JavaOne℠

Sun's 1997 Worldwide Java Developer Conference

JavaOS™ Based Network Computing

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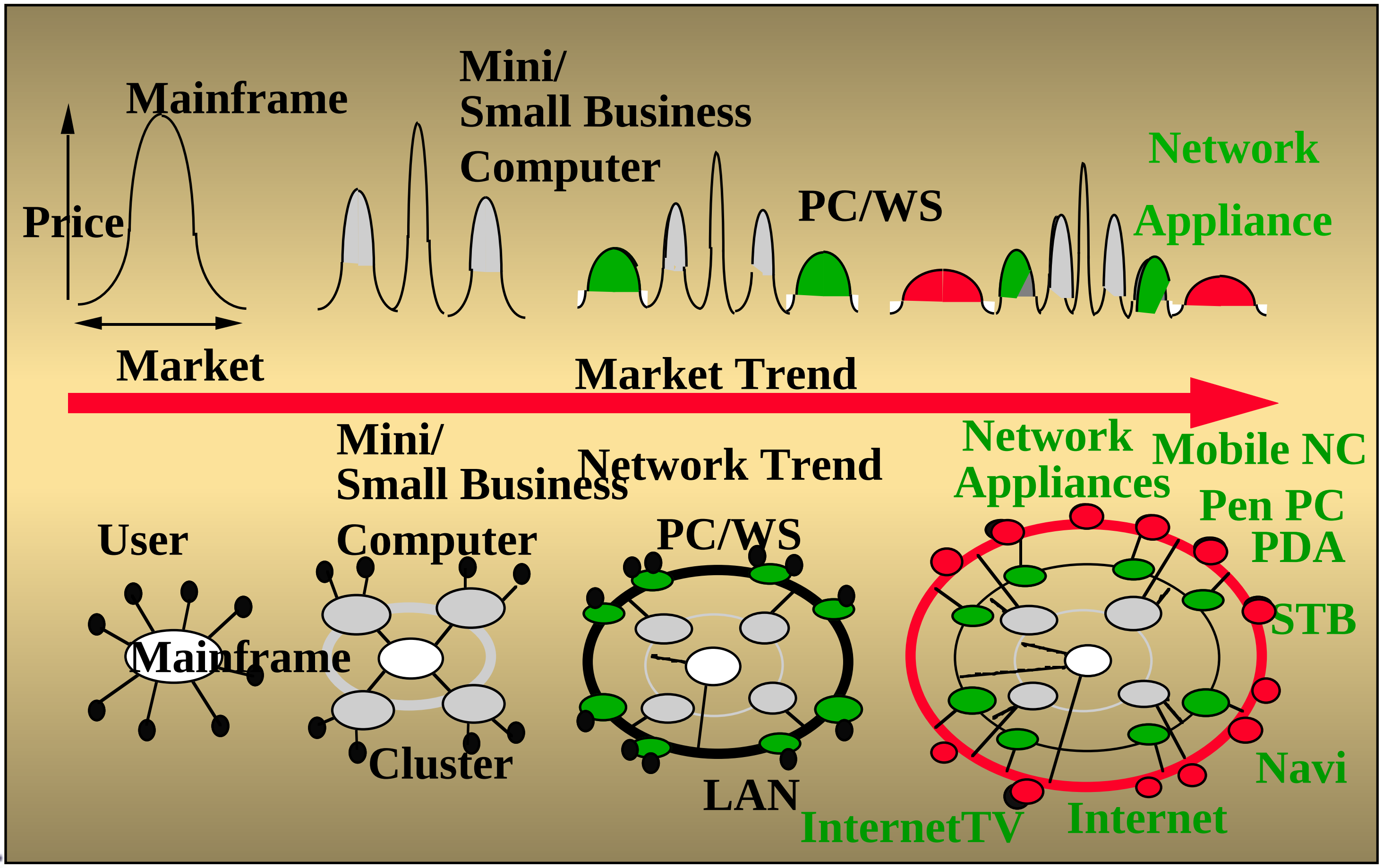
Paradigm Shift and the New Wave



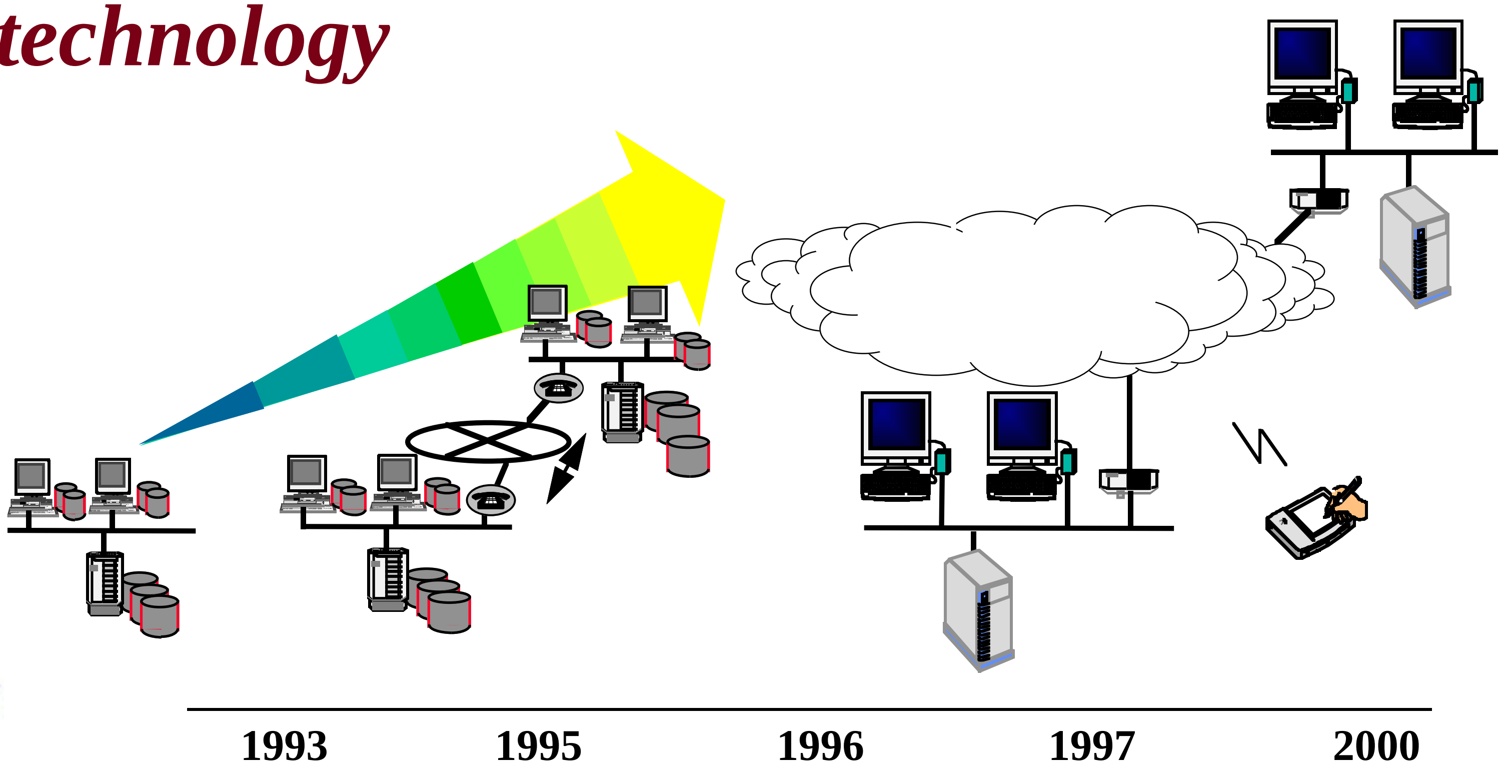
Network Computing Strategy

Focus on new tide of network computing based on Mitsubishi’s technological advantages

- Semiconductor (TFT, M32R/D, etc.)
- Consumer (TV, digital camera, etc.)
- Mobile computing (pen-based PC, etc.)
- Enterprise computing (high-end server)
- System integration
- Basic key technologies

Network Computing Concept

Mobile information systems (anytime, anywhere) using network computing technology



System Concept and Target Application

System Concept

•Seamless Office environment (Wireless LAN, PHS/PCS/CDPD, NC technology)
•Platform independent, intuitive user interface (Java technology)
•Internet/Intranet implementation of flexible systems
  à smooth migration of legacy system (Agent technology)
•Communication and data transfer technology suitable to wireless connectivity
  à (Proxy Server technology, etc)

Target Application Image

•"Anytime, Anywhere" Virtual Mobile Office
•Wide-area Information terminals/Servers System
•Internet/Public Network Information Providing Service
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Network Computing Types

- Enterprise
- Mobile applications
- Home and consumer product

Office -- Enterprise

- MonAMI/NC
  - JavaOS™ based network terminal
  - NC management kit
- System integration for Enterprise
- Platform for VAR, SI

Mobile Applications

- MonAMI-II
  - JavaOS based mobile terminal
  - Wireless communication
  - Mobile server
- Sales support
- Patient care applications
- In car/train information system

Home -- Home and Consumer Product

- In TV
  - Electronic news
  - Virtual mall and home shopping
- In Telephone
  - Personal cell phone
  - SmartPhone

Why JavaOS ?

- Can support any emerging chips
  - Intel, PowerPC, M32R/D, PicoJava
- Run Java™ with limited resources
- Execute new applications efficiently on old CPUs

What Features Are Added

- System initialize
  - Any boot server -- DHCP/BOOTP
  - Local boot and remote boot
- Communication
  - Wireless LAN
  - Wireless WAN -- CDPD,PCS,PHS,etc
- Management
  - NC management kit -- configuration, User/App manage

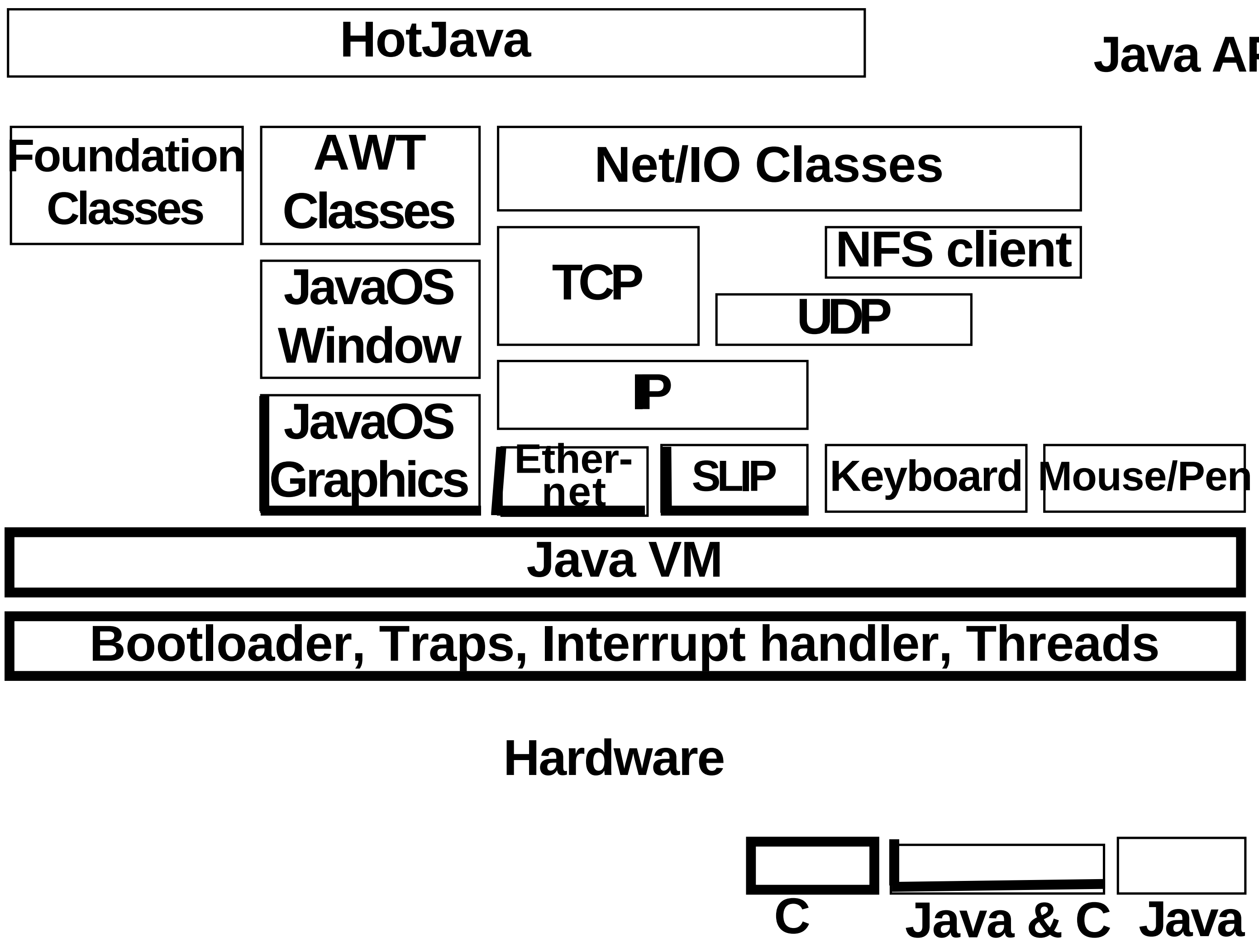
Java Enterprise Network Terminal

- MonAMI/NC -- Compact lunch box
  - At the COMDEX/Fall ’96 exhibition
  - Boot from Unix
- MonAMI/ES -- All-in-One TFT
  - At the JavaOne ’97
  - Boot from WindowsNT

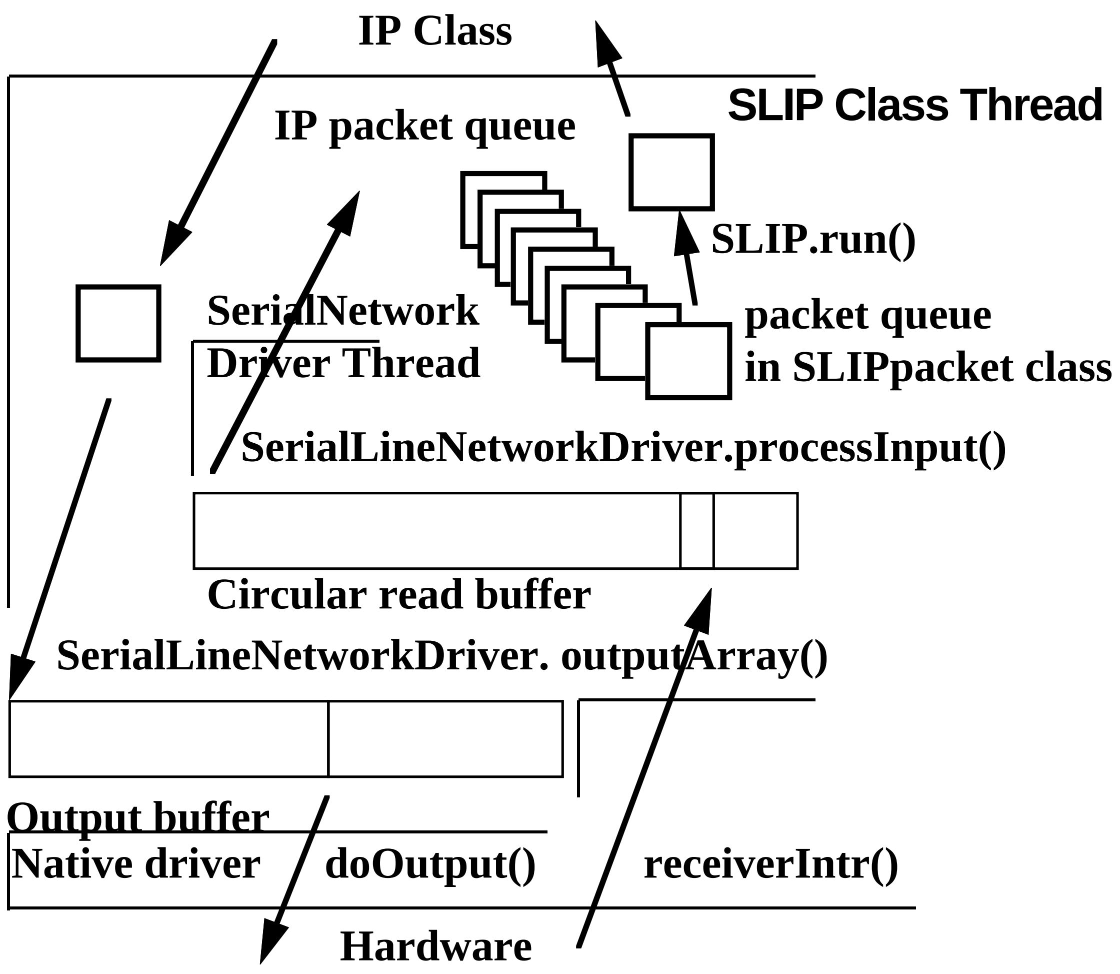
Java Mobile Network Terminal

- MonAMI -- Experimental
  - At the JavaOne ’96
  - At the COMDEX/Fall ’96 with wireless functions CDPD/LAN
- MonAMI-II -- Prototype
  - At the JavaOne ’97

JavaOS Internals



Java Thread Implementation Example



Java Driver or C Driver

- Depends on the interrupt handling
- Currently, trade off between performance and portability

The more written in Java,
the more portable

Speaker Change

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Approach to Java™ for Embedded Systems

Mamoru Sakamoto

Approach to Java for Embedded Systems

- Java advantage
- Java cost
  - Memory / CPU usage
- Java for embedded systems
- JVM-M32R/D demo
- JVM-M32R/D
- Conclusion

Java Advantage

- Application development
- Distributed application
- Secure and robust environment to run external code
    - OO language, MultiThreaded, rich APIs, portable bytecode, interpreted, secure, robust, RMI

JVM Cost

Memory usage

- Stacks for threads
- Class information
- Images
- Object heap
- Java bytecodes
- C codes/static data

JVM Cost

CPU usage

- Bytecode interpretation
- Dynamic checking
    - Null pointer
    - Array index

Memory Cost

Stack for threads

- C stack and Java stack
- Unpredictable stack size
- Typically 14-20 threads

Memory Cost

Class information

- Class hierarchies
- Non private methods and variables
- Constant pools
- Strings
- Required for dynamic linking

Memory Cost

Images

- AWT always holds images decompressed

Memory Cost

Object heap

- Unpredictable max size
- Overhead for GC support
- Overhead by non precise GC

Memory Cost

Java bytecodes
C code, C static data

- AWT
- Java core
- Network
- RTOS
- C libraries

Approach to Embedded Systems

RTOS + Java

- RTOS
- Native device drivers
- Communication between Java threads and native threads

Approach to Embedded Systems

Static Java

- Disable dynamic class loading
- Statically link application and library classes
- Strip unnecessary information
- Convert bytecodes into native codes

Approach to Embedded Systems

Others

- Provide ways to estimate stack size
- Single threaded Java
- Alternative GUI packages other than AWT
- Static object memory management

JVM-M32R/D Demo

JVM/M32R

- RTOS (ITRON)
- no AWT
- JPEG decompression on the fly

JVM-M32R/D

M32R/D

- 32b RISC core
- eRAM (on-chip DRAM)
  - 128b internal bus
- 32b x 16b DSP-like multiply and accumulator

JVM-M32R/D

Implementation

- eRAM
  - C codes
  - C/Java stacks
- External DRAM
  - Class information
  - Bytecodes
  - Object heaps, etc.

Conclusion

- JVM memory cost
  - Stacks, class information, images, object heaps, Java bytecodes, C codes/data
- Approach to embedded systems
  - RTOS
  - Static Java