Funambol DM Server

Developer's Guide

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Topics

Introduction

The Open Mobile Alliance Device Management (OMA DM) protocol, formerly known as the SyncML DM protocol, specifies the message sequence and behaviors that will allow device management commands to be executed against management objects on a SyncML DM compliant device. Management objects might include configuration parameters that enable Internet connectivity, e-mail connectivity, WAP connectivity, MMS settings, and basic network configuration options allowing voice access to an operator network. Other management objects may include the Java Runtime Environment on J2ME enabled devices or any other applicable software environment where extensions of features and functionality can be added via an Over The Air (OTA) upgrade to those environments. SyncML DM protocol is not limited to any particular set of management objects that can be modified via OTA, although the protocol does define a specific methodology and object management tree structure that serves as a profile on how a DM server accesses specific management objects on a particular device.

The Funambol DM Server is a server side implementation of the OMA DM protocol and an extensible framework for the development of device management based applications. The Funambol DM Server architecture and implementation derives from the Funambol OMA DS platform.

Purpose

This document provides developers with basic concepts and guidance for extending the functionality of the Funambol DM Server. Using this document, a developer will acquire the following skills:

- An understanding of the OMA DM protocol
- An understanding of the Funambol DM Server architecture
- The ability to integrate the Funambol DM Server with external applications
- The ability to pre- and post-process incoming and outgoing OMA DM messages
- The ability to implement new management operations

SyncML DM Protocol Message Sequence Overview

The SyncML DM protocol is relatively simple from a messaging sequence standpoint. The message sequence consists of three parts:

- Alert phase – used only for unsolicited management initiation from the server to the client.
- Set up phase (authentication and device information exchange)
- Management phase

Transaction 1: Alert Phase – Server to Client Only

Not required if the client is contacting server. SyncML DM supports the concept of unsolicited alerts via a "notification initiation alert" mechanism. This mechanism allows a management server to initiate a management session with a device, rather than solely relying on a client device to initiate a session. Some devices may be capable of listening on a particular port for alert messages; other devices may not be capable of this paradigm and need an alternate method to trigger a management session. SyncML will rely on two primary methods for delivery of unsolicited alerts:

- WAP Push – This method will deliver the alert via a Push Initiator through a Push Proxy Gateway as defined by the WAP protocol. The SyncML server will act as a Push Initiator in this example, and will deliver the message via an SMS message. The message will have a unique application ID and the message will be routed to the device management user agent per the WAP Specification.
- OBEX – The OBEX protocol can be used to deliver unsolicited alerts to a device via the PUT command as defined by the protocol.

Transaction 2: Set Up Phase – Client to Server

Always required. The set up phase consists of a request from the client and the response from the server. The initial client request of the set up phase will contain three primary pieces of information.

- The information contained in the DevInfo (Device Information) object, as follows:

  Ext - An optional, internal object, marking up the single branch of the DevInfo sub tree into which extensions can be added, permanently or dynamically.

  Bearer - An optional, internal object, marking up a branch of the DevInfo sub tree into which items related to the bearer (CDMA, etc.) are stored. Use of this sub tree can be mandated by other standards.

  DevId - A unique identifier for the device. SHOULD be globally unique.

  Man - The manufacturer identifier.

  Mod - A model identifier (manufacturer specified string).

DmV - A SyncML device management client version identifier (manufacturer specified string).
Lang - The current language setting of the device.

- The client credentials information used for authenticating the client.
- A token that informs the server if this is a client-initiated session or server-initiated session. This is required so the server can synchronize a server-initiated session with an initial incoming request from the client. From the server perspective, server-initiated sessions will look the same as client-initiated sessions, and a token must be present so the server can distinguish both types of transactions.

Transaction 3: Set-up Phase – Server to Client

Always required. The server will respond to the initial client request with server credentials, so as to identify the server to the client for authentication and identification purposes. The server may also send user interaction commands with the response, as well as initial management data.

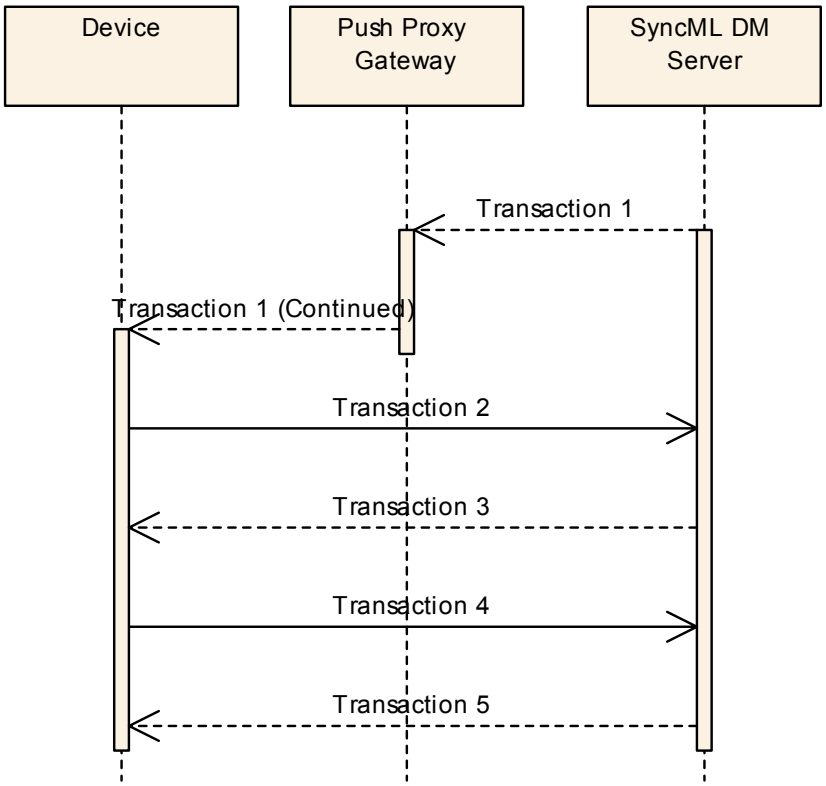
Transaction 4: Management Phase – Client to Server

Only required if management data or user interaction commands were sent in the previous message. The client will respond to the server with the results of the management message sent in the previous transaction, as well as any user interaction command results.

Transaction 5: Management Phase – Server to Client

Always required if Transaction 4 was initiated. This transaction will occur to either close the management session or to begin a new iteration if more management operations are needed. If additional management operations are needed the response to this message will be the same transaction type as transaction 4. This iteration will continue until the management server sends a message in this transaction to close the session with the client.

The diagram below is a representation of the preceding transactions.



SyncML Device Management Tree Overview

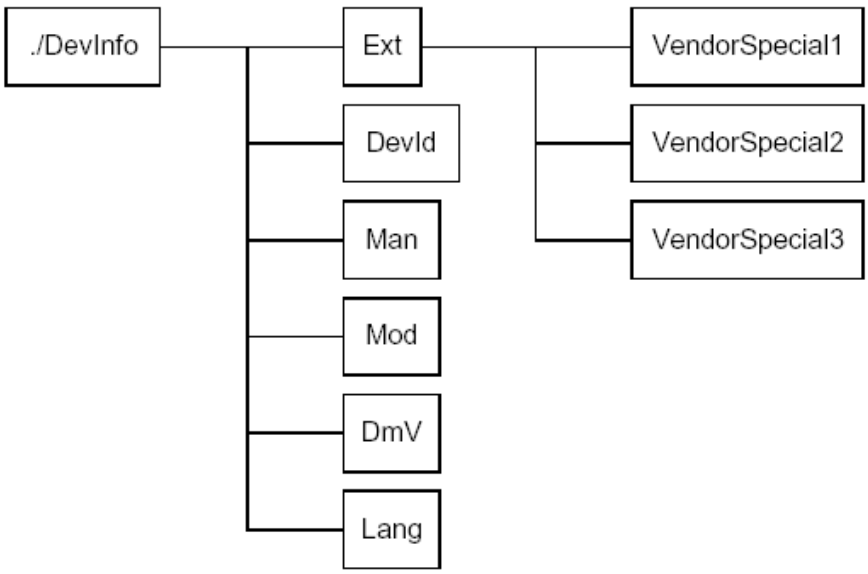
The SyncML DM protocol identifies various messages and message content, the sequence of messages, security framework, and so on. The device itself must adhere to a specific methodology of managing various functions. Because features and functionality are device specific and are often proprietary, a framework defining how a device utilizes device management messages must be specified and in place to operate properly with a device management server. This framework allows a device manufacturer to add new devices or functionality to the market, then modify or add a new device description to the device management server's library of device profiles. This framework is defined as the *Device Management Tree*. The tree data structure allows URI addressing of SyncML DM messages, as well as provides a common framework for device management object addressing.

The device management tree is a data structure of manageable device objects. Device objects can be anything from a single parameter, to a splash screen GIF file, to an entire application. The device management tree is essentially mapped to permanent or dynamic objects as an addressing schema to manipulate these objects. Permanent objects can be thought of as objects that are built into the device at the time of manufacture and typically cannot be deleted e.g. the Device Info object that defines the basic information about a device such as manufacturer or model number. Dynamic objects are objects that can be added or deleted, e.g., ringtones or wallpaper.

The ./DevInfo Node

The initial request from the client will always contain information retrieved from the ./DevInfo (or Device Info) sub tree. The ./DevInfo Node is only part of the overall device management tree structure, and it maps to basic device parameters that allow initial operations and inspection of the device by the CRM specialist

The diagram below is an example that illustrates how the device management tree maps to certain objects.



Properties of Management Tree Objects

Each management tree object has a set of properties that defines metadata information about the object, such as access control, etc. The properties are as follows:

- **ACL** (required) – Access Control List, defines who can manipulate the underlying object.
- **Format** (required) – determines how an object is interpreted, i.e., if the underlying object is a URL for a particular management server, the Format may be defined as chr (character).
- **Name** (required) – the object in the tree.
- **Size** (required for leaf objects, not applicable for interior nodes) – the size of the object in bytes.
- **Title** (optional) – user-friendly name.
- **Tstamp** (optional) – the time stamp of the last modification.
- **Type (**required for leaf objects, optional for interior nodes) – the MIME type of the object.
- **VerNo** (optional) – the version number of the object.

Management Object Manipulation

Management objects can be manipulated via SyncML messages with the following commands through a valid SyncML DM message.

- **Add –** Adds an object (Node) to a tree.
- **Get –** Returns a Node name based on the URI passed with the GET request
- **Replace –** Replaces an object on the Tree.
- **Delete –** Deletes an object on the tree.
- **Copy –** Copies an object (Node) on the tree.

Management Object Security

The ACL property defines the security framework for objects within a tree. This framework allows only certain server's access to objects for manipulation. This will allow tight control on how objects are added, changed, deleted or replaced, as well as how object properties are manipulated, and more importantly *who* is allowed to manipulate objects.

SyncML Security and Initial Provisioning (Bootstrap)

Security

Security is a primary concern when modifying any attributes on a device. SyncML DM protocol specifies that authentication take place in either the transport level or the SyncML DM protocol level. If the transport level authentication is considered too weak, then authentication must occur at the protocol level.

Example 1 – Transport Level Authentication

A device may authenticate itself to a WAP server using basic HTTP authentication. Authentication credentials accompany each request after the initial transaction is sent to the WAP gateway. The WAP gateway in this case would be considered "trusted" since it serves as a Proxy to the SyncML DM server, and additional authentication may not be required at the SyncML protocol level if the requests come via the trusted proxy.

Example 2 – Session Level Authentication

Similar to example 1, this example assumes that a GPRS device authenticates to the operator's portal via TLS or HTTPS. The underlying session is established and considered authenticated therefore any messages that are a part of this secured session can be considered authenticated.

Example 3 – SyncML Protocol Level Authentication

If session level or transport level authentication is not available or considered weak, then the SyncML protocol level authentication must occur. SyncML requires that regardless what the underlying security mechanism that is in place, if the server or client requests credentials one or both must comply. The four basic credentials are Server ID, Username, Password, and Nonce

SyncML DM requires that Basic, MD-5 (server side) and HMAC authentication must be supported.

Bootstrap Provisioning

SyncML DM defines two different use cases of bootstrapping a device and two methods for initial bootstrapping.

Bootstrap Use Cases

- Factory Bootstrap: Devices are loaded with SyncML DM bootstrap information at the time of manufacture or initial distribution.
- Server Initiated Bootstrap: Server initiated bootstrap is intended for devices that do not have the necessary configuration parameters set to establish a SyncML DM session.

Bootstrap Methods

WAP Profile Provisioning

Other aspects of *server initiated bootstrap* are very similar if not identical to *WAP bootstrap provisioning*. If the device supports WAP provisioning, extensions to the WAP profile that define how SyncML parameters are mapped into the SyncML DM management object are defined in the SyncML specifications, and can be used to configure the device for SyncML DM via WAP bootstrap provisioning.

Plain Profile Bootstrap Provisioning

Plain profile is currently defined for devices that do not support WAP bootstrap provisioning. This method utilizes the SyncML DM format for the bootstrap message, and uses the same bootstrap method for security as WAP bootstrap provisioning.

WAP defines several methods for authenticating a bootstrap session and these methods are utilized by the SyncML DM protocol:

- NETWPIN – a shared secret is known by the device and server i.e. an IMSI or ESN. No user intervention is required, and is the simplest yet least secure method of authenticating a bootstrap message.

- USERPIN – where the user enters a PIN code delivered out of band i.e. through customer care who will initiates the bootstrap after confirming the identity of the user. A Plain Profile can use any method capable of sending unprompted requests to a device, i.e. OBEX, SMS, and WAP Push.

- USERNETWPIN – a combination of the NETWPIN and USERPIN methods, requiring the use of a shared secret and a user PIN.

- USERPINMAC – the PIN is delivered out of band to the user. This method calculates the PIN based on the actual bootstrap method using a hashing function. When the bootstrap message arrives, the user is prompted to enter the PIN. If the PIN matches the re-hash of the bootstrap message on the device then the message is accepted.

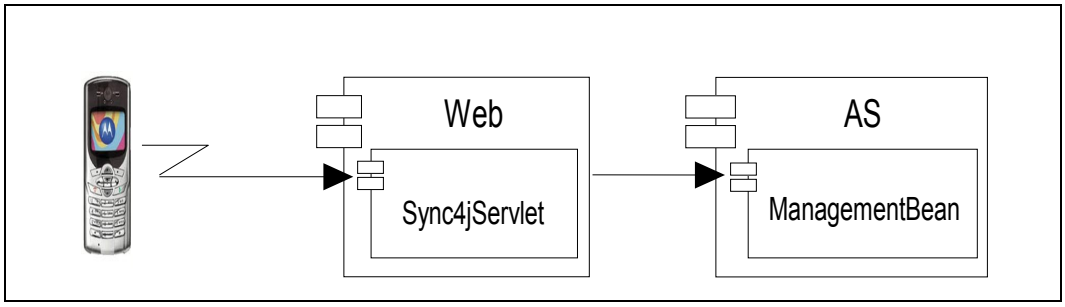
Chapter 2 Developer Overview

This section provides an overview of the Funambol DM Server architecture appropriate for developers who wish to extend the server or integrate it with other applications (i.e., a customer care front end).

Topics

System Architecture

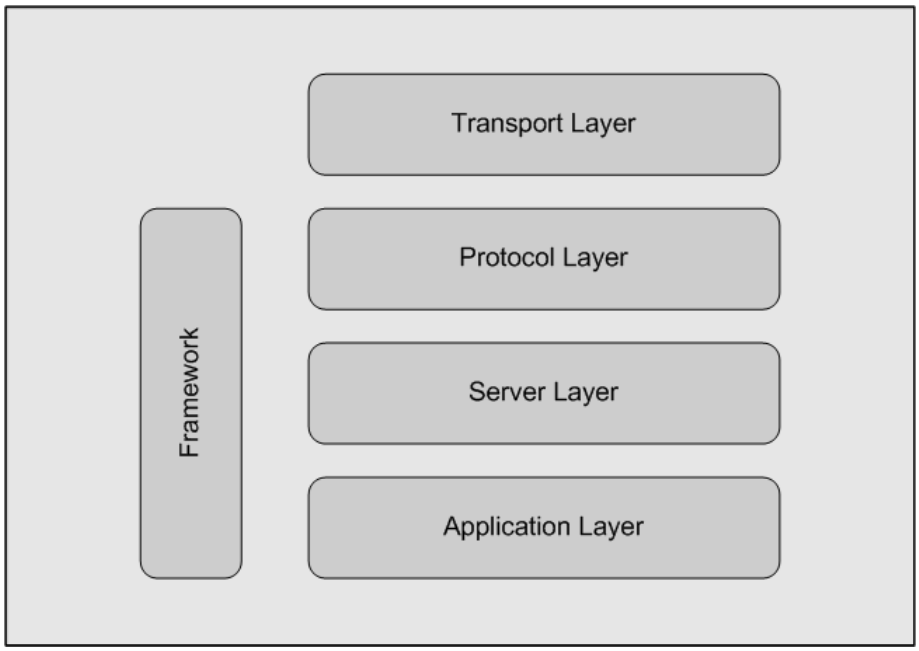
The system architecture of the Funambol DM Server is shown below. The transport and the business logic (protocol handling) are separated in two distinct blocks and handled respectively by a web application running in a J2EE web container and by an Enterprise Java Bean running in a J2EE EJB container.



The web module implements the transport protocol (being OMA DM messages transported over HTTP). The EJB layer contains the real device management server implementation, which is built of many components. This represents the management engine of the system. Both the web layer and engine components are described in further details in the following sections.

Funambol DM Server Architecture

The Funambol DM Server architecture is layered and modular, as shown below:

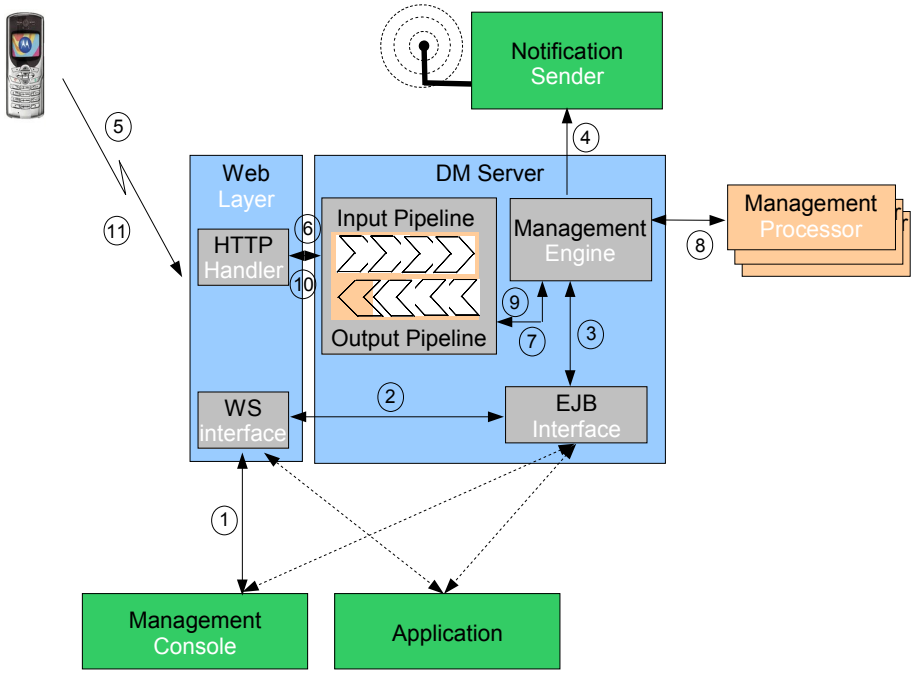


These layers represent groups of functionality with well-defined boundaries and communication interfaces.

Layer	Description
Transport Layer	The medium through which client messages reach the system. The current implementation of the Funambol DM Server implements the HTTP transport protocol and binding as defined by the HTTP binding OMA DM specification. The system is designed so that other transport protocols can be added in the future.
Protocol Layer	Responsible for the interpretation and handling of the SyncML protocol. It works at both representation and protocol levels. This layer is designed so that other device management protocols can be added in the future.
Server Layer	The Funambol DM Server implementation. It is a J2EE-based application that can be deployed on any J2EE compliant application server.
Application Layer	Implements the way the Funambol DM Server interacts with end user DM applications, such as the CRM applications used by customer support personnel. It is not a fully implemented layer, but more a framework used to extend the server in order to meet any application-specific needs.
Framework	Implements and provides services and abstractions used by the different layers to implement the component they are built of. The most important services provided by the framework are the following: • Core SyncML representation and protocol • Configuration framework • Logging framework • SyncML DM engine framework • Security framework • Commonly used utilities

Execution Flow

The execution flow of an OMA DM request is shown below:



The green blocks are external systems or applications. They interact with the Funambol DM Server directly through its EJB interface or indirectly through a web services interface (not available yet). The Notification Sender is used by the Funambol DM Server to send PKG 0 notifications to the devices (for server initiated management sessions).

The light blue and violet boxes represent the mainFunambol DM Server building blocks and are part of the core implementation. The orange blocks are components added and customized by developers to meet the end-user management application needs.

An OMA DM session can be started from the device or solicited by the server; when started from the device, the execution flow of the message is slightly shorter than when started by the server. When the server initiates the DM session, the execution flow is the following.

1. The management application (e.g., a customer support management console) starts a new "management operation" for a specific device. This results in an interaction between the external application and the Funambol DM Server, e.g., via a call to a web service deployed into the server.

2. The web service invokes the corresponding service of the DM Sever EJB interface.

3. The EJB wrapper forwards the call to the management engine, which is the core of the Funambol DM Server.

4. The management engine builds the notification message (OMA DM PKG 0) and tells the Notification Sender to push it to the phone; note in the picture that the management engine is a logical component, which in reality is built of many other blocks.

5. The device receives the notification message; it starts a new OMA DM session sending the OMA DM PKG 1 to the server; the DM message is first received by the HTTP listener and processed by the Funambol DM Server's HTTP handler.

6. The HTTP handler is now ready to open the DM session on the Funambol DM Server and start the real message processing; as show in the figure, the incoming message passes through the input pipeline before getting to the management engine.

7. The management engine processes the request, including authentication and session management.

8. To build the management commands to send to the client, the management engine selects and calls the appropriate management processor for the management operation requested in Step 1.

9. The management actions to be performed are ready to be sent to the client; the outgoing message passes through the output pipeline for post-processing.

10. The return message is translated into an OMA DM message.

11. The return message is returned to the device.

The processing now starts again at Step 5 with a new message from the client; in this case, all commands and results exchanged between client and server belong to the same session until the server stops sending commands. Note that in the case of an unsolicited new DM session, the client starts at Step 5 without receiving a notification message.

Database Schema

The internal database schema used by the Funambol DM Server is shown below.

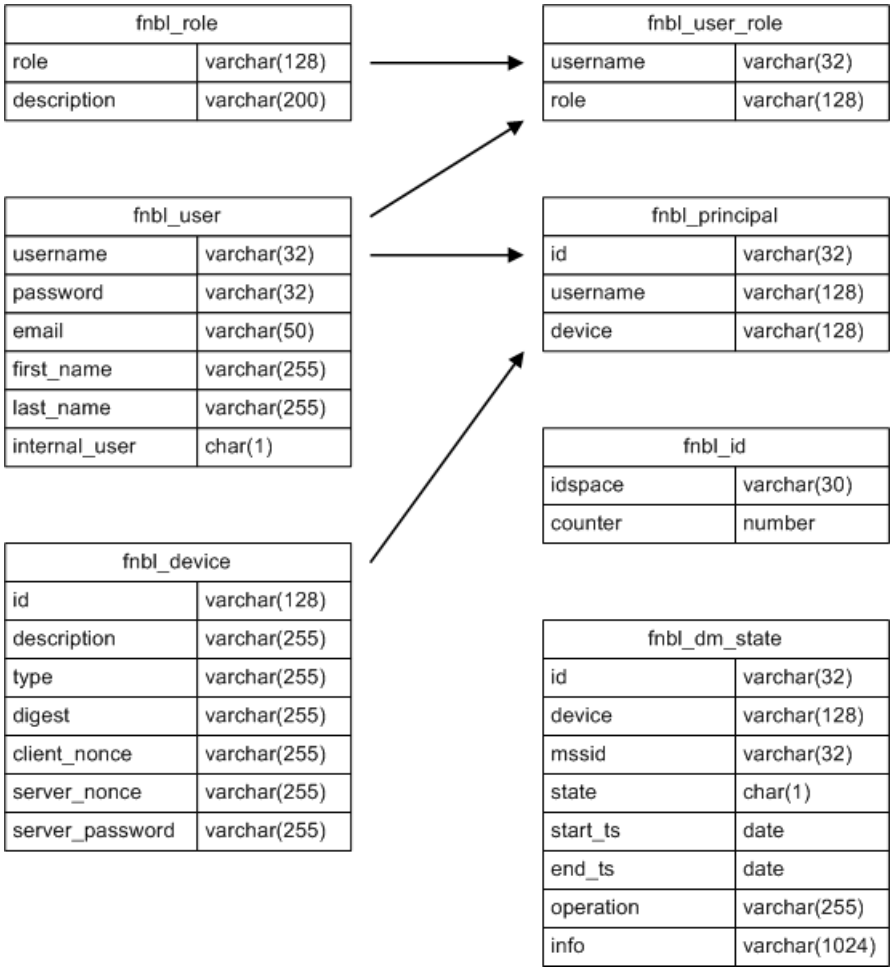


Table Name	Description
fnbl_user	Stores basic user information, such as username, first and last name, and email. The internal_user field represents an applicative user, not a real person, but an application. This field is currently not used, but it was added for future use.
fnbl_role	Stores the list of the available roles (for future use)
fnbl_user_role	Stores the associations between the users and the roles (for future use).

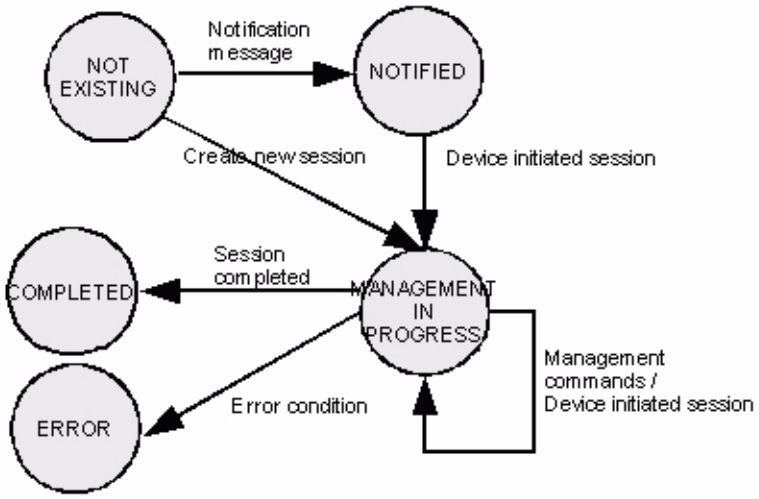
Table Name	Description
fnbl_device	Stores basic information about a device: • device id • description • device type (e.g., Nokia 7650) • digest (the MD5(user:password)) of the user this device will be associated with • client_nonce (the nonce that the client will use to calculate the next session's digest) • server_nonce (the nonce that the server will use to calculate the next session's digest) • server_password (the server password)
fnbl_principal	A principal is an association between a user and a device. This allows more generic scenarios where a user can use many devices and/or a device can be used by many users. The current DM implementation allows an 1:1 association between a user and a device.
fnbl_dm_state	Stores data on pending operations to be performed: • id: record id • device: device id • mssid: session id • state: operation status. One of the following: 'N' = notified; 'P' = management session in progress; 'E' = error. • start_ts: timestamp of the beginning of the session • end_ts: timestamp of the end of the session • operation: operation to be performed in this session • info: application-specific details
fnbl_id	Used to create unique ids in a database-independent manner. There can be many counters, each identified by its own namespace.

Device Management State

The management process is usually performed in multiple phases which are not necessarily close in time or even bound to the same OMA DM session. The state of the overall management process is partially the responsibility of the management server and partially dependent on the specific management process or application. The DM Server defines and handles the following state information for a management process:

- sid - the session id notified by the management server to the client.
- deviceId - the unique identifier of the device under management
- operation - the requested operation (application-specific)
- state - the operation state (management server/application-specific)
- start_ts - timestamp of the beginning of the session
- end_ts - timestamp of the end of the session
- info - additional application-specific details

The state diagram of a management session is illustrated belolw. The NOT EXISTING state is not a real session state, it simply represents the absence of a session. If a device connects to the server and there is no session associated with it, no management operations are executed.



A new session is automatically created by the engine when a device is notified to start a server-initiated management session. In this case, the session is created with the state NOTIFIED ('N'). When the device starts the management session, the state moves to MANAGEMENT IN PROGRESS ('P'). During the management session, in which many device-server interactions may take place, the session stays in state P. When the session successfully completes, the state moves to COMPLETED ('C'). If an unrecoverable error occurs, the state moves to ERROR ('E').

Note that the scenario above requires that the device is notified to start the management session. When a management application needs to support a device-initiated session, the session must be created in state P. This is accomplished by creating a row in the **FNBL_DM_STATE** table, as follows :

id	device	mssid	state	start_ts	end_ts	operation	info
row_id	device_id	NULL	'P'	NULL	NULL	operation to perform	application specific value

For details, see "Database Schema" on page 16.

Chapter 3 Server Configuration

Topics

Overview

The Funambol DM Server provides a framework for implementing many kinds of device management services. You can extend existing modules or add new modules. You configure the server using the following:

- Funambol.properties
- Server JavaBeans

Configuration files are stored in a configuration path (or configpath) containing a tree of subdirectories that is handled in the same way as the JVM classpath. The configuration path is specified by the `funambol.dm.home` system property, to which `config` is appended. For example, if the system property is set to `/opt/funambol`, the base directory of configuration files is `/opt/funambol/config/`.

Funambol.properties

This is the primary configuration file. It is located directly under the configpath and defines the following properties:

Property	Description	Default
server.uri	The server URI that identifies the server.	http://localhost:8080/funambol/dm
server.id	Server identifier.	funambol
syncml.dtdversion	The supported SyncML DTD version	1.1
engine.manufacturer	The manufacturer used in server capabilities.	funambol
engine.modelname	The model name used in server capabilities.	DM Server
engine.oem	The oem used in server capabilities.	-
engine.firmware version	The firmware version used in server capabilities.	-
engine.software version	The software version used in server capabilities.	3.0.x
engine.hardware version	The hardware version used in server capabilities.	
engine.deviceid	The device identifier used in server capabilities.	funambol
engine.devicetype	The device type used in server capabilities.	

Property	Description	Default
engine.strategy	The server bean (see the next section) representing a com.funambol.framework.engine. SyncStrategy object. The given value is searched for in the configuration path first as the name of a serialized object. If no serialized object is found, the value is considered the name of a class and a new instance is created.	com.funambol.server.engine. Sync4jStrategy
engine.store	The server bean representing the persistent store manager (see section on the persistent store architecture).	com/funambol/server/ store/PersistentStore Manager.xml
engine.handler	The server bean representing the session handler.	com.funambol.server. session.Management SessionHandler
engine.pipeline	The server bean representing the pipeline manager (see section on the Message processing pipeline).	com/funambol/engine/ pipeline/PipelineManager. xml
security.officer	The server bean representing the security officer.	com.funambol.framework. security.DBOfficer
user.manager	The server bean representing the User Manager.	com/funambol/server/ admin/DBUserManager.xml
server.dm.selector	The server bean representing the processor selector (see section on the Processor Selector).	com/funambol/server/dm/ OperationProcessorSelector. xml
minXMLMaxMsg Size	The minimum MaxMsgSize allowed for XML messages	1500
minWBXMLMax MsgSize	The minimum MaxMsgSize allowed for WBXML messages	1000

Server JavaBeans

With the exception of Funambol.properties, all other Funambol DM Server components are configured as server JavaBeans. Server JavaBeans are JavaBeans used server-side. A bean configuration is stored as the serialized form of a bean instance; a bean can be instantiated, configured and serialized to persist its configuration. Later, the bean can be deserialized in a properly configured instance.

It would inconvenient, however, if a bean had to be instantiated, configured and serialized every time its configuration changes. To avoid this, the Funambol DM Server uses the standard Java facility to serialize objects into XML (and to deserialize them from XML) in the form of the `java.beans.XMLEncoder` and `java.beans.XMLDecoder` classes. Configuration files created with these classes are easy to work without a dedicated GUI – they can be created, read, and modified with a text editor. An additional advantage is that server JavaBeans do not implement `java.io.Serializable` because XMLEncoder does not require it.

The following is an example of a server JavaBean:

Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<java version="1.4.1_01" class="java.beans.XMLDecoder">
 <object class="com.funambol.framework.server.store.PersistentStoreManager">
  <void property="jndiDataSourceName">
    <string>java:/jdbc/fnblds</string>
  </void>
  <void property="stores">
   <array class="java.lang.String" length="2">
     <void index="0">
      <string>com.funambol.server.store.SyncPersistentStore</string>
     </void>
     <void index="1">
      <string>com.funambol.server.store.EnginePersistentStore</string>
     </void>
   </array>
  </void>
 </object>
</java>
```

For server JavaBean handling, Funambol provides the factory class `com.funambol.framework.tools.beans.BeanFactory`, which in turn uses a customized class loader that handles configuration files in the configpath (class loaders normally handle classes in the class path).

The XML syntax uses the following conventions:

- Each element represents a method call.
- The "object" tag denotes an expression whose value is to be used as the argument to the enclosing element.
- The "void" tag denotes a statement which will be executed, but whose result will not be used as an argument to the enclosing method.
- Elements which contain elements use those elements as arguments, unless they have the tag: "void".
- The name of the method is denoted by the "method" attribute.
- XML's standard "id" and "idref" attributes are used to make references to previous expressions - so as to deal with circularities in the object graph.
- The "class" attribute is used to specify the target of a static method or constructor explicitly; its value being the fully qualified name of the class.
- Elements with the "void" tag are executed using the outer context as the target if no target is defined by a "class" attribute.

- Java's String class is treated specially and is written <string>Hello, world</string> where the characters of the string are converted to bytes using the UTF-8 character encoding.

Although all object graphs may be written using just these three tags, the following definitions are included so that common data structures can be expressed more concisely:

- The default method name is "new".
- A reference to a java class is written in the form <class>javax.swing.JButton</class>.
- Instances of the wrapper classes for Java's primitive types are written using the name of the primitive type as the tag. For example, an instance of the Integer class could be written: <int>123</int>. Java's reflection is internally used for the conversion between Java's primitive types and their associated "wrapper classes".
- In an element representing a nullary method whose name starts with "get", the "method" attribute is replaced with a "property" attribute whose value is given by removing the "get" prefix and decapitalizing the result.
- In an element representing a monadic method whose name starts with "set", the "method" attribute is replaced with a "property" attribute whose value is given by removing the "set" prefix and decapitalizing the result.
- In an element representing a method named "get" taking one integer argument, the "method" attribute is replaced with an "index" attribute whose value the value of the first argument.
- In an element representing a method named "set" taking two arguments, the first of which is an integer, the "method" attribute is replaced with an "index" attribute whose value the value of the first argument.
- A reference to an array is written using the "array" tag. The "class" and "length" attributes specify the sub-type of the array and its length respectively.

Lazy Initialization

When a bean is deserialized from its XML form, the classloader that loads the serialization file first calls the bean class's empty constructor, then it sets the values of the bean properties using the setXXX() methods. However, some classes need additional work to properly initialize; that work has to be done with meaningful properties values (in other words, after the setXXX() methods are called). To support this lazy initialization approach, those classes can implement `com.funambol.framework.tools.beans.LayInitBean`, which defines a separate init() method. When the DM Server loads a LazyInitBean, after the bean instantiation (or deserialization), it calls its init() method, giving the bean the opportunity to complete its initialization.

Configuring a Standard Component

Changing a configuration bean is as easy as editing a text file. Let's take as an example the configuration file for the NotificationSender component. The full path of the configuration bean is `com/funambol/server/engine/dm/NotificationSender.xml` (this path is relative to the configpath) and its contents are shown below:

Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<java version="1.4.2_01" class="java.beans.XMLDecoder">
 <object class="com.funambol.dm.engine.MySender">
  <void property="sendingUrl">
   <string>http://theserver.com/sms/send</string>
  </void>
 </object>
</java>
```

The object element specifies the Java class to be instantiated, and the property element sets the corresponding instance property. To change the sending URL (suppose the sender has a HTTP based interface) of the service used to send notifications, you simply edit and save the file. The next time this bean is used, the new configuration value will be picked up.

Configuring a Custom Component

Any Java object can be configured with this technique, from a simple Java class to a very complex Java object tree. For example, the following configures a String object:

Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<java version="1.4.2" class="java.beans.XMLDecoder">
 <string>Hello world</string>
</java>
```

For a more interesting example, suppose we have a "device inventory" component that can store the properties of a device, and when queried, retrieve the device's capabilities. The class could be defined as follows:

Example:

```
public class DeviceInventory {
    private String s1 = "s1";
    public String  s2 = "s2";
    private HashMap capabilities = new HashMap();

    public DeviceInventory() {}

    public void setCapabilities(String model, Capabilities caps) {
        capabilities.put(model, caps);
    }

    public int getMaxMsgSize(String model) {
        return ((Capabilities)capabilities.get(model)).getMaxMsgSize();
    }

    public int getMaxObjSize(String model) {
        return ((Capabilities)capabilities.get(model)).getMaxObjSize();
    }

     public boolean supportNumberOfChanges(String model) {
        return
((Capabilities)capabilities.get(model)).getSupportNumberOfChanges();
    }

    public boolean supportLargeObjects(String model) {
        return
((Capabilities)capabilities.get(model)).getSupportLargeObjects();
    }

    public void setCapabilities(HashMap capabilities) {
        this.capabilities = capabilities;
    }

    public HashMap getCapabilities() {
        return capabilities;
    }
}
```

The configuration file for such a class could be as folllows:

Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<java version="1.4.2_04" class="java.beans.XMLDecoder">
 <object class="com.funambol.dm.examples.DeviceInventory">
  <void property="capabilities">
   <void method="put">
    <string>siemens-s55</string>
    <object class="com.funambol.dm.examples.Capabilities">
     <void property="maxMsgSize">
      <int>2700</int>
     </void>
     <void property="supportLargeObjects">
      <boolean>true</boolean>
     </void>
     <void property="supportNumberOfChanges">
      <boolean>true</boolean>
     </void>
    </object>
   </void>
   <void method="put">
    <string>nokia-7650</string>
    <object class="com.funambol.dm.examples.Capabilities">
     <void property="maxMsgSize">
      <int>5000</int>
     </void>
     <void property="maxObjSize">
      <int>10000</int>
     </void>
     <void property="supportLargeObjects">
      <boolean>true</boolean>
     </void>
     <void property="supportNumberOfChanges">
      <boolean>true</boolean>
     </void>
    </object>
   </void>
  </void>
 </object>
</java>
```

Getting a Configured Instance

Configuration beans are accessed through the singleton object `com.funambol.framework.config.Configuration`. For example, to instantiate a configured DeviceInventory instance, use the following code:

Example:

```
Configuration c = Configuration.getConfiguration();

DeviceInventory inventory = c.getBeanInstanceByName("com/funambol/server/dm/
DeviceInventory.xml");
```

Tips and Tricks

You do not need to manually write a configuration file from scratch. To write a bean instance for the first time, use the *saveBeanInstance()* method from `com.funambol.framework.tools.beans.BeanFactory` to save a configured instance into a file, as shown below:

Example:

```
import com.funambol.dm.examples.DeviceInventory;
import com.funambol.dm.examples.Capabilities;
import com.funambol.framework.tools.beans.BeanFactory;

DeviceInventory inventory = new DeviceInventory();

Capabilities nokia   = new Capabilities();
Capabilities siemens = new Capabilities();

nokia.setMaxMsgSize(5000);
nokia.setMaxObjSize(10000);
nokia.setSupportNumberOfChanges(true);
nokia.setSupportLargeObjects(true);

siemens.setMaxMsgSize(2700);
siemens.setMaxObjSize(0);
siemens.setSupportNumberOfChanges(true);
siemens.setSupportLargeObjects(false);

inventory.setCapabilities("nokia-7650", nokia);
inventory.setCapabilities("siemens-s55", siemens);

BeanFactory.saveBeanInstance(inventory, new java.io.File("inventory.xml"));
```

Logging

The Funambol DM Server uses the standard Java logging APIs introduced with the JDK 1.4.x. The output produced by the logging system can be configured in term of content and writing media (the system output console, the file system, a database, etc.). To configure the JDK logging system, edit the file `{funambol.dm.home}/lib/logging/common/logging.properties`.

The Funambol DM Server uses many logging namespaces allowing you to selectively enable/disable the logging of a specific module. The namespaces are as follows:

Name	Description
funambol	The default logging namespace, used when no other namespace is specified.
funambol.dm	DM logging information.
funambol.dm.bootstrap	DM Bootstrap logging information.
funambol.dm.notification	DM Notification logging information.
funambol.engine	Synchronization engine logging information.
funambol.engine.pipeline	Pipeline logging information.
funambol.handler	Session handling logging information.
funambol.framework.engine	Framework engine logging information.
funambol.transport.http	Transport logging information.

To enable the maximum of verbosity for a given module, the configuration file `logging.property` should have the following line (other loggers settings under funambol should be commented out):

```
funambol.level=ALL
```

Adding Logging for Custom Components

TheFunambol DM Server logging feature can be use by any Funambol DM Server class or extension. It is even possible to create your own logging namespace, so that you can isolate the logging information produced by your components from all other logging.

The *java.util.logging.Logger* used for logging is acquired with the following sample code:

Example:

```
Logger log = FunambolLogger.getLogger(name);
```

where name is one of the standard name defined in `com.funambol.framework.logging.FunambolLoggerName` or your own logger name. Note that "funambol" will be prepended to the given name, so that all Funambol DM Server loggers will be hierarchically grouped under the funambol name space. This allows all Funambol DM Server logging activity to be enabled or disabled by changing a single line in the `logging.properties` file.

Chapter 4 Customizing Message Processing

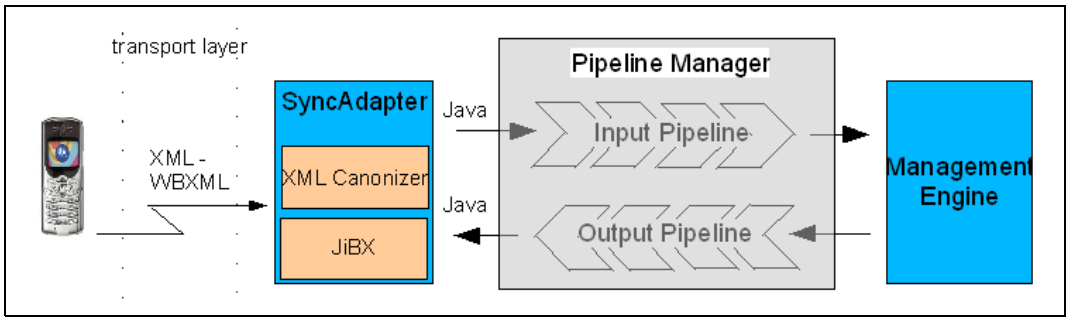
This section explains how to extend the Funambol DM Server by customizing the processing of incoming and outgoing messages.

Topics

Overview

The OMA DM protocol is an XML-based protocol. This means that each OMA DM message is an XML document.

When a OMA DM message reach the Funambol DM Server, it passes through both XML transformations and message transformations. The former works on the message in its XML representation, the latter on a Java representation of the message.



In order to save bandwith and processing power, OMA DM messages can be also WBXML encoded. No matter how the message is coded, its content is first delivered to a SyncAdapter component by the transport layer (). The SyncAdapter first translates the message in XML if it was WBXML encoded and then the XML message is reduced to a "canonical" form in order to get rid of device specific singularities. XML canonization is the XML level transformation.

Even when in the canonical XML form, the message is still hard to manipulate, since XML needs to be parsed. Plus, each component that needs to access any of the OMA DM message elements would have to parse the XML again, with a big impact on performance. For these reasons, the canonic XML message is translated into an object tree that represents exactly the message.

For example, the following DM PKG #1 message:

Example:

```
<SyncML xmlns='SYNCML:SYNCML1.1'>
   <SyncHdr>
       <VerDTD>1.1</VerDTD>
       <VerProto>DM/1.1</VerProto>
       <SessionID>5b</SessionID>
       <MsgID>1</MsgID>
       <Target>
           <LocURI>http://localhost:8080/funambol/dm</LocURI>
       </Target>
       <Source>
           <LocURI>FunambolTest</LocURI>
       </Source>
       <Cred>
           <Meta>
               <Format xmlns='syncml:metinf'>b64</Format>
               <Type xmlns='syncml:metinf'>syncml:auth-basic</Type>
```

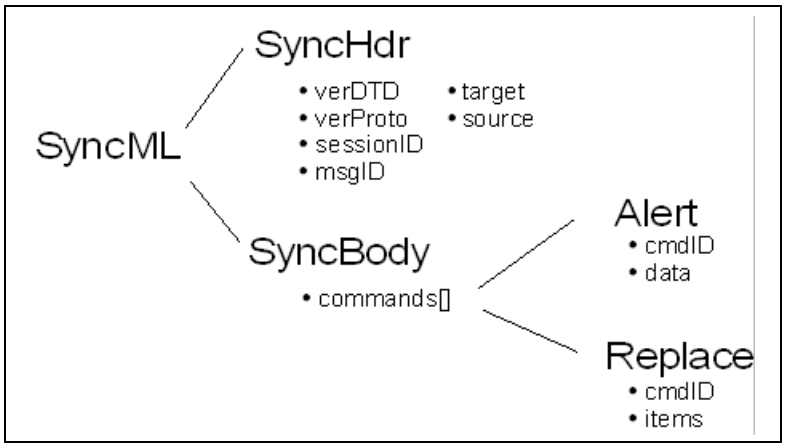
```
            </Meta>
            <Data>c3luYzRqOnN5bmM0ag==</Data>
        </Cred>
        <Meta>
            <MaxMsgSize xmlns='syncml:metinf'>20000</MaxMsgSize>
        </Meta>
    </SyncHdr>

    <SyncBody>
        <Alert>
            <CmdID>1</CmdID>
            <Data>1201</Data>
        </Alert>
        <Replace>
            <CmdID>2</CmdID>
            <Item>
                <Source>
                    <LocURI>./DevInfo/Lang</LocURI>
                </Source>
                <Data>en-us</Data>
            </Item>

            [...]

            <Item>
                <Source>
                    <LocURI>./DevInfo/DevId</LocURI>
                </Source>
                <Data>Funambol</Data>
            </Item>
        </Replace>
        <Final/>
    </SyncBody>
</SyncML>
```

This message will be translated into the object hierarchy shown below.



After being translated into an object tree, an incoming message passes through the input message processing pipeline, before getting to the Management Engine. This gives the opportunity to further processing the message when it is in a manageable representation. In a similar way, a response message going out from the Management Engine, passes through the output message processing pipeline before getting translated to its XML (and then WBXML) representation.

The input and the output pipelines are completely customizable, so that custom message pre- and postprocessing can be easily added to the system.

Input and output message processing components are also referred to as "synclets."

Preprocessing an Incoming Message

To preprocess an incoming message, you create and input processor component and configure the Pipeline Manger accordingly.

Creating an Input Synclet

An input synclet is a class that implements the `com.funambol.framework.engine.pipeline.InputMessageProcessor` interface. This interface defines a single method,

```
void preProcessMessage(MessageProcessingContext context, SyncML msg)
```

where `context` is a request-scoped parameter that is shared by all synclets (both input and output) involved in the message processing, and `msg` is the object tree representing the DM message.

The following is an example of an input synclet.

Example:

```
public class MotorolaV500
implements InputMessageProcessor {
    // ------------------------------------------------ InputMessageProcessor

    public void preProcessMessage(MessageProcessingContext processingContext,
                                  SyncML message)
    throws Sync4jException {
        List items, validItems;
        List results = message.getSyncBody().getCommands();
        Item item;

        AbstractCommand c;
        Results r;

        Iterator i = results.iterator();

        while (i.hasNext()) {
            c = (AbstractCommand)i.next();
            if (c instanceof Results) {
                r = (Results)c;
                validItems = new ArrayList();
                items = r.getItems();

                Iterator j = items.iterator();

                while (j.hasNext()) {
                    item = (Item)j.next();
                    if (item.getSource() != null) {
                        validItems.add(item);
                    }
                }
                List oldItems = r.getItems();
                oldItems.clear();
                oldItems.addAll(validItems);
            }
        }
```

```
    }
}
```

The scope of the synclet is to remove all items from the incoming message that do not have a Source element. For example, the Motorola V500 phone sometimes sends erroneous <Item></Item> elements that are not allowed in SyncML. With the above code, those Items will be removed before the message is processed by the management engine.

Configuring an Input Synclet

You configure the input synclet by telling the Pipeline Manager to insert the new synclet in the input pipeline, as shown in the following server-side JavaBean:

Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<java version="1.4.0" class="java.beans.XMLDecoder">
 <object class="com.funambol.framework.engine.pipeline.PipelineManager">
  <void property="inputProcessors">
    <array class=
      "com.funambol.framework.engine.pipeline.InputMessageProcessor"
     length="1">
      <void index="0">
        <object class="com.funambol.dm.synclet.MotorolaV500"/>
      </void>
    </array>
  </void>
  <void property="outputProcessors">
    <array class=
      "com.funambol.framework.engine.pipeline.OutputMessageProcessor"
     length="0"/>
  </void>
 </object>
</java>
```

Postprocessing an Outgoing Message

To postprocess an outgoing message, you create an output processor component and configure the Pipeline Manger accordingly.

Creating an Output Synclet

An output synclet is a class that implements the `com.funambol.framework.engine.pipeline.OutputMessageProcessor` interface. This interface defines a single method,

```
void postProcessMessage(MessageProcessingContext context, SyncML msg)
```

The concepts behind output message processing are the same as with input processing.

An example of an output synclet is the `com.funambol.server.engine.RespURISynclet` class. The scope of this synclet is to insert the RespURI element into the outgoing message; this element tells the client the URL to which the next message is sent. The code is as follows:

Example:

```
public class RespURISynclet
implements OutputMessageProcessor {
    // ------------------------------------------------------- Constants
    public static final String PARAM_SESSION_ID = "sid";
    // ---------------------------------------- OutputMessageProcessor
    public void postProcessMessage(MessageProcessingContext
                                       processingContext,
                                   SyncML message)
    throws Sync4jException {
        Configuration config = Configuration.getConfiguration();
        String sessionId = (String)processingContext.getProperty(
                                       processingContext.PROPERTY_SESSIONID);
        if (sessionId == null) {
            if (log.isLoggable(Level.INFO)) {
                log.info(processingContext.PROPERTY_SESSIONID + " is null!
Synclet ignored");
            }
            return;
        }

        String serverUri =
            config.getStringValue(ConfigurationConstants.CFG_SERVER_URI);

        message.getSyncHdr().setRespURI(
            serverUri                       +
            '?'                             +
            PARAM_SESSION_ID                +
            '='                             +
            sessionId
        );
    }
}
```

Configuring an Output Synclet

You configure the output synclet by telling the Pipeline Manager to insert the new synclet in the output pipeline, as shown in the following server-side JavaBean (using the same configuration for the input pipeline as in the preceding section on the input synclet).

Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<java version="1.4.0" class="java.beans.XMLDecoder">
 <object class="com.funambol.framework.engine.pipeline.PipelineManager">
  <void property="inputProcessors">
    <array class=
      "com.funambol.framework.engine.pipeline.InputMessageProcessor"
     length="1">
      <void index="0">
        <object class="com.funambol.dm.synclet.MotorolaV500"/>
      </void>
    </array>
  </void>
  <void property="outputProcessors">
    <array class=
      "com.funambol.framework.engine.pipeline.OutputMessageProcessor"
     length="1">
      <void index="0">
        <object class="com.funambol.server.engine.RespURISynclet"/>
      </void>
    </array>
  </void>
 </object>
</java>
```

Chapter 5 Implementing Management Operations

This chapter describes extending the Funambol DM Server by developing custom management operations.

Topics

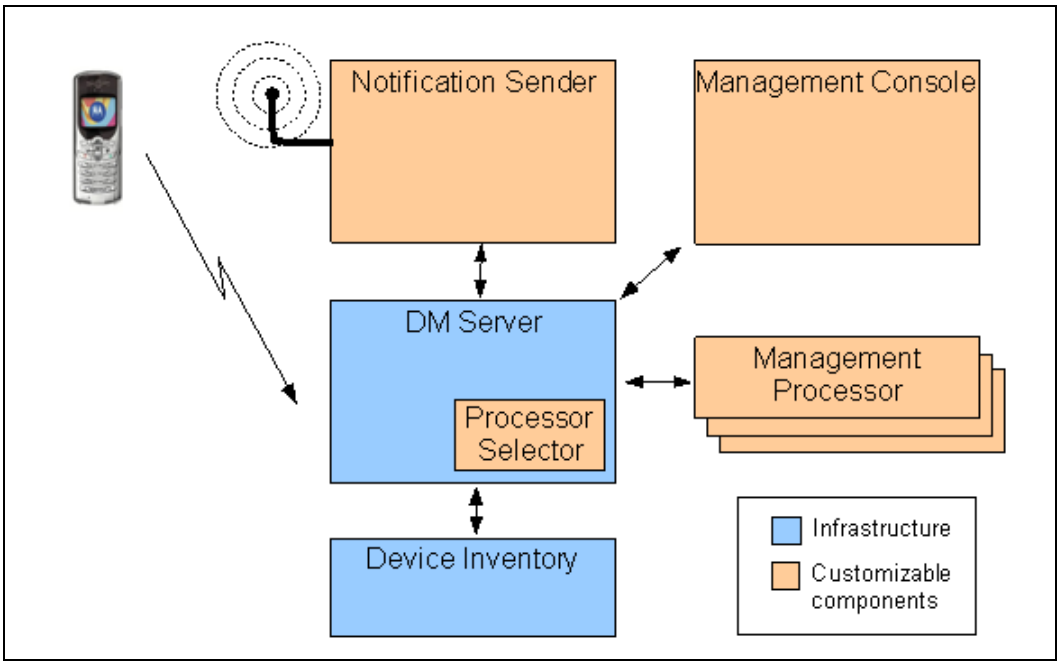
Overview

A management operation is a sequence of management commands that the server sends to the device in order to perform a higher level task. For example, in the case of the client settings provisioning, a "setBrowserSettings" operation is translated into a sequence of Get/Replace commands that will result in setting the phone browser configuration.

The Management Engine is the core component that handles device management sessions and then operations. It implements the protocol requirements but delegates to external management processors the accomplishment of the management actions to perform during a management session.

When a client starts a new management session, the Management Engine selects the Management Processor to use by the means of the Manager Selector. The selector will make its choice based on the content of the first device information sent by the client in the SyncML DM PKG 1.

The architecture of the management engine is shown below.



The orange colored components are those that can be customized. In this section we will focus on management selector and processor developments.

Creating a Processor Selector

The Processor Selector component is represented by an implementation of the interface `com.funambol.framework.server.dm.ProcessorSelector`, which is defined by the following method:

Method	Description
ManagementProcessor getProcessor(DeviceDMSession dms, DevInfo devInfo)	Called by the Management Engine at the beginning of a management session to determine the manager that must handle the session.

Two simple Processor Selector implementations are provided out of the box: `DeviceIdProcessorSelector`, which associates management processors to sets of device identifiers; and `OperationProcessorSelector`, which associates a management processor to the operation stored in the device management state.

DeviceIdProcessorSelector

This is represented by the class `com.funambol.server.dm.DeviceIdProcessorSelector`. It is configured with an array of associations <regexp>-<management_processor>, where <regexp> is a regular expression interpreted by the JDK package `java.util.regex` and used to match the device id; <management_processor> is a server side bean configuration path. If no device id matches any of the given regexp, a default processor will be returned; otherwise the first match is returned.

An example of a `DeviceIdProcessorSelector` configuration file is as follows:

Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<java version="1.4.2" class="java.beans.XMLDecoder">
 <object class="com.funambol.server.dm.DeviceIdProcessorSelector">
  <void property="defaultProcessor">
   <string>com/funambol/server/dm/manager/DefaultProcessor.xml</string>
  </void>
  <void property="patterns">
   <array class="com.funambol.framework.tools.PatternPair" length="2">
    <void index="0">
     <object class="com.funambol.framework.tools.PatternPair">
      <void property="manager">
       <string>com/funambol/server/dm/manager/DeviceDetailProcessor.xml
       </string>
      </void>
      <void property="pattern">
       <string>IMEI:333*</string>
      </void>
     </object>
    </void>
    <void index="1">
     <object class="com.funambol.framework.tools.PatternPair">
```

```
      <void property="manager">
       <string>com/funambol/server/dm/manager/SettingsProcessor.xml</string>
      </void>
      <void property="pattern">
       <string>IMEI:3335{3}1*</string>
      </void>
     </object>
    </void>
   </array>
  </void>
 </object>
</java>
```

The `DeviceIdProcessorSelector` class is a good example of how to develop a selector. A simplified version of the source code is shown below.

Example:

```
public class DeviceIdProcessorSelector
implements ProcessorSelector, LazyInitBean {
    // ------------------------------------------------------------ Private data
    private Pattern[] regexps;
    // ---------------------------------------------------------- Properties
    /**
     * The pattern-pairs used to metch device ids
     */
    private PatternPair[] patterns;

    /**
     * Sets patterns
     *
     * @param patterns the new patterns
     */
    public void setPatterns(PatternPair[] patterns) {
        this.patterns = patterns;
    }

    /**
     * Gets patterns
     *
     * @return the patterns property
     */
    public PatternPair[] getPatterns() {
        return patterns;
    }

    /**
     * The default processor server bean name
     */
    private String defaultProcessor;

    /**
     * Sets defaultProcessor
     *
     * @param defaultProcessor the new default processor name
     */
    public void setDefaultProcessor(String defaultProcessor) {
```

```
        this.defaultProcessor = defaultProcessor;
    }

    /**
     * Returns defaultProcessor
     *
     * @return defaultProcessor property value
     */
    public String getDefaultProcessor() {
        return this.defaultProcessor;
    }

    // ------------------------------------------------- ProcessorSelector

    /**
     * @param sessionId the management session id: ignored
     * @param devInfo the device info
     *
     * @see ProcessorSelector
     */
    public ManagementProcessor getProcessor(DeviceDMState dms, DevInfo
devInfo) {
        String beanName = defaultProcessor;

        String device = devInfo.getDevId();

        Matcher m;
        for (int i=0; i<regexps.length; ++i) {
            m = regexps[i].matcher(device);
            if (m.matches()) {
                beanName = patterns[i].processor;
                break;
            }
        }

        ManagementProcessor processor = null;
        try {
            processor = (ManagementProcessor)

Configuration.getConfiguration().getBeanInstanceByName(beanName);
        } catch (Exception e) {
            // error handling
        }

        return processor;
    }

    // ---------------------------------------------------- LazyInitBean

    /**
     * During bean initialization all the given regular expressions are
compiled.
     * If there are errors, a BeanInitializationException is thrown.
     *
     * @throws BeanInitializationException if one of the patterns cannot be
compiled
     */
    public void init() throws BeanInitializationException {
        if ((patterns == null) || (patterns.length == 0)) {
            regexps = new Pattern[0];
            return;
        }
```

```
        regexps = new Pattern[patterns.length];
        for (int i=0; i<patterns.length; ++i) {
            try {
                regexps[i] = Pattern.compile(patterns[i].pattern);
            } catch (Exception e) {
                if (log.isLoggable(Level.SEVERE)) {
                    log.severe( "Error compiling pattern '"
                              + patterns[i].pattern
                              + "': "
                              + e.getMessage()
                              );
                }
                throw new BeanInitializationException(
                   "Error compiling pattern '" + patterns[i].pattern + "'", e
                );
            }
        }
    }
}
```

Most of the methods are getters and setters for the properties that we want to be able to configure through the XML document seen above. The core of the class is the *getSelector()* method, which tries a match between the device id (extracted from the DevInfo object) and the given regular expressions. If a match is found, the corresponding processor name is considered a server side JavaBean and then is instantiated by the means of the Configuration object.

Note also the use of lazy initialization: init() is called after the instance is created and all properties have been set. It gives `DeviceIdProcessorSelector` the opportunity to compile the regular expressions specified in the configuration file as strings.

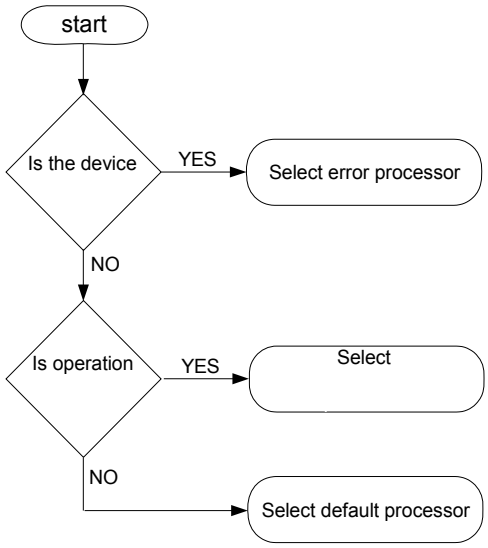
OperationProcessorSelector

This is implemented by the `com.funambol.server.engine.dm.OperationProcessorSelector` class. This selector is used as a dispatcher – it reads the operation to perform on a given device and uses that operation to build the name of the processor that should process the request. This processor is configured with an error processor name (to be used if the device state is 'E' - error) and a default processor name (to be used when no other processors could be selected).

The management processor name is constructed as follows:

prefix + operation + suffix

Where prefix and suffix are configurable values and operation is read from the device management state.



The algorithm used to select the correct management state for the device currently under management is represented in the above figure. If the device management session is in an error state, the error processor is selected. If instead, the device management session is in any other state, the operation field, if specified, is used to select the right processor. Otherwise, the default selector will be used.

An example of an OperationProcessorSelector configuration file is as follows:

Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<java version="1.4.2" class="java.beans.XMLDecoder">
 <object class="com.funambol.server.dm.OperationProcessorSelector">
  <void property="defaultProcessor">
   <string>com/funambol/server/dm/processor/DefaultProcessor.xml</string>
  </void>
  <void property="errorProcessor">
   <string>com/funambol/server/dm/processor/ErrorProcessor.xml</string>
  </void>
  <void property="namePrefix">
   <string>com/funambol/server/dm/processor/</string>
  </void>
  <void property="namePostfix">
   <string>.xml</string>
  </void>
 </object>
</java>
```

Configuring the Management Engine

To configure the management engine in order to use a specific processor selector, set the `server.dm.selector` property in Funambol.properties.

Example:

```
server.dm.selector=com/funambol/server/dm/OperationProcessorSelector.xml
```

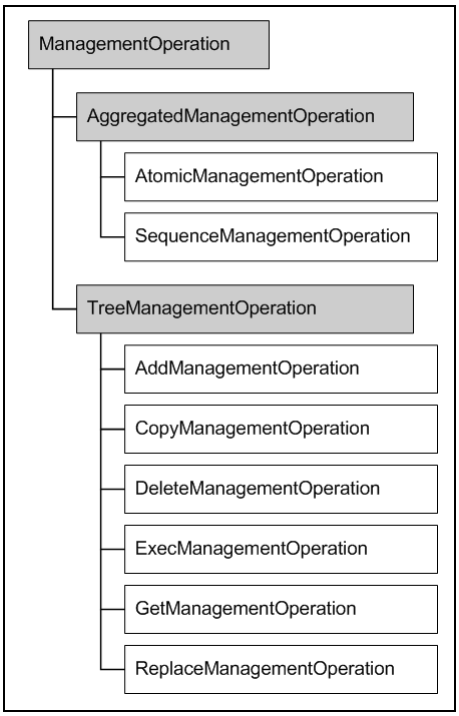
Creating a Management Processor

A Management Processor is represented by the interface `com.funambol.framework.engine.dm.ManagementProcessor`, which defines the following methods:

Method	Description
void beginSession(String sessionId, Principal principal, int type, DevInfo info, DeviceDMState dmstate)	Called when a management session is started for the given principal. SessionId is the content of the SessionID element of the OTA DM message; type is the management session type (as specified in the message Alert); info is the device info of the device under management; dmstate is the device management state, which represents a row of the fnbl_dm_state table.
void endSession(int completionCode)	Called when the management session is closed. CompletionCode can be one of the following: • STATE_COMPLETED • STATE_ABORTED • STATE_ERROR These constants are defined in `com.funambol.framework.engine.dm.DeviceDMState`.
ManagementOperation[] getNextOperations()	Called to retrieve the next management operations to be performed.
void setOperationResults (ManagementOperationResult[] results)	Called to set the results of a set of management operations.
String getName()	Name to uniquely identify the management processor instance (each installed management processor should have a different name in its configuration file).

ManagementOperation

This class represents an action that can be performed on a client management tree, such as a Get, Replace, Exec and so on. It belongs to the `com.funambol.framework.engine.dm` package.



ManagementOperation can represent one of the following actions (for additional information, see the SyncML Device Management Representation Protocol, version 1.1.2):

- Add
- Atomic
- Copy
- Delete
- Exec
- Get
- Replace
- Sequence

To represent all possible operations, the hierarchy shown above is implemented; gray boxes are abstract classes, white boxes are concrete implementations.
`com.funambol.framework.engine.dm.ManagementOperation` is an abstract class used for abstraction purposes only.

`AggregatedManagementOperation` adds the following methods:

Method	Description
ManagementCommand[] getCommands()	Returns the contained commands.
void setCommands(ManagementCommand[] commands)	Sets the commands aggregation.

`TreeManagementOperation` adds the following methods:

Method	Description
Map getNodes()	Returns the management nodes affected by the operation.
void setNodes(Map)	Sets the management nodes affected by the operation.

The Map can contain the following:

- A pair of name/value. The value can be null performing a Get or a Delete.
- A pair of name/TreeNode. A TreeNode has the following properties: name; format; type; value.

ManagementOperationResult

When a management action is performed on the client, result status and possibly data are returned. This information is wrapped into a `com.funambol.framework.engine.dm.ManagementOperationResult` object. It represents a combination of the following SyncML DM commands:

- Results
- Status

For details, refer to the *SyncML Device Management Representation Protocol* (see "Open Mobile Alliance Documentation, Version 1.1.2" on page 72).

`com.funambol.framework.engine.dm.ManagementOperation` has the following methods:

Method	Description
int getStatusCode()	Returns the corresponding status for the operation.
void setStatusCode(int statusCode)	Sets the operation status code.
Map getNodes()	Returns the nodes property.
void setNodes(Map nodes)	Sets the nodes property.

Method	Description
String getCommand()	Returns the requested command, e.g., Add, Replace, Delete and so on.
void setCommand(String command)	Sets the requested command, e.g., Add, Replace, Delete and so on.

Note that the nodes properties may contain results if the ManagementOperationStatus regards a Get, or a set of nodes if it relates to a status of any command with items in it. For example, if the following status is returned for a Delete command:

Example:

```
<Status>
     <CmdID>2</CmdID>
     <MsgRef>1</MsgRef>
     <CmdRef>1</CmdRef>
     <Cmd>Delete</Cmd>
     <TargetRef>./DevInfo/Lang</TargetRef>
     <Data>405</Data>
</Status>
```

The corresponding `ManagementOperationResults` would have:

Example:

```
statusCode: 405
command: Delete
nodes: {./DevInfo/Lang}
```

Using Scripting Management Processors

The ability to implement your own management processing is a powerful tool for the development of device management applications. However, the fact that you have to develop a java class, compile it and embed it into the server may be somehow complicated. For this reason, the Funambol DM Server provides out-of-the-box a concrete implementation of a management processor that makes things much simpler.

The class `com.funambol.server.engine.dm.ScriptManagementProcessor` is a concrete implementation of the `ManagementProcessor` interface that uses a scripting language to carry on the required management logic. The scripting language supported by the current Funambol DM Server implementation is BeanShell (see "Other Resources" on page 73).

The interpreter is created once in the ManagementProcessor's *beginSession()* method and is initialized setting the scripting variable listed below and running the script specified in the *scriptFile* property. Scripts are located under the config path `com/funambol/server/dm/processor/bsh`.

The script specified in *scriptFile* must have five entry points: *init()*, *getNextOperations()*, *setOperationResults()*, *setGenericAlerts()*, and *endSession()*. In order to keep the interaction between `ScriptManagementProcessor` and the underlying scripting engine, input and output values are passed by variables and not as input parameters and return values.

Scripting Variables

The following scripting variables are set in the interpreter environment:

Variable	Description
processor	The ManagementProcessor instance reference.
principal	User principal to be managed.
devInfo	Device info of the device to be managed.
managementType	Value given by the device when starting the management session (such as server or client initiated management session).
config	The configuration object used to get server side JavaBeans objects and other configuration parameters.
sessionId	The current session identifier.
log	The FunambolLogger to use for logging.
dmstate	The DeviceDMState object associated with the session.

The following scripting variables are input/output variables that the management script and the management processor share:

Variable	Type	Description
operations	OUT	ManagementOperation[] to be returned to the device management engine.
results	IN	ManagementOperationResult[] returned by the device management engine.

Scripting Processor Example

A good example of how to develop a management processor script is represented by the GetDeviceDetails script used to retrieve from a device some of its ./DevDetail parameters. This script implements the GetDeviceDetails management operation. The code is the following.

Example:

```
import java.util.*;
import java.util.logging.*;

import com.funambol.framework.core.*;
import com.funambol.framework.engine.dm.*;

// ---------------------------------------------------------------------------

final String DEVDETAIL_FWV = "./DevDetail/FwV";
final String DEVDETAIL_SWV = "./DevDetail/SwV";
final String DEVDETAIL_HWV = "./DevDetail/HwV";

// ---------------------------------------------------------------------------

String buildDetailString(HashMap nodes) {
    StringBuffer xml = new StringBuffer();

    xml.append("<DevDetail>")
       .append("<DevId>").append(devInfo.devId).append("</DevId>")
       .append("<Man>").append(devInfo.man).append("</Man>")
       .append("<Mod>").append(devInfo.mod).append("</Mod>")
       .append("<Lang>").append(devInfo.lang).append("</Lang>")
       .append("<FwV>").append(valueOf(nodes{DEVDETAIL_FWV})).append("</
FwV>")
       .append("<SwV>").append(valueOf(nodes{DEVDETAIL_SWV})).append("</
SwV>")
       .append("<HwV>").append(valueOf(nodes{DEVDETAIL_HWV})).append("</
HwV>")
       .append("</DevDetail>");

    return xml.toString();
}

// ---------------------------------------------------------------------------

void init() {
    log.info("Management script initialization");
    cont = true;
}
```

```
void getNextOperations() {
    log.info("getNextOperations!");

    nodes = new HashMap();

    nodes.put(DEVDETAIL_FWV, "");
    nodes.put(DEVDETAIL_HWV, "");
    nodes.put(DEVDETAIL_SWV, "");

    o = new GetManagementOperation();
    o.nodes = nodes;
    if (cont) {
        operations = new ManagementOperation[] { o };
        cont = false;
    } else {
        operations = new ManagementOperation[0];
    }
}

void setOperationResults() {
    log.info("setOperationResults!");

    String fwv = null;
    String swv = null;
    String hwv = null;

    details = "";
    for (result: results) {
        if (log.isLoggable(Level.FINE)) {
            log.fine("status code: " + result.statusCode);
            log.fine("for: " + result.nodes);
            log.fine("command: " + result.command);
        }

        if (Get.COMMAND_NAME.equals(result.command)) {
            if (result.statusCode != 200) {
                if (log.isLoggable(Level.INFO)) {
                    log.info( "Received error code "
                            + result.statusCode
                            + " for nodes "
                            + result.nodes
                            );
                    log.info( "Device: "
                            + devInfo.devId
                            + "; operation: GetDeviceDetail; sessionId: "
                            + sessionId
                            );
                }
            } else {
                details = buildDetailString(result.nodes);
            }
        }
    }

    //
    // If any error occurred, error contains the error message
    //
    if (status.length() == 0) {
        status = "0:"; // it means ok!
    }
```

```
    if (log.isLoggable(Level.FINE)) {
        log.fine("Device detail: " + details);
    }

    //
    // Reset the operation so that GetDeviceDetails won't be erroneously
    // called again
    //
    dmstate.operation = null;
    dmstate.state = DeviceDMState.STATE_COMPLETED;
}

void endSession(int code) {
    log.info("endSession with code: " + (char)code);
}

// ---------------------------------------------------------------------

log.info("Global script!");

importCommands("com/funambol/server/dm/processor/bsh/command");

cont = true;

status = new StringBuffer();
```

The script looks very similar to a Java class without *main()*. As said before, when the interpreter is first created, this script is evaluated; this makes the global part of the script (the statements in the outermost scope) to be interpreted and executed. In the case above, the utility commands are imported and some variables are initialized. Plus, remember that ScriptManagementProcessor will have set the scripting variables in the table above.

Before calling any other method of the script, ScripManagementProcessor calls *init()*; this is a good point where to put initialization code. Note that in our example there is only the initialization of the *cont* variable. It is done again for two reasons:

- The global cont=true is done so that the variable cont will be created in the interpreter global scope (it is like a declaration)
- The *init()* method could be called more then once (but always once per management session) – for example when initialization is retried in the case of a failed authentication.

The management processor asks the script processors which commands to send to the client calling *getNextOperation()*. In our case, we have to send a Get command for the three parameters *./DevDetail/FwV*, *./DevDetail/SwV*, *./DevDetail/HwV*; therefore, the needed parameters are set in the nodes map and a new GetManagementOperation is created. Note that a simplified syntax is used to set the operation's nodes.

The management operation so created is returned to the management processor as an array of ManagementOperation objects setting the output variable *operations*. *cont* is then set to false to remember that the Get command has already been returned to the processor.

The processor will then processes all the returned commands and will collect the results from the device. Those results are translated to ManagementOperationsResult objects and *setOperationResults()* is called. Again, note that the ManagementOperationResult[] array is passed to the script in the input scripting variable *results*.

setOperationResults() processes the status and returned data and builds the device detail string calling *buildDetailString()*.

Since a DM session is intended to be an iterative process, the processor will ask again for the next operations to send calling again *getNextOperation()*. This time cont is false and an empty array is returned. This tells the management processor that no more management commands are required.

At the end of the process the management processor will call *endSession()*.

Chapter 6 External Applications

This chapter describes how the Funambol DM Server interacts with external applications.

Topics

External Application Interfaces

The Funambol DM Server interacts with the external world in many ways. Any extensible module (such as synclets, message processors, and so on) can interface with external software as needed. A good example is the Notification Sender as described in "Sender Interface" on page 62. This type of integration is mainly used when going from the Funambol DM Server to an external system.

To make Funambol DM Server accessible to other networked applications, an EJB layer is provided. This can be accessed by any EJB client, on the same host or remotely. This EJB layer can be easily wrapped by a web services layer using a WS toolkit such as Apache Axis (for details, see "Other Resources" on page 73).

The EJB Layer

The management server can be accessed through the ManagementBean stateless session EJB. This is implemented by the following classes:

- `com.funambol.server.engine.dm.ejb.ManagementBean`
- `com.funambol.server.engine.dm.ejb.ManagementLocal`
- `com.funambol.server.engine.dm.ejb.ManagementRemote`
- `com.funambol.server.engine.dm.ejb.ManagementHomeLocal`
- `com.funambol.server.engine.dm.ejb.ManagementHomeRemote`

The following interface is exposed by the ManagementBean:

Method	Description
bootstrap(int messageType, int transportType, String deviceUri, String phoneNumber, String username, String password, String info)	This method is used to create a new device into the Funambol DM Server system. It may result in sending a bootstrap message to the physical device or not, depending by the configured sender. • messageType - the type of the bootstrap message as define in NotificationConstants • transportType - the type of the transport as define in NotificationConstants • deviceUri - the device id • phoneNumber - the phone number of the device • username - the user name with which the device will do the next device management • password - the password with which the device will do the next device management • info - application specific info
sendNotification(int messageType, int transportType, String phoneNumber, String operation, String info)	Sends a notification message to the device with the given phoneNumber • messageType – the type of the notification message as define in *NotificationConstants* • transportType – the type of the transport as define in *NotificationConstants* • phoneNumber – the phone number • operation – the management operation to be performed • info – application specific detail information
executeManagementOperation(String phoneNumber, String operation, String info)	Executes the management sequence identified by the given operation name. • phoneNumber – the phone number • operation – the management operation name • info – application specific detail information

Implementing the Sender Component

This section describes how to implement the Sender component.

Sender Interface

This component dispatches notification and bootstrap messages. The behavior of a Sender is defined by the interface `com.funambol.framework.notification.Sender`. You can create multiple implementations of the interface, each specific to a particular protocol or delivery mechanism.

The following interface is exposed by the ManagementBean:

Method	Description

void sendMessage(int messageType,
String phoneNumber,
byte[] message,
String info)
	This method is used to send a single binary message (notification or bootstrap).
	• messageType – the type of message. It can be one of the following:
	`MESSAGE_TYPE_NOTIFICATION_GENERIC`.
	`MESSAGE_TYPE_BOOTSTRAP_WAP`
	`MESSAGE_TYPE_BOOTSTRAP_PLAIN`
	• phoneNumber – the recipient of the messages.
	• message – the message to be sent.
	• info – application-specific detail information.

void sendMessages(int messageType, String[] phoneNumbers, byte[][] messages, String info)	This method is used to send multi-binary notification messages. • messageType – the type of message. In the current version, it can only be `MESSAGE_TYPE_NOTIFICATION_GENERIC`. • phoneNumbers – the recipients of the messages. • messages – the messages to be sent. • info – application-specific detail information.

Method	Description

public void sendMessages(int messageType,
String contentType,
String[] macs,
int[] authMethods,
String[] phoneNumbers,
byte[][] messages,
String info)
throws NotificationException;
	This method is used to send multi-binary bootstrap messages
	• messageType – the type of message. It can be one of the following:
	`MESSAGE_TYPE_BOOTSTRAP_WAP`
	`MESSAGE_TYPE_BOOTSTRAP_PLAIN`
	• contentType – the content type of the message. In the current version, it is the value:
	`application/vnd.syncml.dm+wbxml`
	• macs[] – the macs values of the messages.
	• authMethod[] – the authentication method to use: Valid values:
	`AUTH_METHOD_NETWPIN`
	`AUTH_METHOD_USERPIN`
	`AUTH_METHOD_USERNETWPIN`
	• phoneNumbers – the recipients of the messages.
	• messages – the messages to be sent.
	• info[] – application-specific detail information.

All constants used in the Sender interface are defined in `com.funambol.framework.notification.NotificationConstants`.

Sender Component Configuration

You configure the sender components using the following server-side JavaBeans:

- NotificationSender – `com/funambol/server/engine/dm/NotificationSender.xml`
- BootStrapSender – `com/funambol/server/engine/dm/BootstrapSender.xml`

A sample configuration is shown below:

Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<java version="1.4.2" class="java.beans.XMLDecoder">
    <object class="com.funambol.dm.engine.MySender">
        <... any MySender specific property ...>
    </object>
</java>
```

NOTE: Since Funambol does not implement a service to deliver SMS messages (i.e., shipping notification/bootstrap messages), a custom component must be implemented. You can configure the Funambol DM Server to use such a component by simply changing the appropriate server JavaBean.

Chapter 7 Bootstrapping Devices

Topics

Bootstrap Overview

The Open Mobile Alliance defines *bootstrap* as "the process of provisioning the DM client to a state where it is able to initiate a management session to a new DM server." The DM client requires the following information to perform a management session:

- Account information
- Connectivity information

The DM Server uses the information contained in the `dm-server/config/com/funambol/server/engine/dm/SyncMLDMbootstrapMessage.xml` file to create the bootstrap message. The file is an XML serialization of the `com.funambol.framework.core.dm.ddf.SyncMLDM` class and contains the information to send to the device. In addition, the following information is created or set by the server at the time of the bootstrap:

Information	Example
Name of the account	Funambol
Address to be used in the management sessions	`http://myserver:myport/funambol/dm`
Server identifier	funambol
Server password	srvpwd
Server nonce	cy8rVlFOVi5NJmokM0xcYw==
Client username	funambol
Client password	funambol
Client nonce	PyQzSUM4PDwjJjw/WzlKLA==
Preferred authentication type	syncml:auth-md5

The following is an example of the `SyncMLDMbootstrapMessage.xml` file:

Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<java version="1.4.2_01" class="java.beans.XMLDecoder">
 <object class="com.funambol.framework.core.dm.ddf.SyncMLDM">
  <void property="dmAcc">
   <object class="com.funambol.framework.core.dm.ddf.DMAcc">
    <void property="DMAccounts">
     <object class="org.apache.commons.collections.map.ListOrderedMap">
      <void method="put">
       <!-- This name will be replaced from the server -->
       <string>AccountName</string>
       <object class="com.funambol.framework.core.dm.ddf.DMAccount">
        <void property="conRef">
         <string>test</string>
        </void>
       </object>
      </void>
     </object>
    </void>
   </object>
  </void>
  <void property="con">
   <object class="com.funambol.framework.core.dm.ddf.ConNode">
    <void property="connections">
     <void method="put">
      <string>test</string>
      <object class="com.funambol.framework.core.dm.ddf.Connection">
       <void property="PX">
        <object class="com.funambol.framework.core.dm.ddf.PX">
         <void property="address">
          <string>address</string>
         </void>
         <void property="addressType">
          <string>5</string>
         </void>
         <void property="auths">
          <object class="org.apache.commons.collections.map.ListOrderedMap">
           <void method="put">
            <string>auth-method</string>
            <object class="com.funambol.framework.core.dm.ddf.Auth">
             <void property="id">
              <string>username</string>
             </void>
             <void property="secret">
              <string>password</string>
             </void>
            </object>
           </void>
          </object>
         </void>
         <void property="portNbr">
          <string>80</string>
         </void>
        </object>
       </void>
```

```
        <void property="nap">
         <object class="com.funambol.framework.core.dm.ddf.NAP">
          <void property="address">
           <string>address</string>
          </void>
          <void property="addressType">
           <string>5</string>
          </void>
          <void property="auths">
           <object class="org.apache.commons.collections.map.ListOrderedMap">
            <void method="put">
             <string>PAP</string>
             <object class="com.funambol.framework.core.dm.ddf.Auth">
              <void property="id">
               <string>username</string>
              </void>
              <void property="secret">
               <string>password</string>
              </void>
             </object>
            </void>
           </object>
          </void>
          <void property="bearer">
           <string>11</string>
          </void>
         </object>
        </void>
       </object>
      </void>
     </void>
    </object>
   </void>
  </object>
</java>
```

WAP Provisioning Profile

The content of the bootstrap message is based on the *OMA Provisioning Content Specification* using the registered document 'w7' that specifies how the APPLICATION characteristic should be used to bootstrap a DM device. For an example, see "Bootstrap XML Message Examples" on page 74.

An external application can start a bootstrap process with this profile using the `bootstrap()` method of the external application API, with the following message type:

```
com.funambol.framework.notification.NotificationConstants.
MESSAGE_TYPE_BOOTSTRAP_WAP.
```

For details on the external application API, see "External Application Interfaces" on page 60.

The process of generating and sending a bootstrap message by the server consists of the following steps:

1. Update the database with the information of the device to be bootstrapped.
2. Read the `SyncMLboostrapMessage.xml` file and create a new SyncMLDM object.
3. Update the object created at the previous step with the server information.
4. Convert the SyncMLDM object in a WBXML WAP message and send it using the configured BootStrap sender.

Plain Profile

The content of the bootstrap message is a SyncML DM message containing the nodes to be added to the device. For an example, see "Bootstrap XML Message Examples" on page 74.

An external application can start a bootstrap process with this profile using the `bootstrap()` method of the external application API, with the following message type:

`com.funambol.framework.notification.NotificationConstants.MESSAGE_TYPE_BOOTSTRAP_PLAIN`.

For details on the external application API, see "External Application Interfaces" on page 60.

The process of generating and sending a bootstrap message by the server consists of the following steps:

1. Update the database with the information of the device to be bootstrapped.
2. Read the `SyncMLboostrapMessage.xml` file and create a new SyncMLDM object.
3. Update the object created at the previous step with the server information.
4. Create a SyncML DM 1.1.2 message with the bootstrap information.
5. Convert the message in WBXML and send it using the configured BootStrap sender

Appendix A Appendix

Topics

Resources

This section lists resources you may find useful.

Related Documentation

This section lists documentation resources you may find useful.

Funambol DM Server Documentation

The Funambol DM Server documentation set includes the following documents:

- *Funambol DM Server Administration Guide*: Read this guide for server installation instructions.
- *Funambol DM Server Developer's Guide*: This document.
- *Funambol DM Server DM Demo User's Guide*: Read this guide for a demonstration of the basic management operations of the DM Server.
- *Funambol DM Server SCTS Testing Guide*: Read this guide for instructions on using the SCTS tool to test devices and the DM Server for SyncML 1.1.2 compliance.

Open Mobile Alliance Documentation, Version 1.1.2

- SyncML Device Management Protocol
- SyncML Device Management Tree and Description
- SyncML Device Management Bootstrap
- SyncML Notification Initiated Session
- SyncML Device Management Security
- SyncML Device Management Standardized Objects
- SyncML Device Management Representation Protocol
- SyncML Data Sync Protocol
- SyncML Representation Protocol (version 1.1)

Other Resources

For information on BeanShell, visit `http://www.beanshell.org`.

Read the *BeanShell User's Guide* at `http://www.beanshell.org/manual/contents.html`.

For information on Apache Axis, visit `http://ws.apache.org/axis/`.

Bootstrap XML Message Examples

WAP Profile

The following example is for demonstrative purposes only.

Example

```
<?xml version="1.0" encoding="UTF-8"?>
<wap-provisioningdoc version="1.0">
    <characteristic type="APPLICATION">
        <parm name="APPID"       value="w7"/>
        <parm name="NAME"        value="1"/>
        <parm name="PROVIDER-ID" value="funambol"/>
        <parm name="TO-NAPID"    value="test"/>
        <characteristic type="APPADDR">
            <parm name="ADDR" value="http://localhost/funambol/dm"/>
            <characteristic type="PORT">
                <parm name="PORTNBR" value="8080"/>
            </characteristic>
        </characteristic>
        <characteristic type="APPAUTH">
            <parm name="AAUTHLEVEL"  value="APPSRV"/>
            <parm name="AAUTHNAME"   value="funambol"/>
            <parm name="AAUTHSECRET" value="PkFcRTVRLzc1dUd1Qns1JA=="/>
            <parm name="AAUTHDATA"   value="Q3lHUkRRKUEhMlQnSH88Tg=="/>
        </characteristic>
        <characteristic type="APPAUTH">
            <parm name="AAUTHLEVEL"  value="CLIENT"/>
            <parm name="AAUTHNAME"   value="1"/>
            <parm name="AAUTHSECRET" value="1"/>
            <parm name="AAUTHDATA"   value="TzpNeD5FWSctMGRHPCdOMg=="/>
        </characteristic>
    </characteristic>
    <characteristic type="NAPDEF">
        <parm name="NAPID"        value="test"/>
        <parm name="BEARER"       value="11"/>
        <parm name="NAP-ADDRESS"  value="address"/>
        <parm name="NAP-ADDRTYPE" value="5"/>
        <characteristic type="NAPAUTHINFO">
            <parm name="AUTHTYPE"   value="PAP"/>
            <parm name="AUTHNAME"   value="username"/>
            <parm name="AUTHSECRET" value="password"/>
        </characteristic>
    </characteristic>
    <characteristic type="PXLOGICAL">
        <characteristic type="PXPHYSICAL">
            <parm name="PXADDR"     value="address"/>
            <parm name="PXADDRTYPE" value="5"/>
            <characteristic type="PORT">
                <parm name="PORTNBR" value="80"/>
            </characteristic>
            <characteristic type="PXAUTHINFO">
                <parm name="PXAUTH-TYPE" value="auth-method"/>
                <parm name="PXAUTH-ID"   value="username"/>
                <parm name="PXAUTH-PW"   value="password"/>
```

```
            </characteristic>
        </characteristic>
    </characteristic>
</wap-provisioningdoc>
```

Plain Profile

The following example is for demonstrative purposes only.

Example

```
<?xml version="1.0" encoding="UTF-8"?>
<SyncML>
    <SyncHdr>
        <VerDTD>1.1</VerDTD>
        <VerProto>DM/1.1</VerProto>
        <SessionID>0</SessionID>
        <MsgID>0</MsgID>
        <Target>
        <LocURI>1</LocURI>
        </Target>
        <Source>
        <LocURI>http://localhost:8080/funambol/dm</LocURI>
        </Source>
    </SyncHdr>
    <SyncBody>
        <Add>
            <CmdID>1</CmdID>
            <Item>
                <Target>
                    <LocURI>./SyncML/DMAcc/funambol</LocURI>
                </Target>
                <Meta>
                    <Format xmlns='syncml:metinf'>node</Format>
                </Meta>
            </Item>
            <Item>
                <Target>
                    <LocURI>./SyncML/DMAcc/funambol/Addr</LocURI>
                </Target>
                <Data>http://localhost/funambol/dm</Data>
            </Item>
            <Item>
                <Target>
                    <LocURI>./SyncML/DMAcc/funambol/AddrType</LocURI>
                </Target>
                <Data>1</Data>
            </Item>
            <Item>
                <Target>
                    <LocURI>./SyncML/DMAcc/funambol/PortNbr</LocURI>
                </Target>
                <Data>8080</Data>
```

```
</Item>
<Item>
    <Target>
        <LocURI>./SyncML/DMAcc/funambol/ConRef</LocURI>
    </Target>
    <Data>test</Data>
</Item>
<Item>
    <Target>
        <LocURI>./SyncML/DMAcc/funambol/ServerId</LocURI>
    </Target>
    <Data>funambol</Data>
</Item>
<Item>
    <Target>
        <LocURI>./SyncML/DMAcc/funambol/ServerPW</LocURI>
    </Target>
    <Data>PkFcRTVRLzc1dUd1Qns1JA==</Data>
</Item>
<Item>
    <Target>
        <LocURI>./SyncML/DMAcc/funambol/ServerNonce</LocURI>
    </Target>
    <Data>Q3lHUkRRKUEhMlQnSH88Tg==</Data>
</Item>
<Item>
    <Target>
        <LocURI>./SyncML/DMAcc/funambol/UserName</LocURI>
    </Target>
    <Data>1</Data>
</Item>
<Item>
    <Target>
        <LocURI>./SyncML/DMAcc/funambol/ClientPW</LocURI>
    </Target>
    <Data>1</Data>
</Item>
<Item>
    <Target>
        <LocURI>./SyncML/DMAcc/funambol/ClientNonce</LocURI>
    </Target>
    <Data>TzpNeD5FWSctMGRHPCdOMg==</Data>
</Item>
<Item>
    <Target>
        <LocURI>./SyncML/DMAcc/funambol/AuthPref</LocURI>
    </Target>
    <Data>syncml:auth-md5</Data>
</Item>
<Item>
    <Target>
        <LocURI>./SyncML/DMAcc/funambol/Name</LocURI>
    </Target>
    <Data>1</Data>
</Item>
<Item>
    <Target>
        <LocURI>./SyncML/Con/test</LocURI>
</Target>
```

```
        <Meta>
            <Format xmlns='syncml:metinf'>node</Format>
        </Meta>
    </Item>
    <Item>
        <Target>
            <LocURI>./SyncML/Con/test/NAP</LocURI>
        </Target>
        <Meta>
            <Format xmlns='syncml:metinf'>node</Format>
        </Meta>
        <Data></Data>
    </Item>
    <Item>
        <Target>
            <LocURI>./SyncML/Con/test/NAP/Bearer</LocURI>
        </Target>
        <Data>11</Data>
    </Item>
    <Item>
        <Target>
            <LocURI>./SyncML/Con/test/NAP/AddrType</LocURI>
        </Target>
        <Data>5</Data>
    </Item>
    <Item>
        <Target>
            <LocURI>./SyncML/Con/test/NAP/Addr</LocURI>
        </Target>
        <Data>address</Data>
    </Item>
    <Item>
        <Target>
            <LocURI>./SyncML/Con/test/NAP/Auth</LocURI>
        </Target>
        <Meta>
            <Format xmlns='syncml:metinf'>node</Format>
        </Meta>
    </Item>
    <Item>
        <Target>
            <LocURI>./SyncML/Con/test/NAP/Auth/PAP</LocURI>
        </Target>
        <Meta>
            <Format xmlns='syncml:metinf'>node</Format>
        </Meta>
    </Item>
    <Item>
        <Target>
            <LocURI>./SyncML/Con/test/NAP/Auth/PAP/Id</LocURI>
        </Target>
        <Data>username</Data>
    </Item>
    <Item>
        <Target>
            <LocURI>./SyncML/Con/test/NAP/Auth/PAP/Secret</LocURI>
        </Target>
        <Data>password</Data>
    </Item>
```

```
                    <Item>
                        <Target>
                            <LocURI>./SyncML/Con/test/PX</LocURI>
                        </Target>
                        <Meta>
                            <Format xmlns='syncml:metinf'>node</Format>
                        </Meta>
                        <Data></Data>
                    </Item>
                    <Item>
                        <Target>
                            <LocURI>./SyncML/Con/test/PX/PortNbr</LocURI>
                        </Target>
                        <Data>80</Data>
                    </Item>
                    <Item>
                        <Target>
                            <LocURI>./SyncML/Con/test/PX/AddrType</LocURI>
                        </Target>
                        <Data>5</Data>
                    </Item>
                    <Item>
                        <Target>
                            <LocURI>./SyncML/Con/test/PX/Addr</LocURI>
                        </Target>
                        <Data>address</Data>
                    </Item>
                    <Item>
                        <Target>
                            <LocURI>./SyncML/Con/test/PX/Auth</LocURI>
                        </Target>
                        <Meta>
                            <Format xmlns='syncml:metinf'>node</Format>
                        </Meta>
                    </Item>
                    <Item>
                        <Target>
                            <LocURI>./SyncML/Con/test/PX/Auth/auth-method</LocURI>
                        </Target>
                        <Meta>
                            <Format xmlns='syncml:metinf'>node</Format>
                        </Meta>
                    </Item>
                    <Item>
                        <Target>
                           <LocURI>./SyncML/Con/test/PX/Auth/auth-method/Id</LocURI>
                        </Target>
                        <Data>username</Data>
                    </Item>
                    <Item>
                        <Target>
                            <LocURI>./SyncML/Con/test/PX/Auth/auth-method/Secret</
LocURI>
                        </Target>
                        <Data>password</Data>
                    </Item>
                </Add>
                <Final></Final>
```

```
    </SyncBody>
</SyncML>
```

WAP Headers for Bootstrap Message

PLAIN Profile

Header

```
06 05 04 0B 84 C0 02 01 06 2E C2 91 80 92 45 36 34 30 37 42 37 42 30 46 37 42
46 38 39 37 43 32 45 44 37 43 43 45 46 35 31

35 43 30 37 44 42 31 44 32 34 33 39 34 00 AF 87
```

WDP Header

```
06:  User-Data-Header(UDHL) Length

05:  UDH IE Identifier Port Number

04:  UDH port number IE length

0B:  Destination port (high)

84:  Destination port (low)

C0:  Origination port (high)

02:  Origination port (low)
```

WSP Header

```
01:  Transaction ID / Push ID

06:  PDU Type(push)

2E:  Headerslength (content type + headers)

C2:  Content-type

91:  SEC

80:  Auth. method = 0

92:  MAC

MAC Value: 45 36 34 30 37 42 37 42 30 46 37 42 46 38 39 37 43 32 45 44 37 43
43 45 46 35 31 35 43 30 37 44 42 31 44 32 34 33 39 34 00

AF:  X-WAP-Application-ID

87:  x-wap-application:syncml.dm
```

WAP Profile

Header

```
06 05 04 0B 84 C0 02 01 06 2E B6 91 80 92 36 34 42 33 45 46 37 35 45 38 39 42
32 35 41 33 44 35 36 45 37 30 30 32 33 30 33

46 41 31 39 41 36 34 38 41 33 34 42 37 00 AF 82
```

WDP Header

```
06:  User-Data-Header(UDHL) Length
05:  UDH IE Identifier Port Number
04:  UDH port number IE length
0B:  Destination port (high)
84:  Destination port (low)
C0:  Origination port (high)
02:  Origination port (low)
```

WSP Header

```
01:  Transaction ID / Push ID
06:  PDU Type(push)
2E:  Headerslength (content type + headers)
B6:  Content-type
91:  SEC
80:  Auth. method = 0
92:  MAC
MAC Value: 36 34 42 33 45 46 37 35 45 38 39 42 32 35 41 33 44 35 36 45 37 30
30 32 33 30 33 46 41 31 39 41 36 34 38 41 33 34 42 37 00
AF:  X-WAP-Application-ID
82:  x-wap-application:wml.ua
```

Notification Message Using WAP Push

Notification Message Created by the DM Server

The following examples are valid notification messages with 'sync4j' as server id.

Example 1

```
81 6B 41 D3 1C 99 84 52 65 73 70 F8 C1 CC 32 C5 02 C0 00 00 00 00 04 06 73 79
6E 63 34 6A
```

Example 2

```
47 E3 FC D5 C5 09 81 36 AF 01 4F E7 9C 1C AD F1 02 C0 00 00 00 00 03 06 73 79
6E 63 34 6A
```

Complete SMS (WDP + WSP + Notification Message)

Example 1

```
06 05 04 0B 84 C0 02 01 06 03 C4 AF 87 81 6B 41 D3 1C 99 84 52 65 73 70 F8 C1
CC 32 C5 02 C0 00 00 00 00 04 06 73 79 6E 63 34 6A
```

Example 2

```
06 05 04 0B 84 C0 02 01 06 03 C4 AF 87 47 E3 FC D5 C5 09 81 36 AF 01 4F E7 9C
1C AD F1 02 C0 00 00 00 00 03 06 73 79 6E 63 34 6A
```

Example 3

```
06 05 04 0B 84 C0 02 01 06 03 C4 AF 87 A0 96 3B 47 B8 D0 B3 D7 4C 45 9F B5 44
35 98 B1 02 C0 00 00 00 00 09 06 73 79 6E 63 34 6A
```

Explanation of Example 3:

WDP Header:

```
06: User-Data-Header(UDHL) Length = 6 bytes

05: UDH IE Identifier Port Number

04: UDH port number IE length

0B: Destination port (high)

84: Destination port (low)

C0: Origination port (high)

02: Origination port (low)
```

WSP Header:

```
01: Transaction ID / Push ID
06: PDU Type(push)
03: Headers length (content type + headers)
C4: Content type
AF: X-WAP-Application-ID
87: Id for urn: x-wap-application:syncml.dm
```

Digest:

```
A0 96 3B 47 B8 D0 B3 D7 4C 45 9F B5 44 35 98 B1
```

Notification Message:

```
02 C0 00 00 00 00 09 06 73 79 6E 63 34 6A
```