Active Networking:
A 2020 Vision
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Outline of talk

The human I/O architecture
  basic properties
  technical implications

Active Networks
  information movement + processing

“2020 vision”
  higher human I/O!
Human I/O architecture

- High-bandwidth video input
  - feeds slow symbol processor (Card, et al)
  - asymmetric - no fast video out!
- Audio input/output (100 kilobits/sec)
- Other senses (touch, smell, taste...)
- The asymmetry is HUGE (10-1000)
- Lots of intermediate filtering
Technology echoes biology...

- **Newspapers**
  - Many readers, few writers

- **Television**
  - Video out, remote control in

- **Web**
  - Video, etc. out, text/clicks in

- Coupled to I/O architecture!
Optimally

- Information flows in audio/video
- Information flows out audio (speech recognition *should* be faster than keyboarding!)
- Information systems get the “best” (necessary, relevant, etc.) information to the presentation point (eyes, ears)
“Passive” Networking

- Smart hosts on the edges
- Passive switches in the center
Active Networking Nodes

Store, COMPUTE and Forward!
Active Network Model

- Packets ("switchlets") can change the behavior of the switches "on-the-fly"
  - In-band active packets
  - Out-of-band active extensions
Why Do This?

- Faster response to problems and possibilities in network
- Per-user protocols
- Allows experimentation
- Accelerates network evolution

Example Applications
- Auctions
- Reliable multicast
- Sensor Fusion
An Example Active Application: 
Active Reliable Multicast (ARM)

- Reliable Multicast plagued by “ACK implosion” when an error occurs
- Retransmission expensive
- In MIT’s ARM, Active Elements are embedded in the multicast tree (not all tree nodes need be active for ARM to work)
ARM techniques

1. Duplicate NACKs
2. Best-Effort Multicast data Caching
3. Local retransmission
Example: SwitchWare Architecture

http://www.cis.upenn.edu/~switchware
Activation potential at various commercially deployed rates:

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

Increasing Traffic Aggregation

Increasing Preference for SW Restriction to Control Plane

Increasing SW Service Deployment Times

More Nodes
Fiber-coupled processing?

Register-Only Media Processor (ROMP)
The “2020 Vision”

Is (# people)*(video bit rate) all the bandwidth we will ever need?

NO! There’s a lot going on!

The “vision” is one of information fusion

The goal is: right information, to right person, at the right time

Huge challenges in systems design
The basic architecture

- Nets and computers improving exponentially. Humans, well...
- Active nodes have “delegates”
  - select information (watching a million cameras...... )
  - forward towards you for consumption
  - your senses extended into the network
Can we do it?

- Active nets are getting there
  - Architecture being developed
  - Performance, security, scale all issues
  - Mature in 2-5 years

- We need deployable HCI and AI technologies

- Towards the ultimate SPAM filter!
Conclusion

- Today’s applications of active networks are incremental, against today’s problems.
- Tomorrow’s problems just taking shape, but people already complaining of information overload with slow nets!
- Active information movement
- Hope to see you there!