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**OSGi Device Management  
Load & Volume Test Results  
Single-Host mPRM System**

Load & Volume Test Results	Version: 1.0
Load&Volume-Testi-Results-Single-Host.doc	Date: 23 July 2007

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## 1. Introduction

### 1.1 Test Goals

This document contains a summary of the load and volume tests covering basic OSGi Device Management functionality with a **single-host** mPRM system. The tests aim to determine the limits of a single mPRM host in regards to the maximum number of devices (either simultaneously or subsequently connecting to the mPRM server), as well as to measure how is the performance of the system influenced by the number of the online and/or registered devices.

The following generic test types have to be covered:

- Load Tests – this type of testing covers the performance of the system when a large number of the devices are simultaneously connected (the system maintains open permanent session with all of them) and a number of operations are executed with all of them at once.
- Volume Tests – this type of testing covers the performance of the system, with a very large number of registered devices (huge data volume in the database), which connects to the mPRM server periodically - thus only sub-set of them are connected to the system at the same time.

Both load and volume testing are performed with different number of devices to evaluate the impact of the performance according to the number of the devices.

### 1.2 Test Approach

The requirements for the number of OSGi device that should be connected simultaneously to the mPRM server for the needs of the tests highly exceed the number of hosts that can be used during the testing procedures. For this purpose a special simulation environment has been developed that allows a single OSGi framework running on a PC to behave as multiple OSGi devices.

The multi-OSGi simulation PC opens multiple management sessions to the mPRM, each session having a different ID, so the mPRM is treating them as separate distinct devices.

These tests are performed with multiple such PCs each simulating up to 3000 (configurable) simultaneously connected OSGi frameworks or unlimited number of subsequently connecting devices.

## 2. Test Cases Description

**Note:** this document contains only a more representative sub-set of all test procedures performed over each configuration, in order to keep it relatively short.

### 2.1 Load Tests Description

The tests described in the table below are performed with different number (10 000, 30 000, 50 000, ...) of simultaneously connected OSGi devices. The tests verify the stability of the system with the given load, as well as measure the time (total and per device) for execution of the each test case.

TC Name	Description
1.1. Simultaneous session establishment	Measure the system performance for establishing the management session. All devices are initially disconnected and begin to connect to the mPRM server simultaneously. During the establishment of the management session the mPRM performs synchronization of the configuration of the current device state with the data in backend database. The successful end of this test case is when all of the devices become online in the mPRM.

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1.2. Simultaneous session establishment with pending commands	<p>This test case is similar to the TC 1.1 above, but there in addition there are two management operations scheduled over all registered devices, which are executed right after session establishment (and state synchronization) over each of the devices.</p> <p>The two management commands, scheduled over the devices, are:</p> <ul style="list-style-type: none"> <li>• A simple command for changing of one system property</li> <li>• A command for downloading and installing of a relatively small (~20K) OSGi bundle.</li> </ul> <p>The successful end of this test case is when all of the devices become online in the mPRM and when the above two management operations are executed over each of the devices.</p>
1.3. Simple Commands Execution	<p>This test case measures the performance for instant execution of a simple management operation while all devices are connected to the system. The command is used in the test changes the value of one system property in the target OSGi frameworks.</p> <p>The successful end of this test case is when the command is executed over each of the devices the corresponding device configuration change is updated in the mPRM DB.</p>
1.4. Installing of a single bundle	<p>This test case measures the performance for instant execution of a management operation for downloading and installation of a single OSGi bundle with size ~100 K, while all devices are connected to the system.</p> <p>The successful end of this test case is when the command is executed over each of the devices the corresponding device software configuration change is updated in the mPRM DB.</p>
1.5. "Smart" bundle installation of multiple bundles	<p>This test case performs smart installation of a bundle, which depends of other 3 bundles. "Smart" installation means that mPRM evaluates the dependencies of this bundle and all of bundles, which it depends on and are not currently available on the device, will be installed as well. This results in installing of total of four bundles over each device. The total size of the bundles used for this test is ~250 K.</p> <p>The successful end of this test case is when the command is executed over each of the devices the corresponding device software configuration change is updated in the mPRM DB.</p>

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1.6. Uninstall by scripted filter	<p>Execution of a management operation over a set of bundles specified by a filtering condition. This means that mPRM will search the configuration of each device for bundles matching this filter and will perform the action over them. For this test the operation is the following:</p> <pre>UNINSTALL ("Bundle-Category" == "wap")</pre> <p>which means that mPRM will install all bundles, which bundle category property is "WAP". Since the previous test case (TC 1.5) has installed 4 such bundles, this TC should uninstall them from all devices.</p> <p>The successful end of this test case is when the command is executed over each of the devices the corresponding device software configuration change is updated in the mPRM DB.</p>
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## 2.2 Volume Tests Description

The tests described in the table below has to be performed with different (larger then in the previous test case set) number (10 000, 30 000, 50 000, ...) of registered OSGi devices, which connect periodically to the mPRM and after performing the synchronization (and possibly executing of the pending management operations for them) disconnect from it. Thus the number of the devices which are simultaneously connected to the mPRM server do not exceed several thousands.

TC Name	Description
2.1. Initial device registration	<p>The test case starts with empty DB (i.e. there are no any device registered). The test case consists of session establishment of each of the simulated devices and initial synchronization of their configuration.</p> <p>The test case finishes after each of the target number of devices have been registered and their configuration is retrieved and stored into the mPRM DB.</p>
2.2. Simple Commands Execution	<p>This test case schedules and operation for execution of a simple command (as defined in TC 1.3 above) over all registered (but currently offline devices). The operation is executed on each device when it establish a connection to it (which happens periodically in a rate which ensures that at any time between 100 and 1000 are connected to the system).</p> <p>The successful end of this test case is when the command is executed over each of the devices the corresponding device configuration change is updated in the mPRM DB.</p>
2.3. Smart bundle install	<p>This test case schedules and operation for download and install of four dependant bundles (as defined in TC 1.5 above) over all registered (but currently offline devices). The operation is executed on each device when it establish a connection to it (which happens periodically in a rate which ensures that at any time between 100 and 1000 are connected to the system).</p> <p>The successful end of this test case is when the command is executed over each of the devices the corresponding device software configuration change is updated in the mPRM DB</p>

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### 3. Test Environment

#### 3.1 mPRM Environment

<b>MPRM Configuration</b>	Single-host mPRM
<b>Hardware</b>	Intel Core2 Duo 2.13 MHz, 2G RAM
<b>OS</b>	Linux - OpenSUSE 10.2
<b>JVM</b>	1.5.0_08
<b>RDBMS &amp; Hardware</b>	Oracle 10g running on a separate machine than the mPRM server - Intel Core2 Duo 2.13 MHz, 2G RAM. Network connection between the mPRM and Oracle machine – 100 Mbit Ethernet.

#### 3.2 Clients Environment

<b>Hardware</b>	20 PC - Intel P4 – 1800 – 3000 MHz, 1G RAM
<b>OS</b>	Windows 2000
<b>JVM</b>	JDK 1.4.*, JDK 1.5.*, JDK 6.0.*
<b>OSGi Framework</b>	mBS 6.1 Professional, standard initial bundle configuration + mPRM management agents: 22 bundles initially.
<b>Network Connectivity</b>	100 Mbit Ethernet – star topology, i.e. all test PCs and mPRM server are connected directly to an Ethernet switch. The OSGi devices are configured with the TCP Transport protocol without secured connection enabled.

### 4. Load Test Results

#### 4.1 Test Results<sup>1</sup>

Test Case	20x2,000 (40,000)	25 x 2,000 (50,000)	25 x 2,400 (60,000)	30x2500 (75,000)
1.1. Simultaneous session establishment	1:00:51/ 0:00.091	1:17:25/ 0:00.092	1:37:47/ 0:00.097	2:14:41/ 0:00.107
1.2. Simultaneous session establishment with pending commands	1:18:20/ 0:00.117	1:44:29/ 0:00.125	2:15:45/ 0:00.135	3:01:55/ 0:00.146
1.3. Simple Command Execution (set system property)	0:07:41/ 0:00.011	0:10:47/ 0:00.012	0:13:57/ 0:00.013	0:20:20/ 0:00.016
1.4. Install bundle (100 K) with predefined configuration	0:34:05/ 0:00.051	0:42:35/ 0:00.051	0:52:25/ 0:00.052	1:11:57/ 0:00.057
1.5. Smart bundle install (4 bundles - total 250 K)	0:53:28/ 0:00.080	1:10:51/ 0:00.085	1:40:57/ 0:00.100	<b>OutOfMemory Error</b>
1.6. Uninstall by scripted filter (uninstall all bundles with Bundle-Category = WAP)	0:34:05/ 0:00.051	0:45:47/ 0:00.054	0:50:03/ 0:00.050	<b>OutOfMemory Error</b>

<sup>1</sup> Times are in the format <total time for all devices> / <time per single device>. The total time is in the format hours:mins:sec, while time per device is in the format: min:secs.millis.

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## 4.2 Analysis of the Load Test Result

The tests shows that single mPRM host can hold simultaneously permanently open sessions with a large number of OSGi devices – the system is completely stable with up to 60,000 active sessions (each of them runs over single permanently open TCP connection). The response time of the user actions performed through the mConsole is good and the functional behavior is correct.

However the tests performed with 75,000 online devices start to show signs of overloading of the system. Although the mPRM was able to accept all 75,000 sessions and to perform some of the more simple management actions over them, attempt to execute more complex actions – such as “smart” install of bundle resulted with `OutOfMemoryError`. This error however shows that a machine with larger operating memory (than the 2G RAM installed on our test server environment) should be able to handle even larger number of devices.

On the other hand, the performance measurements taken for each operation with the different number of devices show that the mPRM performance scales nearly linear with the increasing number of active sessions. I.e. the per-device-times for finishing of different tasks are identical or very slightly bigger when the number of active sessions increase.

## 5. Volume Test Results

### 5.1 Test Results<sup>2</sup>

Test Case	20x5,000 (100,000)	20 x 10,000 (200,000)	25 x 20,000 (500,000)
2.1. Initial device registration	3:04:35/ 0:00.110	6:17:23/ 0:00.113	17:03:47/ 0:00.122
1.2. Simple Commands Execution (set system property)	3:18:23/ 0:00.119	6:48:32/ 0:00.122	18:15:49/ 0:00.131
1.3. Smart bundle install (4 bundles - total 250 K)	5:33:51/ 0:00.200	11:21:51/ 0:00.204	28:58:11/ 0:00.209

### 5.2 Analysis of the Volume Test Result

The volume test results shows that the mPRM system does not have limitations on the number of registered devices which can be managed by single host, if it doesn't keep a permanent connection with all the them at the same time.

The performance measurements taken for each operation with the different number of devices show that the mPRM performance scales nearly linear with the increasing number of registered devices. I.e. the per-device-times for finishing of different tasks are close when they are executed with 100,000, 200,000 and 500,000 registered devices.

<sup>2</sup> Times are in the format <total time for all devices> / <time per single device>. The total time is in the format `hours:mins:sec`, while time per device is in the format `min:secs.millis`.