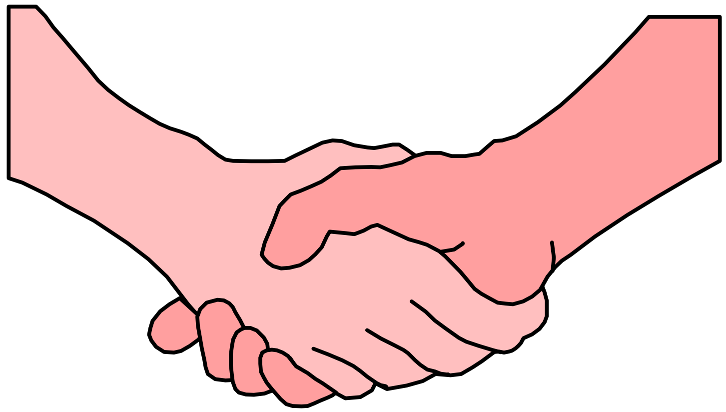
Addressing Interoperability: Issues and Challenges

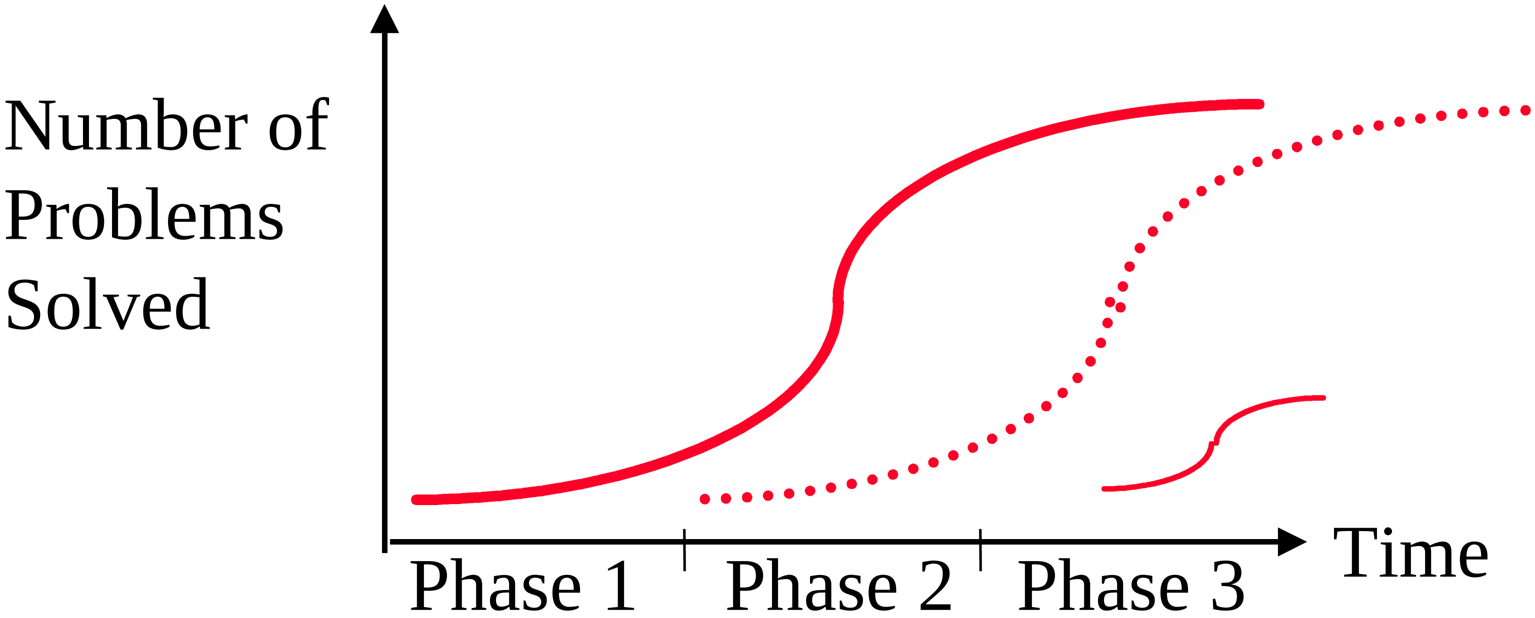


Raj Jain

Raj Jain is now at
Washington University in Saint Louis
Jain@cse.wustl.edu
http://www.cse.wustl.edu/~jain/

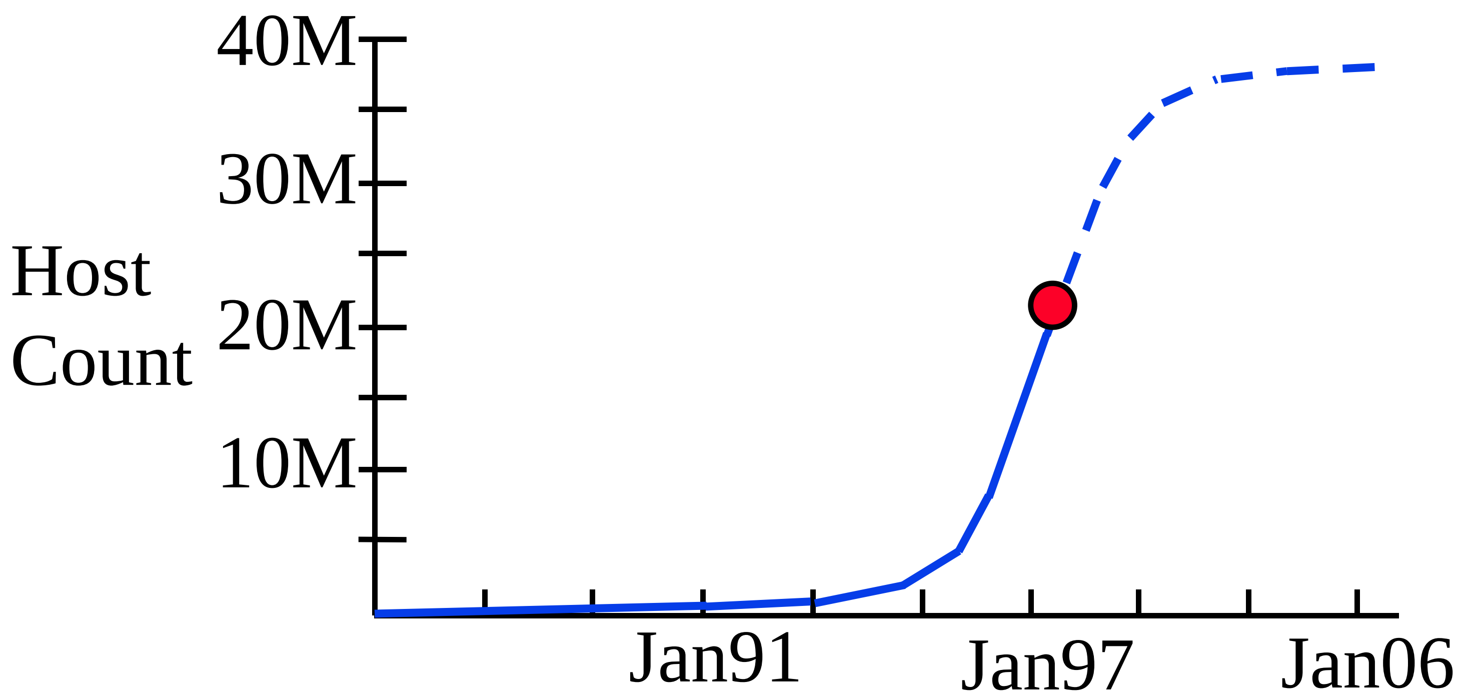
- Life Cycle of Technologies
- Interoperability and Standards Issues
- ATM Traffic Management

Life Cycles of Technologies

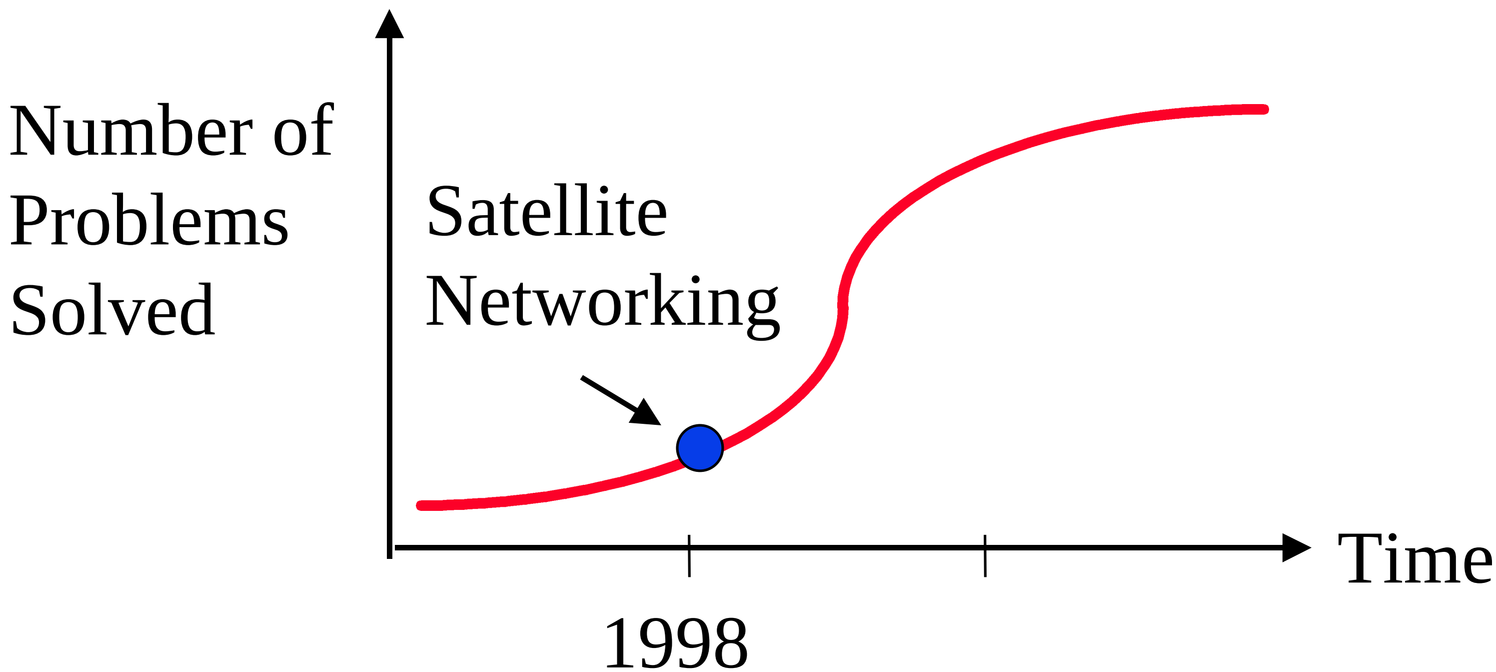


- Phase 1: Research
- Phase 2: Productization
- Phase 3: Transition to the next technology

Internet Technology



Life Cycle: Satellite Networking



- Phase 1: Research Proprietary/competing solutions
- Phase 2: Standard based interoperable solutions

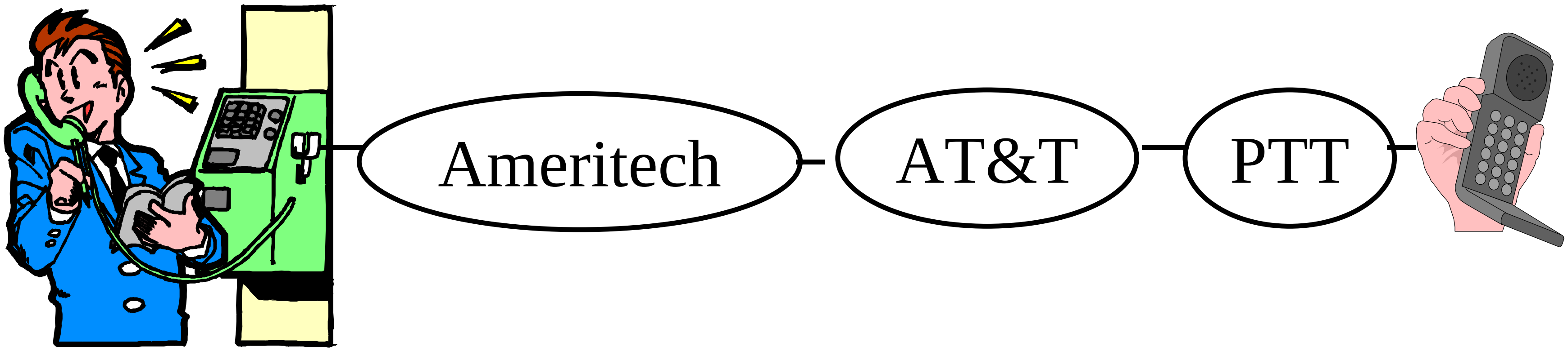
Networking: Failures vs Successes

- 1980: Broadband Ethernet (vs baseband)
- 1984: ISDN (vs Modems)
- 1986: MAP/TOP (vs Ethernet)
- 1988: OSI (vs TCP/IP)
- 1991: DQDB
- 1992: XTP (vs TCP)
- 1994: CMIP (vs SNMP)

Requirements for Success

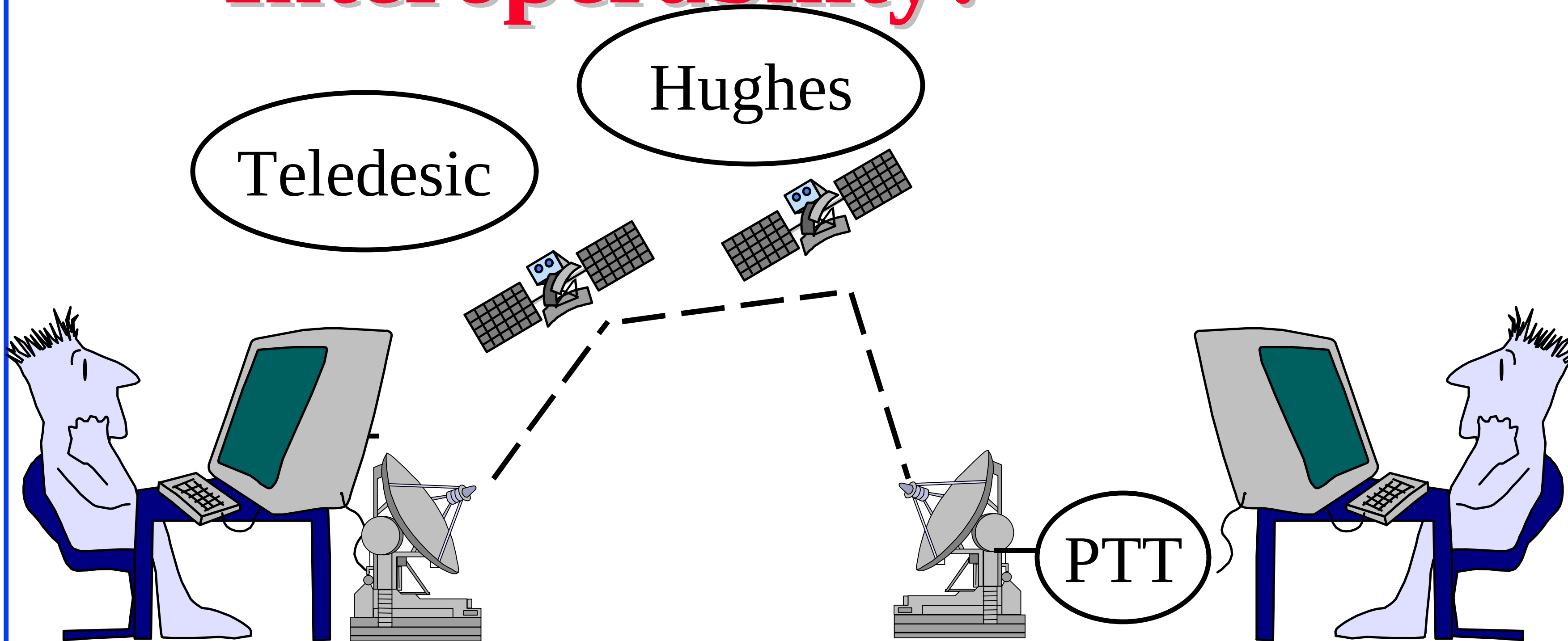
- Low Cost
- High Performance
- Killer Applications (Remote areas, Distance Insensitive, Multicast)
- Timely completion
- Manageability
- Interoperability
- Coexistence with legacy (terrestrial) networks

Interoperability: Example



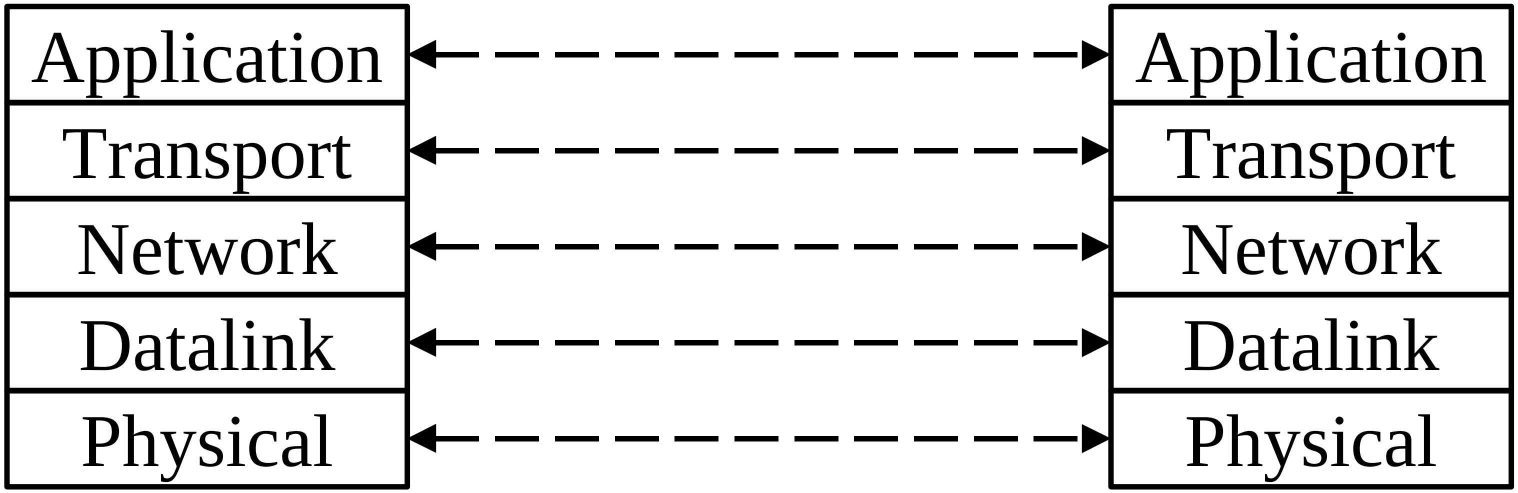
- Phone System: Any phone, any carrier(s), any place

Interoperability?



- Satellite Network: Any dish, any satellite system, any place

Layers of Interoperability



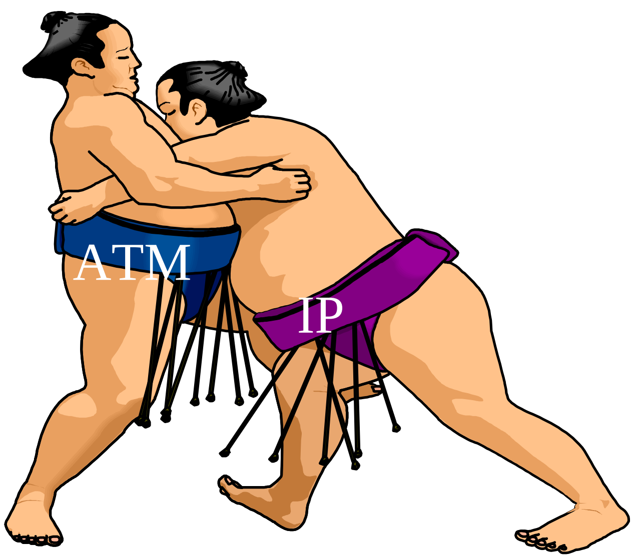
- Physical: Spectrum Management, Common Air Interface
- Datalink: DAMA/MAC
- Network: Mobility, Handoff
- Transport: Satellite/Terrestrial TCP/ATM
- Application: Paging, Data, Messaging

Standards: A Partial List

- Telecommunication Industries Association (TIA)
  - Common Air Interface
  - Spectrum Management
- International Telecommunications Union (ITU)
  - QoS
- ATM Forum
  - Wireless ATM
  - Traffic Management

Why ATM?

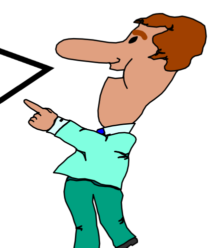
- ATM vs IP: Key Distinctions
  1. Traffic Management: Explicit Rate vs Loss based
  2. QoS based routing: PNNI
  3. Signaling: Coming to IP in the form of RSVP
  4. Switching: Coming to IP as label switching



Our Goal

- Ensure satellite/terrestrial interoperability in ATM TM
  - 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 NASA Lewis Research Center

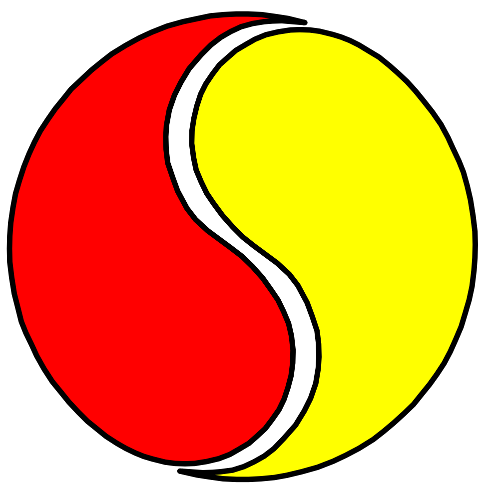


Issues

- Binary vs Explicit Rate Feedback
- ABR vs UBR: Available bit rate vs Unspecified bit rate
- Improving performance over ABR: VS/VD
- Improving Performance over UBR: Guaranteed Rate

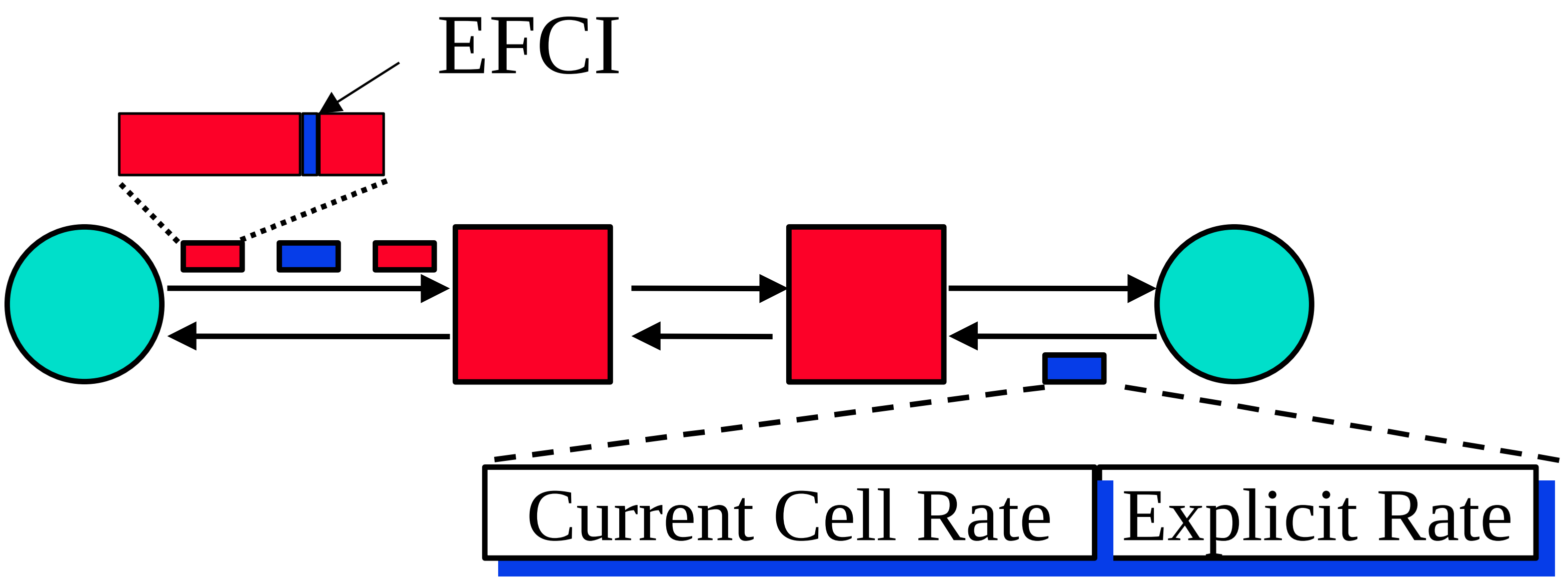
Note: The alternative that is best for satellite networks may or may not be so for terrestrial networks.

Satellite



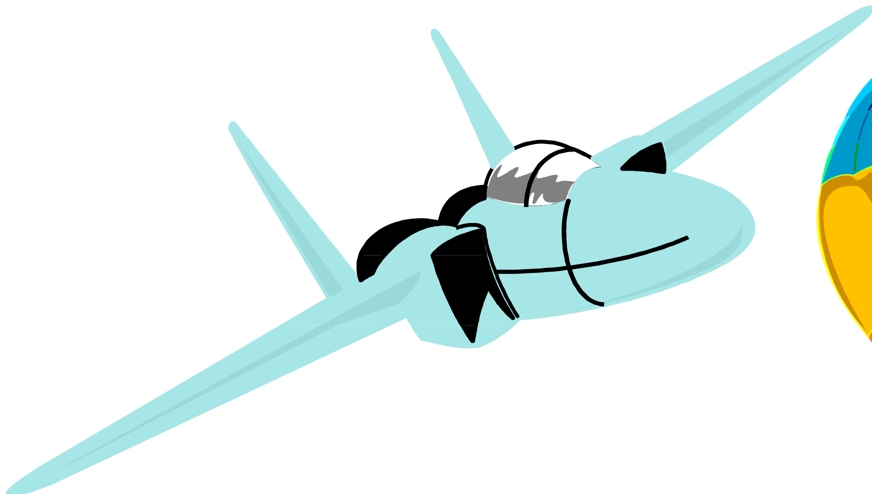
Terrestrial

Binary vs Explicit Rate



- Binary: Explicit forward congestion indication (EFCI) bit in the cell header set by congested switches. Based on DECbit scheme.
- Explicit Rate: Sources send one RM cell every n cells. The switches adjust the explicit rate field down.

Binary vs Explicit Feedback



Go
30 km East
35 km South

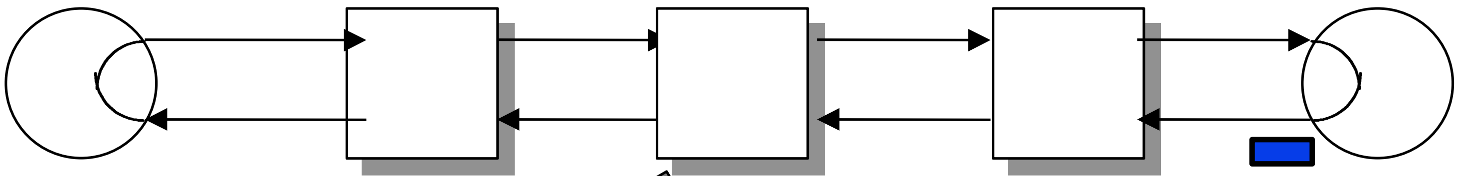
Go left

Why Explicit Rate Indication?

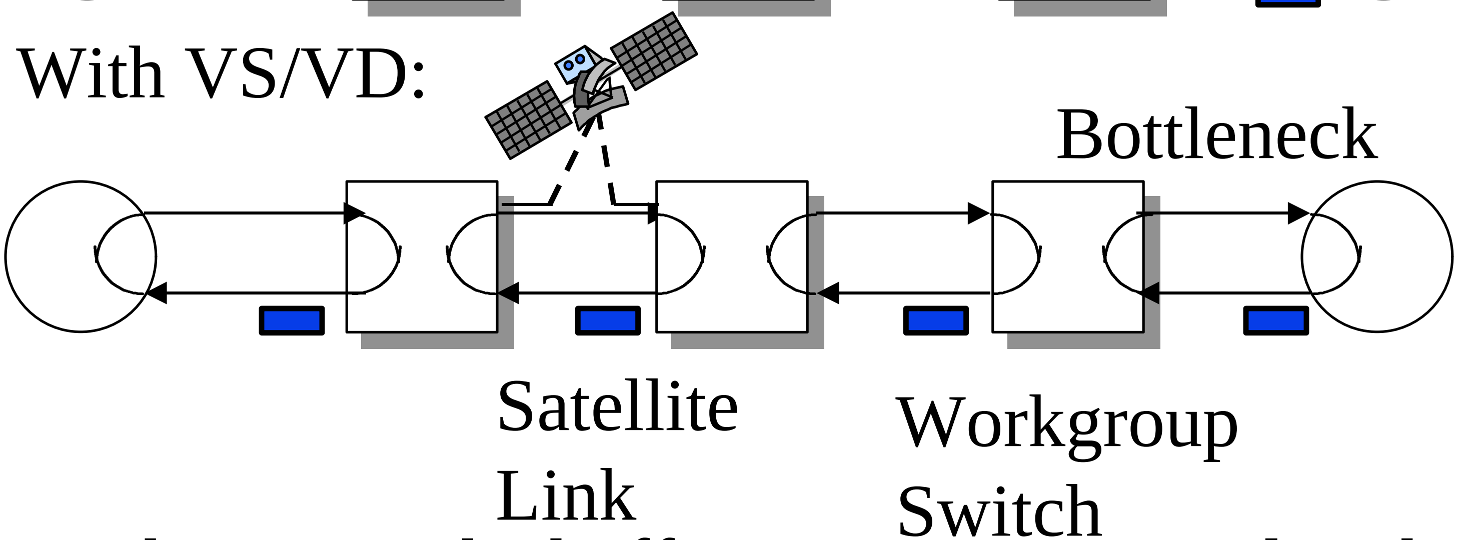
- Longer-distance networks
  ⇒ Can't afford too many round-trips
  ⇒ More information is better
- Rate-based control
  ⇒ Queue length = ΔRate $\times$ ΔTime
  ⇒ Time is more critical than with windows

VS/VD

- Without Virtual Source/Virtual Destination:

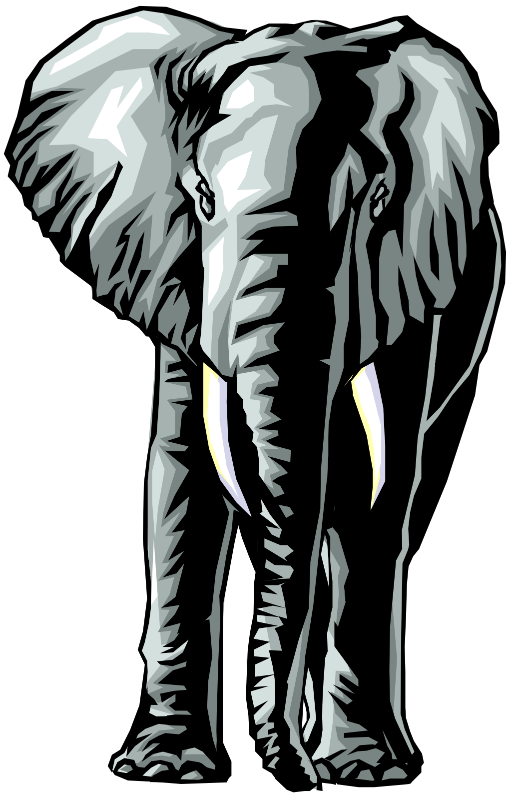


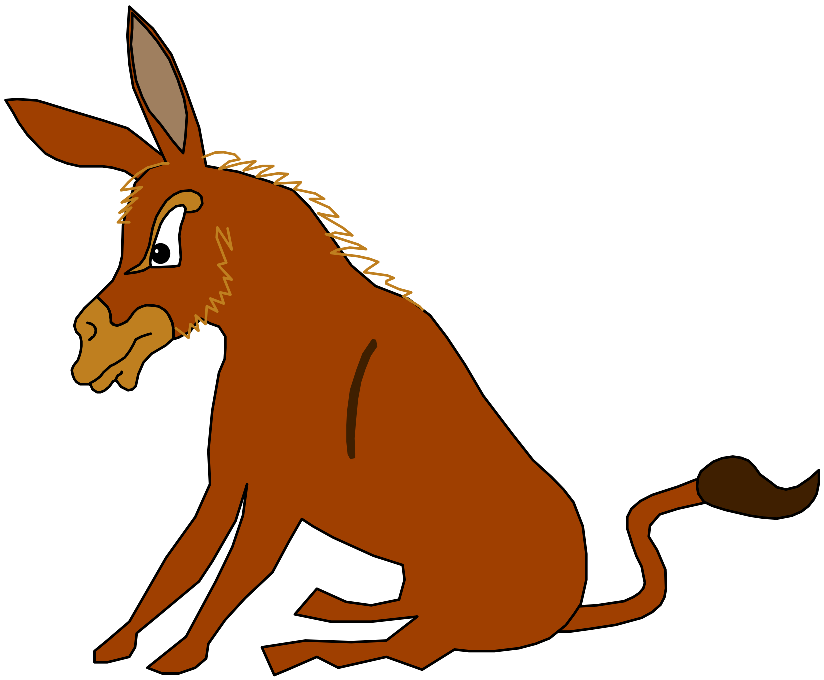
- With VS/VD:



- With VSVD, the buffering is proportional to the delay-bandwidth of the previous loop
  $\Rightarrow$ Good for satellite networks

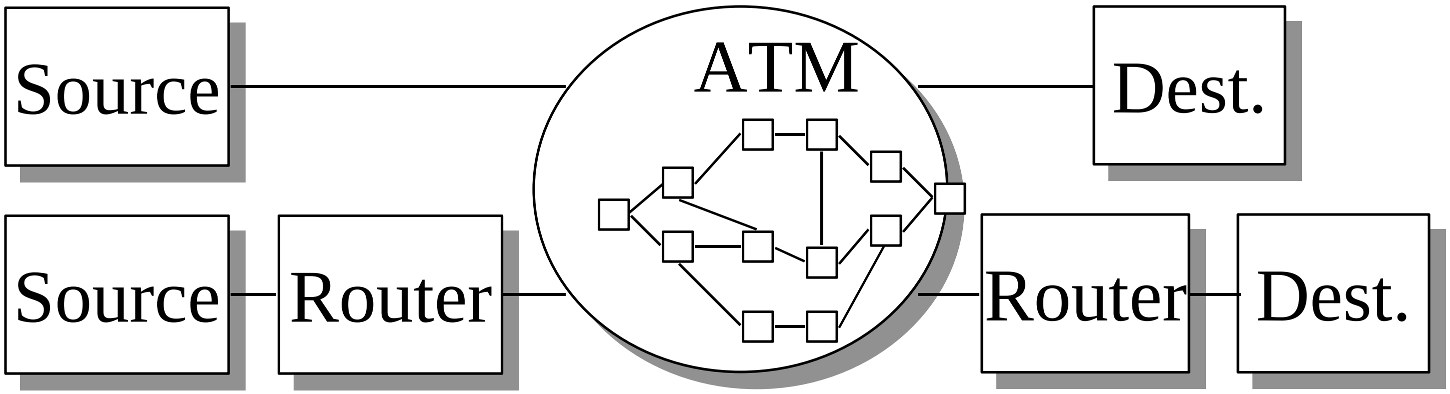
ABR or UBR?





- Intelligent transport or not?

ABR vs UBR

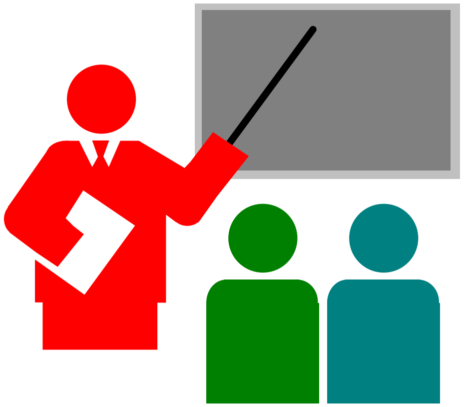


ABR	**UBR**
Queue in the source Network Qs = *k* RTT	Queue in the network Network Qs = Σ Windows
Pushes congestion to edges	No backpressure
Good iff end-to-end ABR	Good iff TCP.
Fair	Generally unfair

Ways to Improve UBR over Satellites

1. Reserve a small fraction of bandwidth for UBR class in the switches ⇒ Guaranteed Rate Service.
   - 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.
2. Implement "Selective Acknowledgement" in end-systems. Disable "Fast retransmit and recovery" in end-systems.

Summary



- Interoperability is the key to success of a technology
- Layers of interoperability: Air interface to applications
- ER better for satellites than Binary feedback.
- ABR better than UBR for long-delay paths
- VS/VD can help reduce the impact of satellite delays
- Reserving a small capacity helps UBR

Our Publications

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

- Specially see "Recent Hot Papers"