
ECE 697J – Advanced Topics in Computer Networks

Active Networks

10/09/03

Dynamic Functionality

- Networks implement various packet processing functions
- These applications change over time
 - New protocols
 - New application
 - Etc.
- We need a mechanism to easily deploy such functions
 - Without need for hardware replacement
 - Without complex administration
 - Packets should be able to “choose” functions
- One approach are “Active Networks”

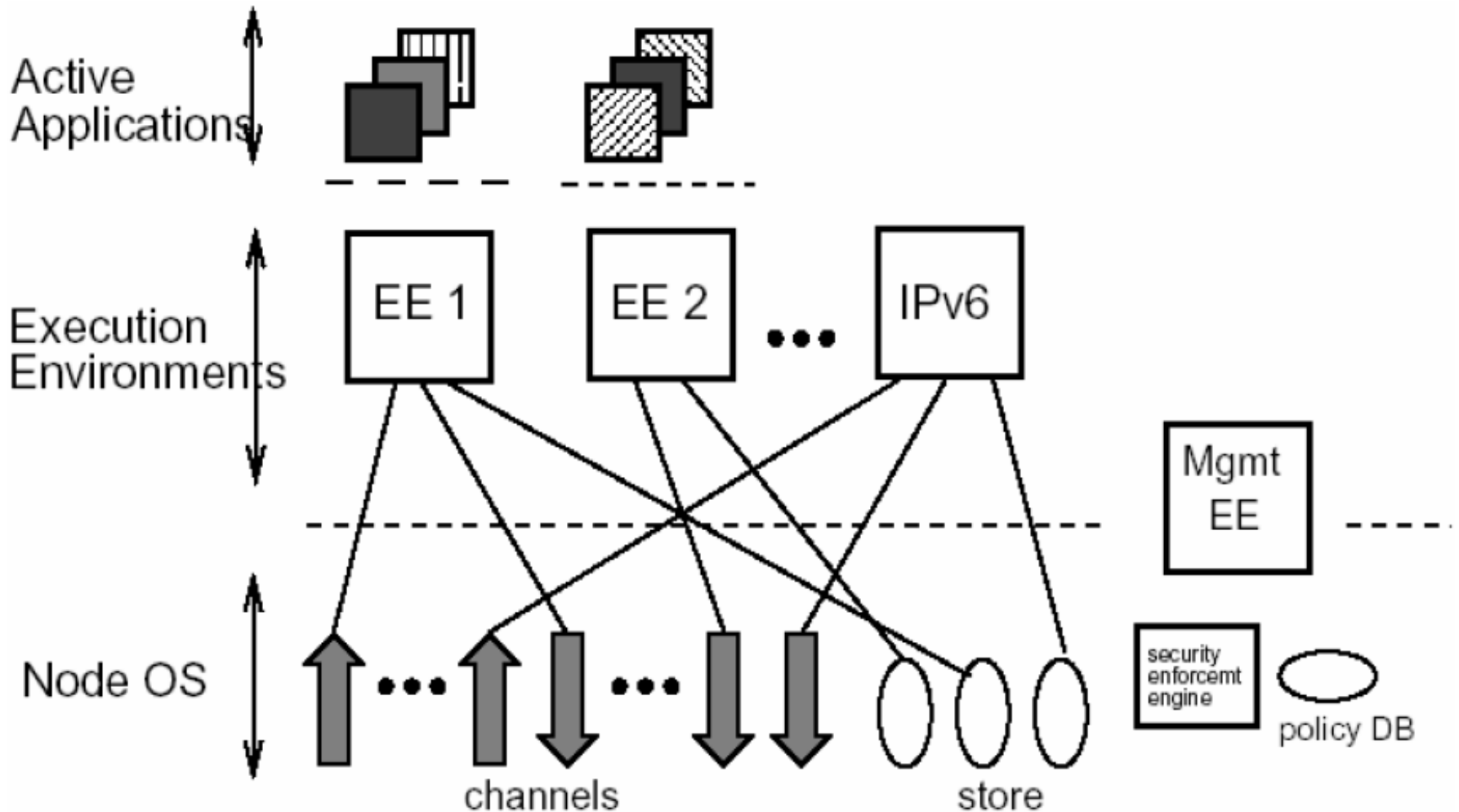
Active Networks

- Basic idea: packets carry processing code
 - Processing code describes how to handle packet
 - Node/router executes code on packet data
- Routers need to provide processing infrastructure
 - Unified, interoperable programming interface/language
 - Safe, efficient execution environment
- Two approaches:
 - Capsule approach: each packet carries code
 - Programmable router: preinstalled functions, packet selects
- What are the major challenges here?

Some AN Research

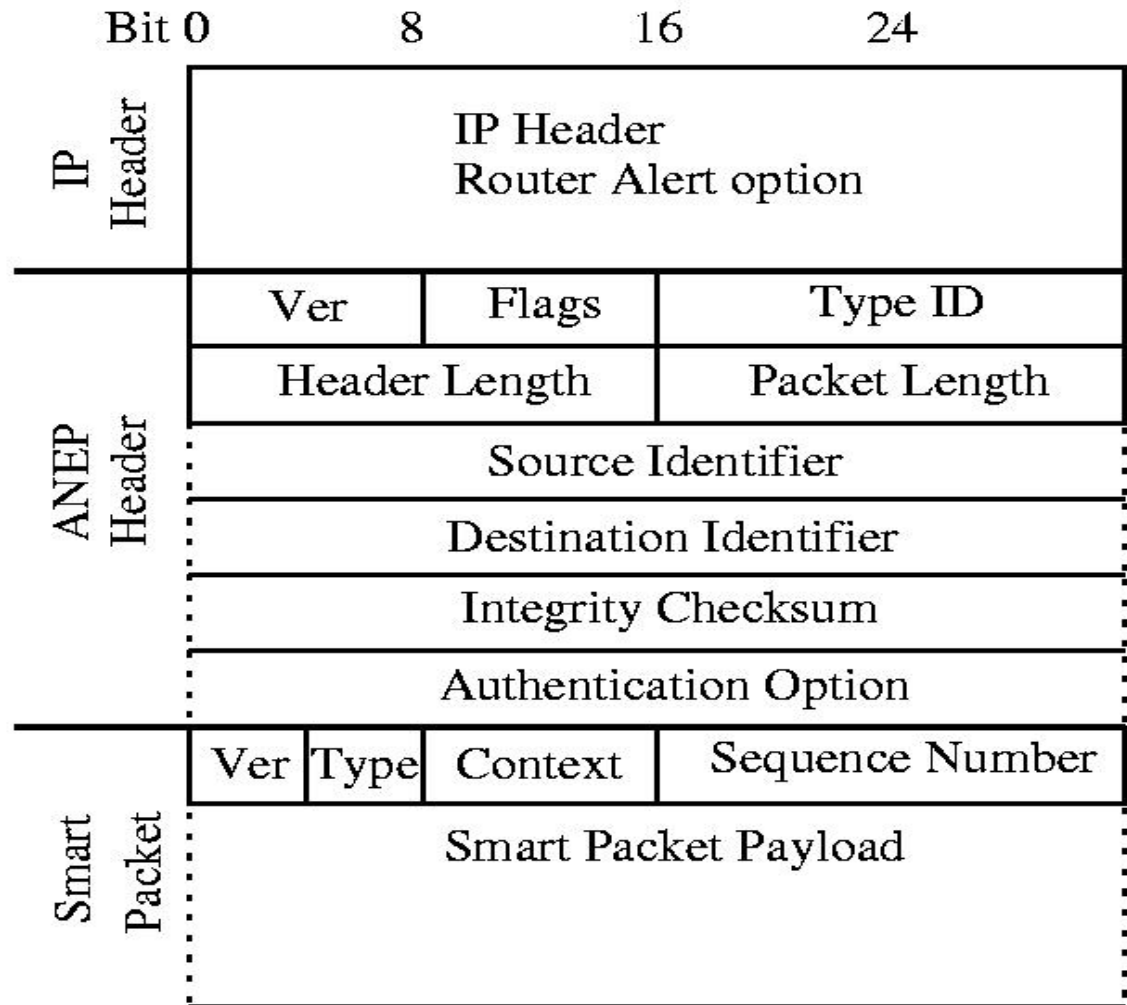
- Active Network Architecture
 - NodeOS for Interoperability
 - Execution Environments
- Packet format
 - Active Network Encapsulation Protocol
- Programming Languages
 - Java bytecode
 - PLAN & SNAP

NodeOS



ANEP Header

- Layered approach:
 - IP
 - ANEP (general AN)
 - Particular EE



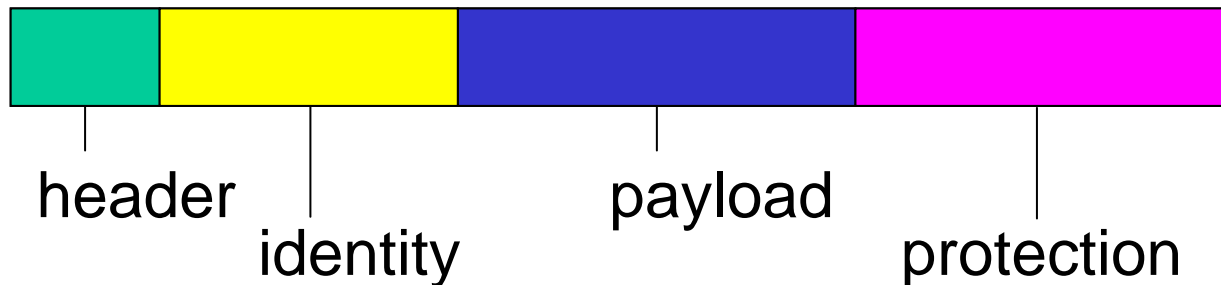
Programming Languages

- Java bytecode:
 - Easy to use (executes on Java VM)
 - Problems?
- Alternative: PLAN & SNAP
 - PLAN (Packet Language for Active Networks)
 - SNAP (Safe and Nimble Active Packets)
 - Very restrictive constructs
 - No backward jumps
 - No loops
 - Achieves resource bounds proportional to packet size
 - Problems?
- Yet another approach:
 - Kernel module without any constraints
 - Problems?

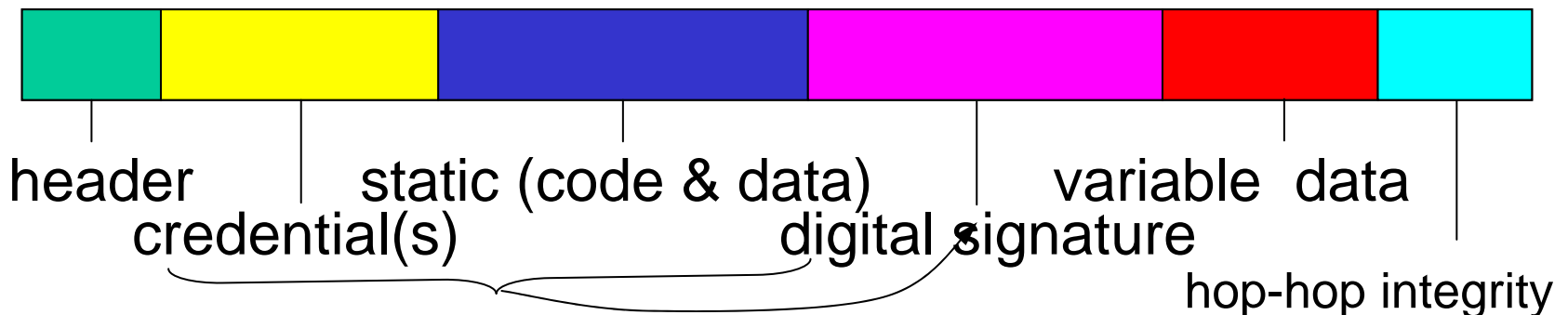
Security for Active Networks

- Packets need to be encrypted in a special way to support hop-by-hop processing:

General Crypto Protected Packet



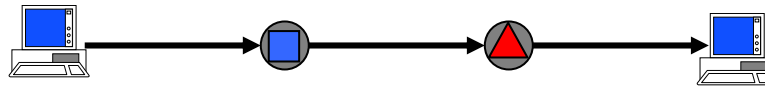
SANTS Protected Packet



Routing and Path Selection

- Processing is essential part of communication
 - Path needs to be chosen to traverse processing nodes

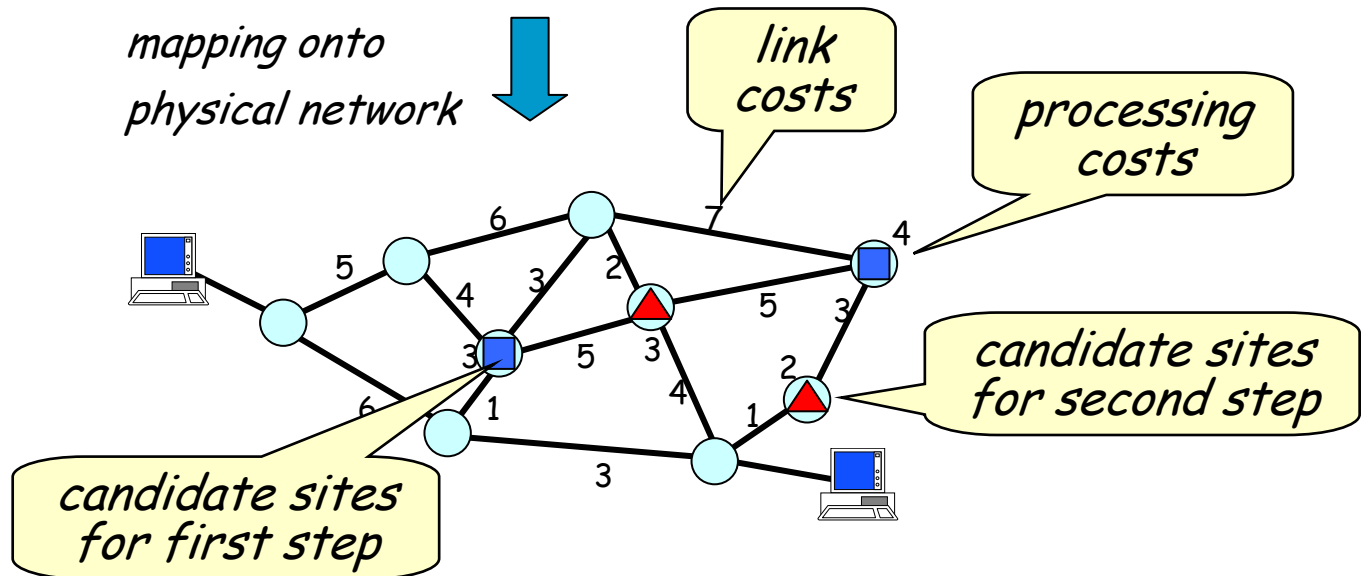
*Active Pipe
Description*



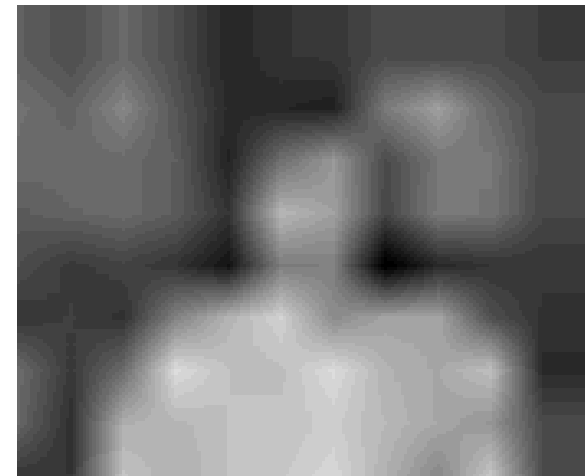
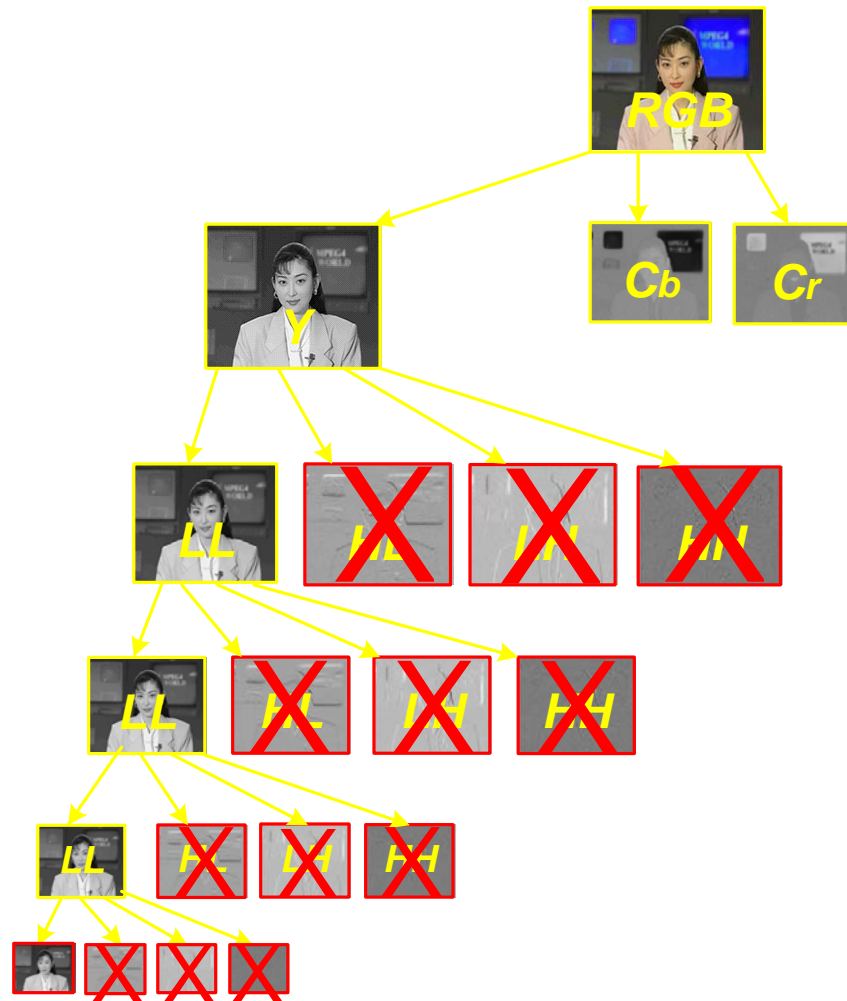
*mapping onto
physical network*



*Physical
Network*



Scaling with sub bands

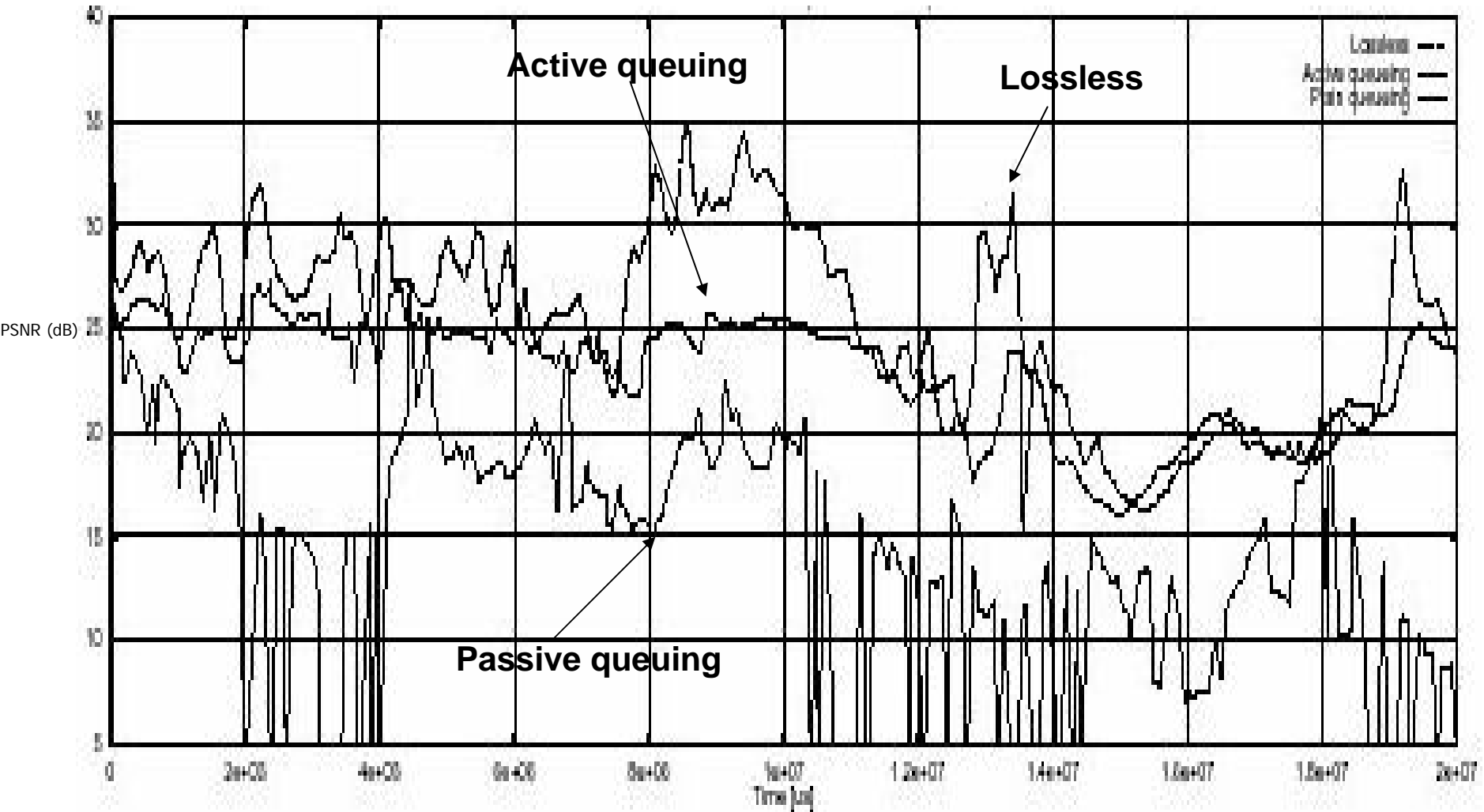


Decoded Image

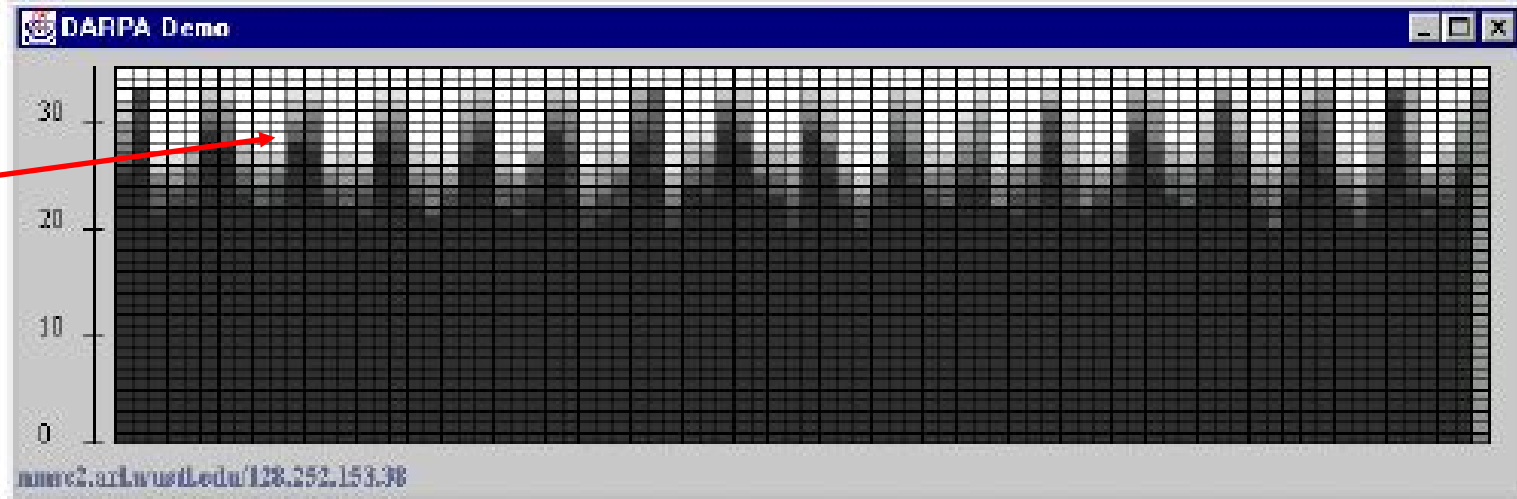
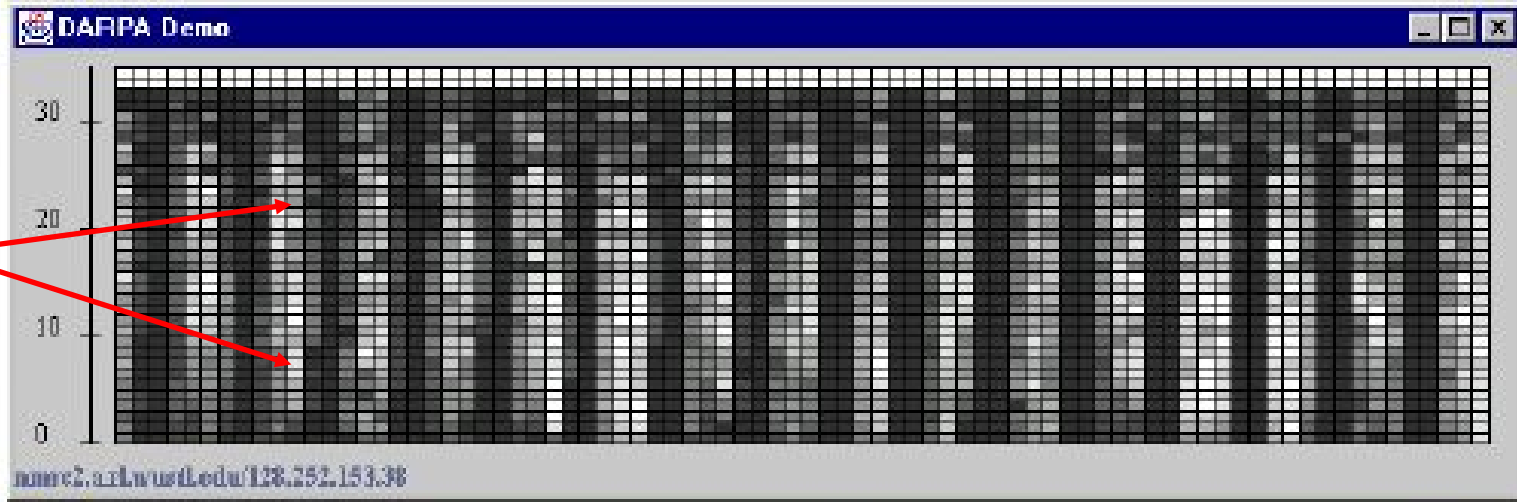
Congestion Control

- Each subband is sent in a separate packet
 - Header information indicates subband level
- When link becomes congested
 - Drop high-frequency packets
 - Keep low-frequency packets
- Decision is per-packet and needs local information
 - End-to-end approach is more difficult
- Simple scheme but highly effective

WaveVideo under Congestion



WaveVideo Visualization



Active Networks Summary

- Active Networks allow dynamic programmability
 - “Capsules” with Java bytecode
 - Programmable routers with predefined functions
- Lots of system issues need to be solved
 - Safe and secure execution
 - Resource sharing
 - Programming abstractions
 - Interoperability
- Good idea but too dynamic
 - Not every end-user (or application) can program the network
- Concepts that have come from AN research
 - Some more or less programmable functions on routers
 - Need for high-performance processing platforms: Network Processors

Next Class

- Introduction of Network Processors
 - Read chapters 11 & 12