# Research in Active Networks

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# Introduction

- Idea first proposed by
  - Tennenhouse, Wetherall (MIT) - 1995-96
- Others
  - Smith (UPenn)
  - Yemini, da Silva (Columbia)
  - Partridge, Jackson (BBN)

  - Also, GaTech, U Kansas, U Arizona et al

# Basic Idea

- Add customized processing in network
- Motivation from existing needs
  - Firewalls
  - Web Proxies
  - Transport Gateways
  - Nomadic Routers
- These applied from above network layer
- Active nets - add this to network

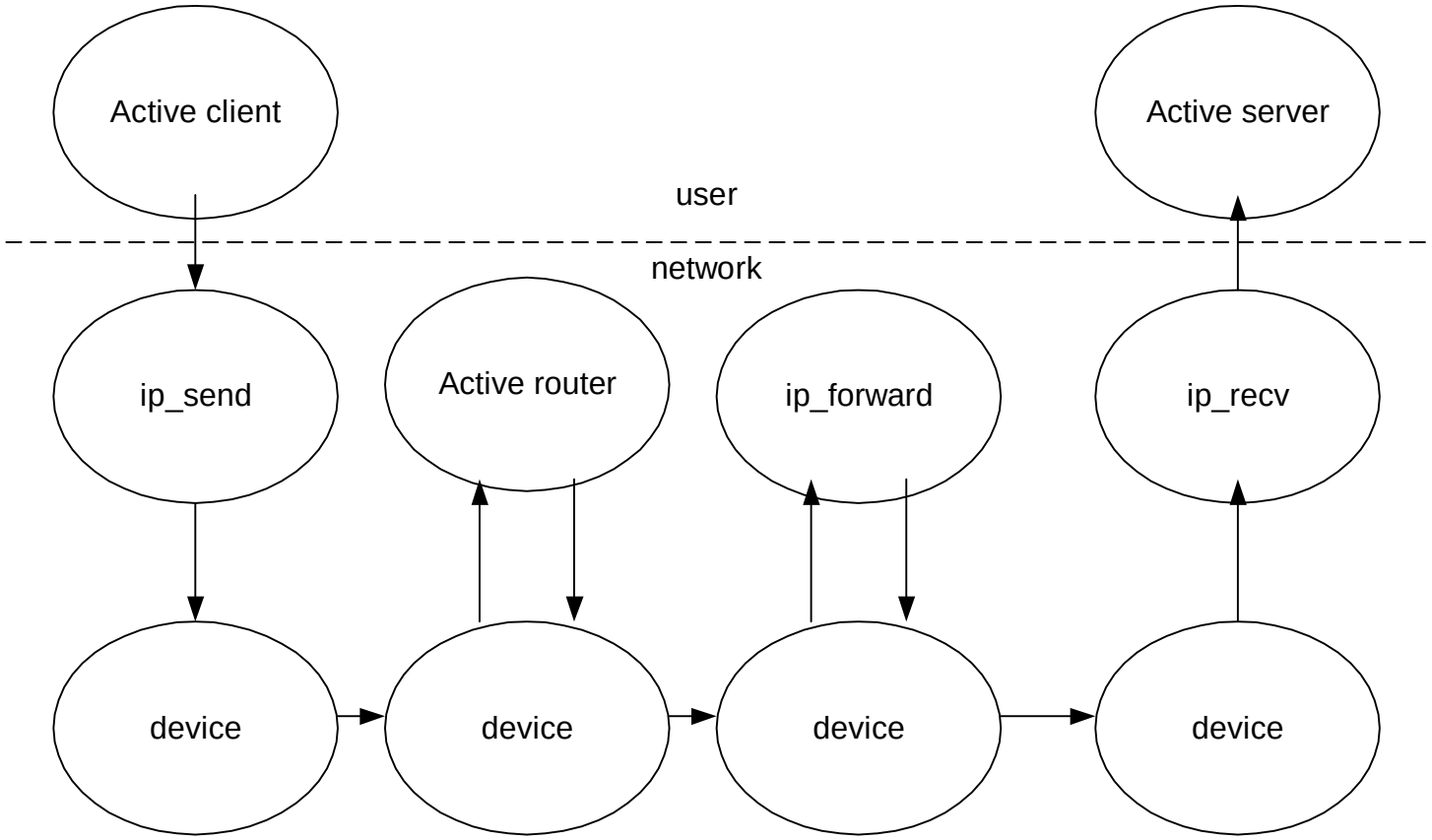
# What is active ?

- Routers have processing power
- Processing `code' not resident in routers
  - Network resident service routines
- Packets decide processing
- Routers just provide facility
- All packets are not processed in same way

# Basic Strategies

- Two basic strategies (2 extremes)
  - Router as programmable switch
    - Net Admin loads processing code
    - Packets choose among available options
    - Probably secure
  - Capsules
    - Packets carry programs which execute on router
    - Less secure

# Generic organization



# Capsule approach

- Capsules carry code
- Code may contain
  - Routing decision (QoS)
  - Generate more packets (multicasting)

- MIT's approach
  - Defined IP options IP_ACTIVE

# Programmable switch

- Switch contains multiple routines
- Packets encode which routine to execute

- Back door to load routines in switch dynamically
  - Decouple data and control
- UPenn SwitchWare
  - Incremental deployment (active and passive routers)

# Congestion Control

- Congestion happens at routers
- Control done at end points - not good
- Do control at the routers

- GaTech technique - no feedback
  - MPEG streams
  - GOP level and Frame level
  - Drop a group of packets (similar to Early Packet Discard)

# Congestion Control

- Adaptive Congestion Control
  - USC - Theodore Faber
- Extend GaTech idea to feedback based schemes
  - e.g. TCP
- Window size info in packets
- Active routers use that to rate control and drop packets - decision at router rather than endpoints

# Other uses

- Multicasting
- Web caching
- Anything that would be better with application specific support

# Security Implications

- Loading unfamiliar code into routers
  - Use `safe' languages
    - Java
    - Safe-Tcl
    - Omniware object-code (sandboxing approach)
    - Proof-carrying code

# Concluding Remarks

- Interesting research area
- Wide scale deployment is still a dream

- Big issue -
  - Is Active Networks necessary
  - Or can all its operations be done efficiently by passive networks too ?

- Only one difficult to replicate - flexibility