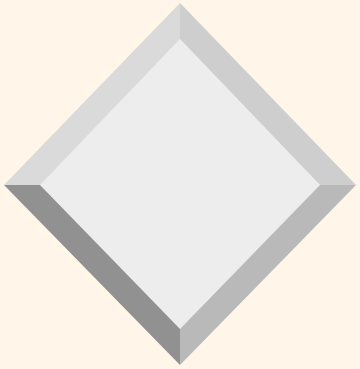
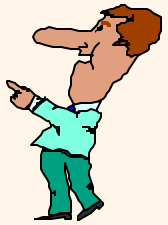


Backbone: FDDI, ATM or Gigabit Ethernet?

April 5, 2001

Chao Chen, Fang Liu, Yong Wang

Topics



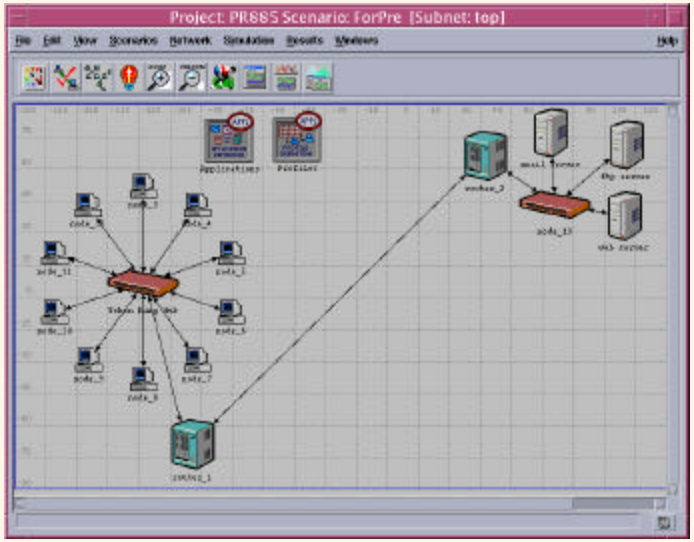
- Introduction
- Comparison of Backbone Technologies
- Analysis and Conclusions
- Encountered Problems and Future Works
- References

Introduction

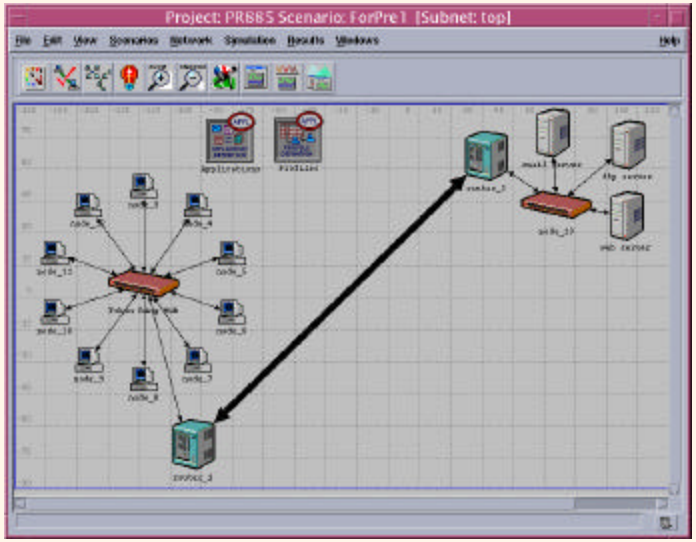
- Why Backbone ?
  - Various applications
  - Growing size of data
  - More users
  - Increasing LAN traffic
  - Higher bandwidth and better performance

- Which Backbone ?
  - Fast Ethernet, FDDI
  - ATM, Gigabit Ethernet

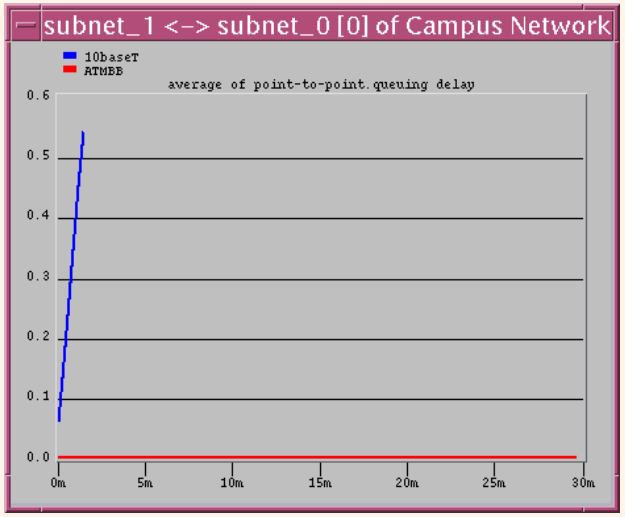
Experiment: 10Base-T vs. ATM Backbone



10Base-T Link



ATM OC-3 Link



Queuing Delay on Links

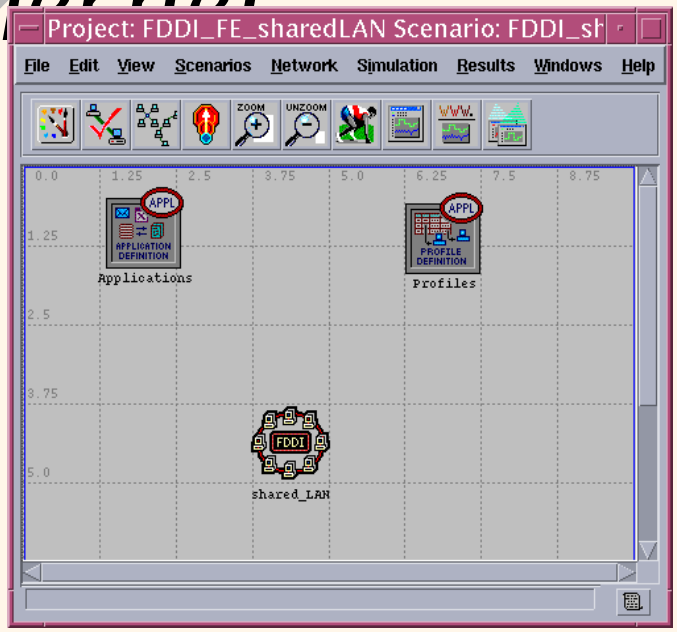
FDDI and Fast Ethernet

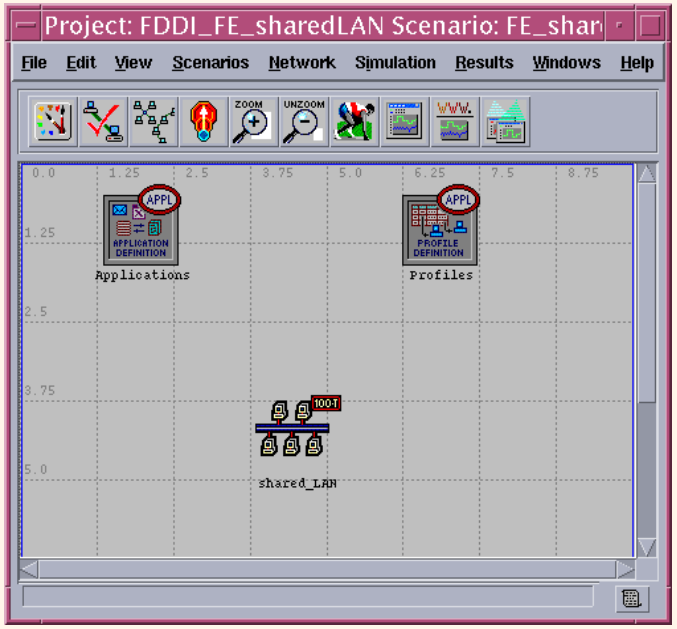
- FDDI
  - 100Mbps
  - Dual-ring topology providing high degree of fault tolerance
  - Token-passing access scheme providing deterministic performance
  - Great Redundancy

- Fast Ethernet
  - 100BaseT
  - Same frame format and length as Ethernet
  - Low cost and high performance
  - Easy integration with traditional Ethernet

Experiment: FDDI vs. Fast Ethernet

FDDI

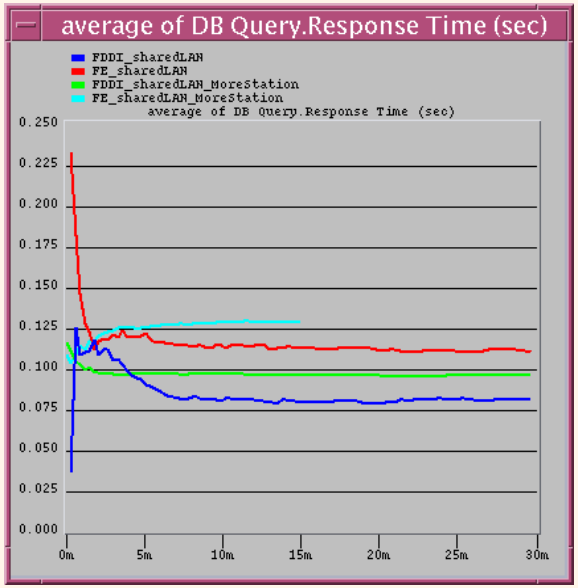


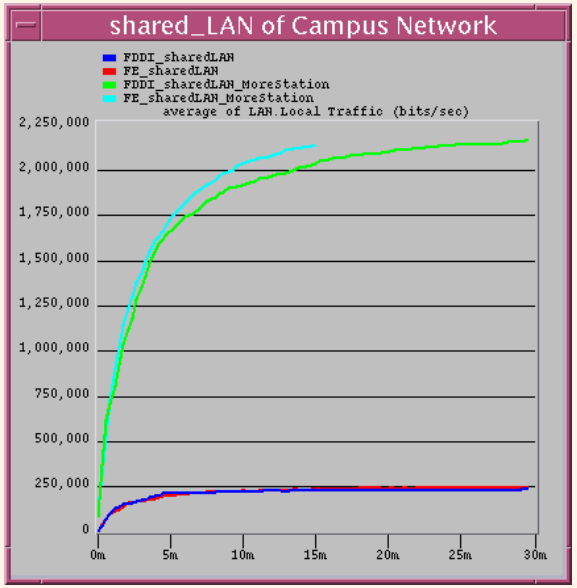


Fast Ethernet

- FE_100wkst
- FE_10wkst
- FDDI_100wkst
- FDDI_10wkst

Response Time





LAN Traffic

ATM backbone

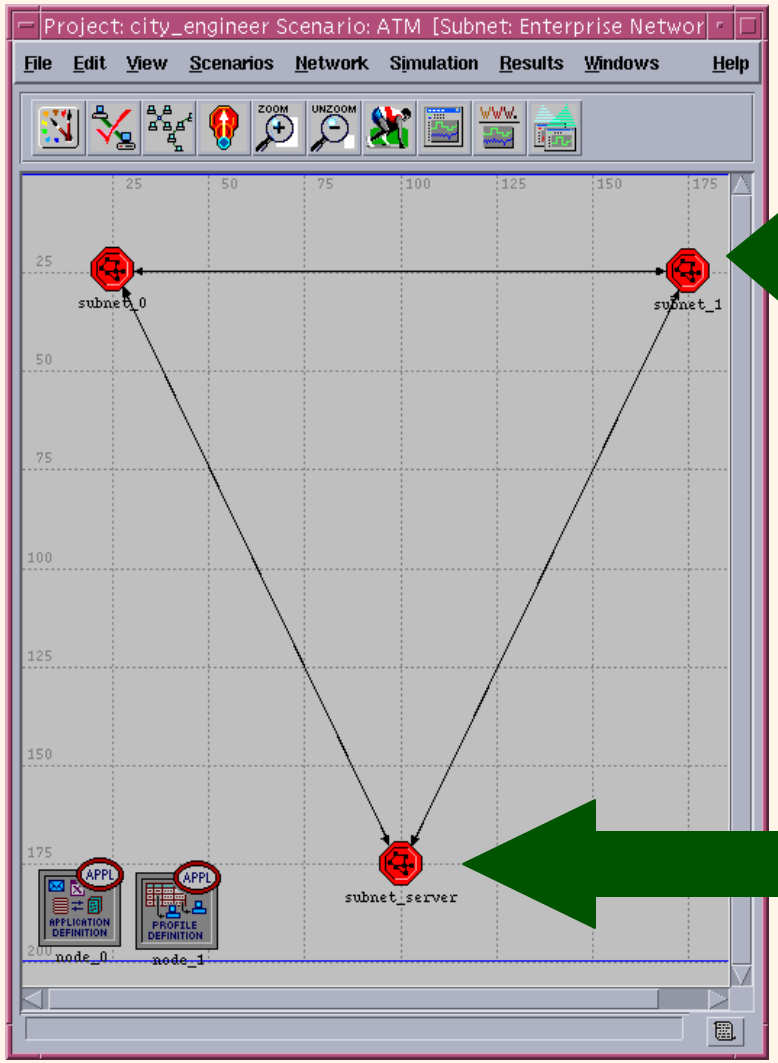
- Scalable amounts of bandwidth
- Provide different services over a common network
- Easy integration of LAN and WAN
- high reliability and Quality of Service for mission-critical applications, such as voice and video

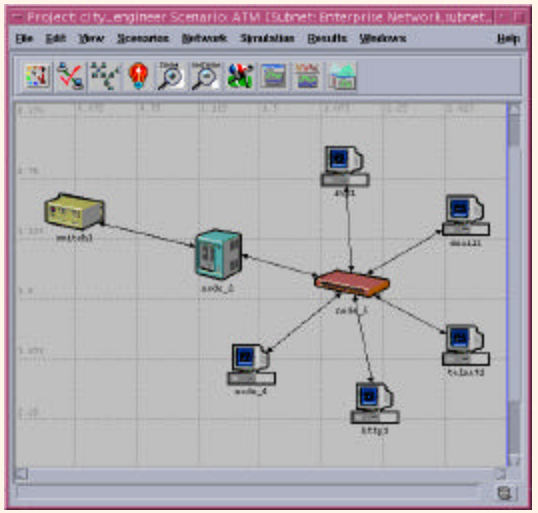
Experiment: ATM vs. FDDI

- 10km*10km Campus Network
- Three Token Ring LANs
- Two scenarios: ATM (OC-3) and FDDI
- Network Services
  - Email, FTP, HTTP, Telnet
  - Voice and Video Conference

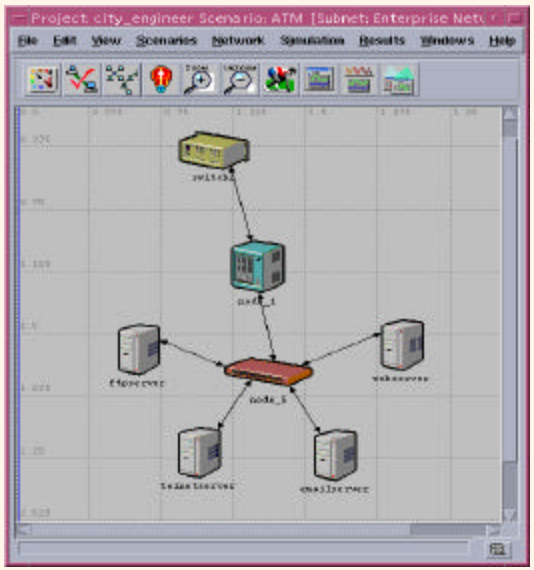
Experiment: ATM vs. FDDI (cont.)

--- *Email, FTP, HTTP, Telnet Applications*





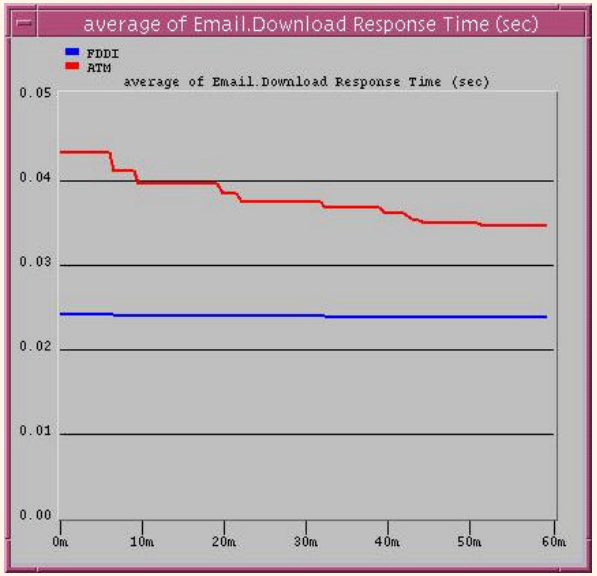
Subnet with Clients

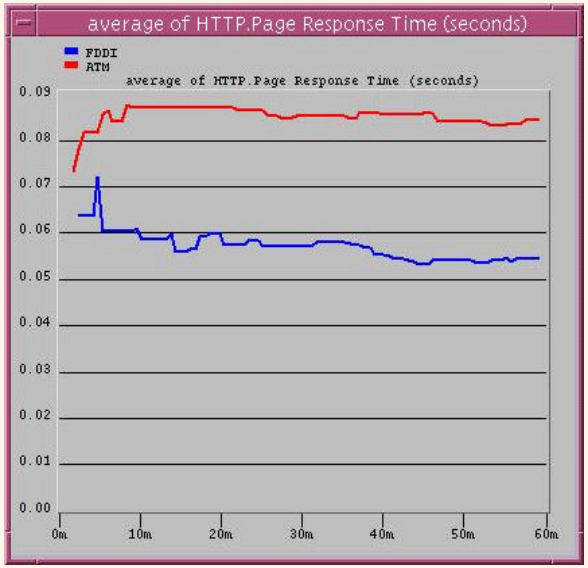


Subnet with Servers

Experiment: ATM vs. FDDI (cont.)

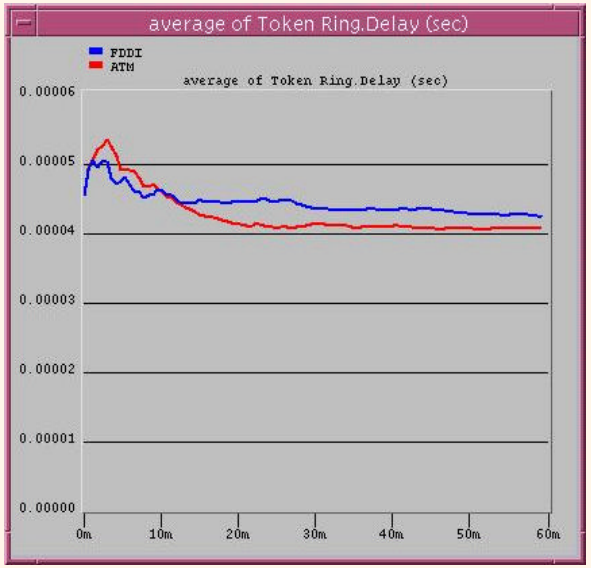
--- *Email, FTP, HTTP, Telnet Applications*

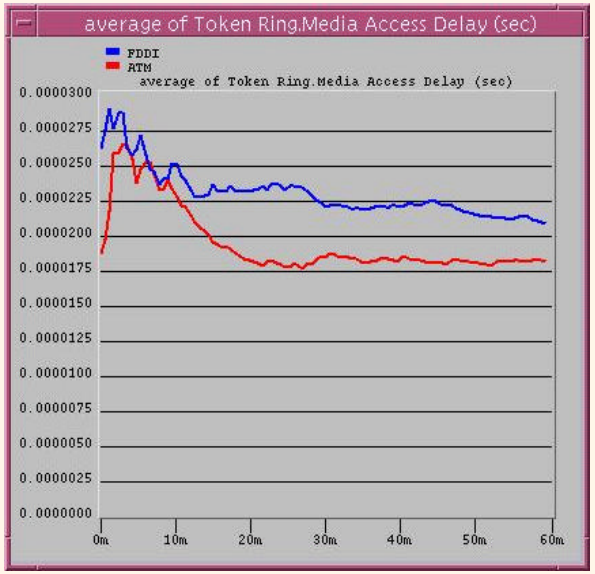




Email, HTTP Service Response Time

ATM > FDDI



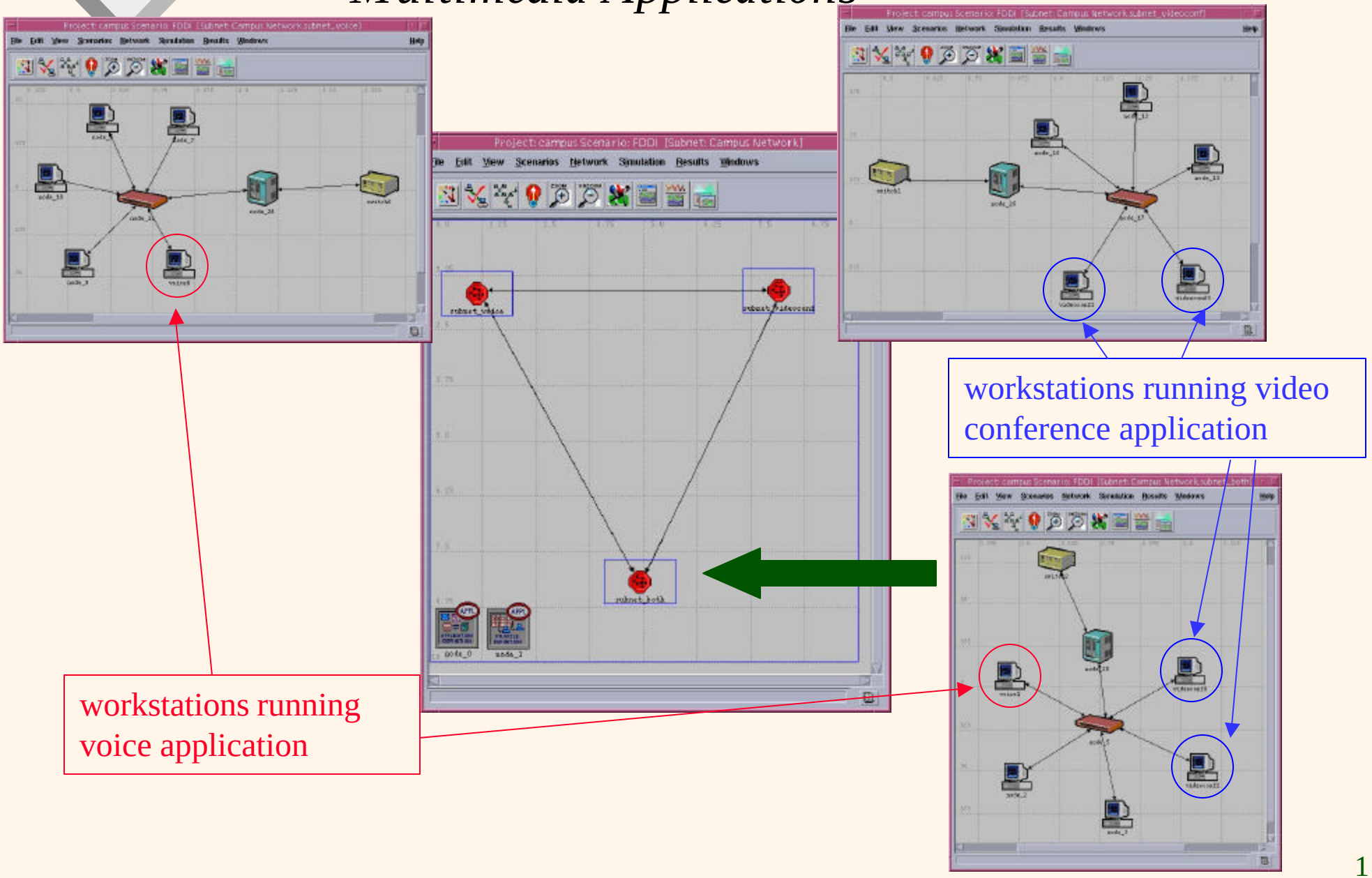


Token Ring Delay and MAC Delay

FDDI > ATM

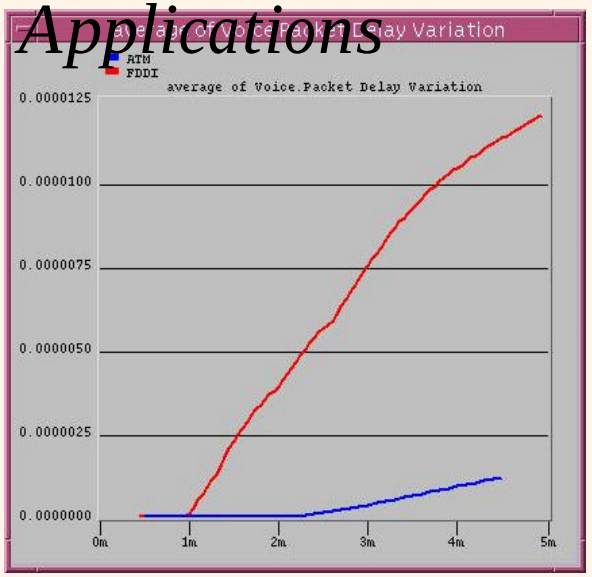
Experiment: ATM vs. FDDI (cont.)

--- *Multimedia Applications*



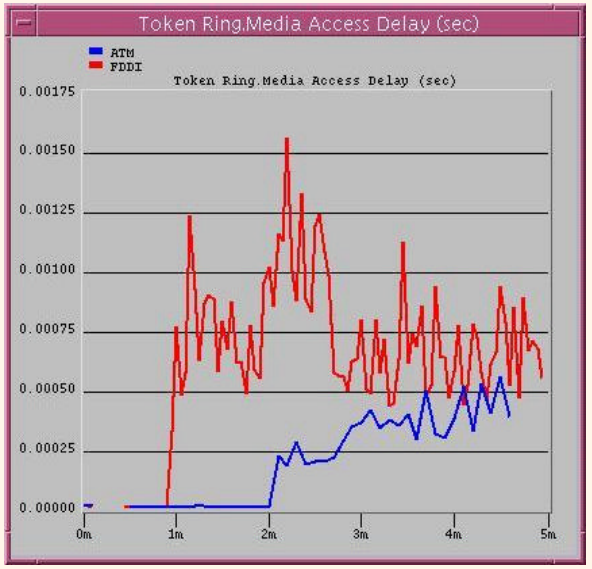
Experiment: ATM vs. FDDI (cont.)

Multimedia Applications



Voice Delay and Delay Variation

FDDI > ATM



Token Ring Delay and MAC Delay

FDDI > ATM

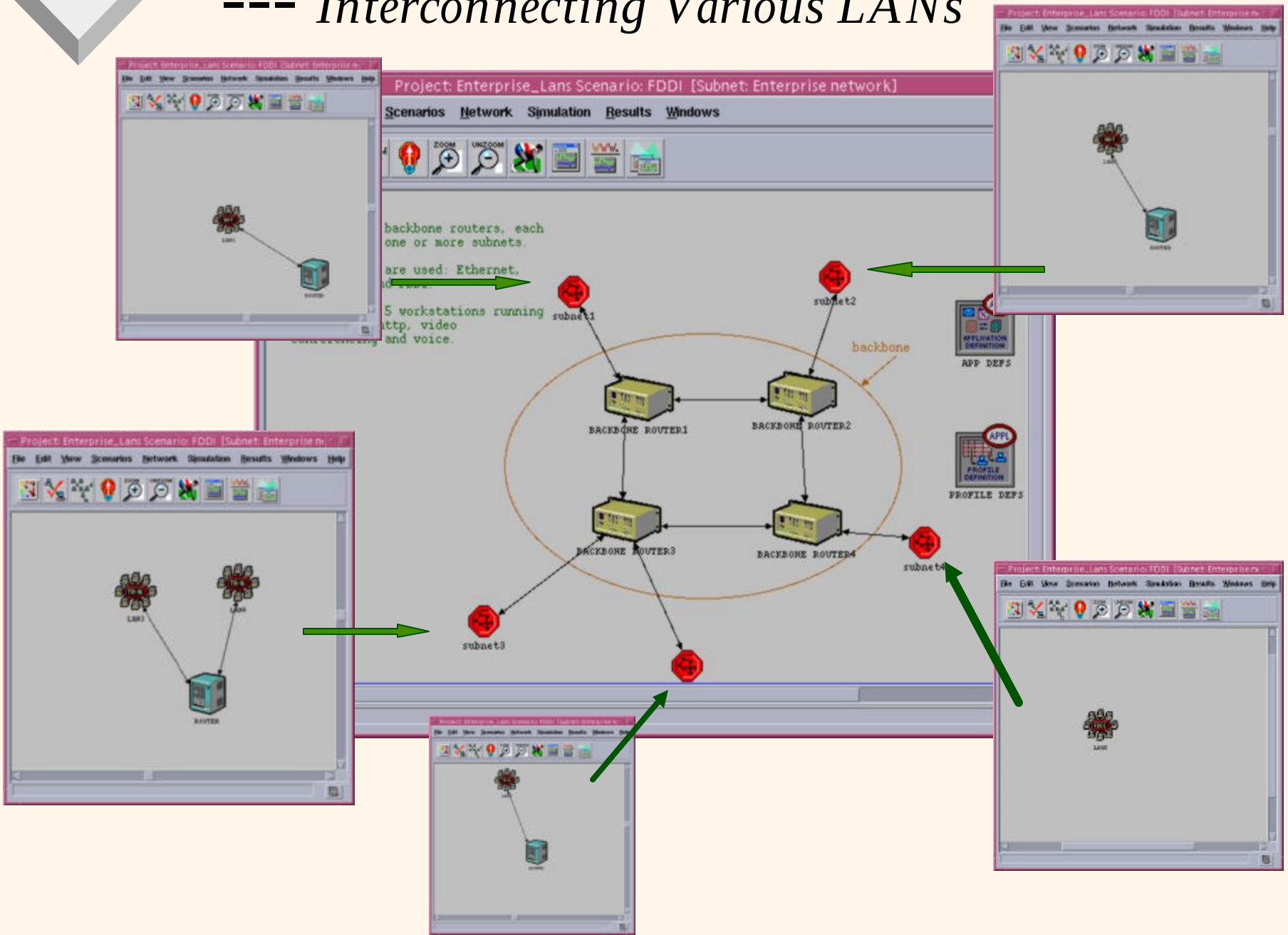
Experiment: ATM vs. FDDI (cont.)

--- *Interconnecting Various LANs*

- Enterprise Network
- Three types of LANs :
  Ethernet, Token ring and FDDI
- Two scenarios: ATM (OC-3) and FDDI backbone
- Network Services
  - Email, FTP, HTTP, Telnet
  - Voice and Video Conference

Experiment: ATM vs. FDDI (cont.)

--- *Interconnecting Various LANs*

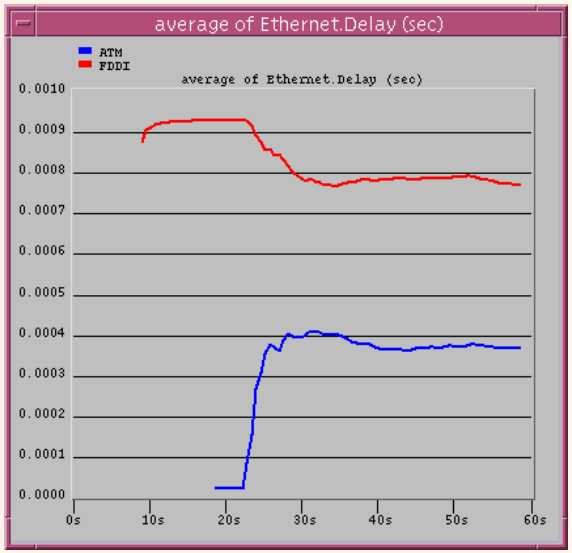


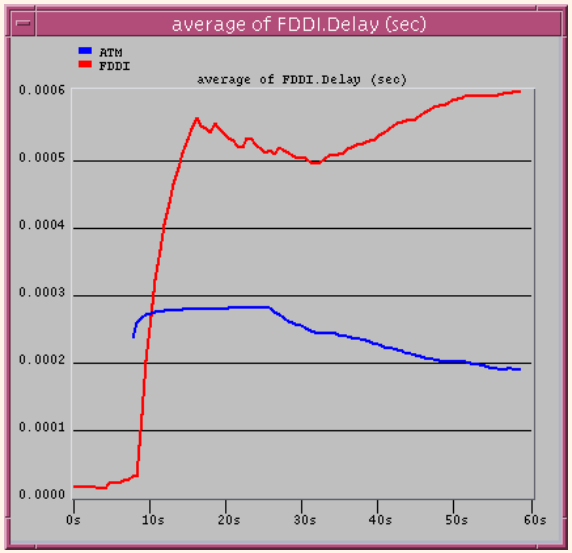
Experiment: ATM vs. FDDI (cont.)

--- *Interconnecting Various LANs*

Ethernet Delay

FDDI > ATM



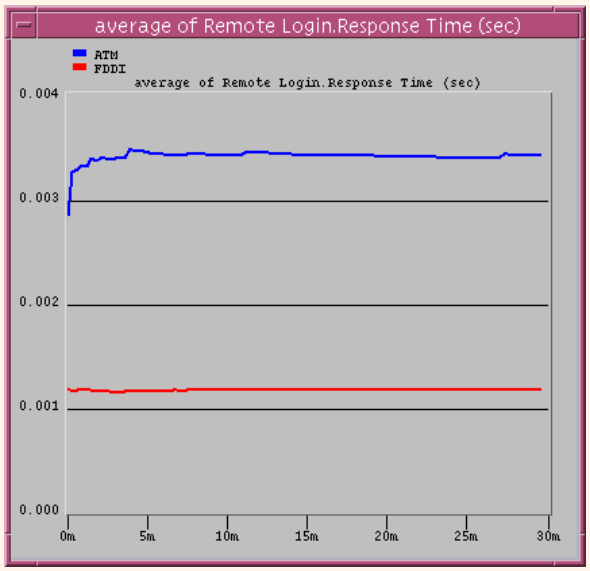


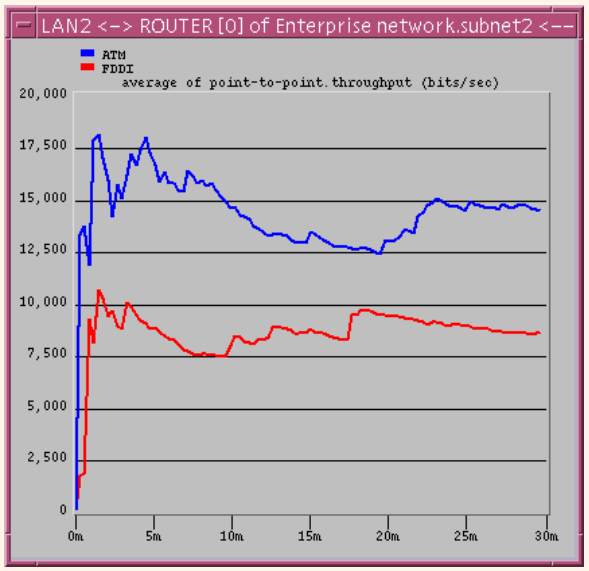
FDDI Delay

FDDI > ATM

Telnet Response Time

ATM > FDDI





Throughput

ATM > FDDI

Conclusions on ATM and FDDI

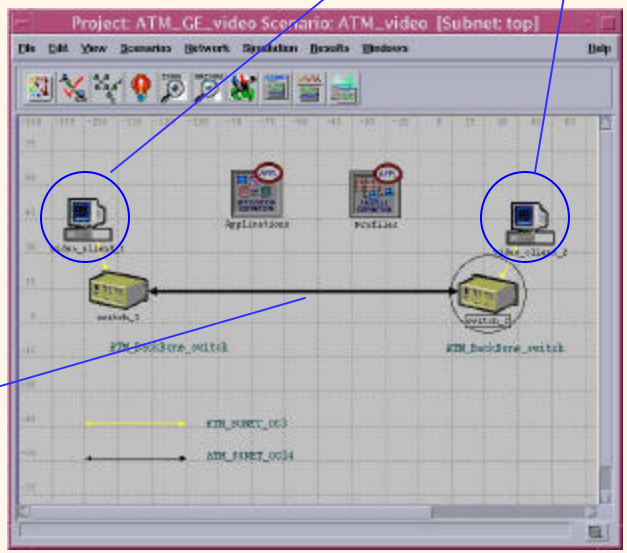
- For some applications, FDDI has shorter response time than ATM, while ATM has less LAN delay.
- For time-critical services, such as voice data, ATM can achieve much lower delay and delay variation than FDDI.
- FDDI might have higher fault-tolerance than ATM due to the dual-ring topology.
- ATM can supply bandwidth of 155Mbps up to 2.5Gbps, while FDDI has only 100Mbps.

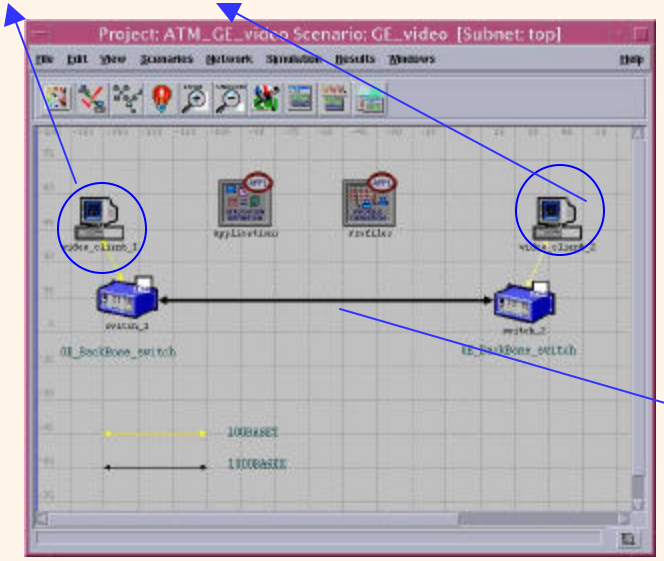
Gigabit Ethernet

- IEEE 802.3z
- Offers high bandwidth of 1,000 Mbps
- Physical Media : 1000Base -X standard
- MAC Operation : enhanced CSMA / CD
- Uses the IEEE 802.3 Ethernet frame format, with the addition of carrier extension field
- Addresses backward-compatibility with 10 Mbps and 100 Mbps Ethernet technologies

Experiment 1 : Gigabit Ethernet vs. ATM

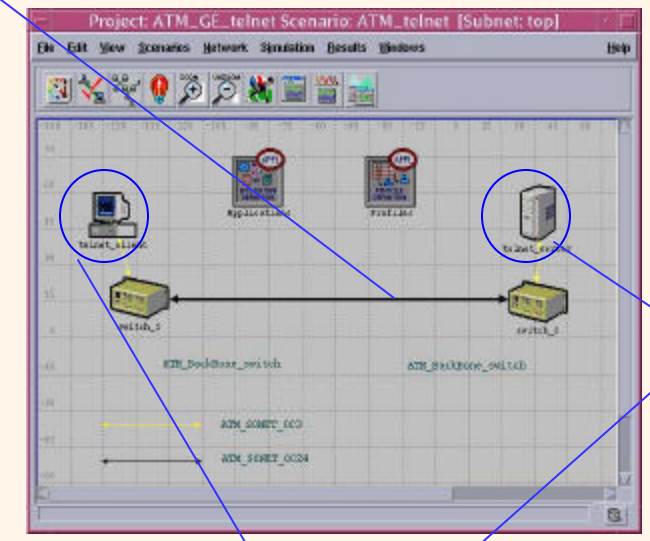
Video Conferencing clients

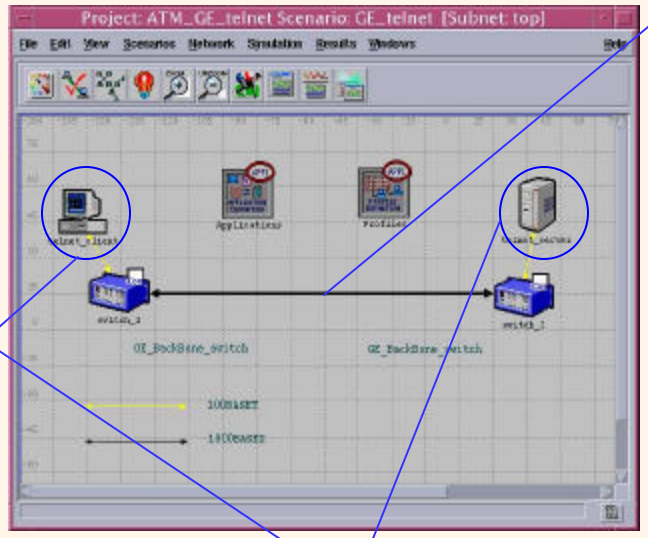




ATM_OC24

1000Base-X



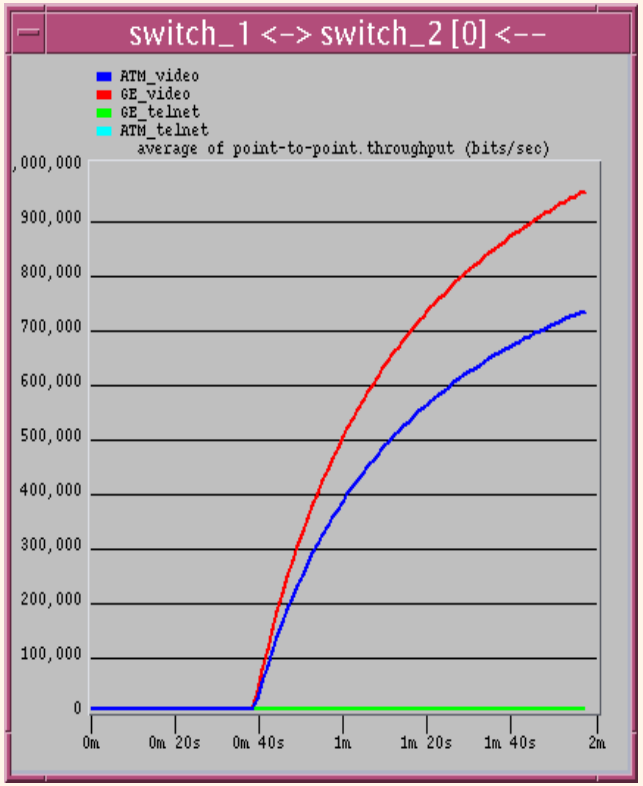


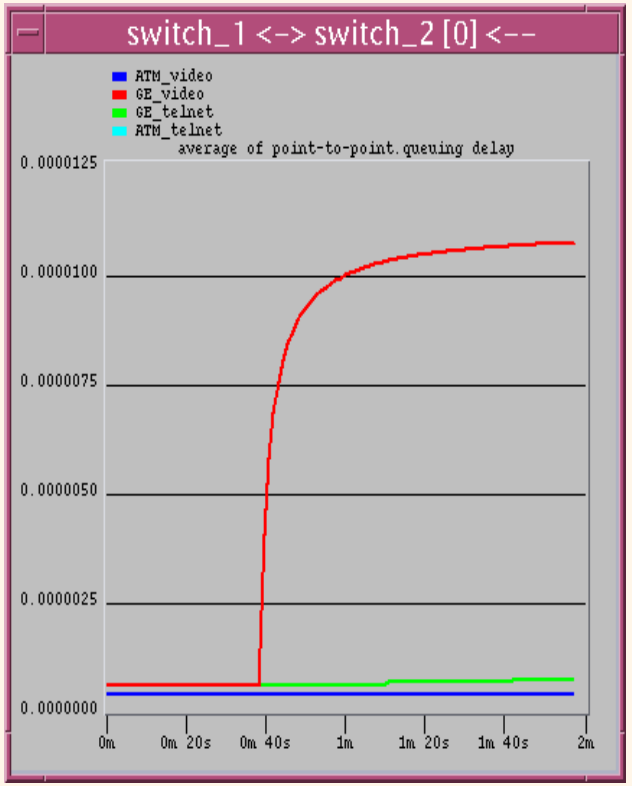
Telnet client

Telnet server

Experiment 1: Gigabit Ethernet vs. ATM (cont.)

- GE_Video
- ATM_Video
- GE_Telnet
- ATM_Telnet





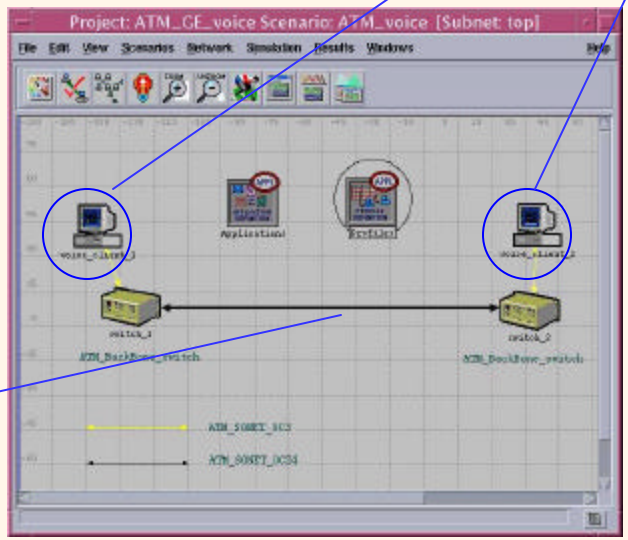
Backbone throughput

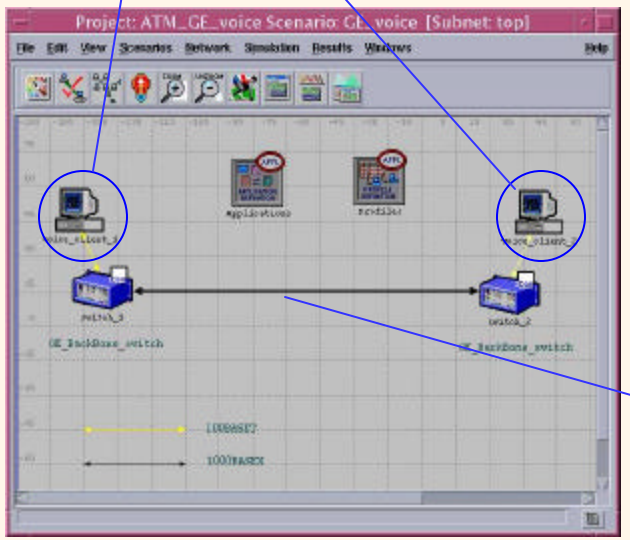
Gigabit Ethernet is better

Backbone queuing delayATM is better

Experiment 1: Gigabit Ethernet vs. ATM (cont.)

Voice application clients



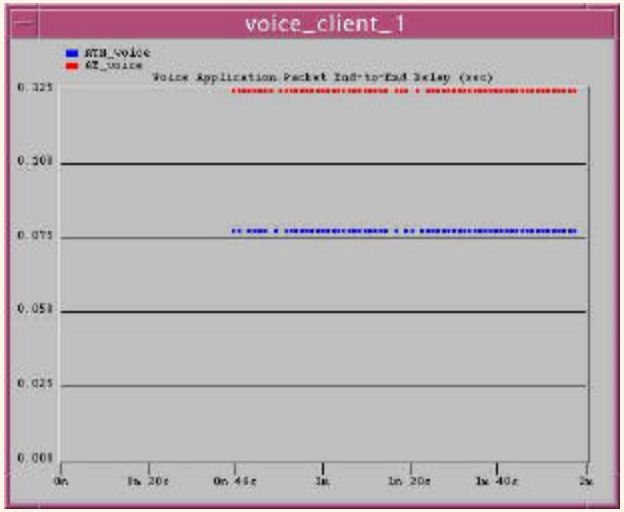


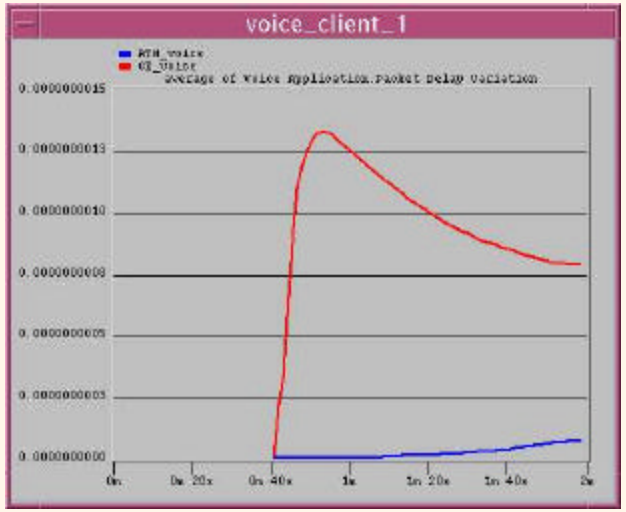
ATM_OC24

1000Base-X

GE_Voice

ATM_Voice





Packet Delay

GE > ATM

Packet Delay Variation

GE > ATM

Conclusion 1 on Gigabit Ethernet and ATM

In the long run, it will not be a question of people using
only ATM or only Gigabit Ethernet , it is more a question of **where do they fit**.

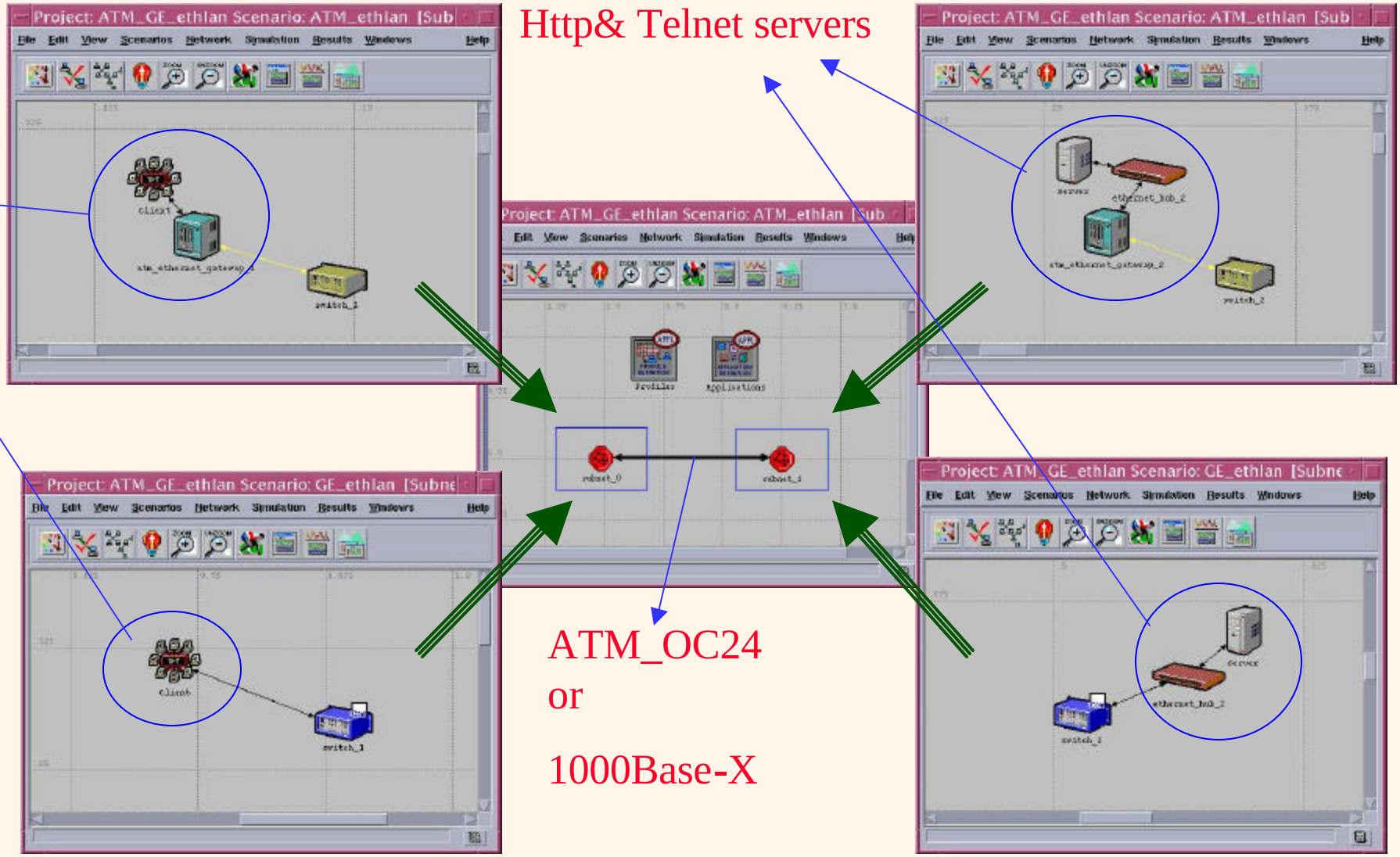
- Gigabit Ethernet : Should be used in areas where high data throughput is required,but quality of service is not a main concern.

- ATM : should be used in environments where video, voice and other delay sensitive traffic exist.

Experiment 2: Gigabit Ethernet vs. ATM

10BaseT LAN containing only Http& Telnet servers

10BaseT LAN containing only Http&Telnet clients

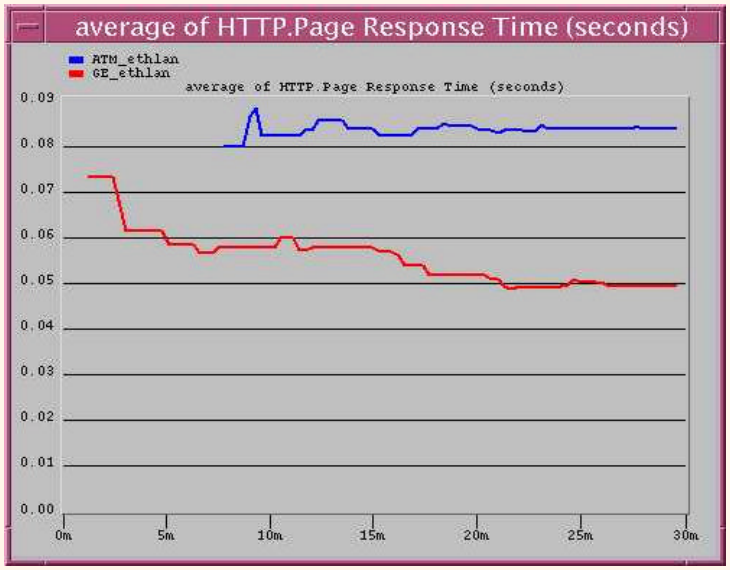


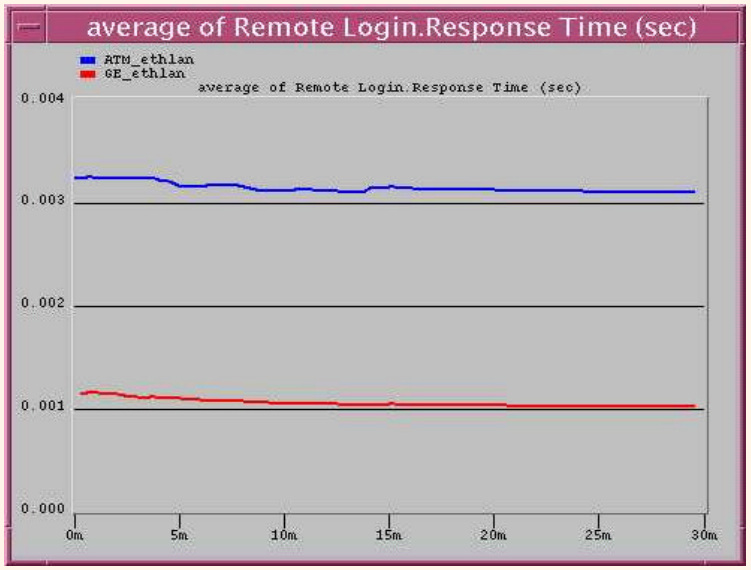
ATM_OC24
or
1000Base-X

Experiment 2: Gigabit Ethernet vs. ATM (cont.)

Gigabit Ethernet

ATM





Http page response time

ATM > GE

Telnet response time

ATM > GE

Conclusion 2 on Gigabit Ethernet and ATM

Since Gigabit Ethernet's technology is fully backward-compatible with existing Ethernet hardware standards, so it can provide the **seamless connectivity with legacy Ethernet LANs**.

This point is valuable because 80 percent of current LANs use Ethernet technology.

Summary on Four Backbones

Technology	Features	Limitations
Fast Ethernet	100BaseT Same frame as Ethernet Low cost High performance	Slow 100Mbps speed Unable to support multi-service
FDDI	100Mbps speed Stable technology Redundancy Fault-tolerant Inexpensive	Slow 100Mbps speed Distance limitation of 200km Unable to support multi-service No QoS
ATM	Flexible access speeds Strong standards High reliability Handles all traffic types Highly scalable Easy to integrate LAN with WAN Quality of Service	Small cell size leads to higher traffic Expensive
Gigabit Ethernet	1Gbps speeds Compatible with legacy Ethernet equipment Strong standards Highly scalable Reliable with low operating cost	Not matured yet Limited to LAN backbone so far

Encountered Problems

- Opnet
  - We met quite some problems such as memory allocation error and segmentation error, which forced some simulations be terminated.
  - We tried to create some heavy traffic in order to get some statistics on packet drop rate, bit error rate, but opnet performs bad and results with no statistics collected
- Incomparable issues among backbones
  - Fault Tolerance of FDDI
  - Distance advantage and QoS of ATM

Future Work

- More analysis work
- Investigate those particular properties of each backbone
- Try real trace data (Star Wars) on our network, and see if we can get some more interesting results.

References

[1] Shapiro, Sydney F., " FDDI moves closer to fruition as standard network backbone", Computer Design, Volume 27, Aug. 15, 1988, pp. 35-38

[2] Ranai, Kisenchand, Lim, Koon Seng, Deng, Roert Huijie, " Simulating a multimedia FDDI backbone network", The Computer Journal, Volume 37 Nov. 3, 1994, pp. 188-98

[3] Mirchandani Khanna, "FDDI Technology and Applications", Chapter 14, "Interconnecting LANs Using FDDI".

[4] Darling, Charles B, "Hook your legacy LAN to ATM". Datamation, Volume 42, 1996, pp. 98-103 [http://staging-datamation.earthweb.com/nwinf/09eval1.html]

[5] Strauss, Paul, "ATM backbones: complex? And how!". Datamation, Volume 40, July 15 1994, pp. 44-46

[6] Raif O. Onvural, "Asynchronous Transfer Mode Network: Performance Issues", Chapter 3, "Source Characterization in ATM Networks".

[7] Akyildiz, Ian F., Bernhardt, Keith L, "ATM local area networks: a survey of requirements, architectures, and standards". IEEE Communications Magazine, Volume 35, July 1997, pp. 72-80.
[http://www.comsoc.org/pubs/surveys/reprints/akyildiz.html]

[8] Stephen Elbert, et.al, " Gigabit Ethernet and Low-Cost Supercomputing", Ames Laboratory Technical Report IS-5126.
[http://www.scl.ameslab.gov/Publications/Gigabit/tr5126.html]

[9] Stephen Saunders, "Gigabit Ethernet Handbook", Chapter 14, "Comparing Gigabit Ethernet to Other High-Speed LANs", Chapter 15, "Choosing Between ATM and Gigabit Ethernet in the Backbone".

[10] Joe Melki and Jonathan Knop, "ATM vs Gigabit Ethernet For High Speed LANS", Project of EE 4984, Virginia Polytechnic Institute and State University, April 15, 1997.

Acknowledgement

- Thanks to:

  Our Professor Ljiljana Trajkovic

  Our TA Milan Nikolic

  Nazy Alborz

  Opnet technical support

  Some helpful people in Opnet Forum

Working Distributions

- We plan the project together
- Cooperation in experiments
  - 10Base-T vs. ATM backbone (Fang)
  - FDDI vs. Fast Ethernet (Chao and Yong)
  - ATM vs. FDDI (Chao and Fang)
  - ATM vs. Gigabit Ethernet (Yong)
- Analysis results together