MOBILEHCIDS

TUTORIAL: DEVELOPMENT OF INTERACTIVE APPLICATIONS FOR MOBILE DEVICES

7th International Conference on Human Computer Interaction with Mobile Devices and Services
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APPLICATION DEVELOPMENT WITH J2ME

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Outline

- History / Java Universe
- J2ME Basics
- The J2ME Universe
- J2ME: CLDC/MIDP
- Midlets
- Developing a user interface / storing data
- Resources / Documents / Tools (IDEs)
- Implementing "Hello World"
- Experiences

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Java on mobile devices: History [1,4,9]

- 1990: Java started as an internal project at Sun Microsystems
- 1995: Initial release of JDK 1.0 (applets → servlets)
- 1999: JavaOne conference
  - Subdivision of Java in
    - Java 2 Enterprise Edition (J2EE)
    - Java 2 Standard Edition (J2SE)
    - Java 2 Micro Edition (J2ME) (successor of Personal Java and Embedded Java)
- 2000/01 First mobile phones with support for J2ME

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Java on mobile devices: History [1,4,9]

- 2002: Second version of Mobile Information Device Profile (MIDP 2.0)
- April 2004: 250 Million mobile phones support J2ME [4]
- June 2005: 700 Million mobile phones support J2ME [10, 4] - more mobile phones with Java support than desktop PCs with Java support
- Now: most vendors of mobile phones (Motorola, Nokia, Panasonic, Samsung, Sharp, Siemens, Sony Ericsson, Toshiba, etc.) provide mobile phones that support J2ME

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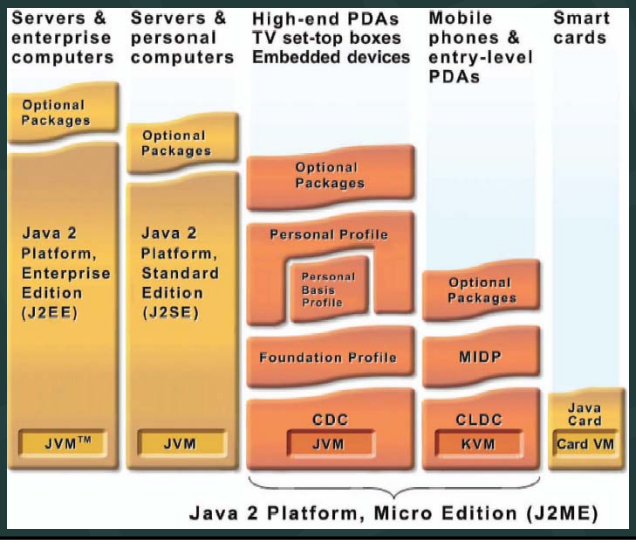
The Java universe [3]



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J2ME: Basics

J2ME: Java 2 Platform, Micro Edition
- "Java for small devices"
- Divided in configurations, profiles and optional APIs

Stack
- Configuration + profile + optional APIs

Configuration: for a specific kind of devices
- Specifies a Java Virtual Machine (JVM)
- Subset of J2SE (Standard Edition)
- Additional APIs

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J2ME: Basics

Profile: more specific than configuration
- based on a configuration
- adds APIs for user interface, persistent storage, etc.

Optional APIs: additional functionality (Bluetooth, Multimedia, Mobile 3D, etc.)

Everything is specified by a JSR (Java Specification Requests)

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The J2ME universe [1,9]

Smaller ⟷ Larger

Pagers | Mobile Phones | PDAs | Car Navigation Systems | Internet Appliances | Set-Top Boxes

MIDP (Mobile Information Device Profile)	**PDAP** (Personal Digital Assistant Profile)	Personal Profile
		Personal Basis Profile
		Foundation Profile
CLDC (Connected, Limited Device Configuration)		**CDC** (Connected Device Configuration)
J2ME (Java 2, Micro Edition)		

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J2ME: CLDC [JSR 30, 139]

- Connected, Limited Device Configuration
- For small devices (e.g. mobile phone, pager, PDA) with small screen size, limited memory, slow network connection
- For devices with 160 to 512KB (according to the specification) of memory for Java Platform
- JVM: KVM ("Kilobyte Virtual Machine")
  - Not a full standard bytecode verifier
  - Adding native methods not allowed → not possible to access platform-specific functionality
- CLDC 1.0 / CLDC 1.1. (Floating point data types)

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J2ME: MIDP 2.0 (JSR 118, based on CLDC) [9]

- Mobile Information Device Profile for mobile phones and pagers
- Device characteristics (according to the specification):
  - Min. 128KB RAM (Java Runtime Heap)
  - 8KB for persistent data
  - Screen: → 94*54 pixel
  - Input capacity, Network connection
- Advantages:
  - WORA (Write Once, Run Anywhere)
  - Security (Sandbox KVM)

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J2ME: APIs in CLDC 1.1 + MIDP 2.0

MIDP 2.0
javax.microedition.lcdui
javax.microedition.lcdui.game
javax.microedition.media
javax.microedition.media.control
javax.microedition.midlet
javax.microedition.pki
javax.microedition.rms
CLDC 1.1
java.lang
java.lang.ref
java.io
java.util
java.microedition.io

APIs are restricted when compared with J2SE

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Device configurations: some examples

Type	Nokia 6600 (June 2003)	Nokia 6630 (June 2004)	Nokia N91 (End 2005)
Configuration	CLDC 1.0	CLDC 1.1	CLDC 1.1
Profile	MIDP 2.0	MIDP 2.0	MIDP 2.0
Optional APIs	Nokia UI, Wireless Messaging, Mobile Media, Bluetooth	APIs of 6600 + FileConnection and PIM, Mobile 3D Graphics	APIs of 6630 + Web Services, Security and Trust, Location, SIP, Scalable 2D Vector Graphics, Advanced Multimedia Supplements, JTWI
Heap Size	3 MByte	Unlimited	Unlimited
Shared Memory for Storage	6 MByte (the only limitation is the amount of free memory)	10 MByte	29 MByte
JAR size	Unlimited	Unlimited	Unlimited

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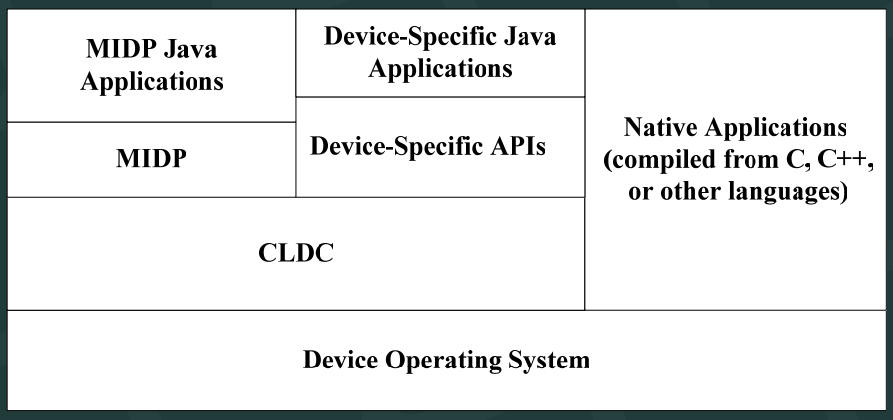
J2ME: Compatibility [1, 9]



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MIDlet

MIDP applications are called MIDlets

Every MIDlet is instance of javax.microedition.midlet.MIDlet

- No argument constructor
- Implements lifecycle methods

Conceptually similar to Applets

- Can be downloaded
- Executed in host environment

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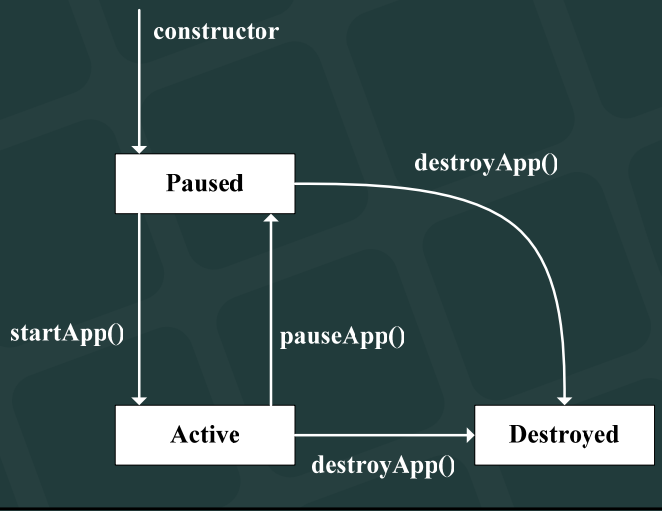
MIDlet (MIDP Application): Life Cycle



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MIDlet (MIDP Application): Life Cycle

- Application Manager: controls the installation and execution of MIDlets
- Start of a MIDlet: constructor + startApp (done by Application Manager)
- MIDlet
  - place itself in Paused state (notifyPaused())
  - destroy itself (notifyDestroyed())

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MIDlet (MIDP Application): Life Cycle

- Application Manager
  - pauseApp() and destroyApp() could be triggered by Application Manager
- ‘ active’ Paused state
  - resumeRequest() – MIDlet wants to become Active
- Methods for every state transition

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MIDlet Build Cycle

- Edit source code
- Compile
- (Application) Package, MIDlet Suite
  - MIDlets + Classes + Ressources + Manifest Information =→ Java Archive (JAR)
  - Manifest: describes content of archive (versions of CLDC and MIDP, name, version, vendor)
  - Application Descriptor (*.jad)
    - same information like manifest (+ MIDlet-Jar-Size, MIDlet-Jar-URL), but a external file
    - Sometime used for installation
- Test or Deploy

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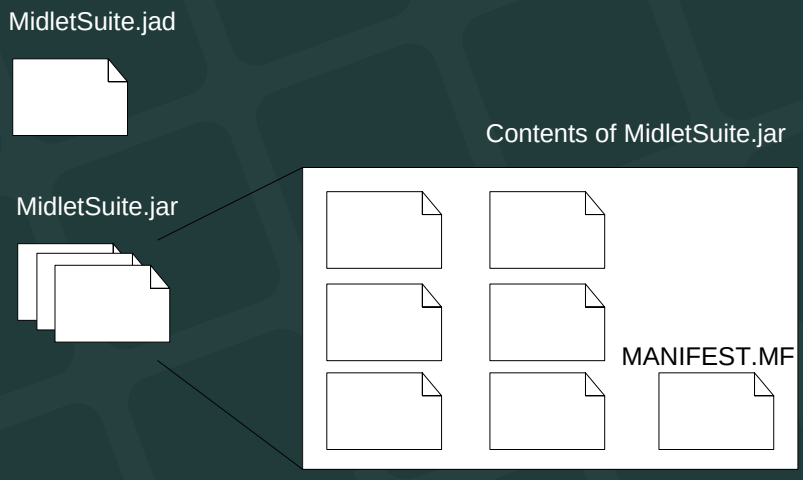
Anatomy of a MIDlet suite



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MIDP: User Interface

Goal: Write Once, Run Anywhere

Anywhere?

- different screen sizes
- resolution of screen
- color or grayscale screen
- different input capabilities (numeric keypad, alphabetical keyboards, soft keys, touch screens, etc.)

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User Interface: Methodology

Abstraction (→ Preferred Method)

- specifying a user interface abstract terms
- (Not:) "Display the word ' Next' on the screen above the soft button."
- Rather: "Give me a Next command somewhere in this interface"

Discovery (→ Games)

- Application learns about the device + tailors the user interface programmatically
- Screen size → Scaling

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User Interface: View from the Top

User-interface classes *javax.microedition.lcdui*

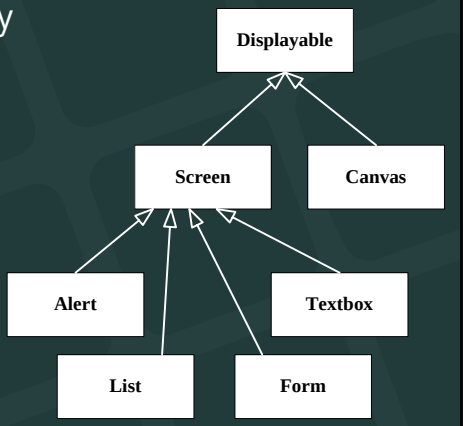
Device display represent by *Display (getDisplay())*

Display: easel

Displayable: canvas on easel

Canvas: Discovery

Screen: Abstraction



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User Interface: View from the Top

Changes the contents of the display: passing *Displayable* instances to *Display's setCurrent()*

Typical Sequence

- Show a *Displayable*
- Wait for input
- Decide what *Displayable* should next
- Repeat

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User Interface: Simple Example

```
public class Commander extends MIDlet {
  public void startApp() {
    Displayable d = new TextBox("TextBox", "Commander", 20, TextField.ANY);
    Command c = new Command("Exit", Command.EXIT, 0);
    d.addCommand(c);
    d.setCommandListener(new CommandListener() {
      public void commandAction(Command c, Displayable s) {
        notifyDestroyed();
      }
    });

    Display.getDisplay(this).setCurrent(d);
  }

  public void pauseApp() {}

  public void destroyApp(boolean unconditional) {}
}
```

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MIDP: Persistent Storage [8]

Goal: Write Once, Run Anywhere

Anywhere?

- Device with Flash ROM
- Battery-backed RAM
- Small Hard Disk

Abstraction is needed

Record stores (small databases)

Min. 8KByte (Nokia 6600: ‘ the only limitation is the amount of free memory’)

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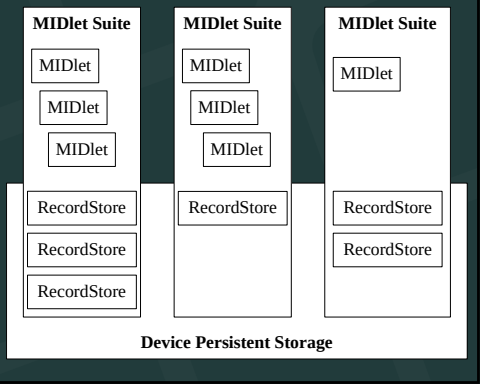
Persistent Storage: Records

Record store
- contains records (pieces of data)
- instance of javax.microedition.rms.RecordStore

Every MIDlet in a MIDlet Suite can access every Record Store
Since MIDP 2.0: Access across suite boarders possible !!!



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Connecting to the World

- Generic Connection Framework
- Extremely flexible API for network connections
- Contained in javax.microedition.io
- Classes based on *connection* interface
  - HttpConnection (Get / Post) / HttpsConnection
  - SocketConnection
  - ServerSocketConnection (Responding to incoming connections)
  - SecureConnection (TLS or SSL socket)
  - CommConnection (SerialPort)
  - DatagramConnection (UDP DatagramConnection)

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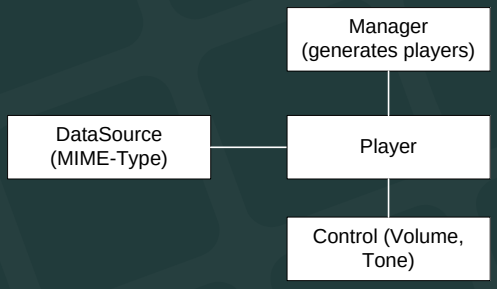
MMAPI (Sound, Music, Video)

- Mobile Media API
- General API for multimedia rendering and recording
- ABB (Audio Building Block) – play simple tones (MIDI – note, duration, volume) and sampled audio (wav, mp3)
- Player lifecycle
  - UNREALIZED
  - REALIZED
  - PREFETCHED
  - STARED
  - CLOSED



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Further APIs

Wireless Messaging API (JSR-120)
Mobile Media API (JSR-135)
Bluetooth API (JSR-82 no OBEX)
FileConnection and PIM API (JSR-75)
Mobile 3D Graphics API (JSR-184)
Location API (JSR-179)
Web Services API (JSR-172)
Advanced Multimedia Supplements (JSR-234)

Further APIs (not JSRs): kXML, kSOAP, Parsing of GPS data, etc.

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Material

Jonathan B. Knudsen, Sing Li. Beginning J2ME: From Novice to Professional. ISBN: 1590594797. 2005.

Java.Sun.Com (Documentation, Code samples & Articles, FAQs, white papers, technical articles, etc.)
http://java.sun.com/products/cldc/

Forum.nokia.com (Documents, Code & examples, tools, forum)
http://www.forum.nokia.com

Links to documentations and tutorials at hcilab.org
http://www.hcilab.org/documents/tutorials/DocuTuto/index.html

Sun Wireless Toolkit: JavaDoc

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Tool Support / Development Kits

Sun's MIDP reference Implementation
Sun J2ME Wireless Toolkit (Javadoc)
IDE
- Netbeans 4.1 + Mobility Pack
- Eclipse (with Plug-In EclipseME)
- Borland JBuilder MobileSet
- IBM WebSphere Studio Device Developer
- Metrowerks Code Warrior Wireless Studio
- Sun ONE Studio, Mobile Edition

Vendor Specific Toolkits & Documentation

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Netbeans 4.1

Cross-platform Java IDE

Available for free for non-commercial use.

Download and install Netbeans 4.1 (requires a J2SE JDK, version 1.4.2 or higher + Sun's Wireless Toolkit) + Mobility Pack at www.netbeans.org

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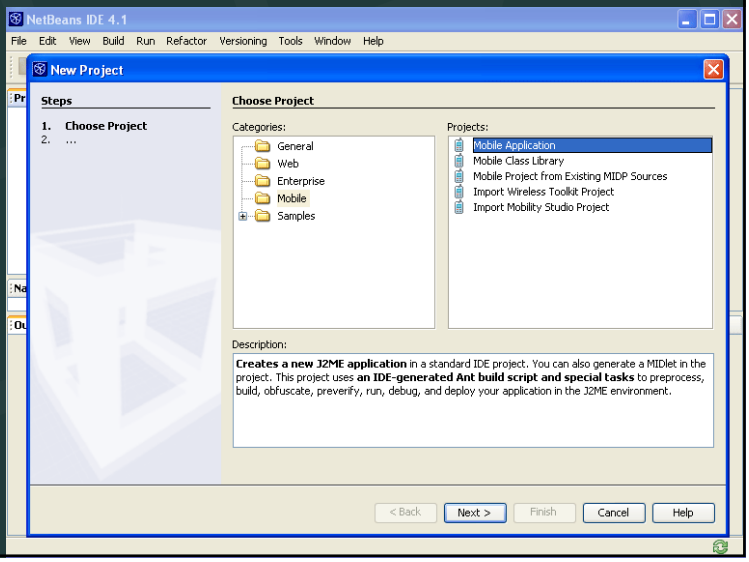
New Project



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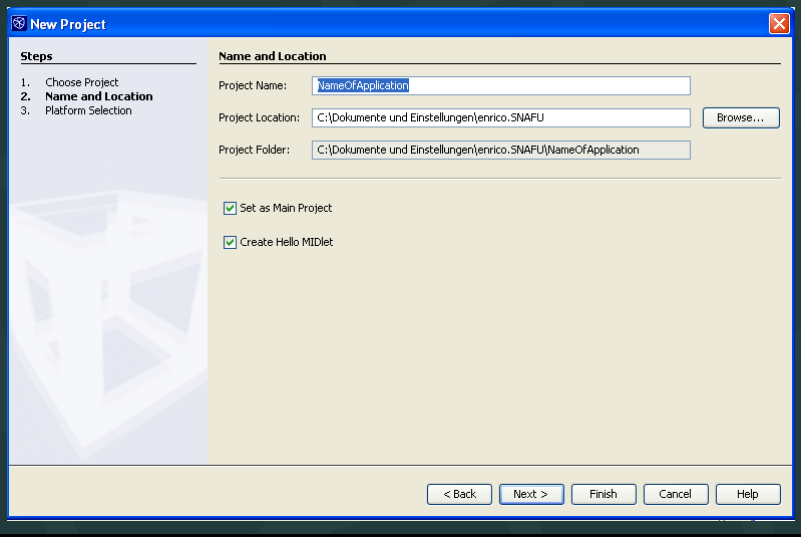
New Project: Name and Location



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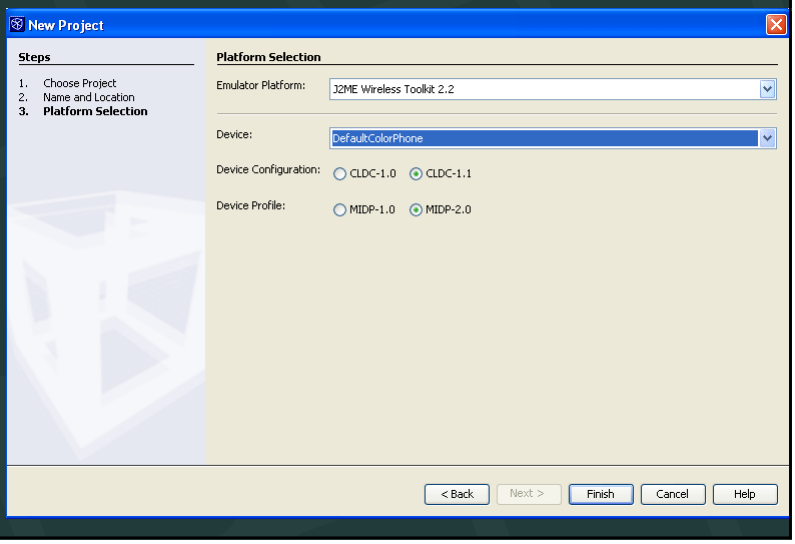
New Project: Platform Selection



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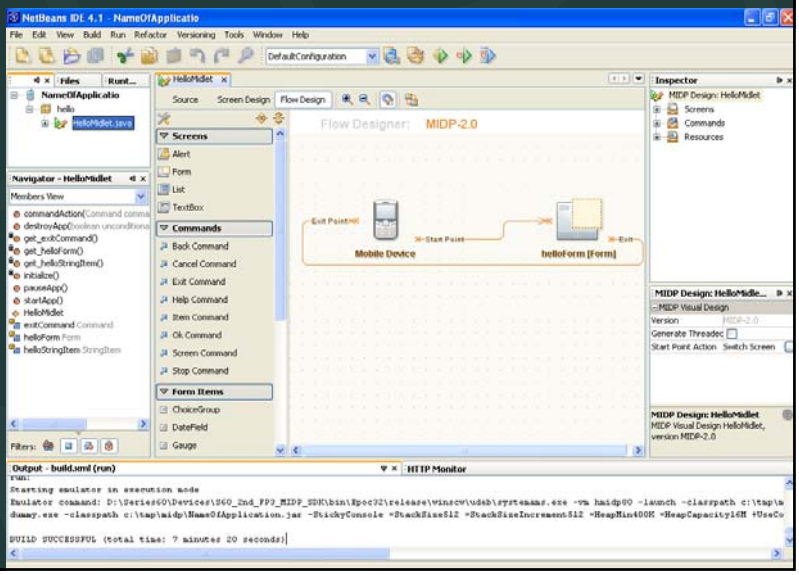
IDE



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IDE: Source

```
package hello;

import javax.microedition.midlet.*;
import javax.microedition.lcdui.*;

/**
 *
 * @author enrico
 */
public class HelloMidlet extends MIDlet implements javax.microedition.lcdui.CommandListener {

    /** Creates a new instance of HelloMidlet */
    public HelloMidlet() {
    }

This section is auto-generated by NetBeans IDE.

    public void startApp() {
        initialize();
    }

    public void pauseApp() {
    }

    public void destroyApp(boolean unconditional) {
    }

}
```

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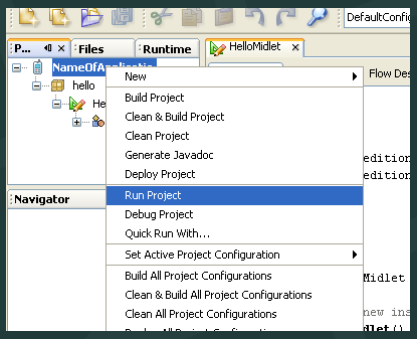
IDE: Run Project



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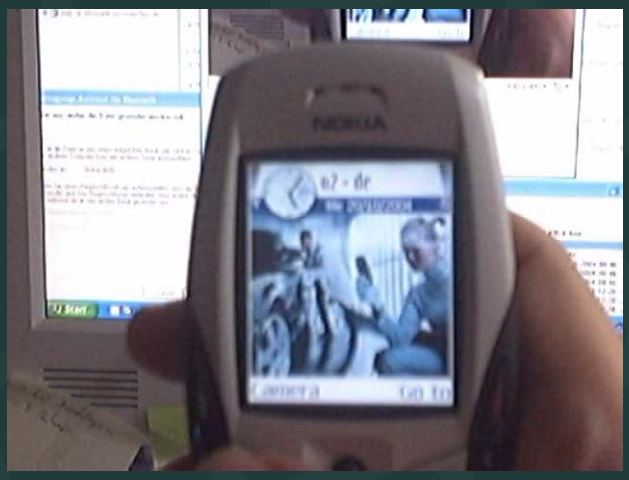
Install MIDlet on Mobile Phone



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Experiences

- CLDC/MIDP is a powerful platform for building novel application on mobile devices
- Everything (phones, APIs, tools, books, documentation, etc) is getting better in a very fast way
- Programming with J2ME It is still a novelty for most people.
- New APIs (Mobile Media, Bluetooth, etc.) have new bugs. "Old" APIs (storage, UI) are already in a matured state.

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Experiences

- Different mobile devices have different KVMs (with different bugs)
- Testing of applications on the mobile phone (!!!) is very important.
- Big differences between the emulators and the real phone.
- Lack of memory and processing power is still a problem.
- Debugging on the mobile phone is a big problem. (No meaningful error messages.)

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Experiences

Implementation on an abstract level. Not so much possibilities like in Symbian.

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Wishes for the next CLDC/MIPD Generation

New security model for J2ME

- Accessing data (record stores)
- Accessing the camera, microphone, network, Bluetooth

Quality of service

- Uncertain behavior when recording (quality, encoding) and playing (Which player?) media

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Market

Mobile devices

- are an exploding market
- because of increasing processing power, available memory and internet connectivity → attractive platform

Most supported platform on mobile devices: J2ME

- Write once – run everywhere
- Safety features for downloadable code

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References

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[3] J2ME datasheet http://java.sun.com/j2me/j2me-ds.pdf
[4] Heise Newsticker http://www.heise.de/newsticker/
[5] CDC Data Sheet. http://java.sun.com/j2me/docs/j2me_cdc.pdf
[6] What's in MIDP 2.0: A Guide for Java Developers http://www.forum.nokia.com/ndsCookieBuilder?fileParamID=3632
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Deleted Slides

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J2ME: CDC (JSR 36, 218) [5, 9]

- CDC: Connected Device Configuration
- For set-top boxes, car navigation systems, smart communicators, high end PDAs, etc.
  - 32bit microprocessor
  - 256 KB RAM and 512 KB ROM for Java Runtime Environment
- Full Java Virtual Machine
  - CDC 1.01 (JSR 36) based on J2SE 1.3.1
  - CDC 1.1 (JSR 218) based on J2SE 1.4
- Supports three profiles: Foundation Profile, Personal Basis Profile, Personal Profile
- Outdated Personal Java is still used