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# J2ME

## Java 2 Micro Edition



*Intro To J2ME*

*Template 4.0*

# **Valtech Technologies**

## ■ **Valtech Facts**

- Offices in Europe, and the U.S. (Dallas, Denver, Houston, New York)
- Provides Consulting, Education Services, and JumpStart programs

## ■ **Consulting Services**

- Provides both project delivery and technology consulting

## ■ **Educational Services**

- Process, UML, OOAD
- Java, C++
- J2EE, Web Development, CORBA, XML
- Emphasis on use of proven design patterns and techniques

## ■ **All services emphasize *knowledge transfer***

## ***J2ME Topics***

- **Setting The J2ME Stage**
- **J2ME Architecture**
- **Terms And Concepts**
- **Connected, Limited Device *Configuration* (CLDC) Overview**
- **Mobile Information Device *Profile* (MIDP) Overview**
- **J2ME Toolkit Demo**
- **Where To Find Out More**

## **J2ME : Scope Of Presentation**

- **“J2ME components are flying out of Sun like shrapnel from a detonated hand grenade; and they mutate in flight”.... Daniel Savarese (from Ask The JavaPro)**
  
- **Many....**
  - Specifications ( CLDC, CDC, MIDP, .... )
  - Devices ( Cell Phones, Handhelds, Pagers, .... )
  - Vendors ( Palm, Motorola, Nokia, HP, Compaq, ... )
  - IDEs ( Forte, IBM VAME, Espial Kalos, Metroworks,...)
  - OS ( WindowsCE, PalmOS, ...)
  - VMs ( Waba, SuperWaba, Emwerks Kada, IBM J9, ... )
  - Processors ( StrongARM, MIPS, Hitachi HS3/4, ... )
  
- **KVM / CLDC / MIDP form the basis of this presentation.**

## **Java 2 Lay Of The Land**

### ■ **J2EE : Java 2 Enterprise Edition**

- Heavyweight, high volume server systems
- WebSphere, WebLogic, ....

### ■ **J2SE : Java 2 Standard Edition**

- Desktop, workstation systems
- HotSpot, many others

### ■ **J2ME : Java 2 Micro Edition**

- Electronic devices, wireless devices, information appliances
- Addresses resource constrained devices

# Java 2 : The Big Picture



Java 2  
Enterprise  
Edition API  
( J2EE )



Java 2  
Standard  
Edition API  
( J2SE )



Your J2ME Application

J2ME *Profile* API's

J2ME *Configurations*



Java Card  
API

Java Language

Java Virtual Machine

CVM / KVM

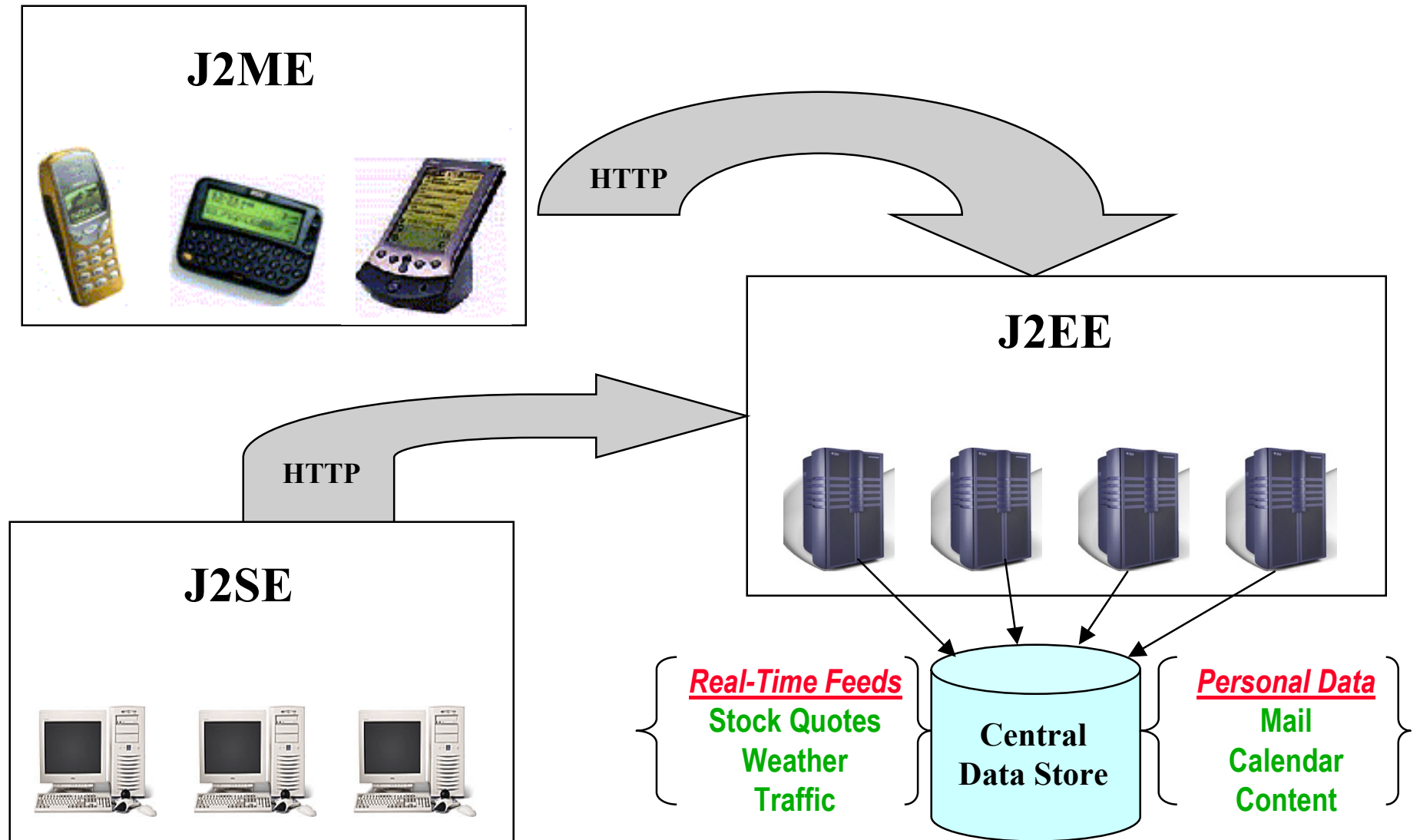
Smart Card

Operating System

## ***J2ME Motivational Factors***

- **High consumer demand for mobile devices**
  - Expected 350 million cell phones shipped this year
  - Anticipated 1 billion worldwide cell phone users by 2003
  
- **Common features among heterogenous mobiles**
  - Limited memory
  - Many are battery powered
  - Limited screen size
  - Scaled back bandwidth
  
- **Device connectivity to the personal data**
  - Many devices accessing data from a single data source

# J2ME, J2SE, J2EE Interaction

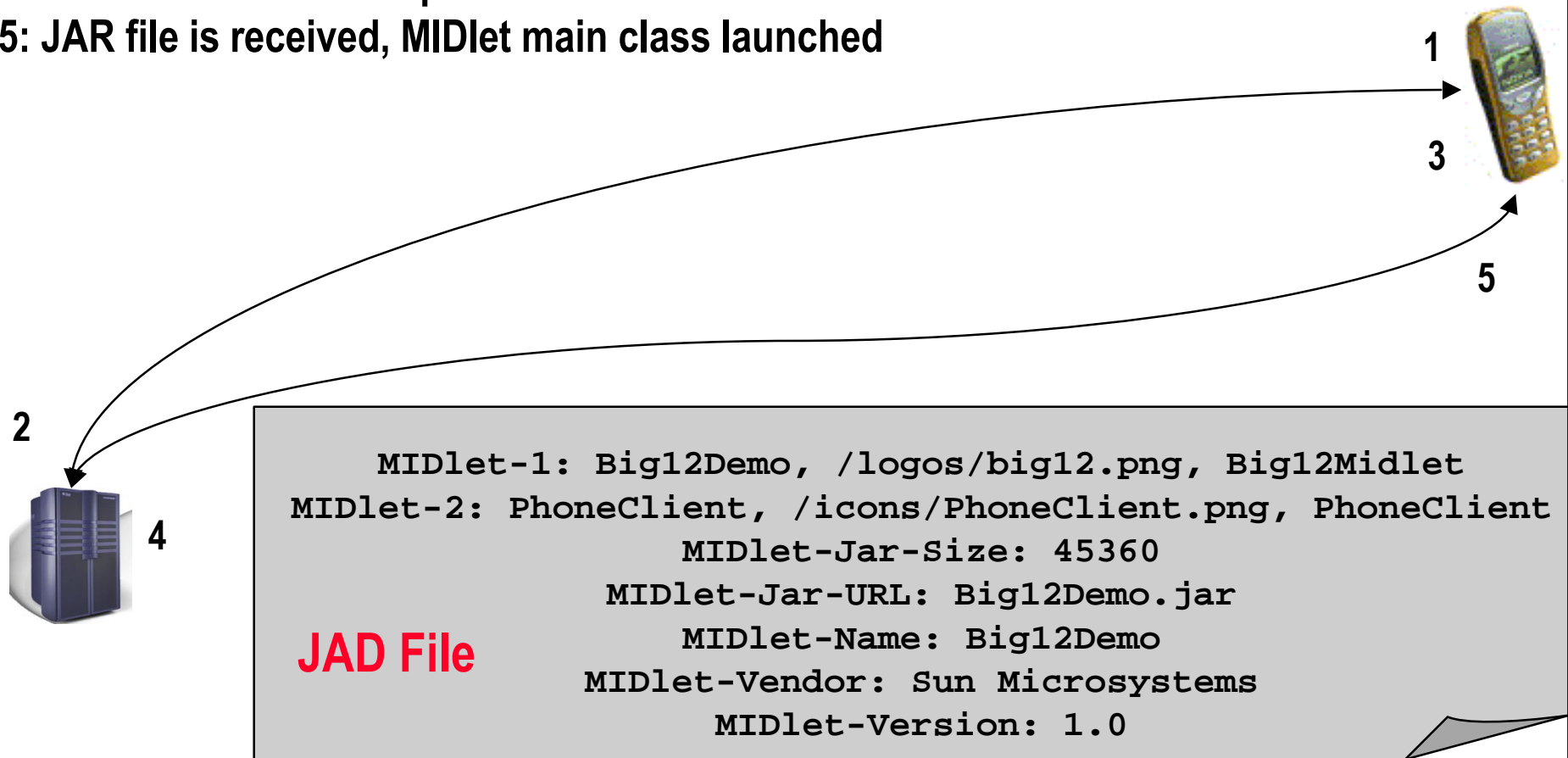


## ***J2ME Objectives***

- **Portability of code to applicable devices**
- **Ignite a large developer base via ease of use**
- **Intended to be used with J2SE and J2EE**
- **Consistency across devices**
- **Web-based download of desired applications**

# J2ME Application Download

- 1: User Clicks On JAD File URL Link From Web Page
- 2: Server sets MIME Type ( text/vnd.sun.j2me.app-descriptor ) and returns JAD file.
- 3: midp.exe launched, version checks, size checks, requests JAR file
- 4: Server returns the requested JAR file
- 5: JAR file is received, MIDlet main class launched



# The J2ME Challenge : Many Devices



- Cell Phones
- Smart Phones
- Palm Pilot
- Pocket PC
- Handheld PC
- TV-Top Boxes
- Communicators
- POS Terminals
- Smart Appliances
- Consumer Electronics



## ***What Happened To.....***

### ■ **Personal Java**

- Future releases planned for J2ME adaptability
  - ***CDC / Foundation Profile / Personal Profile***

### ■ **JavaPhone API, JavaTV API**

- Specialized profiles for these based on device families

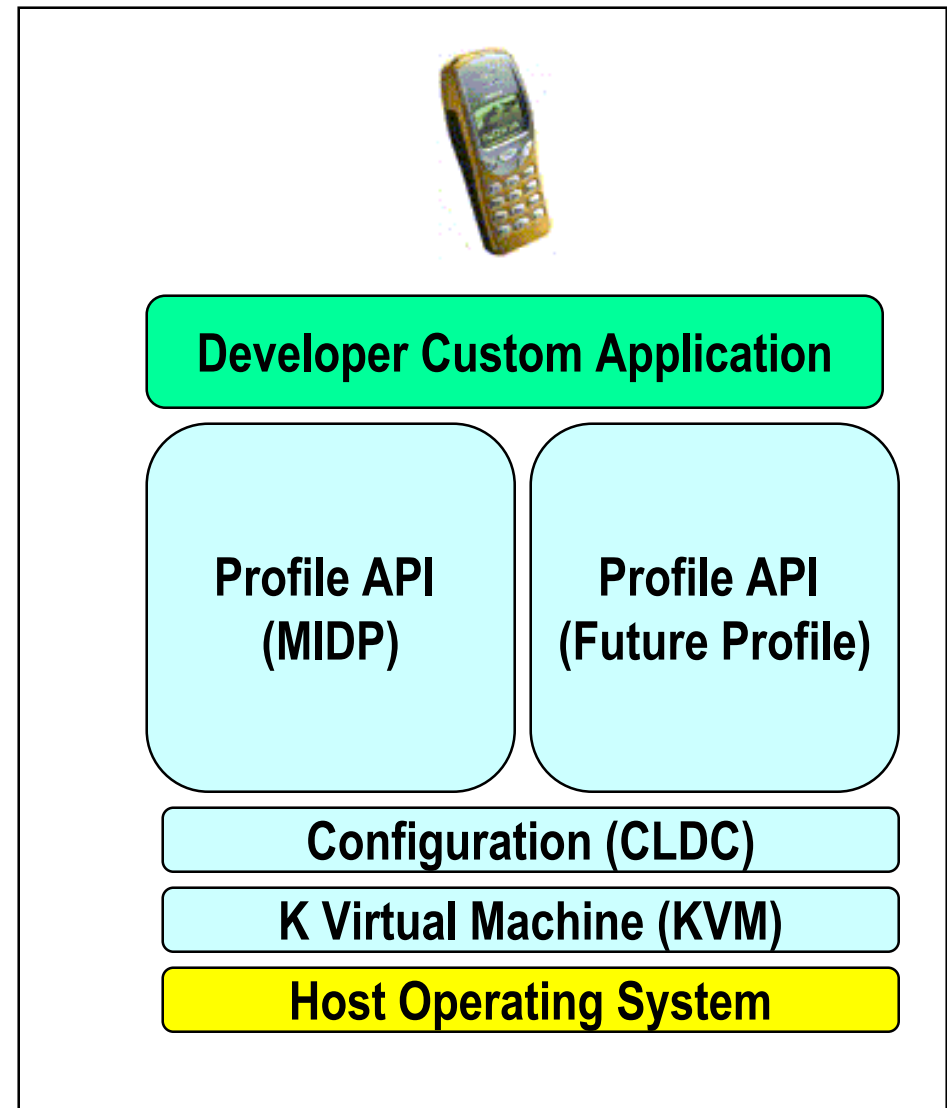
### ■ **Embedded Java**

- Popular for devices with extremely constrained resources
- Allows for filtering of unused data and methods
- Complimentary technology to J2ME

# J2ME Software Architecture

- **Host Operating System**
  - Win CE, PalmOS, SavaJe etc.
- **Java Virtual Machine**
  - KVM / CVM
  - Footprints from 6 KB to 2.2 MB
- **Configuration Layer**
  - CDC : for “plug-in” (2MB) devices
  - CLDC : (128KB) wireless devices
- **Profile Layer**
  - Functional “slices” appropriate for a given family of devices.
  - MIDP : for cell phone device family

Example Configuration



## **Terms And Concepts : KVM**

### ■ **“Kilobyte” Virtual Machine**

- Specifically designed for resource constrained device
- Actually, the reference implementation of the CLDC Specification
- Minimal static memory footprint ( 40-80 kB advertised )
  - *Varies by device, compile options*
- Requires minimal memory resources of targeted devices
  - *Minimum of 128 kB, preferable 256 kB*
  - *Typical of cell phones, pagers, POS terminals, organizer*
- Implemented via ‘C’ programming language
  - *Portability accomodated via compile time options*
- Portable To :
  - *Linux, Motorola devices, RIM, Nokia Phones, ...*

# Terms And Concepts : Configurations

## ■ Configurations

- A specific VM and its associated APIs and libraries
- A “horizontal” grouping of devices
  - *Share similar requirements of memory and processing speed*
  - *May span various flavors of devices used for various purposes*
- The minimum Java platform for a set of common devices
  - *Memory*
  - *Communications bandwidth*
  - *Power requirements*
- Defined by the Java Community Process (JCP)
  - *~20 Companies.....Collectively evolve specifications*
- Currently Only Two Configurations Defined
  - *Connected, Limited Device Configuration (CLDC)*
  - *Connected, Device Configuration (CDC)*

# Terms And Concepts : Profiles

## ■ Profile

- Provide additional “device family” type of API's
  - *MIDP for cell phone screen size, persistence requirements*
  - *Foundation Profile for CDP configurations*
- Written to run with a specific configuration
  - *CDC : Example....Foundation Profile*
  - *CLDC : Example....MIDP Profile*
- Typical profiles exist to :
  - *Provide Persistence (MIDP)*
  - *Perform User Interface Support (MIDP, Personal Profile)*
  - *Allow Event Handling (MIDP)*
  - *Provide Additional Networking Capability (MIDP, RMI Profile)*

## **CLDC Overview**

- **Attributes of devices targeted in the CLDC specification**
  - 128 – 512 KB Memory
  - Processor Speed 16-32 MHz
  - Limited Power ( Typically Battery Operated )
  - Connectivity To A Network, But Minimal Bandwidth
  - High Volume Manufacturing
  
- **Devices That Qualify : pagers, phones, pocket pcs, PDAs**



## **CLDC Overview**

### ■ **For Clarity....**

- CLDC defines minimum functionality for low-end micro devices.
- KVM performs bytecode interpretation on a device.
- Profiles written for CLDC agree to the contract of the CLDC.

### ■ **CLDC Specification**

- Application developers use the classes specified by CLDC spec
- Profile API's offer additional functionality
- CLDC preserves interfaces from inherited J2SE classes
- CLDC offers new framework package for networking
  - *J2SE java.net package classes too large for targeted devices*

# CLDC Overview : Glance At API

- Incorporated J2SE packages

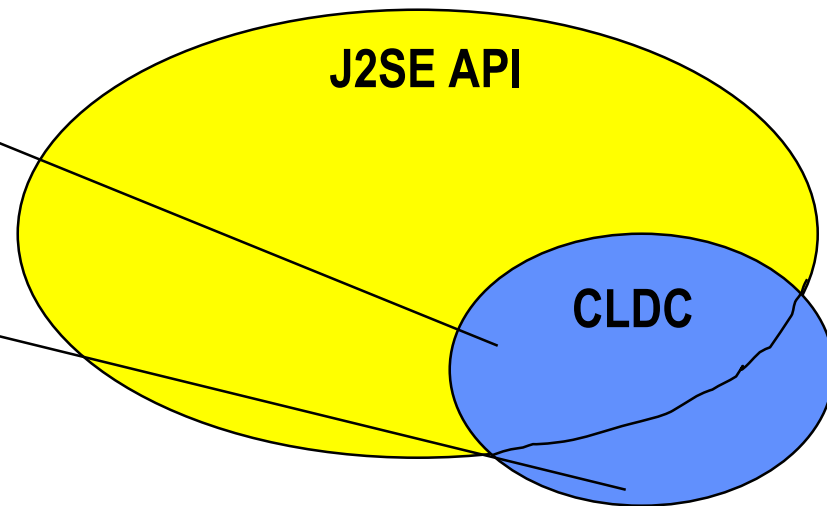
- java.lang.\*
- java.io.\*
- java.util.\*

- New J2ME framework package

- java.microedition.io.\*

- J2SE packages are not fully supported

- Examples
  - *No Double class*
  - *No ObjectInputStream, ObjectOutputStream, .....*



## ***CLDC Overview : Glance At API***

- **Key functionality you will notice**
  - Basic language features ( collections, key data types, threads )
  - Basic I/O support
  - Reworked networking support ( Connection framework )
  - Fundamental security model (Class File Verification, App Partitioning)
  - Internationalization
  
- **Key functionality you won't see due to resource constraints**
  - Event handling
  - User interface support
  - Persistence support
  - Floating point support

## **CLDC Overview : Connection Framework**

- **Lightweight replacement for java.net.\* package**
- **Necessary due to size of java.net.\***
- **Variety of connection protocol objects are offered**
  - Protocol specified in the URL string when connector is opened
  - Connector.open (“<protocol>:<path>:<parameters>”)
- **Can be used to :**
  - Interact with server side software
    - *Servlets*
    - *JSPs*
  - Communicate via sockets
  - Open files for reading and writing
- **Only a framework ! Profiles provide concrete implementations.**

# MIDP Overview

## ■ MIDP Specification Objectives

- Small Footprint
  - *Targeted 128 KB ROM*
- Reasonable Performance
  - *Must run on low end microprocessors*
  - *Must run using minimal heap ( 32-200 KB RAM )*
  - *Minimal creation of garbage for KVM to clean up*
- Offer useful extensions not accommodated by the CLDC
  - *User interface classes*
  - *Event handling classes*
  - *Persistence capability through record-oriented database*
  - *Application life cycle management ( similar to applets )*

# MIDP Overview : Glance At API

## ■ MIDP API Consists Of :

- Timers
- Networking
- User Interface
- Persistent Storage

## ■ Application is known as a “Midlet”

- Extends MIDlet MIDP Class
- MIDlet Class interacts with application level software
  - *Allows for use of property file (JAD file ) to identify resources*
  - *Allows for MIDlet application state change*
    - Create
    - Start
    - Pause
    - Destroy

## ***MIDP API : Timer Functionality***

- **Two classes involved**
  - TimerTask
  - Timer
- **Multiple tasks can be executed upon timer expiration**
- **Timer can take on several forms**
  - Fixed Interval
  - Date Time ( Cron Job )
  - Combination
- **Example Applications**
  - Collect Stock Quote Data At 5 Minute Intervals Beginning At 8:00 AM
  - Get Flight Information For All Flights To NY Between 8 and 10PM.

## ***MIDP API : Networking Extensions***

- MIDP network API extends generic CLDC Connection Framework
- MIDP devices must implement HTTP protocol
- Key class is `HttpConnection`
- Key methods include :
  - `get/setRequestProperty`
  - `get/setRequestMethod`
  - `getResponseCode`
  - `getResponseMethod`
  - `getHeaderField`
  - `getURL, getHost, getPort, getFile, getRef`

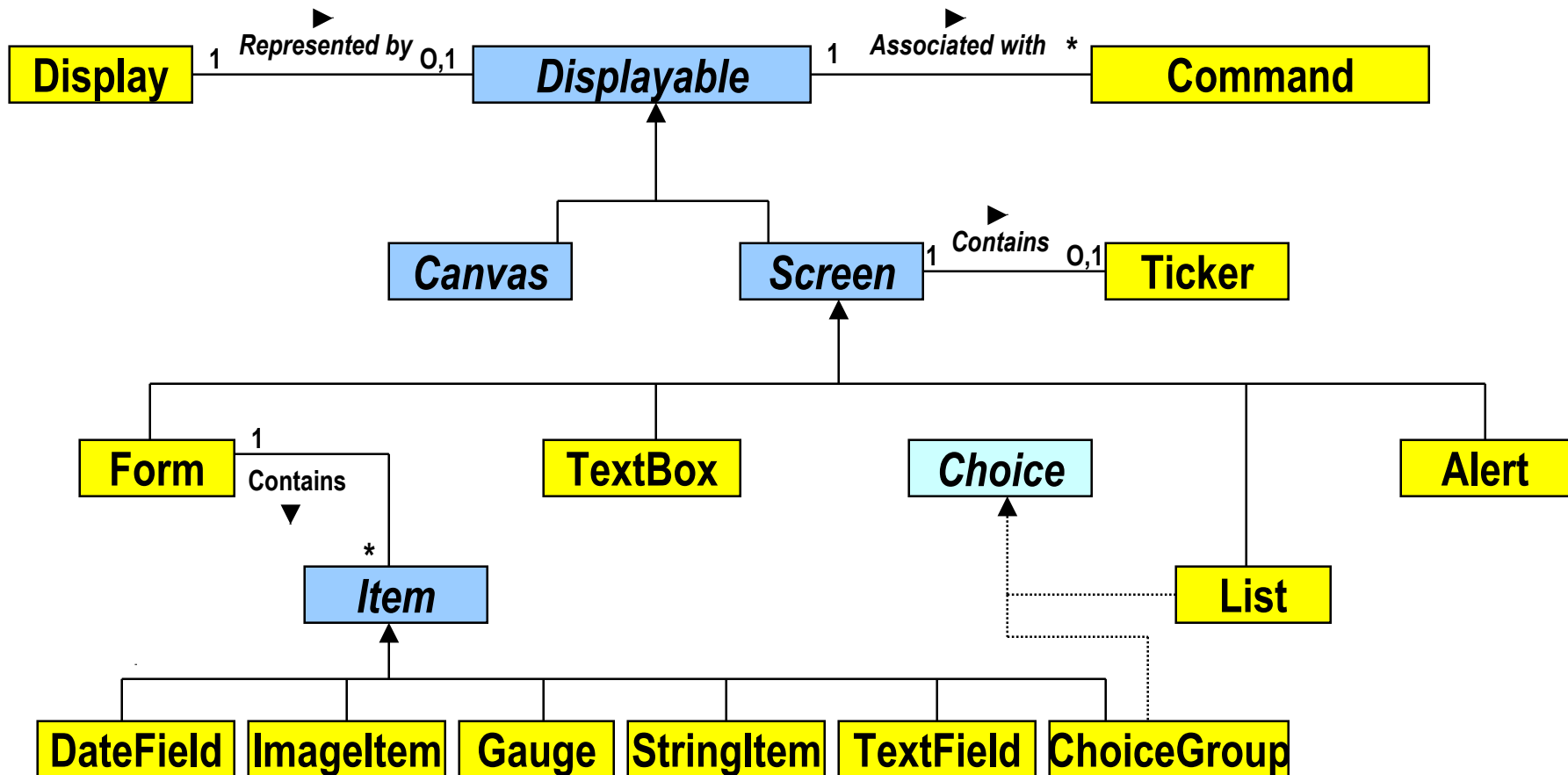
# MIDP API : UI Functionality

## ■ Screen Design Considerations

- Think Of The User !
  - *Remember the screen size is not like a desktop*
  - *Remember the application should behave similar to native device apps*
  - *User will desire only very simple interactions*
  - *Not all devices have a pointing device*
  - *Majority of devices are 'one-hand' operated*
- Screens Should Contain Minimal Information !
  - *No complex screens with scrolling and complicated selection widgets*
  - *Render only the most valuable information to the end user*

# MIDP API : UI Functionality

## UI API class hierarchy :



## ***MIDP API : Persistence Support***

- **Lightweight record oriented database**
  - Device independent API
  - Unique record id for each record within the store
  - Records are arrays of bytes
  - Shared within MIDLet suite
  - Support for enumeration, filtering, sorting
- **Device is responsible for**
  - Integrity of data across reboots and battery changes
  - Storage in flash or other memory device

# ***MIDP API : Persistence Support***

## ■ **Record Store**

- openRecordStore, closeRecordStore
- listRecordStores, deleteRecordStore
- getNumRecords

## ■ **Record Data**

- addRecord, deleteRecord
- getRecord, setRecord, getRecordSize

## ■ **Record Enumeration / Selection / Sorting**

- RecordEnumeration, RecordFilter, RecordCompare

## **Appendix : Other Terms**

- **kJava ( Package : com.sun.kjava )**
  - Used early on for Palm demonstration purposes
  - Replaced by PDA Profile for CLDC.
  - Application is called a “spotlet”
- **kAWT ( <http://www.kawt.de/> )**
  - Michael Kroll and Stefan Haustein authored
  - Device UI almost equals AWT as we know it
- **SavaJe XE OS ( <http://www.javasoft.com> )**
  - Replaces OS on high-end micro-devices
  - Alternative to CDC
  - Full J2SE implementation
  - Targets StrongArm Processors ( 77% of processor market )

## References

- **Vince Huston**
  - <http://myweb.onramp.net/~huston/j2me/vocabulary.html>
- **Robert Evans KVM Site ( Palm )**
  - <http://webdev.apl.jhu.edu/~rbe/kvm/>
- **Micro Java Web Site ( General )**
  - <http://www.microjava.com/>
- **Sun J2ME Site**
  - <http://java.sun.com/j2me/>
- **J2ME Wireless Toolkit Download**
  - <http://java.sun.com/products/j2mewtoolkit/download.html>