Technical Manual

Motorola C370, C450, and C550 Series of Handsets

J2ME™ Developer Guide

Version 1.1

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1 Introduction

Purpose

This document describes the application program interfaces used to develop Motorola compliant Java™ 2 Platform, Micro Edition (J2ME™) applications for the Motorola C370, C450, and C550 series of handsets.

Audience

This document is intended for developers involved with the development of J2ME applications for the C370, C450, and C550 series of handsets.

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References

Reference	Link
Sun™ J2ME Documentation,	http://java.sun.com/j2me/
Sun™ MIDP Specification,	http://java.sun.com/products/midp/

Revision History

Version	Date	Name	Reason
0.1	Novemeber 24, 2003	Motocoder	Initial Draft
1.0	December 15, 2003	Motocoder	Baseline
1.1	December 29, 2003	Motocoder	Update

Definitions, Abbreviations, Acronyms

Acronym	Description
AMS	Application Management Software
API	Application Program Interface.
CLDC	Connected Limited Device Configuration
FDI	Flash Data Integrator. The memory used to store the applications.
GPS	Global Positioning System
IDE	Integrated Development Environment
ITU	International Telecommunication Union
JAD	Java Application Descriptor
JAID	Java Application Installer/De-Installer
JAL	Java Application Loader
JAR	Java Archive. Used by J2ME applications for compression and packaging.
J2ME	Java 2 Micro Edition
JSR 120	Java Specification Request 120 defines a set of optional APIs that provides standard access to wireless communication resources.
JVM	Java Virtual Machine
KVM	KJava Virtual Machine
LCC	Licensee Close Classes
LWT	Lightweight Window Toolkit
MDP	Motorola Developers Program

MIDP	Mobile Information Device Profile
OEM	Original Equipment Manufacturer
OTA	Over The Air
RMS	Record Management System
RTOS	Real Time Operating System
SC	Service Center
SDK	Software Development Kit
SMS	Short Message Service
SU	Subscribe Unit
UI	User Interface
URI	Location Services Unified Resource Identifier
VM	Virtual Machine

Document Overview

This developer's guide is organized into the following chapters and appendixes:

Chapter 1 – **Introduction:** this chapter has general information about this document, including purpose, scope, references, and definitions.

Chapter 2 – **J2ME Introduction:** this chapter describes the J2ME platform and the available resources on the C370, C450, and C550 series of handsets.

Chapter 3 – Developing and Packaging J2ME Applications: this chapter describes important features to look for when selecting tools and emulation environments. It also describes how to package a J2ME application, how to package a MIDlet, and generate JAR and JAD files properly.

Chapter 4 – Downloading Applications: this chapter describes the process for downloading applications.

Chapter 5 – Application Management: this chapter describes the lifecycle, installation/de-installation, and updating process for a MIDlet suite.

Chapter 6 – Networking APIs: this chapter describes the Java Networking API.

Chapter 7 – LCDUI: this chapter describes the Limited Connection Device User Interface API.

Chapter 8 – Gaming and Sound API: this chapter describes the Gaming API and Sound API.

Chapter 9 – Vibe and Backlight API: this chapter describes the Vibe and Backlight API.

Chapter 10 – SMS MO: this chapter describes SMS MO.

Chapter 11 – JAD Attributes: this chapter describes what attributes are supported.

Chapter 12 – Record Management System: this chapter describes the Record Management System API.

Chapter 13 – Phonebook Access: this chapter describes the Phonebook Access API.

Chapter 14 – iTAP: this chapter describes iTAP support.

Appendix A – Key Mapping for the C370, C450, and C550 series of handsets: this appendix describes the key mapping of the Motorola C370, C450, and C550 series of handsets, including key name, key code, and game action of all Motorola keys.

Appendix B – Memory Management Calculation: this appendix describes the memory management calculations.

Appendix C – FAQ: this appendix provides a link to the dynamic online FAQ.

Appendix D – Spec Sheet: this appendix provides the Motorola C370, C450, and C550 spec sheets

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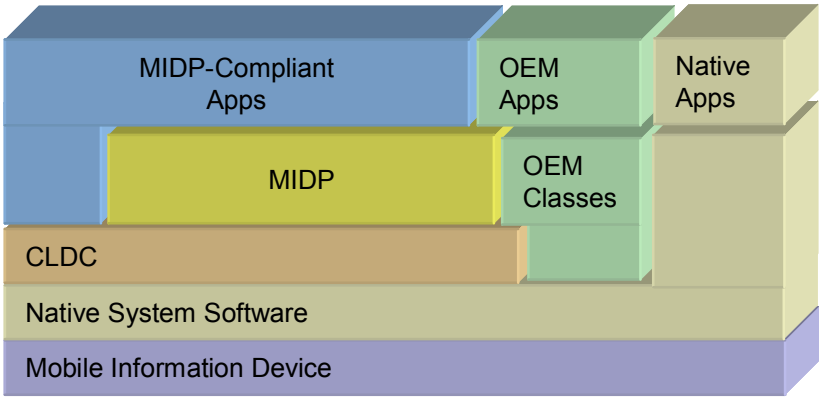
J2ME Introduction

The C370, C450, and C550 series of handsets includes the Java™ 2 Platform, Micro Edition, also known as the J2ME platform. The J2ME platform enables developers to easily create a variety of Java applications ranging from business applications to games. Prior to its inclusion, services or applications residing on small consumer devices like cell phones could not be upgraded or added to without significant effort. By implementing the J2ME platform on devices like the C370, C450, and C550 series of handsets, service providers, as well as customers, can easily add and remove applications allowing for quick and easy personalization of each device. This chapter of the guide presents a quick overview of the J2ME environment and the tools that can be used to develop applications for the C370, C450, and C550.

The Java 2 Platform, Micro Edition (J2ME)

The J2ME platform is a new, very small application environment. It is a framework for the deployment and use of Java technology in small devices such as cell phones and pagers. It includes a set of APIs and a virtual machine that is designed in a modular fashion allowing for scalability among a wide range of devices.

The J2ME architecture contains three layers consisting of the Java Virtual Machine, a Configuration Layer, and a Profile Layer. The Virtual Machine (VM) supports the Configuration Layer by providing an interface to the host operating system. Above the VM is the Configuration Layer, which can be thought of as the lowest common denominator of the Java Platform available across devices of the same “horizontal market.” Built upon this Configuration Layer is the Profile Layer, typically encompassing the presentation layer of the Java Platform.



The Configuration Layer used in the C370, C450, and C550 series of handsets is the Connected Limited Device Configuration 1.0 (CLDC 1.0) and the Profile Layer used is the Mobile Information Device Profile 1.0 (MIDP 1.0). Together, the CLDC and MIDP provide common APIs for I/O, simple math functionality, UI, and more.

For more information on J2ME, see the Sun™ J2ME documentation (http://java.sun.com/j2me/).

The Motorola J2ME Platform

Functionality not covered by the CLDC and MIDP APIs is left for individual OEMs to implement and support. By adding to the standard APIs, manufacturers can allow developers to access and take advantage of the unique functionality of their series of handsetss.

The C370, C450, and C550 series of handsets contain OEM APIs for extended functionality ranging from enhanced UI to advanced data security. While the C370, C450, and C550 series of handsets can run any application written in standard MIDP, it can also run applications that take advantage of the unique functionality provided by these APIs. These OEM APIs are described in this guide.

Resources Available

The C370, C450, and C550 series of handsets allows access to a richer set of resources than our previous Java™ capable phones. The changes range from a larger heap for Java applications to the presence of a color display. All of the enhancements allow for more compelling and advanced Java applications to be created. In addition to increasing resources present on the device, new APIs to access other device resources were added. These new APIs allow a Java application to leverage other capabilities of the device that are currently not accessible through standard MIDP and CLDC APIs.

Resource	Description
Display	
Resolution	96 x 64
Color Depth	12 bit color (4096 colors)
Networking	
Max HTTP, UDP and TCP Socket connections*	4 with any combinations
File & RMS	
Max number of Files/RMS*	500
Java VM	
Heap Size	512 KB
Program Space	1.2 MB
Max Resource Space*	450 KB
Recommended Maximum JAR Size	100 KB
*: These resources are shared with the rest of the phone and there could be less available to Java at any given time.	

3 Developing and Packaging J2ME Applications

Guide to Development in J2ME

Introduction to Development

This appendix assumes the reader has previous experience in J2ME development and can appreciate the development process for Java MIDlets. This appendix will provide some information that a beginner in development can use to gain an understanding of MIDlets for J2ME series of handsetss.

There is a wealth of material on this subject on websites maintained by Motorola, Sun Microsystems and others. Please refer to the following URLs for more information:

- http://www.motocoder.com
- http://www.java.sun.com/j2me
- http://www.corej2me.com/
- http://www.javaworld.com/

As an introduction, brief details of J2ME are explained below.

The MIDlet will consist of two core specifications, namely Connected, Limited Device Configuration(CLDC) and Mobile Information Device Profile (MIDP). Both of these specifications (Java Specification Requests) can be located at the http://www.jcp.org/ site for reading.

- For MIDP 1.0; JSR 37 should be reviewed.
- For CLDC 1.0.4; JSR 30 should be reviewed.
- For CLDC 1.1; JSR 139 should be reviewed.

To determine what implementation is on Motorola series of handsets, review the “Java System” details through the menu on the Motorola series of handsets (located under Java Settings).

For beginning development, key points to remember are memory size, processing power, screen capabilities and wireless network characteristics. These all play an important part in development of a MIDlet. The specifications listed above are designed to work upon devices that have these characteristics.

Network conditions would only apply for networked applications such as streaming tickers, email clients, etc.

In addition to the specifications, an array of tools are available to assist the development cycle. These range from the command line tools provided with Software Development Kits (SDK) from Sun (as of writing 1.4.1_04) to Integrated Development Environments (IDEs) which can be free or purchased. These IDEs come from a range of sources such as Sun, IBM, Metrowerks and Borland to name a few.

In addition to the IDEs and Sun SDK for development, Motorola offers access to our own SDK which contains Motorola device emulators. From here, a MIDlet can be built and then deployed onto an emulated target series of handsets. This will enable debugging and validation of the MIDlet before deployment to a real, physical series of handsets. The latest Motorola SDK can be downloaded from the MOTOCODER website.

Please refer to the product specifications at the back of this guide for detailed information on each series of handsets.

4 Downloading Applications

OTA Procedure

There is no need of additional software tools, or cables, to downloaded MIDlet suites through WAP browser. The application developer just has to use the C370, C450, and C550 browser and connect to a WAP server site that contains the desired MIDlet suite to be downloaded. The application developer should follow the WAP server site instructions to download the MIDlet properly.

After loading the JAR and JAD file on the Motorola C370, C450, and C550 series of handsets, the friendly name specified in the MANIFEST.MF file for the MIDlets should appear on the Games & Apps menu.

Installation

The following checklist should be covered before attempting to install a MIDlet Suite. Failure to verify this checklist could lead to an installation failure.

- Applications supports CLDC-1.0 and MIDP-1.0 (the configuration and profile supported by the Motorola C370, C450, and C550 series of handsets)
- JAD file has been created.
- JAR file contains META-INF/MANIFEST.MF.
- Verify the MIDlet-Name, MIDlet-Version, and MIDlet-Vendor attributes are duplicated in both the MANIFEST.MF and the JAD file.
- File names (JAR and JAD) are less than 32 characters (not including extension).
- Less than 20 MIDlet suites are currently installed.
- Maximum number of MIDlets in a suite is 5
- Maximum length of class path inside JAR file must be 64 characters.
- Maximum length of URL path must be 256 characters.

- No more than ~500 files are used by installed MIDlet suites.
- JAR size listed in JAD matches actual JAR size.
- MIDlet suite name and MIDlet vendor are 32 bytes max
- MIDlet suite version must be higher than an already installed one.

Even though the Data and Program Space in Java System indicate more available space than the size of a particular JAR file, it doesn't necessarily mean the JAR will install. Moreover, if it is able to install, there's no guarantee the MIDlet will execute because on occasion, more RAM is required for execution than installation. In addition, MIDlets that will not install or execute on the phone because of lack of memory will most certainly execute on the Sun Wireless Toolkit since the PC has virtually unlimited memory with respect to the size of MIDlets.

The memory requirements for MIDlet suite installation are the following:

First, there must be enough Data Space (file system space) to temporarily store the JAR. If there's not enough Data Space, the browser (in the OTA mechanism) will display the error "Insufficient Memory".

Secondly, there must be enough heap memory to uncompress the JAR file. The JAR size should be a predefined safe proportion of the heap size. The JAR maximum size recommended is 100K. This means that MIDlet typically will not install if the JAR is greater than 100K. There are exceptions to this and it depends on how many class files vs. resource files are contained within the JAR. If there's not enough heap, the device will typically display the message "Memory Full".

Third, there must be enough Data Space to store not only the temporary JAR but also all the resource files needed by the MIDlet. The JAR is essentially a zip file that must be uncompressed. It contains class files (the actual application) and resource files that are used by the MIDlet. These resources typically include, png images, database files and any other data the MIDlet needs. These resource files are stored in the Data Space during installation. The JAR is deleted after the installation phase completes. If there's not enough Data Space, the device will typically display the message "Memory Full". Also, note that total size of the uncompressed resources in the JAR doesn't necessarily equal the Data Space occupied by that MIDlet once installed.

Fourth, there needs to be enough Program Space to store the actual MIDlet. The class files in the JAR are the application files and are converted into a native format and stored in the Program Space during installation. This native format size will be greater than the total of the uncompressed class files in the JAR. Once stored in the Program Space, the MIDlets are referred to as DAV Objects. DAV reserves additional Program Space equal to the largest DAV Object. This reserved space cannot be used for additional MIDlets. Its purpose is to provide power loss protection during a DAV reclaim of the flash memory. The allocation of this reserved Program Space is often a point of confusion with users. When the largest DAV object is installed, the Program Space in Java System will be reduced by more than the size of Program Space in Suite Details. Java System shows the free Program Space. Suite Details shows the amount of Program Space occupied by that MIDlet.

Program and Data space notes:

To check Program and Data space from the Java menu, select “Java System” and press the “Select” soft key.

Program space is used to store class files.

Data space is used to store the JAR files before installation and resource files after installation. After installation, the JAR file is destroyed.

Then to install the MIDlet Suite, select the “Java Application Loader” option and press the SELECT soft key. A dialogue will be displayed indicating the serial cable is connected to the device. Execute the MIDway tool on PC, select and send the desired MIDlet to be installed. The MIDway tool indicates exactly which steps are being executed.

Java Application Installer/De-Installer (JAID)

JAID is a component built into the Motorola KVM to handle installation and de-installation of Java applications to a device. The process of installing an application is time intensive involving loading of the class files from the JAR file and writing the image, in a platform-specific manner, to memory. By installing Java applications, class files do not have to be stored in RAM, allowing more runtime memory for the application at hand. Additionally, the time required to launch Java applications is decreased dramatically.

After successful installation, the class files are placed in the Program space and the resource files are placed in the Data space. The original JAR file is then destroyed.

Applications only need to be JAID installed once. If the Motorola C370, C450, and C550 series of handsets’s software is upgraded, Java applications must be re-installed.

Once the application is done the user can launch the MIDlet right after installation using the Autorun After Install Feature.

If you cancel the installation progress screen while the MIDlet Suite is still being installed, the installation will fail, and you must repeat all installation procedures again.

Starting Applications

Often times a MIDlet Suite only contains one MIDlet. If so, then that MIDlet can be launched from the Games & Apps menu simply by highlighting that MIDlet Suite and pressing the “SELECT” soft key.

If there are multiple MIDlets in the Suite, then a suite content menu will be displayed, and one of the individual MIDlets can be highlighted. From there, pressing the “RUN” soft key will launch the selected MIDlet.

Exiting Applications

During the development process, chances are a MIDlet may not exit properly via the “correct” and “elegant” method. The Motorola C370, C450, and C550 series of handsets’s policy on Java applications is to allow the user to exit an application at anytime, either forcefully or via a menu option. If an application, during the development process, becomes unstable or fails to respond, the user/developer may end the application by pressing the END key.

Launching Web Session for HTTP Download

The Web Sessions implementation will be modified to allow the user to download Java content using an HTTP server instead of a WAP gateway. The user will then need to enter a Web Session from the Web Sessions menu.

Downloading MIDlets

The Browser must be connected before the series of handsets is able to download any MIDlets. The user may access the Browser application by any of the following methods:

- Selecting “Browser” from the Main Menu
- Selecting a URL from a message

Once the series of handsets is connected to the WAP browser, different locations may be visited where J2ME Applications can be downloaded. From here, a MIDlet can be selected to download to the series of handsets.

The series of handsets initially receives information from the Java Application Descriptor (JAD) file. The JAD includes information about MIDlet-name, version, vendor, MIDlet-Jar-URL, MIDlet-Jar-size, and MIDlet-Data-size. Two additional JAD attributes will be Mot-Data-Space-Requirements and Mot-Program-Space-Requirements. These two attributes will help the KVM determine whether there is enough memory to download and install the selected MIDlet suite. If there is not enough memory, the series of handsets will display a “Memory Full” dialog prior to beginning the download.

Error Checks

There are two distinct cases when a Memory Full error can occur during the download process. Memory Full will be displayed when the series of handsets does not have enough memory to completely download the MIDlet. If the Mot-Data-Space-Requirement and Mot-Program-Space-Requirements attributes are added to the JAD of the MIDlet, a Motorola series of handsets can determine if enough memory exists on the phone before the MIDlet is downloaded. These attributes may or may not be provided in all MIDlets. Two separate prompts will be displayed depending on the existence of these attributes.

If there is not enough memory to download the application, the user will be given a message to delete existing applications in order to free additional memory.

Once the MIDlet is successfully downloaded, the installation process begins. During the installation of the MIDlet, the phone may determine there is insufficient memory to complete the installation. This error can occur whether the Mot-Data-Space-Requirements and Mot-Program-Space-Requirements JAD attributes are present or not.

In some instances, an application being downloaded may already appear on the series of handsets. If this case exists, the series of handsets compares the version number of the

application being downloaded with the version on the series of handsets. One of the following instances will occur:

- Same version exists – user is prompted with a dialog stating application already exists and is prompted to cancel or read details of the download.
- Older version of application exists – user is prompted with a dialog stating a different version exists and is prompted to update or cancel the download.
- Newer version of application exists – user is prompted with a dialong stating the application already exists and is prompted to cancel the download.

XML Screen Renderings

The following are XML Screen Renderings based on the code sample below:

```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
"http://www.wapforum.org/DTD/wml_1.1.xml">

<wml>
<card title="J2ME Tests">
<p>
 The case scenario's below tests J2ME Midlets.
</p>

<p>
 <a href="http://www.drawbridge.ca/wml/mid/HelloWorld1/bin/HelloWorld1.jad">HelloWorld1
1k</a><br/>
<!-- <a href="http://www.drawbridge.ca/wml/mid/games/bin/games.jad">Games 39k</a><br/>
>
<!-- <a
href="http://www.drawbridge.ca/wml/mid/HelloMidletServlet/bin/HelloMidletServlet.jad">o
test</a><br/> -->
 <a href="http://www.drawbridge.ca/wml/mid/PhoneBook/bin/PhoneBook.jad">Phone Book
3k</a><br/>
 <a href="http://www.drawbridge.ca/wml/mid/Pizza/bin/Pizza.jad">Pizza Order 2k</a><br/>
 <a href="http://www.drawbridge.ca/wml/mid/CurStcQue/bin/CurStcQue.jad">Remote HTTP Sto
Chk</a><br/>
 <a href="http://www.drawbridge.ca/wml/mid/stockMidlet/bin/stockMidlet.jad">Stock from
MySQL</a><br/>
 <a href="http://www.drawbridge.ca/wml/mid/CurExcQue/bin/CurExcQue.jad">Currency
Exchange</a><br/>
 <a href="http://www.drawbridge.ca/wml/mid/UIDemo/bin/UIDemo.jad">User Interface Test
21k</a><br/>
 <a
href="http://www.drawbridge.ca/wml/mid/licenseValidate/bin/licenseValidate.jad">Licence
Validation</a><br/>
 </p>
 </card>
</wml>
```

```
<file name="Jad Test" href="AppPropertyTests.jar" type="jar" size="4000"
```

```
vendor="Motorola" version="1.0" date="20010101" adf="DESC.jad" >

<file name="Digital Clock" href="clock.jar" type="jar" size="10000" vendor="Motorola"
version="1.0" date="20010101" adf="DESC.jad" >

This is a digital clock running on your series of handsets.

</file>

<file name="Bouncing Ball" href="bounce.jar" type="jar" size="6000" vendor="Sun"
version="1.0"  date="20010101" adf="Bounce.jad" >

An example illustrating a bouncing ball on your screen.

</file>

<file name="Bomb Man" href="bombman.jar" type="jar" size="21645" vendor="Motorola"
version="1.0" date="20010101" adf="DESC.jad" >

BombMan is back, now on your Taichi series of handsets.

</file>

<dir name=”New Games” href=”games/index.xml”>

     This is a directory full of games.

</dir>

<a href=”index2.xml”>

     Next page.

</a>

</index>
```

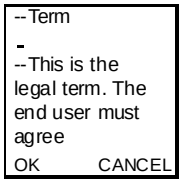
Screen Renderings

- <notice>

No rendering will be done based on this tag and the notice will be displayed as its own screen. This notice shall be displayed and acted on befor
the rest of the page is rendered. The Caption attribute of the <notice> tag will be displayed as the title of the page. The type attribute will determ
which softkeys are displayed.

Example:

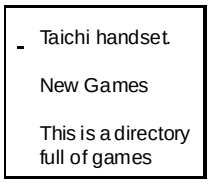
Type=okcancel will display the left softkey as OK and the right softkey as CANCEL



- <dir>

The text between the open and close of the <dir> tag will be rendered as plain text on the page.

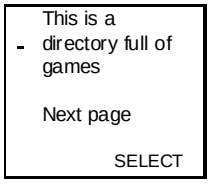
Example:



- <a>

The text between the open and close of the <a> tag will be rendered as hyperlink on the page.

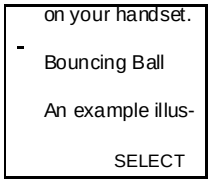
Example:



- <file>

The Name attribute of the <file> tag will be rendered as a hyperlink and will be selectable. A space will appear between <file> elements on the page. The text between the open and close of the <file> tag will be rendered as plain text on the page.

Example:

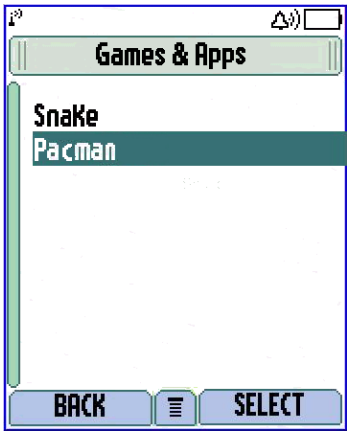


5
Application Management

MIDlet Lifecycle

A MIDlet's lifecycle begins once its MIDlet Suite is downloaded to the device. From that point, the Application Management Software (AMS) manages the MIDlet Suite and its MIDlets. The user's primary user interface for the AMS is the Java Apps feature built into the device's firmware.

From the Games & Apps feature, the user can see each MIDlet Suite on the device. If a MIDlet Suite has only a single MIDlet, then the MIDlet's name is displayed in the Games & Apps menu for that MIDlet Suite. Otherwise, the MIDlet Suite name is displayed. Then when that MIDlet Suite is highlighted, the user has the option of opening the MIDlet Suite and viewing the MIDlets in that MIDlet Suite.

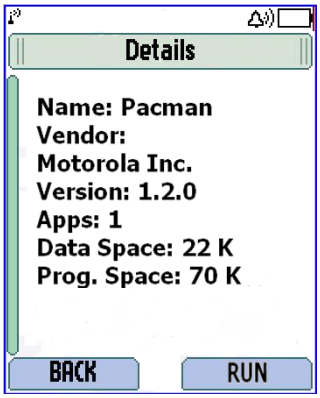


Note: This image reflects a 176 x 220 display for document readability purposes only. The C370, C450, and C550 maintain a 96 x 64 display.

From the Games & Apps menu, the user can highlight a MIDlet Suite, selecting the Menu soft key, and bring up the Details dialog for that MIDlet Suite. The Details dialog contains:

- MIDlet Suite Name
- MIDlet Suite Vendor

- MIDlet Suite Version
- The number of MIDlets in the MIDlet Suite
- The Data Space (MIDlet suite resources).
- Program Space (Unpacked JAR)

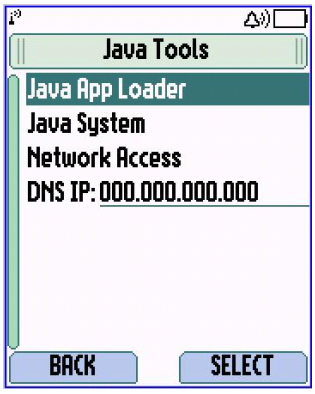


Note: This image reflects a 176 x 220 display for document readability purposes only. The C370, C450, and C550 maintain a 96 x 64 display.

MIDlet Suite Installation

Installation of MIDlet suites can occur from the Java Settings menu or the Browser. A MIDlet Suite must be installed before any of its MIDlets can be executed. Installation involves extracting the classes from the JAR file and creating an image that will be placed into Program Space. The resources are then extracted from the JAR file and placed into Data Space. The JAR file is then removed from the device, thus freeing up some Data Space where it was originally downloaded.

The space savings from removing the JAR file is one advantage of installation, but perhaps an even greater advantage is that class loading is not done during run time. This means that a MIDlet will not experience slow-down when a new class is accessed. Even further, the MIDlet will not have to share the heap with what has been loaded from the JAR file. The figure below shows the Java Settings screen.

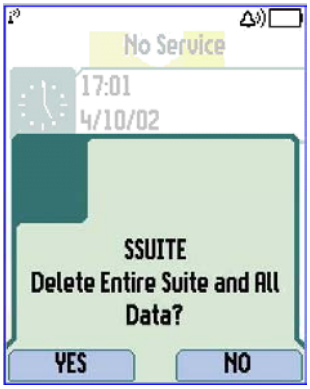


Note: This image reflects a 176 x 220 display for document readability purposes only. The C370, C450, and C550 maintain a 96 x 64 display. Additionally, the items that may appear on the actual device may differ from those displayed in the image above

MIDlet Suite De-installation

An installed MIDlet can only be removed from the device by de-installing it from the Java Apps menu. De-installing a MIDlet Suite will remove the installed image from Program Space. The resources are then removed from Data Space along with the JAD file.

From the Games & Apps menu, the user can highlight a MIDlet Suite, selecting the menu soft key, and bring up the Delete dialog for that MIDlet Suite.



Note: These images reflect 176 x 220 displays for document readability purposes only. The C370, C450, and C550 maintain a 96 x 64 display.

MIDlet Suite Updating

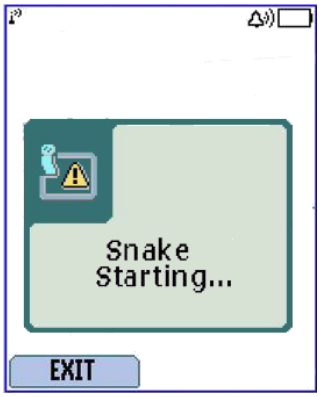
When a MIDlet Suite is de-installed, all of its resources are removed including any resources that were created by the MIDlets in the suite, such as RMS databases. If a user gets a new version of a MIDlet Suite, then the user can simply download that new version to the device that has the older version installed. Once the new version is downloaded, the user will have the option to update the MIDlet Suite, causing the old version to be de-installed, followed by the immediate installation of the new MIDlet Suite.

A newer version of the MIDlet Suite should know how to use, upgrade, or remove the data in the RMS databases created by older versions. This idea of forward compatibility should not be extended to backward compatibility, because the C370, C450, and C550 device will not allow a user to update a version of a MIDlet Suite with an older or equal version of that MIDlet Suite. If an older or equal version attempts to be installed, the C370, C450, and C550 will ignore the installation and launch the current version of the MIDlet suite.

Starting, Pausing, and Exiting: AMS Control of MIDlet State Transitions

A MIDlet has three different states: Destroyed, Active, and Paused. A MIDlet's natural state is destroyed. The AMS typically controls the transition through these states. When a user decides to launch a MIDlet, the device puts up a screen indicating that the MIDlet is transitioning through these states. The AMS notifies MIDlets about state transitions by calling the MIDlet's methods, `startApp()`, `pauseApp()`, and `destroyApp()`.

The figure below shows the MIDlet starting screen.

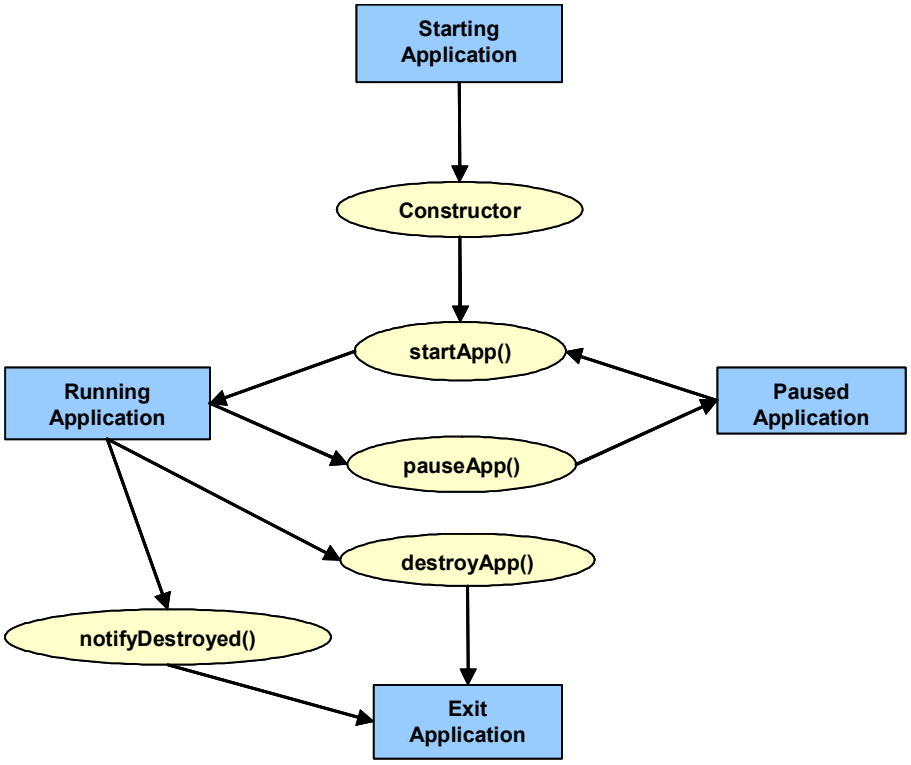


Note: This image reflects a 176 x 220 display for document readability purposes only. The C370, C450, and C550 maintain a 96 x 64 display.

The constructor of the MIDlet's class that extends MIDlet is first invoked. Then its `startApp()` method is called to indicate that it's being started. The MIDlet will have focus when its `startApp()` method finishes execution. If a MIDlet takes too long

initializing state variables and preparing to be run in its constructor or `startApp()` methods, it may appear to be stalled to users.

The flow below depicts MIDlet State Transitions.



The following table shows MIDlet State Transition methods.

Method	Caller	Purpose
Constructor	AMS	Initializes the MIDlet – should return quickly
`startApp()`	AMS	The `startApp()` method is called to start the application either from a newly constructed state or from a paused state. If the `startApp()` is called from a paused state, the MIDlet should not re-initialize the instance variables(unless it is the desired behavior). The `startApp()` method may be called multiple times during the lifespan of the MIDlet. The MIDlet may set the current display to its own Displayable from the `startApp()` method, but is shown only after the `startApp()` returns. When exiting a paused application, the KVM calls `startApp()` first followed by a call to `destroyApp()`

`pauseApp()`	AMS, MIDlet	The `pauseApp()` method is called from either AMS or from within the MIDlet. The `pauseApp()` should pause active threads, and prepare for `startApp()` to be called. If the application is to be resumed with a screen other than the present, then the Displayable should be set current in the `startApp()` or the `pauseApp()`.
`destroyApp()`	AMS	The `destroyApp()` method is called from AMS and signals the MIDlet to clean up any resources to prepare for termination. For example, open RMS records should be closed, threads should be stopped, and any other housekeeping chores should be performed. The MIDlet should not call `destroyApp()`.
`notifyDestroyed()`	MIDlet	The `notifyDestroyed()` method is called by the MIDlet to exit and terminate itself. All housekeeping such as stopping active threads and closing RMS records should be performed before calling `notifyDestroyed()`. `notifyDestroyed()` notifies AMS to terminate the calling MIDlet.

On a device without a windowing system, only one application can have focus at a time. When an application has focus, it receives keypad input, and has access to the display, speakers, LED lights, vibrator, etc. The C370, C450, and C550 device can only run one MIDlet at a time, but that MIDlet has to share focus with the system user interface. That user interface is a higher priority than the MIDlet, so the MIDlet will immediately lose focus when the system needs to handle a phone call or some other interrupt.

The concept of focus correlates directly with the MIDlet state. i.e. when a MIDlet loses focus because of a phone call, the MIDlet is immediately paused. Conversely to the example of starting the MIDlet, the MIDlet loses focus immediately, then its `pauseApp()` method is called.

The paused state is not clearly defined by MIDP. The only requirement placed on the device manufacturer is that a paused MIDlet must be able to respond to network events and timer events. On Motorola devices, the paused state simply implies that the MIDlet is in the background as mentioned above, but it doesn't force any of the threads to stop execution. Essentially, a paused MIDlet is a MIDlet without focus whose `pauseApp()` method has been called. It's up to the developer to control their threads, such as making them sleep for longer periods, completely pausing game threads, or terminating threads that can be restarted when the MIDlet is made active again.

Similarly, a MIDlet's focus is also lost immediately before its `destroyApp()` method is called.

The MIDlet must be written properly (as described above) to implement all methods in the javax.microedition.midlet package, especially `startApp()` and `pauseApp()`. A

common error is to implement `startApp( )` to execute instructions that are only intended to be executed once during MIDlet execution. The correct implementation is to include in `startApp( )` those instructions which can and should be executed each time the MIDlet changes from the Paused state to the Active state. The same logic should be applied to `pauseApp( )`.

The code sample below shows implementation of using `startApp( )`. `startApp( )` performs operations for the initial launch of the MIDlet as well as any operations that need to take place each time the MIDlet changes state from Paused to Active. Booleans are used to determine whether the MIDlet has started and whether it's in the Active state. These Booleans can also be used by other MIDlet threads to determine state.

Using startApp()

```
package midp.demo;
import javax.microedition.midlet.MIDlet;

   public class Demo extends MIDlet {
   // The MIDlet has been started already
   private boolean isStarted  = false;

   // The MIDlet is in active state
   public  boolean isActive   = false;
   // (in most cases these booleans are used by other threads)

   protected void destroyApp(boolean unconditional){
               isActive  = false;
   }
   protected void pauseApp(){
               isActive = false;
   }
   protected void startApp(){
               isActive = true;
               if (!isStarted){
                  //...Use getDisplay(), setCurrent(),
                  // and other initial actions
                  isStarted = true;
               }
   }
```

The MIDP specification of `javax.microedition.midlet` allows for some latitude in the implementation, therefore, it cannot be assumed that all MIDlets are perfectly compatible with all devices. Some MIDlets may execute flawlessly on desktop simulators such as Sun's Wireless Toolkit and contain a gain/loose focus mechanism such that the MIDlet transitions between the Paused and Active states and `startApp()` and `pauseApp()` are called.

MIDlet Control of MIDlet State Transitions

MIDlets have a lot of flexibility to control their own state. A MIDlet can call its own `startApp(), pauseApp(),` and `destroyApp()` methods, however those are the methods that the AMS uses to indicate a state transition to the MIDlet. The MIDlet can call those methods if it wishes to perform the work that it would typically do during that state transition.

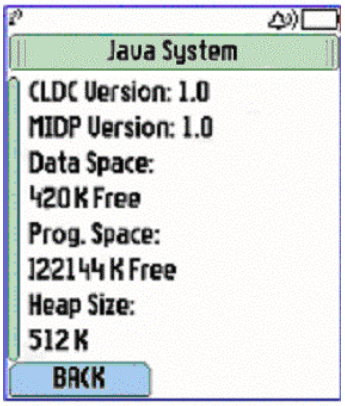
Other sets of methods the MIDlet can use to cause state transitions are `resumeRequest(), notifyPaused(),` and `notifyDestroyed().` Since the system user interface has priority, a MIDlet cannot force itself into the active state, but it can request that it be resumed via a `resumeRequest().` If the system is not busy, it will automatically grant the request. However, if the device is not in the idle screen, then it displays an alert dialog to the user to resume or end the MIDlet. If the user denies the request, the MIDlet is not notified, however if the user grants the request, the MIDlet's `startApp()` method is called, and it gains focus when that finishes.

The MIDlet has more control when it decides it wants to be paused or destroyed. The MIDlet performs the necessary work by calling its own `pauseApp()` or `destroyApp()` method, then notifies the AMS of its intentions by calling `notifyPaused()` and `notifyDestroyed()` appropriately. Once notified, the AMS transition the MIDlet's state and revoke focus.

Java System

The Java Settings Menu allows management of MIDlet suites, as well as system maintainance. The Java System feature gives statistics about the system such as:

- CLDC Version
- MIDP Version
- Data Space and Program Space (Free space)
- Total Heap Size
- The figure below depicts the Java System Menu.



Note: This image reflects a 176 x 220 display for document readability purposes only. The C370, C450, and C550 maintain a 96 x 64 display.

6
Network API

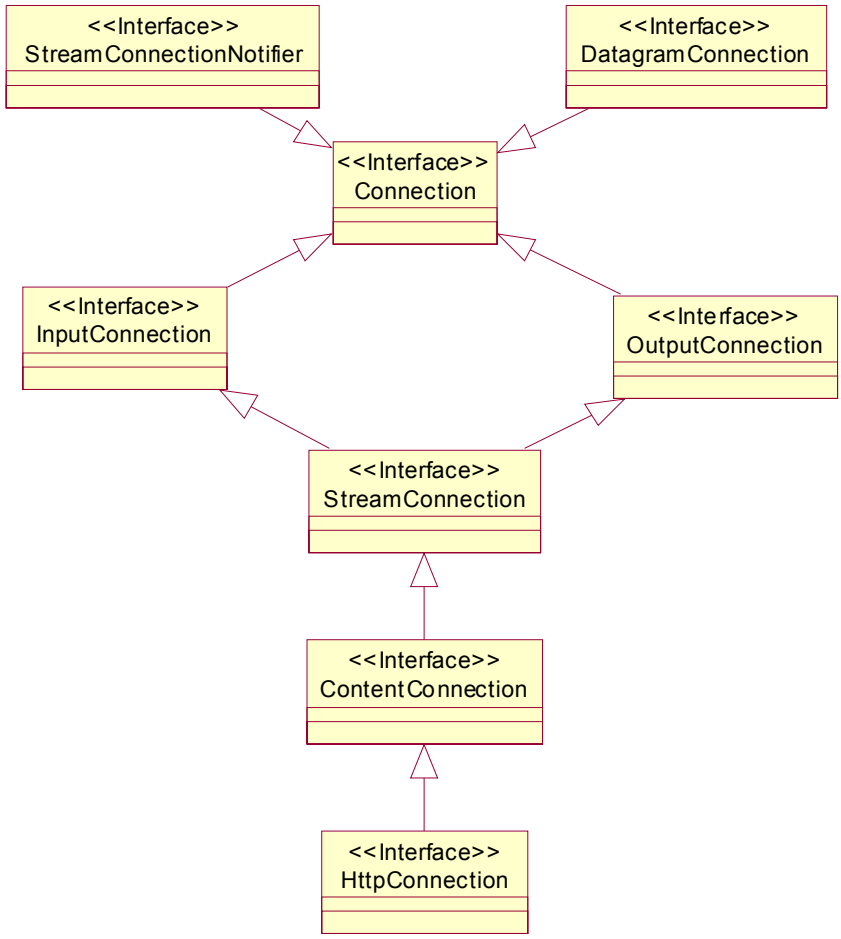
Network Connections

The J2ME platform on the Motorola C370, C450, and C550 series of handsets provides a variety of networking functionalities beyond those specified in MIDP. The additional networking protocols are added through the Generic Connection Interface in order to simplify the interface to the application as well as to reduce the need for additional classes. Most of the additional network connections are invoked using a runtime parameter similar to HTTP, reducing the learning curve for developers as well as the reducing potential application porting efforts. The following is a list of networking features for the Motorola C370, C450, and C550 series of handsets:

- HTTP
- TCP Sockets
- UDP Sockets

The standard networking protocol specified in MIDP 1.0 is HTTP. Although HTTP is useful and flexible for most data exchanges, many of the applications fall outside the standard request/response models of most browsers. Applications such as games and stock tickers require networking protocols with different characteristics. In order to accommodate these types of applications with reasonable efficiency, additional protocol stacks including UDP and TCP Sockets, have been added. These added networking functionalities not only provide the application developer with more communication options, it alleviates the need to perform inefficient workarounds for a strict HTTP environment. Other applications may also choose to take advantage of the bottom connector on the devices.

Class Descriptions



Since all the additional communication protocols have been added to the Generic Connection Framework, the access methods and parameters are very similar. The main calls are to the `Connector` class, which provides three static methods that accept different compile time parameters. The commonality between the three static methods is the first parameter in their signatures. This particular runtime parameter accepts `Strings` formatted in the standard Uniform Resource Locator format. The following is the list of method signatures:

```
Connector.open(String URL) - default READ_WRITE, no timeout.
Connector.open(String URL, int mode) - defaults to no timeout.
Connector.open(String URL, int mode, Boolean timeout)
```

`- String URL –` parameter string describing the target conforms to the URL format as described in RFC 2396 for all networking protocols.

`- int mode –` READ/WRITE/READ_WRITE

`- boolean timeout –` An optional third parameter, protocol may throw an IOException when it detects a time-out condition.

The time-out period for the TCP implementation on the Motorola C370, C450, and C550 series of handsets is 20 seconds on read operation and about 45 seconds on write operation if the time-out flag is set to true. If the time-out flag is set to false, the time-out time is indefinite. The lingering time for closing sockets is 0 second (if the socket closed by the server the lingering time will be less than 100 ms). If a new socket is requested within this time frame and the maximum number of sockets opened has been reached (5 sockets), then an IOException is thrown.

Applications requesting a network resource for any protocol must use one of the three methods above. The URL is the distinguishing argument that determines the difference between HTTP, etc. The following chart details the prefixes that should be used for the supported protocols.

Protocol	URL Format
HTTP	`http://`
TCP Sockets	`socket://`
UDP Sockets	`datagram://`

HTTP

The HTTP implementation follows the MIDP 1.0 standard. The `Connector.open()` methods return a `HttpConnection` object that is then used to open streams for reading and writing. The following is a code example to show implementation of HTTP:

```
HttpConnection hc = (HttpConnection)Connector.open(
“http://www.motorola.com”);
```

In this particular example, the standard port 80 is used, but this parameter can be specified as shown in the following example:

```
HttpConnection hc = (HttpConnection)Connector.open(
“http://www.motorola.com:8080”);
```

The other static Connector methods work in the same manner, but they provide the application additional control in dealing with the properties of the connection. By default, HTTP 1.1 persistency is used to increase efficiency while requesting multiple pieces of data from the same server. In order to disable persistency, set the “Connection” property of the HTTP header to “close”.

TCP Sockets

The low-level socket used to implement the higher-level HTTP protocol is exposed to applications via the Generic Connection Framework. The usage is similar to the examples above, however, a `StreamConnection` is returned by the `Connection.open()` method, as shown in the following example:

```
StreamConnection sc =
      (StreamConnection)Connector.open(
      "socket://www.motorola.com:8000");
```

Although similar to HTTP, notice the required port number at the end of the remote address. In the previous protocols, those ports are well known and registered so they are not required, but in the case of low level sockets, this value is not defined. The port number is a required parameter for this protocol stack.

UDP Sockets

If networking efficiency is of greater importance than reliability, datagrams (UDP) sockets are also available to the application in much the same manner as other networking protocols. The `Connector` object in this case returns a `DatagramConnection` object, as is shown in the following example:

```
DatagramConnection dc = (DatagramConnection)Connector.open(
"datagram://170.169.168.167:8000");
```

Much like low-level sockets, accessing UDP requires both a target address and a port number. The Motorola C370, C450, and C550 series of handsets supports a maximum outgoing and incoming payload of 1472 bytes and 2944 bytes, respectively.

Implementation Notes

As stated in the previous sections, the Motorola C370, C450, and C550 series of handsets supports some networking options. The networking options however are limited by both memory and bandwidth, which place hard restrictions on the applications. These limitations manifest themselves mainly in the number of simultaneous connections that can be opened.

Maximum number of sockets is 5 of any combinations of HTTP and UDP. Due to memory constraints, the C370, C450, and C550 can support only one secure session (i.e. if other application like Browser already opened a secure socket, a KJava midlet will get an IOException when it tries to open only one connection which is HTTP connection). If the maximum number of sockets is concurrently opened by the application and a sixth socket is requested, an exception is thrown to the calling application.

Notes

It is important to take into consideration the blocking nature of many javax.microedition.io and java.io object methods with regards to networking applications. It is advisable to spawn another thread specifically dedicated to retrieving data in order to keep the user interface interactive. If a single thread is used to retrieve data on a blocking call, the user interface becomes inactive with the end-user perceiving the application as “dead”.

Reading from an `InputStream` using an array is faster then reading byte by byte, when the length of the data is known. For example, if the content length is provided in the header of the `HttpConnection`, then an array of the specified size can be used to read the data.

The `InputStream` and `OutputStream` as well as the `Connection` object need to be completely closed.

An application in the paused state can still continue to actively use the networking facilities of the Motorola C370, C450, and C550 series of handsets.

The platform does not support simultaneous voice and data transmissions.

7
LCDUI

LCDUI API

The following table lists the specific interfaces supported by Motorola implementation:

Interface	Description
Choice	Choice defines an API for user interface components implementing selection from a predefined number of choices.
CommandListener	This interface is used by applications which need to receive high-level events from implementation
ItemCommandListener	A listener type for receiving notification of commands that have been invoked on Item$_{286}$ objects
ItemStateListener	This interface is used by applications which need to receive events that indicate changes in the internal state of the interactive items within a Form$_{231}$ screen.

The following table lists the specific classes supported by Motorola implementation:

Classes	Description
Alert	An alert is a screen that shows data to the user and waits for a certain period of time before proceeding to the next Displayable.
AlertType	The AlertType provides an indication of the nature of alerts.
Canvas	The Canvas class is a base class for writing applications that need to handle low-level events and to issue graphics calls for drawing to the display.
ChoiceGroup	A ChoiceGroup is a group of selectable elements intended to be placed within a Form.
Command	The Command class is a construct that encapsulates the semantic information of an action

	information of an action.
CustomItem	A CustemItem is customizable by sub classing to introduce new visual and interactive elements into Forms.
DateField	A DateField is an editable component for presenting date and time (calendar) information that will be placed into a Form.
Display	Display represents the manager of the display and input devices of the system.
Displayable	An object that has the capability of being placed on the display.
Font	The Font class represents fonts and font metrics.
Form	A Form is a Screen that contains an arbitrary mixture of items: images, read-only text fields, editable text fields, editable date fields, gauges, choice groups, and custom items.
Gauge	Implements a graphical display, such as a bar graph of an integer value.
Graphics	Provides simple 2D geometric rendering capability.
Image	The Image class is used to hold graphical image data.
ImageItem	An item that can contain an image.
Item	A superclass for components that car be added to a Form[231].
List	A Screen containing a list of choices.
Screen	The common superclass of all high-level user interface classes.
Spacer	A blank, non-interactive item that has a settable minimum size.
StringItem	An item that can contain a string.
TextBox	The TextBox class is a Screen that allows the user to enter and edit data.
TextField	A TextField is an editable text component that will be placed into a Form.
Ticker	Implements a “ticker-tape”, a piece of text that runs continuously across the display.

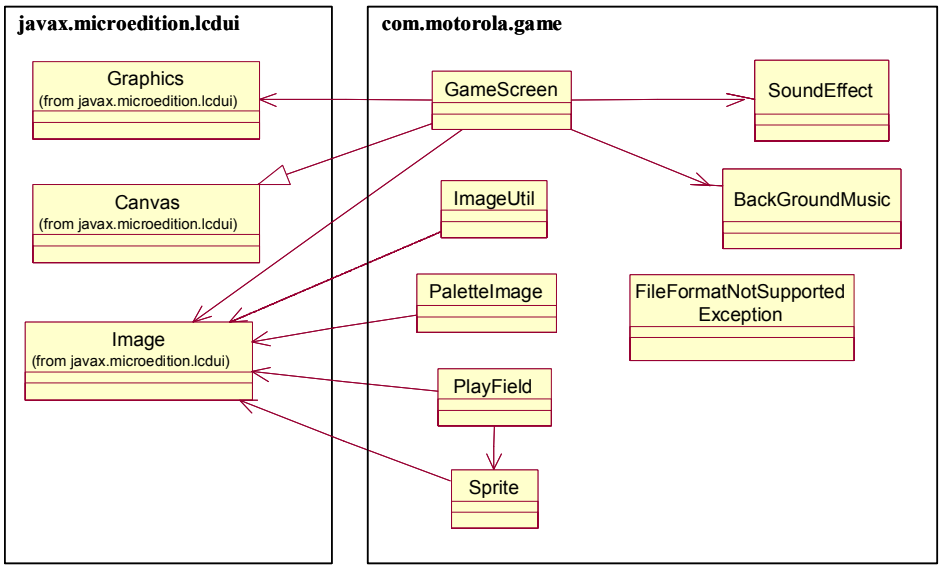
8
Gaming API and Sound

Functional Description

The Gaming API provides gaming related functionality to J2ME MIDlet writers. This functionality includes the ability and support for transparent images, the ability to play simple sounds and sound effects during a game, the ability to detect simultaneous key presses, support for sprites, and support for dynamically changing the palette color associated with an image.

Class Hierarchy

The following diagram shows the Gaming API hierarchy.



BackgroundMusic Class

The `BackgroundMusic` class encapsulates the data for a game's background music. A game may create several `BackgroundMusic` objects, but only one can be playing at any one time. The sound data can be stored on the device as a named resource in the application JAR file, or it can be stored on a server and retrieved via the network. `BackgroundMusic` is played by a `GameScreen`.

BackgroundMusic Methods

The `BackgroundMusic` class defines the following methods:

- `public static BackgroundMusic createBackgroundMusic(java.lang.String name)` throws `FileFormatNotSupportedException` – Creates a BackgroundMusic for the sound data stored in the specified named resource or URL. This method currently supports the use of MIDI format 0 and format 1 only.

Using BackgroundMusic

The following code sample shows implementation of `BackgroundMusic`:

Using BackgroundMusic

```
BackgroundMusic bgm1 = BackgroundMusic.createBackgroundMusic("/FunkyTunes.mid");
BackgroundMusic bgm2 =
BackgroundMusic.createBackgroundMusic("http://www.motorola.com/sounds/JazzyTunes.mid");
```

The following code sample shows implementation of the Gaming API that contains a sound API:

Gaming API containing a sound API

```
import com.motorola.game.*;
public class GS extends GameScreen {

 public BackgroundMusic bgm;

 public GS()
 {
   bgm = BackgroundMusic.createBackgroundMusic("vinovata.mid");
   playBackgroundMusic(bgm, true);
 }
}
```

GameScreen Class

The `GameScreen` class provides the basis for a game user interface. In addition to the features inherited from MIDP's Canvas (commands, input events, etc.) The GameScreen class provides game-specific capabilities such as an off-screen buffer with synchronized flushing and key status polling. A game can provide its own thread to run the game loop. A typical loop will check for input, implement the game logic, and then render the updated user interface.

GameScreen Fields

The `GameScreen` class defines the following fields:

- `public static final int DOWN_KEY` - The bit representing the DOWN key. This constant has a value of 0x02.
- `public static final int FIRE_KEY` - The bit representing the FIRE key. This constant has a value of 0x10.
- `public static final int GAME_A_KEY` - The bit representing the GAME_A key (may not be supported on all devices). This constant has a value of 0x20.
- `public static final int GAME_B_KEY` - The bit representing the GAME_B key (may not be supported on all devices). This constant has a value of 0x40.
- `public static final int GAME_C_KEY` - The bit representing the GAME_C key (may not be supported on all devices). This constant has a value of 0x80.
- `public static final int GAME_D_KEY` - The bit representing the GAME_D key (may not be supported on all devices). This constant has a value of 0x100.
- `public static final int LEFT_KEY` - The bit representing the LEFT key. This constant has a value of 0x04.
- `public static final int RIGHT_KEY` - The bit representing the RIGHT key. This constant has a value of 0x08.
- `public static final int UP_KEY` - The bit representing the UP key. This constant has a value of 0x01.
- `public static final int PRIORITY_MAX` - The maximum priority for playing sound effects. This constant has a value of 100.
- `public static final int PRIORITY_MIN` - The minimum priority for playing sound effects. This constant has a value of 0.
- `public static final int VOLUME_MAX` - The maximum volume for playing sound effects. This constant has a value of 100.

- `public static final int VOLUME_MIN` - The minimum volume for playing sound effects. This constant has a value of 0.

GameScreen Methods

The `GameScreen` class defines the following methods:

- `protected Graphics getGraphics()` - Obtains the Graphics object for rendering GameScreens. The Graphics object renders to an off-screen buffer whose size is equal to that of the GameScreen (use getWidth() and getHeight() to determine the size of the GameScreen). The buffer is initially filled with white pixels. Rendering operations do not appear on the display until flushGraphics() is called; flushing the buffer does not change its contents (that is, the pixels are not cleared as a result of the flushing operation). Only one image buffer is supported because without a vertical sync blanking period or its equivalent, there is little or no benefit from having multiple image buffers. Only one Graphics object exists for each GameScreen instance.
- `public int getKeyStates()` - Gets the states of the physical keys. Each bit in the returned integer represents a specific key on the device. A key's bit will be set if the key is currently pressed or was pressed at least once since the last time this method was called. The bit will be 0 if the key is not currently pressed and was not pressed at all since the last time this method was called. This latching behavior ensures that a rapid key press and release will always be caught by the game loop, regardless of how slowly the loop runs. This method may be called twice to check if a key is currently pressed; that is, calling this method twice effectively disables the latching behavior. The lower bits are defined by UP_KEY, DOWN_KEY, LEFT_KEY, etc.; the remaining bits may be mapped to device-specific keys.

The following is a code sample to show implementation of `public int getKeyStates()`:

Public int getKeyStates ()

```
// Get the key state and store it
int keyState = gameScreenObject.getKeyStates();
if ((keyState & LEFT_KEY) != 0) {
   positionX--;
} else if ((keyState & RIGHT_KEY) != 0) {
   positionX++;
               }
```

- `public void enableKeyEvents(boolean enabled)` - Enables or disables key event calls to this GameScreen. If disabled, the Canvas key event methods (keyPressed, keyRepeated, keyReleased) are not called when keys are pressed or released; however, the developer can still call getKeyStates to query the state of the keys. For games that poll key state and do not need event-driven key

information, disabling key events can improve performance.
Note that this setting is unique to each GameScreen instance; other GameScreens, when shown, are subject to their own setting for key events.

- `public void paint(javax.microedition.lcdui.Graphics g)` - Paints this GameScreen. By default, this method does nothing. It can be overridden according to application needs.
- `public void flushGraphics(int x, int y, int width, int height)` – Waits until the end of the current screen refresh cycle and then flushes the specified region of the off-screen buffer to the display driver. This method does not return until that region of the buffer has been completely flushed. The pixels of the off-screen buffer are not changed as a result of the flush operation. Upon returning from this method, the application may immediately begin to render the next frame using the same buffer.
- `public void flushGraphics()` - Waits until the end of the current screen refresh cycle and then flushes all of the off-screen buffer to the display driver. This method does not return until the entire buffer has been completely flushed. The pixels of the off-screen buffer are not changed as a result of the flush operation. Upon returning from this method, the app may immediately begin to render the next frame using the same buffer.
- `public static int getDisplayColor(int color) throws IllegalArgumentException` – Gets the color that will be displayed if the specified color is requested. This method enables the developer to check the manner in which RGB values are mapped to the set of distinct colors that the device can actually display. For example, with a monochrome device, this method will return either 0xFFFFFF (white) or 0x000000 (black) depending on the brightness of the specified color.
- `public void playSoundEffect(SoundEffect se, int volume, int priority)` - Plays the specified SoundEffect. A GameScreen's sound effects are heard only while it is the visible screen. A device capability of playing SoundEffects can be found by using the method soundEffectsSupported(). The platform's ability to play several SoundEffects simultaneously can be found by using the method getMaxSoundsSupported(). The priority specified for each request determines which sound(s) are heard when the number of simultaneous sound requests exceeds the capabilities of the device.
- `public boolean soundEffectsSupported()` - Checks whether the underlying platform supports SoundEffects. It returns true if SoundEffects are supported.
- `public boolean backgroundMusicSupported()` - Checks whether the underlying platform supports BackgroundMusic. It returns true if BackgroundMusic is supported.
- `public int getMaxSoundsSupported()` - Queries the underlying platform's capability to play multiple SoundEffects simultaneously.
- `public void stopAllSoundEffects()` - Stops all the SoundEffects that are playing. Note that this method does not affect background music.

- `public void playBackgroundMusic (BackgroundMusic bgm, boolean loop)` - Plays the specified BackgroundMusic object from the beginning. This method first stops the current BackgroundMusic if any. Thus, this method may be used to start background music (by specifying a non-null BackgroundMusic object), restart the current background music (by specifying the same BackgroundMusic object), change the background music, or end the background music (by specifying null). The `loop` parameter is set to true if the BackgroundMusic is to repeat indefinitely. Otherwise, set to false.

Using GameScreen

The GameDemoScreen class uses the `GameScreen` class to provide a UI screen for a hypothetic game. GameDemoScreen is a subclass of `GameScreen` that implements runnable for running the main game loop thread.

The following code sample shows implementation of using GameScreen.

GameScreen

```
class GameDemoScreen extends GameScreen implements Runnable{
    // ...
    public void run() {

        // Get the Graphics object for the
        // off-screen buffer
        Graphics g = getGraphics();
        while (true) {
            // Check user input and update
            // positions if necessary
            int keyState = getKeyStates();
            if ((keyState & LEFT_KEY) != 0) {
                sprite.move(-1, 0);
            }
            else if ((keyState & RIGHT_KEY) != 0) {
                sprite.move(1, 0);
            }
            // Draw the background
            g.drawImage(backgroundImage,0,0, Graphics.TOP
                              + Graphics.LEFT);
            // Draw the sprite on top of the background
            sprite.draw(g);
            // Flush the off-screen buffer
            flushGraphics();
        }
    }
    // ...
}
```

ImageUtil Class

`ImageUtil` provides static methods useful to the manipulation of `Image` objects. Specifically, it provides methods for setting and getting RGB values, and also provides the ability to create a scaled instance of an existing `Image`.

ImageUtil Fields

The `ImageUtil` class defines the following fields:

- public static final int SCALE_AREA - Area scaling method.
- public static final int SCALE_REPLICATE - Replicate scaling method.
- public static final int SCALE_SMOOTH - Smooth scaling method.

ImageUtil Methods

The `ImageUtil` class defines the following methods:

- `public static void getPixels(Image src, int x, int y, int width, int height, int[] rgbData)` throws `ArrayIndexOutOfBoundsException` – Gets RGB pixel data from the specified region of the source image. The data is stored in the provided *int* array in row-major order using the standard 24-bit color format (0xRRGGBB). Note that the color information stored in the image may be subject to the capabilities of the device's display. The `rgbData` must be instantiated previously calling this method, according to pixel amount that the user is requiring to the method. The parameters are the following: `src` - the source Image to retrieve the pixel data from; `x` - the horizontal location of left edge of the region; `y` - the vertical location of the top edge of the region; `width` - the width of the region; `height` - the height of the region; `height` - the height of the region; and `rgbData` - the array in which the pixel data is to be stored.
- `public static void getPixels(Image src, int[] rgbData)` throws `ArrayIndexOutOfBoundsException` – Gets RGB pixel data from the entirety of the source image. The data is stored in the provided int array in row-major order using the standard 24-bit color format (0xRRGGBB). Note that the color information stored in the image may be subject to the capabilities of the device's display. The `rgbData` must be instantiated previously calling this method, according to pixel amount that the user is requiring to the method. The parameters are the following: `src` - the source Image to retrieve the pixel data from; and `rgbData` - the array in which the pixel data is to be stored.
- public static void setPixels(javax.microedition.lcdui.Image dest, int x, int y, int width, int height, int[] rgbData) throws ArrayIndexOutOfBoundsException, IllegalArgumentException – Sets RGB pixel data in specified region of the destination image. The data must be stored in the int array in row-major order using the standard

24-bit color format (0xRRGGBB). The method parameters are the following: `dest` - The mutable destination Image whose pixels will be set; `x` - The horizontal location of left edge of the region; `y` - The vertical location of the top edge of the region; `width` - The width of the region; `height` - The height of the region; and `rgbData` - The array of RGB pixel values.

- public static void setPixels(javax.microedition.lcdui.Image dest, int[] rgbData) throws ArrayIndexOutOfBoundsException, IllegalArgumentException – Sets RGB pixel data in the entirety of the destination image. The data must be stored in the int array in row-major order using the standard 24-bit color format (0xRRGGBB). The method parameters are `dest` - The mutable destination Image whose pixels will be set, and `rgbData` - The array of RGB pixel values.
- public static Image getScaleImage(javax.microedition.lcdui.Image src, int width, int height, int method) throws IllegalArgumentException – Creates a scaled version of the source image using the desired scaling method. All platforms must implement the SCALE_REPLICATE scaling method; other scaling methods may be optionally supported. SCALE_REPLICATE is used if the requested scaling method is not supported by the device. The method parameters are the following: `src` - the source Image; `width` - the width, in pixels, of the new Image, `height` - the height, in pixels, of the new Image, and `method` - The desired method to be used to scale the image data (see the item 0).

Using ImageUtil

The following code sample uses an image (tank.png) to create a data structure (`rgbData`) to stores the RGB pixel data. The `rgbData` is used to draw the same image.

The following is a code sample to show implementation of `rgbData`:

rgbData

```
try {
     Image tank = Image.createImage("tank.png");
} catch(Exception e) {
  // The image can't be loaded
}

// creates a data structure to stores the RGB pixel data from Image
      int rgbData[] = new int[tank.getHeight()*tank.getWidth()];
      // Stores the RGB pixel data from Image
      ImageUtil.getPixels(tank,rgbData);
      // Draws the image pixel by pixel with the respective RGB pixel
      data
      for (i=0;i<tank.getHeight();i++) {
           for (j=0;j<tank.getWidth();j++) {
                 g.setColor(rgbData[i*tank.getWidth() + j]);
                 g.fillRect(j,i,1,1);
```

```
        }
    }
```

PalleteImage Class

`PaletteImage` provides methods for manipulating the color palette data of an image. `PaletteImages` can only be created with palette-based image data (PNG color type 3, or other palette image formats that a particular device may support).

A single palette entry or the entire palette can be retrieved as a series of RGB values in 0xRRGGBB format (MIDP color format). The effects of the palette changes will be visible in the next Image that is generated.

The following will be supported:

- Single color transparency: the entire palette may be fully opaque, or a single palette entry may be designated as being fully transparent. Alpha channels are not supported.

Once the palette entries have been set to the desired values, a MIDP Image object is retrieved that reflects the new palette settings.

PalleteImage Constructor

The `PalleteImage` class defines the following constructors:

- `PalleteImage(byte[] data, int offset, int length)` throws IOException - Creates a new PalleteImage using the provided image data.
- `PalleteImage (java.lang.String name)` throws IOException - Creates a new PaletteImage using the provided image data in a named resource.

PalleteImage Methods

The `PalleteImage` class defines the following methods:

- `public Image getImage()` - Creates and returns a new Image object using this PaletteImage. The Image returned will reflect the PaletteImage's original pixel data and current palette data. This method enables the developer to easily generate a series of differently colored images by adjusting palette data.
- `public int getTransparentIndex()` – Gets the current transparent index. Pixels that reference the transparent index in the palette are not drawn when the image is rendered. By default, the transparent index is -1 even if a transparent color is specified in the original image data.

- `public void setTransparentIndex(int index)` throws `IndexOutOfBoundsException` – Sets the current transparent index. Pixels that reference the transparent index in the palette are not drawn when the image is rendered. The effects of the new transparent index will be reflected in the next Image object that is created by calling getImage().
- `public int getPaletteSize()` - Gets the number of entries in the palette.
- `public int getPaletteEntry(int index)` throws `IndexOutOfBoundsException` - Gets the specified entry in the palette. The method returns the current color value of the entry (0xRRGGBB format).
- `public void setPaletteEntry(int index, int color)` throws `IndexOutOfBoundsException` – Sets the specified entry in the palette. The color must be specified using the MIDP color format (0xRRGGBB, the upper 8 bits are ignored). The effects of the new palette will be reflected in the next Image object that is created by calling getImage().
- `public int[] getPalette()` – Gets the entire palette as an array of ints, each one representing a 24-bit RGB value. The method returns a new int array each time it is called, so this method should be used sparingly to avoid creating excessive garbage.
- `public void setPalette(int[] newPalette)` throws `ArrayIndexOutOfBoundsException, NullPointerException, IllegalArgumentException` - Sets the palette data for this image. The palette data must be specified using MIDP color format (0xRRGGBB, the upper 8 bits are ignored). The size of the new palette must be at least as large as the value returned by `getPaletteSize()`; additional palette entries, if present, are ignored. The effects of the new palette will be reflected in the next Image object that is created by calling `getImage()`.

Using PalleteImage

`PalleteImage` enables a developer to adjust the colors of an image to match the capabilities of the device. It also enables reuse of image data by allowing the developer to change the color scheme. For example, a racing game may use a single `PaletteImage` of a car; the developer may then tweak the palette and generate a series of `Images` of differently colored cars, as seen below:

```
PaletteImage raceCar = new PaletteImage("car.png");

// Set the car color to red and retrieve the Image
raceCar.setPaletteEntry(0, 0xFF0000);
Image redRaceCar = raceCar.getImage();

// Set the car color to blue and retrieve the Image
```

```
raceCar.setPaletteEntry(0, 0x0000FF);
Image blueRaceCar = raceCar.getImage();

// Set the car color to green and retrieve the Image
raceCar.setPaletteEntry(0, 0x00FF00);
Image greenRaceCar = raceCar.getImage();

// The PaletteImage can now be discarded since we have the
// Image objects that we need
raceCar = null;
```

PlayField Class

A `PlayField` is a rectangular grid of cells with a set of available tiles to place in those cells and a set of associated Sprites.

The `PlayField` grid is made up of (rows * columns) cells, where the number of rows and columns are defined by parameters to the constructor. The cells are equally sized. The size of the cells is defined by the size of the tiles, or if the `PlayField` has no tiles, by arguments to the constructor. Each cell is either empty or contains a single tile whose image will be drawn in that cell. An empty cell is fully transparent - Nothing will be drawn in that area by the `PlayField`.

The tiles used to fill the `PlayField` cells can be either static tiles or animated tiles. Tiles are referred to using index numbers. Tile 0 (tile with index 0) refers to the special empty tile. Any cell assigned the tile 0 will be considered empty and will be effectively transparent.

The static tile indices are non-negative (>=0) and the animated tiles indices are negative (<0).

Using Static and Animated Tiles

Static tiles are called static because their image does not often change, i.e., any cell that contains the static Tile 1 will always be drawn as the unchanging image of Tile 1. Tile 0 is a special static tile. It represents an empty cell. Any cell containing tile 0 will be transparent, it will not have a tile image drawn in it.

Animated tiles are called animated because their appearance changes easily over time. At any given time, each animated tile is associated with a particular static tile. When a cell containing an animated tile is drawn, the image of the static tile currently referenced by that animated tile will be drawn in that cell. In effect, the animated tiles provide indirect references to the set of static tiles, and therefore allow many cells to be animated simultaneously. For example, cells (0,0) and (0,1) both contain animated Tile -2. Animated Tile -2 currently references static Tile 1. Cells (0,0) and (0,1) will then be drawn with the image of static Tile 1. If animated Tile -2 is subsequently set to reference static Tile 2 by

calling `setAnimatedTileImage(-2, 2);`, cells (0,0) and (0,1) will then be drawn with the image of static Tile 2.

Using Sprites

In addition to being a grid of cells, a `Playfield` can have a set of associated `Sprites` (see 0 item). When the `PlayField` is drawn, the grid is considered to have depth 0. Therefore, `Sprites` below the grid (`Sprites` with `Sprite.getDepth() < 0`) are drawn first. Then all cells in the grid are drawn. Then all the `Sprites` above the grid (`Sprite.getDepth() >= 0`) are drawn. The `Sprites` are drawn according to their location and visibility status as defined in the `Sprite` class. The location of `Sprites` is relative to the top-left corner of the `PlayField`.

Defining View Windows

A view window onto the `PlayField` can be defined using the method `setViewWindow()`. This defines the area of the `PlayField` that will be drawn by the `draw()` method. The default viewing window onto a `PlayField` (at construction time) is the entire area of the `PlayField`.

PlayField Constructor

The `PlayField` class defines the following constructors:

PlayField (int columns, int rows, Image img, int tWidth, int tHeight) throws NullPointerException, IllegalArgumentException - Creates a new PlayField with a tile set. The parameter are the following:

- `columns` - width of the PlayField in number of cells;
- `rows` - height of the PlayField in number of cells;
- `img` - Image to use for creating tiles;
- `tWidth` - width, in pixels, of the individual tiles;
- `tHeight` - height, in pixels, of the individual tiles.

It creates a new `PlayField`, `rows` cells high and `columns` cells wide. The static tile set for the PlayField will be created from subsections of the image passed in. The `PlayField` grid is initially filled with empty cells (tile 0 - a reserved tile and represents an empty square) and laying out tiles must be accomplished through the use of other methods in the class. The creation of the static tile set follows these standards:

Tiles must be equally sized, all being of the tile width (`tWidth`) and height (`tHeight`) defined in the constructor parameters. They may be laid out in the image horizontally, vertically, or as a grid. The width of the source image must be an integer

multiple of the tile width. The height of the source image must be an integer multiple of the tile height.

The tiles in the source image will have indices as follows:

The static tiles are indexed like words are read on a page; left-to-right, then top-to-bottom. The top-left tile is assigned index 1. If there is a tile to its right, this tile is assigned index 2, and so on, across the first row of tiles. If there is a second row of tiles, the index of the left-most tile in this row is one greater than the right-most tile in the preceding row. The table below is a diagrammatic depiction:

1	2	. . .	N
N+1	N + 2	. . .	2N
2N+1	2N + 2	. . .	
. . .	. . .	. . .	. . .
[(M – 1) * N]+1	[(M-1) * N)] + 2	. . .	(M * N)

So the total number of tiles is M * N, where:

– N = (image width) / (tile width);

– M = (image height) / (tile height).

The indices for the static tile set will be non-negative (>=0) and the indices for animated tiles will be negative (<0). The index sets do not overlap and therefore indices for static and animated tiles can be used interchangeably in the methods that set or move the contents of the `PlayField` cells. The static Tile set shall behave as if the image used in creation were cached. If a mutable image is used to create the tiles, the tiles' appearances should not reflect changes to the mutable source image. The appearance of individual static tiles can be changed with `setStaticTileImage()`. The entire static tile set can be changed using `setStaticTileSet()`. These methods should be used sparingly since they are both memory and time consuming.

PlayField (`int columns, int rows, int cellWidth, int cellHeight`) throws IllegalArgumentException - Creates a new `PlayField` without a tile set. The parameter are the following:

– `columns` - width of the PlayField in number of cells;

– `rows` - height of the PlayField in number of cells;

– `cellWidth` - Pixel width of each cell;

– `cellHeight` - Pixel height of each cell.

It creates a new `PlayField`, `rows` cells high and `columns` cells wide. A PlayField created with this constructor will not have any tiles (animated or static) associated with it. The primary use of a `PlayField` without tiles is expected to be as a container for managing sprites. The on-screen pixel dimensions of cells is defined by the parameters `cellWidth` and `cellHeight`. The cells in the

PlayField are all empty (tile 0 - a reserved tile and represents an empty square). A tile set can later be added using `setStaticTileSet()`.

PlayField Methods

The `PlayField` class defines the following methods:

- `public void addSprite(Sprite s)` throws `NullPointerException` – Add a Sprite to the PlayField. Ignores the request if the Sprite is already associated with the PlayField.
- `public void removeSprite(Sprite s)` throws `RuntimeException`, NullPointerException – Remove a Sprite from PlayField.
- `public void removeAllSprites()` – Remove all Sprites from PlayField.
- `public int createAnimatedTile(int staticTileIdx)` throws `IndexOutOfBoundsException` – Creates a new animated tile and initializes it with a static tile index. Returns the index to use when referring to this animated tile. The indices for animated tiles will be negative (<0) and the indices for the static tile set will be positive (>=0). The index sets do not overlap and therefore indices for static and animated tiles can be used interchangeably in the methods that set or move the contents of the PlayField cells. The first animated tile shall have the index -1, the second, -2, etc.
- `public void setAnimatedTileImage(int animTileIdx, int staticTileIdx)` throws `IndexOutOfBoundsException` – Sets the static tile that will be displayed in any cell that contains the animated tile. The method parameters are `animTileIdx` - index of the animated tile, and `staticTileIdx` - index of a static tile to be referenced by the animated tile.
- `public int getAnimatedTileImage(int animTileIdx)` throws `IndexOutOfBoundsException` – Get the static tile referenced by an animated tile, and returns the index of the static tile that is currently referenced by an animated tile.
- `public void setCell(int celCol, int celRow, int tileIdx)` throws `IndexOutOfBoundsException`, `ArrayIndexOutOfBoundsException` – Sets the tile to be displayed in a cell. The tile can be either a static or an animated tile. The method parameters are `celCol` - column of cell to set, `celRow` - row of cell to set, and `tileIdx` - index of tile to place in cell.
- `public int getCell(int celCol, int celRow)` throws.`ArrayIndexOutOfBoundsException` – Gets the index of the static or animated tile currently displayed in a cell.
- `public void moveTiles(int dstCol, int dstRow, int srcCol, int srcRow, int width, int height)` throws `ArrayIndexOutOfBoundsException` – Move a rectangular set of tiles from a source location to a destination location. Source cells are left empty. If the

source and destination cells overlap, the method shall behave as if the source cells are first copied to a separate array, the source cells are cleared, and the tiles are then copied back to the destination cells. The method parameters are the following: `dstCol` - column of top-left destination cell; `dstRow` - row of top-left destination cell; `srcCol` - column of top-left source cell; `srcRow` - row of top-left source cell; `width` - width, in rows, of area of tiles to move; and `height` - height, in rows, of area of tiles to move.

- public void fillCells(int col, int row, int width, int height, int tileIdx) throws IndexOutOfBoundsException, ArrayIndexOutOfBoundsException – Fill each cell in a rectangular area with a given animated or static tile. The method parameters are the following: `col` - column of top-left cell; `row` - row of top-left cell; `width` - width, in rows, of area of cells to fill; `height` - height, in rows, of area of cells to fill; and `tileIdx` - index of tile to place in fill region.
- `public void draw(javax.microedition.lcdui.Graphics g, int x, int y)` throws `NullPointerException` – Draw the PlayField to a Graphics instance, anchoring the top left corner of the PlayField view window at the position `(x, y)` on the Graphics instance. The method parameters are the following: g - Graphics instance on which to draw the PlayField; `x` - the x coordinate of the top left corner of the PlayField; and `y` - the y coordinate of the top left corner of the PlayField. The PlayField will be drawn as follows:
- Draw all the `Sprites` with depth < 0 in increasing order of depth (depth -2 drawn before or below depth -1);
- Draw the tiles for all cells. Empty cells, those with Tile 0, are considered fully transparent, so nothing is drawn for them.
- Draw the all the `Sprites` with depth >= 0 in increasing order of depth (depth 1 drawn before or below depth 2). The location of the Sprites is defined by the `Sprite` instance and is relative to the top left corner of the `PlayField` grid.
- `public int getCellWidth()` – Get width of a cell, in pixels.
- `public int getCellHeight()` – Get height of a cell, in pixels.
- `public int getGridWidth()` – Get width of the PlayField grid, in cells.
- `public int getGridHeight()` – Get height of the PlayField grid, in cells.
- `public boolean anyCollisions()` – This method checks whether any of the PlayField's Sprites collide with any of the PlayField's tiles or other Sprites on the PlayField. It will return `true` if any Sprite on the PlayField collides with a tile or any other Sprite. Like collidesWithSprites(Sprite) and collidesWithAnyTile(Sprite), this method reports collisions only at a boundary level granularity, not pixel level granularity.
- `public boolean collidesWithSprites(Sprite s)` throws `NullPointerException` – Check for Sprite collision with any other Sprites on the PlayField. This method is complemented by Sprite.collidesWith(Sprite, boolean); If collidesWithSprites(Sprite) returns true, the developer can find the exact Sprite collision(s) by using Sprite.collidesWith(Sprite, boolean). This is similar to how

collidesWithAnyTile(Sprite) and collidesWithTiles(int, int, int, int, Sprite, boolean) complement each other. Sprite `s` does not have to have been added to the PlayField. The collision detection will proceed as if the Sprite is on the PlayField. That is, its location will be treated as relative to the origin of the PlayField's coordinate system.

- `public boolean collidesWithAnyTile(Sprite s)` throws `NullPointerException` – Check for Sprite collision with PlayField tiles. Return true if the Sprite overlaps with a cell that contains a tile (i.e. a cell containing a non-zero tile index). Sprite `s` does not have to have been added to the PlayField. The collision detection will proceed as if the Sprite is on the PlayField. That is, its location will be treated as relative to the origin of the PlayField's coordinate system.
- public boolean collidesWithTiles(int col, int row, int width, int height, Sprite s, boolean pixelLevel) throws NullPointerException, ArrayIndexOutOfBoundsException – Check for Sprite collision with a region of PlayField tiles. It returns true if the Sprite overlaps with a cell in the defined region that contains a tile (i.e. a cell containing a non-zero tile index). If `pixelLevel` is true, this method will report a collision only when opaque Sprite pixels overlap opaque tile pixels. This method complements the collidesWithAnyTile(Sprite) method by letting the programmer focus their search and find specific tiles or regions of collision. This is similar to how Sprite.collidesWith(Sprite, boolean) complements collidesWithSprites(Sprite). The method parameters are the following: `row` - Row of top-left cell for collision check region; `col` - Column of top-left cell for collision check region; `height` - Height, in rows, of area for collision check; `width` - Width, in rows, of area for collision check; `s` - Sprite to check for collision; and `pixelLevel` - Boolean indicating whether collision detection should be done at a pixel level instead of simply as boundary checks.
- `public void setStaticTileImage(int staticTileIdx, Image img, int x, int y)` throws `NullPointerException`, `ArrayIndexOutOfBoundsException` – Modify the image associated with a static tile. Replace the image currently associated with a static tile with a new image of the same size. New static tile image will be extracted from the image passed in, starting from pixel `(x, y)` in the new source image and extending for getCellWidth() pixels horizontally and getCellHeight() pixels vertically. As at tile set creation time, if a mutable source image is used, behavior of the tile set should be as if the new image were cached. Updates to the mutable source image will not cause a change in the appearance of the tile image.
- `public void setStaticTileSet(Image img, int tWidth, int tHeight)` throws `NullPointerException`, `IllegalArgumentException` – Replaces the current static tile set with a new static tile set. See the constructor PlayField(int, int, Image, int, int) for information on how the tiles are created from the image. If the new static tiles have the same dimensions as the previous static tiles, the view window will be unchanged. If the new static tiles have different dimensions than the previous static tiles, the view window will be reset to the construction default, i.e. the entire grid dimension. If the new static tile set has as many or more tiles than the previous static tile set, then the animated tiles will be unchanged, and the contents of the PlayField grid will be unchanged. If the new static tile set has less tiles than the previous static tile set, then the PlayField grid will be reset to completely empty, and All animated tiles will be deleted.

- `public void setViewWindow(int x, int y, int width, int height)` – Sets the portion of the PlayField that will be drawn when draw(Graphics, int, int) is called. This will limit the portion of the PlayField that is drawn to the rectangle defined by the region `(x, y)` to `(x + width, y + height)`. The default view window (at construction time) is the entire area of the PlayField, i.e. the rectangular region bounded by `(0, 0)` and (getGridWidth() * getCellWidth(), getGridHeight() `* getCellHeight())`.The rectangle defined by the parameters may extend beyond the bounds of the PlayField. If this happens, the `draw(graphics, int, int)` method will draw no tiles in the area outside the grid boundaries. Sprites may still be drawn in this area if their position places them outside the bounds of the PlayField grid. The view window stays in effect until it is modified by another call to this method or is reset as a result of calling setStaticTileSet(Image, int, int). The method parameters are `x` - x coord of top-left pixel for the drawing view window, `y` - y coord of top-left pixel for the drawing view window, `width` - width of the drawing view window, and `height` - height of the drawing view window.

Using PlayField

The following is a code sample to show implementation of `PlayField`:

PlayField

```
// Creates a playField with 100 columns and 10
// rows and tiles with 24x16 pixels
PlayField foreground = new PlayField(100, 10,
Image.createImage("tiles.png"), 24, 16);
// Sets the first cell in the first line to
// empty(tile with index 0)
foreground.setCell(0, 0, 0);
// Fills the second cell in the first line with tile 1
foreground.setCell(1, 0, 1);
// Fills the third cell in the first line with tile 2
foreground.setCell(2, 0, 2);
// Fills the fourth cell in the first line with tile 3
foreground.setCell(3, 0, 3);
// Gets the Graphics object for this GameScreen
Graphics g = getGraphics();
// Draws the foreground playfield
foreground.draw(g, 0, 0);
```

SoundEffect Class

The `SoundEffect` class encapsulates the data for a game sound effect. A game may create several `SoundEffect` objects, one for each of the sounds that it needs to play. The sound data may be stored on the device as a named resource in the application JAR file, or it can be stored on a server and retrieved via the network. `SoundEffect` instances are played by a `GameScreen`.

SoundEffect Methods

The `SoundEffect` class implements the following method:

- `public static SoundEffect createSoundEffect(String resource)` throws `FileFormatNotSupportedException` – Creates a `SoundEffect` for the sound data stored in the specified named resource or URL. The data must be in a sound format that is supported by the device. Though additional formats may be supported, all devices must support some format yet to be determined.

Using SoundEffect

As described above, a game can need several different sound effects. The code below exemplifies the creation of some `SoundEffect` objects:

The following is a code sample to show the creation of `SoundEffect` objects:

SoundEffect Objects

```
try{
   // Create a SoundEffect using a wave file inside the JAR
   SoundEffect s1 = createSoundEffect("/jump.wav");

   // Create a SoundEffect using a wave located
   // on a web site
   SoundEffect s2=
       createSoundEffect("http://www.motorola.com/sound/mp.wav");

}catch(FileFormatNotSupportedException fe){}
```

Sprite Class

The `Sprite` class is used to create graphic images, animated or non-animated, that a user can interact with and move around.

Animation Frames

An animated `sprite` is created from an image divided into sections as described in the constructor Sprite(Image, int, int). The individual sections of the image are considered the raw frames of the `Sprite`. The method getNumRawFrames returns the number of raw frames.

Sprite Drawing

`Sprites` can be drawn at anytime using the `draw(Graphics)` method. The sprite will be drawn on the `Graphics` object, according to the current state information maintained by the Sprite (i.e. position, frame, visibility). Some potential uses of Sprites include:

- Arbitrarily draw the Sprite on a `GameScreen`.
- A Sprite can be added to a `PlayField`. Then PlayField.draw(Graphics, int, int) will automatically draw all the Sprites associated with the `PlayField`.
- draw(Graphics) could be called from the `paint()` method in a subclass of `Canvas`.
- draw(Graphics) could be called at any time to draw the `Sprite` on a MIDP mutable image. This is virtually identical to the first bullet, drawing on a `GameScreen`.

Only in the case where a set of Sprites are a part of a container object (i.e. where the `Sprite` is associated with a `PlayField`) is the depth information automatically handled by the system. In other situations, managing the drawing order is the responsibility of the developer.

Sprite Constructor

The `Sprite` class defines the following constructors:

- `public Sprite(Image img)` – Creates a new non-animated `Sprite` from an `Image` object. All animation operations on a non-animated Sprite behave as if there is a single raw frame. At construction time, the `Sprite's` position will be set to (0,0), the depth will be set to 0, and the Sprite will be visible. The Sprite shall behave as if the image used in creation were cached. If a mutable image is used to create the Sprite, the Sprite's appearance should not reflect changes to mutable source image.
- `public Sprite(Image img, int fWidth, int fHeight)` – Creates a new animated `Sprite` from an Image. The constructor parameters are the following:
  - img - Image to use for Sprite;
  - fWidth - width, in pixels, of the individual raw frames;
  - fHeight - height, in pixels, of the individual raw frames.

The creation of the raw frames follows these standards:

– Frames must be equally sized, all being of the frame width (`fWidth`) and height (`fHeight`) defined in the constructor parameters. They may be laid out in the image horizontally, vertically, or as a grid. The width of the source image must be an integer multiple of the frame width. The height of the source image must be an integer multiple of the frame height.

The frames in the source image will have raw frame numbers as follows:

– The frames are numbered like words are read on a page; left-to-right, then top-to-bottom. The top-left frame is numbered 0. If there is a frame to its right, this frame is numbered 1, and so on, across the first row of frames. If there is a second row of frames, the number of the left-most frame in this row is one greater than the right-most frame in the preceding row. The table below is a diagrammatic depiction:

0	1	. . .	N – 1
N	N + 1	. . .	2N – 1
2N	2N + 1	. . .	
. . .	. . .	. . .	. . .
(M – 1) * N	((M-1)* N) + 1	. . .	(M * N) – 1

So the total number of frames is M * N, where:

– N = (image width) / (frame width)

– M = (image height) / (frame height)

At the time of creation, all Sprites have a default frame sequence corresponding to the raw frame numbers. This can be modified with `setFrameSequence()`. At construction time, the Sprite's position will be set to (0,0), the depth will be set to 0, and the Sprite will be visible. The Sprite shall behave as if the image used in creation were cached. If a mutable image is used to create the Sprite, the Sprite's appearance should not reflect changes to mutable source image.

`public Sprite(Sprite s)` – Creates a new Sprite from another `Sprite`. Create a copy of a `Sprite`. All attributes (raw frames, position, frame sequence, current frame, visibility) of the source `Sprite` should be reflected in the new `Sprite`. Any subsequent updates to the source `Sprite` after the creation of the second Sprite should *not* be reflected in the second Sprite.

Sprite Methods

The `Sprite` class implements the following methods:

- `public void setPosition(int x, int y)` – Set Sprite's x,y position. The x, y position is relative to whatever object the sprite is associated with or drawn on.

- `public void setDepth(int d)` – Set Sprite's depth order. The depth order is relative to other Sprites when multiple Sprites are contained in a container object, i.e. a PlayField. When Sprites are drawn explicitly instead of implicitly through the use of a container object, the management of drawing order is the responsibility of the developer. Integer.MIN_VALUE is the lowest depth, Integer.MAX_VALUE is the highest depth. So items with depth Integer.MIN_VALUE would be drawn first, or at the bottom, and items with depth Integer.MAX_VALUE would be drawn last or on top.
- `public void move(int dx, int dy)` – Move Sprite. The method parameters are `dx` - pixels to move Sprite along horizontal axis, and `dy` - pixels to move Sprite along vertical axis.
- `public int getX()` – Get Sprite's x position.
- `public int getY()` – Get Sprite's y position.
- `public int getDepth()` – Get Sprite's depth order.
- `public int getHeight()` – Get Sprite's height order.
- `public int getWidth()` – Get Sprite's width in pixels.
- `public boolean collidesWith(Sprite s, boolean pixelLevel)` throws `NullPointerException` – Check for collision between two Sprites. If `pixelLevel` is false, check for overlap in the rectangular areas of the two Sprites, using positions (x, y) and extents (width, height). The two Sprites are treated as if they are in the same coordinate system. For example, if the two Sprites are on different PlayFields that are drawn at different locations, this method still behaves as if they are on the same PlayField. If `pixelLevel` is true, check for overlap in opaque pixels of the two Sprites. Overlapping in transparent regions of either Sprite will not be considered a collision.
- `public void setFrame(int frame)` – Set Sprite's animation frame. Sets which frame from the frame sequence to draw when draw(Graphics) is called. All Sprites have a default frame sequence as described in the constructor.
- `public int getFrame()` – Get Sprite's current animation frame. All Sprites have a default frame sequence as described in the constructor.
- `public int getNumRawFrames()` – Get the number of raw frames in the original frame set for this Sprite.
- `public void nextFrame()` – Set current animation frame to the next frame. Advance to next frame in the frame sequence. All Sprites have a default frame sequence as described in the constructor. Frame list is considered to be circular, i.e. if `nextFrame()` is called when the last frame is the current frame, this will advance to the first frame.
- `public void prevFrame()` – Set current animation frame to the previous frame. Advance to previous frame in the frame sequence. All Sprites have a default frame sequence as described in the constructor. Frame list is considered to be circular, i.e. if `prevFrame()` is called when the first frame is the current frame, this will advance to the last frame.

- `public void setVisible(boolean visible)` – Set visibility status. If `setVisible(false)` is called, the Sprite will not be drawn by `draw(Graphics)` until `setVisible(true)` is called.
- `public boolean isVisible()` – Get visibility status. The method returns boolean indicating whether the Sprite will be drawn by `draw(Graphics)`.
- `public final void draw(Graphics g)` throws `NullPointerException` – Draw the Sprite. Draw current frame of Sprite to Graphics instance g at location currently set in Sprite. Sprite will be drawn only if `isVisible()= true`.
- `public void setFrameSequence(int[] seq)` throws `ArrayIndexOutOfBoundsException` – Set the sequence of frames to cycle through with next/prevFrame. All Sprites have a default sequence as described in the constructor. This method allows for the creation of an arbitrary sequence from the original frameset. The methods nextFrame(), prevFrame(), getFrame(), and setFrame(int) all operate on the frame sequence. Passing in `null` causes the sequence to revert to the default sequence defined in the constructor. The parameter `seq` is an array of integers, where each integer is a reference to a frame in the original raw frameset, that is, the frames from left to right on the original image.
- `public int[] getFrameSequence()` – Get the current frame sequence. Returns the frame sequence set with `setFrameSequence(int[])` or, if none has been set, return the default frame sequence for this Sprite. Each entry in the array is an index to the original raw frameset, that is, the frame numbering as described in the constructor.
- `public void setImage(javax.microedition.lcdui.Image img, int fWidth, int fHeight)` throws `NullPointerException`, `IllegalArgumentException` – Change the image used for the Sprite. Replaces the current raw frames of the Sprite with a new set of raw frames. See the constructor Sprite(Image, int, int) for information on how the frames are created from the image. Changing the image for the Sprite could change the number of raw frames. If the new frame set has as many or more raw frames than the previous frame set, then:

  – The current frame will be unchanged;

  – If a custom frame sequence has been defined (using setFrameSequence(int[])), it will remain unchanged. If no custom frame sequence is defined (i.e. the default frame sequence is in use), the default frame sequence will be updated to be the default frame sequence for the new frame set. In other words, the new default frame sequence will include all of the frames from the new raw frame set, as if this new image had been used in the constructor.

  If the new frame set have less frames than the previous frame set, then:

  – The current frame will be reset to frame 0;

– Any custom frame sequence will be deleted and the frame sequence will revert to the default frame sequence for the new frame set (all frames in the frame set, left-to-right then top-to-bottom).

Using Sprite

The example below creates two Sprites (bullet and tank) and tests collisions between them. When there are no lives left, the game finishes.

The following is a code sample to show implementation of using sprites:

Sprites

```
try {
    Sprite bullet = new Sprite(Image.createImage("bullet.png");
    Sprite tank = new Sprite(Image.createImage("tank.png");
} catch (Exception e) {
// any image can't be loaded
}
Boolean isGameOver= False;
int lifes= 3; // The number of lives is 3
while(!isGameOver) {
   // verifies the collision between the two sprites
   if(tank.collidesWith(bullet,false)) {
      lifes--;
      // If there are no more lifes, the game is over
      if(lifes == -1) {
          isGameOver = true;
      }
   }
}
```

FileFormatNotSupportedException

The `FileFormatNotSupportedException` is an exception which will be thrown when a `SoundEffect` or `BackgroundMusic` format is not supported by the platform or the size of the data is larger than the size of the internal buffers. The `FileFormatNotSupportedException` extends the `java.lang.RuntimeException` class.

FileFormatNotSupportedException Constructors

The `FileFormatNotSupportedException` class defines the following constructors:

- `public FileFormatNotSupportedException( java.lang.Exception e)` – The parameter `e` is the underlying exception that caused the failure.
- `public FileFormatNotSupportedException( java.lang.String info)` – The parameter `info` is a String containing information about the failure
- `public FileFormatNotSupportedException( java.lang.String info, Exception e)` – The parameters are `info` a String containing information about the failure, and `e` - The underlying exception that caused the failure.

Java Gaming Sound API

BackgroundMusic class objects (from .mid resource file or from bytes array) can be played by using GameScreen.playBackgroundMusic () method.

The following is a code sample to show implementation of the Java Gaming Sound API:

Java Gaming Sound API

```
import com.motorola.game.*;
public class GS extends GameScreen {

 public BackgroundMusic bgm;

 public GS()
 {
   bgm = BackgroundMusic.createBackgroundMusic("vinovata.mid");
   playBackgroundMusic(bgm, true);
 }
}
```

Max MIDI Extension Support

Max MIDI Extension Support is an extension of the Gaming API and allows Java Applications the ability to read Max MIDI file types, specifically for the Karaoke application.

9
Vibe and Backlight

Vibe and Backlight API

The Vibe and Backlight API allows J2ME applications access to vibrator, backlight, and keypad control. This access gives a MIDlet the ability to turn on/off these features based on the application's needs. The MIDlet will use the Vibe and Backlight API to enhance the activity being performed by the application. Examples of these enhancements are the following:

- When in a driving game application, the vibrator is turned on during a crash scenario.
- An alarm clock application will have access to turn the vibrator on and off.
- A stock ticker application turns the backlight on/off when a specified stock hits a target price.

In future releases of the Vibe and Backlight API, keypad and backlight control must function separately. Currently, these functions are dependant on the hardware implementation and which additional drivers are needed to control the keypad and lights separately from the display's backlight.

Native constraints must be in place to protect the battery life of the product. A time-out feature will be created to limit the duration of the vibrator and backlight features. This time-out will protect against a corrupt MIDlet or unattended MIDlet. These native constraints will be flexible to the operator.

10 SMS MO

Overview

Motorola has implemented certain features that are defined in the Wireless Messaging API (WMA) 1.0. The complete specification document is defined in JSR 120.

The JSR 120 specification states that developers can be provided access to send (MO – mobile originated) and receive (MT – mobile terminated) SMS (Short Message Service) on the target device.

A simple example of the WMA is the ability of two J2ME applications using SMS to communicate game moves running on the series of handsetss. This can take the form of chess moves being passed between two players via the WMA.

Motorola in this implementation of the specification supports the following features.

- Creating an SMS
- Sending an SMS

The SMS MO API will support the following content to be sent over SMS:

- Text

Creating a Message

The SMS MO API will enable the creation of SMS messages. The addressing of these messages will be compliant with the standard SMS addressing as specified in the GSM standards. The content of the message can be constructed using any one or combination of the content types specified in the overview.

Sending a Message

The SMS MO API will provide an avenue to send a message to the appropriate SMS address.

Permissions

Prior to the series of handsets sending a SMS message, the series of handsets will check the SMS Access Setting under the Java Settings menu. The SMS access setting gives the user the option to perform the following:

- Always ask the user for authorization on all MO SMS messages
- Ask the user for authorization once per application (default setting)
- Never ask the user for authorization

11 JAD Attributes

JAD Attributes

Motorola has implemented the following support for MIDP 1.0 Java Application Descriptor attributes:

Mandatory attributes for JAD files
MIDlet-Name
MIDlet-Version
MIDlet-Vendor
MIDlet-Jar-URL
MIDlet-Jar-Size
MIDlet-<n>
MIDlet-MicroEdition-Profile
MIDlet-MicroEdition-Configuration
MIDlet-Description
MIDlet-Icon
MIDlet-Info-URL
MIDlet-Data-Size
MIDlet-Permissions
MIDlet-Permissions-Opt
MIDlet-Push-<n>
MIDlet-Install-Notify
MIDlet-Delete-Notify
MIDlet-Deleter-Confirm

Mandatory attributes for manifest files
MIDlet-Name
MIDlet-Version
MIDlet-Vendor
MIDlet-<n>
MIDlet-MicroEdition-Profile
MIDlet-Install-Notify
MIDlet-Delete-Confirm
MIDlet-MicroEdition-Configuration
MIDlet-Description
MIDlet-Icon
MIDlet-Info-URL
MIDlet-Data-Size
MIDlet-Permissions
MIDlet-Permissions-Opt
MIDlet-Push-<n>
MIDlet-Install-Notify
MIDlet-Delete-Notify
MIDlet-Delete-Confirm

12 Record Management System

Overview

The most common mechanism for persistently storing data on a MIDP device is through RMS. RMS provides the capability to store variable length records on the device. Those records are accessible to any MIDlet in the MIDlet Suite, but not to MIDlets outside of the MIDlet Suite. The RMS implementation of the Motorola C370, C450, and C550 series of handsets is MIDP compliant, so there are no significant additions or changes to the MIDP specification.

Class Description

The API for the RecordStore is located in the package `javax.microedition.rms.`

Code Examples

The following is a code example to show implementation of opening the `RecordStore`. If any exception occurs it will be caught.

RecordStore

```
try {
   System.out.println("Opening RecordStore " + rsName + " ...");
   //try to open a record Store
   recordStore = RecordStore.openRecordStore(rsName, true);
   //keep a note for the last modified time for record store
   Date d = new Date(recordStore.getLastModified());
   System.out.println(recordStore.getName()+"modified last time: " +
    d.toString());
   }
   catch (RecordStoreException rse) {
```

```
   //process the IOException
}
```

Tips

It is much faster to read and write in big chunks than it is to do so in small chunks.

Whenever you close a `RecordStore`, the close command will not return until all the pending writes have been written. A successful call to close a `RecordStore` guarantees that the data got written. It is then safe to power off the phone; a side effect to this is that the close command may take a while to return. Therefore, if a `RecordStore` is opened and closed for every write performance will be greatly affected.

Caveats

The maximum number of `RecordStores` that the Motorola C370, C450, and C550 series of handsets supports depends on the number of files installed. Once the phone has 500 RecordStores (that includes resource files, wall papers, ring tones, and other files), then it will not be able to make more.

Therefore, if a MIDlet is to have many images, such as sprites used in animations, it may be advantageous to have them all in one image file and use clipping to display only what you need.

`RecordStore` can be of any size as long as there is file space available. A zero byte `RecordStore` is also allowed.

13 Phonebook Access

Phonebook Access API

Using the Phonebook Access API, an application will be able to locate and update contact information on the series of handsets. This contact information includes phone numbers, email addresses, and any other directory information related to individuals, groups, or organizations. The database used to store phonebook information will be unique and integrated for native phonebook, SIM card, and other applications using Phonebook API.

The primary goal of the Phonebook Access API is to be simple and thin to fit in resource-limited devices like the Motorola C370, C450, and C550 series of handsets series. This API will specify a base storage class for all types of contacts items presented in the vCard specification (RFC2426 –vCard MIME Directory Profile – vCard 3.0 Specification). In addition, schema strings used in querying and storing contact information are those specified in the RFC2426 specification.

The Phonebook Access API will perform the following functions:

- Support multiple phonebook categories
- Allow multiple phone numbers and email addresses for each contact
- Store new entries
- Retrieve entries
- Edit existing entries
- Delete entries
- Check memory status
- Order and sort contact parameters
- Support standard schema strings
- Support recent calls information

Phonebook Access API Permissions

Prior to a MIDlet accessing the Phonebook API for all Phonebook operations, the implementation will check the Phonebook permissions under the Java Settings Menu. The phonebook permissions menu gives the user the following options:

- Always ask the user for authorization on all Phonebook access requests
- Ask the user for authorization once per application (Default setting)
- Never ask the user for authorization

The following are code samples to show implementation of the Phonebook API:

Sample of code to create object of PhoneBookRecord class:

```
PhoneBookRecord phbkRecEmpty = new PhoneBookRecord();

String name = "Name";
String telNo = "9999999";
int type = PhoneBookRecord.MAIN;
int categoryId = PhoneBookRecord.CATEGORY_GENERAL;

PhoneBookRecord phbkRec = new PhoneBookRecord(name, telNo, type,
categoryId);
```

Sample of code for calling of 'add(int sortOrder)' method:

```
int index = phbkRec.add(PhoneBookRecord.SORT_BY_NAME);
```

Sample of code for calling of 'update(int index, int sortOrder)' method:

```
phbkRec.type = PhoneBookRecord.HOME;
int newIndex = phbkRec.update(index, PhoneBookRecord.SORT_BY_NAME);
```

Sample of code for calling of 'delete(int index, int sortOrder)' method:

```
PhoneBookRecord.delete(index, PhoneBookRecord.SORT_BY_NAME);
```

Sample of code for calling of 'deleteAll()' method:

```
PhoneBookRecord.deleteAll();
```

Sample of code for calling of 'getRecord(int index, int sortOrder)' method:

```
phbkRec.getRecord(index, PhoneBookRecord.SORT_BY_NAME);
```

Sample of code for calling of 'findRecordByTelNo(String tel, int sortOrder)' method:

```
index = phbkRec.findRecordByTelNo(telNo, PhoneBookRecord.SORT_BY_NAME);
```

Sample of code for calling of 'findRecordByName(char firstChar, int sortOrder)' method:

```
index = PhoneBookRecord.findRecordByName('N',
PhoneBookRecord.SORT_BY_NAME);
```

Sample of code for calling of 'findRecordByEmail(String email, int sortOrder)' method:

```
String email = "email@mail.com";
index = phbkRec.findRecordByEmail(email, PhoneBookRecord.SORT_BY_NAME);
```

Sample of code for calling of 'getNumberRecords(int device)' method:

```
// get total number of records
int numberRecsInPhone =
PhoneBookRecord.getNumberRecords(PhoneBookRecord.PHONE_MEMORY);
int numberRecsInSim = PhoneBookRecord.getNumberRecords(PhoneBookRecord
.SIM_MEMORY);
int numberRecsAll =
PhoneBookRecord.getNumberRecords(PhoneBookRecord.ALL_MEMORY);
```

Sample of code for calling of 'getAvailableRecords(int device)' method:

```
// get number of available records
int numberRecsAvalPhone =
PhoneBookRecord.getAvailableRecords(PhoneBookRecord.PHONE_MEMORY);
int numberRecsAvalSim =
   PhoneBookRecord.getAvailableRecords(PhoneBookRecord.SIM_MEMORY);
int numberRecsAvalAll =
PhoneBookRecord.getAvailableRecords(PhoneBookRecord.ALL_MEMORY);
```

Sample of code for calling of 'getUsedRecords(int device, int sortOrder)' method:

```
// get number of used records
int numberRecsUsedPhone =
PhoneBookRecord.getUsedRecords(PhoneBookRecord.PHONE_MEMORY,
PhoneBookRecord.SORT_BY_NAME);
int numberRecsUsedSim =
PhoneBookRecord.getUsedRecords(PhoneBookRecord.SIM_MEMORY,
PhoneBookRecord.SORT_BY_NAME);
int numberRecsUsedAll =
PhoneBookRecord.getUsedRecords(PhoneBookRecord.ALL_MEMORY,
PhoneBookRecord.SORT_BY_NAME);
```

Sample of code for calling of 'getNumberRecordsByName(String name)' method:

```
int num = PhoneBookRecord.getNumberRecordsByName(name);
```

Sample of code for calling of 'getMaxNameLength(int device)' method:

```
int maxNameLengthPhone =
PhoneBookRecord.getMaxNameLength(PhoneBookRecord.PHONE_MEMORY);
int maxNameLengthSim =
PhoneBookRecord.getMaxNameLength(PhoneBookRecord.SIM_MEMORY);
int maxNameLengthAll =
PhoneBookRecord.getMaxNameLength(PhoneBookRecord.ALL_MEMORY);
```

Sample of code for calling of 'getMaxTelNoLength (int device)' method:

```
int maxTelNoLengthPhone =
PhoneBookRecord.getMaxTelNoLength(PhoneBookRecord.PHONE_MEMORY);
int maxTelNoLengthSim =
PhoneBookRecord.getMaxTelNoLength(PhoneBookRecord.SIM_MEMORY);
int maxTelNoLengthAll =
PhoneBookRecord.getMaxTelNoLength(PhoneBookRecord.ALL_MEMORY);
```

Sample of code for calling of 'getMaxEmailLength ()' method:

```
int maxEmailLength =
PhoneBookRecord.getMaxEmailLength();
```

Sample of code for calling of 'getIndexBySpeedNo(int speedNo, int sortOrder)' method:

```
int speedNo = 1;
index = PhoneBookRecord.getIndexBySpeedNo(speedNo,
PhoneBookRecord.SORT_BY_NAME);
```

Sample of code for calling of 'getNewSpeedNo(int num, int device)' method:

```
int speedNo = 1;
int speedNo_phone =
PhoneBookRecord.getNewSpeedNo(speedNo,
PhoneBookRecord.PHONE_MEMORY);
int speedNo_sim =
PhoneBookRecord.getNewSpeedNo(speedNo,
 PhoneBookRecord.PHONE_MEMORY);
int speedNo_all =
PhoneBookRecord.getNewSpeedNo(speedNo,
PhoneBookRecord.PHONE_MEMORY);
```

Sample of code for calling of 'getDeviceType(int speedNo)' method:

```
int speedNo = 1;
int type = PhoneBookRecord.getDeviceType(speedNo);
```

Sample of code for calling of 'setPrimary(int index, int sortOrder)' method:

```
int index = 1;
PhoneBookRecord.setPrimary(index, PhoneBookRecord.SORT_BY_NAME);
```

Sample of code for calling of 'resetPrimary(int index, int sortOrder)' method:

```
int index = 1;
PhoneBookRecord.resetPrimary(index, PhoneBookRecord.SORT_BY_NAME);
```

Sample of code for calling of 'isPrimary(int speedNo)' method:

```
int speedNo = 1;
boolean res = PhoneBookRecord.isPrimary(speedNo);
```

Sample of code for calling of 'fromVFormat(InputStream in, int device)' method:

```
buffer = new String("BEGIN:VCARD\r\nN:;" + new String(name) +
"\r\nTEL;TYPE=WORK:1\r\nEND:VCARD\r\n");
int num =
PhoneBookRecord.fromVFormat((InputStream)(new
ByteArrayInputStream(buffer.getBytes())),
PhoneBookRecord.PHONE_MEMORY);
```

Sample of code for calling of 'toVFormat(OutputStream out, int index, int outFormat, int sortOrder)' method:

```
int index = 1;
ByteArrayOutputStream outStream = new ByteArrayOutputStream();
PhoneBookRecord.toVFormat(outStream, index, PhoneBookRecord.VCARD_3_0,
PhoneBookRecord.SORT_BY_NAME);


System.out.println("***** Contents of the output stream: *****");
System.out.print(new String(outStream.toByteArray()));
```

Sample of code for calling of 'createMailingList(int[] members, int sortOrder)' method:

```
PhoneBookRecord mailingList = new PhoneBookRecord();
int mlSpeedNumbers[] = new int[2];
mlSpeedNumbers[0] = 1;
mlSpeedNumbers[1] = 2;
mailingList.name = "MList";
mailingList.type = PhoneBookRecord.MAILING_LIST;
mailingList.speedNo =
 PhoneBookRecord.getNewSpeedNo(1, PhoneBookRecord.PHONE_MEMORY);

index = mailingList.createMailingList(mlSpeedNumbers,
PhoneBookRecord.SORT_BY_NAME);
```

Sample of code for calling of 'addMailingListMember(int mlSpeedNo, int mbSpeedNo)' method:

```
int mlspeedNo = 3, mbspeedNo = 4;
PhoneBookRecord.addMailingListMember(mlspeedNo, mbspeedNo);
```

Sample of code for calling of 'deleteMailingListMember(int mlSpeedNo, int mbSpeedNo)' method:

```
int mlspeedNo = 3, mbspeedNo = 4;
PhoneBookRecord.deleteMailingListMember(mlspeedNo, mbspeedNo);
```

Sample of code for calling of 'getMailingListMembers(int speedNo)' method:

```
int mlspeedNo = 3;
int[] returnArray = PhoneBookRecord.getMailingListMembers(mlspeedNo);
```

Sample of code for calling of 'isMailingListMember(int mlSpeedNo, int mbSpeedNo)' method:

```
boolean returnValue = false;
int mlspeedNo = 3, mbspeedNo = 4;
returnValue = PhoneBookRecord.isMailingListMember(mlspeedNo, mbspeedNo);
```

Sample of code for calling of 'getNumberMailingListMembers(int speedNo)' method:

```
int numberMembers, mlspeedNo = 3;
numberMembers = PhoneBookRecord.getNumberMailingListMembers(mlspeedNo);
```

Sample of code for calling of 'addCategory(String name)' method:

```
String categoryName = "CatName";
int categoryId = PhoneBookRecord.addCategory(categoryName);
```

Sample of code for calling of 'deleteCategory(int categoryId)' method:

```
PhoneBookRecord.deleteCategory(categoryId);
```

Sample of code for calling of 'getCategoryName(int categoryId)' method:

```
String categoryName = PhoneBookRecord.getCategoryName(categoryId);
```

Sample of code for calling of 'getCategoryMembers(int categoryId)' method:

```
int SpeedNumbersArray[] = null;
SpeedNumbersArray = PhoneBookRecord.getCategoryMembers(categoryId);
```

Sample of code for calling of 'getNumberCategoryMembers (int categoryId)' method:

```
int numberMembers =
PhoneBookRecord.getNumberCategoryMembers(categoryId);
```

Sample of code for calling of 'getNumberCategories()' method:

```
int numberCategories = PhoneBookRecord.getNumberCategories();
```

Sample of code for calling of 'getCategoryIdByIndex(int index)' method:

```
int index = 1;
int categoryId = PhoneBookRecord.getCategoryIdByIndex(index);
```

Sample of code for calling of 'getMaxCategoryNameLength()' method:

```
int maxCategoryNameLength = PhoneBookRecord.getMaxCategoryNameLength();
```

Sample of code for calling of 'getCurrentCategoryView()' method:

```
int categoryView = PhoneBookRecord.getCurrentCategoryView();
```

Sample of code for calling of 'setCategoryView()' method:

```
int oldCategoryView = PhoneBookRecord.setCategoryView(categoryId);
```

Sample of code to create object of RecentCallDialed class:

```
String name = "Name";
String telNo = "9999999";
int type = RecentCallRecord.VOICE;
int attribute = RecentCallRecord.CALL_CONNECTED;
long time = 10000;
int duration = 3000;
boolean show_id = true;

RecentCallDialed dialedRecentCall = new RecentCallDialed(name, telNo,
type, attribute, time, duration, show_id);
```

Sample of code for calling of 'add()' method:

```
String name = "Name";
String telNo = "9999999";
int type = RecentCallRecord.VOICE;
int attribute = RecentCallRecord.CALL_CONNECTED;
long time = 10000;
int duration = 3000;
boolean show_id = true;

RecentCallDialed dialedRecord = new RecentCallDialed(name, telNo, type,
attribute, time, duration, show_id);
dialedRecord.add();
```

Sample of code for calling of 'delete(int index)' method:

```
int index = 1;
RecentCallDialed.delete(1);
```

Sample of code for calling of 'deleteAll()' method:

```
RecentCallDialed.deleteAll();
```

Sample of code for calling of 'getRecord(int index)' method:

```
int index = 1;
dialedRecord.getRecord(1);
```

Sample of code for calling of 'getUsedRecords()' method:

```
int usedRecs = RecentCallDialed.getUsedRecords();
```

Sample of code for calling of 'getNumberRecords()' method:

```
int numberRecs = RecentCallDialed.getNumberRecords();
```

Sample of code for calling of 'getMaxNameLength()' method:

```
int maxNameLength = RecentCallDialed.getMaxNameLength();
```

Sample of code for calling of 'getMaxTelNoLength()' method:

```
int maxTelNoLength = RecentCallDialed.getMaxTelNoLength();
```

Sample of code to create object of RecentCallReceived class:

```
String name = "Name";
String telNo = "9999999";
int type = RecentCallRecord.VOICE;
int attribute = RecentCallRecord.CALL_CONNECTED;
long time = 10000;
int duration = 3000;
int cli_type  = RecentCallReceived.CALLER_ID_NAME;

RecentCallReceived receivedRecentCall = new RecentCallReceived (name,
telNo, type, attribute, time, duration, cli_type);
```

Sample of code for calling of 'add()' method:

```
String name = "Name";
String telNo = "9999999";
int type = RecentCallRecord.VOICE;
int attribute = RecentCallRecord.CALL_CONNECTED;
long time = 10000;
int duration = 3000;
int cli_type  = RecentCallReceived.CALLER_ID_NAME;

RecentCallReceived receivedRecord = new RecentCallReceived(name, telNo,
type, attribute, time, duration, show_id);
receivedRecord.add();
```

Sample of code for calling of 'delete(int index)' method:

```
int index = 1;
RecentCallReceived.delete(1);
```

Sample of code for calling of 'deleteAll()' method:

```
RecentCallReceived.deleteAll();
```

Sample of code for calling of 'getRecord(int index)' method:

```
int index = 1;
receivedRecord.getRecord(1);
```

Sample of code for calling of 'getUsedRecords()' method:

```
int usedRecs = RecentCallReceived.getUsedRecords();
```

Sample of code for calling of 'getNumberRecords()' method:

```
int numberRecs = RecentCallReceived.getNumberRecords();
```

Sample of code for calling of 'getMaxNameLength()' method:

```
int maxNameLength = RecentCallReceived.getMaxNameLength();
```

Sample of code for calling of 'getMaxTelNoLength()' method:

```
int maxTelNoLength = RecentCallReceived.getMaxTelNoLength();
```

14
iTAP

Intelligent Keypad Text Entry API

When users are using features such as SMS (short message service), or “Text Messaging”, they can opt for a predictive text entry method from the series of handsets. The J2ME environment has the ability to use SMS in its API listing. The use of a predictive entry method is a compelling feature to the MIDlet.

This API will enable a developer to access iTAP, Numeric, Symbol and Browse text entry methods. With previous J2ME products, the only method available was the standard use of TAP.

Predictive text entry allows a user to simply type in the letters of a word using only one key press per letter, as apposed to the TAP method that can require as many as four or more key presses. The use of the iTAP method can greatly decrease text-entry time. Its use extends beyond SMS text messaging, but into other functions such as phonebook entries.

The following J2ME text input components will support iTAP.

- `javax.microedition.lcdui.TextBox`

  The `TextBox` class is a Screen that allows the user to edit and enter text.

- `javax.microedition.lcdui.TextField`

  A `TextField` is an editable text component that will be placed into a `Form`. It is given a piece of text that is used as the initial value.

Appendix A: Key Mapping

Key Mapping for the C370, C450, and C550

The table below identifies key names and corresponding Java assignments. All other keys are not processed by Java.

Key	Assignment
0	NUM0
1	NUM1
2	NUM2
3	NUM3
4	NUM4
5	SELECT, followed by NUM5
6	NUM6
7	NUM7
8	NUM8
9	NUM9
STAR (*)	ASTERISK
POUND (#)	POUND
JOYSTICK LEFT	LEFT
JOYSTICK RIGHT	RIGHT
JOYSTICK UP	UP
JOYSTICK DOWN	DOWN
SCROLL UP	UP
SCROLL DOWN	DOWN
SOFTKEY 1	SOFT1
SOFTKEY 2	SOFT2
MENU	SOFT3 (MENU)
SEND	SELECT Also, handled according to VSCL specification: incoming call accepted, if Java has high priority Also, call placed if pressed on lcdui.TextField or lcdui.TextBox with PHONENUMBER constraint set.

CENTER SELECT	SELECT
END	Handled according to VSCL specification: Pause/End/Resume/Background menu invoked.

Appendix B: Memory Management Calculation

Available Memory

The available memory on the Motorola C370, C450, and C550 series of handsets is the following:

- 1M shared memory for MIDlet storage
- 512 Kb Heap size
- Recommended maximum MIDlet size is 100K

Appendix C: FAQ

Online FAQ

The MOTOCODER developer program is online and able to provide access to Frequently Asked Questions around enabling technologies on Motorola products.

Access to dynamic content based on questions from the Motorola J2ME developer community is available at the URL listed below.

http://www.motocoder.com

Appendix D: Spec Sheets

C370, C450, and C550 Spec Sheets

Listed below are the spec sheets for the Motorola C370, C450, and C550 handsets. The spec sheets contain information regarding the following areas:

- Technical Specifications
- Key Features
- J2ME Information
- Motorola Developer Information
- Tools
- Other Related Information

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Motorola C370/C450

Developer Reference Sheet

Technical Specifications

Band Frequency	GSM 900/1800 GPRS GSM 850/1900 GPRS
Region	Global
Technology	WAP 2.0, J2ME, SMS, EMS, MMS, AOL/OICQ IM
Connectivity	USB
Dimensions	99.5x44x20.6
Weight	89 g
Display	96 x 65
Operating System	Motorola
Chipset	i250S1

Key Features

- Color display
- J2ME™ games (downloadable)
- Messaging: MMS; EMS 5.0
- WAP 2.0
- Downloadable themes (ring tones, images, sounds)
- MIDI ring tones
- Mini USB connectivity

J2ME™ Information

CLDC v1.0 and MIDP v2.0 compliant	
Maximum MIDlet suite size	100k
Heap size	1Mb
Maximum record store size	64Kb
MIDlet storage available	1Mb
Interface connections	HTTP, Socket, UDP
Maximum number of sockets	4
Supported image formats	.PNG, .JPEG
Double buffering	Supported
Encoding schemes	ISO8859_1, ISO10646
Input methods	Multi tap, iTAP
Extension API's	Gaming, SMS

Related Information

Motorola Developer Information:
Developer Resources at http://www.motocoder.com

Tools:
CodeWarrior® Wireless Studio v7.0
J2ME™ SDK version v4.0
Motorola Messaging Suite v1.1

Documentation:
Creating Media for the Motorola C370/C450/C550 Series of Handsets

References:
J2ME™ specifications: http://www.java.sun.com/j2me
MIDP v2.0 specifications:
http://www.java.sun.com/products/midp
CLDC v1.0 specifications:
http://www.java.sun.com/products/cldc
WAP forum: http://www.wap.org
MMS standards: http://www.3GPP.org

Purchase:
Visit the Motocoder Shop at http://www.motocoder.com/
Accessories: http://www.motorola.com/consumer

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Motorola C550

Developer Reference Sheet

Technical Specifications

Band Frequency	GSM 900/1800 GPRS
Region	EMEA/Asia
Technology	WAP 2.0, J2ME, SMS, EMS, MMS, AOL/OICQ IM
Connectivity	USB
Dimensions	99.5x44x20.6
Weight	89 g
Display	96 x 65
Operating System	Motorola
Chipset	i250S1

Key Features

- Integrated VGA Camera
- Color display
- J2ME™ games (downloadable)
- Messaging: MMS; EMS 5.0
- WAP 2.0
- Downloadable themes (ring tones, images, sounds)
- MIDI ring tones
- Mini USB connectivity

J2ME™ Information

CLDC v1.0 and MIDP v2.0 compliant	
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Related Information

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Motorola Messaging Suite v1.1

Documentation:

Creating Media for the Motorola C370/C450/C550 Series of Handsets

References:

J2ME™ specifications: http://www.java.sun.com/j2me
MIDP v2.0 specifications:
http://www.java.sun.com/products/midp
CLDC v1.0 specifications:
http://www.java.sun.com/products/cldc
WAP forum: http://www.wap.org
MMS standards: http://www.3GPP.org

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