SwitchWare:
Accelerating Network Evolution

University of Pennsylvania and Bellcore
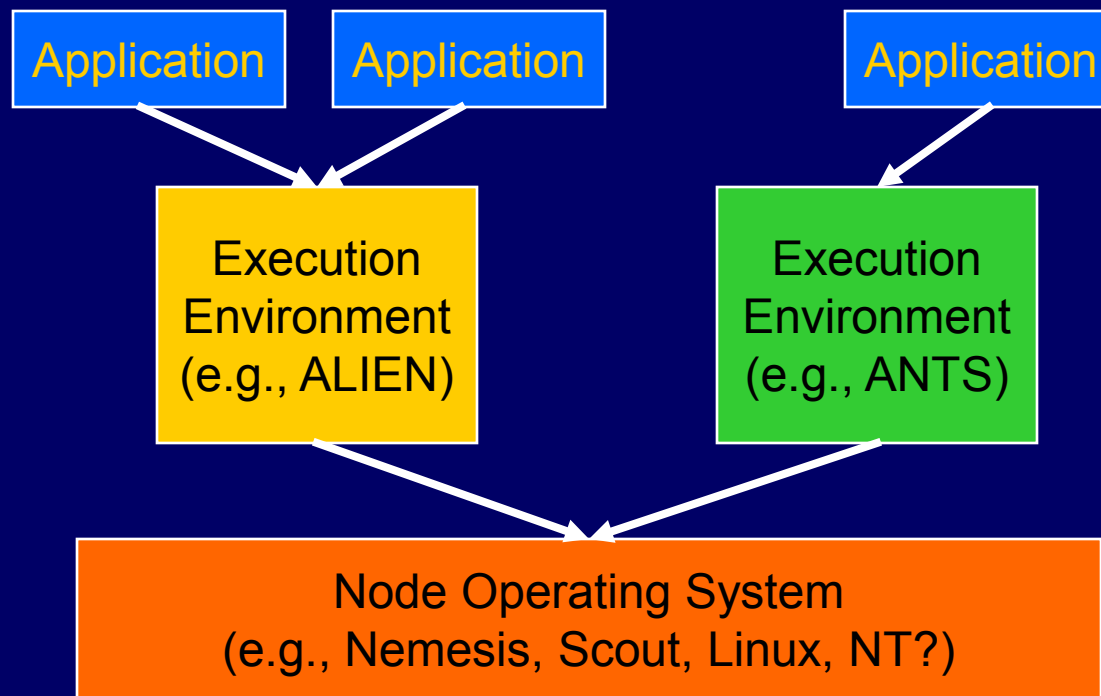
http://www.cis.upenn.edu/~switchware

Goals of the SwitchWare project

☐ Investigate architectures and programming paradigms for A.N.

☐ Use modern programming languages

☐ Find "sweet spots" in tradeoffs among *flexibility, usability, performance* and *security.*

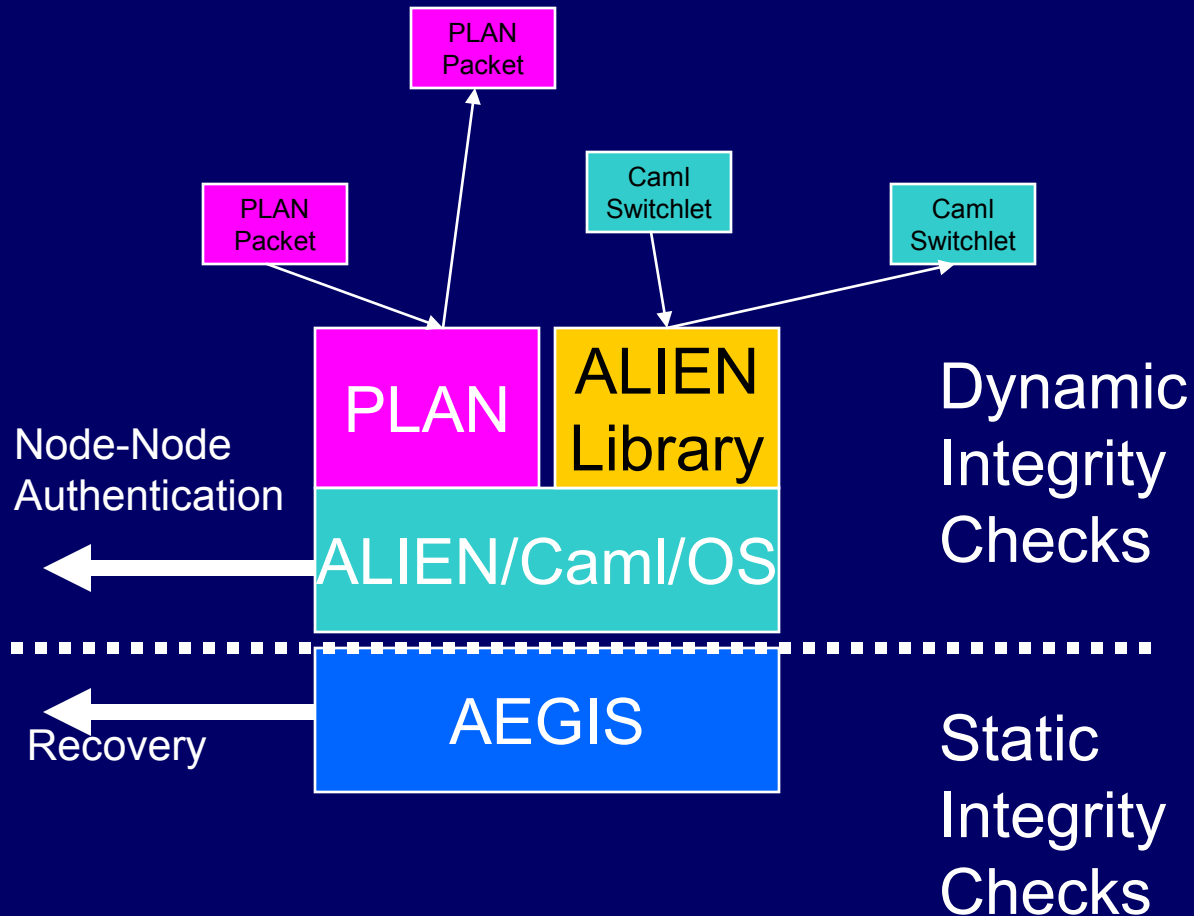☐ Overall: *understand design space!!!*

"News Item"

☐ **Characterized A.N. models by performance with security:** The per-packet costs of cryptography are large enough to favor active extensions over active packets (capsules) in higher bandwidth applications needing authentication (NB: caching makes packets into extensions!)

"Active Network Architecture"

Application	Application		Application

Execution Environment (e.g., ALIEN)

Execution Environment (e.g., ANTS)

Node Operating System
(e.g., Nemesis, Scout, Linux, NT?)
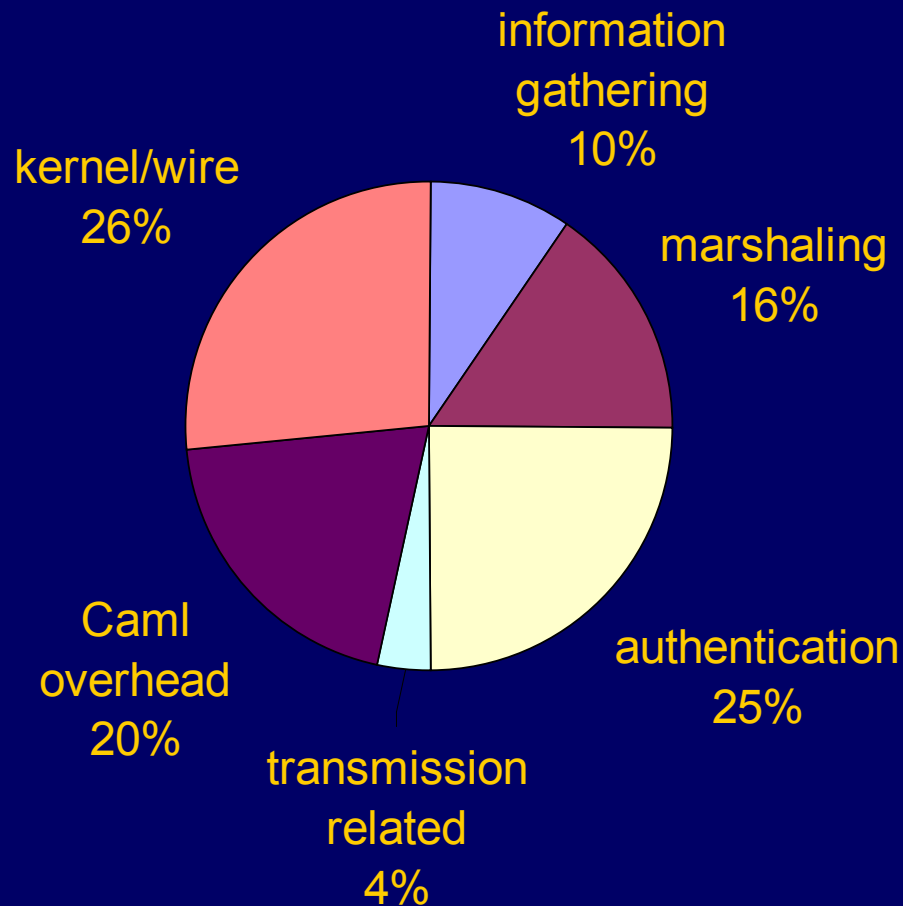
E.g., the SwitchWare A.N. Architecture

Packet Language for Active Networks (PLAN):

- PLAN internetwork demonstrated
    - to be reported in INFOCOM '99
- Formal semantics underway
    - Penn/SRI collaboration
    - will influence future PLAN implementations
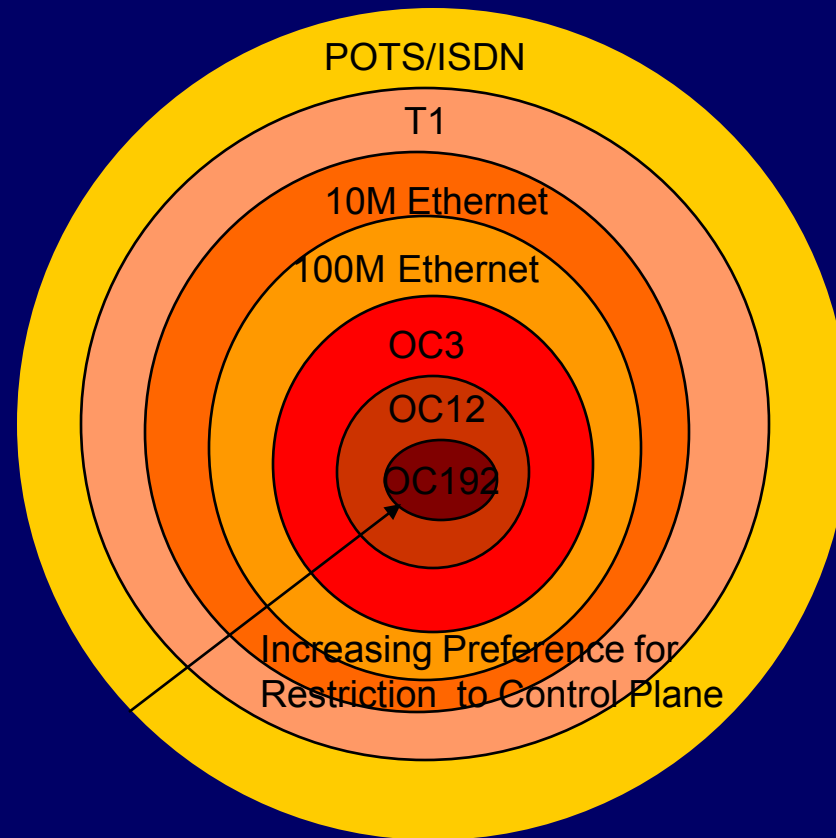- New version available soon (ca. 1 week)
- PLAN on ABONE

The ALIEN Active Loader

- Focus on generality and security
  - module thinning for locally enforced "views"
  - crypto. Credentials extend to remote case
  - *active packets* and *active extensions*
  - all written in Caml with restricted runtime
- Applications to LAN bridging, secure active ping, IP forwarding
- Performance in Alexander Ph.D. (1998)
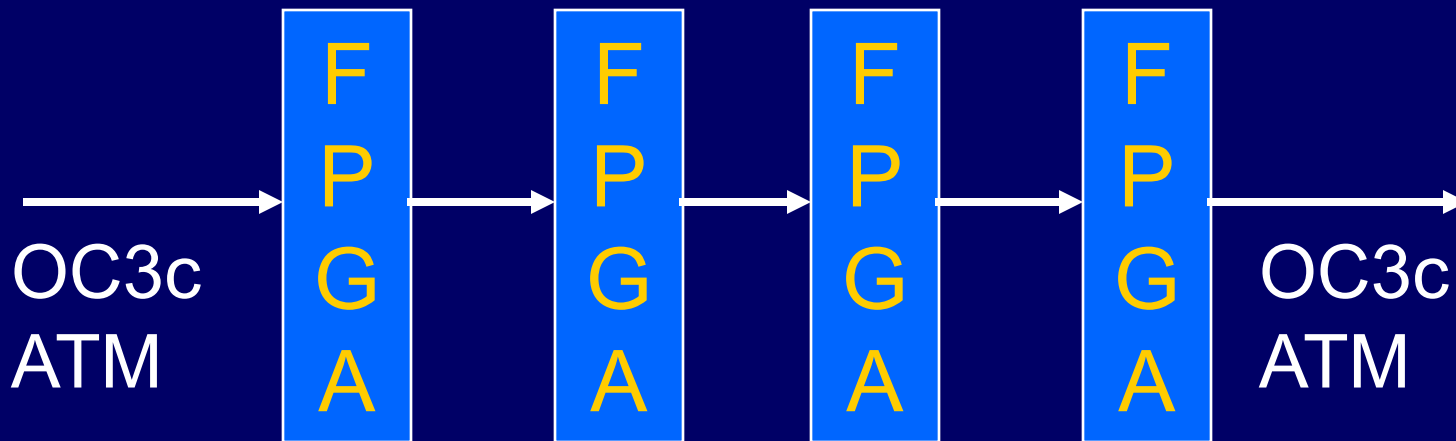
Breakdown of Costs in Alien

Computation / Bandwidth (COB)

POTS/ISDN
T1
10M Ethernet
100M Ethernet
OC3
OC12
OC192

Increasing Preference for Restriction to Control Plane

Programmable Protocol Processing Pipeline (P4)

- See http://www.cis.upenn.edu/~boosters

- FPGA Mechanism controlled by Policy module on P.C.

- Overcome 100ms reconfiguration time with preload of functions; crossbar insert/deletes from cellpath

RESULTS:

- ☐ Active packets/ authentication tension
- ☐ SOME A. N. functions at wirespeed (P4)
- ☐ A.N. Internetworking solution in PLAN
- ☐ P.L. solutions to access control…
- ☐ …extended to remote loading in SANE
- ☐ …SANE protocols now in Java
- ☐ AEGIS secure bootstrap for A.N. nodes

Use of Active Technology

☐ Invented two Active Technologies
- 📫 Alien (early application in Active Bridge)
- 📫 PLAN (programmable internetworking)

☐ Use to understand formal semantics and resource management issues

☐ Large-scale applications with Bellcore

Policy based Publish/Subscribe

☐ publishers publish content onto a *channel*

☐ *channel*: content based data bus - redistributes the received packets to subscribed clients

- 📬IF the client meets the publisher's policy AND
  - 📧e.g., do not send the data to destinations in NY
- 📬IF the publisher meets the client's policy AND
  - 📧e.g., do not receive the packet if contains JPEG encoded data
- 📬IF the overall "transaction" meets the "community" policy
  - 📧do not allow the packet to be delivered unless both the publisher and the destination are known to the network manager.

☐ Example: stock quote distribution system

Service Trading

☐ Services available to AN infrastructure

   ✉e.g., multiple sites offering w/ quotes, different QoS available (free/$ per quote, frequency…)

☐ Service requests include a QoS negotiation <u>procedure</u>

   ✉e.g., get quotes only for ticker AN if realtime & cost <= $0.01 per minute

☐ Request delivered, plus service if provided

Interoperability / ABONE

☐ PLAN/ALIEN available on ABONE

☐ Penn and Bellcore host ABONE nodes

☐ Active applications to be ABONE-wide

☐ Group (U.Wash., Bellcore, Penn and Columbia) challenges on ABONE

A.N. project recommendations

- "Best" (compete and unify) of EEs
  - PLAN formal semantics & resource bounds
  - Non Caml-specific parts of SANE
  - ANTS caching scheme (active extensions?)
  - Commercial (vendor) COTS plans?
- Start collecting performance nuggets
  - cost of MD5, SANE authentication?
  - active packet/ active extension tradeoffs?