



Mobile Phone Programming

J2ME



Java™





Java 2 Micro Edition (J2ME) Overview

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- Introduction
- J2ME architecture
- MIDlets
- Application development





Introduction

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J2ME Key Factors

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- Portability:
 - Write once run anywhere
- Security:
 - Code runs within the confines of its JVM
- Rich set of APIs
- Very quick learning time
- Huge number of possible users





Market Trends

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- 708 millions mobile Java devices shipped by June 2005
- 635 mobile Java device models on the market
- 32 mobile device vendors using Java
- 45000 mobile Java applications on the market
- 180 operators worldwide that have developed Java services
- 23 million mobile Java downloads globally per month in 2005



180+ operators worldwide that have deployed Java services.*

708 million mobile Java devices shipped by June 2005.****

635 mobile Java device models on the market.**

32 mobile device vendors using Java.**

45,000+ mobile Java applications on the market.*****

~23 million mobile Java downloads globally per month in 2005.*



* Source: Nokia, February 2006

** Source: Sun Microsystems, March 2005

*** Source: Symbian, February 2006

**** Source: Ovum, June 2005

***** Source: Informa Telecoms & Media. June 2005





J2ME: Games and...much more

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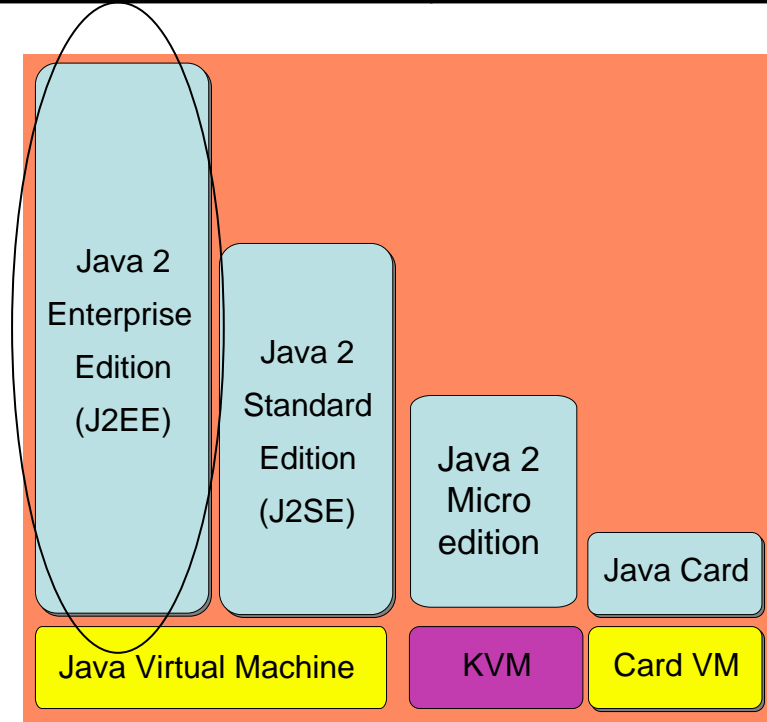
- At the beginning J2ME was intended as a platform for game developing
- Now, with the set of APIs provided by J2ME it is possible to easy develop different kinds of applications (enterprise, multimedia-music applications)



Comms	Graphics	Security & Commerce	Application Connectivity	Personal Information
JSR 82 Bluetooth	JSR 226 2D Scalable Vector Graphics			
JSR 180 SIP	JSR 184 3D Graphics			
JSR 205 MMS Messaging	JSR 234 Mobile-media Supplement	JSR 229 Payment	JSR 211 Content Handler	JSR 179 Location
JSR 120 SMS Messaging	JSR 135 Mobile Media	JSR 177 Security & Trust Services	JSR 172 Web Services	JSR 75 PIM & File
Application Environment	JSR 185 JTWI	JSR 118 MIDP 2.0	JSR 238 I18N	
Virtual Machine		JSR 139 CLDC 1.1		

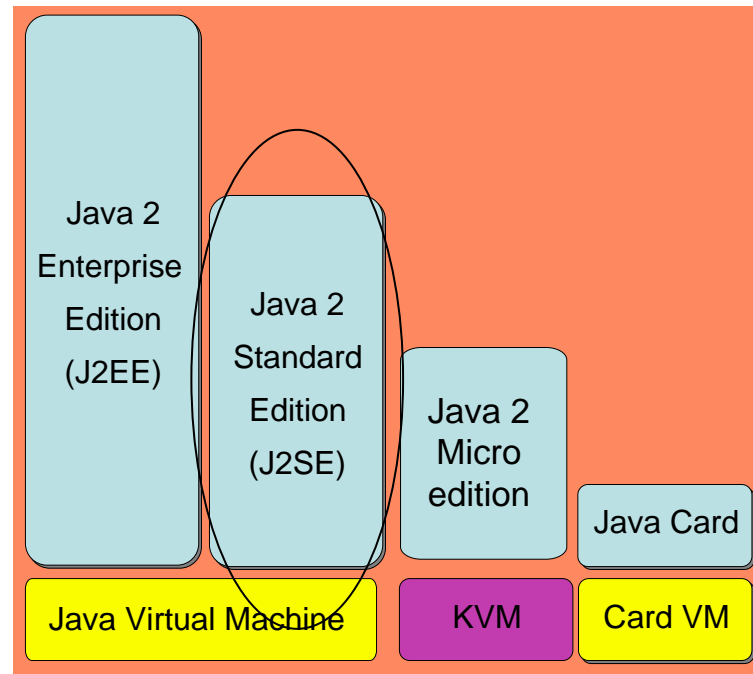
Conditional APIs
 JTWI APIs





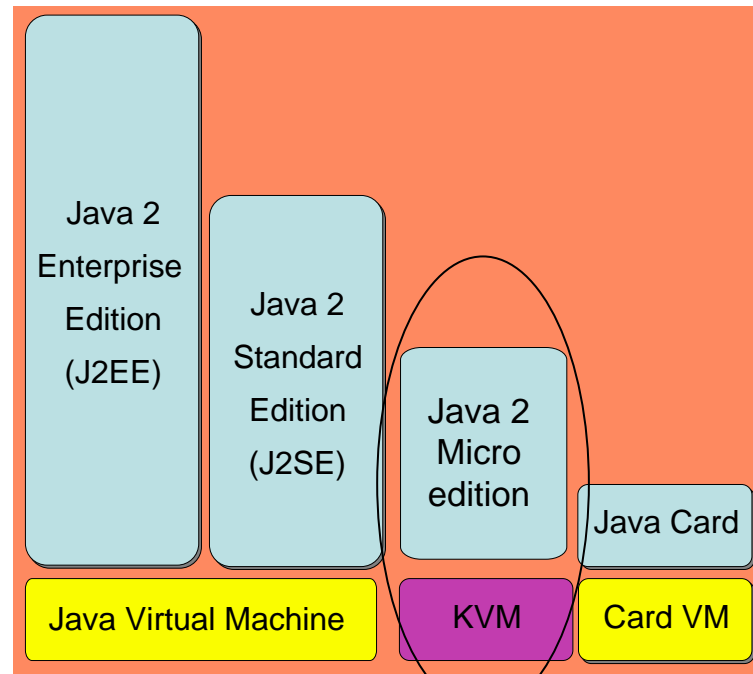
- Java 2, Enterprise Edition (J2EE)
 - Multiuser, enterprise-wide applications
 - Based on J2SE + several APIs for server-side computing





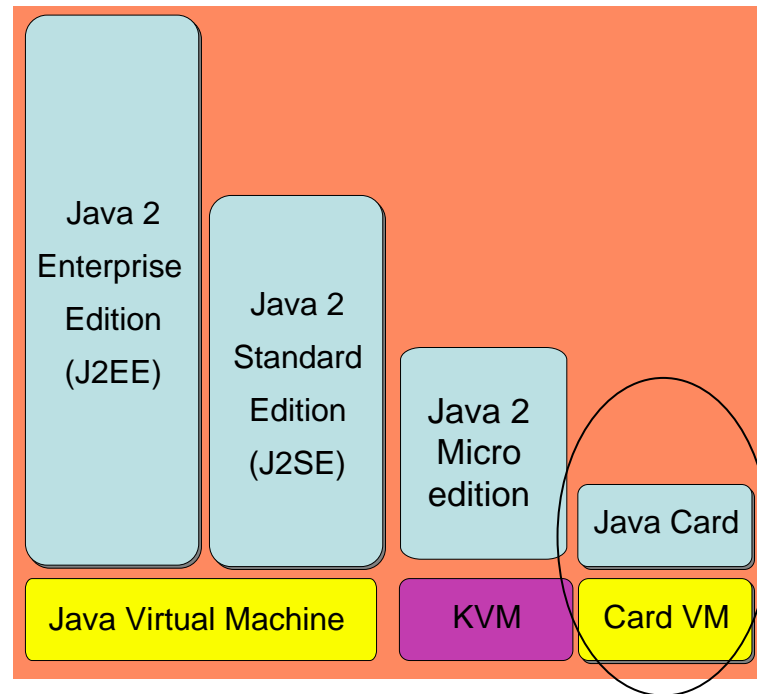
- Java 2, Standard Edition (J2SE)
 - Designed for desktop computers
 - Runs on top of OS:Linux, Windows ...





- Java 2, Micro Edition (J2ME)
 - Designed for small capabilities devices that cannot support a full J2SE implementation





- Java Card
 - provides a secure environment for applications that run on smart cards and other devices with very limited memory and processing capabilities.



J2ME Architecture

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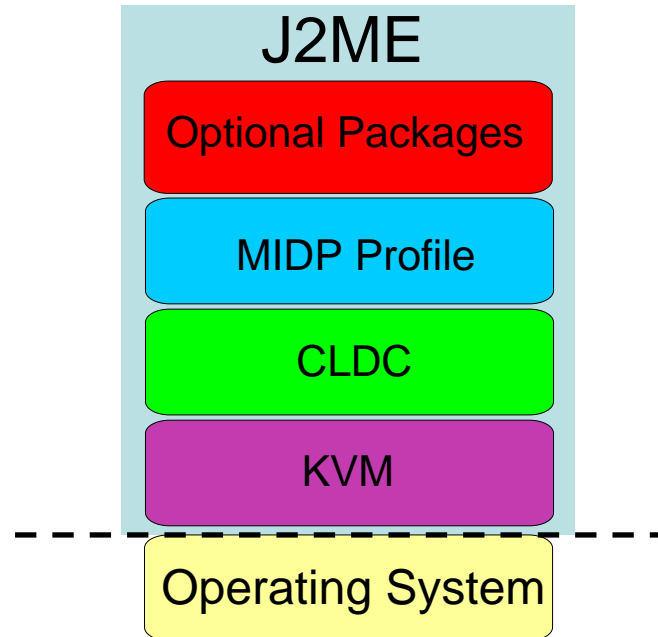




J2ME Architecture

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- **Operating System and Device Configuration:**

is a compact, portable Java virtual machine intended for resource-constrained devices. It offers the core functionality required by mobile applications, such as user interface, networking support and persistent storage.



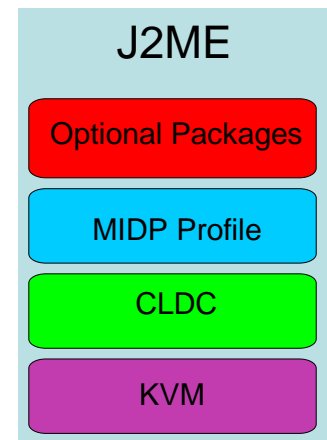


Kilo Virtual Machine

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- The KVM is a layer of software that runs on top of the host operating system
- It is implemented in C and it is responsible for the interpretation of the Java byte-code and translating this into native system calls.
 - This makes J2ME programs highly portable between different computing architectures and different types of embedded devices.



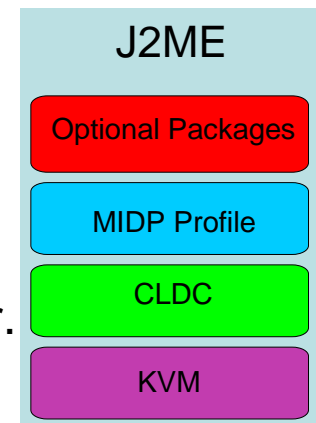


Connected Limited Device Configuration

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- CLDC provides the lowest common denominator for small and resource-constrained devices characterized as follows:
 - 160 kB to 512 kB of totally memory budget available for the Java platform.
 - a 16-bit or 32-bit processor.
 - low power consumption, often operating with battery power.
 - connectivity to some kind of network, often with a wireless connection and with limited (often 9600 bps or less) bandwidth.
- There are 2 versions of CLDC:
 - CLDC 1.0
 - CLDC 1.1



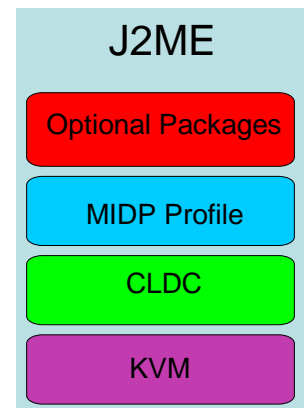


Mobile Information Device Profile

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- MIDP adds an additional layer on the top of the CLDC providing APIs for a specific class of devices:
 - 128KB of non-volatile memory for the MIDP implementation
 - 32KB of volatile memory for the runtime heap
 - 8KB of non-volatile memory for persistent data
 - Input capacity (screen, keyboard, touch)
 - Screen size of at least 96x54 pixels
- Currently there are two versions of MIDP:
 - MIDP 1.0
 - MIDP 2.0





Some Optional Packages

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- Information Module Profile (IMP), JSR 195
- Wireless Messaging API (WMA); JSR 120, JSR 205
- Mobile Media API (MMAPI), JSR 135
- Location API for J2ME, JSR 179
- SIP API for J2ME, JSR 180
- Security and Trust Services API for J2ME, JSR 177
- Mobile 3D Graphics, JSR 184
- J2ME Web Services APIs (WSA), JSR 172
- Bluetooth API, JSR 82
- J2ME RMI, JSR 66
- JDBC for CDC/Foundation Profile API, JSR 169





J2ME





- MIDP applications are called MIDlets
- Every application must extend ***javax.microedition.midlet.MIDlet*** class
- The MIDlet class defines abstract methods that the main class implements (for example: `startApp()`, `destroyApp()`, `notifyDestroyed()`).





MIDlet Skeleton Example

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```
import javax.microedition.midlet.*;
public class Example extends MIDlet
{
    public void startApp()
    {
    }
    public void destroyApp(boolean unconditional)
    {
    }
    public void pauseApp()
    {
    }
}
```





- One or more MIDlets are packaged together into a *MIDlet suite*, composed of:
 - JAR (Java archive) file
 - JAD (Java Application Descriptor) file
- All the user-defined classes and resources required by the suite's MIDlets must be in the JAR file.

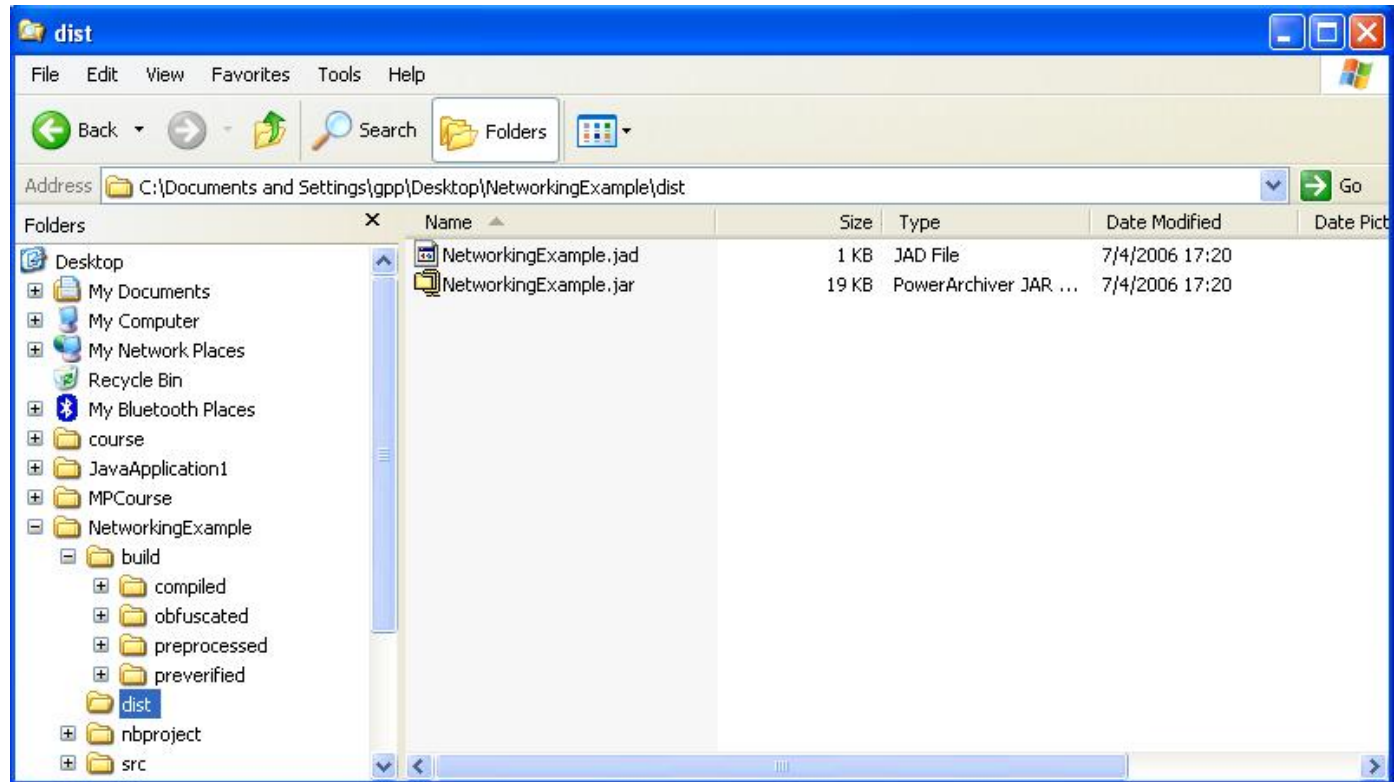




MIDlet Suite

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Data Storage: RMS

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- Several applications need to store some data in a permanent way (even when the device is switched off)
- This kind of data is called “*persistent data*” and they are stored in a dedicated memory part called “*persistent storage*”
- MIDP defines a set of classes for storing and retrieving persistent data called **Record Management System (RMS)**.



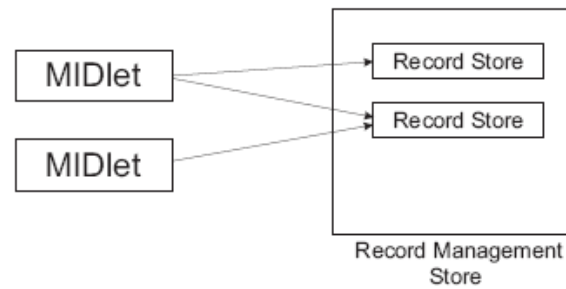


Storage Mechanism

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- The basic storage mechanism used by the RMS is a “*Record Store*”
- A Record Store can be shared among different MIDlets (only MIDP 2.0)
- When a MIDlet suite is removed from the device then all the record stores associated with it will also be removed





Storage Mechanism

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- A Record store is a collection of records:
 - A record is uniquely identified by its Record ID
 - A record is an array of bytes
- The value of RecordId for the first record created is 1
- RecordId for new records will monotonically increase
- A RecordId is never reused:
 - If a record is deleted from the Record Store, its RecordId will never be assigned to any other record

RecordId	Data
1	Data 1
2	Data 2
3	Data 3
⋮	⋮
N	Data N



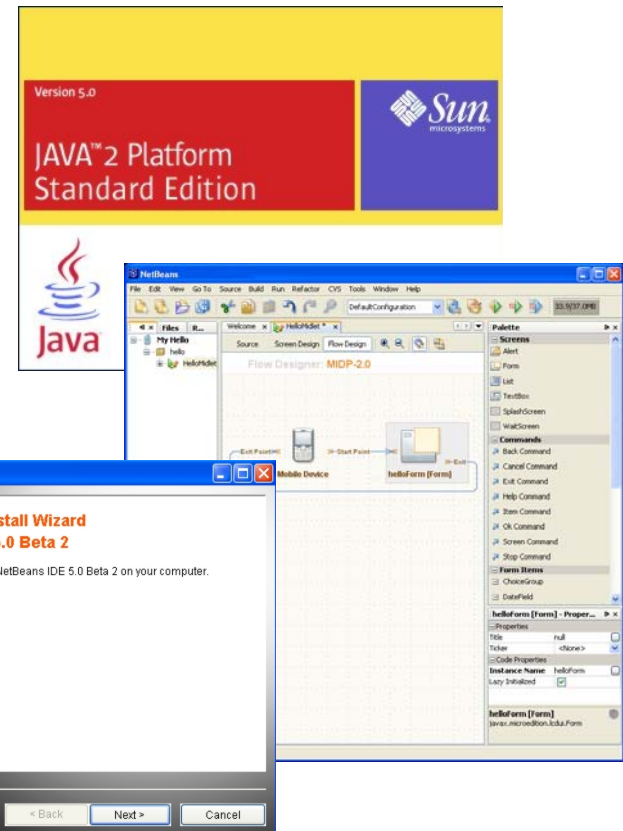


Developing Your Applications

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- Application development
- SDK and development tools installation





Application development

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- Target your users
 - What kind of application do you want to develop?
 - On which platform? (MIDP 1.0 or MIDP 2.0)
- Which tools do you need?
- How to get started?





- The following software needs to be installed on your PC:
 - Java Development Kit (JDK)
 - IDE (Integrated Development Environment)
 - NetBeans
 - Eclipse
 - Carbide.j
 -





SDK and development tools

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- Our suggestion is to install the following software on your PC:
 - J2SE
 - Netbeans 5.5 (IDE)
 - Netbeans 5.5 mobility Pack
- All the files can be downloaded from:

http://mobiledevices.kom.aau.dk/teaching/free_study_activities/mobile_phone_programming_spring_2007/



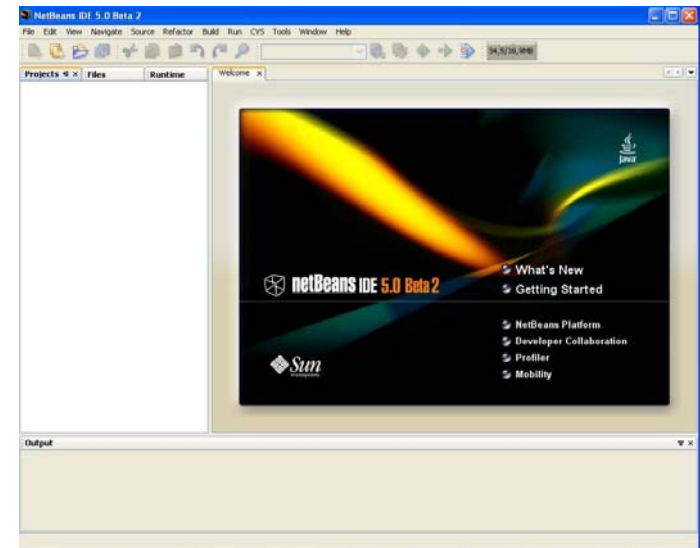


NetBeans 5.5 (IDE)

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- The **NetBeans IDE** is an open-source integrated development environment written entirely in Java
- NetBeans contains all the modules needed for Java development in a single download, allowing the user to start working immediately.





NetBeans 5.0 Mobility Pack

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- The NetBeans Mobility Pack is a Plug-in of NetBeans IDE that can be used to write, test, and debug applications for the Java 2 Micro Edition technology-enabled mobile devices.
- The NetBeans Mobility Pack integrates support for:
 - Mobile Information Device Profile (MIDP) 2.0
 - Connected, Limited Device Configuration (CLDC) 1.1
- You can easily integrate third-party emulators for a robust testing environment.

