Issues in Traffic Management on Satellite ATM Networks

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Overview

❑ Why ATM?

❑ ATM Service Categories: ABR and UBR

❑ Binary and Explicit Feedback

❑ ABR Vs UBR

❑ 4 Ways to improve ABR over Satellites

❑ 4 Ways to improve UBR over Satellites

Why ATM?

❏ ATM vs IP: Key Distinctions

    ❍ Traffic Management:
       Explicit Rate vs Loss based

    ❍ Signaling: Coming to IP in the form of RSVP

    ❍ PNNI: QoS based routing

    ❍ Switching: Coming soon to IP

    ❍ Cells: Fixed size or small size is not important

Service Categories

Standby

Joy Riders

Guaranteed

Confirmed

Service Categories

❑ ABR (Available bit rate):
Source follows network feedback.
Max throughput with minimum loss.

❑ UBR (Unspecified bit rate):
User sends whenever it wants. No feedback. No guarantee. Cells may be dropped during congestion.

❑ CBR (Constant bit rate): User declares required rate. Throughput, delay and delay variation guaranteed.

❑ VBR (Variable bit rate): Declare avg and max rate.
  ❍ rt-VBR (Real-time): Conferencing.
  Max delay guaranteed.
 ❍ nrt-VBR (non-real time): Stored video.

Our Goal

❑ Ensure that the new ATM Forum
TM 4.0/5.0 specs are "Satellite-friendly"

❑ There are no parameters or requirement that will
perform badly in a long-delay satellite environment

❑ Users can use paths going through satellite links
without requiring special equipment

❑ Develop optimal solutions for satellite networks

This work is sponsored by
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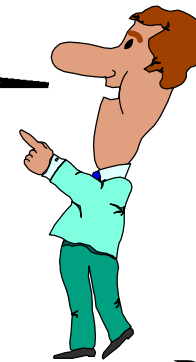
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Binary Rate Scheme

EFCI

Source → ● → ● → Destination

RM
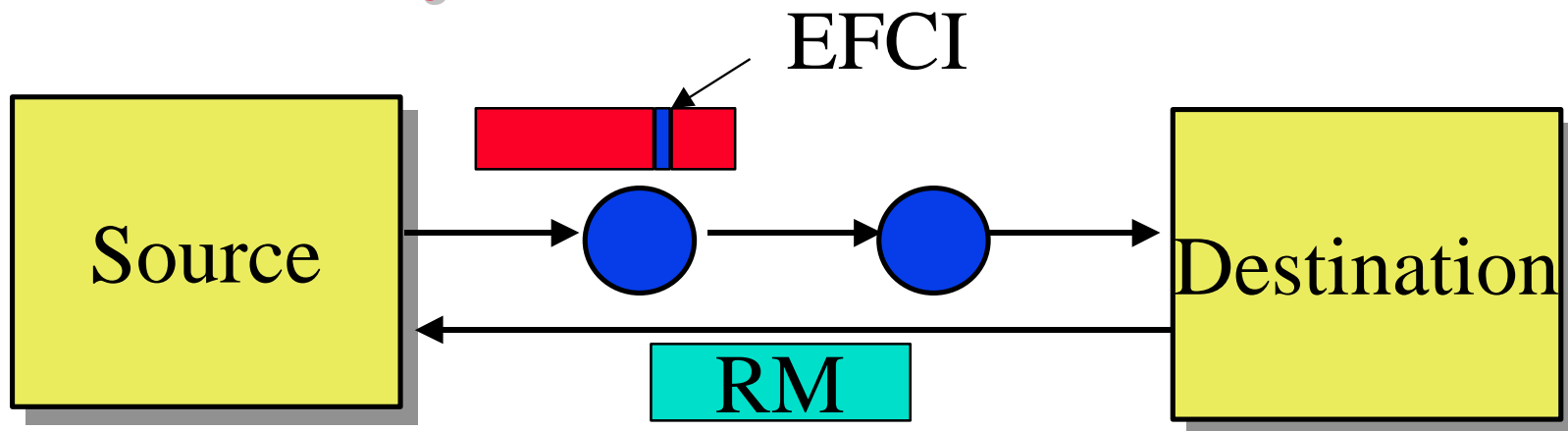
- DECbit scheme in many standards since 1986.

- Forward explicit congestion notification (FECN) in Frame relay

- Explicit forward congestion indicator (EFCI) set to 0 at source. Congested switches set EFCI to 1

- Every nth cell, destination sends an resource management (RM) cell to the source

The Explicit Rate ABR

Current Cell Rate | Explicit Rate
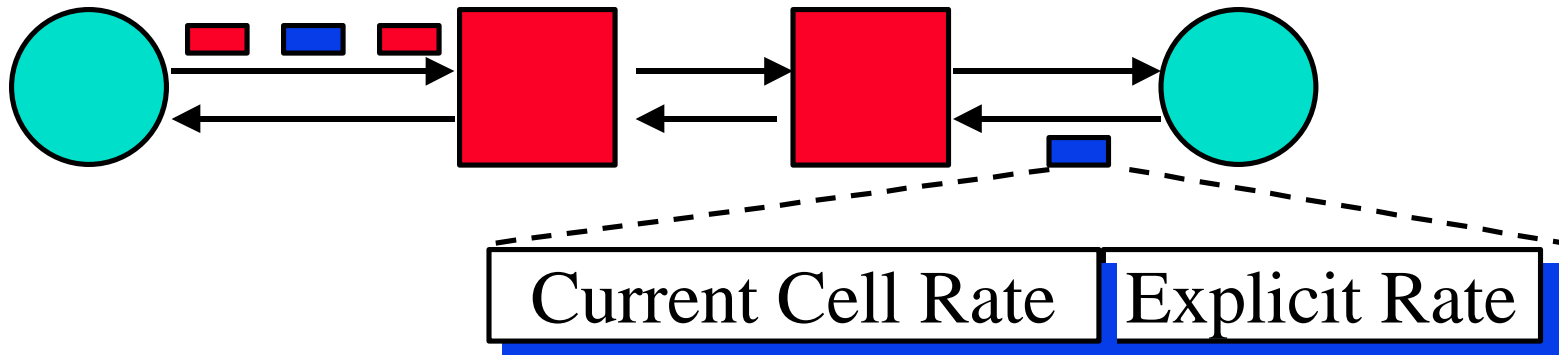
- ❑ Proposed in July 1994
- ❑ Sources send one RM cell every n cells
- ❑ The RM cells contain "Explicit rate"
- ❑ Destination returns the RM cell to the source
- ❑ The switches adjust the rate down
- ❑ Source adjusts to the specified rate

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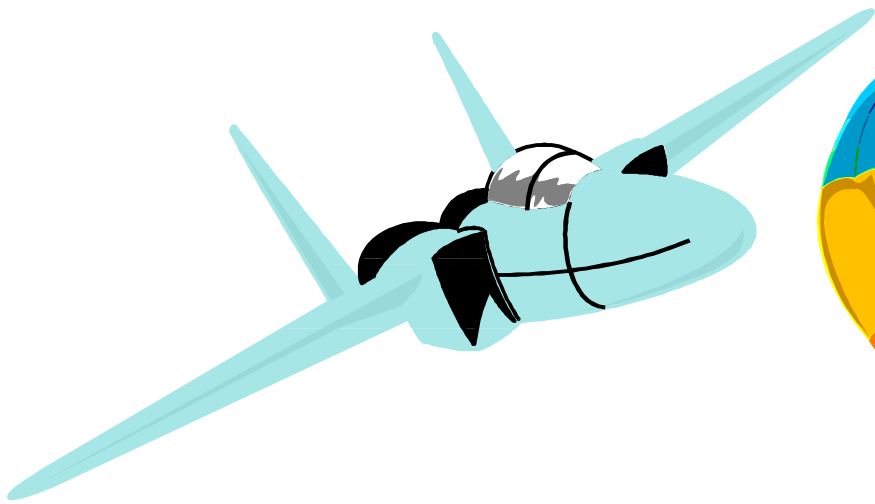
Why Explicit Rate Indication?

❏ Longer-distance networks
  $\Rightarrow$ Can't afford too many round-trips
  $\Rightarrow$ More information is better

❏ Rate-based control
  $\Rightarrow$ Queue length $= \Delta$Rate $\times \Delta$Time
  $\Rightarrow$ Time is more critical than with windows

4 Ways to Improve ABR over Satellite

1. Increase the limit on the number of outstanding cells before decreasing ⇒ Large TBE

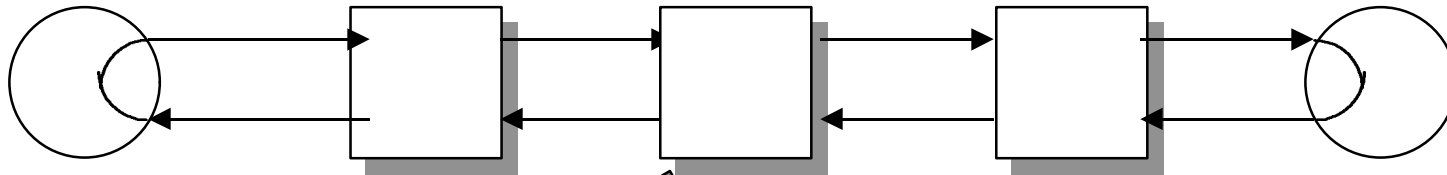   The size of was increased from 8 bit to 24 bit to accommodate satellite paths.

2. Use larger increase factor
   ⇒ RIF=1 ⇒ Fast transient Response

3. Implement backward congestion notification (BECN)

4. Implement Virtual Source/Virtual Destination

VS/VD
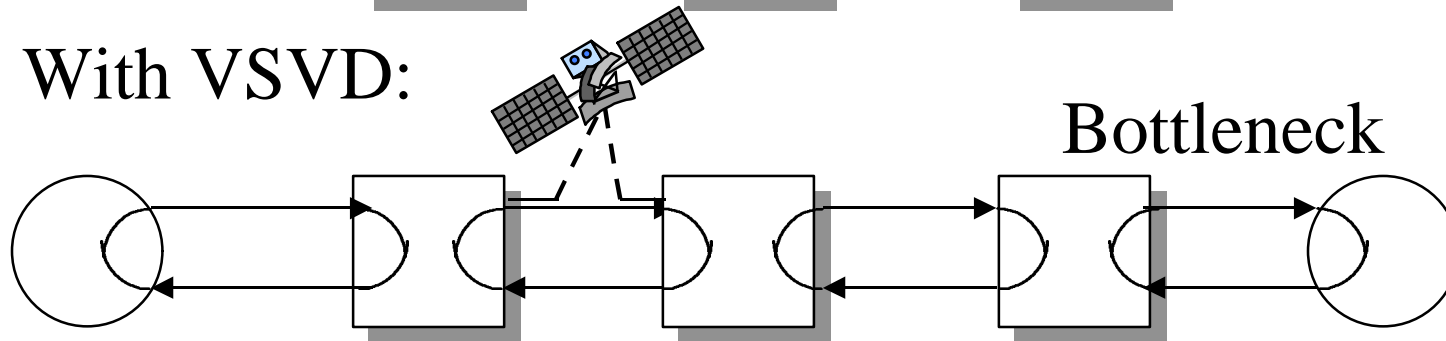

- ❏ Virtual source/virtual destinations (VS/VD) follow all notification/control rules

- ❏ Can be hop-by-hop

- q Virtual dest/sources maintain per-VC queues.

VS/VD: Results

q Without VS/VD:

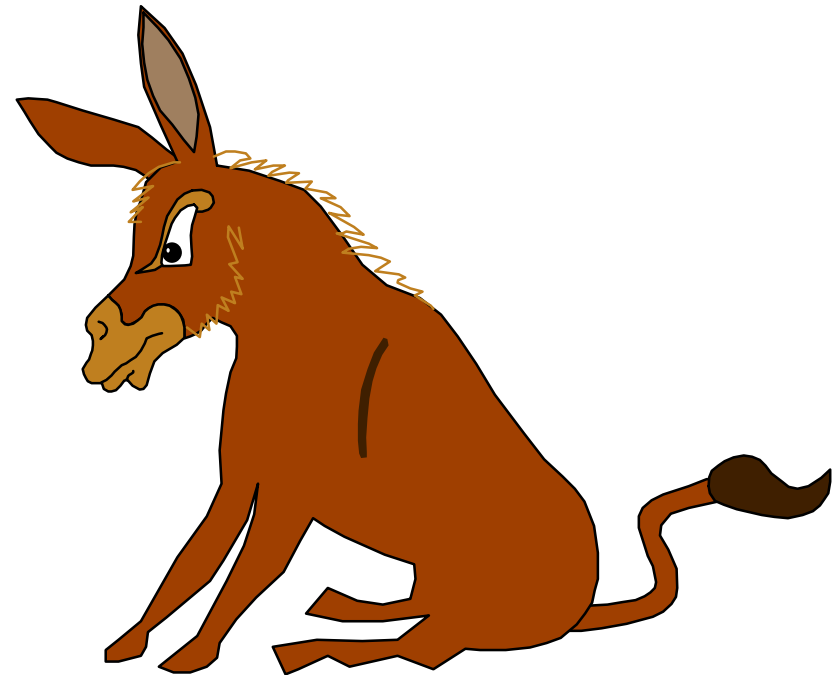❑ With VSVD:

Bottleneck

Satellite
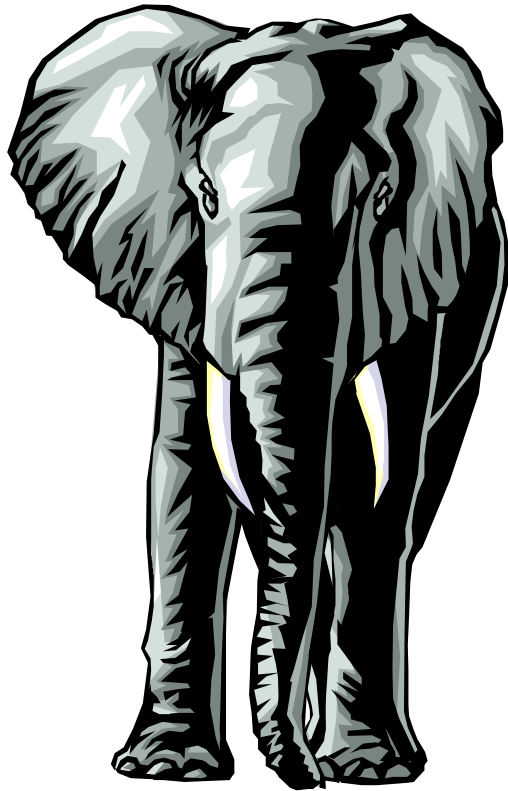Link

Workgroup
Switch

q With VSVD, the buffering is proportional to the delay-bandwidth of the previous loop

$\Rightarrow$ Good for satellite networks

Internet Protocols over ATM

❑ ATM Forum has designed ABR service for data

❑ UBR service provides no feedback or guarantees

❑ Internet Engineering Task Force (IETF) prefers UBR for TCP

ABR or UBR?

❑ Intelligent transport or not?

ABR vs UBR
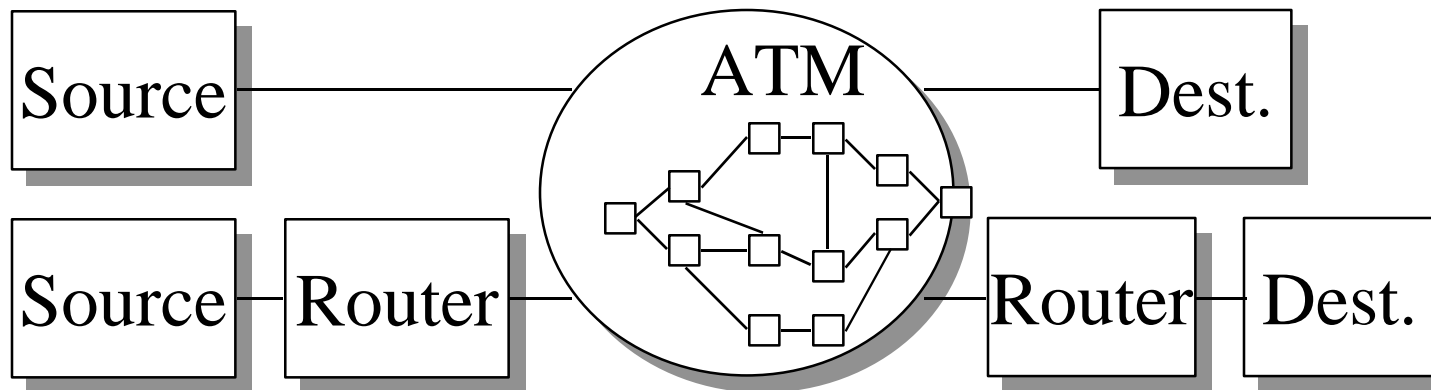
ABR	**UBR**
Queue in the source	Queue in the network
Pushes congestion to edges	No backpressure
Good if end-to-end ATM	Same end-to-end or backbone
Fair	Generally unfair
Good for the provider	Simple for user

Improving Performance of TCP over UBR

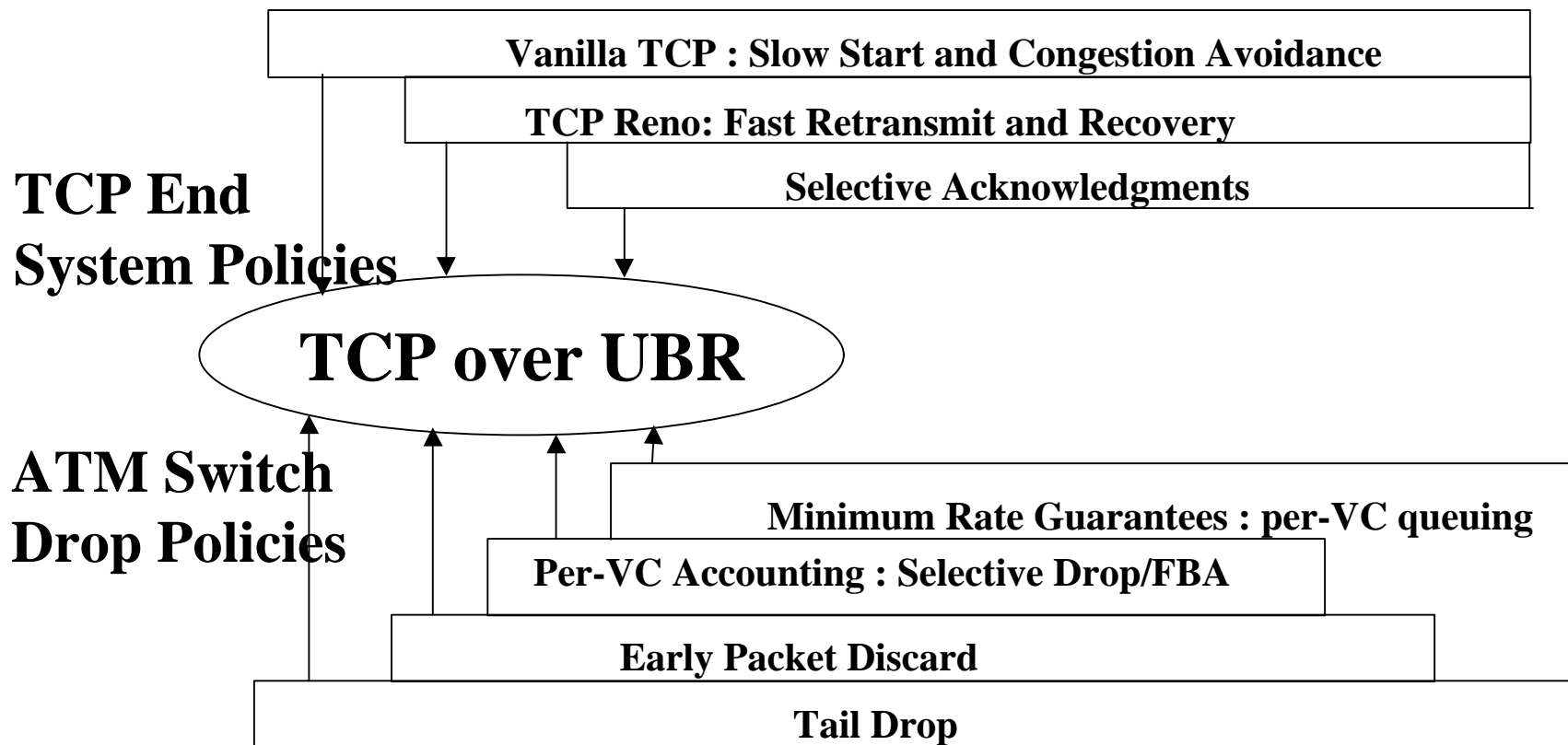| Vanilla TCP : Slow Start and Congestion Avoidance |
| --- |

TCP End System Policies

TCP Reno: Fast Retransmit and Recovery

Selective Acknowledgments

TCP over UBR

ATM Switch Drop Policies

Minimum Rate Guarantees : per-VC queuing

Per-VC Accounting : Selective Drop/FBA

Early Packet Discard

Tail Drop

Policies

		No FRR	FRR	New Reno	SACK + New Reno
No EPD					
	Plain EPD				
EPD	Selective Drop				
	Fair Buffer Allocation				

Switch Policies

Policies: Results

❑ In LANs, switch improvements (PPD, EPD, SD, FBA) have more impact than end-system improvements (Slow start, FRR, New Reno, SACK). Different variations of increase/decrease have little impact due to small window sizes.

❑ In satellite networks, end-system improvements have more impact than switch-based improvements

❑ FRR hurts in satellite networks.

❑ Fairness depends upon the switch drop policies and not on end-system policies

Policies (Continued)

❑ In Satellite networks:

 ❍ SACK helps significantly

 ❍ Switch-based improvements have relatively less impact than end-system improvements

 ❍ Fairness is not affected by SACK

❑ In LANs:

 ❍ Previously retransmitted holes may have to be retransmitted on a timeout
  $\Rightarrow$ SACK can hurt under extreme congestion.

Guaranteed Frame Rate (GFR)

❏ UBR with minimum cell rate (MCR)
$\Rightarrow$ UBR+

❏ Frame based service

○ Complete frames are accepted or discarded in the switch

○ Traffic shaping is frame based.
All cells of the frame have CLP =0 or CLP =1

○ All frames below MCR are given CLP =0 service.
All frames above MCR are given best effort (CLP =1) service.

Guaranteed Rate Service

❑ Guaranteed Rate (GR): Reserve a small fraction of bandwidth for UBR class.

GR	GFR
per-class reservation	per-VC reservation
per-class scheduling	per-VC accounting/scheduling
No new signaling	Need new signaling
Can be done now	In TM4+

Guaranteed Rate: Results

❑ Guaranteed rate is helpful in WANs.

❑ For WANs, the effect of reserving 10% bandwidth for UBR is more than that obtained by EPD, SD, or FBA

❑ For LANs, guaranteed rate is not so helpful. Drop policies are more important.

❑ For Satellites, end-system policies seem more important.

Problem in TCP Implementations

❑ Linear Increase in Segments:
$$CWND/MSS = CWND/MSS + MSS/CWND$$

❑ In Bytes: $CWND = CWND + MSS*MSS/CWND$

❑ All computations are done in integer

❑ If CWND is large, MSS*MSS/CWND is zero and CWND does not change. CWND stays at 512*512 or 256 kB.

Solutions

❑ **Solution 1**: Increment CWND after
N acks (N > 1)
CWND = CWND + N*MSS*MSS/CWND

❑ **Solution 2**: Use larger MSS on Satellite links such that MSS*MSS > CWND. MSS $\geq$ Path MTU.

❑ **Solution 3**: Use floating point

❑ **Recommendation**: Use solution 1. It works for all MSSs.

4 Ways to Improve UBR over Satellites

1. Implement "Selective Acknowledgement" in end-systems

2. Disable "Fast retransmit and recovery" in end-systems

3. Reserve a small fraction of bandwidth for UBR in the switches

4. Fix slow start implementations in end-systems to avoid errors due to integer arithmetic

Summary

❑ Binary feedback too slow for rate control. Especially for satellites. ER switches provide much better performance than EFCI.

❑ ABR service required for long-delay or high-speed networks. UBR+ may be OK for LANs but not for long delay paths.

Summary (Cont)

❑ Implement VS/VD, BECN, RIF=1, TBE=Large to improve ABR over satellites

❑ Implement SACK, Disable FRR, reserve bandwidth for UBR, and correct TCP implementations to improve UBR over satellites.

Our Contributions and Papers

❑ All our contributions and papers are available on-line at
http://www.cis.ohio-state.edu/~jain/

❑ See Recent Hot Papers for tutorials.

Thank You!