Report on Active Network Activity

John Guttag
MIT Laboratory for Computer Science
Cambridge, MA 02139-4307
guttag@lcs.mit.edu

Assigned an Unenviable Task

Define "active networks"

Convince you that it's a good idea

Summarize (fairly) the work at all sites

Assigned Unenviable Task

Define “active networks”

- No general agreement beyond buzz phrases

Convince you that it’s a good idea

- Insufficient evidence exists
  - Situation will persist for some time
- I am comfortable saying
  - It is a plausible idea
  - A testbed for interesting long-term research
  - It’s fun!

Summarize the work at all participating sites

- Requires several hours
- Wonderful opportunity to offend people

What Makes a Net Active ?

Customizable network services
- Application-specific processing
- Even instance/session-specific processing

Environment for running distributed programs
- Routers replaced by nodes that participate fully

Network becomes a programmable entity
- With accessible storage
- Store and forward not all there is

Why a Programmable Network?

Conventional nets rely on agreement about protocols

- Standardization a long and wrenching process
- Stakes are high

Active nets rely on agreement about model of computation

- Encoding of programs and data
- Access to node's resources
  - Security model
- Naming and addressing mechanisms
  - Programs
  - Data
  - Nodes

Is This a Good Idea ?

Not obvious

Benefits?

- New functionality
- Faster deployment
- Better performance

At what cost?

- No clean separation between layers
- Security
- Performance when flexibility not needed

Our goal is to find out

- Start with willing suspension of disbelief

Overview of Activities

Making it possible to build active nets

- Architectures and implementations
- Interface to operating systems and existing networks
- Dealing with security issues, e.g.,
  - Novel flooding attacks
  - End-to-end cryptography

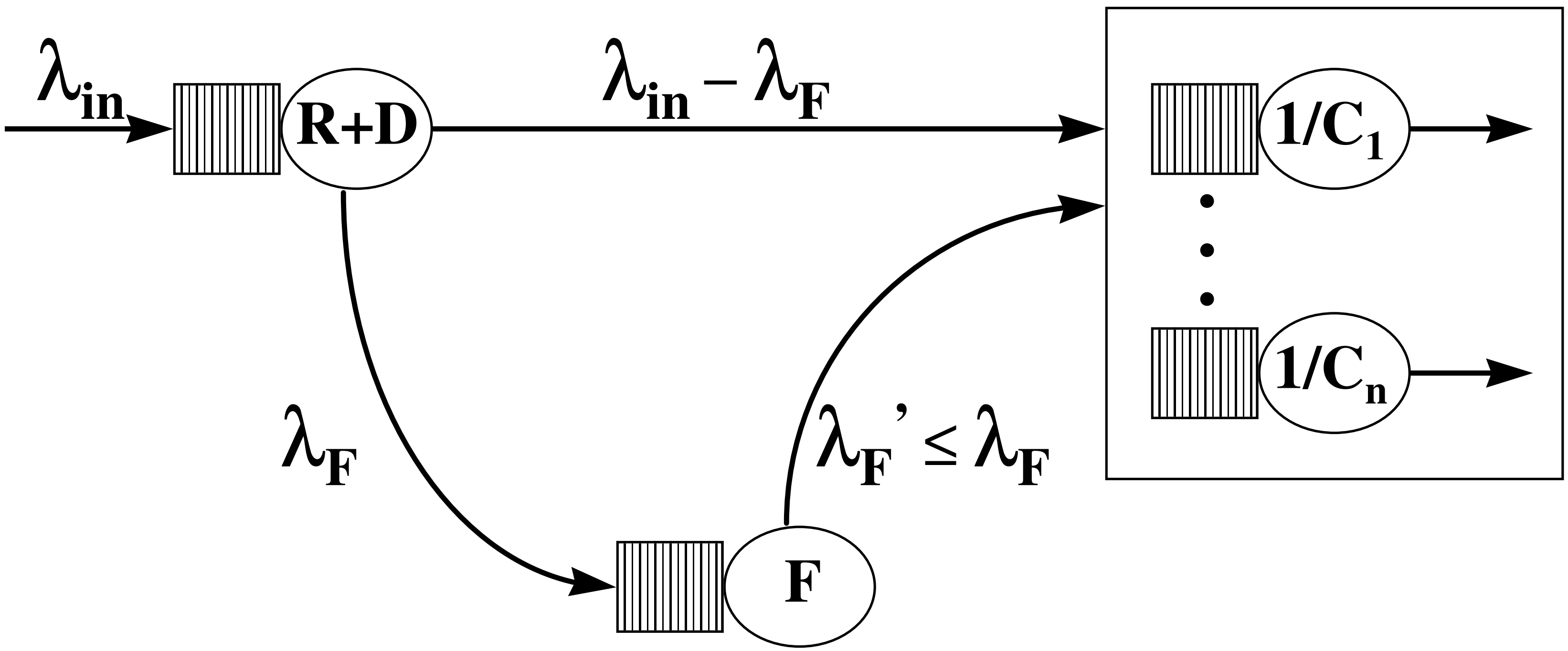
Understanding opportunities

- Low level, e.g., active reliable multicast (ARM)
  - Promising preliminary results
- Application level, e.g., distributed simulation

Understanding performance issues

- Potential benefits and costs

Understanding Performance



Fusion server reduces traffic, esp. in congested regions

Packet throughput goes down

Value throughput goes up

Some of the (potential) Players

BBN- Network management & measurement

IPv6 option, specialized CISC instruction set

Arizona - Liquid software: mobile code technologies

OS support , Java compilation (incl. verification)

Cincinnati - Formal methods & simulation

Kansas - Active network testbeds

Columbia - NetScript

Georgia Tech - Achieving performance

MIT Lincoln - Distributed simulation

More (potential) Players

Pennsylvania/Bellcore - Switchware: linguistic approach

CAML-based, exploiting typing information

Utah - Fluke kernel specialized for active networks

Extensible resource management, Java runtime

Washington - Spin: Customizable OS

Striking parallels between active nets and new OS research

MIT LCS

Specification, semantics, and reasoning

Performance enhancement: reducing net work

Ants: toolkit for nodes and applications

The Ants Architecture

Capsules programs (and data too)

- Programs run to completion (or self-suspension) at a node

Node primitives

- Soft state, cannot be relied upon
- Querying environment
- Capsule creation and manipulation
- Capsule control (e.g., forwarding)
- Capsule scheduling

Code distribution

- Some guaranteed present at each node
- Some transferred using code distribution protocol
  - Demand loading, prefetching, caching all used
  - Well-suited to flows

Conclusion

A good start

- Convinced that it can work
- Plenty of opportunities for performance enhancement

Cost/benefit still an open question

- Demand for protocol innovation
- Difficulty of protocol innovation

Next steps

- More small controlled experiments
- Deploy a large and useful active net
  - Leverage existing infrastructure
- Find and implement 1-3 driving applications
  - Distributed simulation is my nomination

A Good Overview Paper

"A Survey of Active Network Research,"

Tennenhouse, Smith, Sincoskie, Wetherall, and Minden

IEEE Communications, January 1997