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

Application

Execution Environment (e.g., ALIEN)

Application

Execution Environment (e.g., ANTS)

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

PLAN
ALIEN/Caml/OS

AEGIS

ALIEN Library

Node-Node Authentication

Recovery

PLAN Packet

Caml Switchlet

Dynamic Integrity Checks

Static Integrity Checks
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

ALIENT in an Active Element

Three layer architecture

- Libraries
- Switchlets
- Core Switchlet
- Loader
- Runtime (Caml)
- OS (Linux)
Active Packets in ALIEN

If ANEP header indicates ALIEN

- SANE processing as part of ANEP
- Code portion is loaded
- \textit{func} is called with code, data, and func name as arguments

| link layer header | ANEP header/ SANE auth | code portion | data portion | func name |
Breakdown of Costs in Alien

- Kernel/wire: 26%
- Caml overhead: 20%
- Transmission related: 4%
- Information gathering: 10%
- Marshaling: 16%
- Authentication: 25%
Increasing Preference for Restriction to Control Plane
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 it 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 <= $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:

LAN

Routing Policies and Decisions (and New Services)