Java Environment for a JUMPtec WebToNet Embedded System

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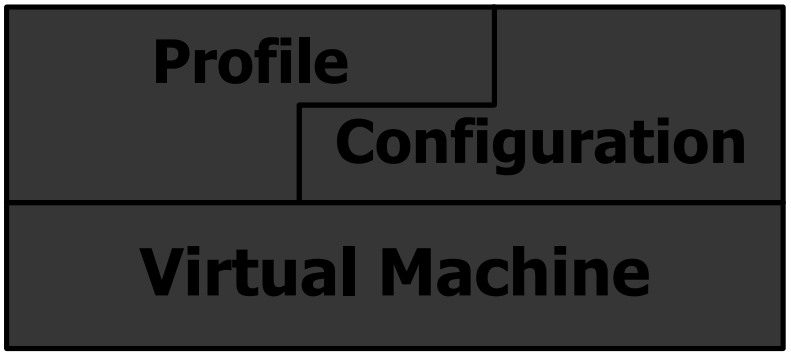
Objectives

- To execute programs written in Java in a small JUMPtec embedded system.
- To help the development of applications for the control aplications.
- To evaluate the Java language performance in this kind of devices.
- To evaluate the possibility of using mobile code in these systems.

Contribution of Java

- Ideal situation, Write Once Run Anywhere...
- Must port the virtual machine for all these platforms.

Java 2 Micro Edition architecture



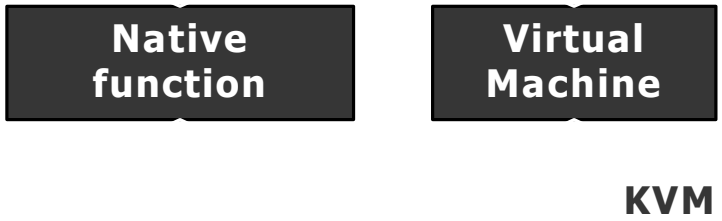
- Java 2 Micro Edition:
  - Two virtual machines
  - Configurations (CDC, CLDC)
  - Profiles (ex. MIDP)
- Configuration
  - Defines the basic environment:
    - Virtual machine
    - Minimal classes
- Profile
  - Oriented to a specific device

➢ **Great flexibility and possibility of evolution**

KVM (*Kilo Virtual Machine*)

- Available with CLDC configuration.
- New implementation of the standard java virtual machine
- Executes the same set and format of Byte Codes than a standard virtual machine.
- Small and modular to satisfy a great number of constrained resource devices.

KVM – Native Functions

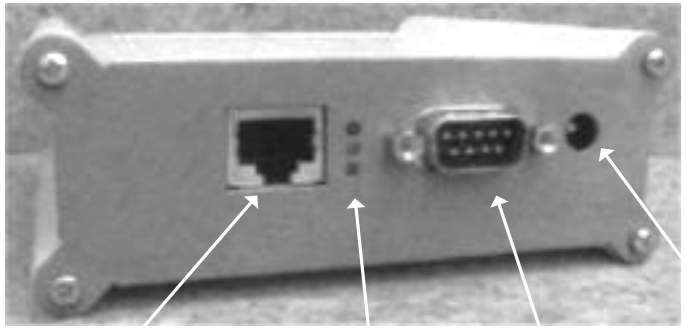


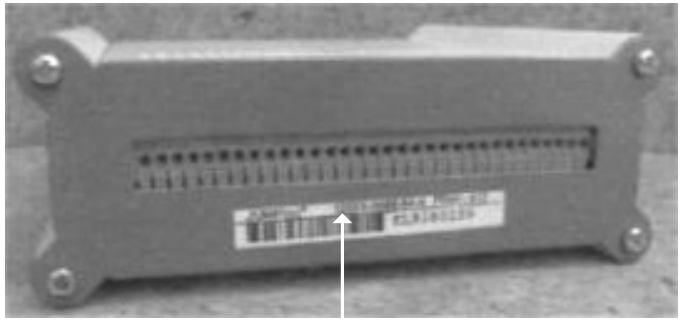
- Different from JNI in J2SE
- Protect the system, but give access to it.
- Written in C.
- Integrated in the Virtual Machine.

Preverification

- Verification divided in two phases in two different systems.
- It is necessary to pre-verify the code outside the target device.
- Better performance and less memory usage

The JUMPtec WebToNet





- Small
  - 11.2*11.6 cm
- 386SX Processor
- 2 MB of RAM
- 2 MB of flash memory
- Integrates a Web server.
- Operating system
  - DR-Dos

The KVM in DOS

- Configuration of source code flags.
- Functions to support 64 bits arithmetic.
- Alterations to the environment to support floating point.
- Native functions to access to the hardware.
- Modification of the Class Loader.
- Compilation of the source code with a 32 bits pointers compiler.

Class Loader problem

Class name	DOS name
My_program.class	My_pro~1.cla
My_program1.class	My_pro~2.cla

- Solution: The Class loader must verify the class name in its internal structure

- The file names in DOS have 8+3 characters.
- In Java, the class name can have more than 8 characters.
- The name of file doesn't reflect the class name.

Floating Point arithmetic

- KVM originally doesn’t provide this support.
- Many applications of this kind of systems use FP arithmetic (e.g. controllers).
- Changes to the environment:
  - KVM, necessary to add some functions
  - KVM, necessary to add native functions
  - Also necessary:
    - To add some classes (namely `float` and `double`)
    - To add some methods to existing classes (e.g. `println`)

Native Functions

- Native functions necessary to provide floating point facilities.
- Native Functions to access the hardware ports:
  - Similar to `inportb()`.
  - Similar to `outportb()`.
- Native functions to access to the ethernet card.

Interaction with the real world

- Serial Port
  - Developed a class with several static methods for common tasks.
- Parallel port
  - Developed a class with some important methods for standard access to the parallel port.
- Programmable LED
  - Static class with two methods, to turn it on and turn it off for debugging purposes.
- Network access
  - Operating System: Dos → Packet Driver must be used.
  - Ethernet access is made with *wattcp* (www.wattcp.com), with the Generic Connection Framework and some native methods.

Application Example

- Send via rs232 an IP address
- The JUMPtec system checks in the DNS the corresponding name.
- The JUMPtec sends via serial port the corresponding host name.
- After, the LEDs are turned on and off according to the switches' state.

Java Performance

- The application to turn on and off the programmable LED.

Programming language	Execution time	Tool
Assembly	14 μS	Masm 6.11
C	14.8 μS	Turbo C 2.0
C++	47 μS	Gnu C 2.95
Java	640 μS	javac

- The Java is about 10 times slower than C++:
  - This performance is acceptable for most of the applications of this kind of systems.
- The source code for java is more structured.

PID controller execution time

language	Arithmetic	JUMPtec	PC
Java	Floating Point	14 mS	33.5 μS
	Integer	1.28 mS	25 μS
C	Floating Point	12.5 mS	8.6 μS
	Integer	65 μS	0.6 μS

- Floating point unit is important...
- Java is slower, but with floating point, has similar performance

Real Test

- Control of a kiln temperature with the JUMPtec system.
- Control algorithms tested:
  - PI
  - On Off
  - Ramp
- Easy to develop programs, namely to control the sampling period.

Possible Utilizations

- Programming paradigm changed for embedded system.
- Simplified Development.
- Applications
  - Instrumentation.
  - Control applications.
  - Systems for teaching purposes.

Mobile Agents

- Serialization
  - KVM doesn’t support serialization.
- User defined Class Loaders
  - Just one class loader is allowed in KVM, the original.
- More tests with the system using network.

Conclusions

- Rapid develop of applications.
- Code portability and platform independence.
- Non proprietary system.
- Facilities for use in control systems.
- In the future we hope use mobile agents in this platform.

Thanks for your attention

Questions

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