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Network Improvements for Application Support

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The Internet as it really is

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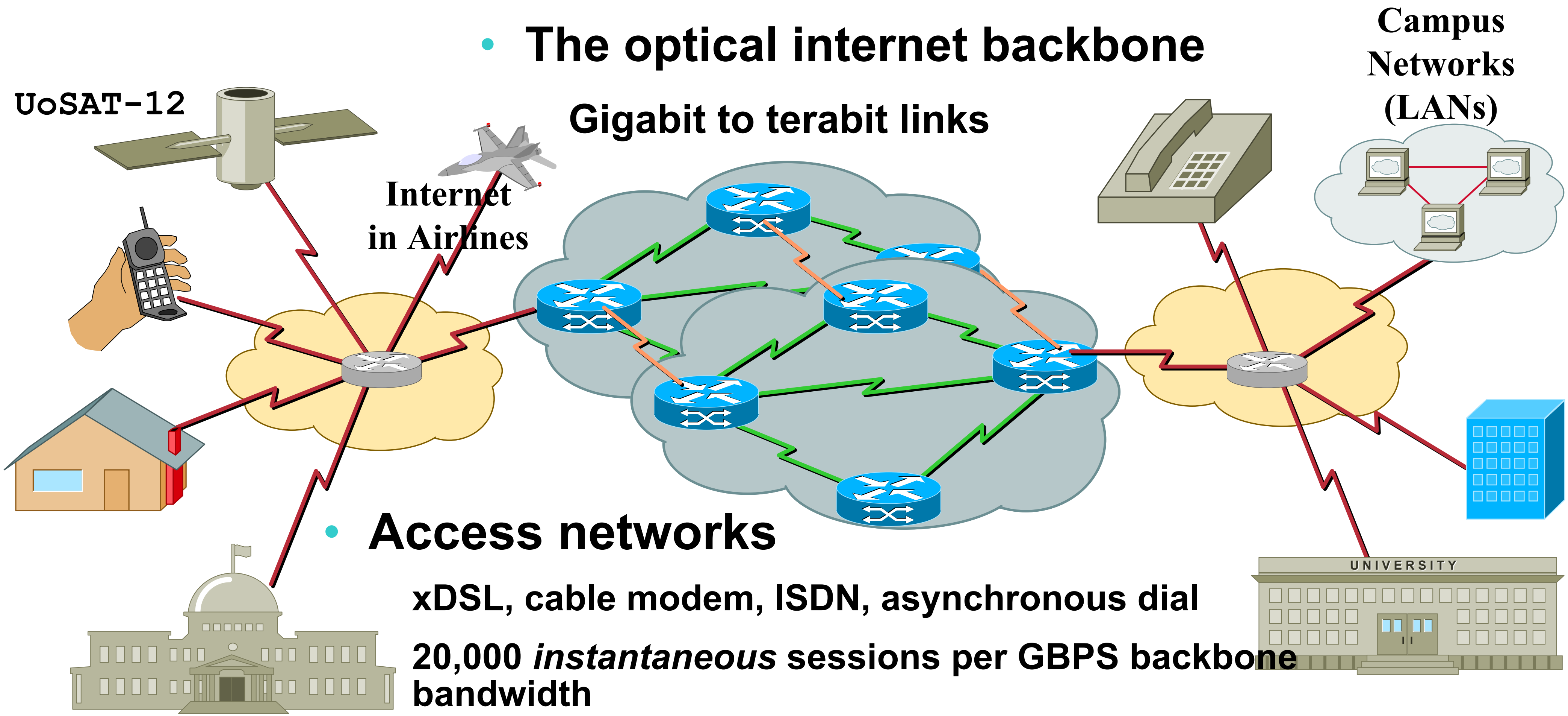
- **The optical internet backbone**

  Gigabit to terabit links

- **Access networks**

  xDSL, cable modem, ISDN, asynchronous dial

  20,000 *instantaneous* sessions per GBPS backbone bandwidth



There are more of us out there

- Billions and billions of new Internet devices
- Billions of new Internet users
- Internet available everywhere, all the time (wired, wireless, mobile,…)
- Convergence of all communication on the Internet (business, personal, entertainment, public services,…)

Client/Server Architecture is breaking down

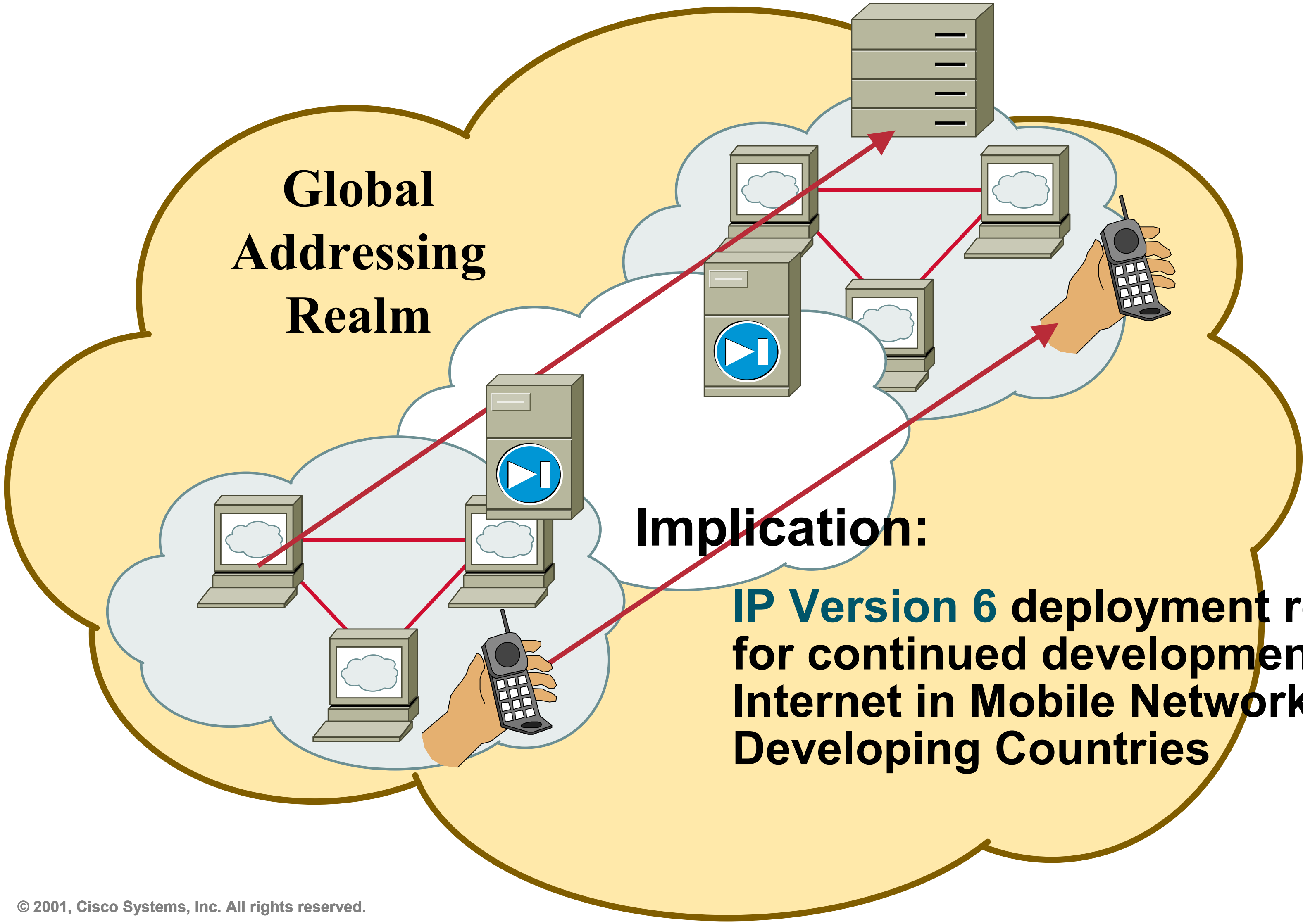
- **For web:**

  Sufficient to have clients in private address spaces access servers in global address space

- **Telephones**

  need an address when you call them, and are therefore servers in private realm

Need an end to end naming and addressing architecture



Implication:

IP Version 6 deployment required for continued development of Internet in Mobile Networks, Developing Countries

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IPv6 Innovations

Plug-and-play

- **One of the nice things about AppleTalk:**

  You can plug the device or computer in, and it just works

- **One of the not-so-nice things about IPv4:**

  You can plug the device or computer in…

  Configuring, and reconfiguring, can be hard

  DHCP helps a lot, but it requires properly configured servers

- **IPv6 allows for**

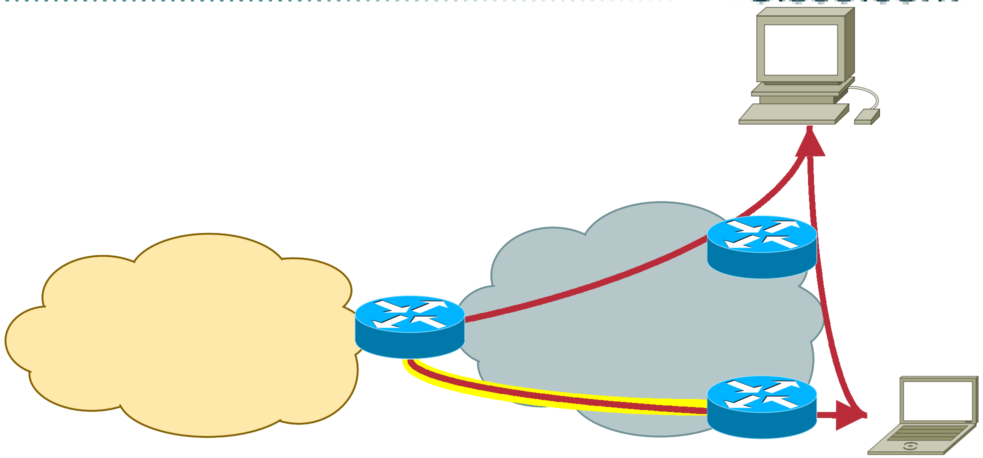
  Significant level of autoconfiguration

  Automated network renumbering

  Arbitrary device addressing within topological limits

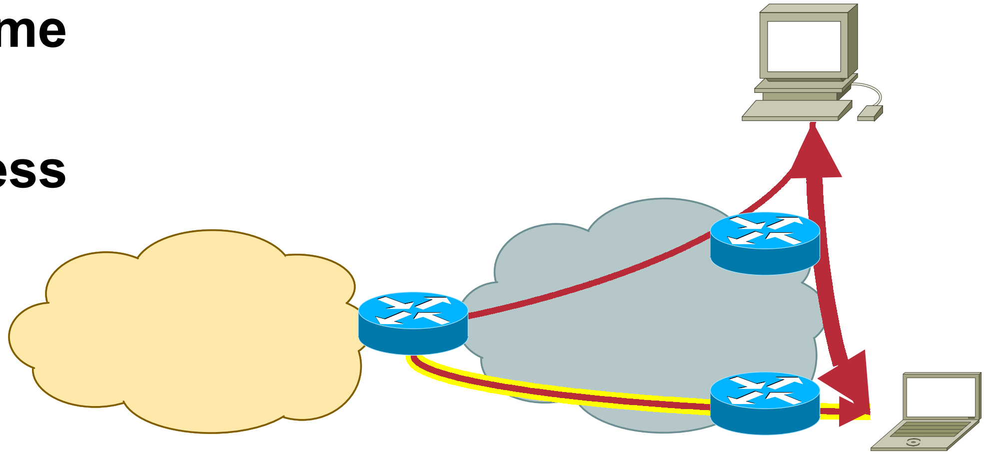
Mobility

- **IPv4 Mobility**
  - **Permits device to move using same home address**
  - **All communication through Home Agent**
  - **Foreign Agent must be a router**



Dogleg Routing

- **IPv6 Mobility**
  - **Permits device to move using same home address**
  - **Communication via care-of address**
  - **No Foreign Agent required**
  - **Security Issues:**
    - **Session hijack**
    - **Duration of Switchover**



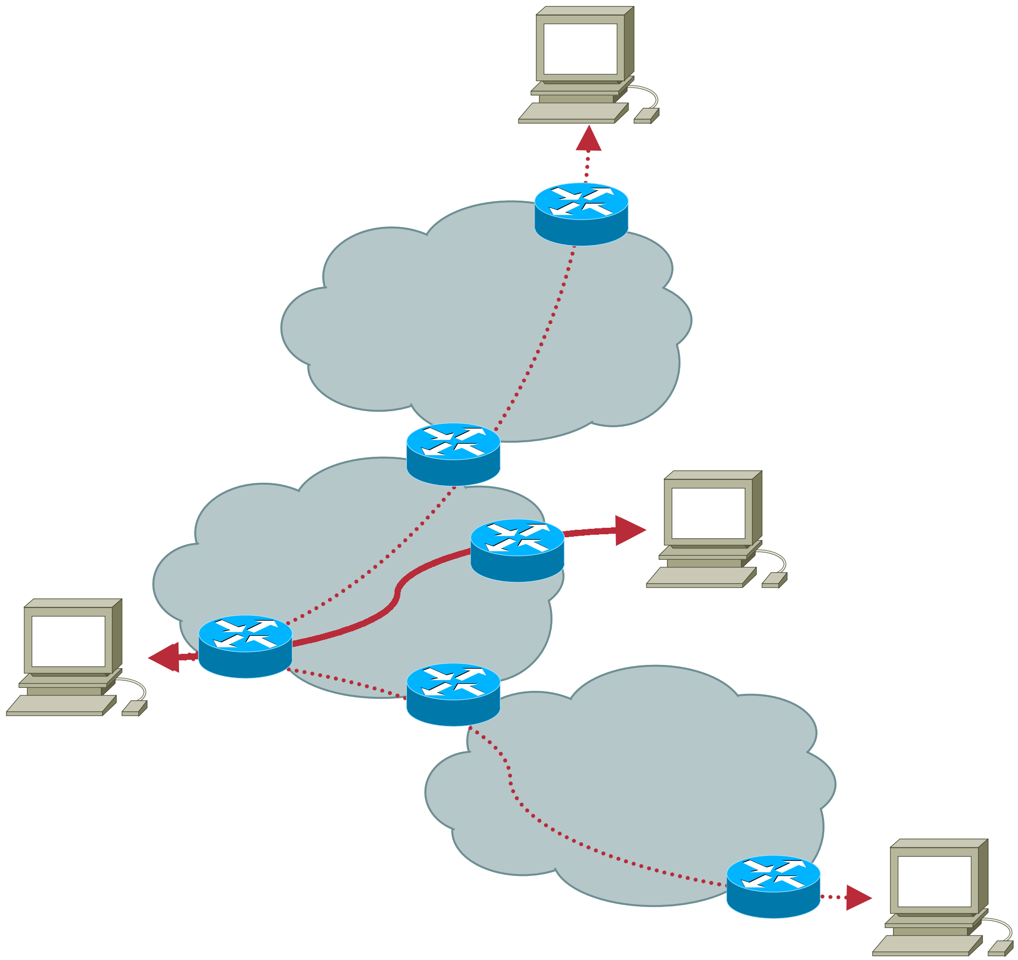
Optimized Routing

IPv4 Anycast

- **Addressing and Naming of Applications**

  One of the nice things about NetWare: Service Location

  Today: DNS lists several addresses for a name, but no information to help select a server



Anycast: what we'd really like to model

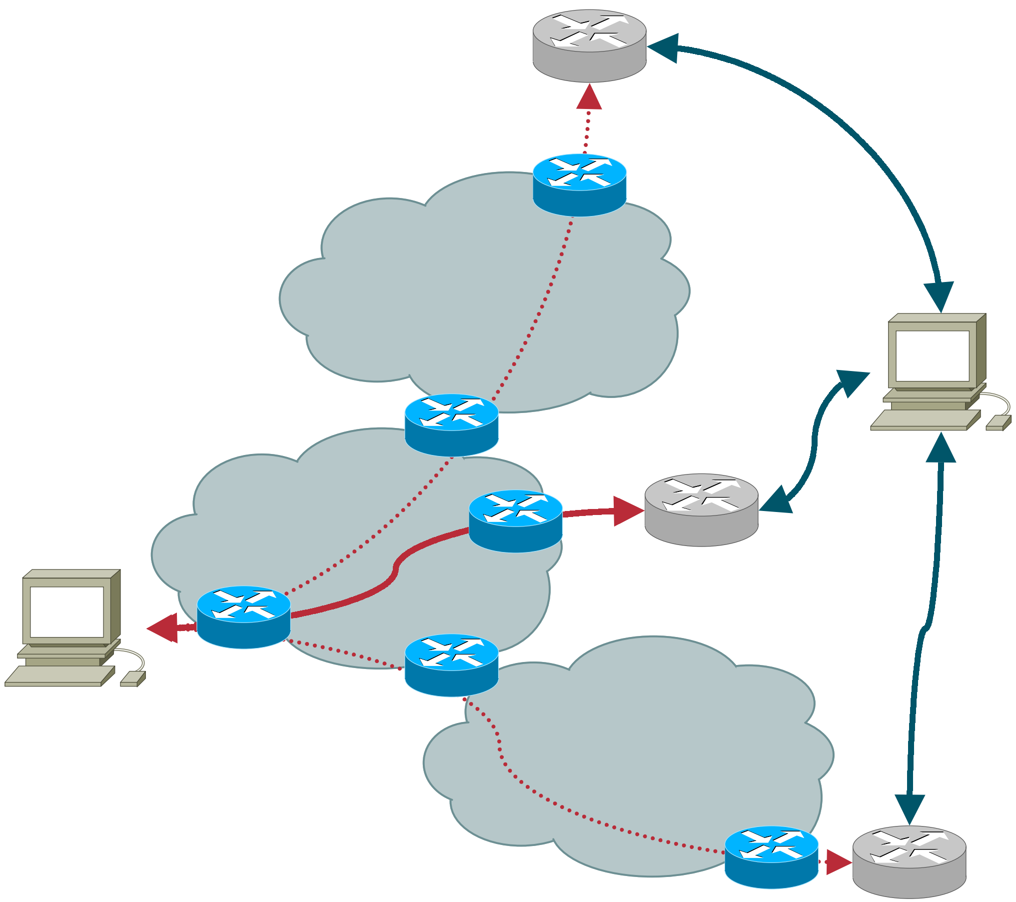
- **Model:**

  The service looks like one computer reachable through many routers

- **We would really prefer:**

  DNS lists one address

  Network magically selects the right server instance



IPv6 Anycast

- **Proposal:**

  DNS lists one address,

  Servers are “routers” to that address

  •DNS for service name,

  •Common address for service location

  •Topological address for specific access

- **Issues:**

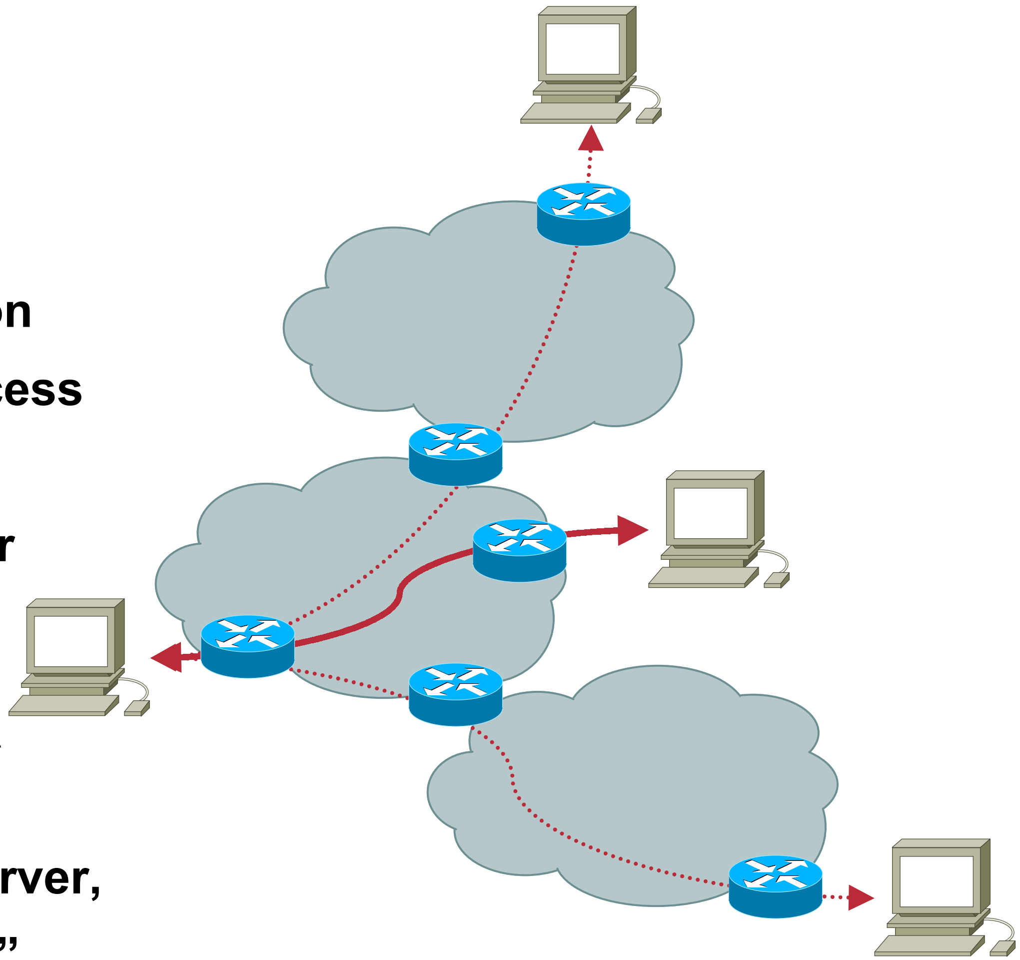
  Route changes can change which server you use in mid-transaction

- **Solution:**

  Treat server as a *mobile device which is currently stationary*

  Connect to “home address” to select server,

  Thereafter talk to fixed “care-of address”



Security issues

- **IPv6 enables end-to-end use of IPsec protocols (because it eliminates NATs),**
  - **Plus for security, although IPsec also exists in IPv4 Internet and is widely used for VPNs**
    - **Authentication ("you are the person who knows this key")**
    - **Antidote to session hijack ("you are the same person I was just talking with")**
    - **Privacy (encryption, using symmetric or public key technology)**
- **IPsec authentication dependant on key distribution infrastructure, which is not currently a solved problem**
  - **Affects mobility, anycast, secure communication in general**

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Quality of Service
IPv4 and IPv6

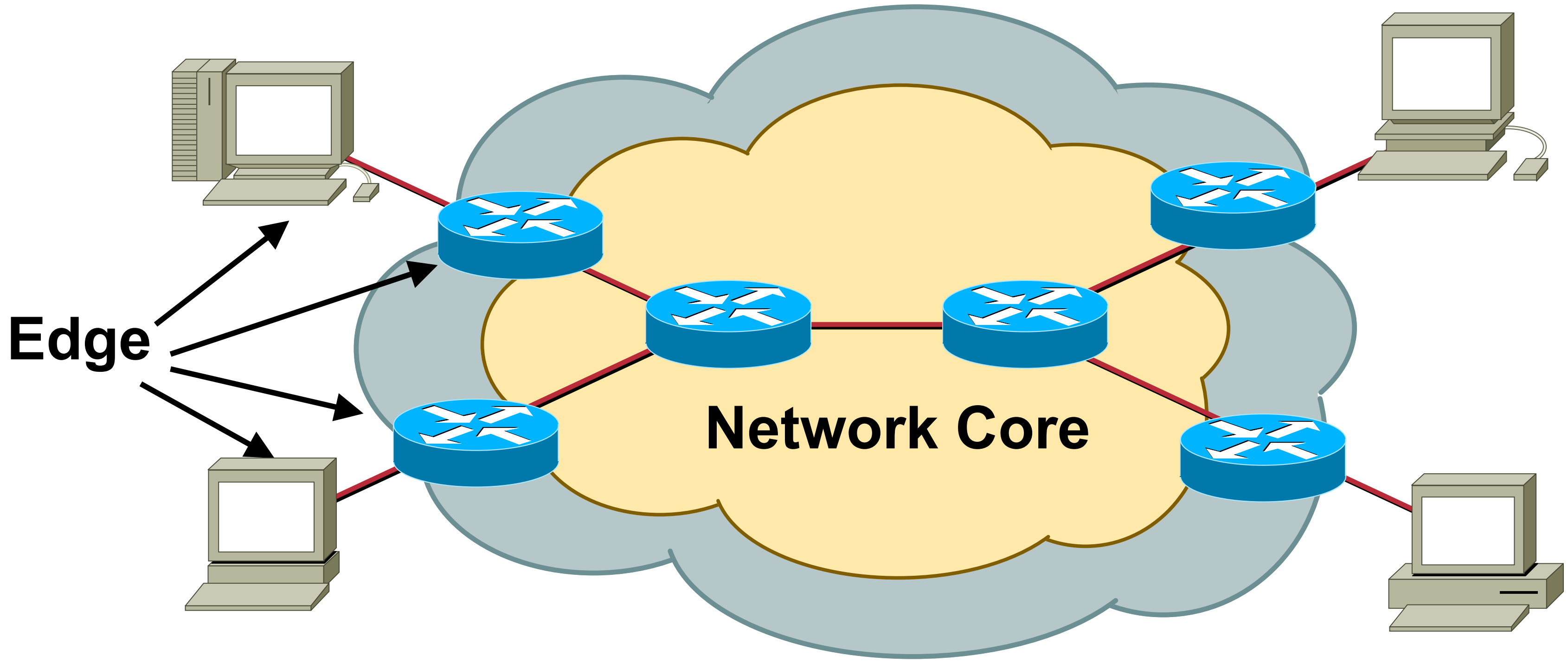
Parekh and Gallagher's Proof

- INFOCOMM '93
- One must have at most a predictable amount of traffic in the network
- One must have predictable traffic delay in each network element
- Given these, end-to-end delay of a host to host message is predictable

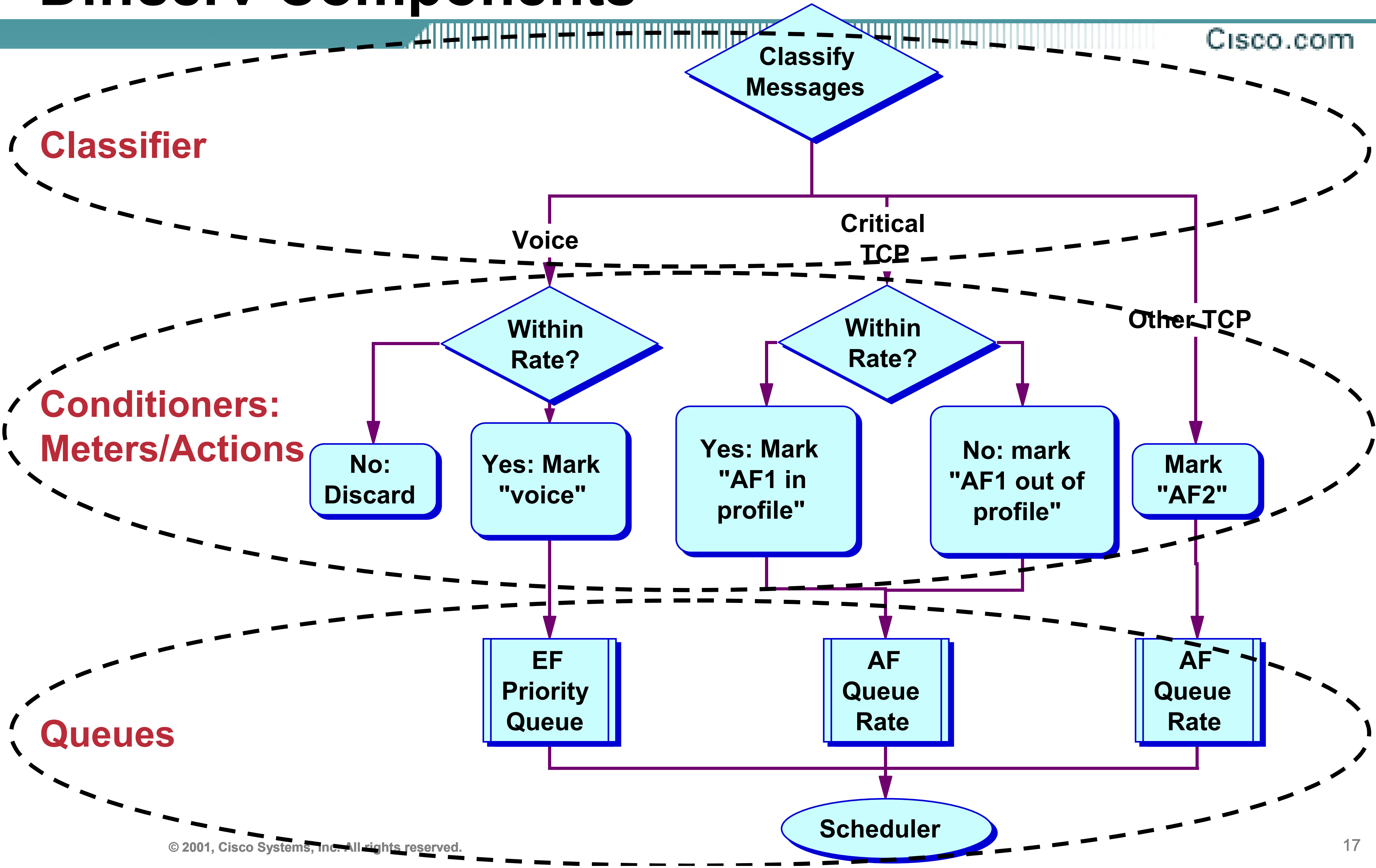
Premises of QoS Technology

- DSCP: identifies a traffic aggregate
- Policy:
  - Separate from aggregate
  - May identify several characteristics
    - Minimum or maximum rate
    - Jitter (variation in latency)
    - Probability of loss

Network Edge, Network Core



Diffserv Components



TCP Technology Issues

- **Single drops communicate from network to sending host**

  "You need to slow down"

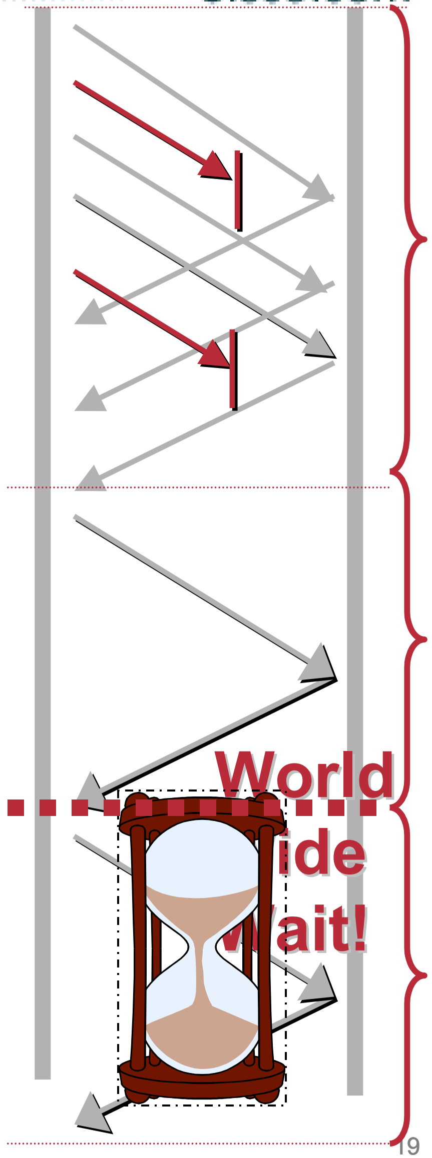
- **Multiple drops in round trip trigger time-outs**

  "Something bad happened out here"

Multiple Drops in TCP

- **In the event of multiple drops within the same session:**

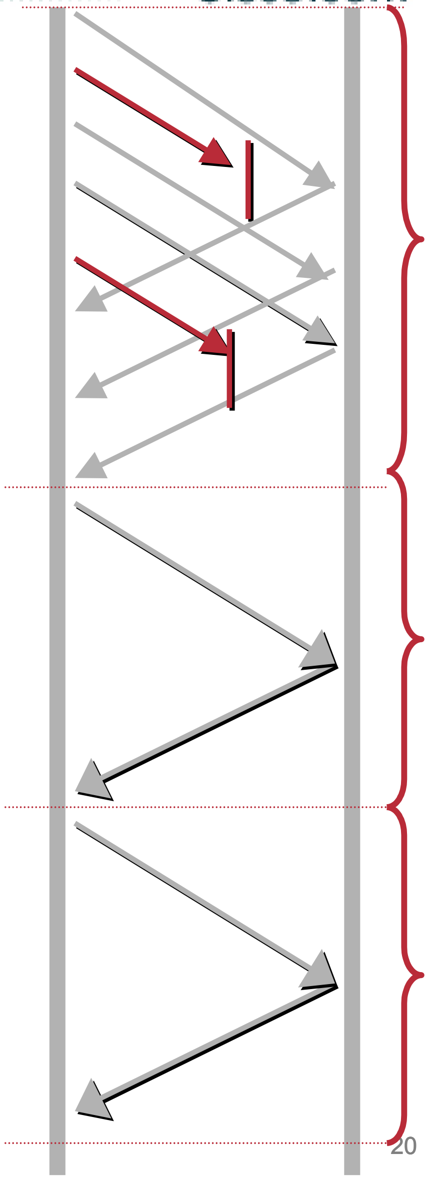
  Vegas/Reno TCPs wait for time-out



Fast Recovery Phase

- **Faster retransmission under multi-drop case**

  New Reno "fast retransmit phase" sends one dropped message per RTT instead of one per time-out



Multiple Drops in TCP

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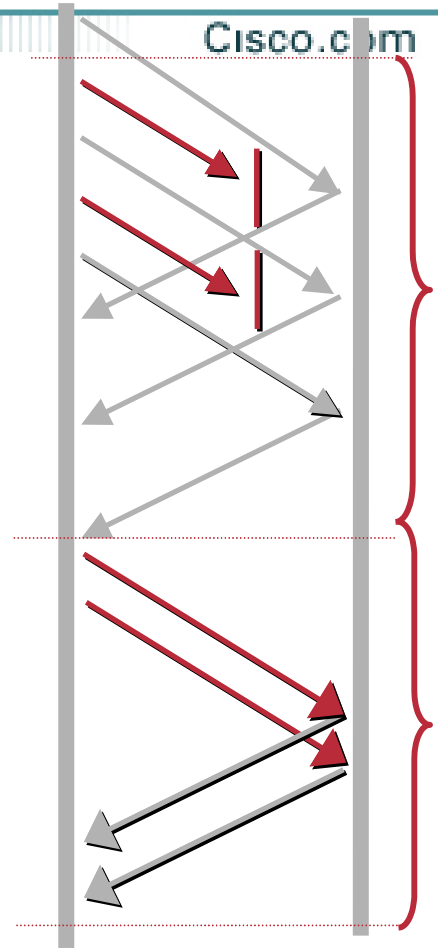
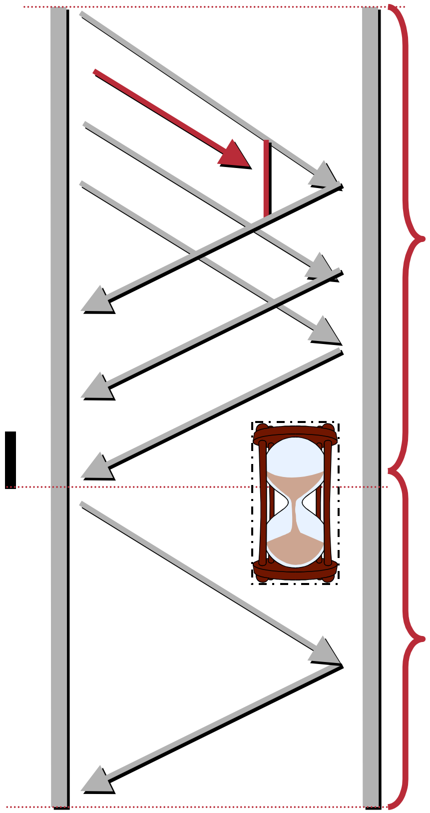
- **In the event of multiple drops within the same session:**

  Selective acknowledge may work around (but see INFOCOM '98)



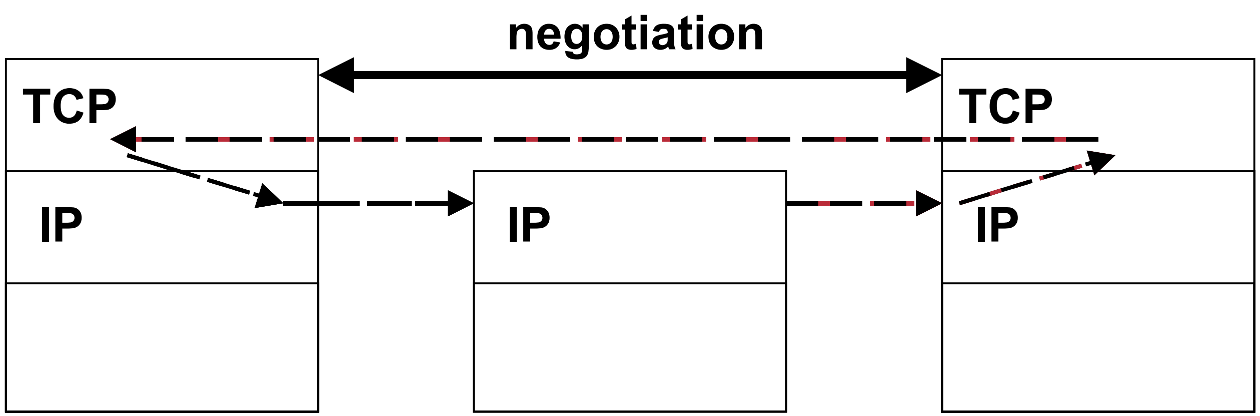
Still, drops result in timeouts

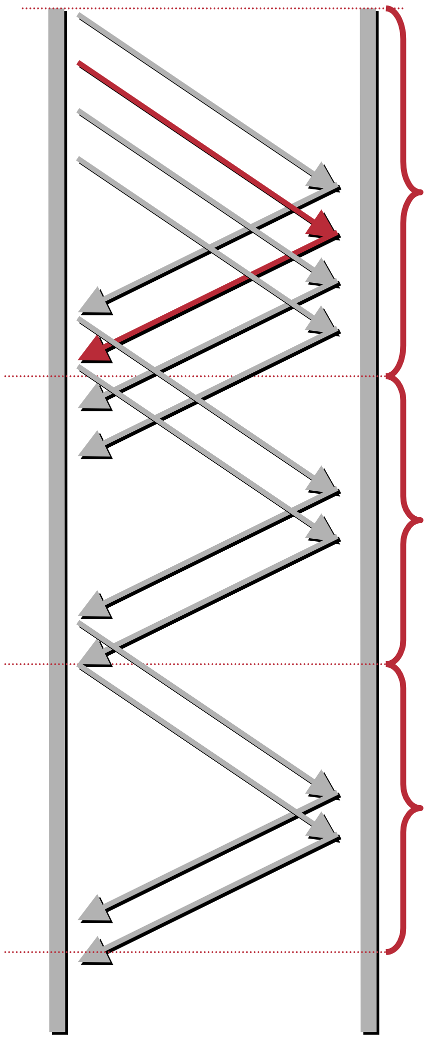
- **Two effects of a drop:**
  - ~90% case: wait for timeout before retransmission
  - Next RTT sends only the retransmission
- **Wouldn't it be nice if we could control congestion without dropping traffic?**
  - Customer desire
  - Complaint about Internet



RFC 3168: Explicit Congestion Notification

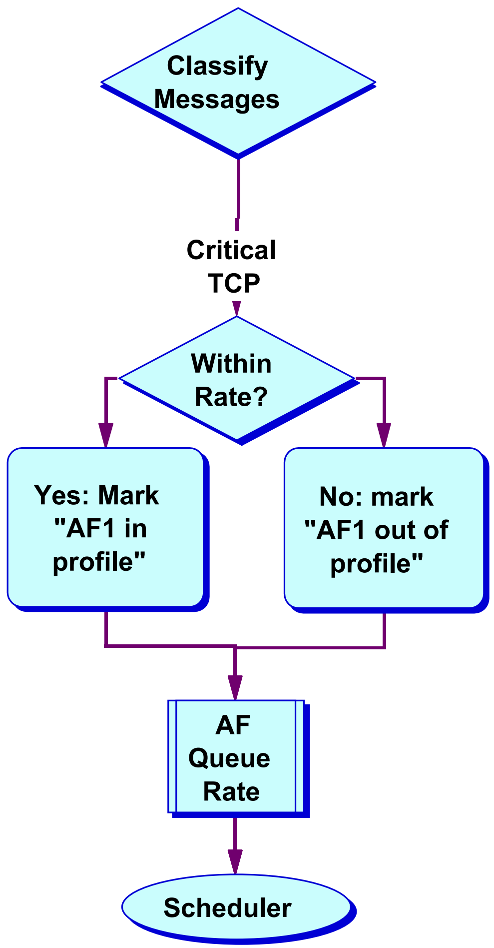
- Manage congestion without loss
- Supported in Linux 7.1





Assured Forwarding PHB, on the edge

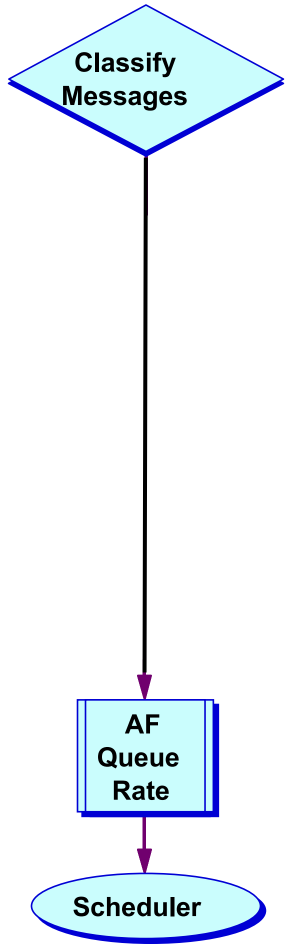
- Rate-limit (MQC Police)
  - Test arrival rate against threshold
  - Conform action is "mark one way"
  - Exceed action is "mark another way"
- External use of WRED required to create actual feedback
  - Clearly identifies the excess traffic
  - Setting WRED min-threshold for excess lower causes it to drop earlier



Assured Forwarding PHB, in the core

- **Arriving traffic has been pre-metered**
- **Traffic belonging to the same PHB (AFx1, AFx2, and AFx3) goes to same queue**
- **Different min-threshold by DSCP**
- **Schedule using rate for class**

  not priority



Best Effort Service in Simple IP Networks

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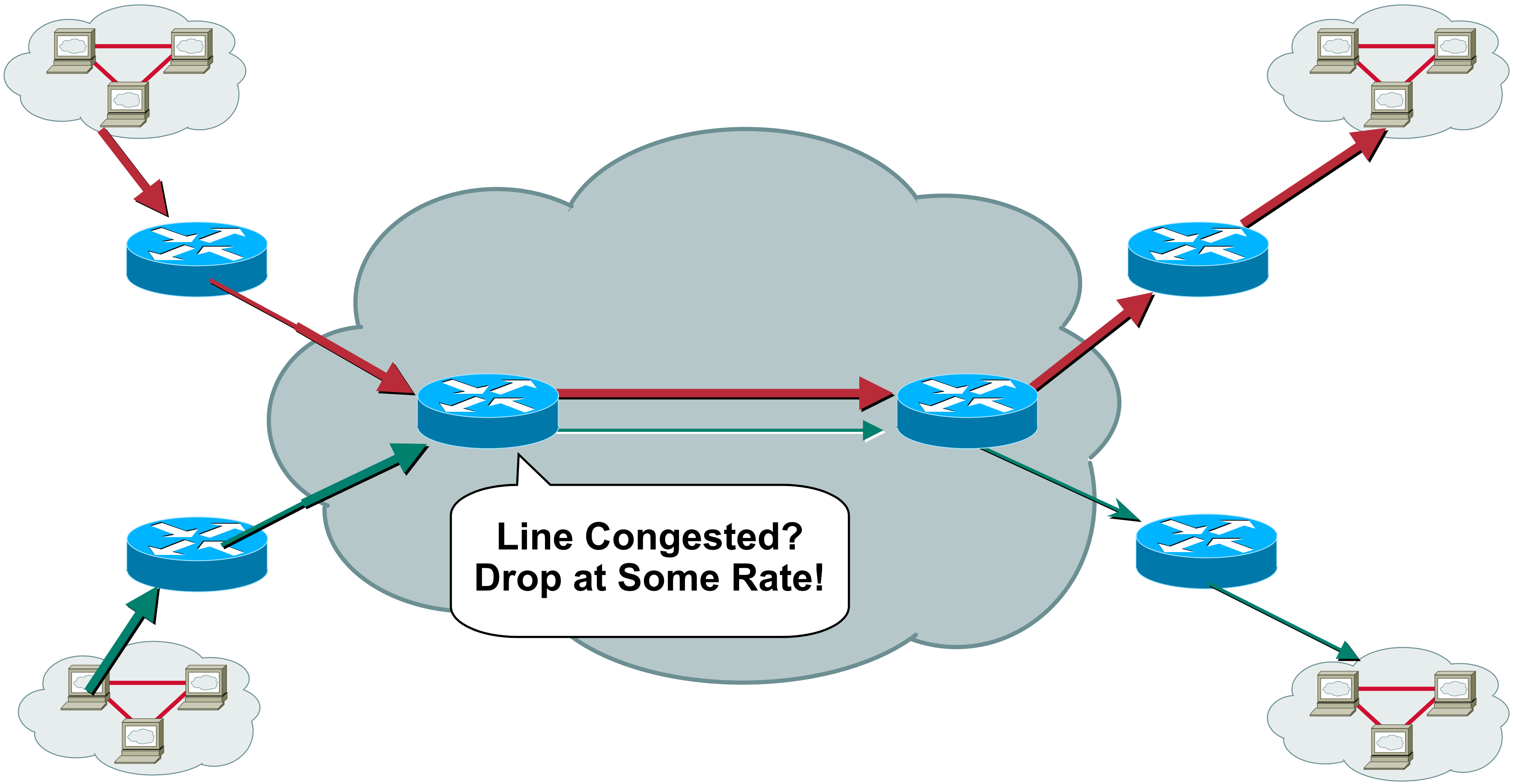

Assured Service in Simple IP Networks

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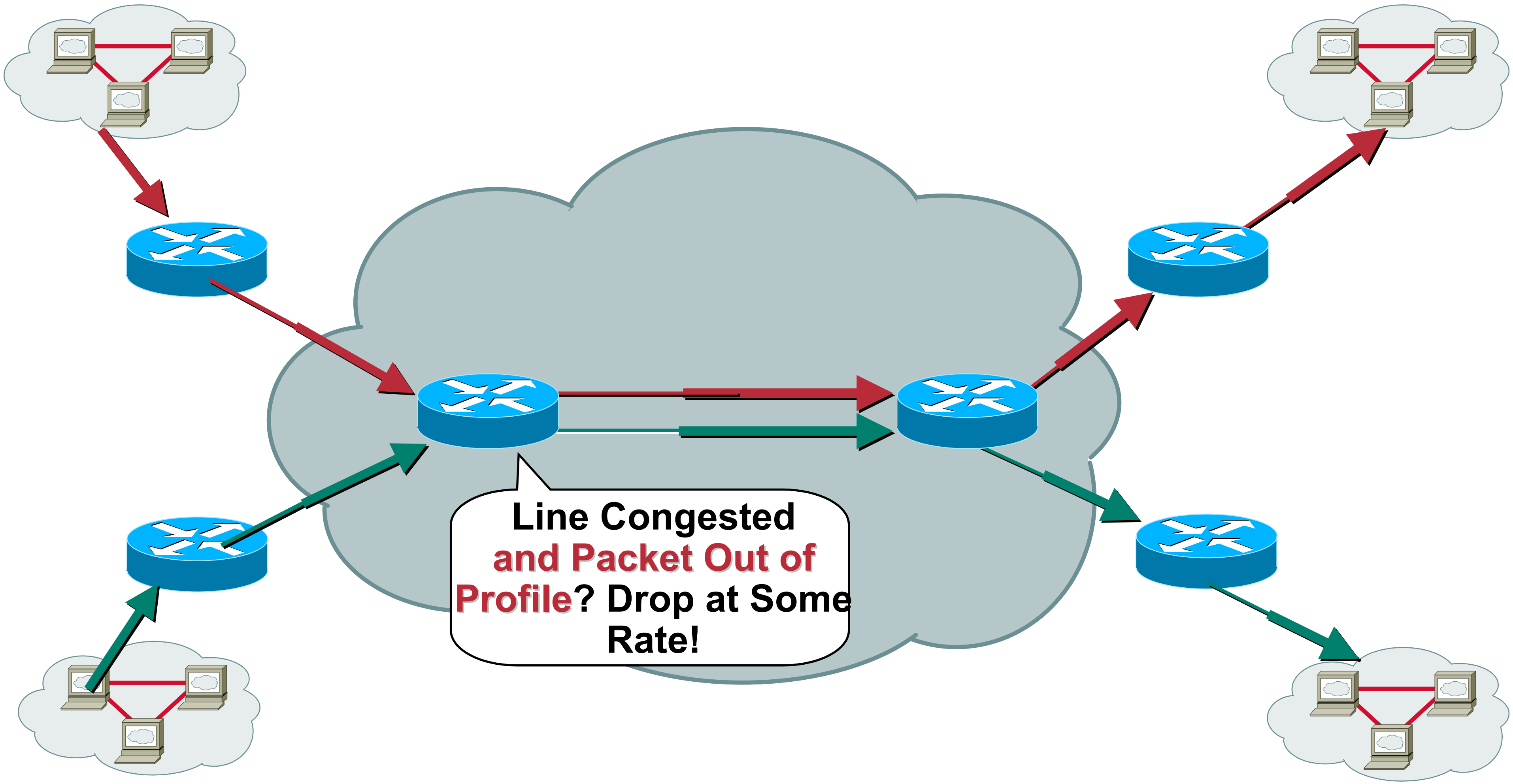

H.323/H.248/SIP/MGCP Voice and Video

- **Voice**
  - Constant bit rate when sending
  - Relatively small messages (44–170 bytes)
- **Video**
  - Generally high variable bit rate
  - Controlled by codec efficiency on picture
  - Message size is generally the MTU

Video: Playback Point

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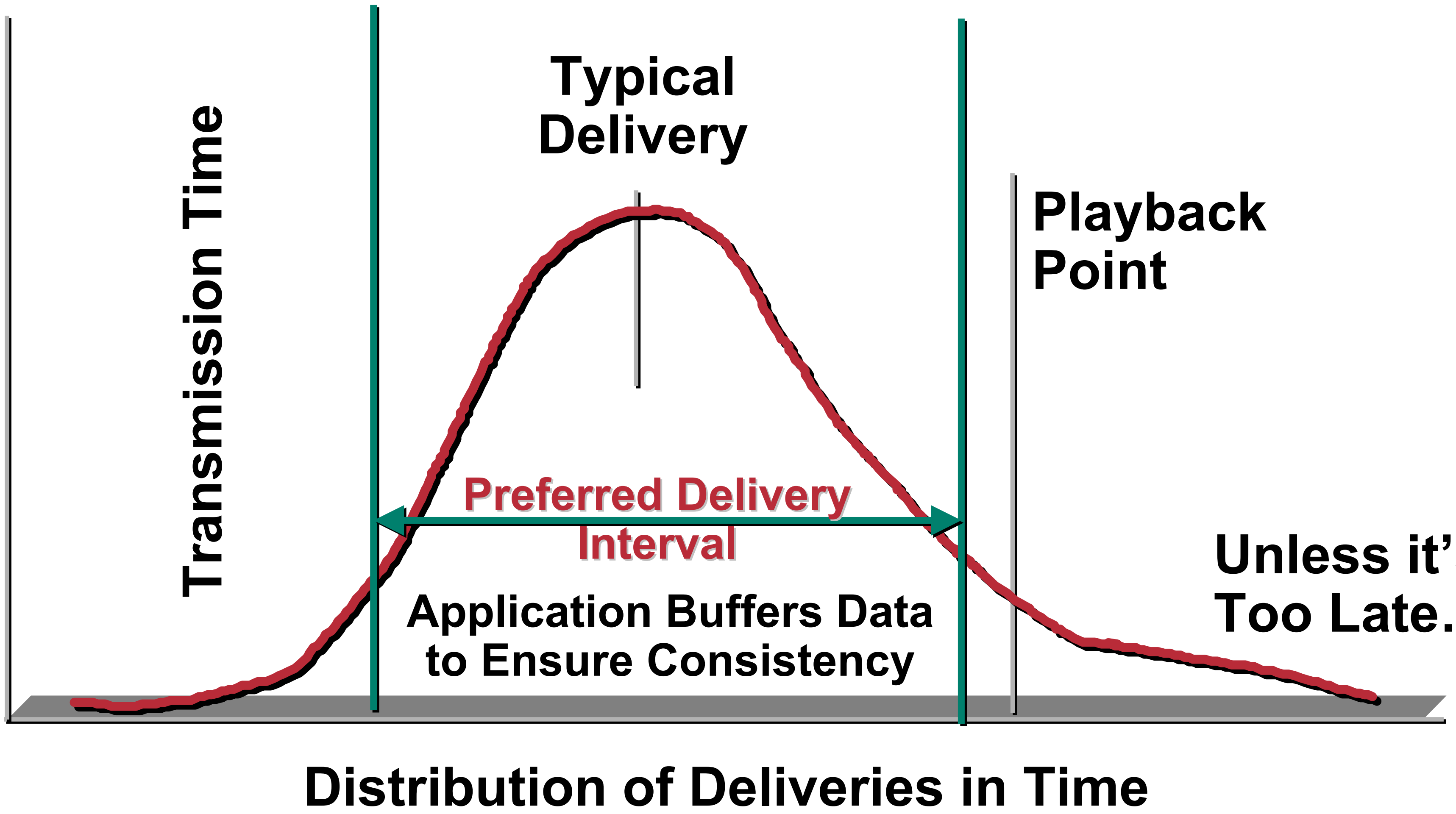

But Voice/Video Are Very Predictable

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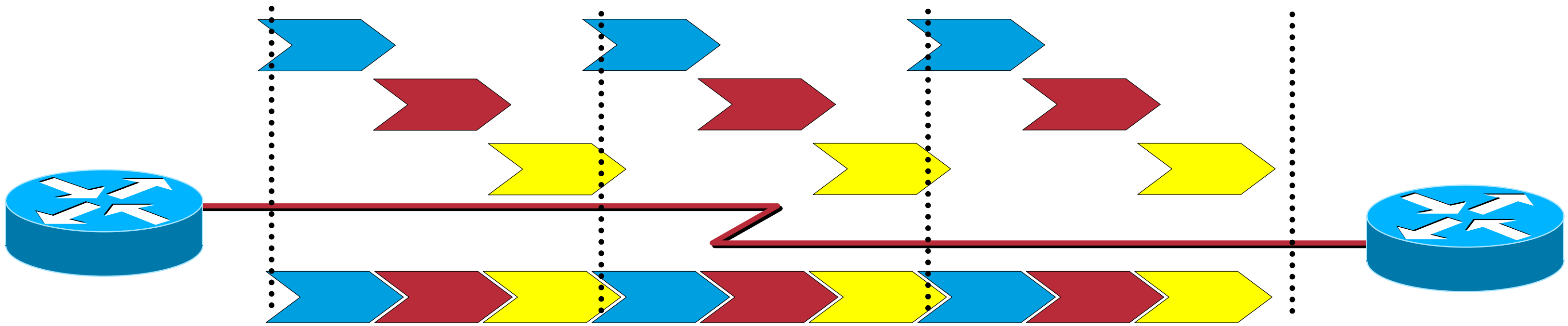
- Codecs generally conform to a dual token bucket scheme, with constant "deadline" from a scheduling perspective (CSZ, SIGCOMM '92)
- This means that traffic with the *same deadline* can use the same FIFO queue
- Any resemblance to TDMA is purely accidental, but happens to be why ATM voice and IP voice work



The EF PHB, on the edge

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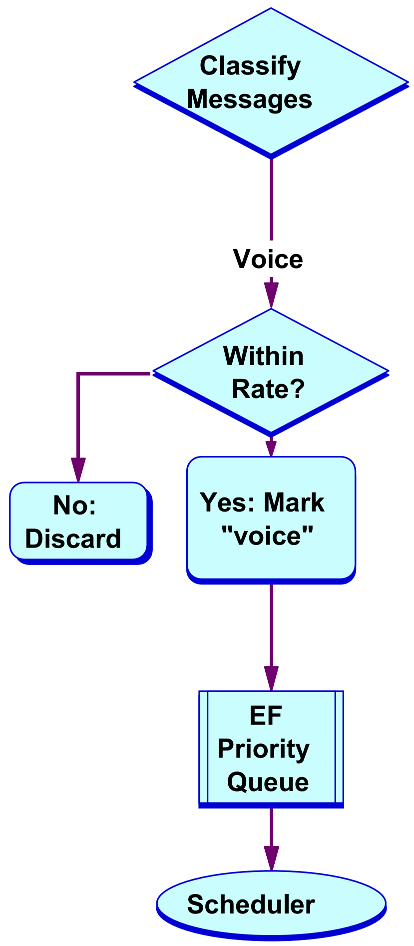
- **Rate-limit (CAR)**
  - Tests rate of traffic against threshold
  - Conforming action is accept
  - Exceed action is drop
- **Effects on traffic**
  - For voice/video should not be exceeding allotment
  - For TCP, this has debilitating loss effects



The EF PHB, on subsequent devices

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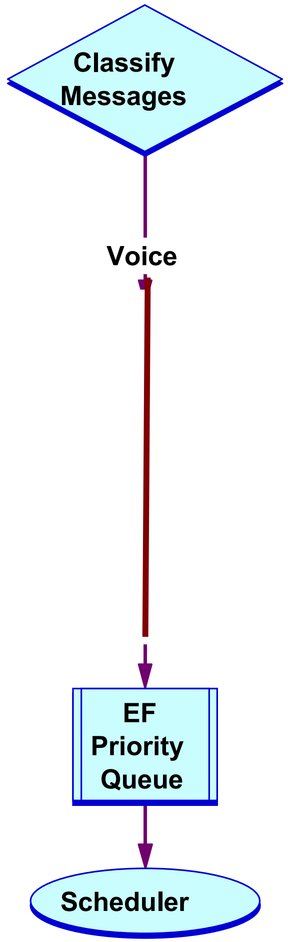
- **A device which has no local traffic originators is working with pre-metered traffic.**
- **It therefore needs only to queue for minimum variation in latency**



Predictable Amount of Traffic in the Network

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- The implication is that we have to control used capacity
  - Capacity that individual calls consume
    - "If you experience poor quality, use a more compact encoding or a lower frame rate"
  - Capacity that total call volume can consume
    - "If there isn't capacity, refuse new calls"

Signaling bandwidth requirements

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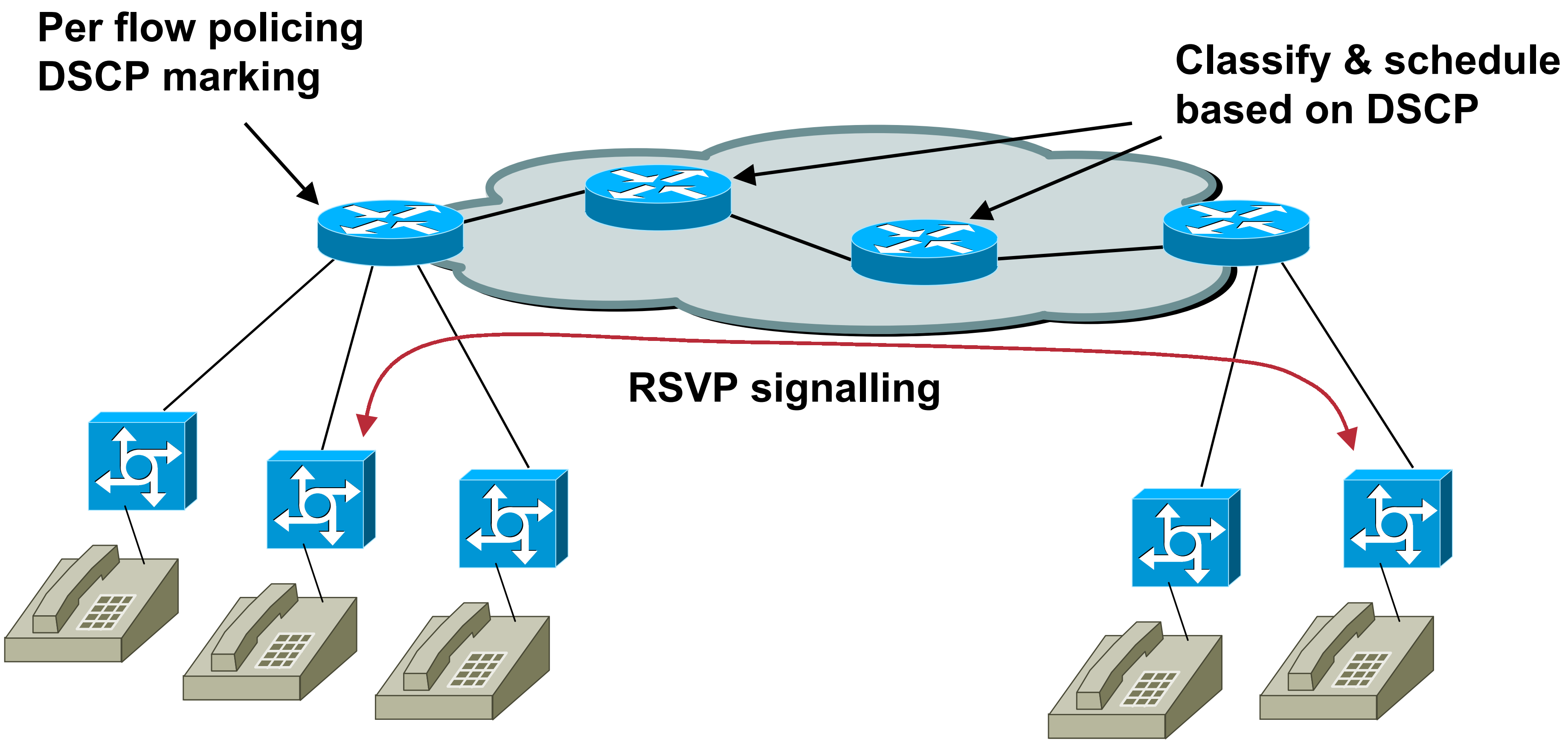

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IPv6 Conclusions

Is it enough better to justify changing?

- **Argument:**

  IPv6 doesn't change routing, trust model, QoS, etc

  It gives us IPv4 Internet with more addresses

- **What IPv6 does do:**

  Removes address conservation as an issue

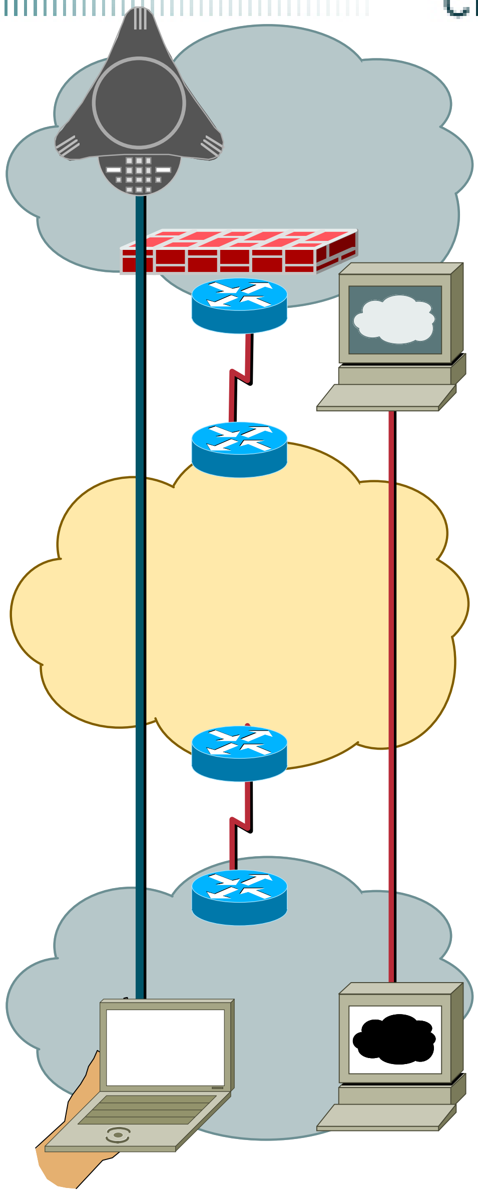
  Enables kinds of applications current addressing makes difficult

  Simplifies deployment of new applications

  Eliminates need to kludge around addressing issues

Application models: a choice

- **In client/server applications**
  - Clients vastly outnumber servers
  - Clients can be addressed on demand
  - Examples: WWW, FTP, X-Windows
- **But every application is not client/server**
- **Peer/peer applications**
  - Peer must be accessible and addressed when someone decides to talk with it
- **Do we want to limit ourselves to the client/server model?**
  - Effect of current IPv4 model assumptions



Conclusions

- **IPv6 is addressing the future…**

  Addresses for new devices, new applications, and new users

  Restoring the end to end model, for performance, robustness, security, manageability, and enabling rapid innovation

  Significant innovations that help applications

  Enhancing IP for next-generation applications: multicast, mobility, plug-and-play, security, and multiple qualities of service

IPv6:
Addressing the Future

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