Active Networking

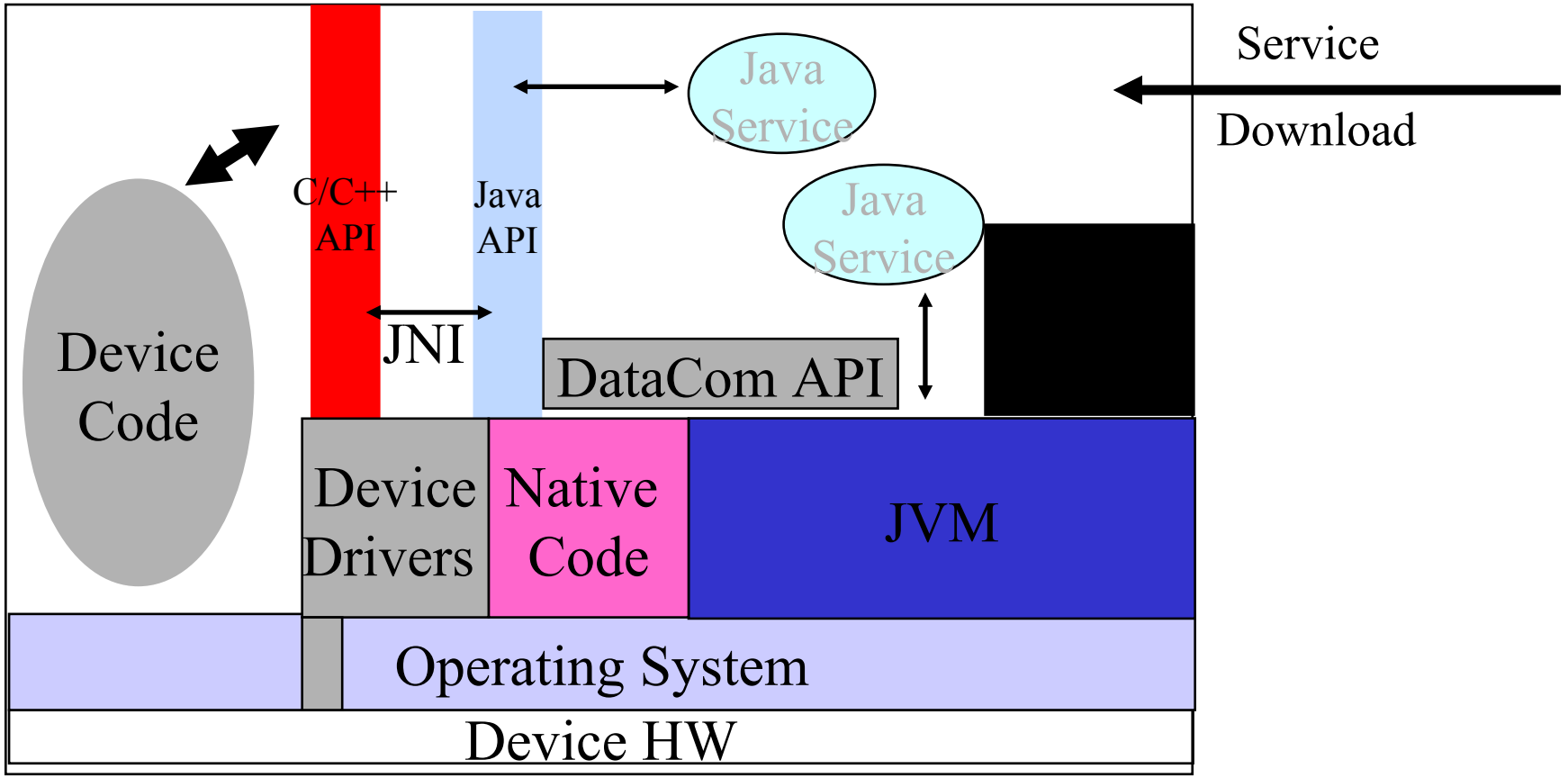
"The active network provides a platform on which network services can be experimented with, developed, and deployed"

http://www.darpa.mil/ito/research/anets/index.html

Active Network Objectives

- Minimize amount of global agreement
  - Do not require global agreement to support dynamic modification of the network
- Support fast-path processing optimization
- Scale to very large global active networks
- Provide mechanisms to ensure security and robustness of nodes and of the network
- Provide mechanisms to support different QoS/CoS

Open Device Architecture (use MY updated one from the LANMAN)

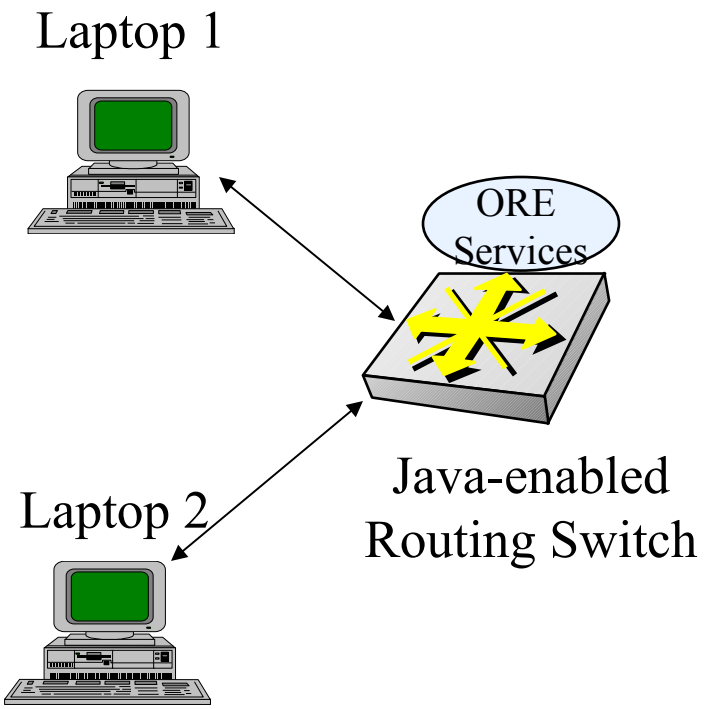


Why Java

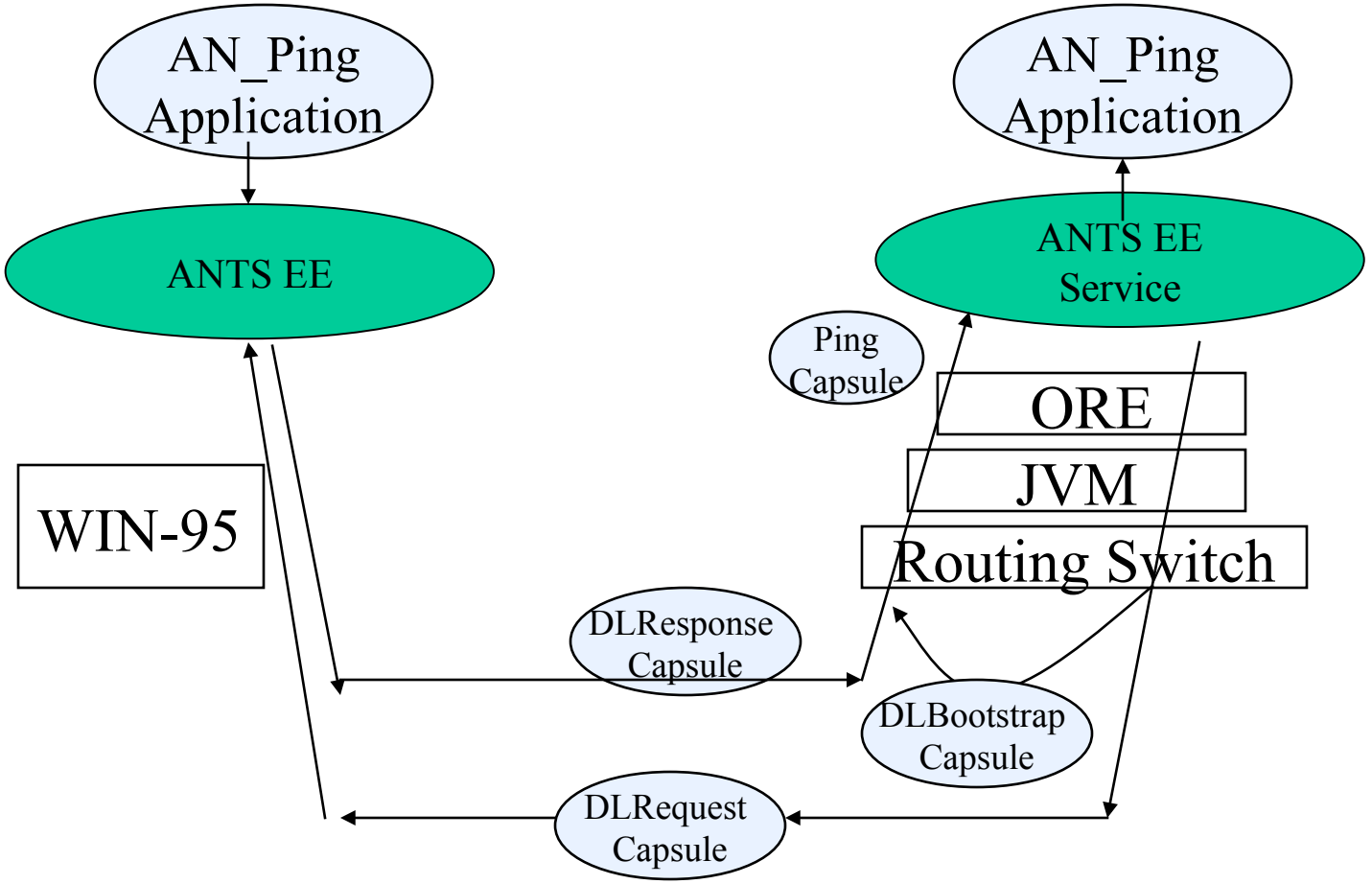
- Dynamic class loading
- Reuse security mechanisms: byte-code verifier, security mgr, class loader
- System stability:
  - Constrain applications to the Java VMs
  - Prohibit native code applications
- Extensible, portable, & distributable services

ANTS Demo Configuration

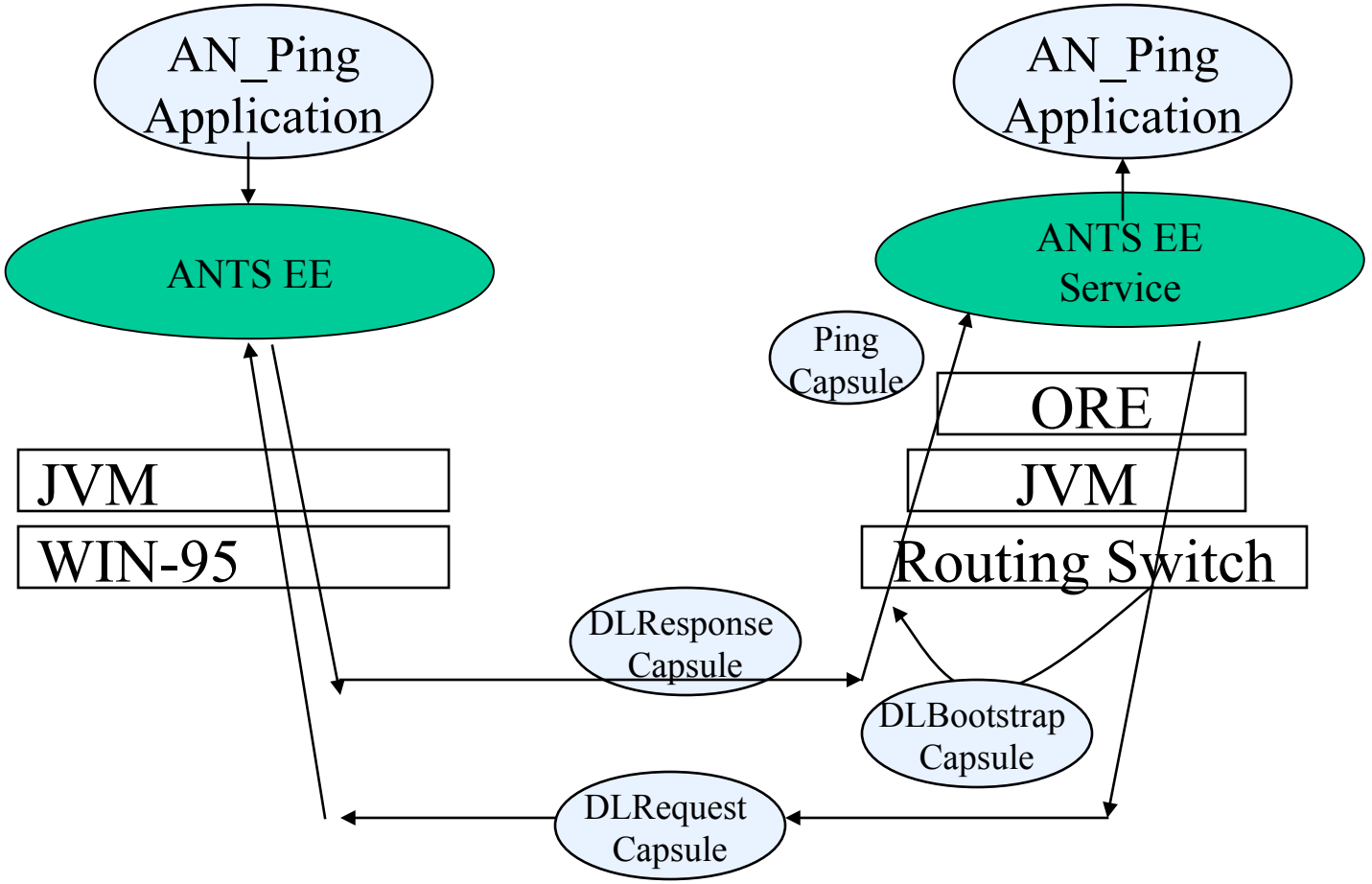
- RoutingSwitch loads boot image from TFTP server
- RoutingSwitch dynamically loads Oplets from the Class Server
- Laptop 1 originates the ping
- Router gets Ping code from Laptop 1.
- Router "evaluates" ping
- Ping forwarded to Laptop2
- Laptop 2 requests code



ANTS Demo


AN_Ping Application
AN_Ping Application
ANTS EE
ANTS EE Service
Ping Capsule
ORE
JVM
Routing Switch
WIN-95
DLResponse Capsule
DLBootstrap Capsule
DLRequest Capsule

ANTS Demo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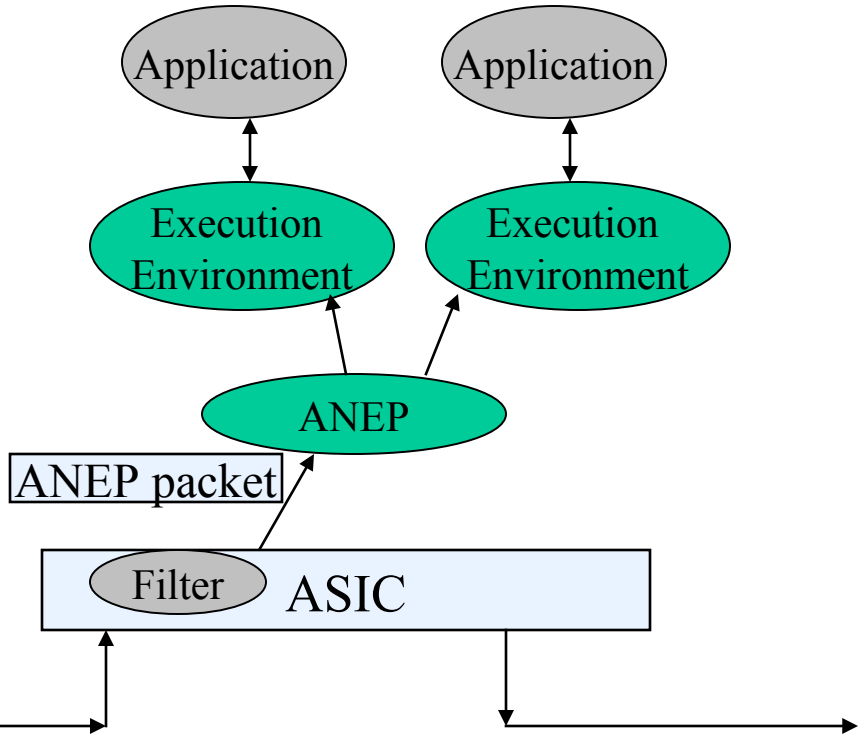
ORE Divert

- Active Network topology is unknown
- ANEP packets NOT addressed to this node are delivered to the control plane for processing
- ANEP daemon receives packets and delivers them to the appropriate EE based on TypeID



ORE Protection

- ORE uses JVM mechanisms to:
  - protect itself from the oplets
  - protect oplets from one another
- Mechanisms include features of the Java
  - type safety, access control, bytecode verification
  - built-in sandbox security manager support
  - signed code
  - strong cryptography infrastructure

ORE Protection

- Java facilities are buttressed by ORE control over the allocation of as many of the system resources as possible
  - thread creation
  - sharing classes loaded by different class loaders
    - cross namespace protection
  - support for object reference revocation
  - Resource allocation -vs- consumption
    - CPU: control thread creation, but not cpu usage
    - File: control access the descriptors but not size

ORE Protection

- Extra JVM support is necessary to protection against misbehavior by oplets
  - Accounting of memory and CPU consumption
  - Promising possibility for memory accounting:
    - the ability to partition the object heap to enforce limits on the memory usage by an oplet

Summary

- User programmable computation engine on network devices
- *dynamic* agents vs. *static* agents
- dynamic loading
- strong security through Java/JVM
- safety among shared components via ORE

Gigabit Router Active Network Platform

References

[1] P.Bernadat, D. Lambright, and F. Travostino, “Towards a Resource-safe Java for Service-Guarantees in Uncooperative Environments,” IEEE Symposium on Programming Languages for Real-time Industrial Applications (PLRTIA) ‘98, Madrid, Spain, Dec. ‘98.

[2] Active Networking Node OS Working Group, NodeOS Interface Specification", June 15, 1999

[3] Active Networks Working Group, "Architectural Framework for Active Networks Version 0.9", August 31, 1999

[4] T. Lavian, R. Jaeger, "Open Programmable Architecture for Java-enable Network Devices", Stanford Hot Interconnects, August 1999.

[5] D. Wetherall et al. ANTS: A Toolkit for Building andDynamically Deploying Network Protocols. OPENARACH'98

[6] C. Hawblitzel, C. Chang, G. Czajkowski, D. Hu, T. von Eicken, “Implementing Multiple Protection Domains in Java”, 1998 USENIX Annual Technical Conference, New Orleans, LA, June 1998

[7] R. Jaeger, T. Lavian, R. Duncan, “Open Programmable Architecture for Java-enabled Network Devices”, To be presented at LANMAN ‘99, Sydney, Australia, November 1999