# Deploying Ubiquitous Connectivity:

# Mechanisms for Resource Allocation and Authentication

Charles Reis
Karthik Gopalratnam

# Wireless Routers Abound

- Cheap
- Widespread
- Programmable

- Presents a new opportunity…

# Ubiquitous Connectivity

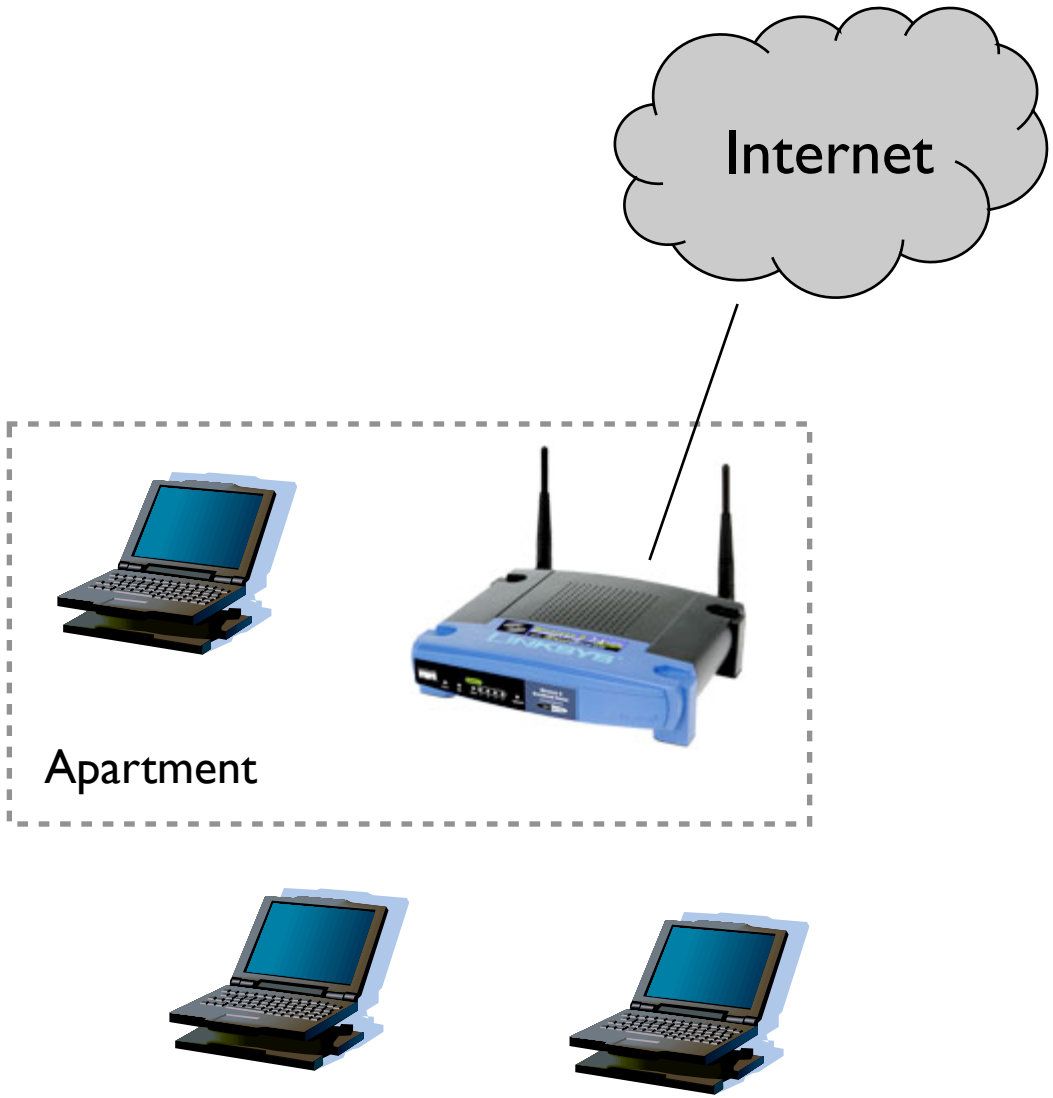
- Widespread Internet access through existing APs
  - Cheap, high bandwidth

- Need incentives to share
- Need backwards compatibility

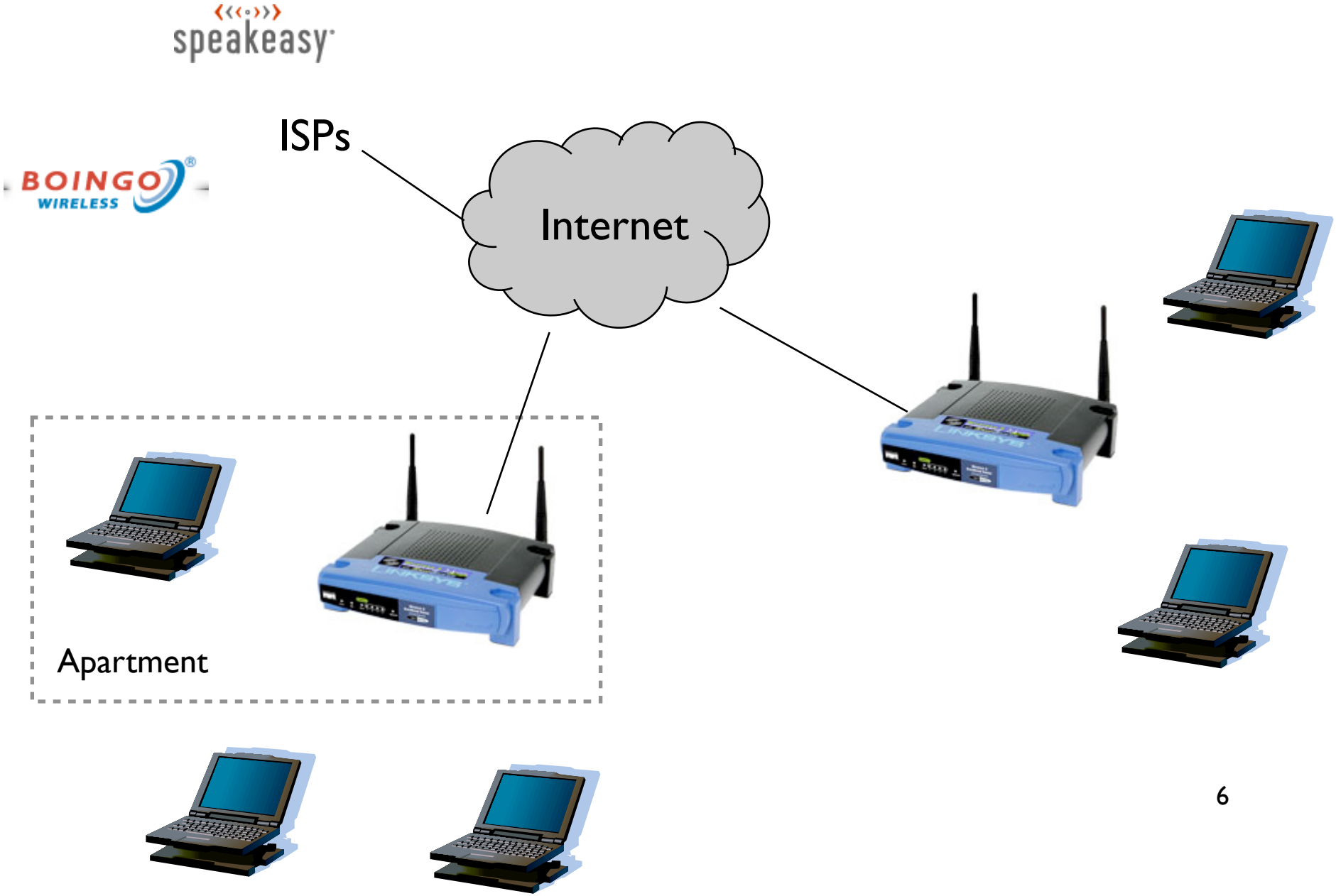
# New Considerations

- Resource sharing
- Security concerns
- (Mobility between APs)
- (Cooperation between APs)

# Local View



# Global View

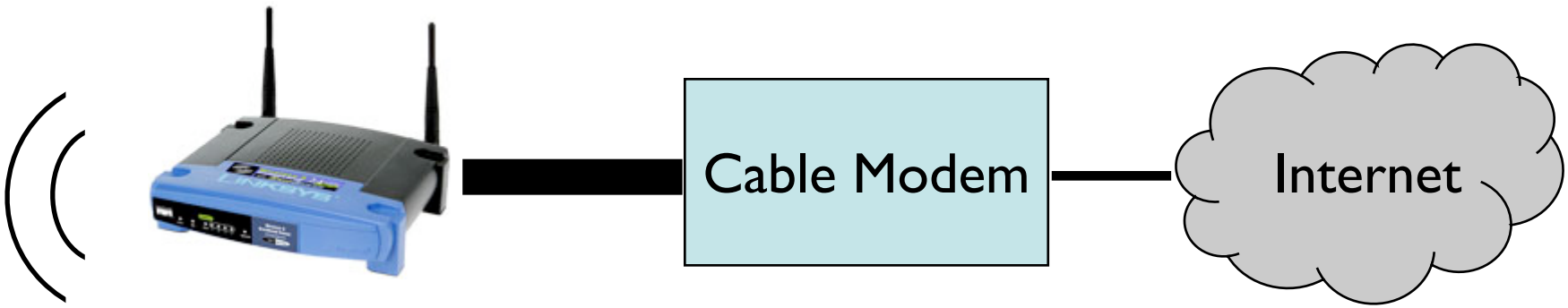


# Authentication

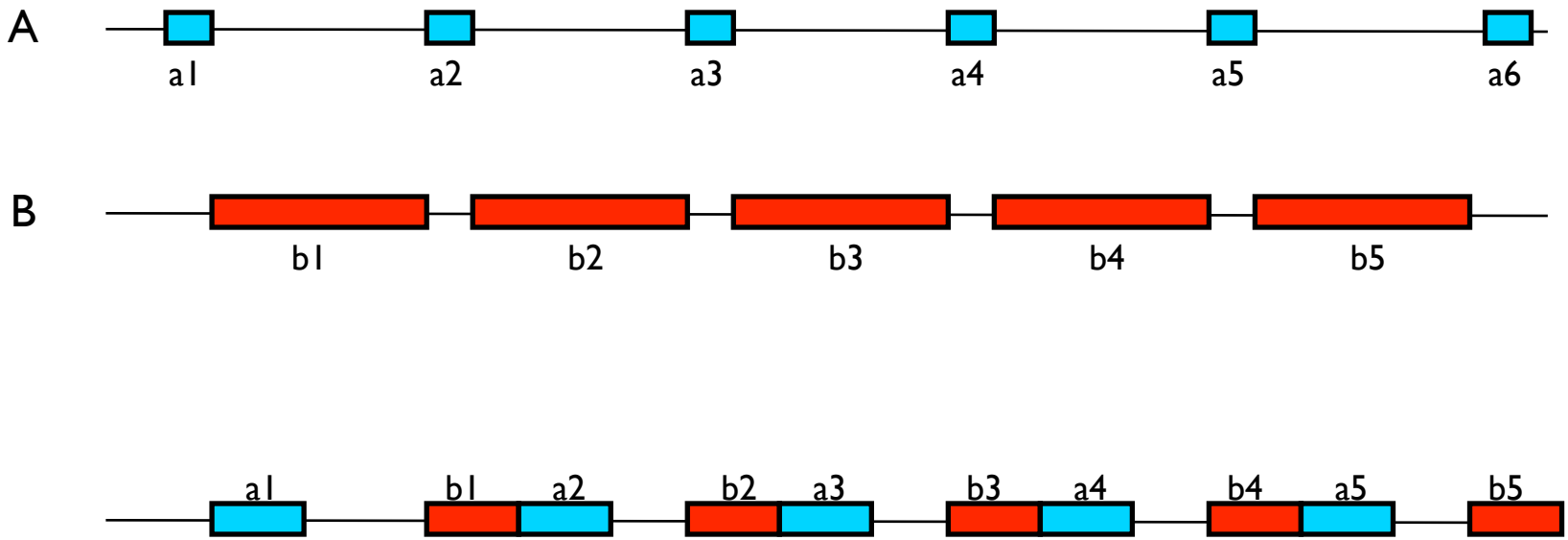
- WPA Enterprise
  - Per-user encryption keys
  - RADIUS authentication
    - Global: ISPs
    - Local: on the router (tinyPEAP)
    - Router associates flows with users

# Resource Allocation

- What is the Shared Resource?
  - Bottleneck Bandwidth to the Internet?
  - Wireless air time?



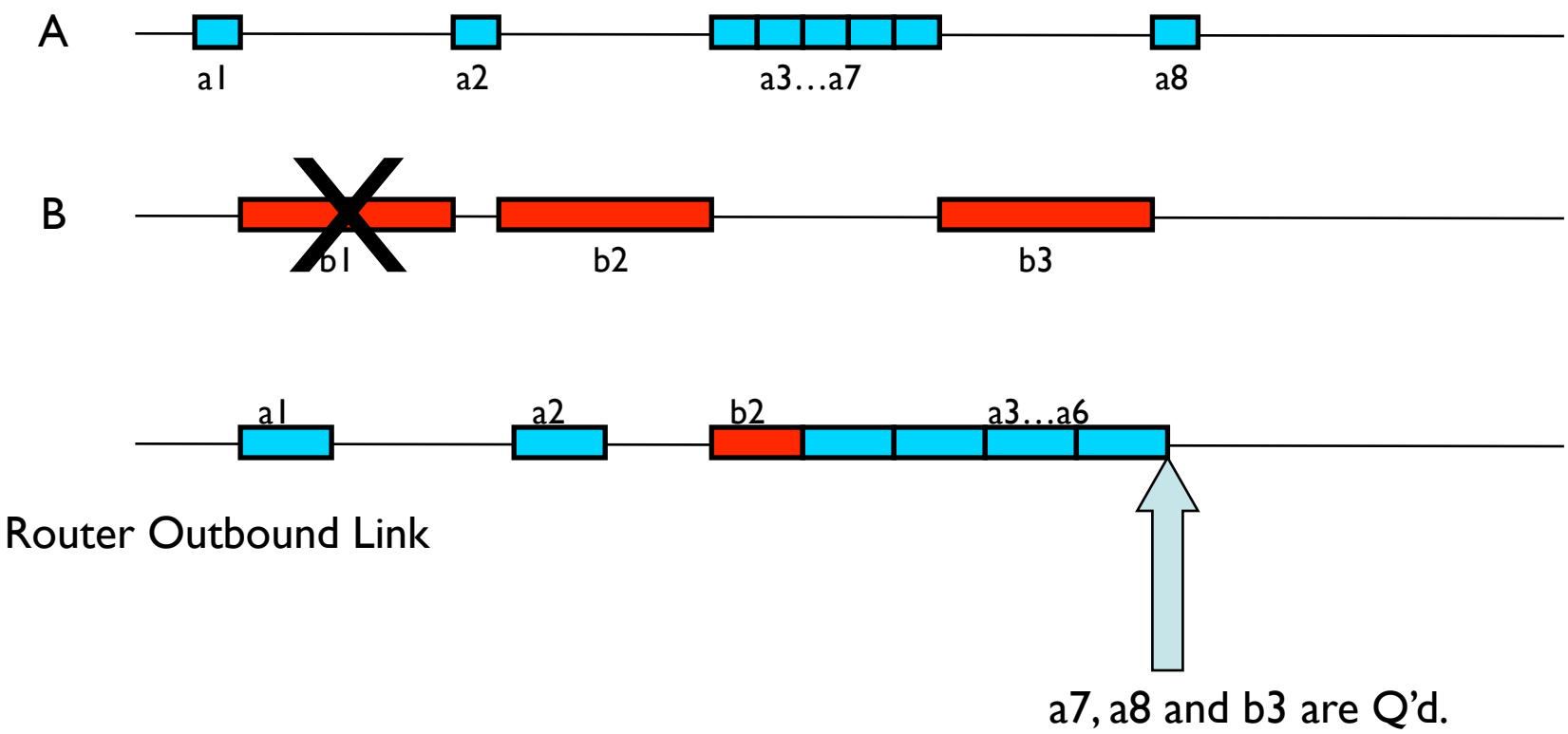
# Sharing Air Time



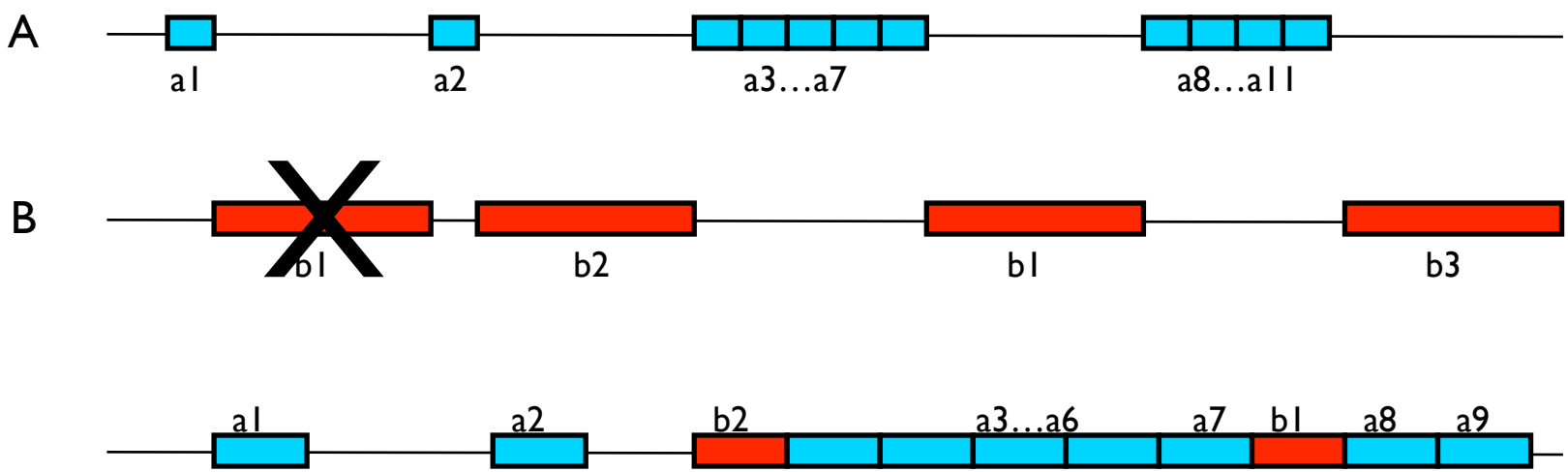

Router Outbound Link

Problem: nothing queues up!

# Sharing Air Time



# Sharing Air Time




Router Outbound Link

Much Better Utilization

# Wireless Weighted Fair Queuing (WWFQ)

- Core idea: Sharing two resources
  - Wireless air time
  - Uplink bandwidth

- Enforce this idea on flows:
  - Ingress mechanism
  - Egress mechanism

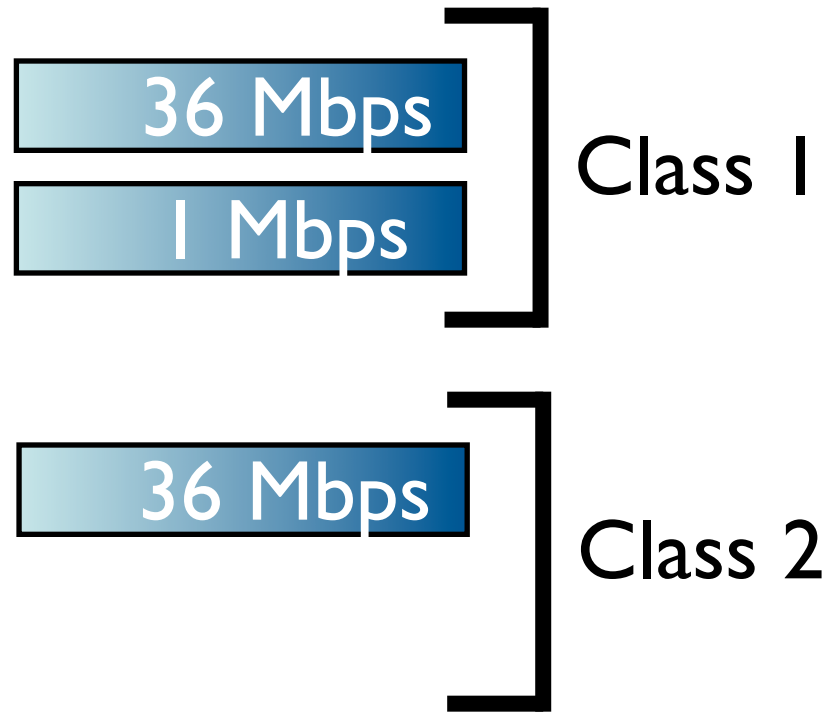
# WWFQ Ingress

- Establish fair sharing of air time
  - Drop packets if clients exceed their share
  -
  -
  -
  -
  -
  -
- Share based on *rate* and *class*

$$\frac{D_i}{r_i} > W_i\left(T - T_{ref}\right)$$

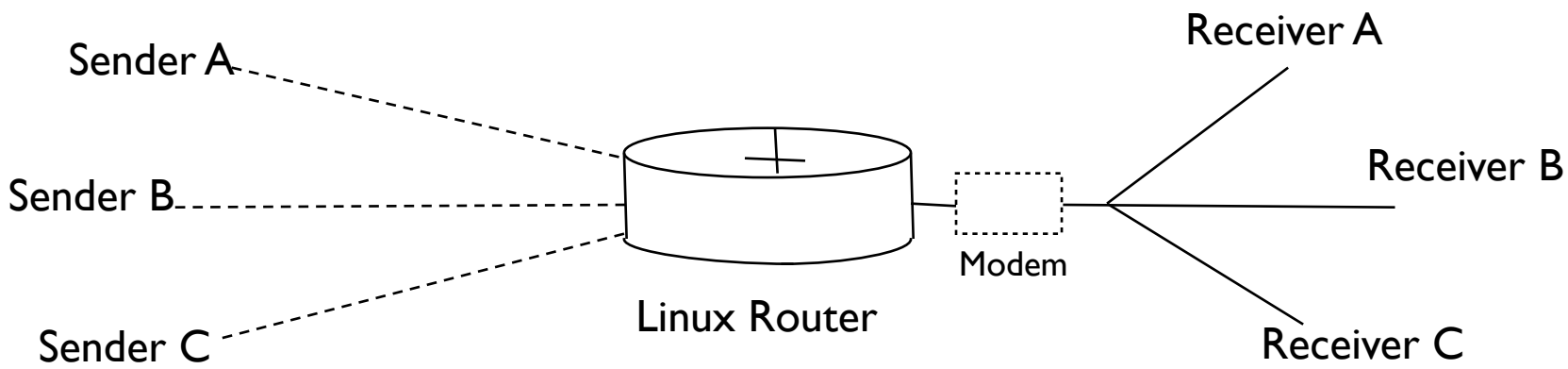
# WWFQ Egress

- Partition uplink bandwidth
- Two-level WFQ scheme:
  - Within a class:
    - Choose candidate packet among flows based on rate
  - Among classes:
    - Choose from candidates based on rate and class weight



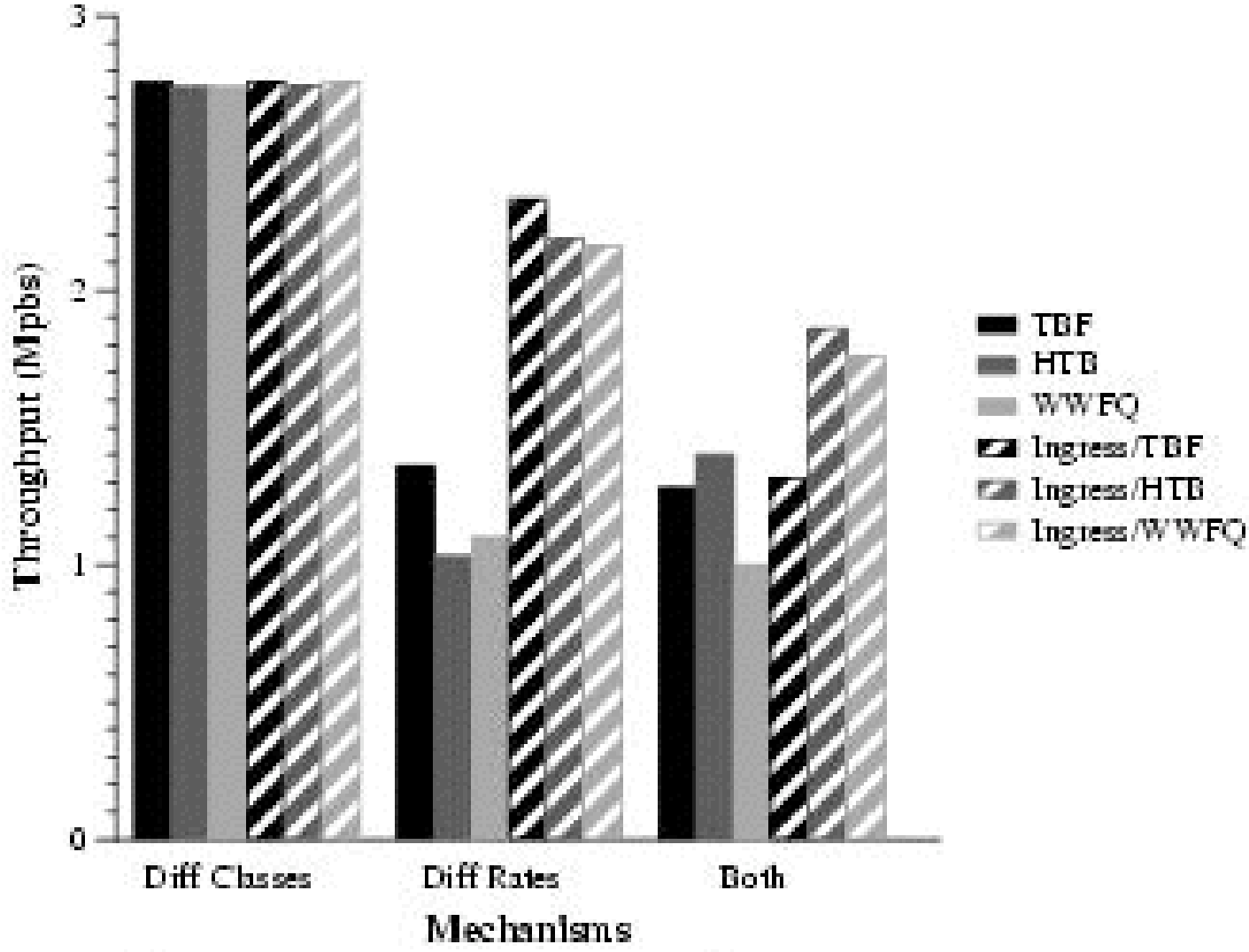
# Evaluation

- Modified Linux kernel
  - Implemented egress scheme (wwfq qdisc)
  - Approximated ingress scheme (TBF filter)
- TOPOLOGY:



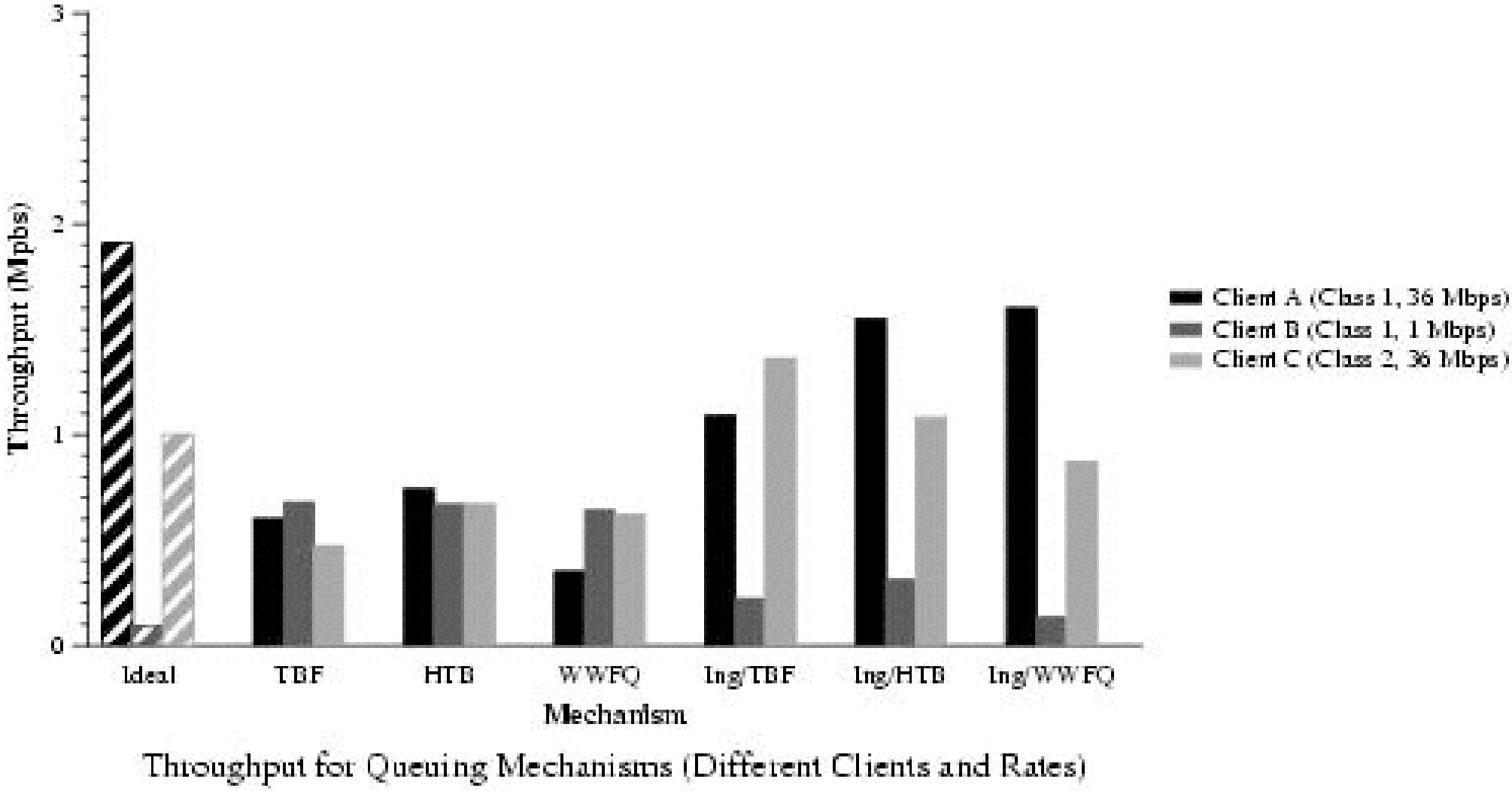

- Focused on upstream traffic

# Higher Utilization




Throughput for Queuing Mechanisms (Different Clients and Rates)

# Fair Sharing




Throughput for Queuing Mechanisms (Different Clients and Rates)

# Future Work

- Automate Ingress filter
- Deal with mixed (up/down) flows
  - Still sharing air time
  - Kernel tricks for policy across queues
- Port to router!

# Summary

- Share connectivity with commodity routers
- Security:
  - Authentication with WPA / RADIUS
- Resource Allocation:
  - Share air time and uplink bandwidth
  - Improve fairness and utilization

# Acknowledgments


- KERNEL GURUS:
  - Mike Swift
  - Muthu Annamalai