPE Service Activator's main UI to allow it to take effect.

NOTE Role mapping is not restricted to OS authentication. It can be used to map the names of roles that are defined in the authentication environment, also for LDAP authentication, to HPE Service Activator role names. If you write your own authenticator module - see "Writing New Authenticator Module" in *HPE Service Activator, Workflows and the Workflow Manager* - you must consider if your module needs to support role mapping.

7.4 Organizing Users in Teams

For use on systems with many users there is a concept of teams. You can divide the user community in teams and appoint one or more administrators for each team. A team administrator can access the user management functions in the Self Management menu, but is restricted to manage the members of his/her own team.

Each user will belong to exactly one team. Roles must then be assigned to teams, and the team roles limit what roles can be assigned to the users in the team. Initially there is a default team which has all roles.

NOTE The team feature is only available when configured on the native authentication module.

7.5 Light Weight Single Sign On

LWSSO is a framework that a number of HPE NGOSS (and other) products adhere to. Within this framework a user can log in to establish a session with one product and may then execute a cross launch action that will bring up a GUI of another product - in a separate window or in a frame of the window from which the action was launched - without having to log in to the second product. LWSSO is based on transferring encrypted cookies between the product servers, via the user's browser client. The cookie will contain the user's identity (user name), but not the password. The password is only authenticated when the initial session is established, and the authentication mechanisms (and users' passwords) may be different on the various products that cooperate within the framework.

HPE Service Activator supports LWSSO. It allows cross launch to and from other products which also support LWSSO. NNMi and UCMDB fall in this category, NA does not. When launching an NA window from HPE Service Activator, the user will be confronted with NA's log in dialog, but only once in a session.

The use of LWSSO must be configured for HPE Service Activator at installation time. At this time a number of parameters concerning the encryption method, etc., must be entered. See the Installation Guide for details.

Some special considerations for the use of LWSSO must be noted: Functions which require access to the user's password are not possible when HPE Service Activator has been cross launched using LWSSO: user management, use of stored filters and searches. Time skew between cooperating servers must not exceed 15 minutes.

7.6 SPNEGO

SPNEGO (Simple and Protected GSSAPI Negotiation Mechanism) is used by client-server software to negotiate the choice of security technology. SPNEGO is used when a client application wants to authenticate to a remote server, but neither end is sure what authentication protocols the other supports. The pseudo-mechanism uses a protocol to determine what common GSSAPI mechanisms are available, selects one and then dispatches all further security operations to it. This can help organizations deploy new security mechanisms in a phased manner.

HPE Service Activator can be configured to use SPNEGO to redirect to the main page. The `spnego-login.jsp` must be used for this.

It is done this way to support both, common login and SPNEGO login at the same time. If the site is configured entirely with SPNEGO then the client itself will prevent a non SPNEGO user to reach the server code making impossible both authentication systems.

HPE Service Activator can be configured to use SPNEGO with Kerberos. The configuration is done as part of running `ActivatorConfig` like with LWSSO.

Internet Explorer will only perform SPNEGO authentication against sites which are configured in the Local Intranet zone.

Firefox will only perform SPNEGO authentication against sites configured in "network.negotiate-auth.trusted-uris" parameter.

Chapter 8

Common Network Resource Model

The Common Network Resource Model (CNRM) is a data model appropriate for a class of commonly managed new generation networks based on IP, Ethernet and MPLS technology. The model is included in the HPE Service Activator core product packaged as a deployable solution (designated CRModel) which can be used as a basis for a customized solution or in fact by multiple solutions which will manage different services over the same network. The CNRM consists of resource definitions, tree definitions for the inventory user interface and functions implemented as workflows which can be launched from the inventory UI.

The model matches well the types of networks which are typically managed with the HPE BTO NNM and NA products. It is eminently suitable for solutions where HPE Service Activator is integrated with these products (as discussed in Chapter 11 and Chapter 12). The CNRM can be populated by uploading data representing the network and its equipment. Data upload can be achieved through integration with NNMI.

NOTE The modelling of classical transmission technologies (SDH, SONET, T1) for layer 1 transport is not covered by the CNRM, but must be added to the model if needed. With respect to the MPLS core network, the model is only concerned with edge devices. Additions will be needed to manage routing of label switched paths across core (P) routers.

The CNRM was introduced in the section “Solution Data Repositories (Inventory)” (starting on p. 22). The introduction included a diagram of the network architecture that CNRM is suitable for and listed some services that such networks are used for: corporate VPN services; traffic between customer sites and (provider or third party) platforms providing a range of services (Internet access, VoIP, IPTV); interconnection of elements of provider infrastructure (mobile backhaul).

The network architecture as depicted in Figure 2-1 includes an MPLS core network and L2 (Ethernet) access networks. L2 and L3 VPN technologies are used to structure traffic across the MPLS core network. Traffic across the L2 access network normally uses provider bridging, i.e. S-VLAN tags are used to identify the traffic for specific services. PE routers can also have interfaces to legacy access networks (ATM, frame relay, SDH, TDM), but the model does not cover these networks.

8.1 Adapting the CNRM for a Solution

For some solutions, those which are not concerned with networks that resemble Figure 2-1, the CNRM will be not be useful. For those solutions a different model must be created according to the requirements.

In many cases, when the network and services of the service provider requiring an activation solution, do resemble Figure 2-1, extensions or adaptations may be needed to match precisely the provider’s network architecture and the data required to manage the equipment and services involved in a solution.

The CNRM is used as the data model basis of Service Provisioner. In fact the model is a generalization evolved from different solutions that have been integrated in the core product taking into account both physical and virtual devices.

The CNRM is present in the core product in the form of resource and tree definition source files, so it is possible to modify the model in any way required for a solution. Even in cases where requirements dictate a significantly different model, it may be useful to take the CNRM as a starting point and work with differences and modifications rather than elaborating a complete model from scratch.

For a project where the CNRM can be used with modest modifications, considerations of support and maintenance of the solution over time suggest that the solution should be constructed in such a way that such evolution of the CNRM as may occur in future product releases may be incorporated smoothly. It is recommended, therefore, to strive to maintain the

resource bean definitions of the CNRM unchanged and implement any modifications in specializations of the classes of the CNRM.

When defining a specialization you can use the <ParentField> element to define for the specialized class properties to override the properties of the superclass (parent) fields, such as: name, label, list of values, visibility, modifiability and formatting.

8.2 CNRM Workflows

The CRModel solution package includes the following workflows:

CRModel_ModifyChannel	execute a dialog with a network element to create or delete an aggregate or channelized interface
CRModel_NNMI_Dataload_Check_Nodes	checks that data in CNRM is also in NNMI
CRModel_NNMI_Dataload_Launcher	master workflow for loading CNRM data model from NNMI
CRModel_PostProcess	post process workflow for dataload from NNMI
CRModel_RouterUpload	loads the interfaces on a network element by direct dialog with the network element

8.3 CNRM on the Inventory User Interface

Three inventory UI trees are included in the CRModel solution package for presentation and management of the CNRM:

CNRM/Equipment	Shows the data of the CNRM
CNRM/Parameters	For configuring the CNRM by editing configuration data
CNRM/NNMI Dataload	For controlling dataload from NNMI
CNRM/queue_notification_failed	For synchronizing with external systems

You can use these trees as you see fit for a customized solution. You can modify them according to customer requirements and taste. Refer to *HPE Service Activator, User's and Administrator's Guide* for a description of the three trees and the functions that can be invoked from them.

The trees use the CNRM resource beans and the forms generated from them by the Inventory Builder. They also use a number of hand crafted JSPs for special operations like dataload from NNMI and management of aggregate and channelized interfaces.

8.4 Model Configuration Data

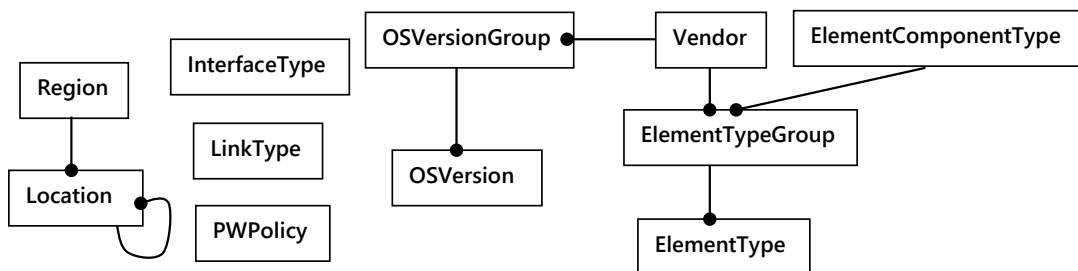
A number of (resource bean) object classes are associated with the CNRM but do not model elements of a network. These classes configure the model by defining valid values for fields of the proper network model classes. They are shown with entity relationships in Figure 8-1. Each region object defines a valid value for the region property of a network, each ElementType object defines a valid value for the ElementType property of a network element, etc.

An important aspect of this is that a solution may contain mappings and templates for different systems or network elements and their interfaces which depend on interface type, OS version and element type. The configured property values will be used as indexes for lookup of the proper mapping or template to apply for each network element or interface. The groupings of OSVersions and ElementTypes make it possible to associate mappings and templates with groups rather than individual OSVersions and ElementTypes without losing accuracy of the model data.

The CRModel solution package itself contains a table, RouterTemplate, which is indexed by Vendor, OSVersionGroup and ElementTypeGroup and identifies a template for the dialog to query a network element for its interfaces and a Java class to parse the response.

NOTE The RouterTemplate table cannot be edited via the trees that are provided on the inventory UI. To add templates corresponding to new OS versions and element types you will need to use a different SQL tool.

Figure 8-1 Model Configuration Data Classes



There are very few fields on these objects (beans): the main one for each is simply the name which defines a valid value of the corresponding property. In addition there are the foreign keys representing the entity relationships and description fields.

The PWPolicy table also falls in the category of model configuration. It contains username and password for a group of devices. This is useful when the same username and password are used for several devices and must be regularly updated. Instead of updating them as properties of each network element object, they need to be updated only on the PWPolicy object.

When the CRModel packaged solution is deployed, the Vendor class is populated with a large number of vendors whose equipment is supported by NNMi. For some vendors OS versions and element types (and groups of both) are also populated at this time. Further the ElementComponentType is populated with some values. Similarly a rich set of interface types relevant for the modelled technologies are also populated. Additional objects of these classes, as well as regions, locations and PWPolicy objects can be added via the Parameters tree on the inventory user interface.

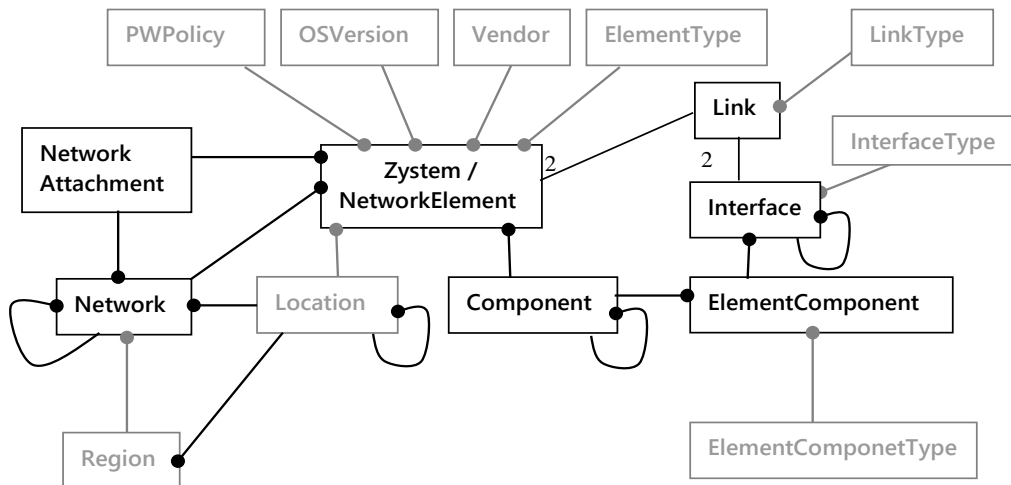
8.5 Object Classes of the CNRM

This section describes the (resource bean) object classes of the actual CNRM. The object classes and their entity relationships are depicted in Figure 8-2. The fields on the objects which have values constrained by the model configuration data classes are indicated by showing relationships to greyed-out model configuration objects.

- All of a provider's physical resources are placed in one or more regions.
- Each region will contain one or more networks; networks can also be hierarchically nested.
- The central object class is System that has a location and belongs to a network. A System can be composed of other different Systems or Components.
- The physical specialization of a System is a NetworkElement (NE)

- Another relevant object in the CNRM is the Component bean, which holds the common fields extended by any other Systems or ElementComponents as well as the relations with the Locations. A NE can be decomposed into ElementComponents, on which there may be interfaces which serve as termination points for traffic.
- Systems and therefore NEs can be connected by links which terminate on interfaces.
- Systems are of specific element types provided by vendors. The operational characteristics (command set) of the System will depend on the firmware (OSVersion); the firmware is also provided by the equipment vendor.

Figure 8-2 Common Network Resource Model Objects



The model is topological in the sense that those links between network elements which are needed for activation purposes, because the devices at their endpoints must be configured for services, are represented by objects. But the topology does not need to be complete to support service activation: links between devices where the endpoints are not configured for individual services do not need to be represented. Unless such devices and their links are also added, the model cannot be used to generate a complete topological map of the provider's network.

The properties of the object classes, including the fields, are described in the following subsections. For each class there is a general description of the meaning of the class and a table which describes the fields of the bean.

The following conventions apply to primary key and foreign key fields:

- Every object class has a single field primary key; hence foreign keys are also single fields.
- For the real resource objects (not system parameters) the primary key is called 'Id'. Foreign keys referencing them have the same or a derived name '<class name>Id', in some cases 'Id' will be preceded by an underscore. These primary keys are generated from sequences to automatically ensure uniqueness. Most of these objects also have a 'Name' field, inherited from the Component bean class, that is intended to be meaningful for users. The convention for device interfaces is to follow the vendor's standard naming scheme that will also be used in device commands.

In general the bean classes have many keys; to study which findBy methods are available, refer to resource definition files in the inventory directory of the CRModel solution package.

An 'M' in the type column indicates the field is mandatory.

8.5.1 Bean Class Component

This object class represents elemental components. Its fields hold the common information for each of the different components, letting the bean inheritance to be used to those specialized components. The components can be modelled under a parent-child hierarchy allowing complex relations.

Components are the basic blocks of the CNRM and other beans like Zsystem, NE, or Interfaces are build as an extension. Thus, notice that when reviewing the Table 8-1 all the fields are common to other beans.

Table 8-1 Fields of Component Bean

Name	Type	Description
Id	String	Primary key
ParentId	String	Foreign key, represents relationship to other Component objects.
Name	String M	Human meaningful name of the component
Description	String	Additional user information about the component
Location	String	Name of the location referenced in LocationId
LocationId	String	Constrained by configured Locations
Network	String	Constrained by configured Networks
Type	String	Type category for the component object
State	String	Current status of the component object
Icon	String	Definition of the image to use for the component object
DDEServiceId	String	Reference to the service used in Service Provisioner
NNMi UUID	String	Universally unique identifier of corresponding NNMi object
NNMi ID	String	Local identifier of corresponding NNMi object
NNMi Last Update	Date	Time the object was last updated/refreshed from NNMi.

8.5.2 Bean Class Zsystem

This object class represents individual physical or virtual systems as an specialization of the component bean. The fields shown in Table 8-2 should be reviewed together with the common fields described in component bean listed in Table 8-1.

Systems are implemented as reservable beans to allow mutual exclusion zones to be implemented easily in workflows: the System is reserved over the section of the workflow where exclusive access is required to the model of the System and its components, or to communicate with the System. Systems are not expected to be reserved in their entirety for subscriber services.

NOTE The System class can be specialized for a solution, the subclass will then inherit the reservability property. Do not set the maxCount attribute on the subclass.

Table 8-2 Fields of System Bean

Name	Type	Description
IP	String	Primary IP address of the device
Management_IP	String	IP address used for management communication with the device
ManagementInterface	enumeration: telnet, ssh	Protocol used for management communication with the device
PWPolicyEnabled	boolean	True if PWPolicy is used
PWPolicy	String	Foreign key, references object defining username and password information to use for the device
UsernameEnabled	boolean	If true, send username to device for authentication
Username	String	The username for authentication by the device
Password	String (password)	The password for authentication by the device
EnablePassword	String (password)	The enable password for authentication by the device
Vendor	String	Constrained by configured Vendors
OSVersion	String	Constrained by configured OSVersions
ElementType	String	Constrained by configured ElementTypes
SerialNumber	String	Serial number of the device (inventory information)
Role	enumeration: AccessSwitch, BladeChassis, BladeNetwork, CPE, ComputeProvider, CoreRouter, EMS, EORSwitch,	The role represented by the system object

	EventMonitor, Hypervisor, NetworkProvide r,NMS, Server, TORSwitch, VIM, VirtualSwitch	
AdminState	enumeration: Up, Down, Unknown, Reserved	Administrative state, semantics defined by solution
LifeCycleState	enumeration: Planned, Preconfigured, Accessible, Ready	Life cycle state, semantics defined by the solution that uses the CNRM, but a NetworkElement will not be eligible as endpoint for a Link created on the inventory UI unless it is Ready
ROCommunity	String	SNMP read-only community string
RWCommunity	String	SNMP read-write community string
Region	String	Constrained by configured Networks
SystemName	String (4000) M	Unique system name used for Service Provisioner
Aggregated	boolean M	If true, this systems is logical. If false the system is physical.
PartOf	String	Foreign key, represents relationship to other Zystem for complex systems relations.
EMS	String	Element management system in control for the object
BeanClass	String	Specialization class of the system
Metadata	Clob	Customized extra data
AuthUrl	String (4000)	Keystone authentication
createReferences	boolean	If true, this Zystem creates vendor, elementTypeGroup and OsVersionGroup automatically

8.5.3 Bean Class NetworkElement

This object class represents individual network elements as a physical specialization of a Zystem. Its fields, defined in the Component bean class and in the Zystem bean class, hold the information needed when management communication takes place directly from HPE Service Activator to each NE (using CLI). Some modification may be needed if the network elements are managed through an element manager. In simple cases it may suffice to use the Management_IP field to

hold the address of the element manager. In more complex case it may be necessary to introduce an additional object class to model the element manager and establish a relationship between the NetworkElement and the ElementManager.

NOTE The NE class is a specialization from Zsystem. As a subclass it inherits the reservability property, thus it does not set the maxCount attribute on the subclass. Any specialization of NE, should not set the maxCount attribute either.

NEs play different physical roles in the network: PE router, CE router, aggregation switch, access switch. The role is represented by the value of the Role field.

When comparing all the fields of the NE bean (Table 8-1, Table 8-2, Table 8-2 and Table 8-3, Table 8-3) to the inventory UI forms for the NetworkElement bean beware that some of the fields have labels which deviate from the values shown in the Name column.

Table 8-3 Fields of NetworkElement Bean

Name	Type	Description
Role	enumeration: PERouter, CERouter, AggregationSwitch, AccessSwitch	See text above

8.5.4 Bean Class ElementComponent

This specialized object class that extends the Component bean class, allows hierarchical decomposition of a Zsystem, typically into racks, slots, cards, ports, in a generic way without restriction to specific component types.

The ComponentType field is used to indicate the type of component, determining its level in the containment hierarchy. The predefined values for this field include Slot and Port as well as Controller. An ElementComponent with ComponentType Slot represents a slot as well as the card that it holds. The value Controller is used for a port on a controller card which supports multiplexing of channels and has the ability to create channelized interfaces on a subset of the channels.

The capability to create a channelized interface on a Controller port is included in the Common Resources solution and can be invoked from the inventory UI.

The EC is reservable for the same reason that is described for NetworkElement above.

The Table 8-4 lists the specialized fields for the ElementComponent bean class, however in order to get a full comprehension of the model, the extended Component bean should be as well inspected in Table 8-1.

Table 8-4 Fields of ElementComponent Bean

Name	Type	Description
RelationId	String	Foreign key, relationship to the Zsystem the ElementComponent belongs to

ComponentType	enumeration: Slot, Port, Controller M	See text above
OtherType	String	<p>For a given ComponentType, the OtherType further characterizes the component. OtherType of slot: what cards can it holds; OtherType of card: for example, SDH linecard, Ethernet linecard; OtherType of port: Ethernet, GigEth, SDH with layer rate - STM-1 etc., E1, etc.</p> <p>By vendor convention this information may also be part of Name field.</p> <p>This field may be informative or may have semantics according to application.</p>
ComponentNumber	String	<p>Slot number, port number, etc. Not expected to be globally unique, only within the parent component.</p> <p>By vendor convention this information may also be part of Name field.</p> <p>This field may be informative or may have semantics according to application.</p>
Capacity	int	<p>Indicates number of units of capacity on the component.</p> <p>Used with ComponentType Port or Controller in situations where ports reside on a daughter cards, which are not modelled as separate ElementComponents, and the daughter card may comprise multiple physical ports or is preconfigured with multiple separate termination points (E1s within STM-1); indicates number of physical or logical ports</p>

8.5.5 Bean Class Interface

An interface is a resource that can be reserved for a service. In the simplest case it corresponds to a physical port on a network element. An Ethernet interface can be divided into VLAN-specific subinterfaces; these are created when needed as child interfaces of the port interface.

It is also possible to create aggregate interfaces with bandwidth in multiples of the port by concatenating single port interface. Some network elements have controllers which allow channelized subinterfaces to be created for specific multiplexing timeslots on a physical port interface. The CNRM comes with a workflow, CRModel_ModifyChannel, to manage aggregate and channelized interface, i.e. creating and deleting them. This workflow can be launched from appropriate branches of the CNRM/Equipment tree on the inventory UI.

Another workflow, CRModel_RouterUpload, is available to load information about ElementComponents and interfaces from an NE, parse it and create the implied objects in the model; it is launchable from network element branches of the CNRM/Equipment tree.

Likewise a workflow to create aggregated interfaces from interfaces on multiple ports is included with the CNRM and can be invoked from the inventory UI.

The interface bean class is an extension of the ElementComponent bean class, that at the same time is an extension of the Component bean class. To fully inspect the list of fields the Interface bean class has the Table 8-1, Table 8-4 and Table 8-5 should be reviewed.

Table 8-5 Fields of Interface Bean

Name	Type	Description
InterfaceType	String	Type of interface
ParentIfRootIf	String	Foreign key, represents relationship to parent interface (only used for subinterface)
IPAddr	String	IP address assigned to the interface
Subtype	String	Subtype of interface, more specific than type (in VPN SP set to indicate how the interface is used for a service)
Encapsulation	String	For Ethernet interface: none or Ethernet-dot1q For serial interface: FR, HDLC or PPP
Description	String	Uploaded from equipment
IfIndex	String	SNMP identification index
ActivationState	enumeratiuon: Activated, Failed, Undefined, Ready	Semantics defined by solution using the CNRM
UsageState	enumeration: Available, SubIfPresent, Uplink, Reserved, InBundle, Trunk,	Semantics defined by solution using the CNRM

	ASBRLink, SwitchPort	
VLANId	String	Tag for traffic belonging to the (sub-) interface
VLANMode	String	
DLCI	String	For a frame relay interface, DLCI of the traffic
Timeslots	String	For channelized interface: which time slots
NumberOfSlots	String	For channelized interface: number of timeslots
Bandwidth	String	Bandwidth of interface (bps)
LMIType	String	For FR: Cisco, ansi or q933a
IntfType	String	For FR: dte/dce interface type
BundleKey	String	Alphanumeric name of an aggregate interface; identical on aggregate and its members
BundleId	String	Numeric identifier of an aggregate interface

8.5.6 Bean Class Location

This bean class represents the elemental location site and it is extended by Region and Network bean classes. The fields defined within this bean class are common for all kind of locations. The location type can be Location, Region or Network and together with the ParentId foreign key is intended for refined hierarchy definition and relationship.

NOTE Region and Network are often used as the main entities representing the location hierarchy in the inventory tree, however it is possible to use the bean Location for the same purpose.

Table 8-6 Fields of Location Bean

Name	Type	Description
Id	String	Primary key
ParentId	String	Foreign key, represents relationship to other Location objects.
Name	String M	Meaningful name of the location site
Description	String	Extra information related to the location
Type	String	See text above

ASN	String	Autonomous system number, Used mainly in Networks.
Within	String	Containing location name
Autocreated	boolean	True when this location has been autocreated

8.5.7 Bean Class Network

This object class is used to represent a collection of Zystems or NEs and the links between them.

In general networks may be nested to any depth. A network which has nested subnetworks may also have direct member Zystems or NEs (not members of any of the subnetworks).

The network object has a type field which can be used to distinguish different types of subnetwork, for example with respect to nesting. The intended meaning of the predefined values is as follows (use Figure 2-1 as architectural reference):

network	A set of PE devices (Zystems) and the CE devices that are attached to them; also used for collections of unattached or unmanaged CE devices. No nesting.
access network	A collection of aggregation devices (Zystems) and the simple access topologies (nested) attached to them. Aggregation devices will be linked by aggregation trunks to PE devices in a network. The relationship of the PE device to the access network is modelled with a NetworkAttachment object. S-VLAN tags assigned to attachment circuits over an access network must be unique on an access network. If several access networks are attached to the same PE device, uniqueness must extend to the union of such access networks (complete flow domain).
topology	A collection of access devices (Zystems) connected in a simple ring or string topology within an access network. Nested within an access network. Aggregation switches may also be part of the ring or string, but in the model they will belong directly to the access network with a NetworkAttachment to represent that topologically they are part of the ring or string.

Other network types may be defined for other network structures, in particular if a solution uses nesting of networks.

Table 8-7 Fields of Network Bean

Name	Type	Description
Id	String	Primary key
Name	String M	User friendly name
Type	enumeration: Network, AccessNetwork, Topology	See text above
ASN	String	Autonomous system number

ParentId	String	Foreign key, represents relationship to enclosing Network object
----------	--------	--

8.5.8 Bean Class NetworkAttachment

This object class models an n:m relationship between NetworkElements and Networks. An object of the class exists to represent that the NE is attached through a link to the network, which is not the one it belongs to, but may be a subordinate one, e.g. the NE can be an aggregation switch belonging to an access network and the network an access topology.

Table 8-8 Fields of NetworkAttachment Bean

Name	Type	Description
NetworkElementId	String	Identifies the NE
NetworkId	String	Identifies the Network the NE is attached to

8.5.9 Bean Class Link

In a classical layer transport network model, a connection in one (server) layer of a network is used as a link in the topology of the next higher (client) layer. In the common network resource model the link property is the more interesting one. Algorithms will generally configure link endpoints to allow certain traffic (typically by VLAN tag) rather than explicitly create connections by setting up cross-connections. Cross-connections occur in the server (transmission) layers that are beyond the scope of the model.

A link connects two interfaces, on two Systems.

Links are typically used as trunks, i.e. traffic for many different customer services identified by different VLAN tags may pass the same link.

Four types of links are distinguished:

- aggregation trunk, connecting a PE router to an aggregation switch
- access trunk, connecting switches in the access network
- access link, where one endpoint is on customer premises, outside of the provider network
- ASBR link, connecting PE routers in two different core networks with different ASN values

Link fields are specified in Table 8-9. Fields which are not stored, but calculated for display or other use to support a form are not listed.

Table 8-9 Fields of Link Bean

Name	Type	Description
LinkId	String	Identifies the link

Name	String	
NE1	String	Foreign key, represents relationship to Zystem object at endpoint 1; shown as name of Zystem
TP1	String	Foreign key, represents relationship to termination point object at endpoint 1; shown as name of termination point. In Create Link form only eligible termination points can be selected.
Type	String	Constrained by configured LinkTypes; see above.
Network	String	Foreign key. Network to link to. Constrained by configured Networks
NE2	String	Foreign key, represents relationship to Zystem object at endpoint 2
TP2	String	Foreign key, represents relationship to interface object at endpoint 2
PortMode	Enumeration: SubIfPresent, SwitchPort	Usage state of interfaces in aggregation trunks
NNMi_UUID	String	Universally unique identifier of corresponding NNMi object
NNMi_ID	String	Local identifier of corresponding NNMi object
NNMi_LastUpdateDate	String	Time the object was last updated/refreshed from NNMi.

The Creation form for the Link bean has wizard functionality. Field values are selected one by one, and the value selected for one field determines what can be selected for the next field. To calculate what can be selected at the steps of the process, each of the classes Network, NetworkElement and Interface has a method, findEligibleForLink, implementing a special algorithm in explicit Java code.

8.6 Configuring CNRM Dataload from NNMi

The CNRM can be populated with data either directly from the network elements or from NNMi, if the latter is present and set up to interwork with HPE Service Activator. Dataload from NNMi comprises network elements, interfaces and links. Direct dataload is performed by the CRModel_RouterUpload workflow that fetches data from one network at a time and can be invoked from the network element branches in the CNRM/Equipment tree.

The dataload process can be repeated regularly to update the model with new entities. One of the three trees of the user interface for the CNRM is dedicated to controlling the dataload process. Refer to *HPE Service Activator, User's and Administrator's Guide* for a description of that tree and how to execute the dataload process. You will need a general understanding of the process before you study this section, which explains how to customize the process.

Before you configure the dataload process you must create the skeleton structure comprising regions, networks and locations that the network elements will belong to. Likewise you can create password policies. This is conveniently accomplished using the Equipment and Parameters trees on the inventory UI.

The primary tool to edit/configure the process is the subtree of the CRModel/Parameters tree which starts from the NNMi Dataload branch, as shown in Figure 8-3.

Figure 8-3 NNMi Dataload Branch of CRModel/Parameters Tree

Name	Value	Description
Name *	Default	Primary key. Scope file identifier
Contents *	<pre><?xml version="1.0" encoding="UTF-8"?> <!DOCTYPE DataloadScope SYSTEM "NNMi_Dataload_Scope.dtd"> <DataloadScope> <HostNames> <Name>c3600-1.dnk.hp.com</Name> <Name>c2600-1.dnk.hp.com</Name><Name>c2600-2.dnk.hp.com</Name> </HostNames> </DataloadScope></pre>	Scope file contents

Two aspects of the configuration are specified using XML documents: scope and enrichment. These XML documents are not stored in files, but in the solution data repository, i.e. database tables. Therefore they are edited using a simple editor in the forms quadrant of the inventory UI, as the example shows. If you prefer, you can copy the document to a text editor and paste it back after editing. The syntax definitions (.dtd files) for the two documents are found in the `etc/config` directory of the CRModel solution package.

The dataload process has a number of steps:

1. Extraction of data from NNMi

2. Pre-commit enrichment; this includes transformations included in the built-in enrichment snippet to map the data to CNRM representation, and finishes optionally with topology analysis
3. Comparison, reconciliation and commitment by the user of changes to existing data in the CNRM
4. Post-commit enrichment (optional)
5. Postprocessing (optional)

The dataload process begins with retrieval of data from NNMi, restricted by the specified scope. The scope is specified in a document which identifies the names of the network elements to upload, as shown in Figure 8-3. The document is in the format accepted by NNMi. Full names can be listed explicitly (Name element), or wildcards can be used (WName element) using the syntax for the SQL LIKE construct, i.e. the percent character '%' matches any sequence of 0 or more characters, and the underscore character '_' matches any single character. Devices which are not in the specified scope will be disregarded by the NMMi dataload operation.

You can define several scope documents. One of them must be selected for each dataload operation. If the dataload operation is large and time consuming, this is a convenient mechanism for dividing it up.

Once the data has been retrieved, it is enriched. A number of specification documents, enrichment snippets, control this part of the process. They are applied one at a time, the built-in snippet shall be the first one. It includes a number of transformations that serve to map the extracted data to a form compliant with the CNRM. Attributes representing equipment vendors, element types and interface types are mapped from the NNMi values to CNRM values. The mappings take several attributes of the loaded NMMi objects into consideration and use regular expression patterns to recognize their values. These mappings are defined in tables that can be edited using the last three branches of the NNMi Dataload subtree. A rich and normally sufficient set of mappings are prepopulated when the CNRM is installed.

Enrichment complements the mapped information with information that is needed for the model but cannot be retrieved from NNMi. You can define several enrichment snippets, typically for different types of enrichment that you want to combine. All of the defined enrichment snippets will be applied to every dataload operation. Enrichment is the most complex part of the dataload process to customize, so it is described under a separate heading below.

The networks to include in the CNRM are not modelled in NNMi, so they must be created by the user before dataload. The roles of network elements and the membership relations between network elements and networks are also not known by NNMi, so you can add them by defining appropriate enrichment rules. When aggregation/access switches are loaded with links to already known aggregation/access switches, the automatic topology analysis can determine that they belong to the same access network/topology, allowing you to save some enrichment rules. This analysis can be disabled by configuration on the third branch of NNMi Dataload subtree.

At this point NetworkAttachment objects are automatically created when the indicative links are created (see "Bean Class NetworkAttachment" above).

After enrichment and topology analysis, the data that have been loaded and enriched is compared to the existing CNRM model, and manual reconciliation must be done to handle conflicts (see the description in *HPE Service Activator, User's and Administrator's Guide* for details). Up to this point the process has only considered a core subset of the fields of the network element, interface and link objects. Only this core subset of the fields is present in the tables which hold the loaded data up to the point of commitment.

After commitment of loaded data, a second round of enrichment may take place to assign values to additional attributes that were not retrieved or mapped.

Finally, optional post processing is performed by running a workflow which has access to the intermediate dataload objects as they appear after manual reconciliation. This makes it possible to determine which network elements have

been affected by the dataload. The workflow CRModel_PostProcess, if configured, will go through those network elements and for each one run a direct interface upload (the workflow CRModel_RouterUpload). The reason for this is that information about aggregate channels configured on the device cannot be extracted from NNMi, so it must be extracted directly from each device. You can also write your own workflow to run at this time. Whether to run a postprocessing workflow, and which one, is configured on the fourth branch of the NNMi Dataload subtree.

8.6.1 Model Enrichment

Once again, the purpose of enrichment is to add the information that could not be retrieved from NNMi. For example, CNRM networks are not modelled in NNMi, so NNMi cannot decide in which network each network element belongs. And there are a number of fields in CNRM that cannot be derived in a generic way from information in NNMi.

Enrichment applies rules to loaded data of the classes network element, interface and link. A rule is evaluated for each object of the class to which it applies. If a condition stated in terms of a field value is satisfied, an action is applied to the object. The action can be:

- to assign values to fields of the object (<Assignment> element), or
- to establish a relation to another object (implemented by assigning a value to a foreign key, but that is not explicitly stated, <Relation> element), or
- to extend the object with a specialization and assign values for the fields of the specialization (<Narrowing> element), or
- to apply a transformation to the object implemented in a custom Java class (<Transformation> element)

Each rule defines the class of data it applies to and states the condition. The condition always refers to a single field. It can be a field of the object itself, or of a related object. The related object can be the network element that an interface belongs to, or it can be a network element or interface at an endpoint of a link. The condition is about the value of the field. It can specify that the field must have a specific stated value, or no value (stated as null, this will also match an empty string), or the value can be stated as a regular expression: if it is matched, the condition will be true. A specific value is specified with the == operator: a regular expression with the like operator. A condition can be empty, then it is always true, i.e. the rule is applied to all objects of the stated class.

Transformations can be used for enrichments which are more complex than what can be expressed with rules, if a condition is needed that cannot be stated using the value of a single field, or the value to be assigned must be computed.

Rules are divided into normal rules and extension rules. Normal rules are executed before commitment of changes, extension rules after. Normal rules can only assign values to the core subset of object fields. Extension rules can assign values to the fields which are not in this subset. Names of the fields in the core subset must be rendered in capital letters. Extension fields must be rendered as specified in the resource definitions (and shown in tables above).

The core fields are the following:

```
NetworkElement: NAME, DESCRIPTION, MANAGEMENTINTERFACE, ADMINSTATE,
LIFECYCLESTATE, ROLE, VENDOR, LOCATION, OS_VERSION, OS_VERSION_GROUP,
ELEMENT_TYPE, ELEMENT_TYPE_GROUP, LAST_UPDATE, MANAGEMENT_IP, PRIMARY_IP,
SERIAL_NUMBER, RO_COMMUNITY, RW_COMMUNITY
Interface: NAME, DESCRIPTION, LAST_UPDATE, TYPE, ACTIVATION_STATE,
USAGE_STATE, IPADDRESS, IF_INDEX, BANDWIDTH, DLCI, VLANID, ENCAPSULATION
Link: NAME, LAST_UPDATE
```

Finally a snippet may also define filters to prevent specified fields to be updated with uploaded values, i.e. eliminate changes before reconciliation (<Overwrite> element). Here is an example enrichment snippet containing some rules to define the network membership relation and some attribute values that cannot be uploaded for two network elements:

```
<?xml version="1.0" encoding="UTF-8"?>
```

```

<!DOCTYPE Enrichment SYSTEM "NNMi_Dataload_Enrichment.dtd">
<Enrichment>
  <Overwrite/>
  <Rules>
    <Rule type="NetworkElement" condition="">
      <Assignment name="LOCATION" value="Lab"/>
    </Rule>
    <Rule type="NetworkElement"
      condition="NetworkElement.NAME=='c3600-1.dnk.hp.com'">
      <Relation type="Network" name="NAME" value="Lab-Core"/>
      <Assignment name="ROLE" value="PE"/>
    </Rule>
    <Rule type="NetworkElement"
      condition="NetworkElement.NAME=='c3400-1.dnk.hp.com'">
      <Relation type="Network" name="NAME" value="Lab-Ring"/>
      <Assignment name="ROLE" value="AccessSwitch"/>
    </Rule>
  </Rules>
  <Extensions>
    <Rule type="NetworkElement"
      condition="NetworkElement.NAME=='c3600-1.dnk.hp.com'">
      <Assignment name="PWPolicy" value="100"/>
      <Assignment name="PWPolicyEnabled" value="true"/>
    </Rule>
    <Rule type="NetworkElement"
      condition="NetworkElement.NAME=='c3400-1.dnk.hp.com'">
      <Assignment name="PWPolicy" value="101"/>
      <Assignment name="PWPolicyEnabled" value="true"/>
    </Rule> </Rules>
  <Extensions/>
</Enrichment>

```

In this example you will note that each network element is identified explicitly, and the relations and assignments are different for each of them. By using general patterns, reflected in password policies, naming conventions, etc., it will be possible to create more generally applicable rules. For example, if a unique prefix is used for the names of network elements belonging to a specific network, then partial wildcarding (in a regular expression) of the network element name can be used to build a single rule for all the network elements in each network.

For complete information on the syntax of enrichment snippets, refer to the file `NNMi_Dataload_Enrichment.dtd`. For information on how to implement transformations in custom Java, see the Javadoc for the `translate` method of class `TransformationTranslator`.

NOTE In the snippet syntax description in the dtd file the (XML) attribute that defines the *class* of data affected by a rule is called *type*; a *field* of a resource bean object is called *attribute*; the object to which the field of a condition belongs is called the *scope* of the condition; and field filters are defined with *overwrite* elements.

Chapter 9

Web Service Designer

The Web Service Designer is a tool dedicated to generating specialized servlets exposing the capability to run HPE Service Activator workflows as web service methods. Each servlet will include a set of convenient methods mapping to the set of workflows which are required for integration with a specific type of client. Each web service method must have input parameters to agree with the contract of the workflow and may return as output parameters result values defined as part of the contract. The web service method in the servlet will receive the input parameters and use them to initialize the case-packet variables. In the case of a synchronous method the servlet will also extract the output parameters from the case-packet when the workflow job has finished and place them in the response message.

The servlets can be deployed very simply with JBossWS on the HPE Service Activator platform. The endpoint where the web service can be called will belong to the web service port of the WildFly server, i.e. the same port where UI requests are served (by default port 8080).

HPE Service Activator also has a generic web service interface supporting a subset of the complete API of the workflow manager whose primary form is RMI. Compared to the generic interface the servlets generated with the Web Service Designer are specialized to contain dedicated methods to use for a particular application; they avoid exposing the concept of workflows and generic methods to control them. As system integrator you will control the names of the methods and their parameters.

Each web service is defined in an XML document, the *web service definition* file, which is created and edited with the tool. Consider this file a source file in the same way as workflow, resource (bean) and tree definition files. It should not be confused with a WSDL file (in W3C standardized web service definition language), which is used for external definition of a web service interface. The file produced by the tool is in a private format, the schema for which is in file `$ACTIVATOR_ETC/config/wsd-config.xsd`. It is concerned with both the definition of the interface and its mapping to workflows.

With the tool you can create and edit the web service definition; you can generate the servlet Java class, you can compile the class and build the web-application archive (.war file) containing the servlet, and you can deploy it on the HPE Service Activator platform. Finally, when the web application has been deployed, JBossWS can generate a WSDL description of the interface, reflecting the methods and parameters that have been specified. Do not expect to be able to retrofit any preexisting interface specified by existing WSDL, it may not be possible to mimick all parameter types.

Servlets generated with the Web Service Designer will use SOAP over HTTP as transport, and the style of communication will be rpc (remote procedure call).

9.1 Defining a Web Service

The web service call to run an HPE Service Activator workflow can be synchronous or asynchronous. This choice is made for each method; you can combine synchronous and asynchronous methods in the same servlet. In both cases the call will start the workflow as a job. In the synchronous case it then waits for the workflow job to complete and is able to return final values of case-packet variables as result information to the caller. In the asynchronous case the web service method does not wait for the job to complete; the only return information is the job id. A separate mechanism will then be needed for providing progress and result information to the caller; refer to the section “Northbound Interface” in chapter Chapter 5 for further discussion of this topic.

Before you use the tool you must prepare the following:

- a list of the workflows you want to be runnable as web service methods; for each one you must name the method you want to expose (typically the name will be similar to the name of the workflow)
- for each runnable workflow the list of case-packet variables that must be initializable from values of parameters of the web service; alternatively the servlet can pass all parameters to the workflow job in an XML document obtained by applying an XSL transformation to the set of parameter values
- for each synchronous method the list of case-packet variables whose final values must be returned to the caller
- for each of the input or output parameters a name for the parameter (the default choice will be the name of the case-packet variable) and a type; the type must agree with the type of the associated case-packet variable in the workflow (the tool does not read the types from workflow definitions; you must select them)
- for each method with multiple output parameters a decision on how to package the parameters in the result message (see below for more information)

With the tool you must then define the methods, each one named and mapped to a workflow and with a list of input and output parameters. From these definitions the tool will generate a Java class with your methods annotated to be callable as web service methods. The call parameters and result types of the generated methods will be translated to input and output messages to be exchanged between the caller and the HPE Service Activator platform.

The input parameters will be combined as named elements (like members of a bean) of the input message.

NOTE All specified input parameters will be mandatory, even if this may not be specified in the generated WSDL. Calls with missing parameters will be rejected by the servlet.

The result returned from a servlet method must be a single object. If there is exactly one output parameter, the type of the result message will be the type of the output parameter. If there are multiple output parameters, you can choose to package them as a record (bean) with the parameters as named fields or as a hashmap with an entry for each parameter, in which case the parameter name is passed as the key. The latter form is more generic: the parameter names will not appear in the external definition (WSDL) of the interface, only as data in the messages.

You can use all the types supported for workflow case-packet variables for input and output parameters: String, Integer, Long, Boolean, Double, Float, Data, Object, List, Map, Set, Bean. Along with List and Set collection types you must also define a subtype, i.e. the type of the elements. Along with a Map parameter you must define two subtypes, for the keys and values, respectively. For Object and Bean you must provide a properly annotated Java class (library) that implements the class in question. Bean classes generated by the inventory builder can be used.

If you want to use the same multi-field response from several methods, you can define a bean class to represent the response. Then you will not need to list the bean members as output parameters for each method, and you will avoid to have several response bean classes generated with the same members but different names (derived from the name of the method).

For information on how to create resource definitions and running the inventory builder to create bean classes, refer to *HPE Service Activator, Inventory Subsystem*. If you create beans for the sole purpose of using them as parameters for web service methods, you can keep them separate from any beans created to be used for managing inventory. Create the beans before you work with the Web Service Designer to build the web service. Combine all beans you need in a jar file; the jar file will be included in the web archive you build. Beans you use for web services do not need to be deployed.

Authentication of the calling client is mandatory. There are two ways to authenticate the caller of the web service methods: either it is done globally, once per session, by the JBossWS authentication handler using username and password supplied in the HTTP header when the session is opened, or it is done by each method. When the latter mechanism is selected, username and password will be added as two parameters to each method.

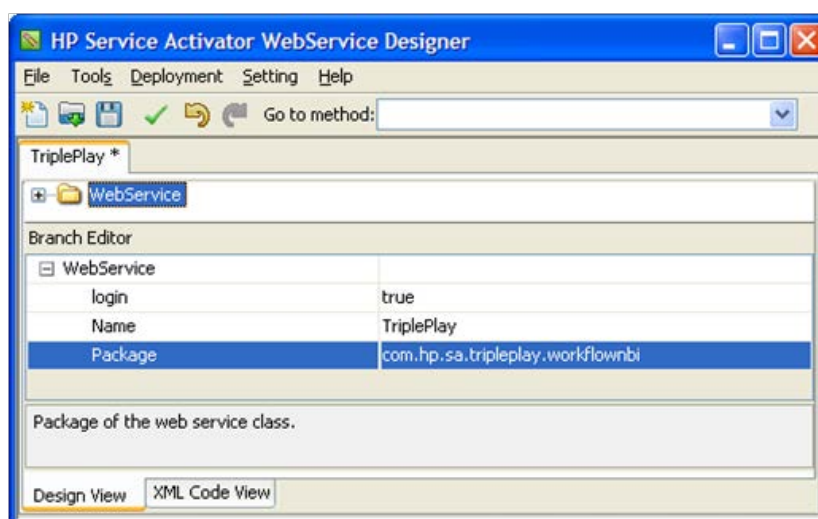
9.2 Web Service Designer Tool

The Web Service Designer is a stand-alone tool in the family of HPE Service Activator design time tools. It is basically a UI tool for editing a web service definition with additional capabilities to generate servlet Java classes, build web archives and deploy them. All the functions except editing are also available as command line functions, and the tool is integrated with the Deployment Manager for deploying web services even across a multi-node cluster platform.

As the tool is quite simple, it has no dedicated manual; it is fully described in this chapter.

Figure 9-1 shows the user interface of the Web Service Designer, where the definition of an example web service called TriplePlay is open. The root of the web service tree is selected, allowing to edit the global properties of the web service.

Figure 9-1 Web Service Designer, Global properties



For the login property select true, if you want each method to login separately, or false, if you want session based authentication. In the first case each method will automatically get two parameters, username and password, before any explicitly specified parameters.

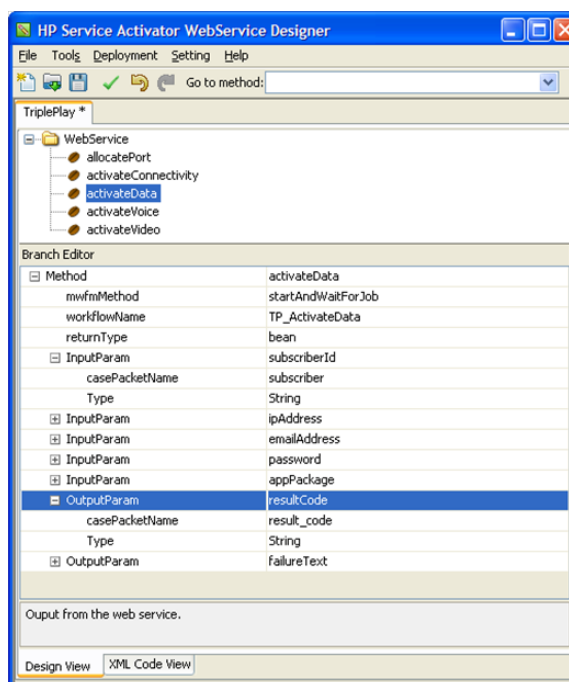
The Name property defines the name of the servlet. You must also define a package name for the Java class to be generated. The name of the servlet class will be appended to the package name you give.

9.2.1 Defining a Web Service Method

Right-click in the upper frame on the tree root (labelled WebService) to bring up a menu where you can add or paste a method to the servlet (prepare for pasting by selecting the copy operation from the right-click menu of an existing method).

Figure 9-2 shows the Web Service Designer UI, where the servlet has been expanded to show its methods, and one of them (activateData) is selected, so that its properties and parameters can be edited. You can right-click on a method in the upper frame to get a menu comprising the following operations: copy the method, delete the method, move up and move down.

Figure 9-2 Web Service Designer, Method properties and parameters



To add an input or output parameter to the selected method, right-click on the root of the lower frame (labelled Method) and select the appropriate item in the menu that appears; the same applies to the `mwfmMethod` and `workflowName` properties of the method, which in Figure 9-2 have already been added.

The method properties are as follows:

Method	the name of the method is editable
<code>mwfmMethod</code>	selectable as <code>startJob</code> (asynchronous, applies if omitted) or <code>startAndWaitForJob</code> (synchronous)
<code>workflowName</code>	name of the workflow to run (Method is used if omitted)
<code>returnType</code>	selectable as <code>none</code> , <code>all (hashmap)</code> or <code>bean (record)</code>

For each input or output parameter you can enter its name, add the name of the associated case-packet variable and select its type. If you omit the name of the variable it is assumed to be the same as the parameter name.

9.2.2 Using a Template for Method Input as XML Document

If you don't want the servlet to initialize individual case-packet variables from the input parameters, you can specify an XSL transformation to apply. The resulting XML document, which will then contain all the parameters in a format that the workflow can parse, will be passed to the workflow job through the case-packet variable `message_url`. The workflow must include logic to parse the document, typically to reextract the parameter values. To handle input parameters in this way you must specify an input template by adding the `InputTemplate` element to the method. As the value of this element you must specify the file name of the XSL file defining the transformation and two (optional) properties: `storeMessage` and `directory`.

The parameters that must be present in incoming messages that invoke the method must be specified as values of the name attribute of an `<xsl:param>` element appearing in the beginning of the template. A simple example of a template with 3 parameters: `id`, `h_param` and `b_param` is shown here:

```
<?xml version="1.0" encoding="UTF-8"?>
<xsl:stylesheet version="1.0"
xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
  <xsl:output method="xml" indent="yes" xalan:indent-amount="2"
encoding="UTF-8" xmlns:xalan="http://xml.apache.org/xslt"/>
  <xsl:param name="id"/>
  <xsl:param name="h_param"/>
  <xsl:param name="b_param"/>
  <xsl:template match="/">
    <msg msg_id="{ $id }">
      <header>h_param</header>
      <body>b_param</body>
    </msg>
  </xsl:template>
</xsl:stylesheet>
```

If a message to invoke the example method contains the parameter values 1, 2 and 3, the resulting XML document that is passed to the workflow job after the transformation will be:

```
<?xml version="1.0" encoding="UTF-8"?>
<msg msg_id="1">
  <header>2</header>
  <body>3</body>
</msg>
```

All parameters will be string typed.

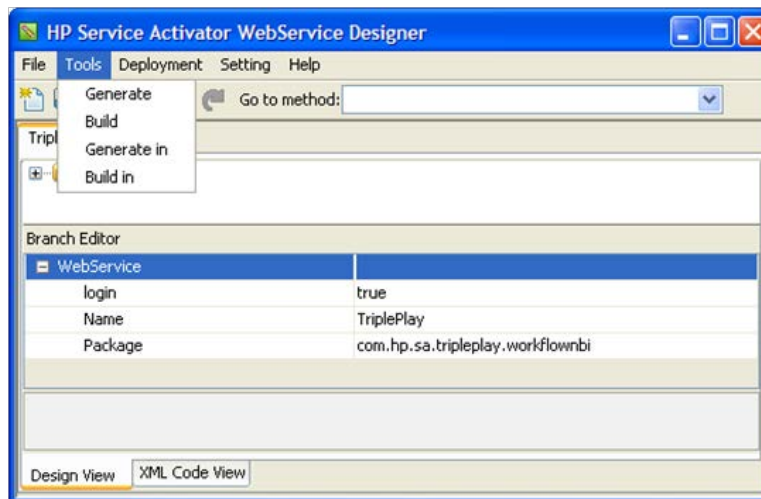
The following details apply to the `InputTemplate` element and its properties:

<code>InputTemplate</code>	The name of the XSL file. It can be an absolute file name, or it can start with and be relative to <code>\$ACTIVATOR_ETC</code> (the default, can be omitted), <code>\$ACTIVATOR_OPT</code> , <code>\$ACTIVATOR_VAR</code> or <code>\$ACTIVATOR_SOLUTION</code> .
<code>storeMessage</code>	The value determines where the XML document resulting from the transformation is placed:
<code>database</code>	(default) the document is placed in a row in the <code>database_message</code> table,
<code>file</code>	the document is placed in a file,
<code>memory</code>	the document will be passed in its entirety through the <code>message_url</code> case packet variable.
	The choice will be encoded in the <code>message_url</code> value, and the encoding is supported by the workflow nodes that use it.
<code>directory</code>	Only used when <code>storeMessage</code> is <code>file</code> ; this is the directory where the file is stored. It can be an absolute path name, or it can start and be relative to <code>\$ACTIVATOR_VAR</code> , <code>\$ACTIVATOR_ETC</code> , <code>\$ACTIVATOR_OPT</code> or <code>\$ACTIVATOR_SOLUTION</code> . The default is the value is omitted is <code>\$ACTIVATOR_VAR/received/messages</code> . The name of the individual XML document file is autogenerated and includes a timestamp.

9.2.3 Build and Deploy Web Servlet

When you have finished defining the servlet and its methods, you can generate the code and build the web application archive. Select each step from the Tools menu which is shown in Figure 9-3.

Figure 9-3 Web Service Designer Tools menu



If your generated code will need to make reference to other Java classes, for example resource beans, you can place such classes in libraries (.jar files) and add those libraries into the process in the Web Service Designer through the 'Default Libraries...' operation that you can launch from the Setting menu.

To build and deploy the servlet, first select Generate from the Tools menu. This operation will generate the Java code for the servlet. It will generate a sequence of directories, according to the Package defined, starting with classes, in the directory where the web service definition file is located, normally <Solution>/etc/web-services. The operation also generates a deployment descriptor file (web.xml), defining the mapping from URL to servlet code. This file is placed in the web subdirectory, which will be a sibling to the classes directory. If you want to place the classes and web directory in a different location (from that of the web service definition file), choose 'Generate in' from the Tools menu and browse to the desired location.

Next select Build. This operation will compile the Java code with the specified libraries in the classpath and place the resulting class file along with you have specified, in a web archive, packaged as a .war file, in the war directory. Again, if you do not want the generated war directory to be place in the same parent directory as the web service definition file, use 'Build in' from the Tools and browse to the desired location.

Finally, if you also want to deploy the web service, select the Deploy operation in the Deployment menu. This function will retrieve the .war file from the war directory and copy it to the `$JBOSS_DEPLOY/hpsa.ear` directory, whereby it will be activated when WildFly is restarted (it is not hot deployed in a subdirectory of `$JBOSS_DEPLOY`).

To include the web service servlet in a deployed solution, you must include either the definition file and the library files or the generated .war file in the solution distribution archive and include in the deployment descriptor (deploy.xml) file a description of how to (generate and) deploy the servlet.

9.3 Extracting WSDL Definition

To obtain the WSDL for a service, you can enter the Endpoint Address followed by `?wsdl` in a web browser. For instance, to obtain the WSDL for the Workflow Manager SOAP web service, you can enter the following URL in your web browser:

```
http://<SA host>:<SA port>/mwfmssoap/WFManagerService?wsdl
```

Chapter 10

Usage Monitoring

This chapter covers the Usage Monitoring component in HPE Service Activator, that counts incoming *service requests* and allows generation of so-called *usage reports*.

10.1 Introduction

HPE Service Activator 6.2 introduces a new way to monitor the usage of a HPE Service Activator server or cluster. A new module, called the “Usage Monitoring Module”, counts *service requests* for all nodes in a cluster, analyzes the data, and stores usage data records to the database at regular intervals. The Usage Monitoring module cannot be disabled.

DEFINITION A *service request* is defined as a workflow job that is launched by an external source; this includes workflow jobs started via HPE Service Activator’s Java/RMI interface (e.g. from the web UI or using the `mwfmt001`). If a workflow job starts one or more child workflow jobs (within the same HPE Service Activator cluster), the child jobs will *not* be counted as service requests.

The Usage Monitoring module has been carefully designed so that it will have negligible impact on the system performance; the number of database transactions caused by the Usage Monitoring module cannot exceed one transaction per minute.

10.2 Configuration

The Usage Monitoring module accepts two configuration parameters that can be configured in the “usage_monitoring_module” in the file `$ACTIVATOR_ETC/mwfm.xml`:

- **collection_interval** determines the number of seconds between two consecutive usage data collection events. The collection interval cannot be lower than 60 seconds. (Default: 3600)
- **usage_threshold** determines the maximum number of service requests within a collection interval. (Default: Unlimited)

If HPE Service Activator is running in a cluster configuration, the Usage Monitoring module configuration must be identical on all cluster nodes.

10.3 User Interface

The Usage Information UI is launched by clicking the “Usage Information” menu item in HPE Service Activator navigation menu (in the “Self Management” section).

An example of the Usage Information UI is shown in Figure 10-1. The Usage Information UI consist of three panels:

- **Usage Summary** displays the average rate, the maximum rate, the total number of processed service requests, as well as an indication of whether or not the configured threshold has been exceeded.
- **Configuration** display the configuration data.
- **Download Usage Report** allows you to download a usage report covering the last 1, 2, 3, 6, 12, or 24 months. The usage report is a zipped text file protected by a digital signature.

NOTE If the data collection interval is set to 1 minute (which is the shortest possible collection interval), the size of a usage report zip file covering three months will be approximately 1 megabyte.

In this example the threshold was set to 25 and the collection interval was set to 3 minutes. In addition, the UI shows that the threshold value was exceeded twice.

Figure 10-1 Usage Information View

Usage Information

Usage Summary

- Average Rate: 9.143 service requests per 3 minutes
- Maximum Rate: 63 service requests per 3 minutes
- Total: 128693
- Threshold Exceeded: Yes (2 times)

Reset rate values Reset threshold

Configuration

- Threshold: 25
- Interval: 3 minutes

Download Usage Report

Period: 1 month ↓ Download

The Usage Information view contains two reset buttons that can be used to reset the rate values (average and maximum rate) and “threshold exceeded” events, respectively. Please note that pressing the reset buttons does *not* affect the raw usage data in a usage report. This means that threshold violations that might have occurred before the [Reset threshold] button was pressed will still be marked as threshold violations in the usage report.

10.4 Threshold Violations

If the configured service request threshold has been violation, the user will be notified in three different ways:

- Workflow Manager logs
 - A warning message will be written with the text “Usage Threshold violation! Current breaches count N ”, where N is the number of detected threshold violations.
- WildFly `server.log` file
 - A log message will be written with the text “Usage Threshold violation! Current breaches count N ”, where N is the number of detected threshold violations.
- HPE Service Activator web UI
 - In the “System Status” area (lower-left corner of the main web UI) an exclamation mark will be displayed to indicate threshold violations.

Figure 10-2 shows an example of the “System Status” area in the case of a threshold violation; please notice the exclamation mark inside the green status indicator. The exclamation mark can be removed by clicking the [Reset threshold] button in the Usage Information view; but this will not prevent threshold violations from being displayed in usage reports.

Figure 10-2 System Status Indicating a Threshold Violation

Total Jobs:	80
Activating:	17
Waiting:	21
Scheduled:	4
System Status:	🚨

NOTE If the system is in either suspended or locked state, the “System Status” area will not display an exclamation mark in the event of a threshold violation. However, once the system enters “normal” state, the exclamation mark will be displayed.

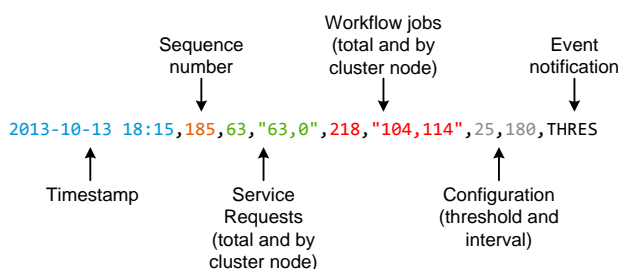
10.5 Usage Reports

The usage records collected by the Usage Monitoring module are stored in the system database. If and when needed, it is possible to generate a so-called *usage report* that contains the usage data records for a selected duration preceded by some additional information. A *usage report* is structured as follows:

- HPE Service Activator basic information
 - Header and exact HPE Service Activator version
 - Report generation timestamp
 - List of cluster nodes (hostnames and IP addresses)
 - Java version information
- Configuration
 - onfigured collection interval and threshold
- Summary
 - Average and maximum rates
 - Number of threshold violations
- Changes in configuration (if any)
- License information
 - Detailed information about all valid HPE Service Activator licenses
- Raw data
 - A list of *usage records* (one line per record). This section may grow very large if the collection interval is short. The usage records are written as comma-separated values in order to make is easy to import them into other programs for further analysis (e.g. Microsoft Excel).
- Digital signature
 - Used to protect against fraud

10.5.1 Usage Records

The usage records consist of a single line of comma-separated values. Figure 10-3 shows an annotated example of a usage record; in this example the HPE Service Activator system consists of two cluster nodes.

Figure 10-3 Usage Record example

As shown in the figure, a usage record consists of:

- A **time stamp** for when the usage record was collected
- A monotonically increasing **sequence number**
- The number of processed **service requests** within this collection interval; specified as the total number followed by the number of service requests per cluster node (in double quotes).
- The number of processed **workflow jobs** within this collection interval; specified as the total number followed by the number of workflow jobs per cluster node (in double quotes).
 - In the example shown in Figure 10-3 the two cluster nodes have been running 104 and 114 workflow jobs, respectively. Hence, the load seems to have been distributed reasonably well. If the number of workflow jobs varies a lot between the cluster nodes, it may indicate that the load distribution needs to be adjusted.
- The **configured** threshold and collection interval
- An optional event notification string. The following events are possible:
 - **THRES** if the threshold was exceeded in the current collection interval
 - **CONF** if a Usage Monitoring configuration change was detected in the current collection interval
 - **FAILOVER** if a cluster failover event was detected in the current collection interval
 - If more than one of these three events occur in the same interval, they will be written as a double-quoted list of comma-separated values.

10.5.2 Generating a Usage Report

A usage report can be generated in two ways:

- From the Usage Monitoring web UI
 - In the Usage Monitoring UI, select the number of months you wish to cover (counting backward from today) and then click the [Download] button to download the usage report as a zip file.
- From command line
 - Run the `createUsageReport [.bat]` utility and provide the number of days (counting backward from today) you want the usage report to cover.
 - Run the utility with the `-help` option to see a full list of supported parameters.
 - The command-line utility generates a plain (unzipped) text file that can be easily searched using standard tools.

10.5.3 Usage Report Example

An example of a usage report with two consecutive threshold violations is shown below (a few parts, marked with asterisks, have been left out):

```

=====
                        HPE Service Activator V80-1A Usage Report
=====

HPE Service Activator version: V80-1A (V80-1A)

Report generation timestamp : 2016-03-13 18:37:29:279

Cluster nodes
- sa1.example.com      (10.20.232.11)
- sa2.example.com      (10.20.232.12)

Java information
- Java HotSpot(TM) 64-Bit Server VM
- Version: 1.6.0_29
- Architecture: 64-bit

Usage collection configuration
- Threshold            : 25
  
```



```

- Interval      : 3 minutes
- Maximum permitted rate is 25 service requests per 3 minutes

Summary
- Average service requests      : 9.143 service requests per 3 minutes
- Maximum rate                  : 63 service requests per 3 minutes
- Threshold exceeded            : Yes (2 times)

Detected configuration changes
2013-10-13 17:58:00:000
- Old configuration              : UNLIMITED service requests per hour
- New configuration              : 25 service requests per 3 minutes

License information
- License Type: Instant On
- Expiration Date: Apr 1, 2014
- Days Remaining: 163
- ...

Raw data
...
2013-10-13 18:03,181,12,"12,0",55,"30,25",25,180
2013-10-13 18:06,182,0,"0,0",40,"20,20",25,180
2013-10-13 18:09,183,15,"15,0",113,"54,59",25,180
2013-10-13 18:12,184,0,"0,0",92,"45,47",25,180
2013-10-13 18:15,185,63,"63,0",218,"104,114",25,180,THRES
2013-10-13 18:18,187,37,"37,0",134,"66,68",25,180,THRES
2013-10-13 18:21,189,0,"0,0",40,"20,20",25,180
2013-10-13 18:24,190,0,"0,0",40,"20,20",25,180
2013-10-13 18:27,191,0,"0,0",40,"20,20",25,180
2013-10-13 18:30,192,0,"0,0",40,"20,20",25,180
2013-10-13 18:33,193,0,"0,0",40,"20,20",25,180
2013-10-13 18:36,194,0,"0,0",40,"20,20",25,180
>>>>50d9c654cd7554aeabe3ff622162939b53b2dad7<<<<

```

If the an operator has clicked the [Reset threshold] button in the Usage Monitoring UI, the number of displayed "Threshold exceeded" events in usage report may be lower than the *actual* number of threshold violations.

To get an exact list of threshold violations you need to search through the usage report for occurrences of the string "THRES". In this way, you will also be able to see exactly when the threshold violations have occurred.

In the usage report example shown above, a search for "THRES" will reveal that the two threshold violations happened on October 13, 2013 at 18:15 and 18:18, respectively.

Chapter 11

Integration with NNMi

This chapter covers the integration of HPE Service Activator with the HPE NGOSS product Network Node Manager (NNMi).

The components dedicated to integration of HPE Service Activator with NNMi are licensed for use as the *NNMi Liaison*. To use these components the RTU (right to use) must be purchased in addition to the license for the HPE Service Activator core product.

11.1 Positioning of NNMi

NNMi enables a customer to monitor and manage all the devices in an IP network from a single point of control; a graphical web browser based user interface offers the user topological and tabular views of the network and its status, and is launch pad for control functions.

NNMi interworks with devices by means of the SNMP protocol. The product has built-in knowledge of a large number of devices through their SNMP MIBs.

NNMi can automatically discover and build a model of a network as it is.

Fault reports from devices are received as SNMP traps and correlated to perform root cause and service impact analysis.

11.2 Summary of Benefits of Integration with NNMi

Overall, instead of two separate solutions NNMi and HPE Service Activator will appear and behave as a well-integrated single solution for network and service management including service activation.

The capabilities of NNMi are enhanced in ways which will significantly assist operators in focusing on high priority incidents to meet committed SLAs and provide better visibility of the state of important services.

- HPE Service Activator workflows to activate services by configuring network elements can also enrich NNMi objects with service and customer related information. This will enable prioritization of network faults based on evaluation of service importance. You get new possibilities to group interfaces based on the type of service that is using each interface, or the customer that is using the interface.
- Enhanced synchronization of NNMi data model with the network, as HPE Service Activator may request NNMi to rediscover the state of a device when a service has been activated on it.
- HPE Service Activator workflows to perform diagnostic analysis and corrective actions can be initiated from NNMi. This will enrich the scope of control actions an NNMi operator can take when faults have been discovered, or the action could even be fully automated.
- GUI crosslaunch from NNMi views to HPE Service Activator inventory and service order views allows an operator to view HPE Service Activator data and activity related to known objects.
- Not only the network, but also the activation system based on HPE Service Activator can be monitored with NNMi

Through the integration with NNMi the HPE Service Activator solution will benefit greatly from availability of consolidated information about the network and its state:

- The resource inventory data model of the network can be populated by loading data already discovered by NNMi. Likewise the data model can be synchronized with the NMMi data model on an ongoing basis.
- HPE Service Activator workflows can obtain real-time device status from NNMi.
- GUI crosslaunch from a HPE Service Activator inventory view into NNMi topology view and status lists. For example with HPE Service Activator resource inventory objects such as network or subnetwork as launch pad, launch a topological view. Or from HPE Service Activator service inventory customer object, launch an NNMi interface group view of all the device interfaces carrying the customer's traffic.

11.3 Readily Available Capabilities with NNMi

The capabilities that are available “out of the box” without customizing items like HPE Service Activator workflows, modules and data models include populating and synchronizing the Common Network Resource Model and mutual GUI crosslaunch.

11.3.1 Loading and Synchronizing of the CNRM

The workflow for this purpose and the definition of the inventory UI tree from which it can be launched is provided as part of the Common Network Resource Model deployable solution pack which is described in chapter Summary of Techniques for Configuring Integration on NNMi.

The first time the dataloader is used it will populate the CNRM data model with network elements, interfaces and links. On subsequent runs it will update the CNRM data model to include newly discovered objects.

11.3.2 UI Cross Launch from HPE Service Activator to NNMi

Cross launch from HPE Service Activator to NNMi generally requires JSP customization and incorporation in an inventory tree or main UI menu (see below). Some cross launch functions are precustomized as part of CNRM:

- from every interface branch in the CNRM equipment tree the NNMi interface form is launchable
- from every network element branch in the CNRM equipment tree the NNMi L2 and L3 neighbor views are launchable

11.3.3 UI Cross Launch from NNMi to HPE Service Activator

Cross launch from NNMi to HPE Service Activator inventory UI is simple to configure in NNMi. It will be a menu item associated with the relevant NNMi object type, for example node or interface. The substance of the menu item is the URL to launch (see “Summary of Techniques for Configuring Integration on NNMi” below).

11.4 Components for Customized Integration with NNMi

The components that are available on HPE Service Activator for use as a basis for customized integration with NNMi include a plug-in to automate configuration of NNMi as part of service activation, three workflow manager modules and three workflow nodes. The nodes serve essentially to invoke the functions provided by the modules.

11.4.1 NNMLiaison plug-in

The plug-in contains atomic tasks that can create an interface group view on NNMi.

11.4.2 SNMP trap module

This is a general purpose module, not restricted to integration with NNMi, which can issue an SNMP trap.

11.4.3 NNMi module

This module acts as a web service client towards NNMi. It supports all needed calls from HPE Service Activator to the NNMi web application, as used by the workflow nodes and the data load module. It can create annotations on NNMi objects and pull data from NNMi.

11.4.4 Dataload module

This module performs the task of loading and synchronizing the CNRM data model from/with NNMi using the functions of the NNMi module to communicate with NNMi.

11.4.5 Workflow Nodes

Three workflow nodes are available that can be used in solution workflows:

- GetBeans retrieves objects from NNMi's network data model
- RediscoverHost requests NNMi to rediscover a specific network element
- UpdateCustomAttributes sets values of custom attributes on an NNMi data object

For details, consult HPE Service Activator, Workflows and the Workflow Manager.

11.5 Summary of Techniques for Configuring Integration on NNMi

To configure nodes and interfaces for cross launch of HPE Service Activator views: define for a type of NNMi object a URL action to launch an HPE Service Activator view. Refer to the section "User Interface and Roles" in Chapter 5 for a description of the URL formats to use to launch the various HPESA views.

The action (that you define on NNMi) may use one or more ext properties of the NNMi installation (for example hostname and port of HPESA server) and custom attribute values of the object, such as primary key of the HPESA counterpart object) to construct the URL. The URL action will typically include a filter to enable it when necessary custom attributes are set. Note that HPE Service Activator has a script that can be used to set ext properties on an NNMi installation. Consult NNMi online help for URL Actions for specific detailed information.

To create action scripts to launch HPE Service Activator workflows you can install and use the mwfm command line tool.

11.6 Customizing and Configuring HPE Service Activator to Work with NNMi

To use the NNMi workflow manager module and the NNMi dataload module you must configure them in the configuration file for the workflow manager. Parameters for other aspects of interactions with NNMi, including UI cross launch, NNMi dataload, and settings for workflows are configured through the inventory UI, in the Parameters tree for the CNRM as described in *HPE Service Activator, User's and Administrator's Guide*.

11.6.1 Workflows to Interwork With NNMi

You can create workflows to perform functions on HPESA that you want NNMi users to be able to perform as actions; there are no special integration concerns for the workflow as such; integration is done by the invoking script on the NNMi side.

In activation workflows you can use NNMi workflow nodes to retrieve information from NNMi, create interface groups or annotations on NNMi objects, and invoke host rediscovery. Beware of the control parameters which are part of the `NNMiConfiguration` singleton resource bean (part of the CRModel solution) as mentioned in the preceding paragraph. If relevant your workflows should obey these settings.

If you use the NNMLiaison plug-in, note that it can be configured in file `$ACTIVATION_ETC/config/NNMLiaisonConfig.xml` (see also example file and dtd file in the same directory).

11.6.2 UI Cross Load

You can create JSPs (with Struts actions) to implement cross load functions in addition to the ones already available (see above); for this you will need to understand NNMi URLs. As an example, study the UI part of the CRModel solution, the Struts-config and JSPs.

Chapter 12

Integration with NA

This chapter covers the integration of HPE Service Activator with the HPE NGOSS product Network Automation.

The components dedicated to integration of HPE Service Activator with NA are licensed for use as the *NA Liaison*. To use these components the RTU (right to use) must be purchased in addition to the license for the HPE Service Activator core product.

12.1 Positioning of NA

NA maintains router configurations and enforces configuration policies.

NA connects to devices and configures them. NA also allows other system to establish connections to devices and intercepts them to monitor and log the configuration changes. NA typically establishes a baseline configuration for each device according to its role in the network.

NA enforces compliance of policies for configuring devices; this involves monitoring, comparing configurations to policies applicable to a group that a device belongs to, detection of violations, alerting.

NA manages and downloads firmware versions and patches to all devices in a network and performs backup and restoring of device configurations.

NA is generally not concerned with configuring specific interfaces on service provider devices for individual customer services.

12.2 Summary of Benefits of Integration with NA

By combining configuration management, setting up baseline configuration of devices done with NA, and service activation, setup of customer service specific configuration done with HPE Service Activator, the complete device/service lifecycle is managed. NA is used heavily in the buildup of network and service infrastructure, specifically to configure routing protocols, MPLS forwarding, core network interfaces, BGP peering, ASN, general security settings, ACLs, passwords, QoS for the service provider's own traffic and other aspects which are general and not specific to individual customers' VPNs. Once the infrastructure for a service offering is in place, HPE Service Activator will automate flow-through configuration of devices for all aspects of customer specific services with minimal operator involvement and elimination of the requirement for operators to master the commands needed to configure services.

HPE Service Activator workflows can be used to control and automate processes consisting of several NA actions, for example to run test scripts, draw conclusions and take remedial actions.

NA can provide connectivity to devices that HPE Service Activator can use including tunnelling to devices that are not easily reachable, thus eliminating the need to configure HPE Service Activator with device specific usernames, passwords, etc., and ensuring that all device interactions to activate services are logged together with all other device interactions.

NA can ensure integrity of services configured on devices: when configuring the device HPE Service Activator will also configure NA to monitor the setup, leveraging NA's ability to enforce policy compliance.

Also in the process of configuring a device for a specific customer service, HPE Service Activator can instruct NA to backup the device configuration, after all changes have been made, and annotate the backup with a comment stating it was requested by HPE Service Activator due to the specific service that was configured.

As a minimum, even if the functions of NA and HPE Service Activator are not combined to obtain these benefits, some coordination is necessary to avoid counterproductive effects such as NA detecting and “repairing” by undoing the service specific device configurations set up by HPE Service Activator as violations of policy.

12.3 Readily Available Capabilities with NA

NA, with its management of connections across the network and into shielded network domains can be used as a proxy for network elements to provide connectivity for HPE Service Activator to establish command sessions with network elements. The generic CLI plug-in can be configured to use this capability.

The NA user interface can be accessed by cross launch from the CNRM tree of the HPE Service Activator inventory user interface. Note that NA does not support Single Sign On.

The platform for running HPE Service Activator and NA can be shared, including hardware, operating system, and the database server (Oracle or PPAS). The two applications both include JBoss, and it will be necessary to configure one or the other JBoss instance to use non-default port numbers for overlapping functions, such as web service access, etc.

12.4 HPE Service Activator Components for Customized Integration with NA

A large number of workflow nodes are available, allowing HPE Service Activator workflows to exercise a range of the capabilities of NA, including:

- take backup snapshot of device
- run scripts of different types
- create/delete devices and device groups, and manage group membership
- manage associations between device groups and rules, conditions and policies
- retrieve different types of information from NA to HPE Service Activator

These nodes interwork with NA by invoking its web service interface through a dedicated workflow manager module.

12.5 Summary of Techniques for Configuring Integration on NA

Where NA functions involve the running of scripts, it will be possible in a script to use the mwfm command line tool to run a HPE Service Activator workflow.

Cross launching of HPE Service Activator UI from NA is not possible.

12.6 Customizing and Configuring HPE Service Activator to Work with NA

To use the NA workflow manager module you must configure it in the configuration file for the workflow manager; this will be needed for workflows that interwork with NA as well as for GUI cross launch.

12.6.1 Workflows to Interwork With NA

In general workflows can be written to perform any tasks which can be accomplished through execution of NA actions or scripts, using the workflow nodes that are available. Such workflows can be integrated in flow-through activation systems, or they can be launchable from the inventory UI.

If you write workflows with the capability to access devices through the CLI plug-in using NA as a proxy, you will need the following parameters to connect to NA: protocol, hostname, port, username and password. Your workflow can get them from the singleton resource bean named `NAConfiguration` which is included in the CRModel solution and edited in the inventory UI, in the Parameters tree for the CNRM as described in *HPE Service Activator, User's and Administrator's Guide*.

12.6.2 Monitoring Integrity of Constructs Configured on Devices

When HPE Service Activator activates a service by configuring one or more devices with specific constructs, for example Virtual Router Forwarding tables, the activation workflow can be extended to set up a rule and a policy on NA to monitor the integrity of those constructs. The rule that defines remedial actions when the policy has been violated must be created on NA in advance and may involve such actions as creating trouble tickets, sending email, even executing automatic repair. NA is generally geared to manage groups of devices, not individual services, so it will be necessary to define a dedicated "group" per service instance and add the affected device to that group. Then the policy which knows the command pattern for the construct for the service can be defined for the group and associated with the action rule. The activation workflow can accomplish all of that by means of the workflow nodes for NA integration.

Chapter 13

Development Hints

This chapter contains miscellaneous useful information that will be useful during development, including testing and debugging.

13.1 Configuring Database Credentials

The Workflow Designer, Deployment Manager, Tree Deployer, Tree Designer and the Inventory Builder all require the user name and password for the system database to deploy data. To avoid having to enter the credentials repeatedly, it is possible to create a configuration file with this information that is read by the tools during start up. The file must be named `dbAccess.cfg` and be placed in the directory `$ACTIVATOR_ETC/config`. An example file exists in this directory and is named `dbAccess_example.cfg`.

NOTE This file must not be present in a production environment.

13.2 Configuring Injection of Request Messages for Test

If you use the socket listener to receive incoming request messages, a message injector can be configured as part of the System Administrator menu in the navigation pane of the main UI. Files that you wish to be able to inject must be placed in `$ACTIVATOR_ETC/templates_files/<your solution>`.

In the UI configuration file `$JBOSS_ACTIVATOR/WEB-INF/web.xml` configure these two parameters, then restart HPE Service Activator.

<code>tests</code>	True enables injection of messages to a socket (CRM simulation). Default is false.
<code>socketListener_port</code>	The socket port to which tests messages will be injected. This port must match the configuration of the socket listener module which is to receive the messages.

A menu item named `Test Messaging` will appear at the bottom. When you select it a view listing available files for injecting are shown. Right-click on the one you want and select `start Test`. This will inject the message into the socket listener which will should start your workflow.

13.3 Workflow Testing and Debugging

To avoid having to inject messages to start workflows, you can start your workflow from the Workflows view available in the Work Area of the navigation pane of the main UI. For this to work, your workflow must be independent of pre-initialized variables. For initial testing you can start the workflow in debug mode and initialize variables manually (see below). When you are confident with the workflow, make the northbound integration and test the interaction with a northbound system to start the workflow.

There are several ways to trace what is happening when you run your new and unproven workflows.

- You can output trace messages that you can read in the Messages view. A number of messages will be generated automatically by the workflow manager when the workflow contains or does something invalid.
- You can study the log file produced by the workflow manager and resource manager. You can include entries generated from your own workflow (Log node) or plug-in (context method). Such log entries can be directed to dedicated files.
- You can dump the case-packet of your workflow to a file (WriteCasePacket node).
- You can place extra AskFor nodes to interact with your workflow job, thus controlling its progress.
- If you set the `tests` variable in the UI configuration file (see above), you can start your workflow in debug mode from the Workflows view. It will then interact with you from a special queue, `Debug`, in the Active Jobs view when it reaches a breakpoint node, initially the first node, before the breakpoint node is executed. In the debug interaction window you can select single-step or set the next breakpoint, and you can read and edit values of case-packet variables, for example to initialize them as discussed above. You can view the current breakpoint in a flowchart (workflow) view, and you can dump the case-packet to a file. An example of the debug window is shown in Figure 13-1.

Figure 13-1 Debug Interaction Window

The screenshot displays the 'Debug View - Google Chrome' window for the Service Activator. The URL is `iron.dnk.hp.com:8080/activator/jsf/debugGUI/saDebugUI.jsf?jobId=22&queueName=debug`. The page title is 'Service Activator'.

Job Details

Job Id	Service Id	Host Name	Work-flow	Status	Start Time	Post Time	Step	Description	Queue
22	22	iron.dnk.hp.com	askFor_test1	Initialized	Fri Jan 09 15:39:44 CET 2015	Fri Jan 09 15:39:44 CET 2015	AskFor		debug

Configure Break Point

Select Break Point
 Remove Break Point

STOP AT EVERY NODE

User Case-Packet Details

Name	Type	Value		Edit Case-Packet Variable	
add_op1	Float	1000.0		<input type="text" value="1000.0"/>	or <input type="text" value="add_op1"/>
add_op2	Float	1000.0		<input type="text" value="1000.0"/>	or <input type="text" value="add_op2"/>
add_op3	Float	1000.0		<input type="text" value="1000.0"/>	or <input type="text" value="add_op3"/>
add_op4	Float	1000.0		<input type="text" value="1000.0"/>	or <input type="text" value="add_op4"/>
add_op5	Float	1000.0		<input type="text" value="1000.0"/>	or <input type="text" value="add_op5"/>
add_result	Integer	1		<input type="text" value="1"/>	or <input type="text" value="add_result"/>
test_queue	String			<input type="text"/>	or <input type="text" value="test_queue"/>
var0	String			<input type="text"/>	or <input type="text" value="var0"/>

Proceed Dump Case-Packet Close

System Case-Packet Details

Name	Type	Value		Edit Case-Packet Variable	
ANNOTATION	String			<input type="text"/>	or <input type="text" value="ANNOTATION"/>

Chapter 14

System Configuration

Most of the configurable aspects of HPE Service Activator solutions are covered in detail elsewhere:

- The resource manager has its own configuration file (`resmgr.xml`) which is described in detail in *HPE Service Activator, Developing Plug-Ins and Compound Tasks*
- The workflow manager has its own configuration file (`mwfm.xml`) which is described in detail in *HPE Service Activator, Workflows and the Workflow Manager*. Note that some important workflow manager modules are not configured to be active upon installation, you must change the configuration file to use these modules: authentication, audit, socket listener/sender, statistics collection
- The user interface is configured has a main configuration file (`web.xml`) and separate files for solution specific modifications to the default Work Area menu. Both aspect are described in *HPE Service Activator, User's and Administrator's Guide*.
- Appendix B contains a list with descriptions of all configuration files

A couple of topics deserve special mention here.

14.1 Number of Threads and Memory Usage

The amount of parallel activity that can take place in an HPE Service Activator system is configured for the workflow manager (in file `mwfm.xml`). The maximum number of workflow jobs that can exist simultaneously is determined by the parameter `Max-Work-List-Length`. When this number is reached, attempts to start additional jobs will fail. A typically much smaller number of operating system threads will be used to execute the workflows, determined by the (global) parameter `Max-Threads`. The assignment of threads to active jobs is managed by the Work Manager module.

When a job is waiting on a queue or for an activation, it will not occupy a workflow job thread. However, to control the amount of parallel activation activity, the Activation module (normally named `activator`), manages a private pool of so-called activation threads. The maximum number of concurrent activations will be limited by the (module) parameter `max_threads`. When all these threads are in use, additional workflow jobs attempting to start activations will be queued. Activations do not occupy operating system threads in the workflow manager, but they do in the resource manager. That is the real significance of the `max_threads` parameter.

A starvation problem may occur in the resource manager: if the arrival rate of activation requests is higher than the execution rate over a period of time, all activation threads may become busy and some activation tasks may need to wait to acquire a thread. This is not in itself a problem, as the capacity of the activation target will necessarily set the ultimate limit for the number of activation requests that can be processed. However, if a solution has multiple activation targets, it may occur that all activation threads are waiting for just one or some of them, while others targets are not engaged. It may then be advantageous to divide up the total number of activation threads and dedicate different pools for different targets or groups of targets to let loose the full potential of parallel processing. This can be achieved by configurings multiple instances of the Activation module, each one with a thread pool dedicated to one or more activation targets. Activate nodes in workflows must then use the `activation_module` parameter to select an Activation module instance and hence one of the thread pools.

The memory consumption of the workflow engine, i.e. workflow manager plus resource manager, will depend on the number and size of deployed workflows and plug-ins, but even more on the number of workflow threads and activation threads along with the sizes of their case-packets and the variables of the plug-ins. If you set the maximum numbers for the threads very high, out-of-memory exceptions may occur at run-time. You should make sure that your system testing goes to the limits that you have configured.

Instructions for increasing the memory size of the WildFly process that includes the workflow engine are found in *HPE Service Activator, Installation Guide*.

14.2 Data Sources

Pools of JDBC database connections are known as data sources. Separate data sources are used for different data access purposes. The configuration script for HPE Service Activator (ActivatorConfig) generates a data source configuration with six data sources. All of the generated data sources will refer to the same database, the system database. Except for the inventoryDB data source this must remain so.

Depending on the needs of a solution it can be appropriate to add data sources and modify the autogenerated pool sizes. When pools are temporarily exhausted, parallel processing will be limited. If customized elements of a solution fail to release connections to their pools, permanent pool exhaustion will cause the processing of the kind that uses the pool to stop.

The automatically generated data sources are the following (with names used in the `standalone.xml` configuration file):

defaultDB	for a number of internal system purposes
mwfmDB	for access from the workflow manager, to persisted workflow states and by default to inventory data (via the db database module)
resmgrDB	for access from the resource manager, to resource locks, to deployed plug-ins
inventoryDB	for access from UI to inventory data (solution data repository)
uiDB	for all other access from UI
serviceDB	for access from the workflow manager to definitions of atomic and compound tasks

The generated data source configuration shall be changed in the following cases:

- To access inventory data (solution data repository) in more than one database (for example in the case of external inventory integration; see the section on the topic in Chapter 5). To access inventory data in more than one database from workflows will require a database module to be configured for the workflow manager per database (see *HPE Service Activator, Workflows and the Workflow Manager*), and to access the inventory data from the inventory UI will require separate inventory tree definitions (see *HPE Service Activator, Inventory Subsystem*).
- To use separate pools for data access from workflows when some of the accesses use generated beans and others use explicit SQL code and/or custom nodes. This will facilitate troubleshooting and support by isolating the effect of errors in the custom code.

Refer to the *HPE Service Activator, User's and Administrator's Guide* for a description of how to configure data sources.

Chapter 15

Localization

This chapter describes the different resource bundles that must be translated to localize an HPE Service Activator solution.

In general the Java resource bundles you must translate are files with names ending in `_en.properties`. You must make a copy of each resource bundle file, where you replace `_en` in the file name with the appropriate abbreviation for the locale, like `_jp` or `_dk`.

Then you must translate the contents of each file to the language of the locale. The files must be saved encoded in the ISO 8859-1 character set with appropriate escape sequences to represent characters that do not have 8-bit codes; the Java utility `native2ascii` may be helpful to convert from a UTF character set to ISO 8859-1.

NOTE When the same English word or phrase appears in property files for several parts of the UI, make sure to translate it consistently. On the other hand, a property may be used in several places within a single part of the UI, and you should make sure that the translation you choose is appropriate in all of those places.

After you modify resource bundles, restart HPE Service Activator for the new resources to become available.

15.1.1 Localizing the Main UI Window and some other views

The basic resource property bundles are found in `$ACTIVATOR_ETC/nls`.

You must create a Java archive named `nls.jar` containing all the translated resource bundle files and deploy it to `$JBOSS_EAR_LIB`.

There are a couple of small exceptions: column headers for the Logs view, non-default column headers for the Active Jobs view, and non-default entries in the Work Area menu are not defined in the resource property bundles. The “non-default” items occur only when the UI has been configured in special ways; follow the reference at the beginning of chapter Chapter 14 to understand the options.

If you want to localize the column header for Logs views, do it directly in file `$JBOSS_ACTIVATOR/xsl/saLogs.xslt`.

If you define non-default columns for the Active Jobs view, you must define them exactly as you want them to appear in file `$JBOSS_ACTIVATOR/WEB-INF/web.xml`.

If you introduce new items in the Work Area menu or change the label on existing ones, you must define the labels exactly as you want them to appear in the solution menu file.

15.1.2 Localizing JSFs

Some parts the UI are implemented with Java Server Faces. The resource property bundles for these parts are found in `$JBOSS_ACTIVATOR/WEB-INF/classes/jsf-resources`. When you add support for a new locale, you must also add that locale in file `$JBOSS_ACTIVATOR/WEB-INF/classes/faces-config/locales.xml`.

15.1.3 Localizing Inventory UI

There are several parts to localize for the Inventory UI relating to inventory resources and tree definitions, as described in a dedicated chapter in *HPE Service Activator, Inventory Subsystem*.

15.1.4 Custom UI Files in Solution Source Hierarchy

In the solution source hierarchy you build, files to be deployed for the UI should be placed under the UI directory, which is a direct child directory of the main solution directory (in Figure 3-2 there is no UI directory, but it should be at same level as etc, inventory, plugins). The paths used under the UI directory should equal the target paths relative to `$JBOSS_ACTIVATOR`

Appendix A

Scripts

This table contains locations and descriptions of the scripts that are available in HPE Service Activator. Unless otherwise indicated, these files are located in the \$ACTIVATOR_BIN directory. In general the scripts have help options to explain usage, or do so when called without or with incorrect parameters.

Table A-1 HPE Service Activator Scripts

Script	Description
/etc/init.d/activator	Starts/stops the HPE Service Activator processes (Linux only)
ActivatorConfig[.bat]	Configures HPE Service Activator for a specific environment.
AssignNonRoot	Configures HPE Service Activator to run as non-root, only on UNIX
AuditFilter[.bat]	Creates audit filters
CatchSocketSenderMessages[.bat]	Listens for messages on a given port and prints those messages to stdout. This script is typically used for testing and demonstration of the SocketSenderModule of the Workflow Manager. By default, it listens on port 4099, but takes a single parameter to specify the port.
checkLicence.[bat]	Checks the status of the HPE OpenView AutoPass license and prints out debug information.
CleanLogs[.bat]	Deletes all but the active logs
createUsageReport[.bat]	Generates a digitally signed usage report and stores the result in a file.
crypt[.bat]	Encrypts or decrypts a password for local use, to avoid storing unencrypted passwords in the workflow manager configuration file.
dc[.bat]	Starts Data Collector, command line tool for gathering information about the HPE Service Activator components (Workflow Manager, Resource Manager, WildFly).
DeleteCompleteTransactions[.bat]	Cleans up saved completed activation transactions.
deploymentmanager[.bat]	Invokes the Deployment Manager executable.
designer[.bat]	Runs the Workflow Designer tool
generateEncryptedPassword[.bat]	Utility to generate an encrypted password. This can be used when an additional data source file has to be created.
generateMD5[.bat]	Calculates MD5 checksum for a file.
InventoryBuilder[.bat]	Runs the InventoryBuilder tool.

<code>InventoryTreeDeployer[.bat]</code>	Runs the InventoryTreeDeployer tool.
<code>InventoryTreeDesigner[.bat]</code>	Runs the InventoryTreeDesigner tool.
<code>modifySystemPassword[.bat]</code>	Utility to update the system user password.
<code>mwfmtool[.bat]</code>	A command line tool for performing workflow engine tasks such as starting workflows and viewing posted messages. If this script is executed without any parameters, it will display a list of all the tasks that can be performed.
<code>NNMExtProperties[.bat]</code>	Creates ext properties on NNMi.
<code>QueueTool[.bat]</code>	Creates queues for the queuing sub-system
<code>remove.serviceactivator</code>	Uninstalls HPE Service Activator on UNIX.
<code>removeClusterNode[.bat]</code>	Removes the specified cluster node from the clusternodelist table in the system database.
<code>servicebuilder[.bat]</code>	Invokes the Service Builder executable, either the command line (if arguments are passed) or the GUI (if no arguments are passed).
<code>SorAlterTable[.bat]</code>	Adds extra columns to the Service Order Registry
<code>TestAtomicTask[.bat]</code>	Starts an atomic task for testing purposes.
<code>UMMData[.bat]</code>	Imports/export roles with inventory UI privileges from/to file.
<code>updateLicence.[bat]</code>	The script lets you update your trial or existing licence for HPE Service Activator.
<code>ViewTransactionState[.bat]</code>	Displays the different states of a completed transaction.
<code>WebServiceDesigner[.bat]</code>	Runs the WebServiceDesigner tool.

Appendix B

Configuration Files

The following table identifies and describes the configuration files that are provided with HPE Service Activator. Unless otherwise indicated, these files are located in `$ACTIVATOR_ETC/config`.

Table B-1 HPE Service Activator Configuration Files

File	Description
CompoundTask.dtd	Document type definition (DTD) for compound task files created by Service Builder.
par.dtd	DTD for the MANIFEST/par.xml file found in the Plug-in Archive (PAR).
resmgr.xml (resmgr.dtd)	Configuration file for the Resource Manager and associated DTD.
CLiv4.dtd	DTD for dialog control document for the Generic CLI plug-in.
LDAP.dtd	DTD for dialog control document for the LDAP plug-in.
service_builder.xml	Configuration file for Service Builder.
designer.xml	Configuration file for the Workflow Designer.
<code>\$ACTIVATOR_ETC/ workflows/workflow.dtd</code>	DTD for workflow definition.
inventoryTree.dtd	DTD for inventory tree definition file.
mwfm.xml (mwfm.dtd)	Configuration file for the Workflow Manager and associated DTD.
role_mappings.xml (role_mappings.dtd)	Definition file and associated DTD for configuring role mappings. The role mappings definition file is optional.
dm.dtd (dm.xml)	Configuration file and associated DTD for the Deployment Manager.
deploy.dtd	DTD for deployment descriptor.
menu.xml (menu.dtd)	Default menu definition file for Work Area menu and its DTD.
audit_filter.xsd	XSD for configuration of audit filters
queues.xsd	XSD for configuration of queues for the queuing sub-system
sor.xsd	XSD for configuration of extra columns for Service Order Registry

solutionmenu.dtd	DTD for solution specific modifications to menu definition.
Queues.xsd	XDS for queue management configuration
ummData.xsd	XSD for user management data
xmaps.xsd	XSD for xmaps
WebService.xsd	XSD for web service definitions (SOAP)
\$JBOSS_DEPLOY/ hpsa.ear/activator.war/ WEB-INF/web.xml	<p>Configuration file for the UI and servlets. For additional information, see the following references:</p> <p>Chapter 7, the section “Other User Interface Configuration” in <i>HPE Service Activator, User’s and Administrator’s Guide</i>;</p> <p>Chapter 5, the beginning, in <i>HPE Service Activator, Inventory Subsystem</i>;</p> <p>Chapter 4, the section “AskFor” in <i>HPE Service Activator, Workflows and the Workflow Manager</i>.</p>
\$JBOSS_HOME/standalone/ configuration/standalone.xml	<p>General configuration file for WildFly. Data sources used by HPE Service Activator are defined in this file. For additional information, see:</p> <p>Chapter Chapter 14, the section “Data Sources” in this guide;</p> <p>Chapter 7, the section “Data Source Configuration” in <i>HPE Service Activator, User’s and Administrator’s Guide</i>;</p> <p>Chapter 4, the section “Adding a Data Source for Inventory UI”, in <i>HPE Service Activator, Inventory Subsystem</i>.</p>
\$JBOSS_DEPLOY/ hpsa.ear/deployer.war/ WEB-INF/web.xml	<p>Contains the configuration for the deployer servlet used by Service Builder. See “Configuring Authentication or Authorization” in <i>HPE Service Activator, Developing Plug-Ins and Compound Tasks</i> for a description of the configurable parameters in this file.</p>

Appendix C

Java Message Service

This appendix gives you a quick introduction to those aspects of JMS, Java Message Service, which are relevant with respect to using this type of communication interface for an HPE Service Activator solution.

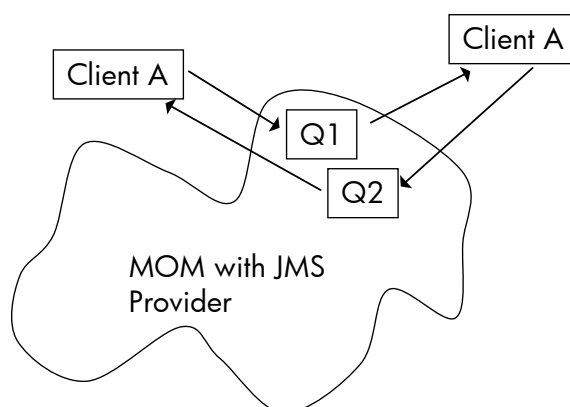
JMS is a standardized interface for access from a Java-based client to a MOM infrastructure (Message Oriented Middleware). A MOM product is used build the infrastructure for intercommunication between applications within an enterprise. Several MOM products come with JMS providers, i.e. a software layer that makes it possible to access the intercommunication service over a JMS interface. When such a MOM is available it can be used for intercommunication between HPE Service Activator and other systems that it must be integrated with.

JMS comprises two data transfer modes, using two kinds of service access points known as *destinations*: queues and topics. An installation may support one or both modes. Queues are for point-to-point communication: one client, the sender, puts a message into the queue; the other client receives the message. Topics are for one-to-many communication, where the sender does not know the receivers. A sender client publishes a message on a topic; several clients can subscribe to receive messages from the topic.

When one client receives request messages from another client, the queue is the appropriate mode of communication. If the response is only of interest for the originator of the request, it is also appropriate to send it on a queue; two different queues will be needed for requests and responses. If the response is actually a general status update which could be of interest to multiple parties the appropriate mode will be topic. The same is the case when a client wishes to communicate a state change which is not the result of a specific request; this situation could occur, for example, when the client is an Element Manager detecting changes that happen on network elements, or even new network elements that are deployed in the network.

Figure C-1 shows two JMS clients exchanging messages through two queues, one for each direction of traffic.

Figure C-1 MOM, JMS Provider and JMS Clients



Queues and topics are generally created and managed by administration of the MOM and JMS provider software, not by client-server interactions. Clients connect to destinations which already exist through administrative configuration of the infrastructure by making requests to a JMS connection factory to create connection objects, which will be different for queues and topics. The client will find the connection factory and the destination by looking them up using a JNDI naming service.

C.1 JMS Listener and Sender Modules

From V5.1 HPE Service Activator includes JMS listener and sender workflow manager modules which make it possible for an HPE Service Activator-based system to act as a JMS client, i.e. to receive and/or send messages over a JMS interface.

The communicating parties on HPE Service Activator will be workflow jobs. A running job can put a message to the JMS service by executing the SendMessage node with a parameter specifying the sender module. The listener module can start a workflow job to process each received message.

Some administrative facts about a JMS provider must be known to its clients. These facts must be known to the JMS listener and sender modules as configuration parameters.

Before a client can access a destination, it must connect to it. To do that, it must look up the destination through a JNDI naming server. The basic installation specific administrative facts that any communicating client must know are: the host name/address and port number where the JNDI server provides the lookup service, the name of the initial context class that must be instantiated to use the JNDI server, the name of the connection factory of the JMS server, and the name(s) of the destination(s) it will use. Finally, depending on its configuration, the JMS provider may demand that the client authenticate the request to connect to a destination by supplying username and password.

Additional parameters of the JMS listener and sender modules control the local behaviour of the modules, internally and vis-a-vis communicating workflow jobs. These parameters are not related to JMS as such. You will find them described in *HPE Service Activator, Workflows and the Workflow Manager*, in the sections about these modules.

What is sent as a message from a workflow using the JMS sender module is conveyed as the body of a JMS message. There are currently no means to control and use JMS message header fields (JMSDeliveryMode, JMSMessageID, JMSTimestamp, JMSCorrelationID, JMSReplyTo, JMSRedelivered, JMSType, JMSExpiration, JMSPriority, or message properties). Likewise it is only the body of a received JMS message which is passed to the workflow job that will process the message.

C.2 Durable Topics

Queues are always store-and-forward. The MOM is expected to retain messages until they are consumed. The receiving client is not required to listen for messages at all times. If it is inactive for a period and then reconnects, it will receive messages that have been sent in the meantime.

With topics, in general, listeners only receive the messages that are published while the listener is connected, but it is possible to create a durable topic subscription, thereby requesting of the JMS provider that when the listening client temporarily disconnects, published messages shall be retained and delivered when it reconnects. A durable topic subscription must be identified by a unique identifier supplied by the client. A durable subscription will exist until it is explicitly unsubscribed by the client.

C.3 Using HornetQ in WildFly as MOM

If you need to integrate HPE Service Activator with another application that also supports JMS, and the capabilities of JMS are appropriate for the integration, but there is no suitable MOM in the customer's environment, then it is possible to use HornetQ which is available as a part of the WildFly application server that HPE Service Activator is running on.

To accomplish this, you will need to configure HornetQ to support the necessary destinations with the appropriate security (roles, user names and password). The topic of managing HornetQ is beyond the scope of this manual. You must find and read the applicable WildFly documentation.

You will need to add the use of HornetQ under messaging in the WildFly configuration file

`$JBOSS_HOME/standalone/configuration/standalone.xml`. You will need to use the utility `add-user` in `$JBOSS_HOME/bin` to add application user(s) with role(s)