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
  - Execution Environment (e.g., ALIEN)
- Application
  - Execution Environment (e.g., ANTS)
- Application
  - Node Operating System (e.g., Nemesis, Scout, Linux, NT?)
E.g., the SwitchWare A.N. Architecture

- Node-Node Authentication
- Recovery
- PLAN Packet
- Caml Switchlet
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- Caml Switchlet
- Dynamic Integrity Checks
- Static Integrity Checks

PLAN
ALIENT/Caml/OS
AEGIS
ALIEN Library
PLAN Packet
Caml Switchlet
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

Breakdown of Costs in Alien

- Kernel/wire: 26%
- Information gathering: 10%
- Marshaling: 16%
- Authentication: 25%
- Caml overhead: 20%
- Transmission related: 4%
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 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 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?