Active Networking on the ENIAC 2000
May 3rd, 1999

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SwitchWare is joint work with Dave Farber, Carl Gunter and Scott Nettles of Penn, and Bill Marcus and Dave Sincoskie of Telcordia. See:
http://www.cis.upenn.edu/~switchware
1. Dequeue Packet from Input Port
2. Determine “best” Output Port
3. Queue Packet on Output Port

From Store-and-Forward

To Store-Compute-and-Forward!
Smart Hosts + Dumb Switches = Passive Nets

Smart Hosts + Smart Switches = Active Nets
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 Packet
- Caml Switchlet
- PLAN Packet
- Caml Switchlet

Node-Node Authentication

Recovery

Dynamic Integrity Checks

Static Integrity Checks

ALIEN/Caml/OS

ALIEN Library

PLAN

AEGIS
Packet Language for Active Networks (PLAN): Ideas

- Domain-Specific Language for A.N.
  - Active packets of ML-like code (but restricted for security & performance)
  - Active extensions for restricted tasks (such as link-layer access)
  - "Glue language" to build active applications (think of a UNIX shell for A.N.)

- PLAN internetwork demonstrated
  - Reported in IEEE INFOCOM ‘99
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 (SIGCOMM '97), secure active ping, ...

ALIENT in an Active Element

- Three layer architecture

- 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
Breakdown of Costs in Alien

- Kernel/wire: 26%
- Marshaling: 16%
- Authentication: 25%
- Information gathering: 10%
- Caml overhead: 20%
- Transmission related: 4%
Active Router Control (Active Border Gateways?)

- IP Router/Forwarders co-located with Active Elements:
  - Forwarding Tables
  - Active Element
  - Routing Policies and Decisions (and New Services)
The basic architecture

- Policies
  - Measure
  - Measure

- Router A
- Router B

Route Updates
The Basic Opportunity: Internet routing does not utilize the available network topology unless manually configured:

Goal: Resource Discovery and Exploitation!