Challenge Problems

"Novel Protocols and Network Configurations" Team
November 19th, 1998

Tom Anderson, University of Washington

Bill Marcus, Bellcore

Jonathan Smith, U. Penn

Yechiam Yemini, Columbia University

Team Approach

- Pick apps that benefit the Internet
  - people care about the problem
  - *require* programmability *in network*
  - infect Internet with active net virus… :-)
  - work through issues end-to-end
- Example I: Active Routing (ARC, Detour)
- Example II: Active Service Attack Prevention (ASAP)

Challenge: Interoperability

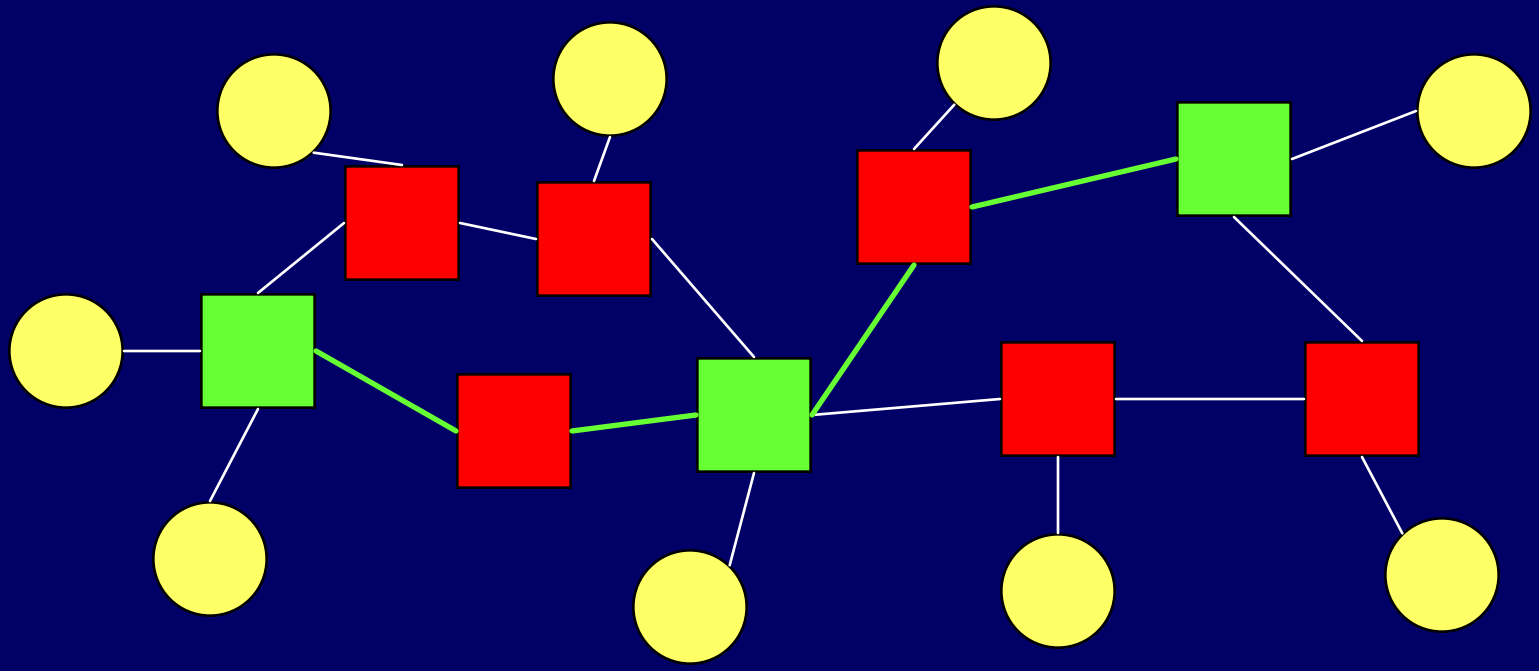
- Towards PLANTScript
  - Internet -- hook networks together
  - Interactive network -- hook active networks together
- Federated administrative domains
  - No single node OS, API, prog lang Required if system is to *scale*
  - Security, perf. isolation, local decision making, upgrade path, ease of devel.

Outline

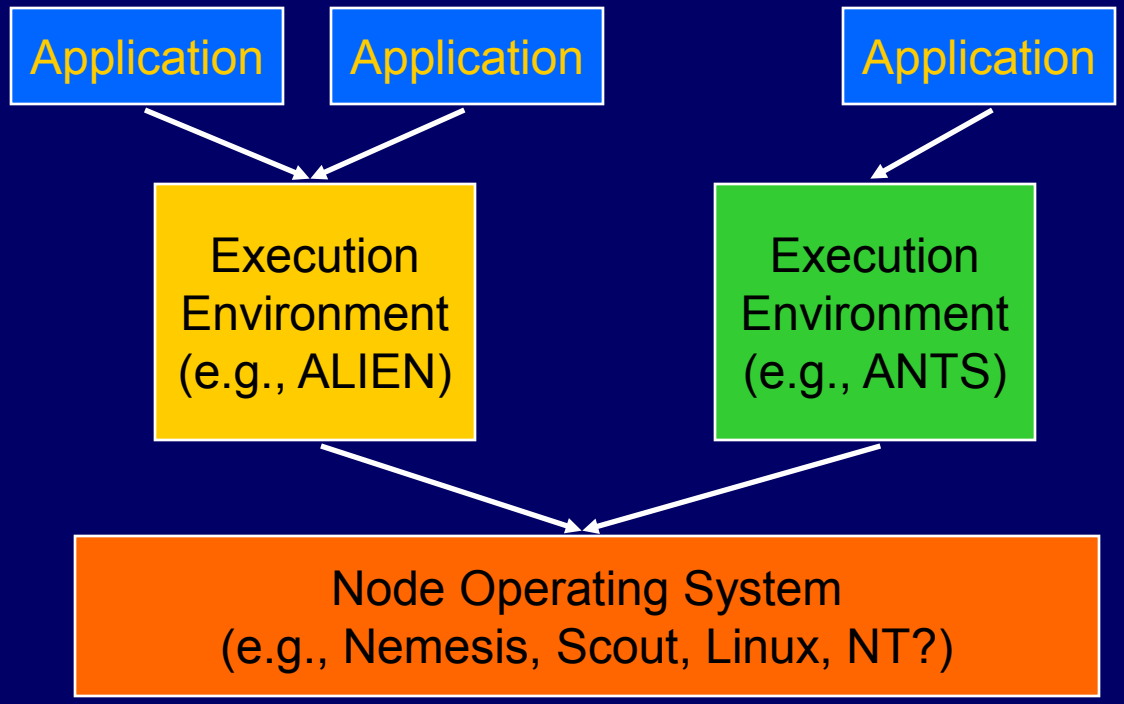
- Background
- Interoperability Issues
- Example Apps: ARC/Detour and ASAP
- Deployment Challenges

ABONE tunnels over Internet

- Hosts
- IP Routers
- Active Network Elements

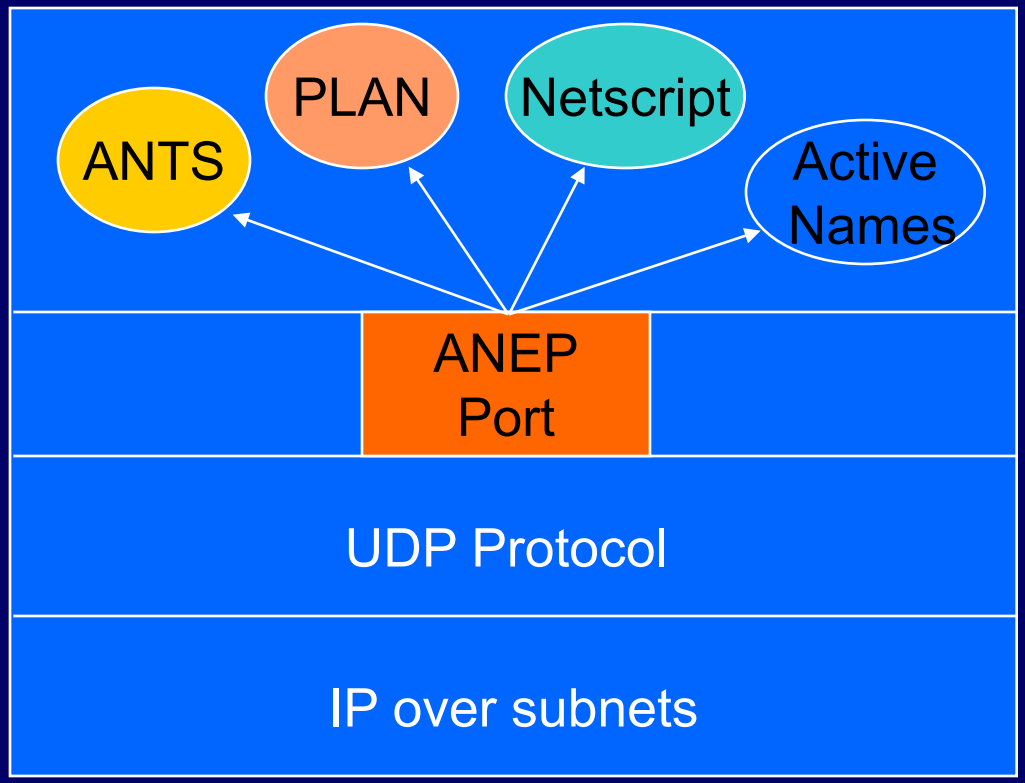


"Active Network Architecture"



ANEP demultiplexes to EEs

- Well-known UDP/IP Port for ANEP



Challenge: Scale to 1K Nodes

- Assume a single execution environment standard?
  - no single solution best for all apps
- Assume a single node OS standard?
  - inflexible, hard to upgrade
- Assume backward compatibility with node OS API?
  - still need trust boundaries

Interoperability

- Heterogeneous clouds of homogeneity
  - part PLAN, part ANTS, part inactive
  - part Scout, part Nemesis, part SecureXOK
- End to end solution requires:
  - Active border gateways for translation, security domains
  - Communication and resource allocation between execution environments

Example #1: Active Routing

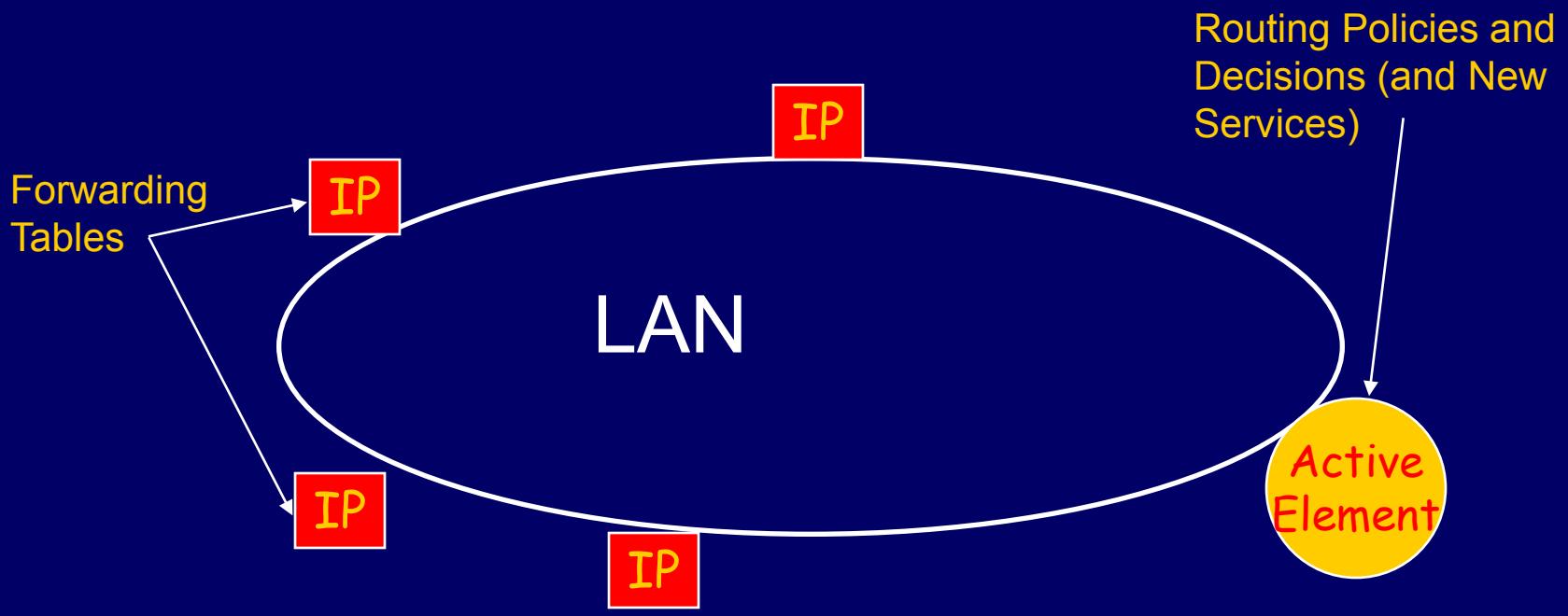
- Internet routing is performance *in*sensitive
  - AS path length, early exit, private peering
  - at best, hand tuned policy
- Even so: Internet is black box
  - hard to know where the problems are
  - no multipathing/load balancing
  - poor congestion control for short flows

Opportunities for Active Nets

- At single router
  - program control over policy decisions
  - measurement based
- Within admin domain
  - cooperating routers
- Across domains
  - active BGP?

Active Router Control

- IP Router/Forwarders co-located with Active Elements:



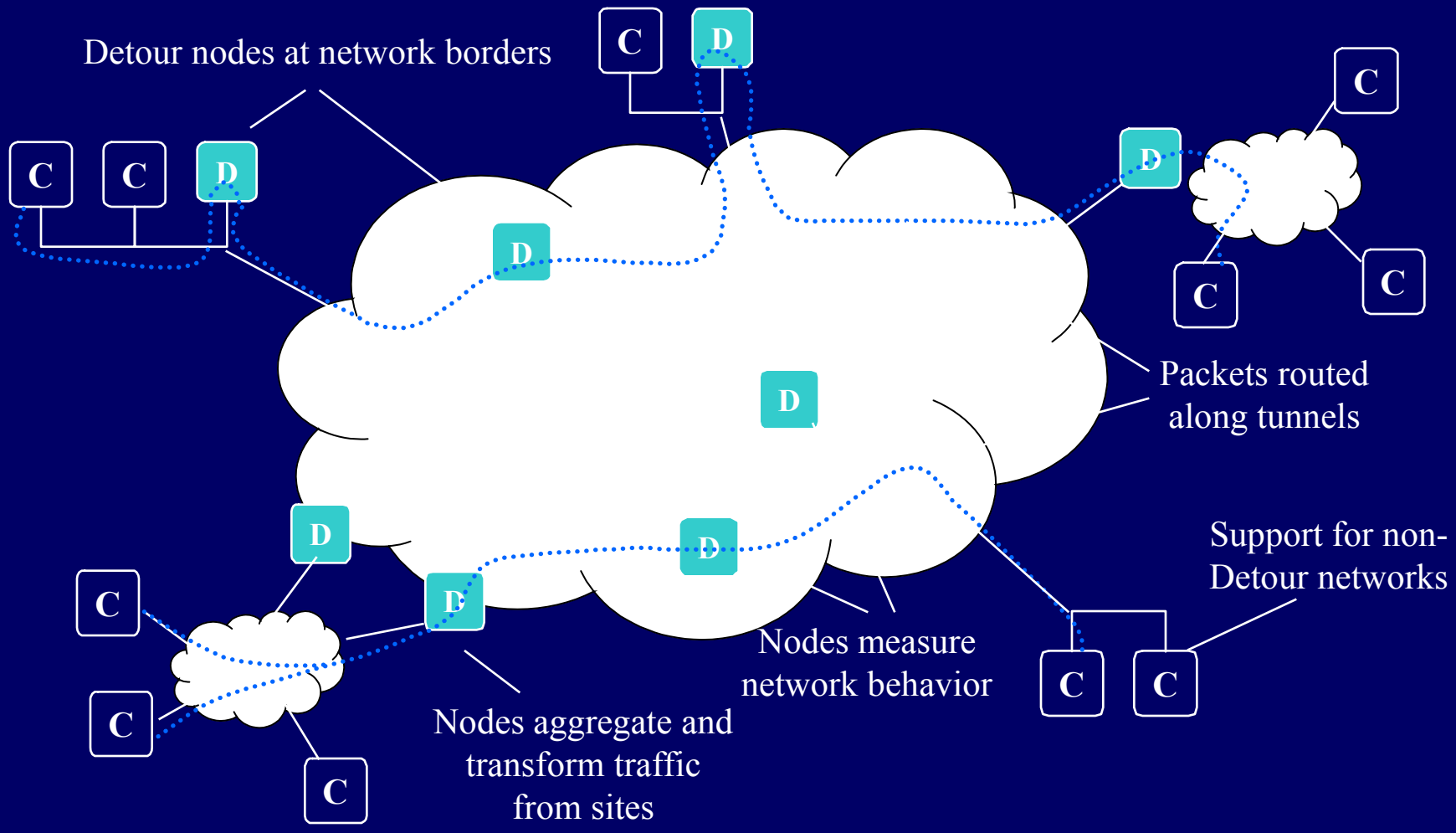
Implementation Status I

- Early experiment by Bill Marcus
  - Bellcore protocol booster kernel on P.C.
  - Control Cisco 7000 through policy based routing (PBR) interface
- Current work by Osman Ertugay at Penn
  - Java program controlling Cisco 3600 through PBR, running on P.C.
  - Working with 3Com on CB 3500 platform

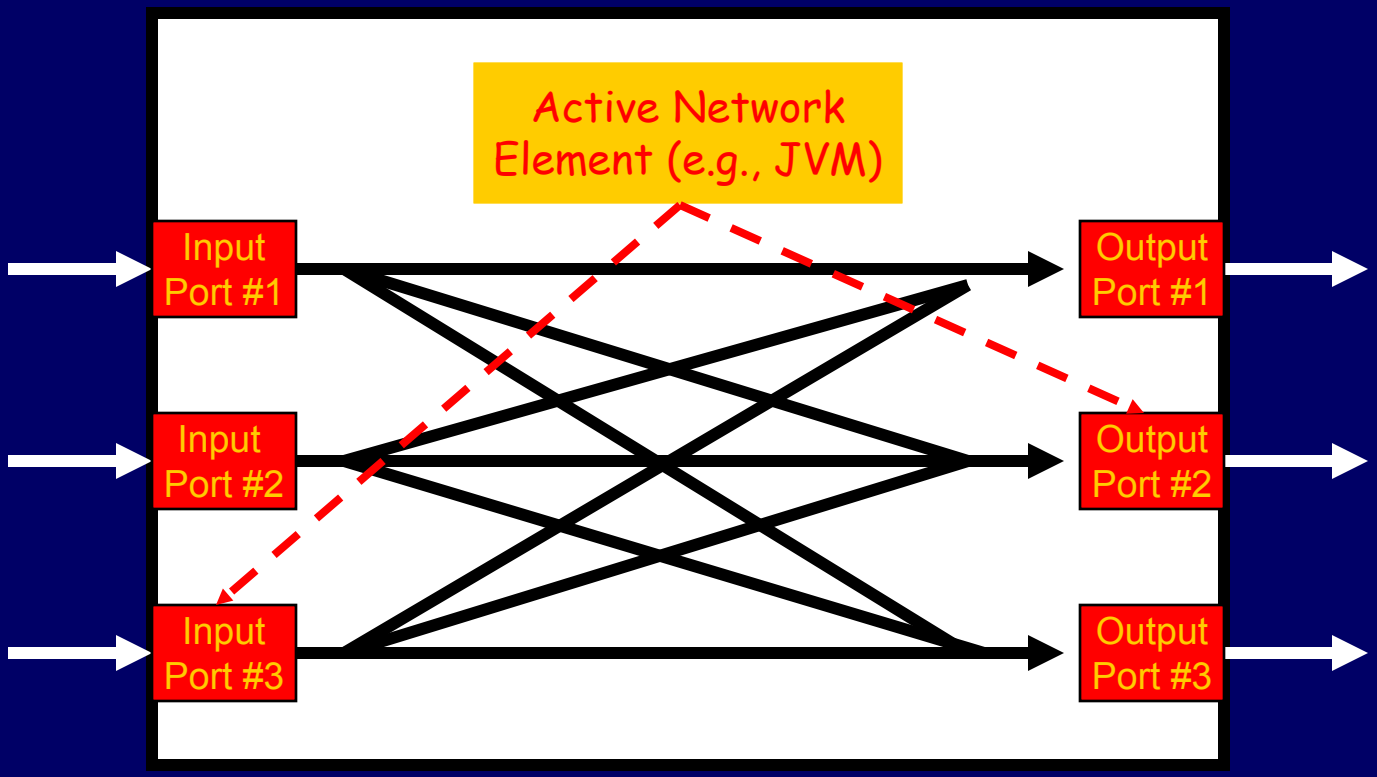
Implementation Status II

- Project by Columbia & Bay/Nortel
  - Netscript on Accelar
- Programmable gateway:
  - Router, firewall, analyzer/shaper, caching server… (boundary smarts!)
  - Investigate SW architecture and HW support

Detour Architecture: Cooperating Active Routers



ARC becoming possible in COTS



Research/Engineering Issues

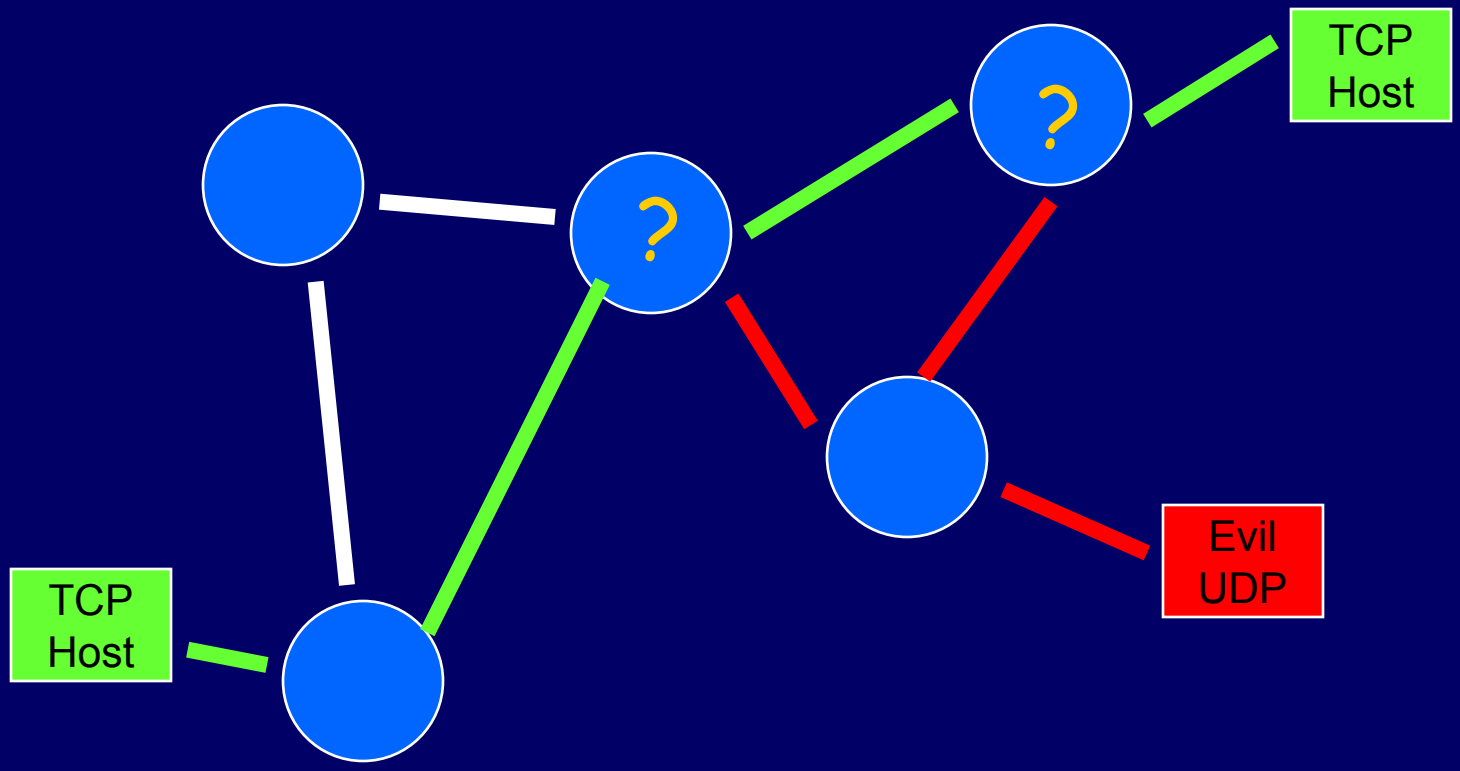
- Hierarchy necessary to scale
- Extend with ARC<->ARC protocol
  - ARCs will be organized in Admin. Domains
  - Arbitrary ARCs cannot control routers
  - ARCs resemble active firewalls
- At border gateway, need translation/communication between EE's

Example #2: Denial of Service

- Easy to protect server hosts
  - Resource domains, interrupt masking, firewall shielding on host *itself*
- But service is unprotected between client and server site
- This problem *must* be solved with network-embedded functionality

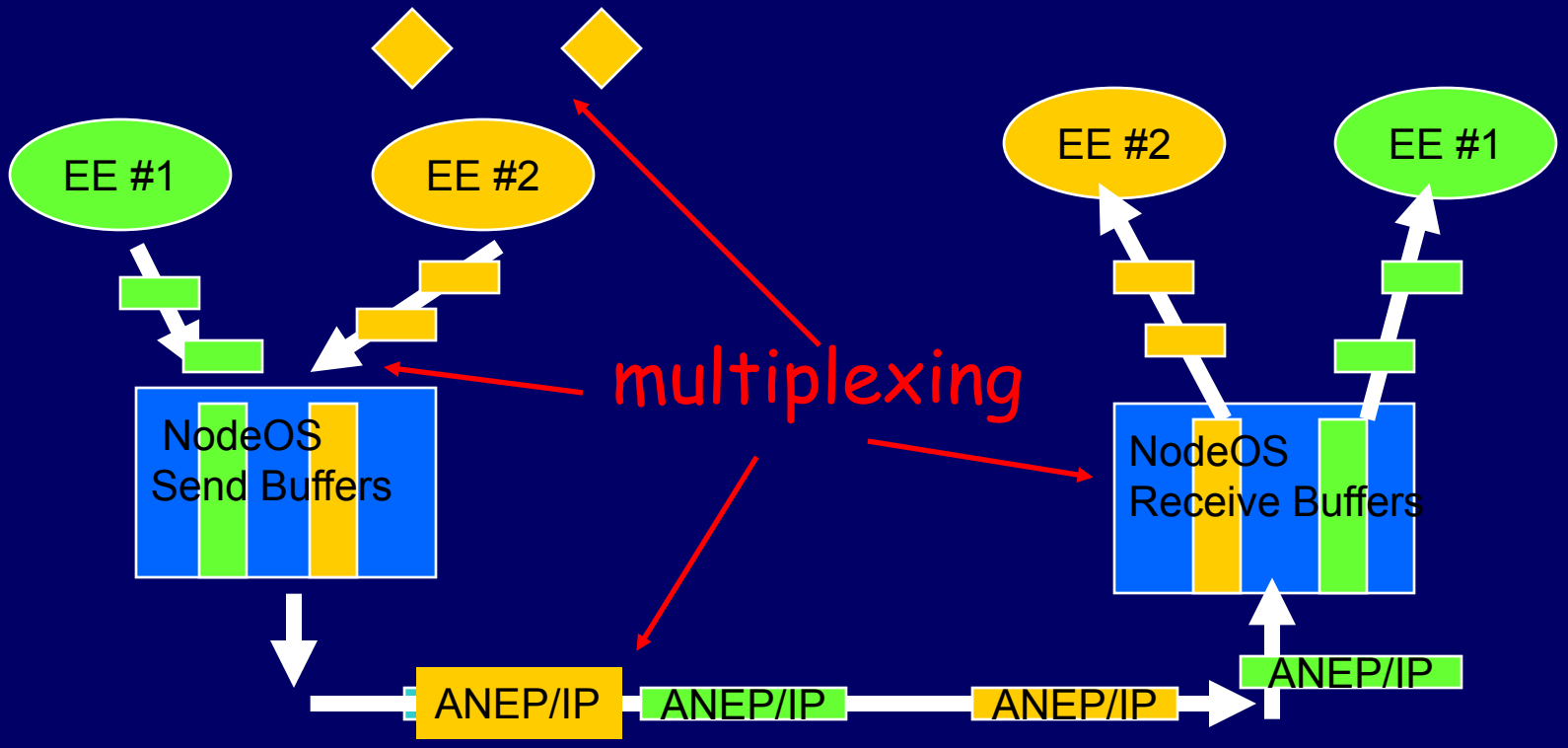
Denial of Service attack

- Cross traffic in an Internet



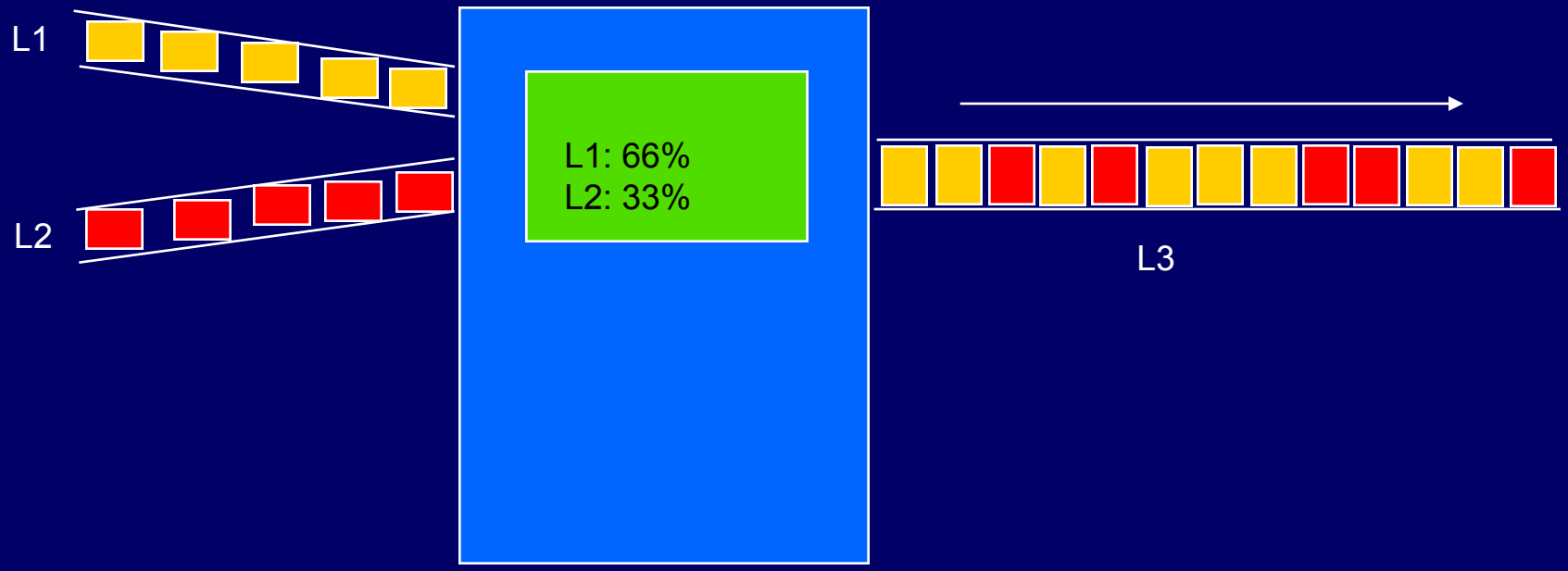
End-to-End Activations

- Resource Management Challenges



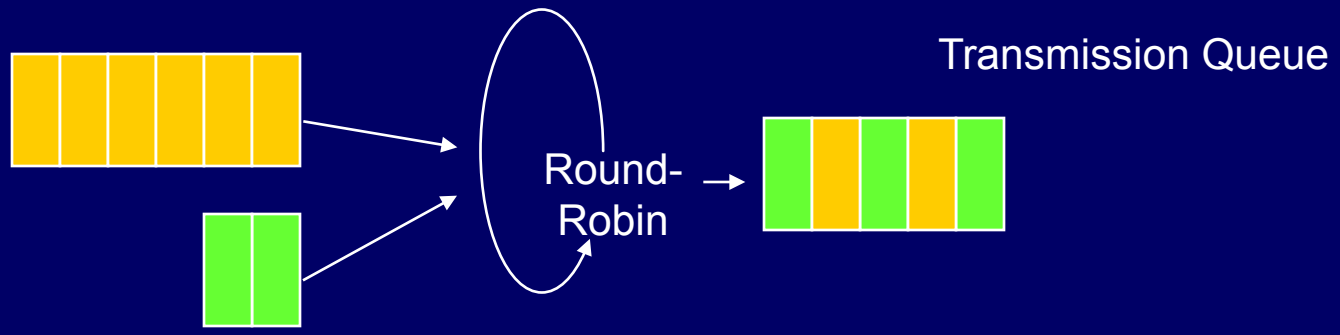
Need to control multiplexing

- E.g., assign L3 bandwidth 66%/33%



Fair Queuing Code for an A.N.E.

- Discriminates between "flows"
- Separate queue for each current flow
- Queues are serviced "round-robin"



Research/Engineering Issues

- What is the relationship between the EE and the NodeOS?
  - What can A.N. applications request?
  - How does NodeOS mux EEs?
- What is the language used for loading disciplines?
  - Per-EE (PLAN code generates Netscript?)
  - RSVP interpreted by A.N.E.?

Deployment Challenges

- EE interoperability
  - Will we need an EE-interoperability EE?
  - Or will we be limited to a subset of nodes?
  - Difficulties with P.L.-based security
- Local Autonomy vs. Global behavior
- Varying capabilities of NodeOS?
- Challenges use ANEP, ABONE, EEs

Results, if it works:

- Every commercial service will need it
- Provides big incentive to *Internet services* to extend ABONE *for us*
- But, of course, it *is* programmable…

(Obligatory) Whingeing Slide

- Interoperability necessary and fun, *but*
  - not in workplans for many projects
  - takes *lots* of time and coordination
  - requires more staffing and $$
- Cautionary: *temporary* infrastructure often outlives its inventors…