

SwitchWare: Accelerating Network Evolution

U. Penn. and Telcordia, 03/17/99

<http://www.cis.upenn.edu/~switchware>

Goals of the SwitchWare project

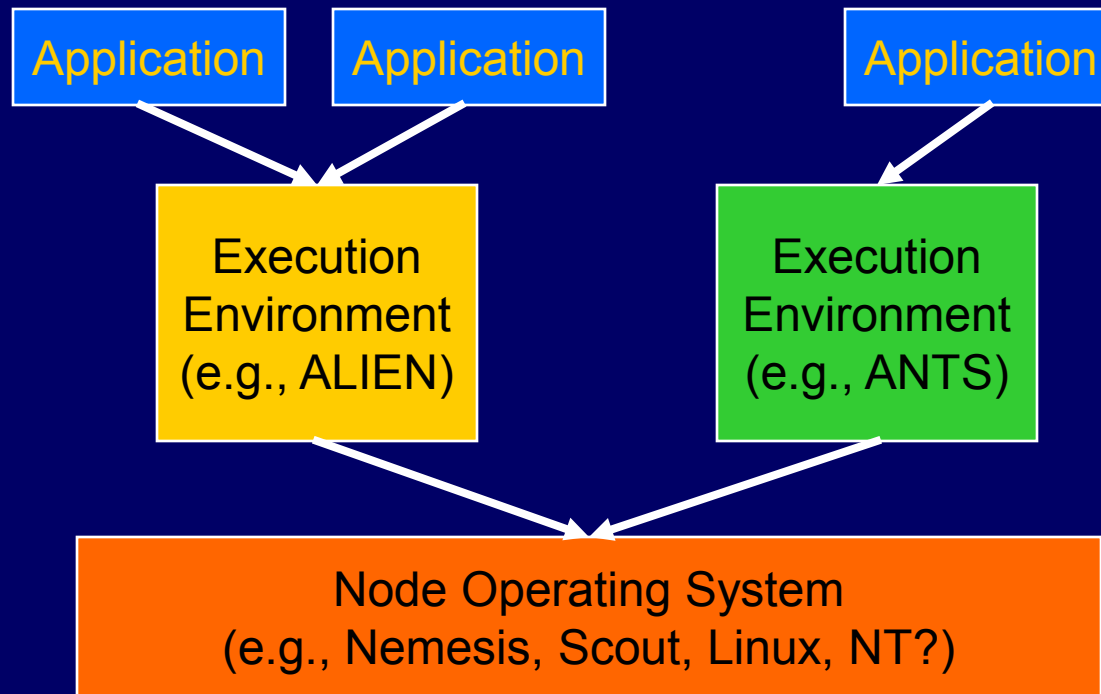
- Investigate architectures and programming paradigms for A.N.
- Use modern programming languages
- Find “sweet spots” in tradeoffs among *flexibility, usability, performance and security.*
- Overall: *understand design space!!!*

Recent Results on design space:

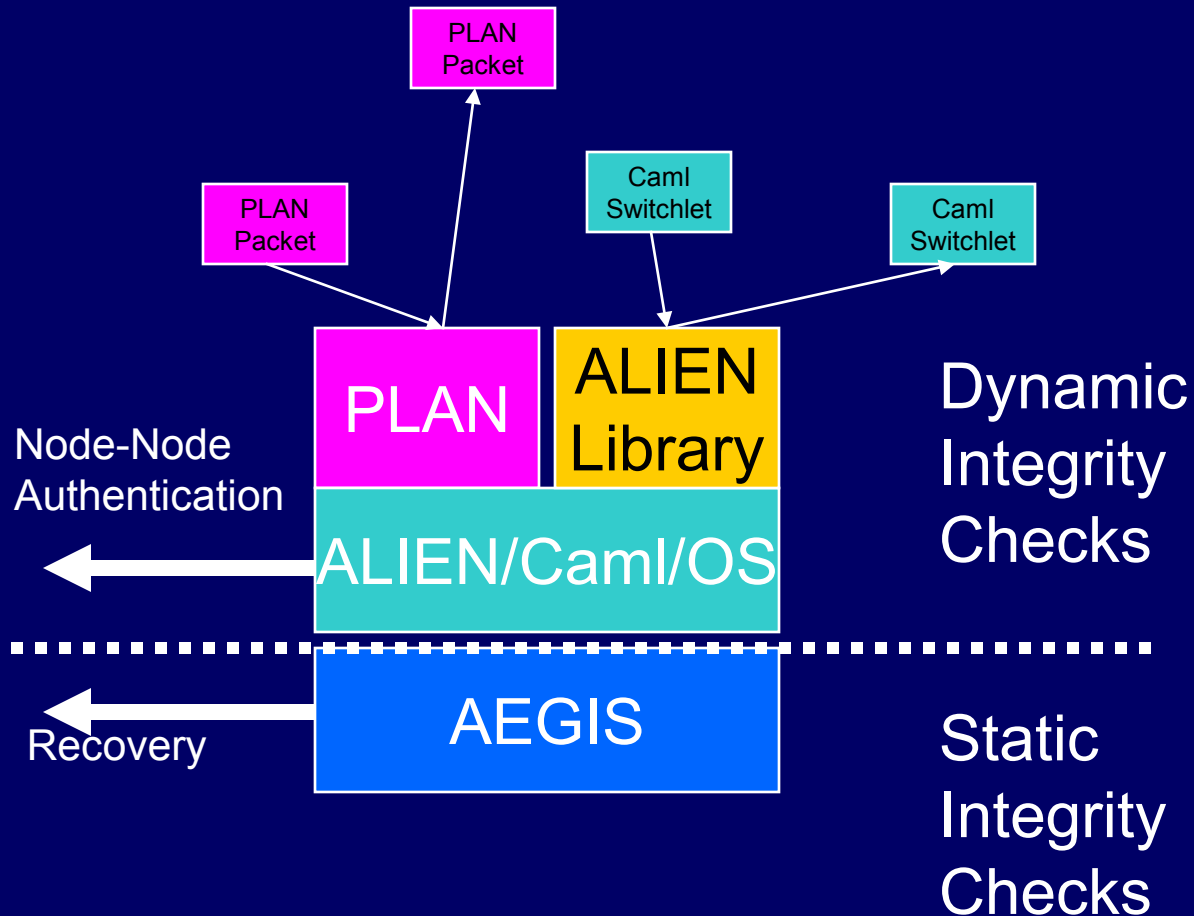
□ A.N. models, performance & security:

*Per-packet costs of cryptography are large enough to favor active extensions over active packets (capsules) in higher bandwidth applications needing authentication (Caching “capsules” makes *soft-state extensions!*)*

Active Network Architecture



E.g., the SwitchWare A.N. Architecture



Packet Language for Active Networks (PLAN): Ideas

□ Domain-Specific Language for A.N.

- ▢ Active Packets of ML-like code
- ▢ Restricted for security & performance
- ▢ Active extensions for restricted tasks
- ▢ “Glue language” to build *active applications*
- ▢ Think of a UNIX shell for A.N.
- ▢ Resource-bounds for *network* protection
- ▢ Access to link-layers w/extensions

PLAN Status:

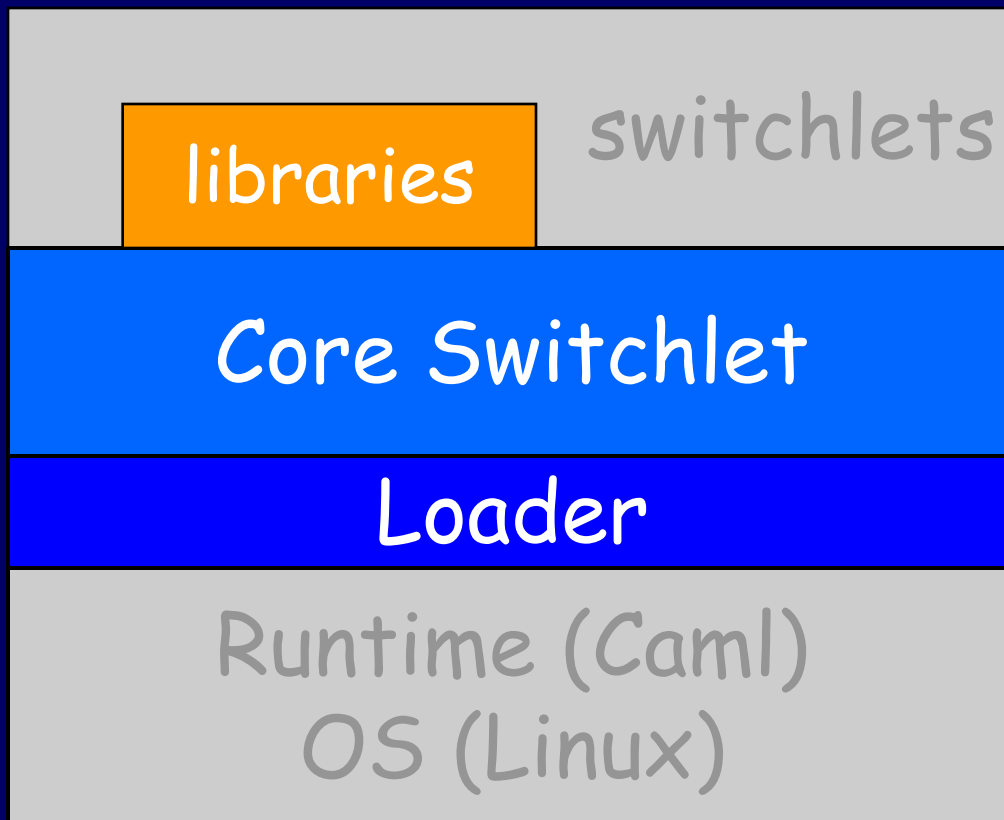
- PLAN internetwork demonstrated
 - Paper in INFOCOM '99 (next week)
- Formal semantics underway
 - Penn/SRI collaboration
 - will influence future PLAN implementations
- New version available on web site
- PLAN on ABONE; QCM-based ACLs

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)

ALIEN in an Active Element

- Three layer architecture



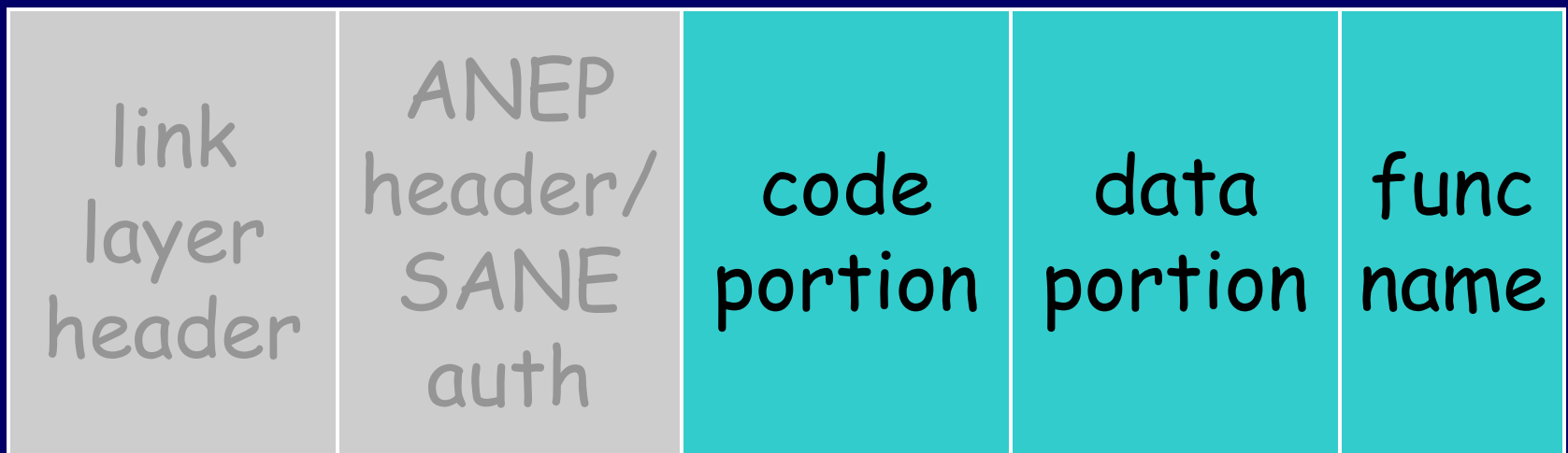
Active Packets in ALIEN

□ If ANEP header indicates ALIEN

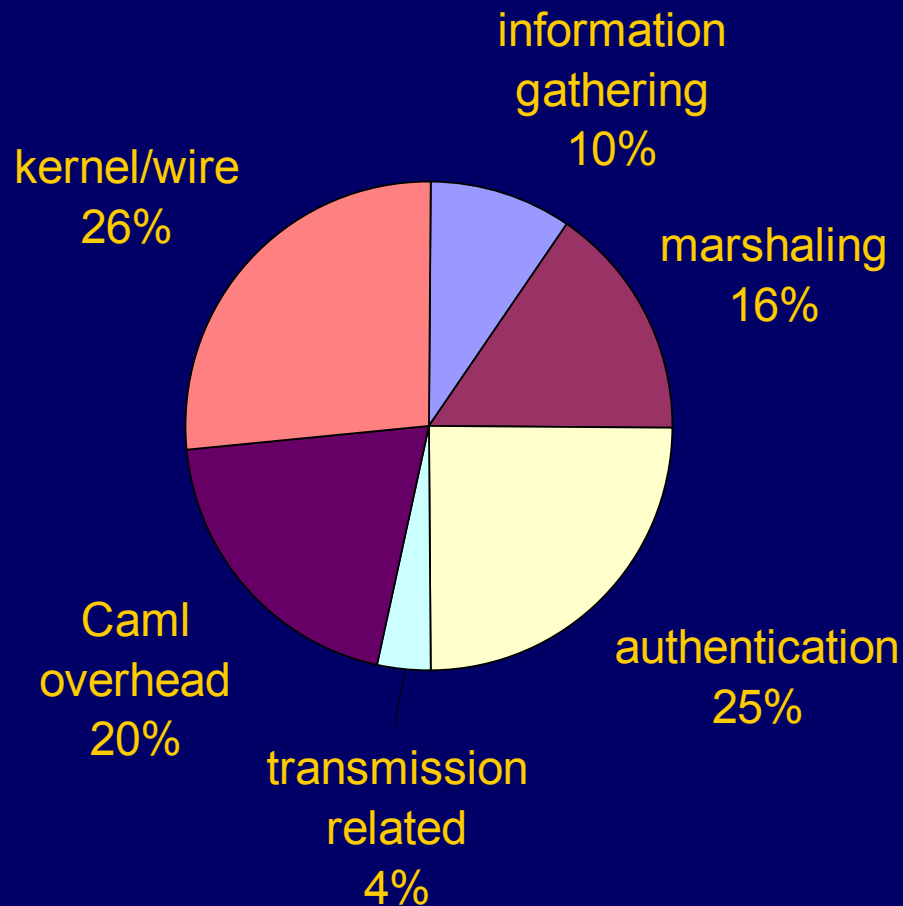
☞ SANE processing as part of ANEP

☞ Code portion is loaded

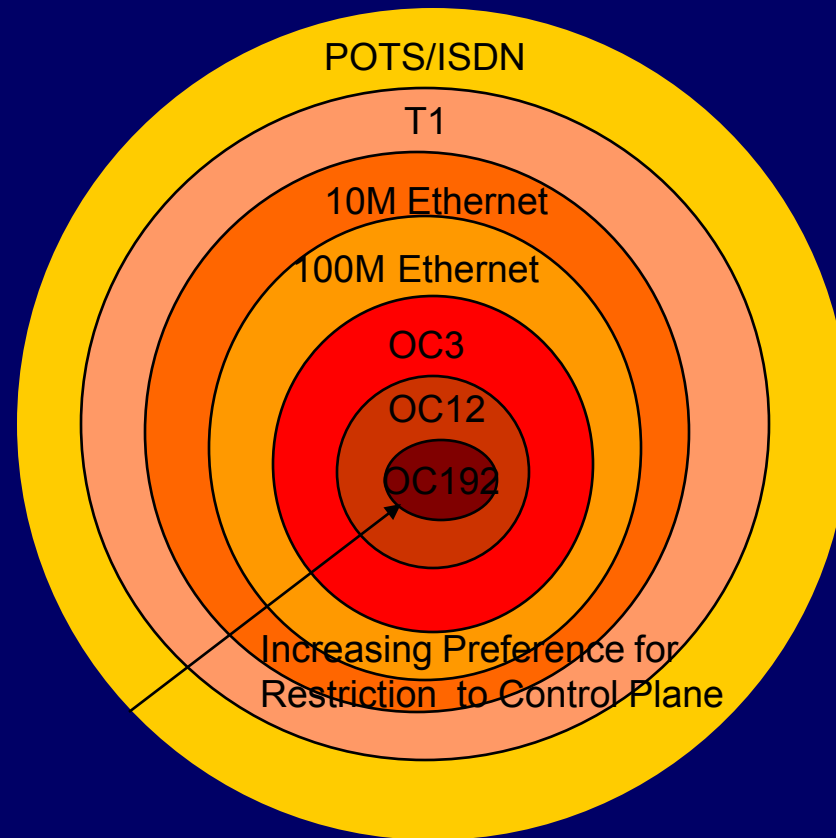
☞ *func* is called with code, data, and func name as arguments



Breakdown of Costs in Alien



Computation / Bandwidth (COB)



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 Telcordia

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 procedure
 - ▣ e.g., get quotes only for ticker AN if realtime & cost \leq \$0.01 per minute
- Request delivered, plus service if provided

Interoperability / ABONE

- PLAN/ALIEN available on ABONE
- Penn & Telcordia host ABONE nodes
- Active applications to be ABONE-wide
- Group (U.Wash., Telcordia, Penn and Columbia) challenges on ABONE

Futures

□ Continue to explore design space

- 📖 fiber-embedded processors, as in Smith, Hadzic & Marcus *Hot Interconnects*

□ Applications Space

- 📖 A.N. support for DMSO HLA
- 📖 Active Firewalls with PLAN/Alien
- 📖 Team 1 Challenge Applications

Active Router Control (Active Border Gateways?)

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

