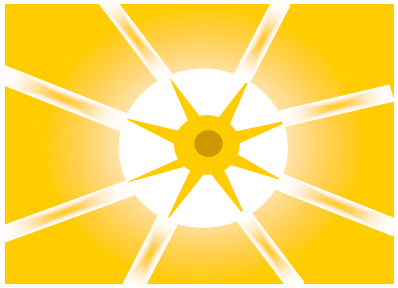

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BROADNETS 2004

The Second Generation of IP Flow State Aware (FSA) Routers

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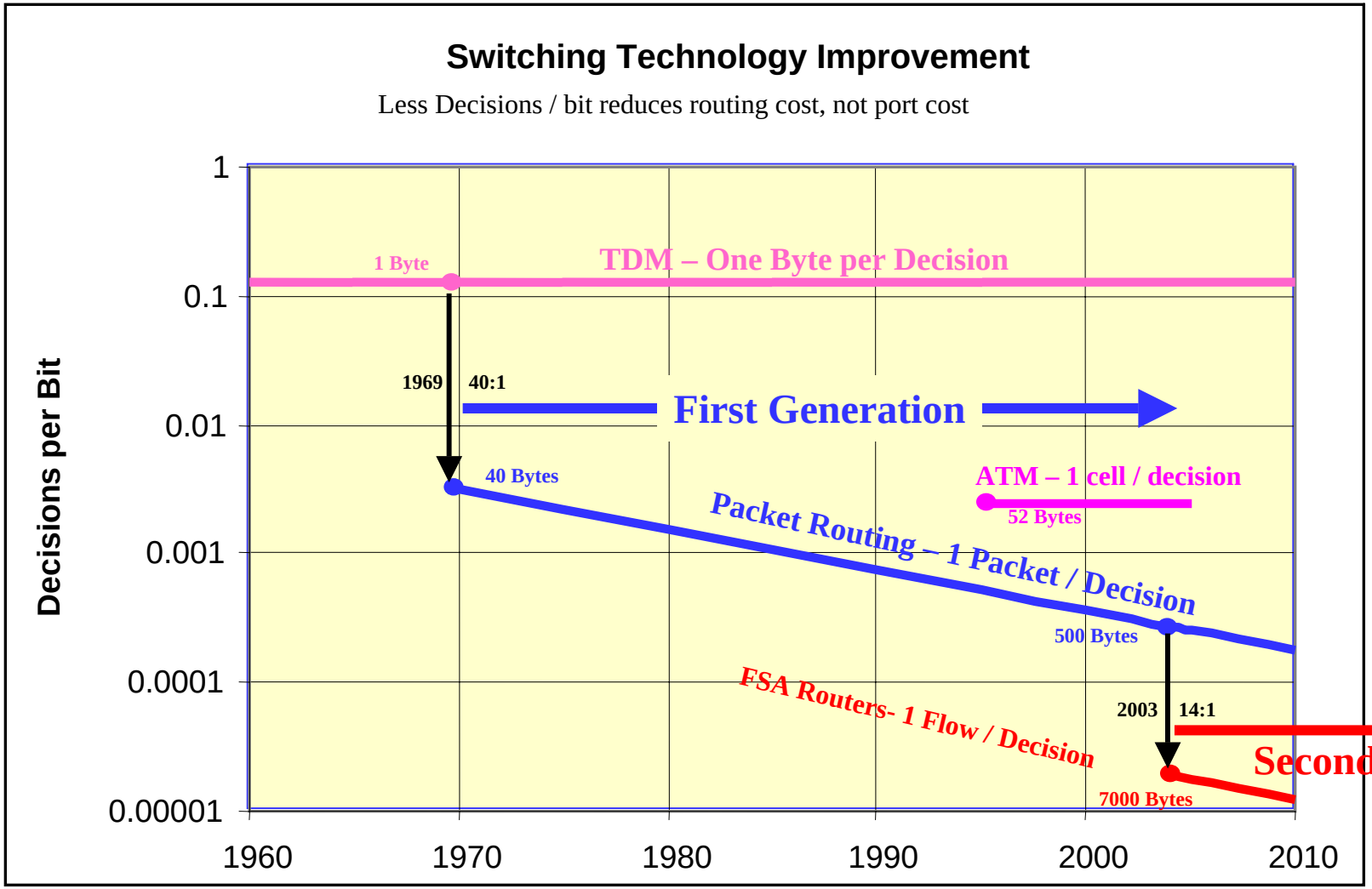
October 27, 2004

Switching History – Byte, Packet, Flow



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What is a Flow?

- Individual Flows
  - A stream of data between one user/system and another
    - Web Access, VoIP call, File Transfer, P2P transfer, etc.
  - In IPv4 it is uniquely identified by the 5- tupple
    - (Dest. Address, Source Address, Protocol, Dest. Port, Source Port)
  - In IPv6 it is uniquely identified by the 3-tupple
    - (D-Address. S -Address, Flow Label)
- Composite Flows
  - Groups of individual flows (like in MPLS)
    - VPN's, one users flows, all flows with similar CoS

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What is Flow State Aware (FSA) Routing?

- **What is different about FSA routing from Packet routing?**
  - **–All routers were packet routers from 1969 to 2003**
  - **– They examine only the packet and keep no history about the flow**
  - **– This allows them to route the packet, dropping by priority (DiffServ)**
  - **– They cannot determine the duration, rate or byte count of the flow**
  - **–FSA routers are also IP routers and can be intermixed with packet routers**
  - **– They keep Flow State about all packets in each active flow**
  - **– There are about 100 K flows/Gbps which requires memory**
  - **– However, they can determine the duration, rate or byte count of the flow**
  - **– Thus, they can identify flow types and control the rate and delay per flow**

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How does FSA compare to Intserv or RSVP

- **Before the 2000 all flow setup was processed in software**
  - **SS7, ATM, RSVP, LDP, Intserv all are software signaling**
  - **Software processing typically limits switch to 1000's flow/sec**
  - **Only large or permanent flows can be setup**
- **ASIC technology now permits hardware flow setup**
  - **IPv4 & IPv6 – recognize flow and save state**
  - **IPv6 with QoS – look at short option field**
  - **Hardware optimization allows M's flows/sec/port**
  - **All flows in any IP trunk can utilize flow setup**

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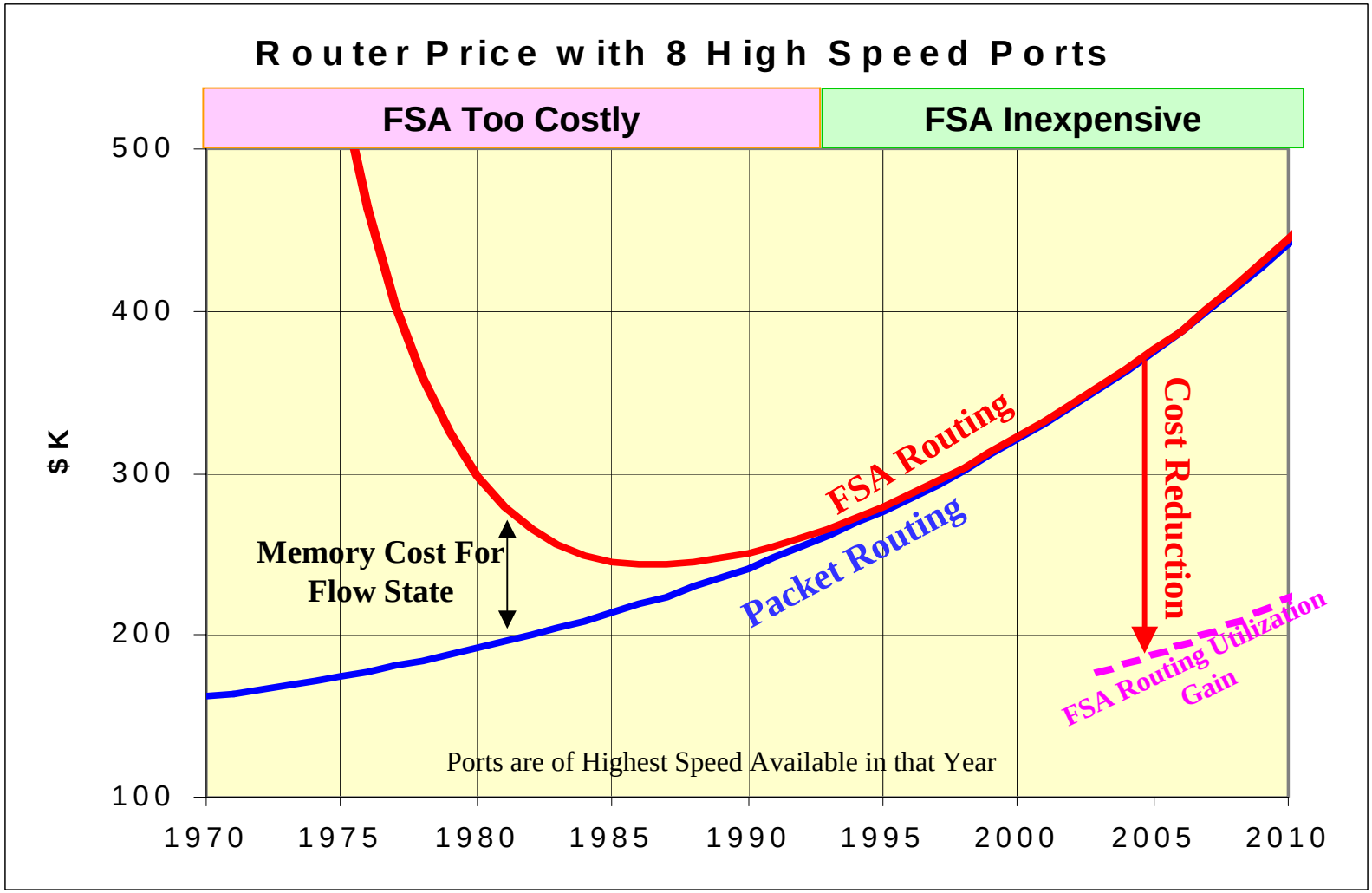
Economics of FSA Routing



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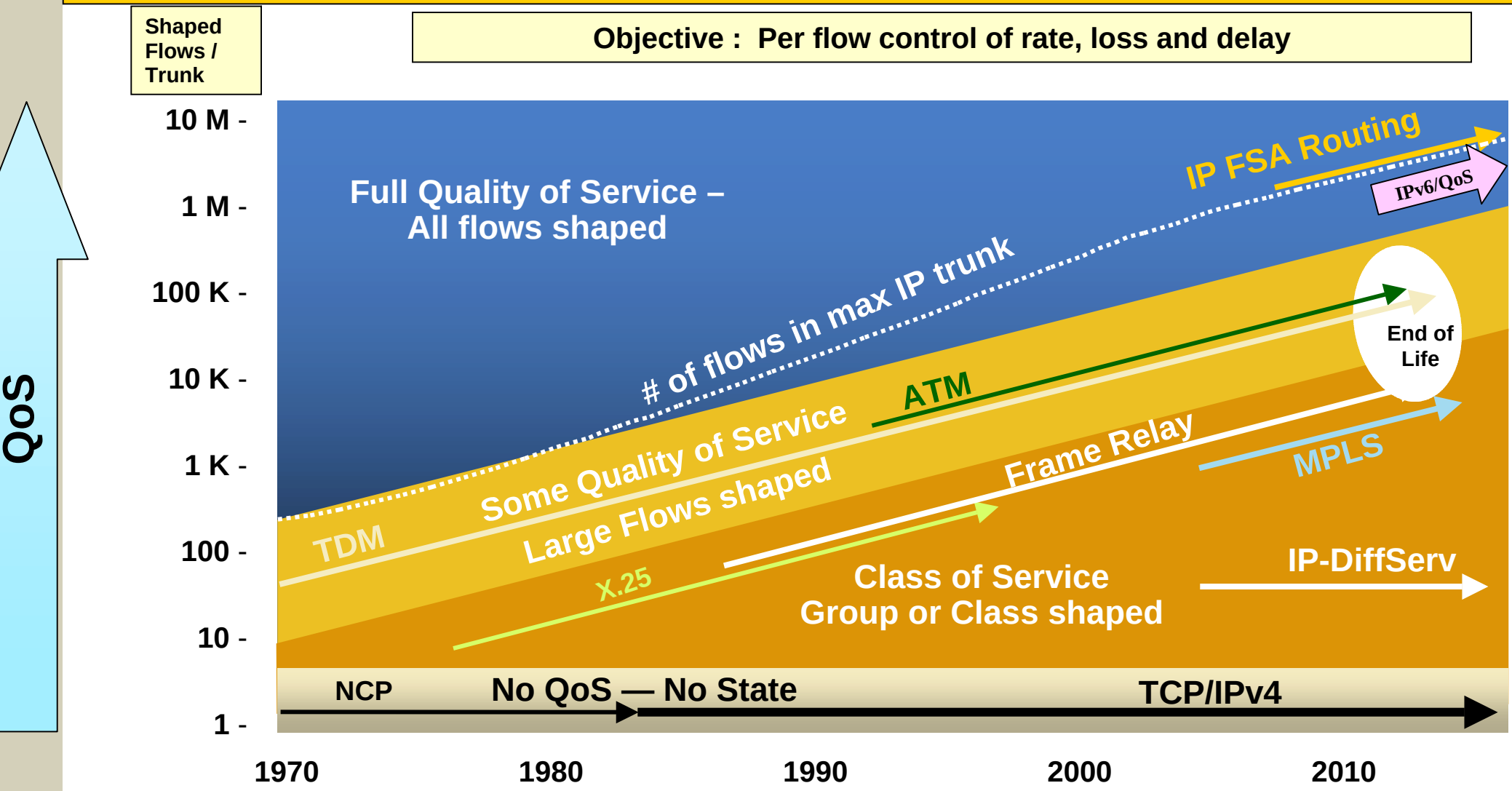
Telecommunications Protocols and QoS



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Identifying Flows with IPv4 or IPv6*

- Flows can be identified by rules looking at:
  - Protocol, Ports, Addresses, DiffServ and Physical port
    - Ports and Protocol unavailable with IPSEC or IPv6
    - With IPv6, Flow Label is available
  - After the first portion of a flow (say 1 MB) looking at:
    - Byte count, Average packet size, Duration, Rate
    - This allows reclassification as flow progresses
- After Measuring Traffic for Each User by Flow Type
  - Capacity for each flow type can be enforced or
  - Minimum capacity for certain flow types can be enforced
  - Reporting of total usage by flow type can be collected

**** IPv6 where no QoS option (TIA 1039) is used***

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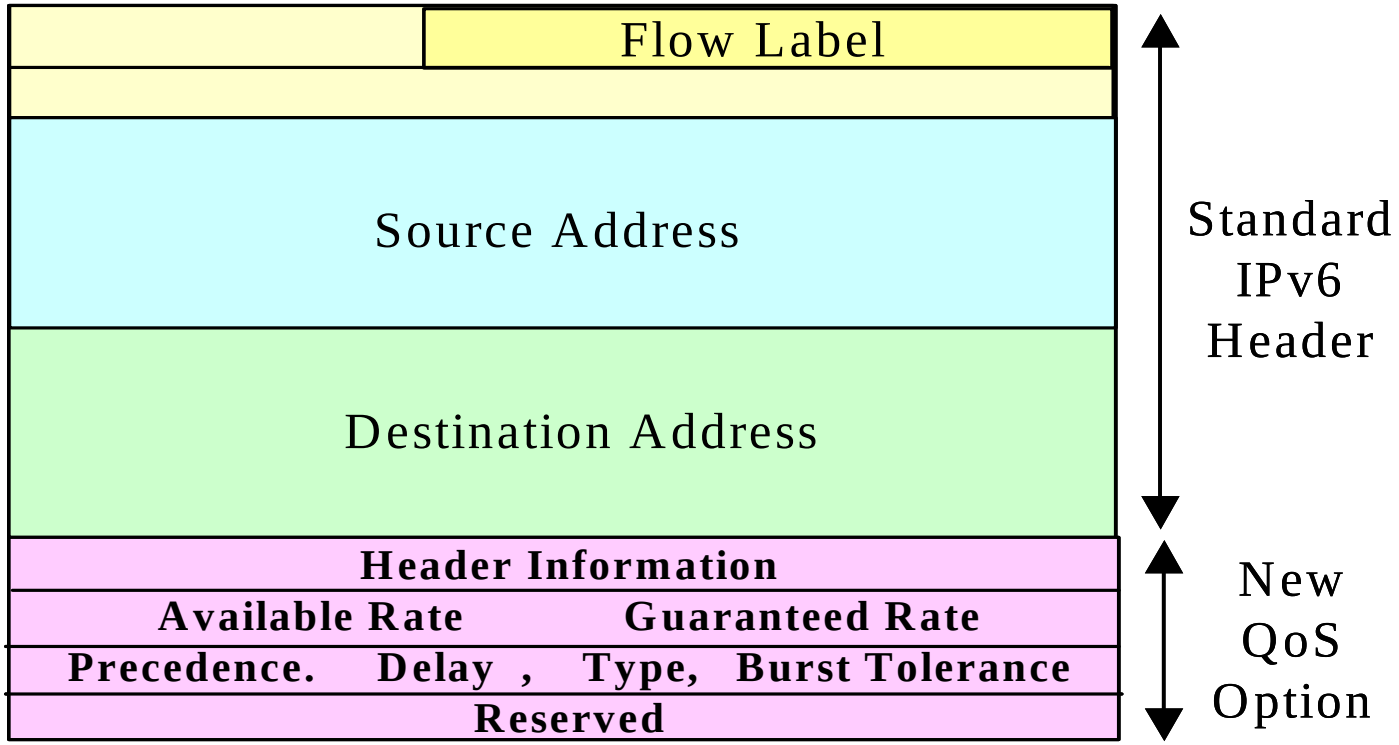
IPv6 QoS Signaling Standard (TIA 1039)

This IPv6 Protocol sets up a path across a network with each router confirming what rate and delay it can support so that the sender will have the best guaranteed bandwidth available with no congestion for the flow



- **Guaranteed Rate Setup**
  - **No Loss Video, Voice**
- **TCP Rate Feedback**
  - **Faster WWW, Files**

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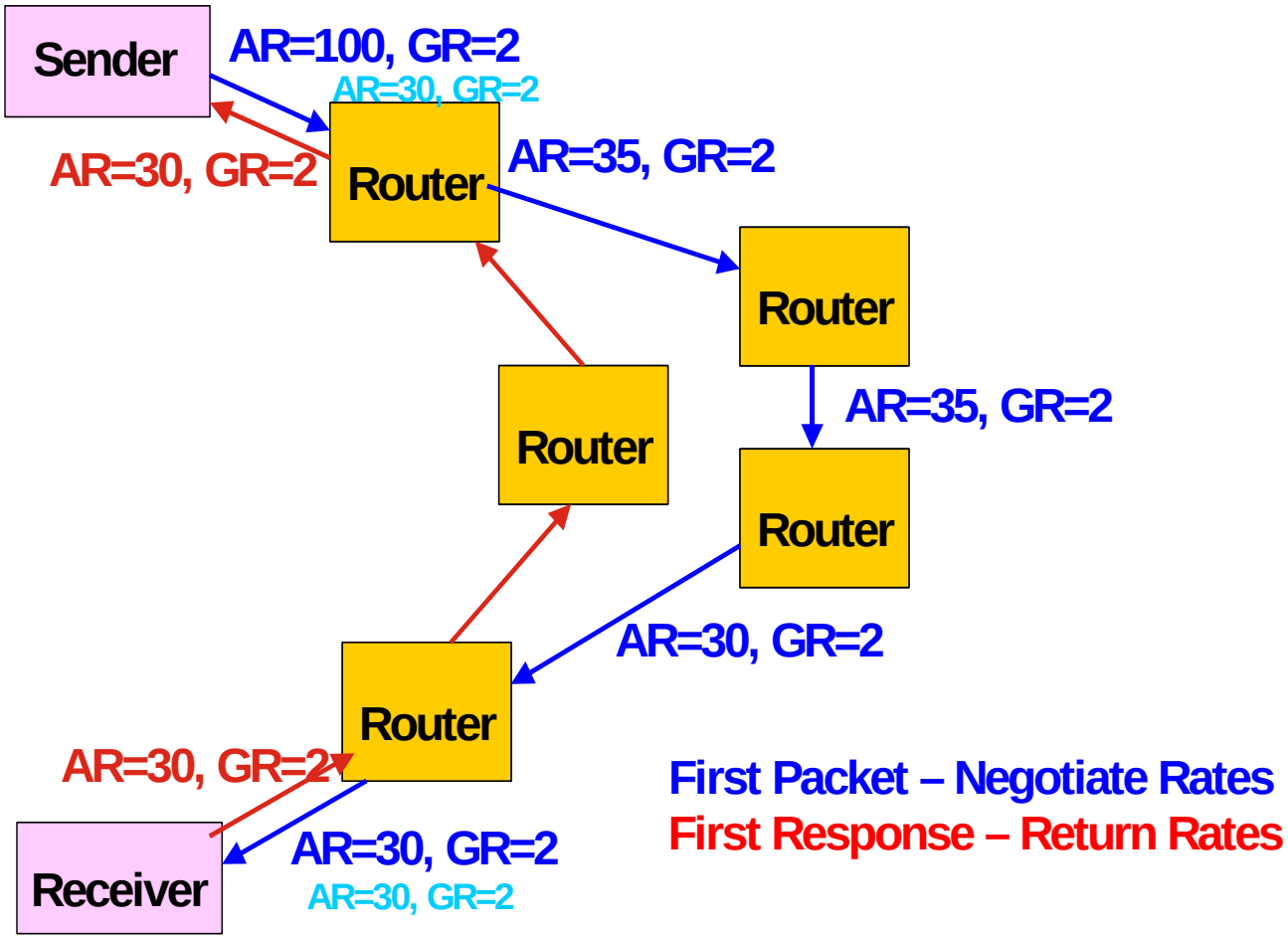
IPv6 QoS Signaling Standard - TIA 1039



- Uses IPv6 header options
- Signaling is between adjacent routers
- Each router confirms or changes the requests for a specific rate and delay
- Sets up a "best available bandwidth" path
- Enables a very high probability of delivery

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Applications
Enabled by FSA Routers

Traffic Control and Accounting
Premium Services – Video, Voice
TCP Speedup
High Trunk Utilization

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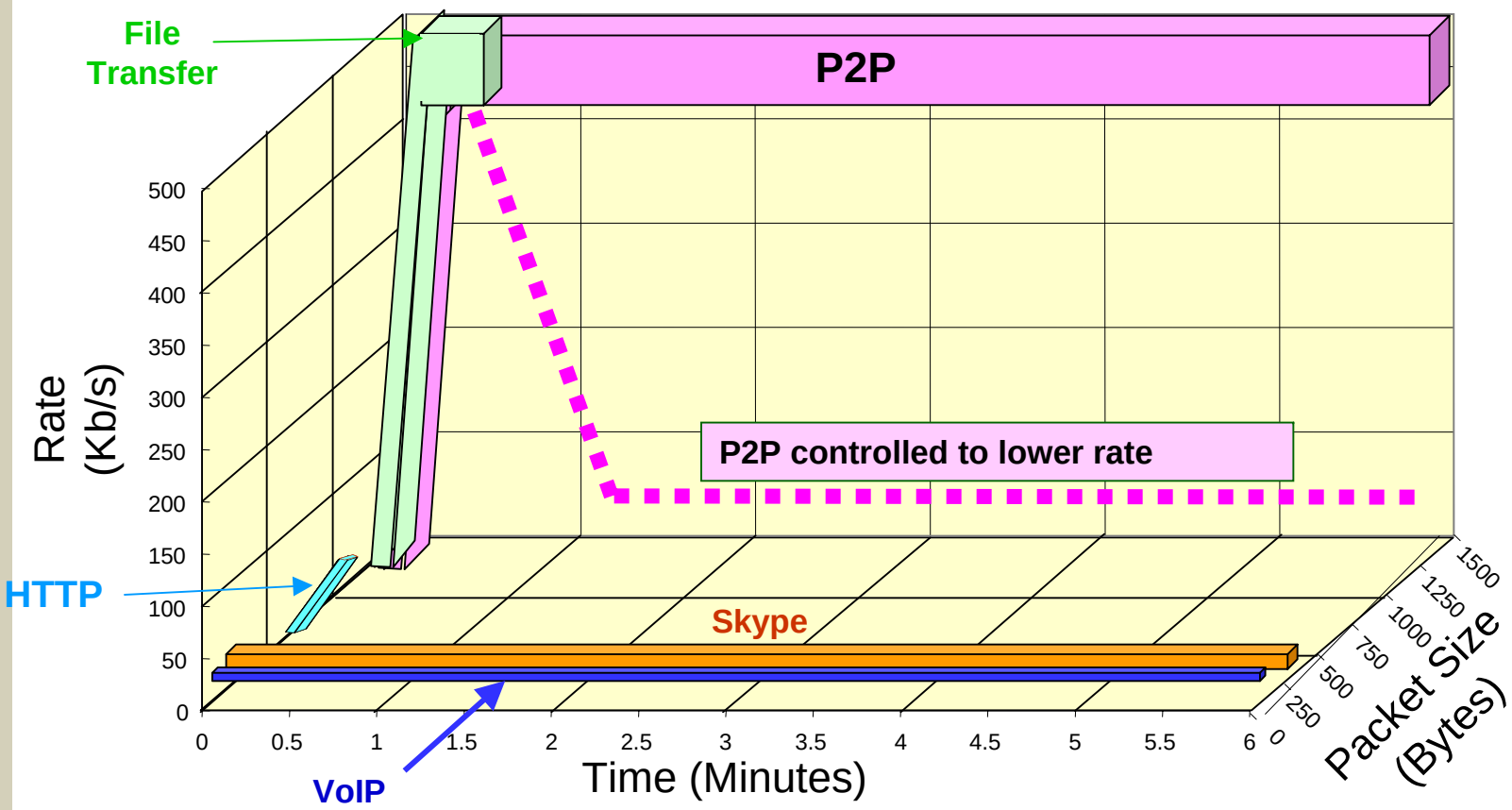
Flow State Aware – Can Identify & Control



Dimensions

- Rate
- Total Bytes
- Total Time
- Packet Size
- Port
- Protocol
- DiffServ

Controls

- Rate
- Priority
- Delay Var.
- Loss Rate

Flow State provides information about each flow

This permits the router to identify the type of traffic over time

Enables control of the rate, delay, or loss allowed for that flow

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Guaranteed Rate Flow Call Control

- **Guaranteed Rate Needed for Streaming**
  - **Interactive Video, Voice, Real Time Video**
- **Too many flows in highest priority**
  - **Every flow loses packets with DiffServ packet routing**
  - **All flows have increased noise – Worse with encryption**
- **Preferred control is to limit number of flows accepted**
  - **Without Precedence – Reject new flows if at capacity**
  - **With Precedence**
    - **Reject new low precedence flows if near capacity**
    - **Kill low precedence flows if needed**
    - **911 & Emergency Service, Military Override, Office, Home**

This is unlike TCP today where all flows get bandwidth reduced. It applies to UDP

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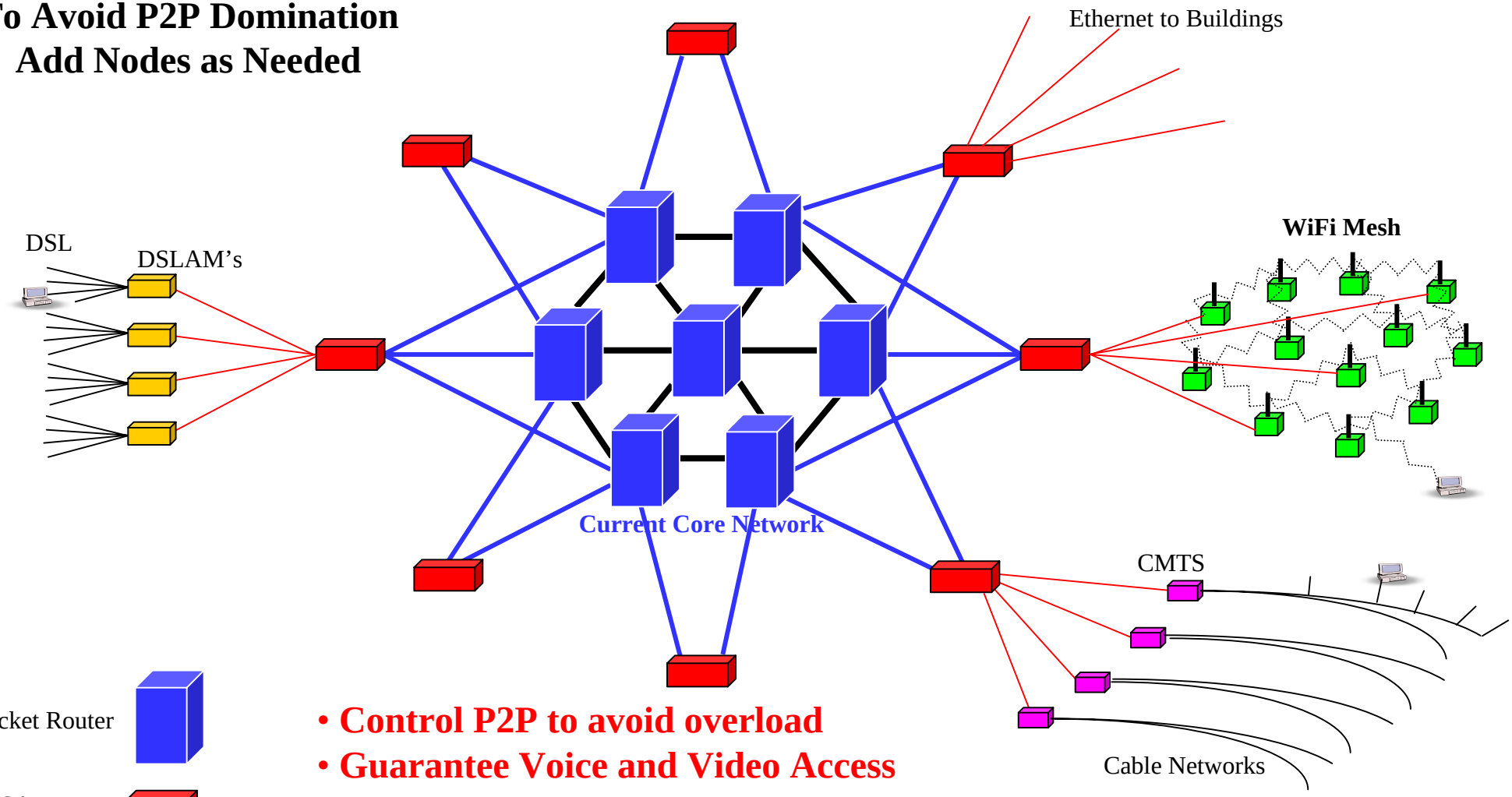
Traffic Control at Network Edge

To Avoid P2P Domination
Add Nodes as Needed



- **Control P2P to avoid overload**
- **Guarantee Voice and Video Access**
- **Provide Fair Access**
- **Support Different Service Levels**

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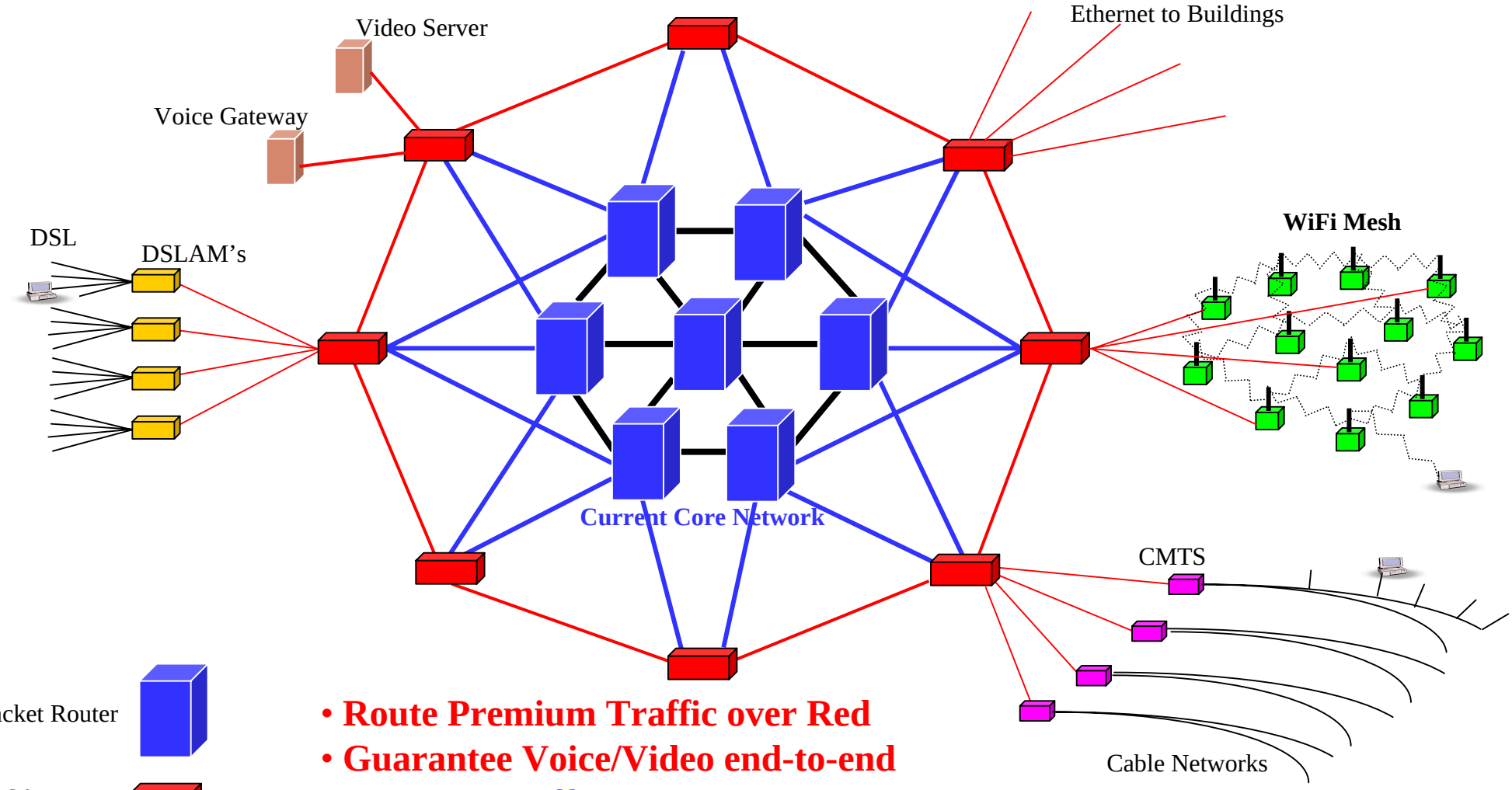
Add Premium Service Overlay



- **Route Premium Traffic over Red**
- **Guarantee Voice/Video end-to-end**
- **Route Best Effort over Blue**
- **Use all current capacity**

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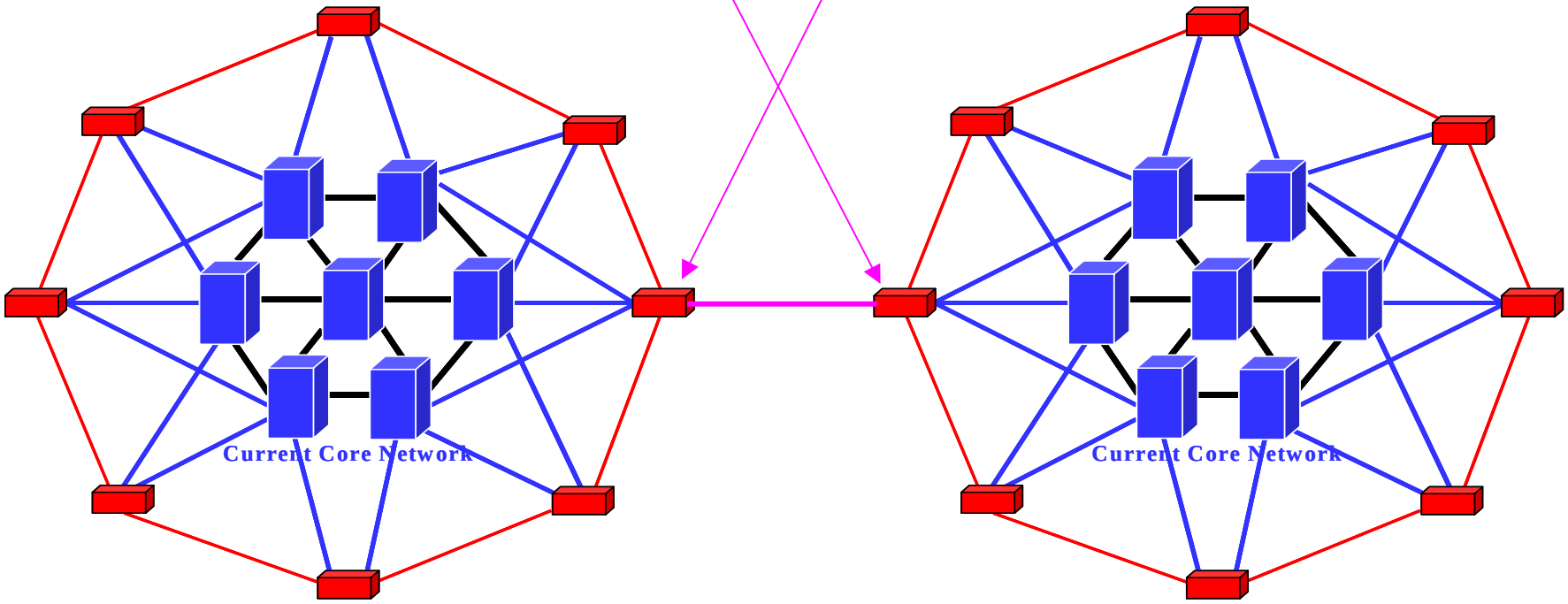
Network Gateway – Control and Accounting

FSA Router at Network Gateway
- **Classify flows by type and control rate by type**
- **Account for traffic by flow class and type**

When two Networks are controlling traffic, either can reduce or block traffic levels by class or type, thereby allowing the increase of the more favorable traffic types



The Ideal Structure is to control traffic at the user edge and each Gateway to another Network
The first and simplest step is to use FSA traffic control at the Network Gateway

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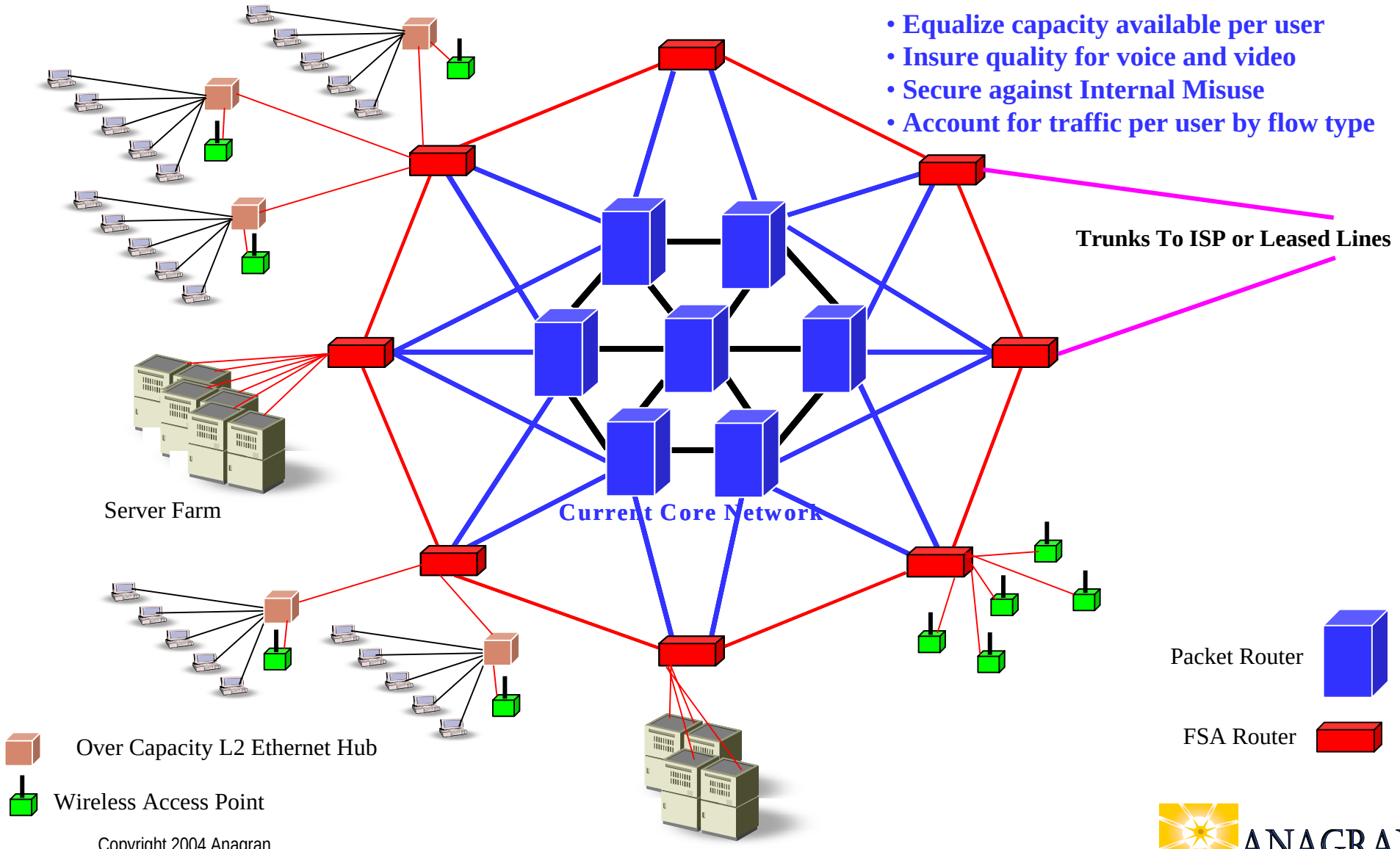
Corporate Use of FSA Routing Control



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FSA Impact on Security and Accounting

- With FSA, every flow is measured
  - Packets, Bytes, and Time plus the QoS used
- This flow information can be accumulated per user
- Flow traffic can be reported to provider for
  - Accounting – supporting tiered pricing or class pricing
    - If User Price Class is provided, enforcement is automatic
  - Security – Protect against DDOS attacks automatically
    - Watch for user overload, control rate or acceptance of flows
    - Watch for new traffic flow patterns – suppress and/or report
    - When a destination is under attack:
      - Detect offending flow types
      - Limit those flow types, either by flow rate or count as necessary

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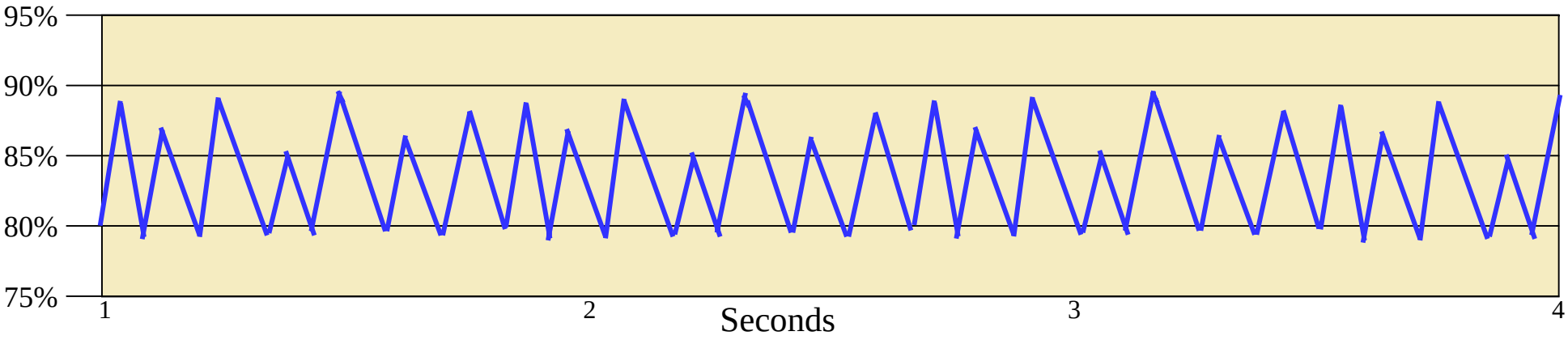
Trunk Utilization Improved 3:1



- **Pictorial view of trunk utilization exiting from an FSA router**
- **Trunk is 2.5 Gbps with typical IP traffic mix, TCP and UDP**
- **Average number of active flows are 350,000**
- **Every flow is controlled individually**
  - **TCP flow rate is controlled to keep total under 90%**
  - **UDP flow acceptance is controlled to limit UDP to 45%**
- **Only possible with a fast load measurement feedback system**

Total utilization averages 83% with FSA
vs. a US Internet average of 27% utilization

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Unique FSA Features

- Cost Reduction – 3:1
  - High Utilization through Rate Management – 1/3 cost`
- IPv6 with QoS Signaling Protocol Extensions
  - TIA 1039 Standard will enable End-to-End QoS setup with IP
  - QoS Signaling has Guaranteed Rate, CAC and Precedence (911)
    - Enables Video Conferencing, 3G Phones, Emergency Override
  - TCP Rate Feedback – 10:1 faster for Web access – Critical for Satellites
- End-to-End QoS Control per Flow and per User
  - Integrated Video, Voice and Data over IP – Triple Play
  - P2P and other Flow Type Traffic Management
    - At Terminal, Corporate Edge, Network Edge, and Network Gateway
  - Enables Tiered or Service Type Pricing with Automatic Enforcement
  - Provides Flow records for accounting and/or security management

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