Java Embedded: The Internet of Things

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Java Platform Group
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Everything Connected

3B -> 50B Devices by 2020

Mobile Traffic 5X in 3 years

Key milestones

| Number of permanently Internet-connected devices | > 15 billion | > 30 billion |
| Number of intermittently Internet-connected devices | > 50 billion | > 200 billion |
| Volume of traffic from things | Minority | Majority |
M2M System Evolution
Migrating from proprietary, single-function to platform-based and integrated

A radical architecture shift

1. Transition from proprietary to shared application frameworks
2. End-to-end IP based connectivity
3. Horizontal platform delivers core “system” functionality including security, upgrades, lifecycle and config. mgmt, status monitoring and data mgmt and analytics
4. Horizontal platform enables spread of vertical applications
5. Analytics drives real-time value
IoT/M2M Development Challenges

<table>
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<tr>
<th>Multitude of devices</th>
<th>Variety of devices</th>
<th>No human control</th>
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<tbody>
<tr>
<td>Critical nature</td>
<td>Information privacy</td>
<td>Limited functionality</td>
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<tr>
<td>Low powered</td>
<td>Hard to reach</td>
<td>Long device lifecycle</td>
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- CPU
- Programming Language
- Proprietary API
- RTOS
Java-based IoT/M2M Platform
Single development platform across all domains

Java Abstracts the Platform

Common Security
Common Development
Common Management
Java Embedded
Example devices powered by Oracle

Small
- Wireless Modules
- RFID Readers
- Parking Meters
- Intelligent Power Module
- Smart Meters

Medium
- Routers & Switches
- Storage Appliances
- Network Management Systems
- Factory Automation Systems
- Security Systems

Large
- Multi Function Printers
- ATMs
- POS Systems
- In-Flight Entertainment Systems
- Electronic Voting Systems
- Medical Imaging Systems
Oracle Java Embedded Offering Today

Platform Footprint

- SMALL
- MEDIUM - LARGE

50KB-1MB

Java card

1MB-10MB

ME-E

ARM 7  Cortex M  ARM9/11

10MB-100MB

OJEC

MIPS32/Intel  Atom/ARM  CortexA/PPC

Device

CPU/ GPU/I-O
Java ME Embedded
Oracle Java ME Embedded

Software Stack

Runtime Environment
- OEM APIs
- Access Point APIs
- AMS APIs
- Device Access APIs

IMP – NG
- CLDC-HI Virtual Machine
- On-Device Debugging

Device Port
- Porting Layer
- Embedded Hardware and RTOS

Tools
- Java ME SDK
  - Test, Emulate
- NetBeans IDE
  - Develop, Debug, Profile

Logging APIs
XML
Messaging
Security & Trust
Location
Web Services
PIM and File

Tools

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# Java ME Embedded 3.2 Device Profile

Targeting wireless modules and small M2M

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Description</th>
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</table>
| **System Architecture** | ARM architecture SOCs  
|                         | incl. ARM9, ARM11, Cortex-M, -R, and –A                                                                                                    |
| **Device Type**         | Resource-constrained, headless, always-on                                                                                                   |
| **Operating System**    | Simple embedded kernel or more capable OS/RTOS                                                                                               |
| **Network**             | IP-based wired (Ethernet) or wireless (cellular or other)  
|                         | Including multiple access points                                                                                                             |
| **Peripheral I/O**      | Versatile access to peripheral I/O  
|                         | Serial, file, GPS, I2C, SPI, I2C, GPIO, mem.-map                                                                                             |
| **Footprint**           | Minimum configuration (custom)  
|                         | approx. 130 KB RAM/350 KB ROM  
|                         | Full, standard configuration  
|                         | approx. 700 KB RAM/1500 KB ROM                                                                                                              |
ME Embedded Direction
Ensure alignment between ME/SE over the upcoming ME releases

Key Principles
- Java ME is the “little sibling” of Java SE.
- CLDC is a strict subset of Java SE
- Any Java ME app/library works on Java SE.
- Java ME vs Java SE is a footprint/functionality tradeoff.
- Java ME and Java SE releases are synchronized

Benefits
- Unified development experience & community
- Align language, core APIs, development and management tools
- Reuse Java ME APIs in Java SE: Bluetooth, Location, Sensors, Messaging....
- Reuse Java SE tools and management features in Java ME
- 9+ Million developers for all of Java from Card to Enterprise
Java ME 8 Platform Architecture

**Vertical Specific APIs**
- Core device vertical APIs
- MSA JSRs
- Add. Optional APIs
- Add. Optional APIs

**On-Device I/O Peripheral Access**
- Device Access API (aka DA API)

**Java VM**
- CLDC 8 (with Support for Java Language 8)

**Application Environment**
- Java ME Embedded Profile (aka IMP 8)
## Java ME 8 Platform

New JSRs for small Embedded

<table>
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<tr>
<th>JSRs</th>
<th>Description</th>
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<tbody>
<tr>
<td>CLDC 8</td>
<td>• New JVM Spec. aligned with JavaSE 7/8 language features</td>
</tr>
<tr>
<td>Java ME Embedded Profile 8</td>
<td>• Evolution of IMP and MIDP for the small embedded market. &lt;br&gt;• Addresses MIDP 3 usability issues and feature gaps. &lt;br&gt;• New Headless Application Management APIs</td>
</tr>
<tr>
<td>Device Access API</td>
<td>• APIs to enable access from/to device interfaces and peripherals</td>
</tr>
</tbody>
</table>
Java ME 8 Platform

Compatibility with existing optional ME JSRs

• Existing Java ME JSRs can be implemented atop ME8
• Optional JSRs enables fine-tuned addressing of embedded needs
  – Address vertical requirements
    • Communication module/M2M, smartmeter, healthcare, mobile,…
  – Meet device static and dynamic memory budgets for Java
  – Support a variety of hardware/peripherals/networks
Wireless Modules
A natural fit for Java ME - Embedded

• Java adds intelligence and connectivity to vertical solutions with small, wireless devices
  ➢ Industrial automation
  ➢ Healthcare applications
  ➢ Security
  ➢ Monitoring

• Smart & programmable
  ➢ CPU, RAM/Flash, I/O, SIM
  ➢ Highly integrated, 2G/3G (voice + data), low power
  ➢ Java runtime based on Java ME Embedded
  ➢ Remote provisioning and management
Java SE Embedded
Java SE Embedded Overview

What is Java SE Embedded?

- Java Standard Edition implementation optimized for embedded devices
  - Reduced static footprint (60+% smaller than standard JRE)
    - 42MB versus 140MB on x86 Linux Java SE 7u6
  - Reduced memory requirements (32MB headless, 64MB headful)
  - Headless and Headful configurations
  - Embedded architectures supported (ARM, PPC, x86)
  - Full Java SE compatibility
  - Available today!
Java SE / CDC Embedded Convergence

Goals for JDK 8

- Bring the critical features of ME/CDC to Java SE Embedded
- Small Static Footprint starting at 10MB
- Smaller dynamic footprint (16MB headless, 32MB headful)
- New embedded specific FX graphics stack
Java SE / CDC Embedded Convergence

Convergence VM features

- Small Hotspot VM (< 3MB)
- JIT Code cache reduction
- Class file memory reductions
- Hotspot improvements
  - JSR-292, Permgen removal, NMT, Compiler Control
- ARM and PPC performance improvements
- Improved serviceability (serviceability agent support for ARM & PPC)
Java SE 8 Compact Profiles

Profiles Introduction

- Define three new Java SE Runtimes in JDK 8
- New Runtimes will be Java SE compatible subsets
- Benefits
  - Provide smaller Java runtimes for resource constrained devices
    - Smaller Headless Runtime
    - Platform for FX only graphical UI stack
    - Quicker download and startup
- Basis for Java ME / CDC Converged product
  - Similar to Foundation profile & optional packages
Java SE 8 Compact Profiles

Overview

SE Embedded Compact Profiles

1. Base Compact1 Classes
2. Compact2 Class libraries
3. Compact3 Class libraries
4. Optional Components

SE Embedded Full JRE

1. Hotspot VM
2. Lang & Util Base Libraries
3. Other Base Libraries
4. Integration Libraries
5. UI & Toolkits
6. Hotspot VM
Java SE 8 Compact Profiles
Approximate Static Footprint Size Targets

- Compact1 Profile: 10MB
- Compact2 Profile: 17MB
- Compact3 Profile: 24MB
- Full JRE: 140MB
Java SE 8 Compact Profiles
Profile package contents

Compact1
- java.lang
- java.io
- java.nio
- java.text
- java.math
- java.net
- javax.net
- java.util
- java.util.logging
- javax.security
- java.security
- javax.crypto
- javax.script
- javax.lang.model
- javax.lang.model.element
- javax.lang.model.type
- javax.lang.model.util
- javax.tools

Compact2
- java.sql
- javax.sql
- javax.xml
- org.w3c.dom
- org.xml.sax
- java.rmi
- javax.rmi
- javax.transaction
- java.lang.management
- javax.management
- javax.naming
- javax.sql.rowset
- javax.security.auth.kerberos
- org.ietf.jgss
- javax.script
- javax.xml.crypto
- java.util.prefs
- javax.security.sasl
- javax.security.acl
- java.lang.instrument
- java.lang.annotation
- java.security

Compact3
- java.lang.management
- javax.management
- javax.naming
- javax.sql.rowset
- javax.security.auth.kerberos
- org.ietf.jgss
- javax.script
- javax.xml.crypto
- java.util.prefs
- javax.security.sasl
- javax.security.acl
- java.lang.instrument
- java.lang.annotation
- java.security

Java Runtimes
- Full JRE
- Compact3
- Compact2
- Compact1
JavaFX for Embedded
Next-gen UI platform for Java

- Powerful set of 100% Java APIs
- Rich graphics and animation
- Common graphics architecture across all Java SE platforms
- Integrated contents for various devices
Java Embedded Suite
# Building an end-to-end IoT Application

## Components

<table>
<thead>
<tr>
<th>IoT Application</th>
<th>Device</th>
<th>Middleware</th>
<th>Database</th>
<th>Infrastructure</th>
</tr>
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<tbody>
<tr>
<td>Gateway</td>
<td>Event Processing</td>
<td>Analytics</td>
<td>Portal/Social/Comms</td>
<td>VM (Java)</td>
</tr>
<tr>
<td>Data</td>
<td>Analytics</td>
<td>Search</td>
<td>Content</td>
<td>Spatial</td>
</tr>
<tr>
<td>Application Runtime</td>
<td>VM (OS)</td>
<td>Storage</td>
<td>Servers</td>
<td></td>
</tr>
</tbody>
</table>

- **Device**
  - IoT Application
- **Middleware**
  - Event Processing
  - Analytics
- **Database**
  - RDBMS
  - NoSQL
  - Analytics
  - Search
  - Content
  - Spatial
- **Infrastructure**
  - Storage
  - Servers
  - VM (OS)
What is Oracle Java Embedded Suite?
Proven platform built on Java SE Embedded

- Extends the success and versatility of the Java Embedded platforms to by pre-integrating additional capabilities needed in today’s intelligent devices
- Devices built on Java Embedded Suite provides flexibility to ensure your solutions continue to meet your needs into the future
Oracle Java Embedded Suite: Application Runtime

- **Java SE Embedded**
- **Java DB**
- **Glassfish Embedded**
- **OS & Hardware**

**Trusted Application Platform**

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<tr>
<th>Portability</th>
<th>Developer Ecosystem</th>
<th>Common Dev platform</th>
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<tbody>
<tr>
<td>Software Updatability</td>
<td>Security</td>
<td>Standards-based</td>
</tr>
<tr>
<td>Proven</td>
<td>Off-the-shelf components</td>
<td>Trusted vendor</td>
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</table>
Oracle Java Embedded Suite: Collect & Consolidate
Oracle Java Embedded Suite: **Analyze & Share**

- **OS & Hardware**
- **Java SE Embedded**
  - Glassfish (Servlet, Web & RESTful)
- **Java DB**

**Your applications**

**Data Consumers**
- CRM
- GIS
- ERP
- Custom Apps
- BI

**Consumers**
- Services & Management
- Demand Response
- Analytics & Business Intelligence
Key Use Cases

- **Industrial Automation**
  - Embedded Server and Appliances
  - Gateways
  - Concentrators
  - Diagnostic systems

- **Healthcare**

- **Connected Devices**

- **Smart Energy**

- **Automotive & Transportation**
  - Multi-function Printers
  - Imaging systems
  - M2M Device Cloud Hub
Oracle Java Embedded Suite
Integral part of E2E Connected Solution

Java Card
Java Embedded Suite
Java ME/SE Embedded
Sensing Device
Concentrator or Gateway
Network Cloud

Base Stations
Switches
Management
Billing
Provisioning

Java Card
Java Embedded Suite
Java ME/SE Embedded
Sensing Device
Concentrator or Gateway
Network Cloud

Base Stations
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Roadmap
Embedded Java

Java Embedded Suite 7
- SE Embedded 7
- GlassFish for Embedded
- Java DB

Java ME Embedded 3.2
- Microcontroller support
- Device Access APIs

Java ME SDK 3.2
- Embedded emulator
- Eclipse integration

Java ME Embedded 3.3
- Enhanced device access
- Footprint optimization & configuration tools
- Improved developer tooling & experience

Java SE Embedded 8
- Complete JVM convergence
- Additional compact profiles
- JavaFX for Embedded

Java Embedded Suite 8
- Additional enterprise middleware integrations
- Flight Recorder/Mission Control

Java Embedded 9
- JDK9
- Modularity based on Jigsaw
- Additional Embedded device APIs
- Ease of Development

NetBeans IDE 7.2
- ME Embedded support

NetBeans IDE 7.2
- Java ME/SE 8 Embedded support

NetBeans IDE 8
- Java ME/SE 8 Embedded support

NetBeans IDE 9
- Java ME/SE 9 Embedded support
- Jigsaw support
Summary: Oracle for Internet of Things

- Oracle Java on Devices & in Data Center
- Best-of-Breed Solutions
- Open Standards
- Vertical Integration
- Extreme Performance
- Engineered Systems

Complete Customer Choice
- On-Premise
- Private Cloud
- Public Cloud
- Hybrid

Complete Stack

Applications
Middleware
Database
Operating System
Virtual Machine
Servers
Storage
## More Information

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