Course Summary and Conclusions

ECE 697J

December 12th, 2002

Active Networks

- Processing inside the network
- Dynamic deployment of code
- Support for new services/applications
- Issues:
  - Functionality
  - Performance
  - Safety and security
  - Usefulness
  - Scalability
- Concepts of active networks are in use today

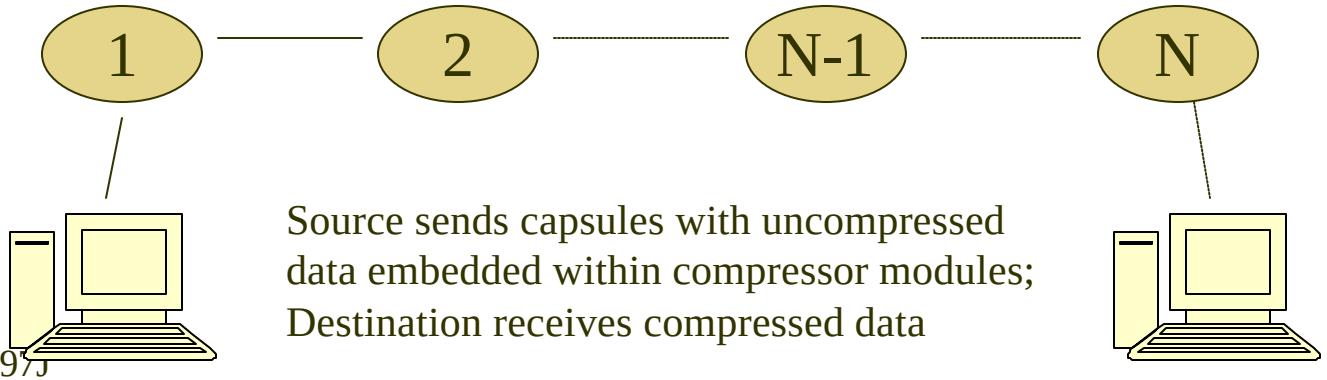
Network Processors

- Infrastructure for processing network traffic
- Very different from workstation processors
- Exploit parallelism in network workloads
- System-On-A-Chip:
  - Multiprocessor
  - On-chip memory
  - Coprocessors
  - I/O oriented
- Many different designs in market
- Still area of research

“Highlights”

A Conceived Modus Operandi

- Packets can be replaced with active Capsules
- Capsules have code embedded in them so that they are executed at each node they traverse
- These mini-programs incorporate within them the user data also, a la in PostScript code
- Each node may have predefined program methods that may be dynamically invoked by the capsules



Part 1: Smart Packets

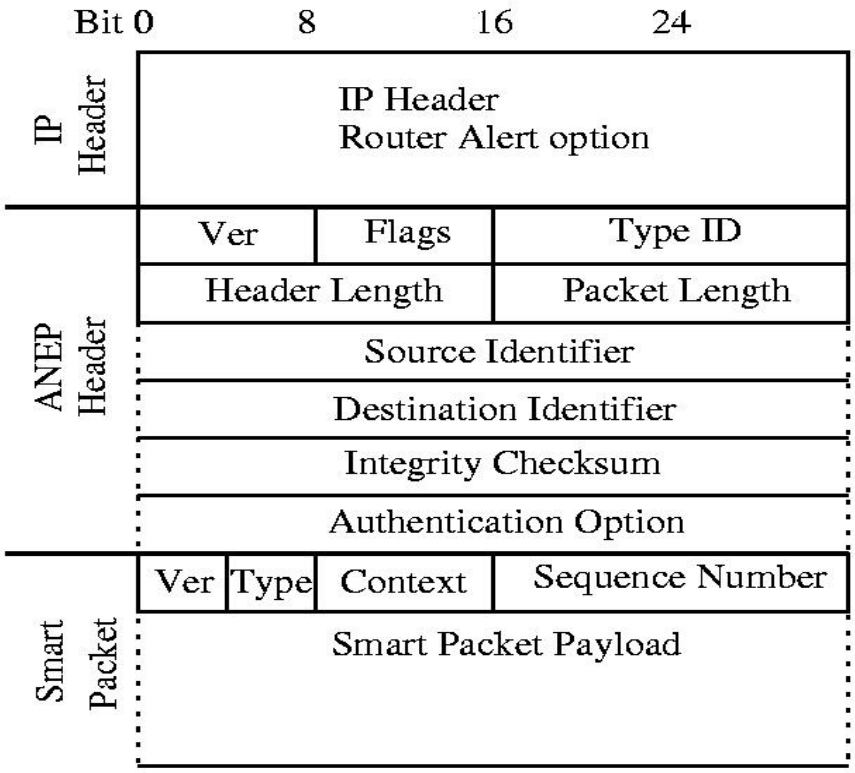
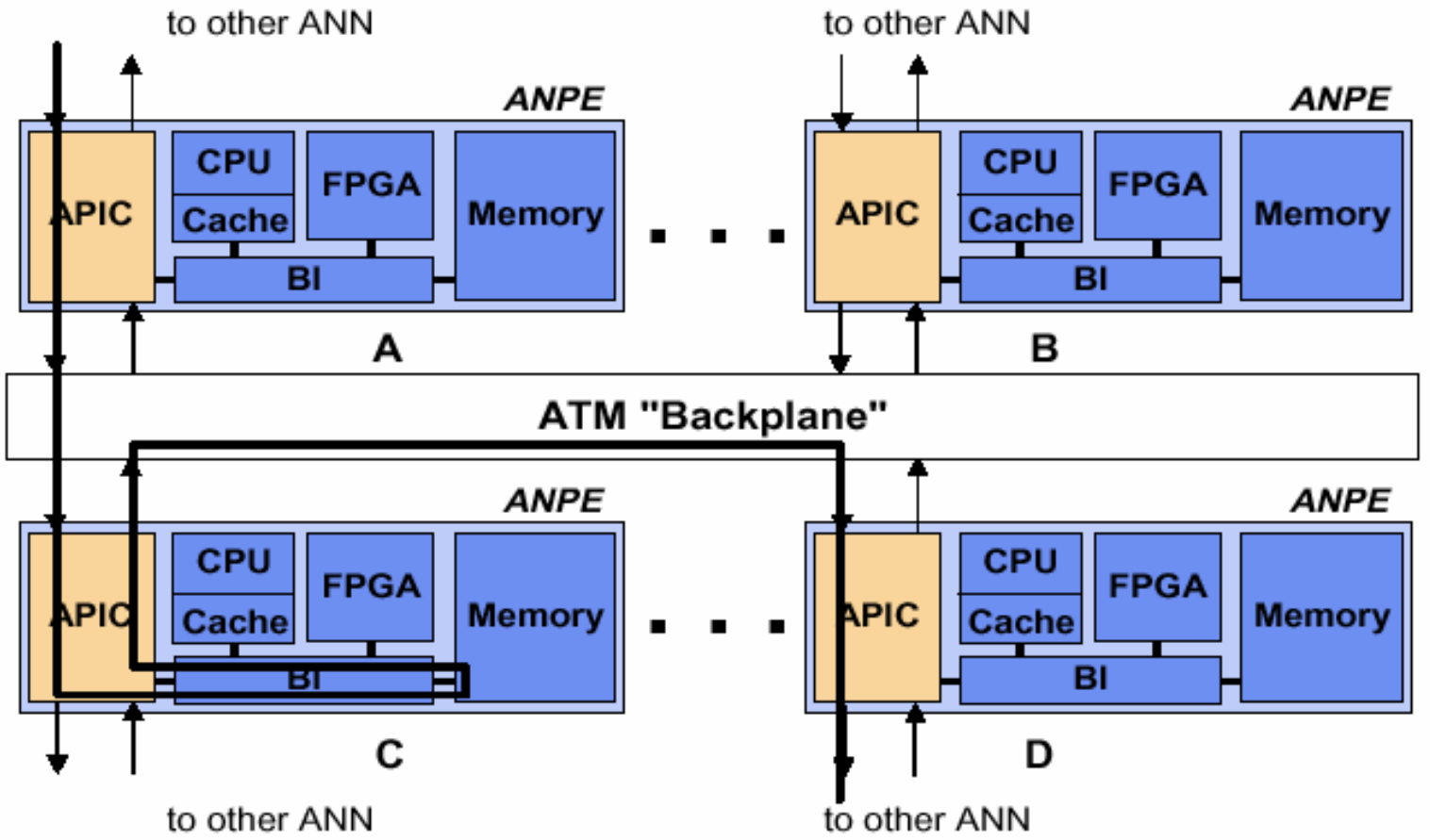


Fig. 2. A smart packet with IP and ANEP encapsulation

Hardware for ANN Overview



End-to-end recovery latency

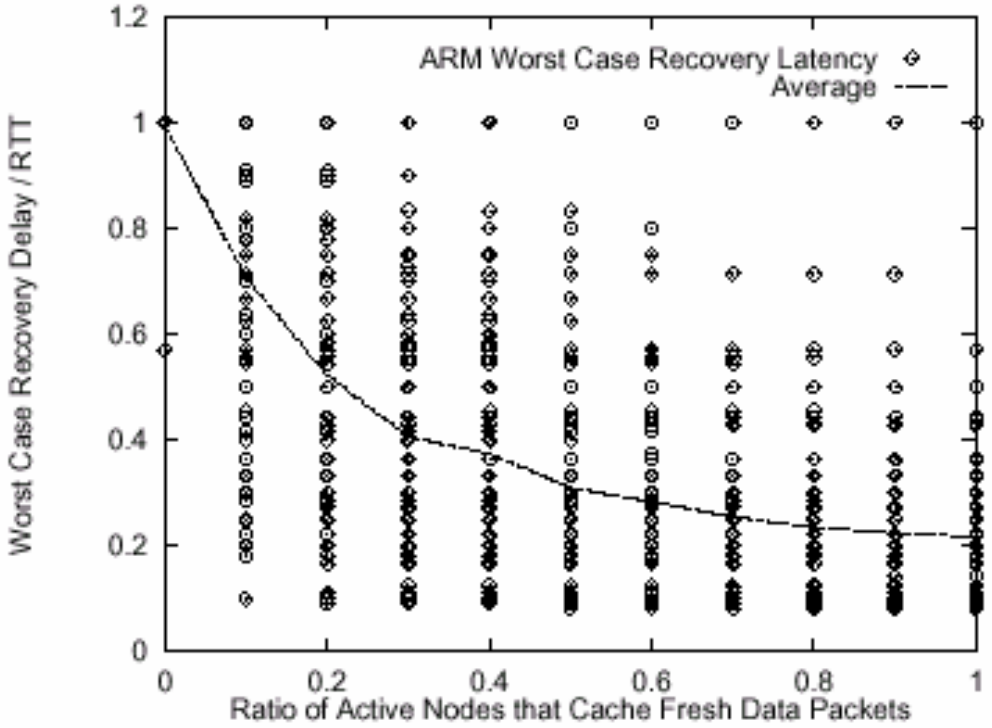
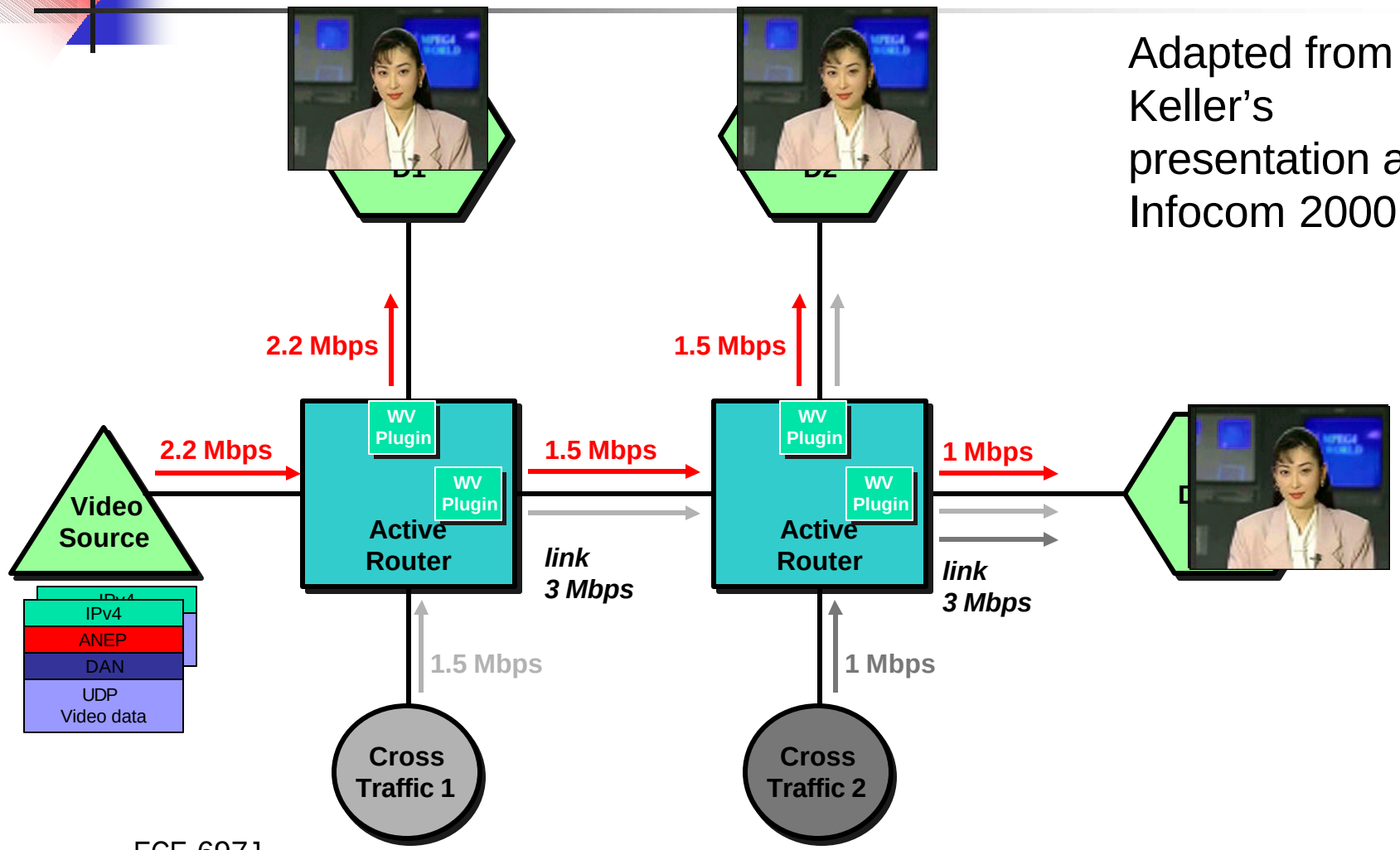


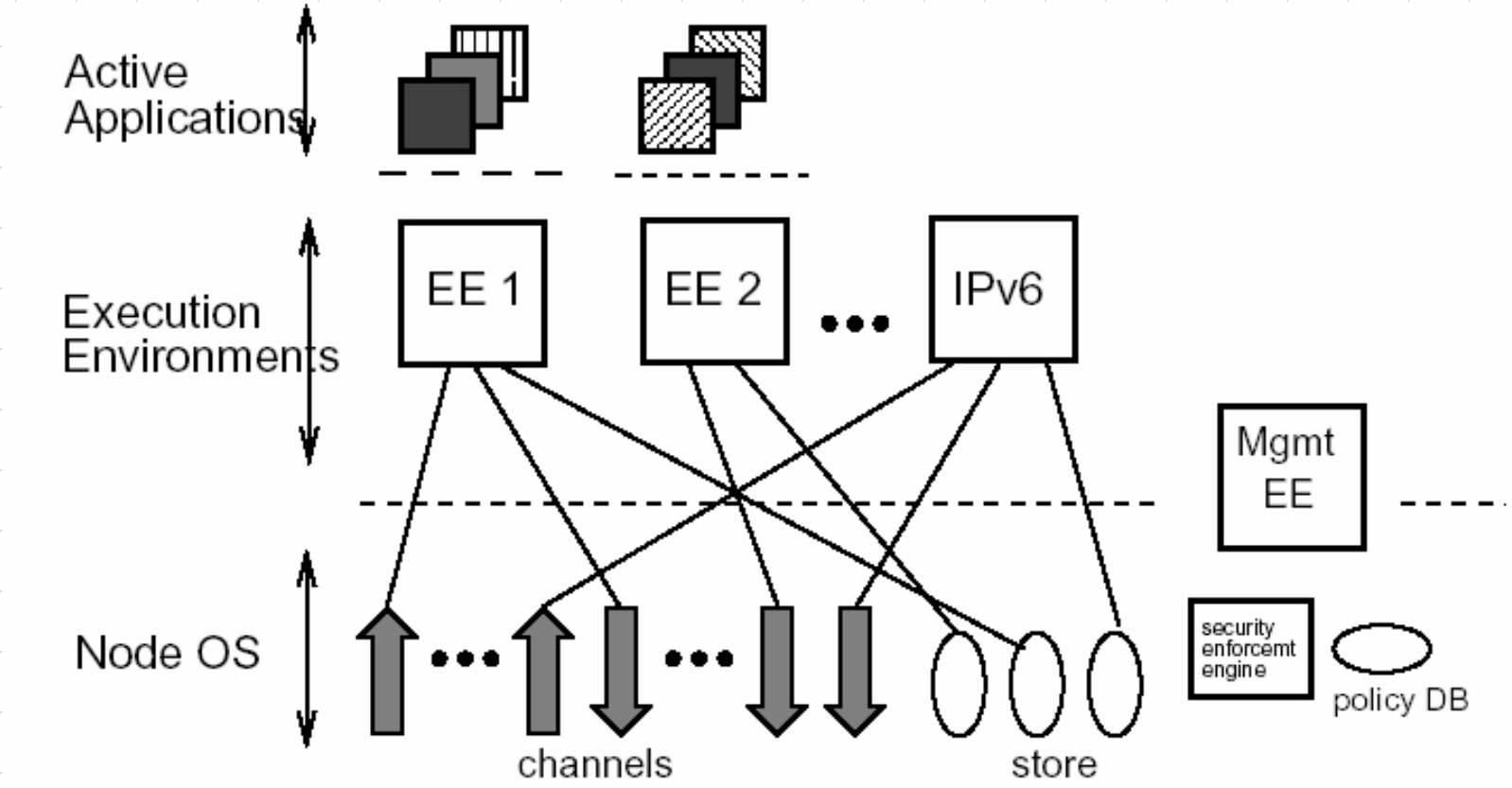
Fig. 2. ARM tradeoff between caching of fresh multicast data and latency (random loss, group size 100, 1000 nodes, degree 4). All non-leaf nodes in multicast tree are active; caching of repair packets is enabled at all nodes.

How it works



Adapted from Dr. Keller's presentation at Infocom 2000

Architecture Components



Resource Bound

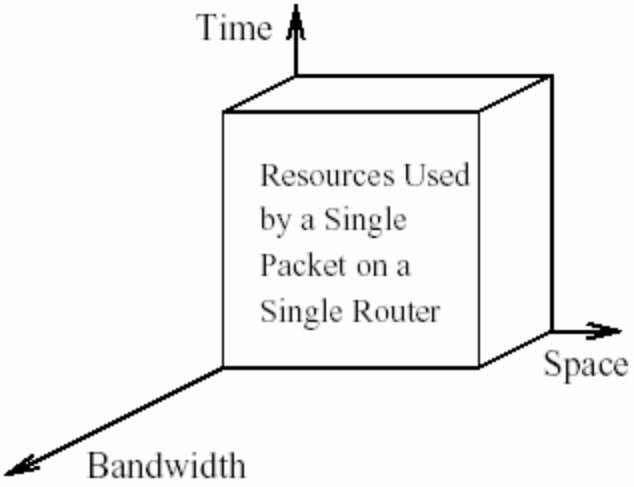
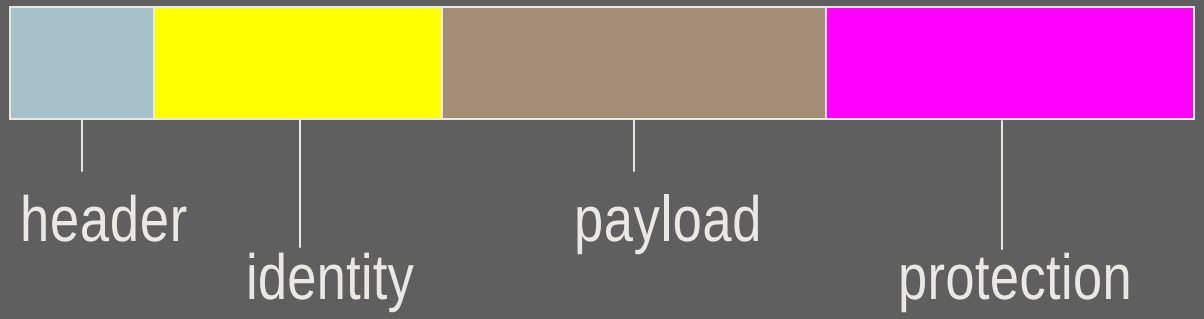


Figure 5: Resource Cube

Authentication Issues

General Crypto Protected Packet



SANTS Protected Packet

Darwin Node Software Architecture

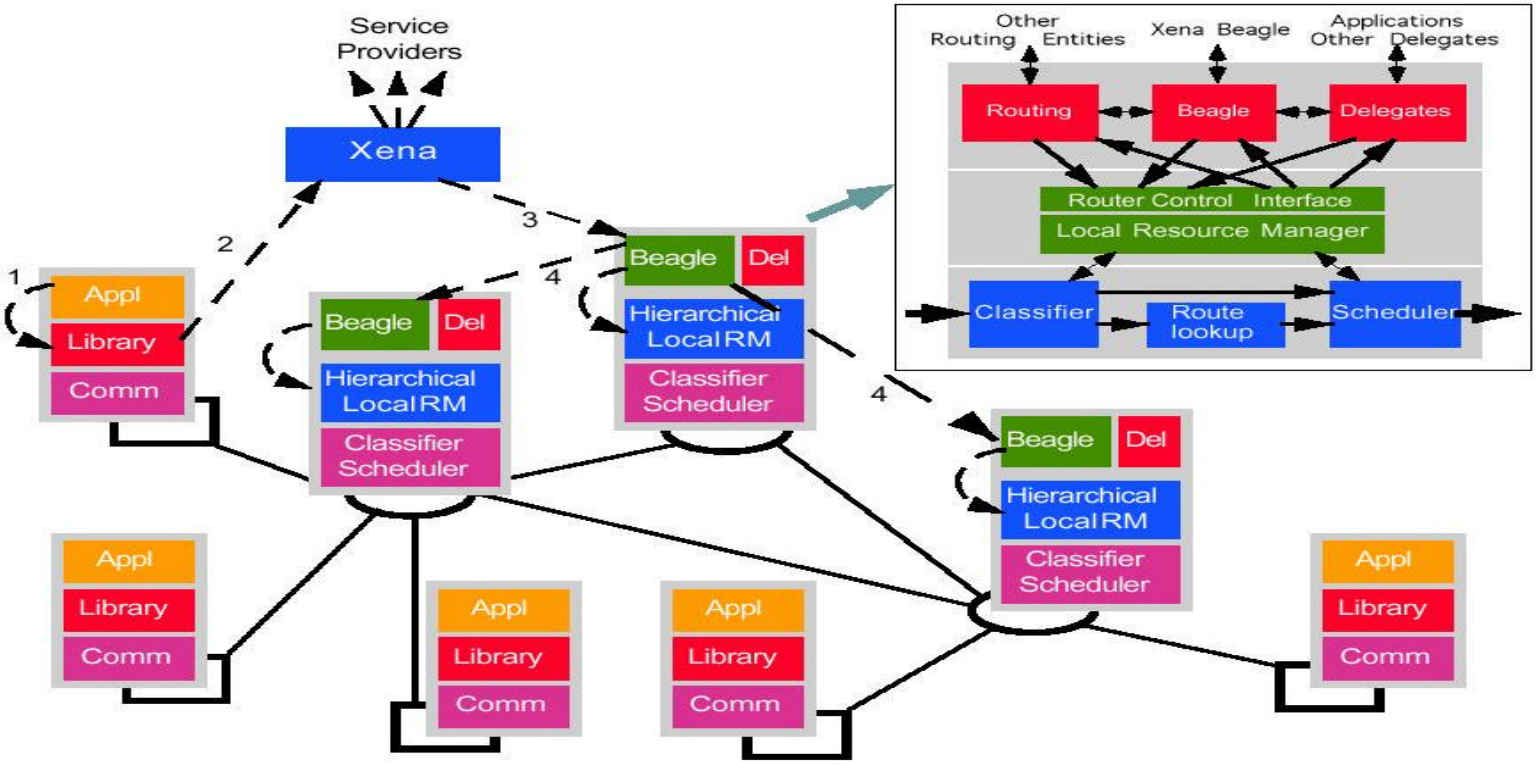
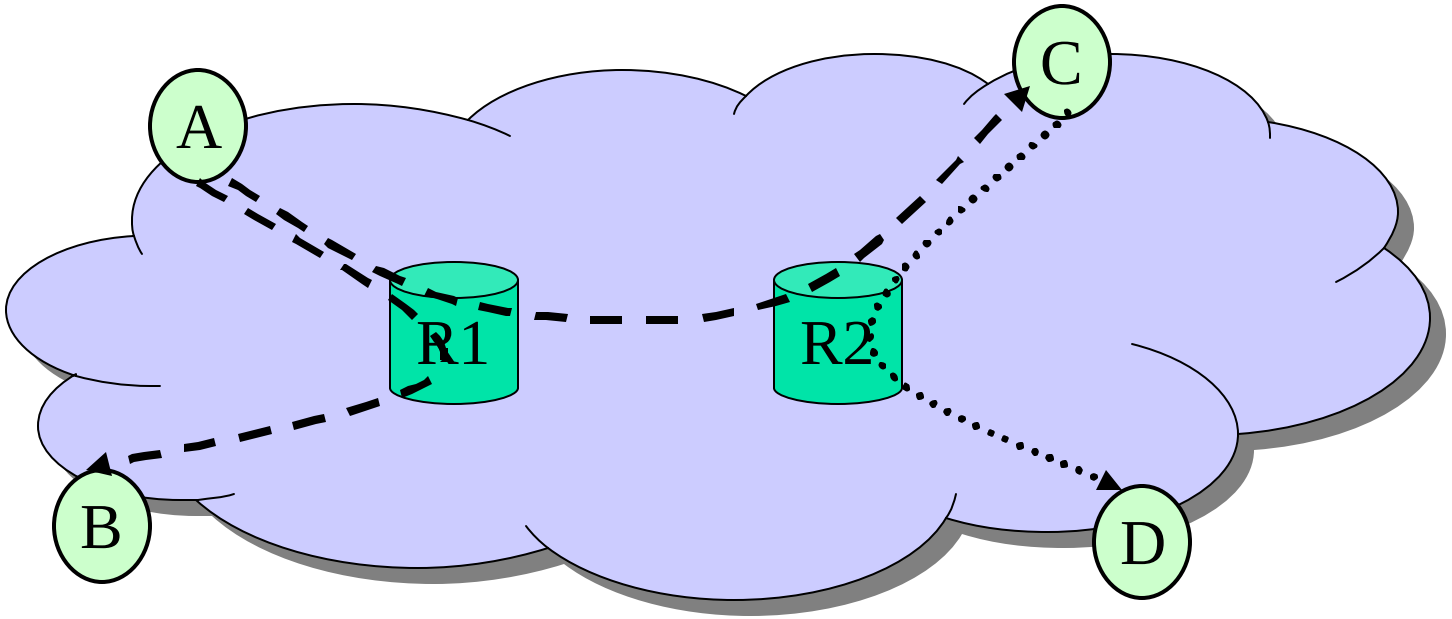


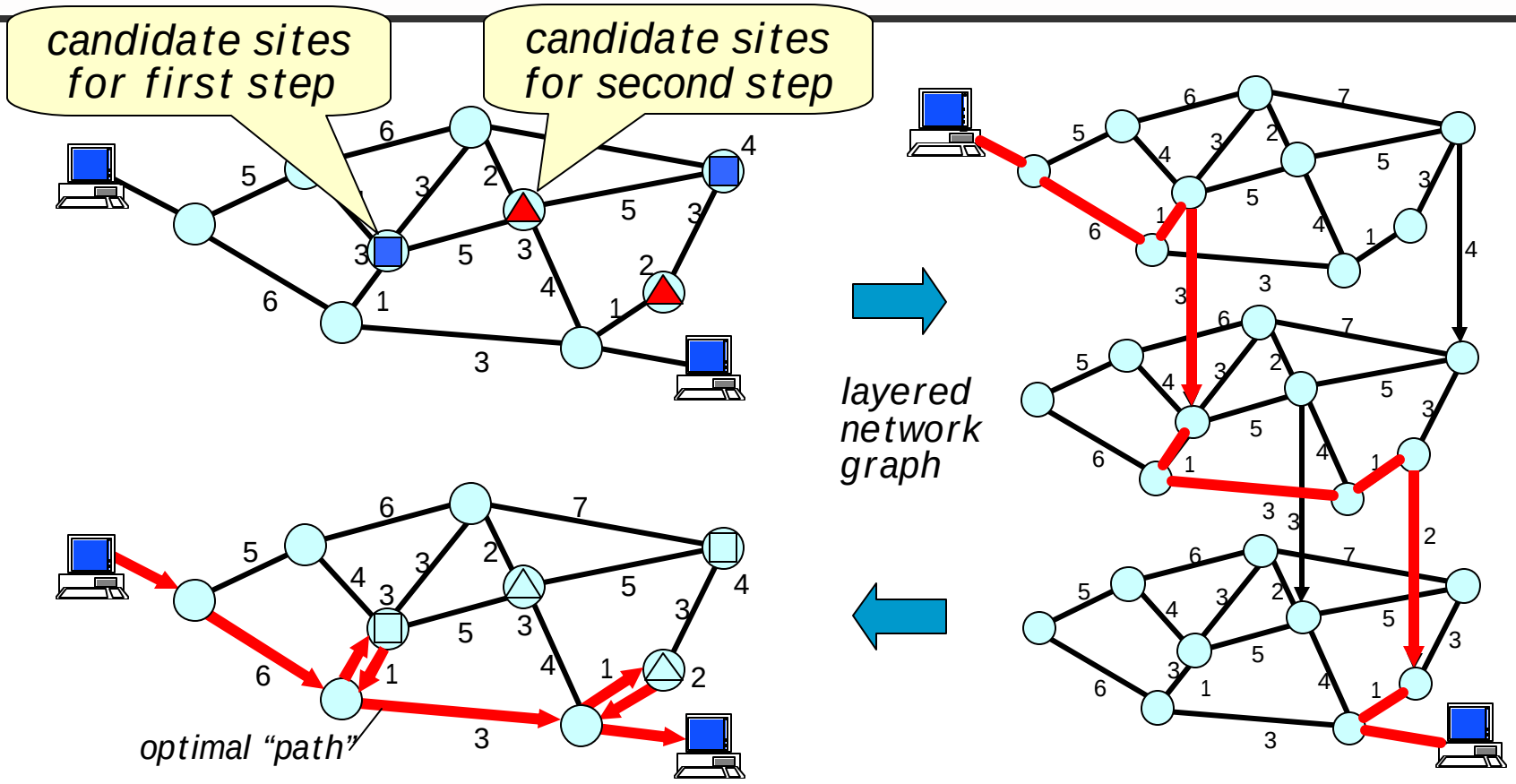
Figure 3: Darwin node software architecture

End System Multicast

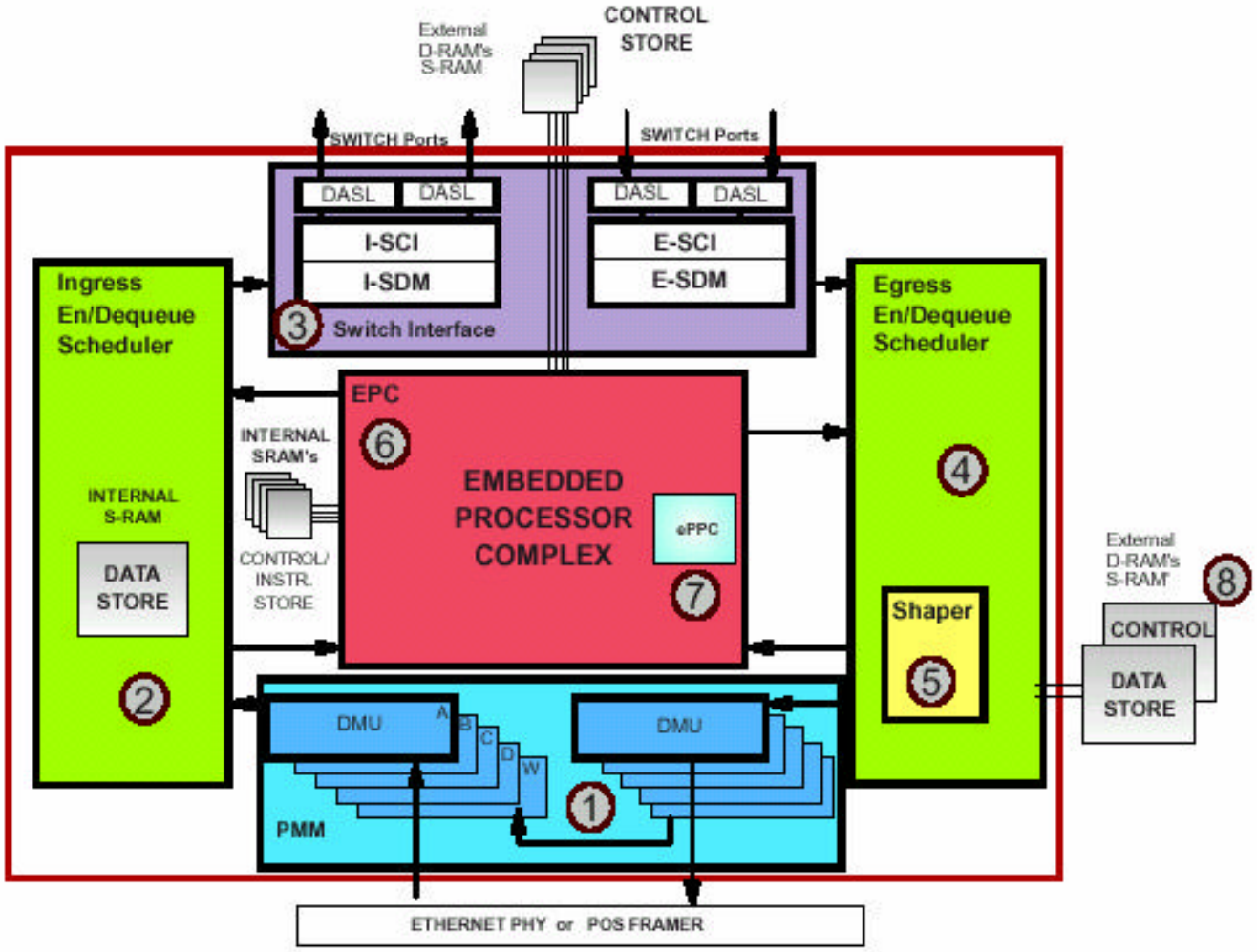


The dumb network
Smart end points

Layering Model for Two Processing Sites



Architectural view



Characteristics --- Computational Complexity

- Computational Complexity
  - Respect to the number and size of processed packets
  - Based on the # of instructions
- Definition of $N_{a,l}$
  - # of instructions per byte for application a on a packet of length l

HPA a	$N_{a,64}$	$N_{a,576}$	$N_{a,1536}$
TCP	10.3	1.2	0.4
FRAG	7.7	0.9	0.3
DRR	4.1	0.5	0.2
RTR	2.1	0.2	0.1

PPA a	$N_{a,\forall}$ (enc)	$N_{a,\forall}$ (dec)
REED	603	1052
ZIP	226	35
CAST	104	104
JPEG	81	60

Scheduler II

- Separate traffic classes
  - Multiple queues
- Process queues individually
- Schedule among queues for output port
- Process assignment:
  - I: READ + CLASSIFY + ENQUEUE
  - O: SELECT + DEQUEUE + WRITE
  - F: FORWARDING

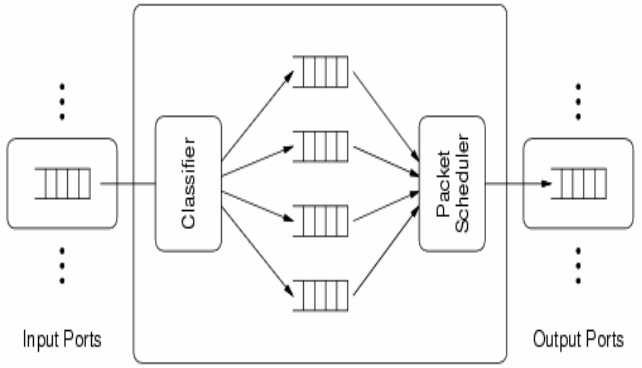


Figure 1: Supporting Differentiated Service

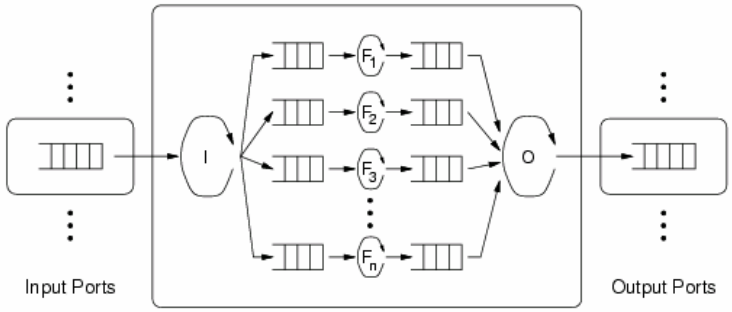
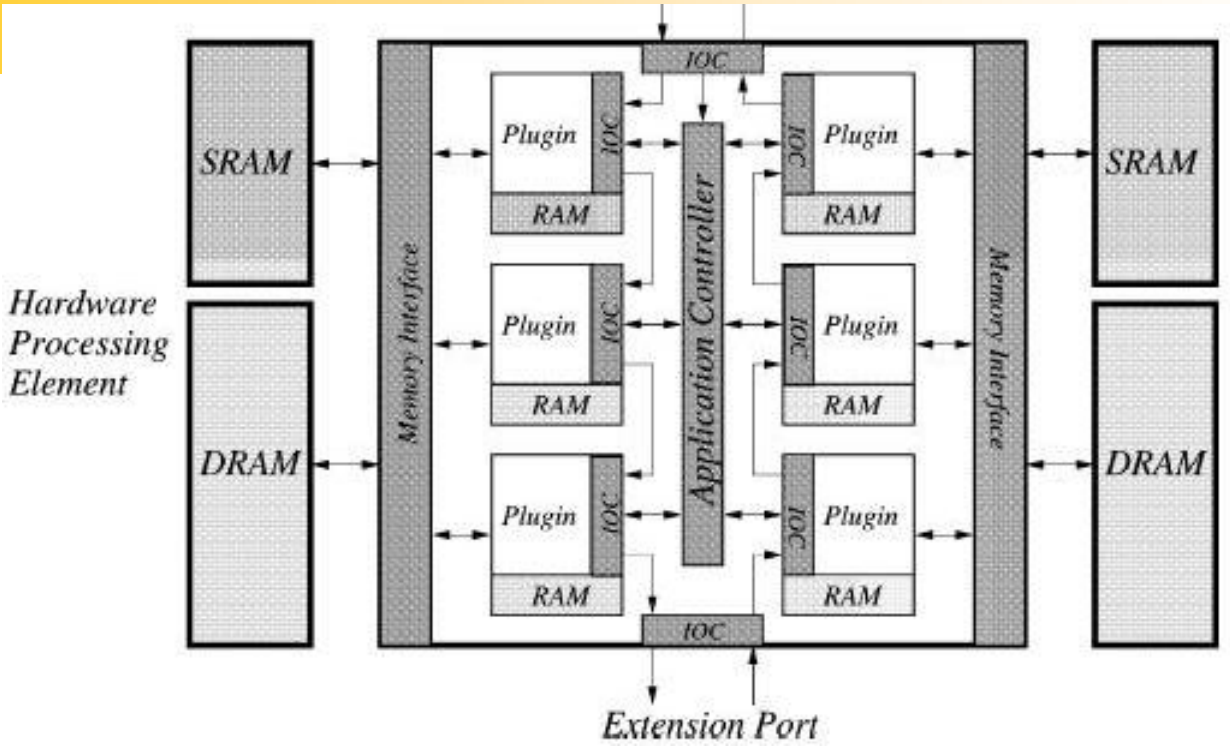


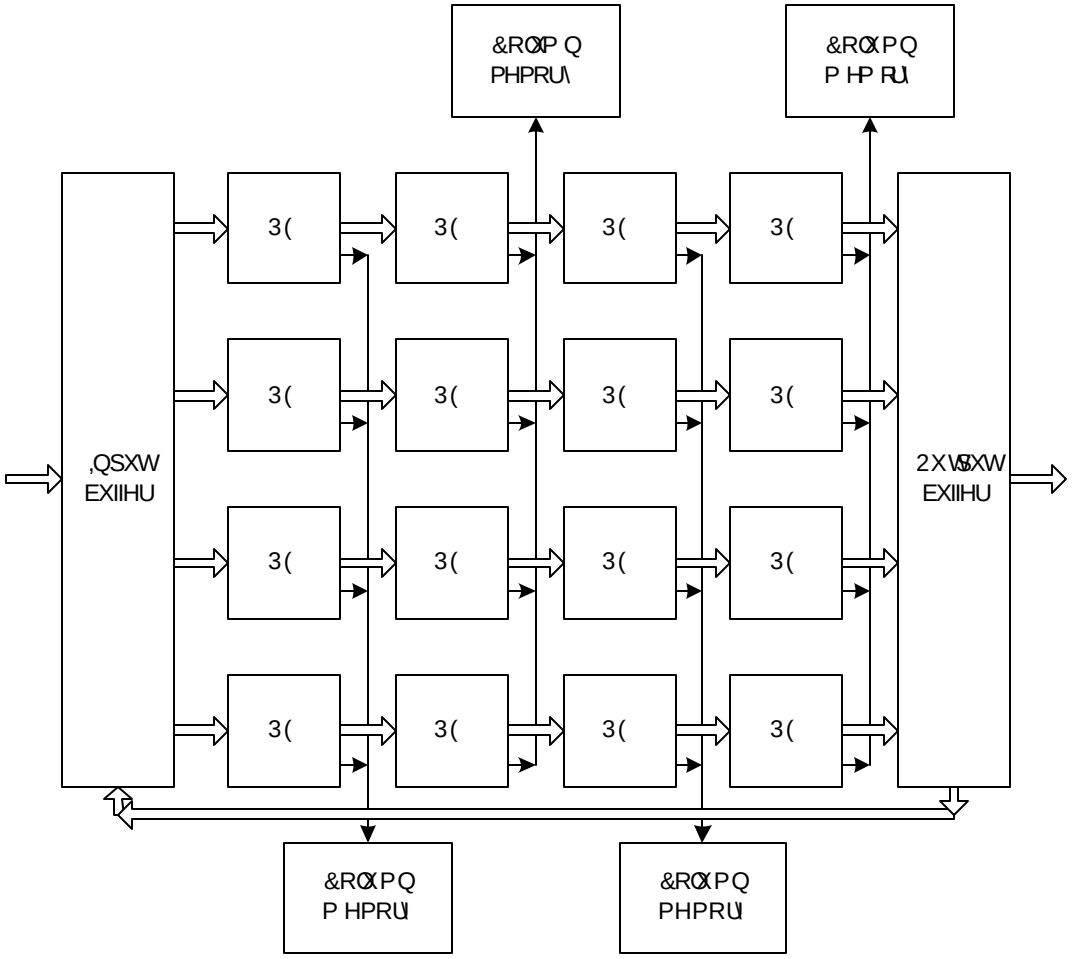
Figure 2: Supporting Differentiated Service and Variable Processing

DHP Architecture

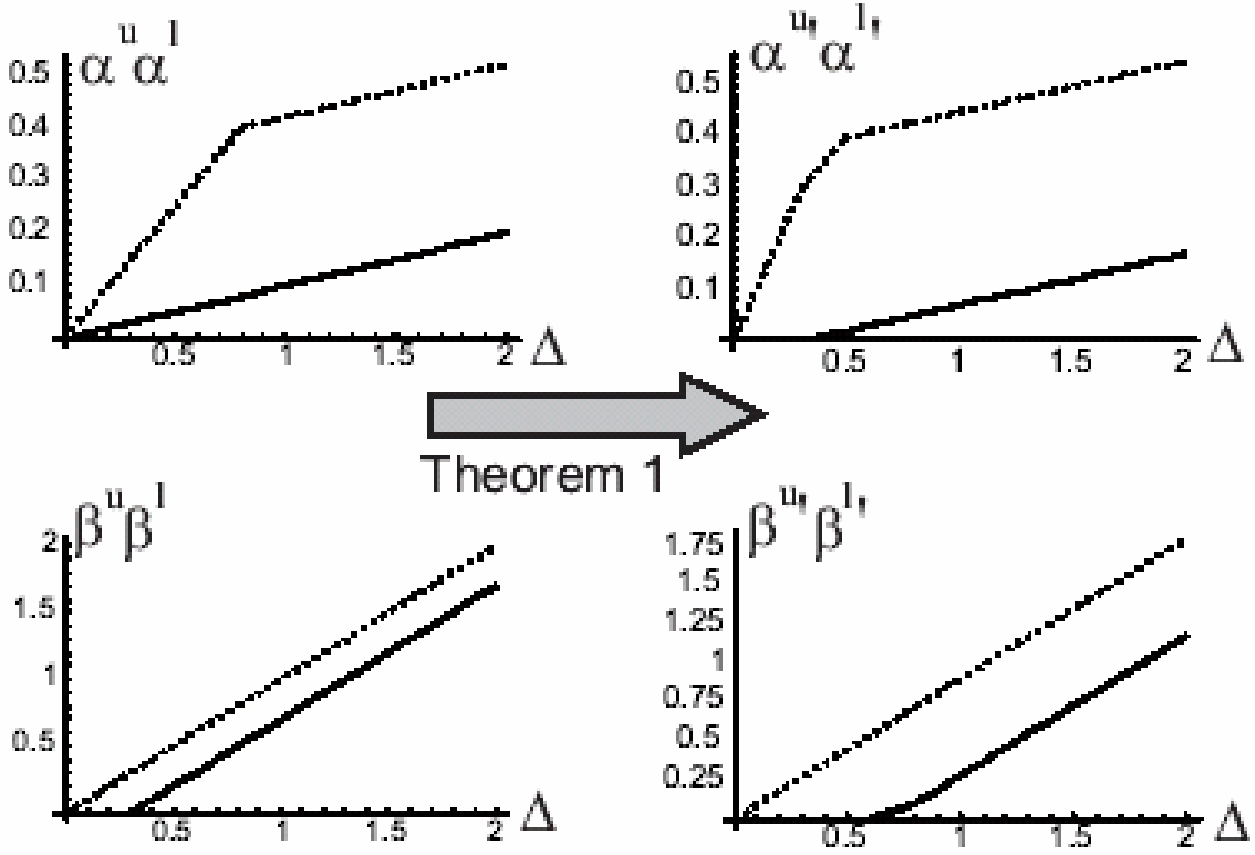


- The hardware processing element of PP is implemented in DHP.
  - Hardware Plugins – Dynamically Reconfigurable Components
  - Infrastructure – Static Control and Datapath components

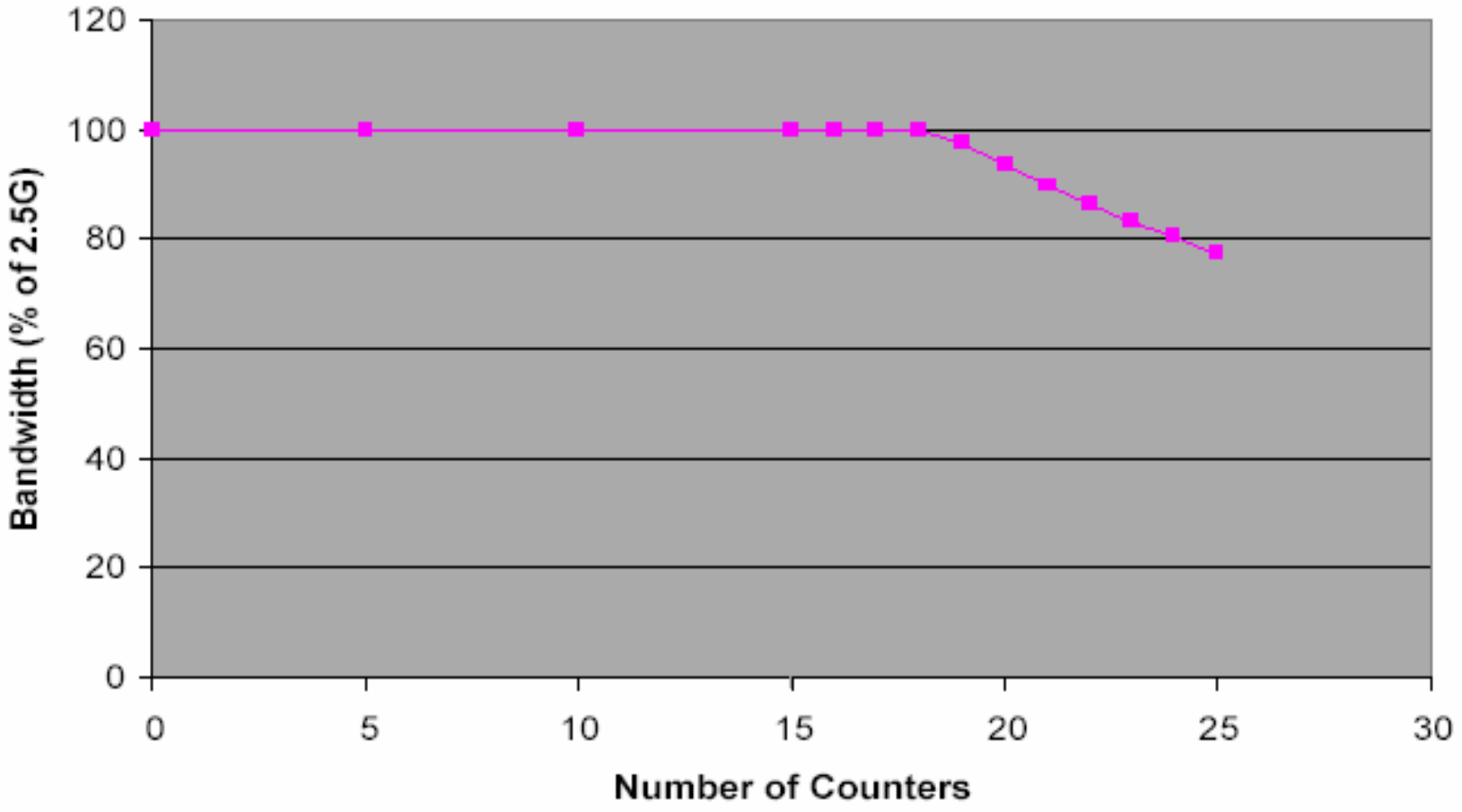
Cisco Toaster



Arrival/Service Curve Transformation



IPv6 Forwarding (ATM)



Thank You!

- Thanks for taking this course.
- Thanks for presenting papers.
- Thanks for developing projects.
- Thanks for participating in class discussions.

I hope you found this course interesting and you learned about the concepts and systems in this exciting area of networking research.