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# Performance Evaluation of Educational Workstation Network Systems

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# Concentrated Educational Workstation Systems

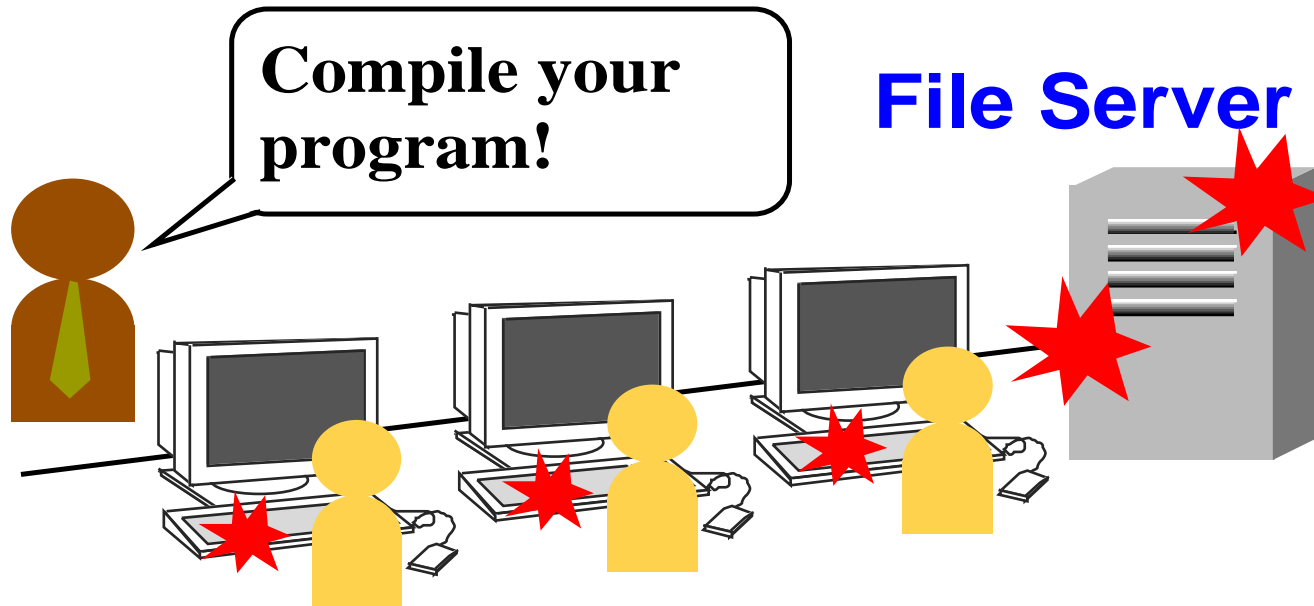
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- ◆ **Many Registered Users**
- ◆ **Many Users at a Time**
- ◆ **Many Workstations**
- ◆ **Unique Working Environment at All Workstations**
- ◆ **Easy to Maintenance**

# "Ready Go!" Situation

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- ◆ Momentary High Load to the LAN
- ◆ Long Response Time



# Approach

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- ◆ **Detailed Network Simulator**

- Ethernet CSMA/CD, Propagation Delay
- TCP / NFS Retransmission Strategies

- ◆ **Users' Behavior Model**

- “Ready Go!” Situation
- Based on Measurements in an Educational System



**Proper Designs for Educational Systems**

# Related Works

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## ◆ Performance Evaluation of LANs

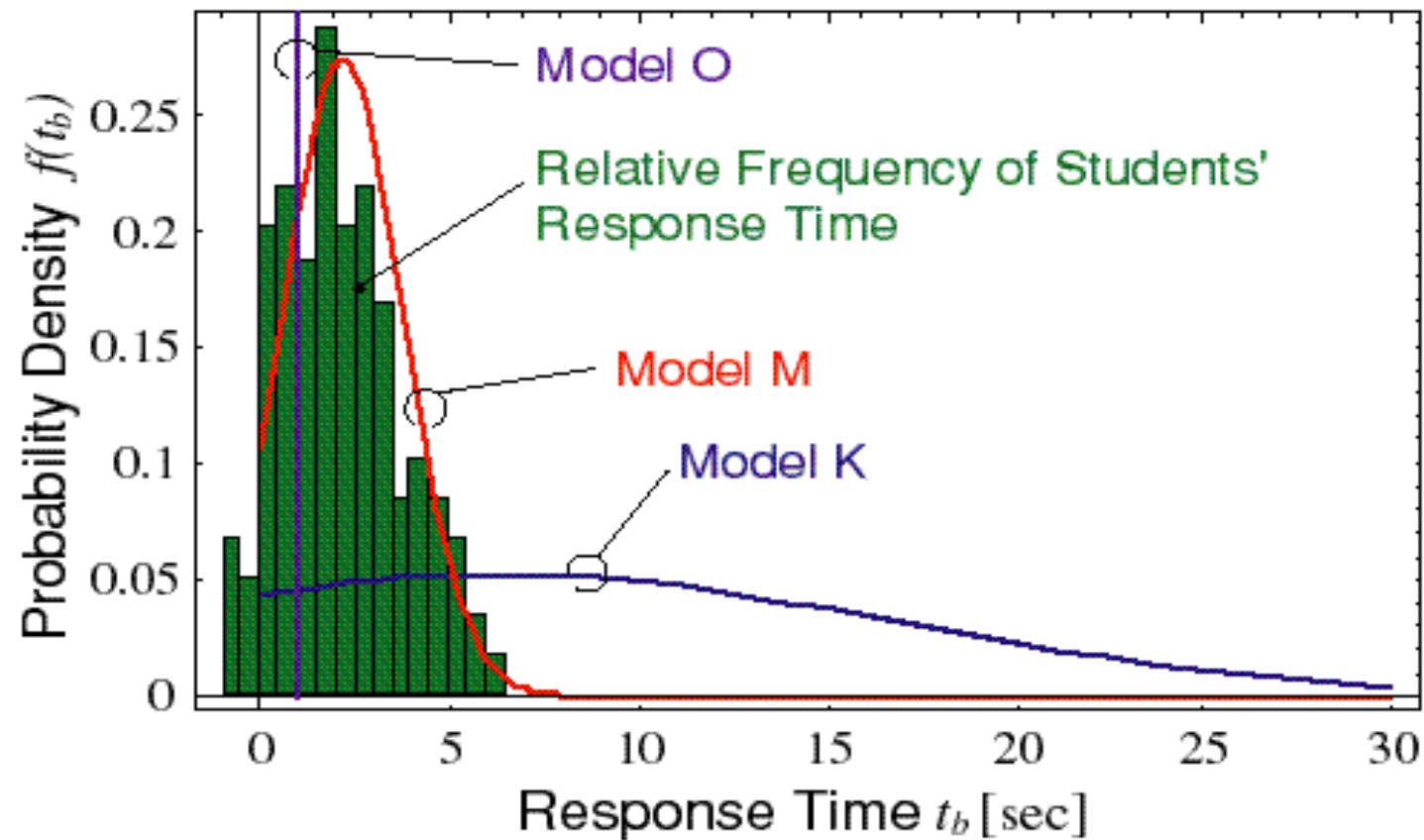
- Gigabit Ethernet [Molle 97]
  - » **Only under MAC Layer (Ethernet)**
- Packet Length Distribution in Practical LAN [Ishida 94]

## Yet to be Achieved

- Educational Systems (“Ready Go!” Situation)
- Analysis from 1st to 7th Layers

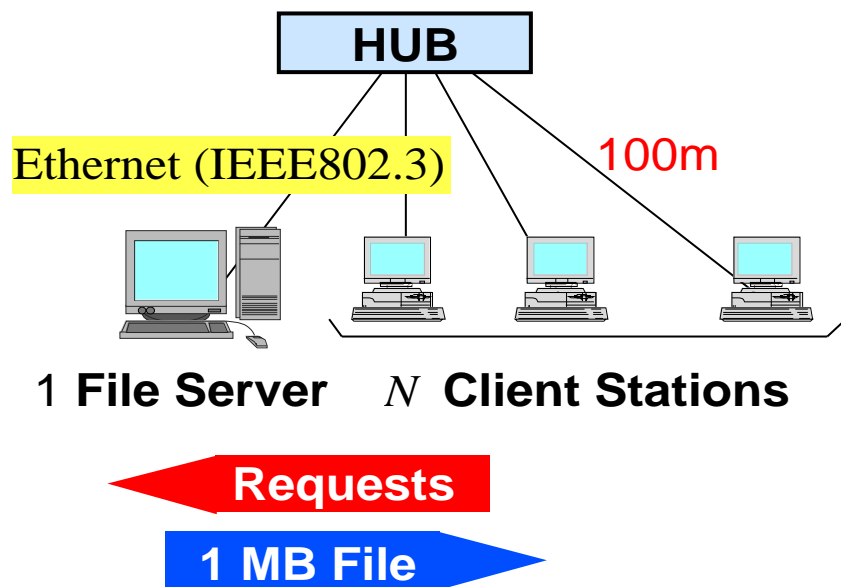
# Users' Behavior Model

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# Simulation

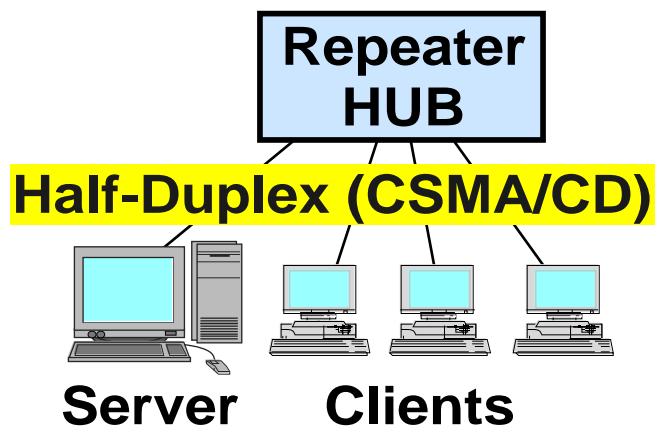
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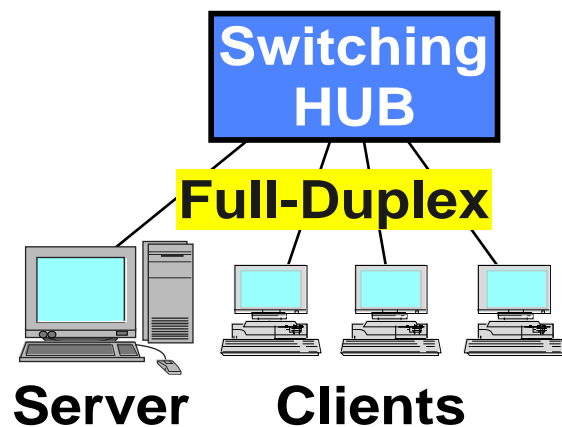
- ◆ NFS (SunOS 4.1), FTP
- ◆ TCP (BSD 4.3Tahoe), UDP/IP
- ◆ Ethernet
  - 10BASE-T (10Mbps)
  - 100BASE-TX (100Mbps)
  - 1000BASE-X (1Gbps)
    - » with Carrier Extension & Frame Bursting

# Network Topologies

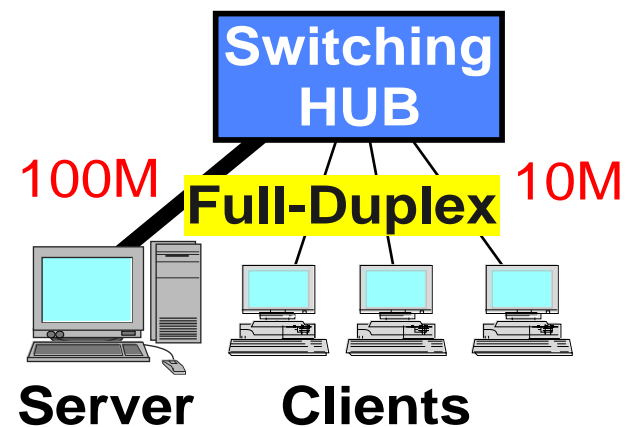
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(a) Shared-10M  
Shared-100M  
Shared-1G



(b) Switched-10M  
Switched-100M



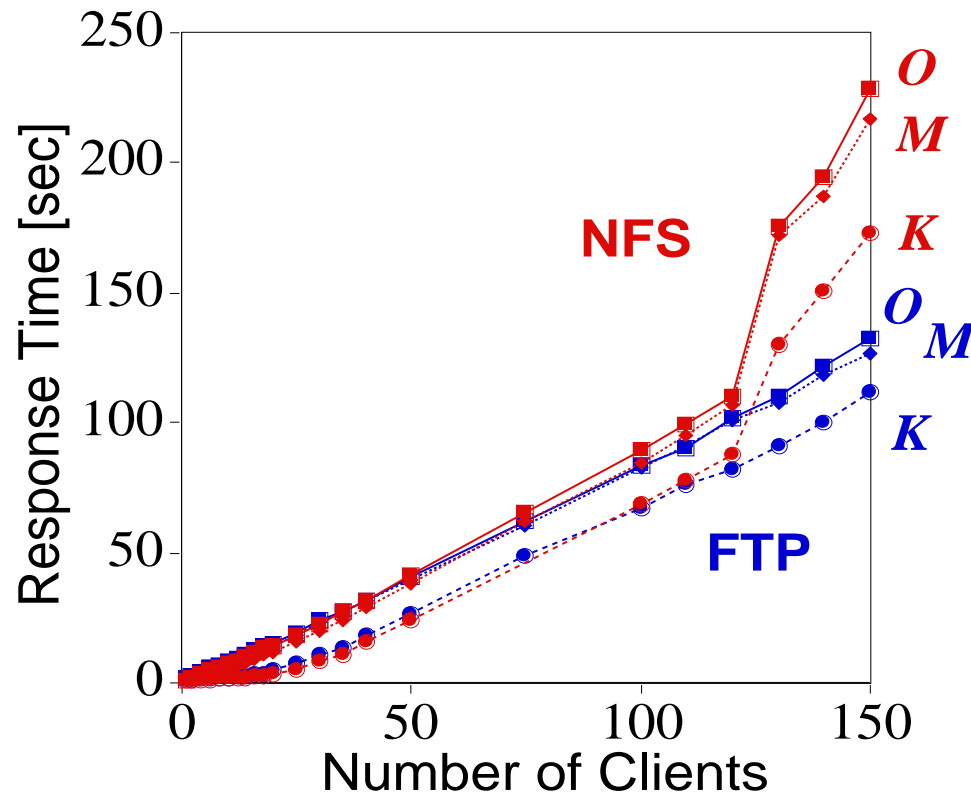
(c) BigPipe-10M/100M



# Simulation Results: 10Mbps (Shared)

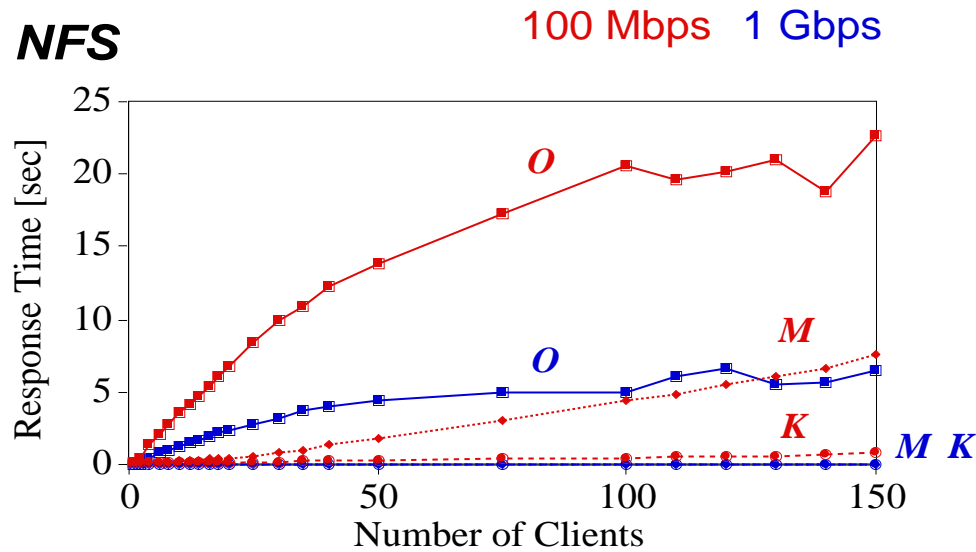
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**10BASE-T**



- ◆ **Rapid Increase at**  
 $N = 10$  (Model M)  
 $N = 20$  (Model K)
- ◆ **Response Time Explosion at  $N > 120$  (NFS)**  
NFS time-out

# Simulation Results: 100Mbps & 1Gbps (Shared)



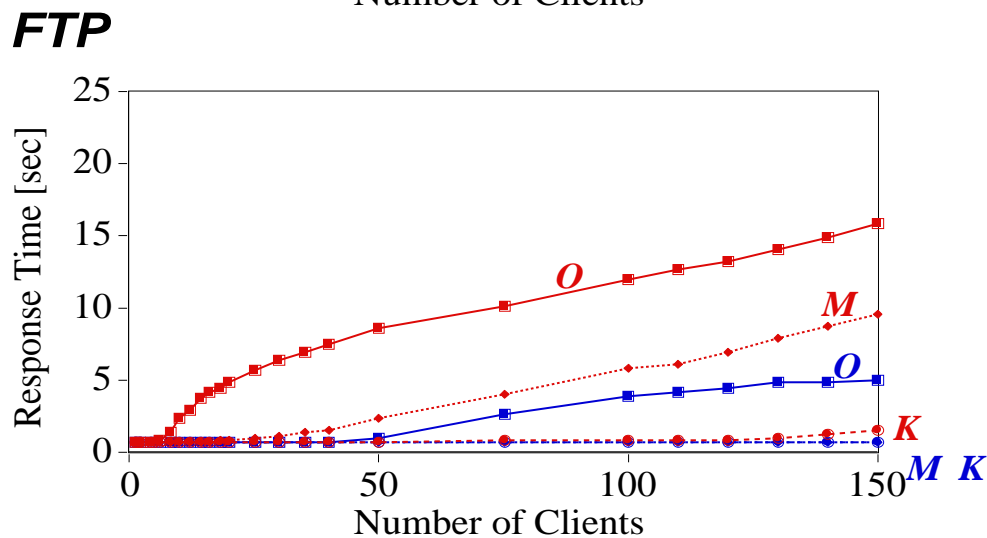
## ◆ Suitable Number of Clients

$$N < 50$$

(100BASE-TX)

$$N > 150$$

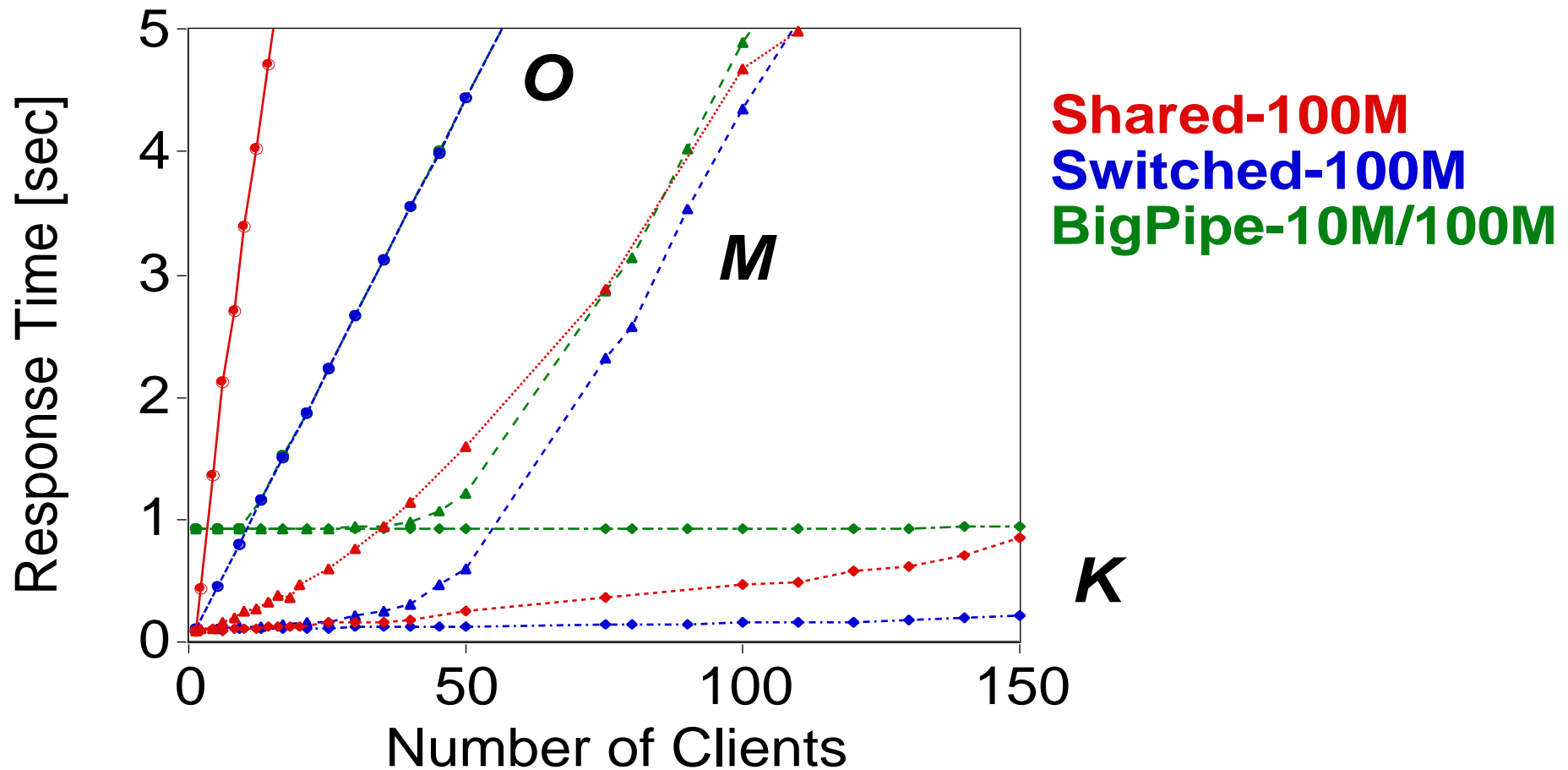
(1000BASE-X)



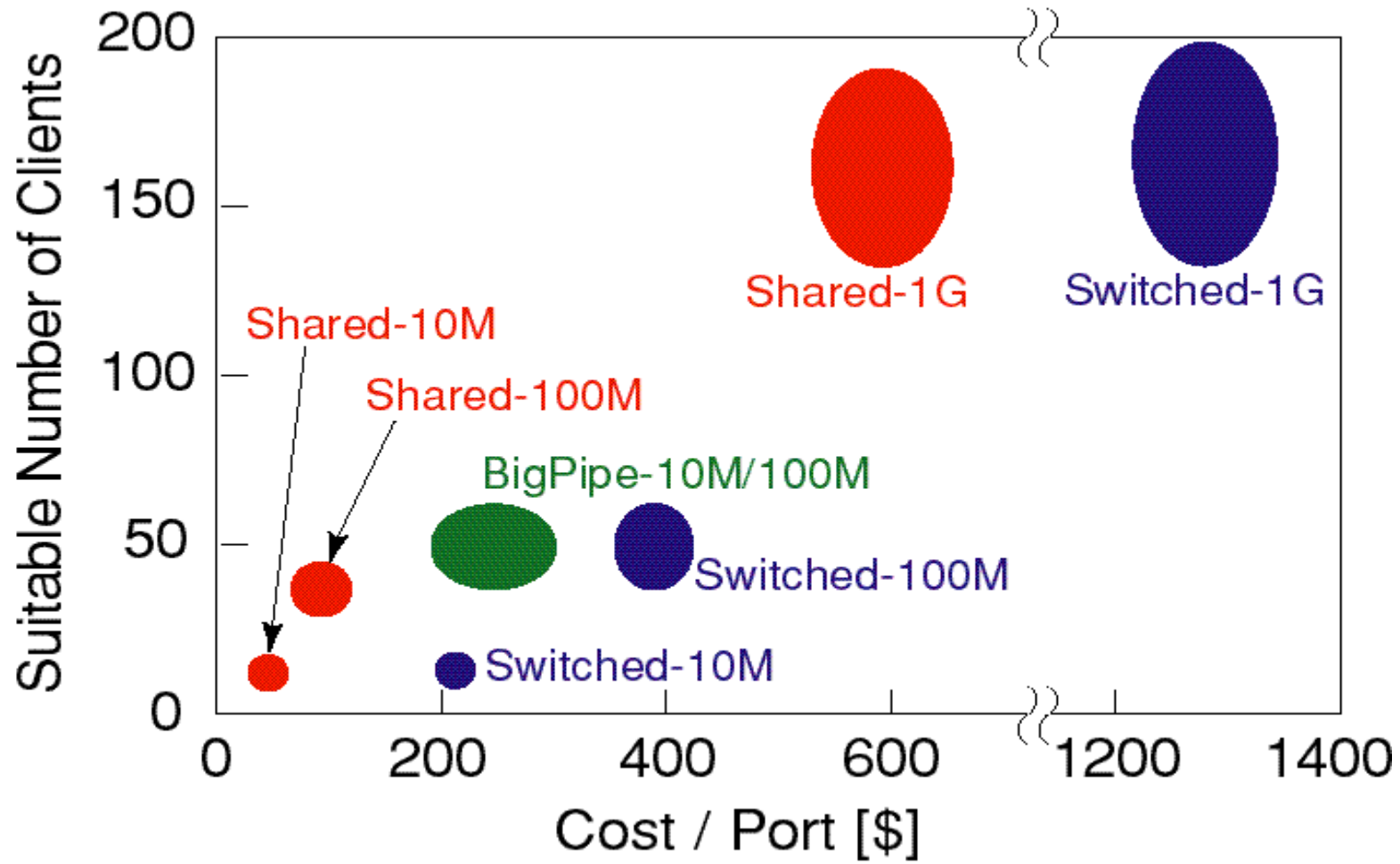
# Simulation Results: Switched & BigPipe

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## *NFS*



# Cost and Performance



# Conclusion

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- ◆ **Suitable Design for Educational Workstation LAN Systems**

*obtained by*

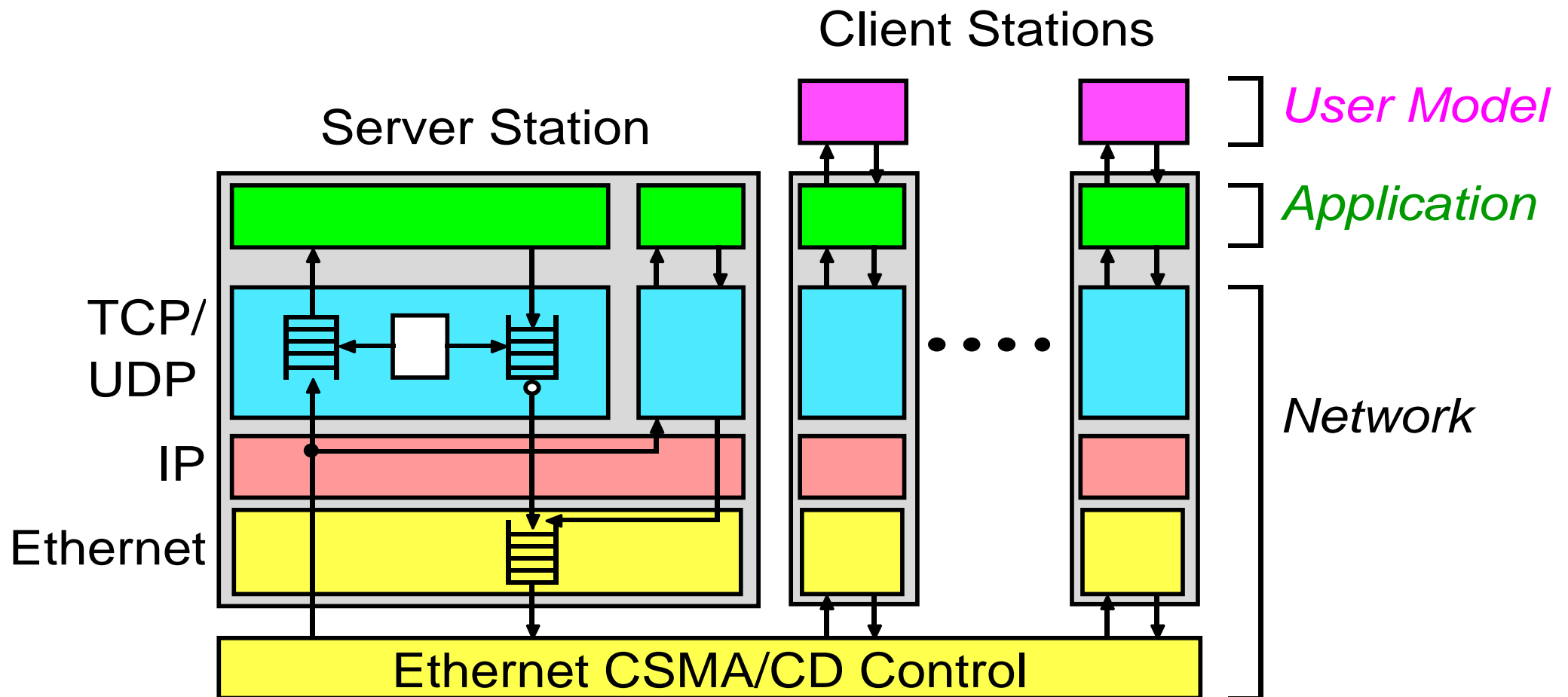
- Detailed Network Simulation
- Users' Behavior Models of the "Ready Go Situation"

- ◆ **Future Studies**

- Other Network Topologies
- Consideration of the Server Performance
- Multimedia Data Transmission

# Network Simulator

**SimNET**



# Proper Number of Clients

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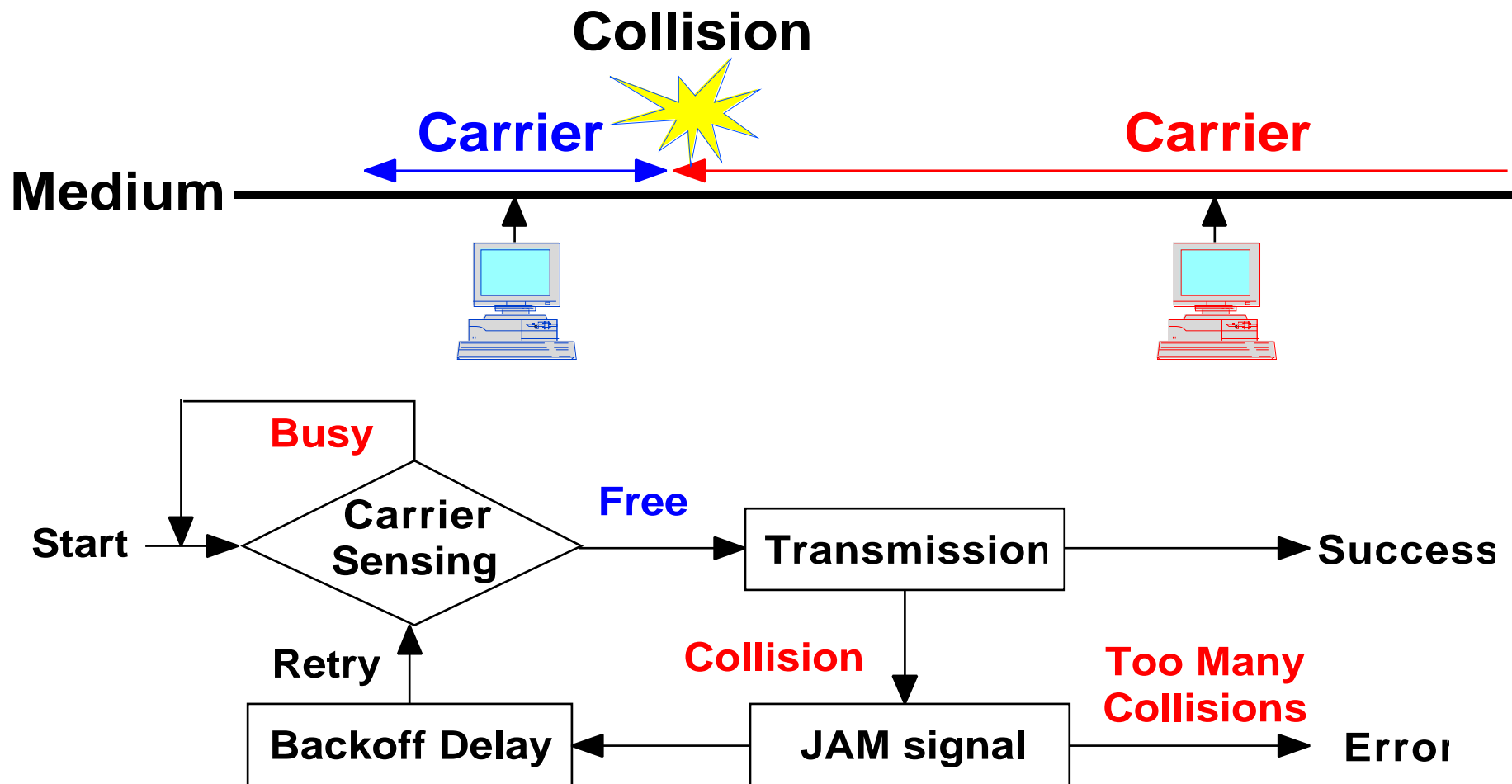
- Response Time < 1 sec
- No rapid increasing of response time

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	Mouse Operation	Keyboard Operation
Shared-10M	< 10	< 20
Switching-10M	< 10	< 20
Shared-100M	< 30	< 150
Switching-100M	< 50	> 150
BigPipe-10M/100M	< 50	> 150
Shared-1G	> 150	> 150

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# CSMA/CD Algorithm

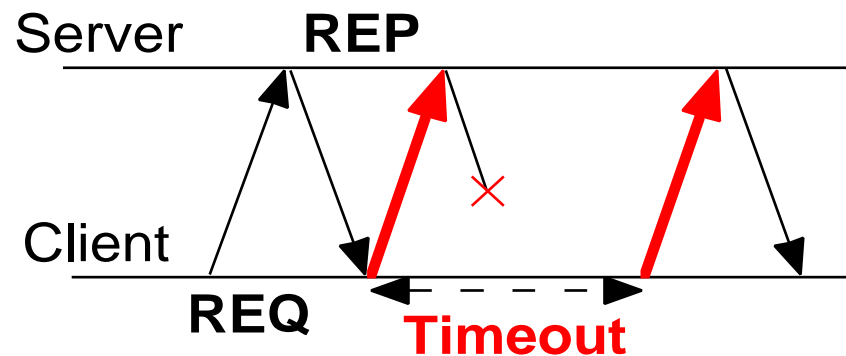




# Application Models

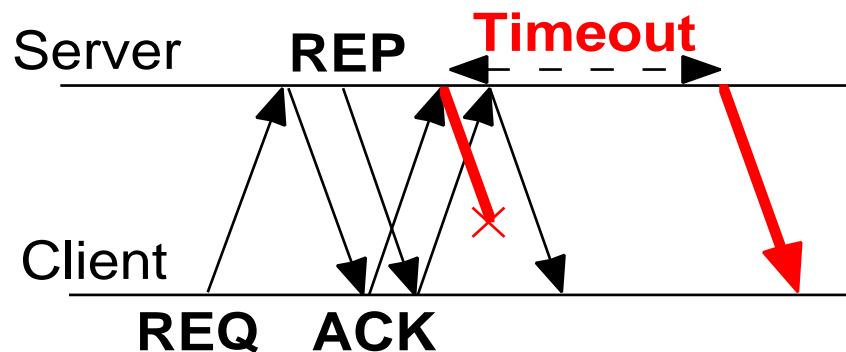
## ◆ NFS

- Simple Time-out and Retry



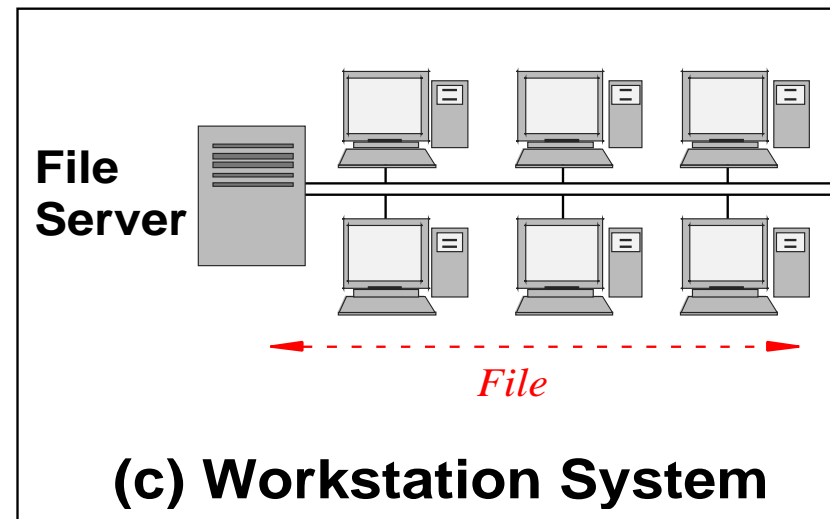
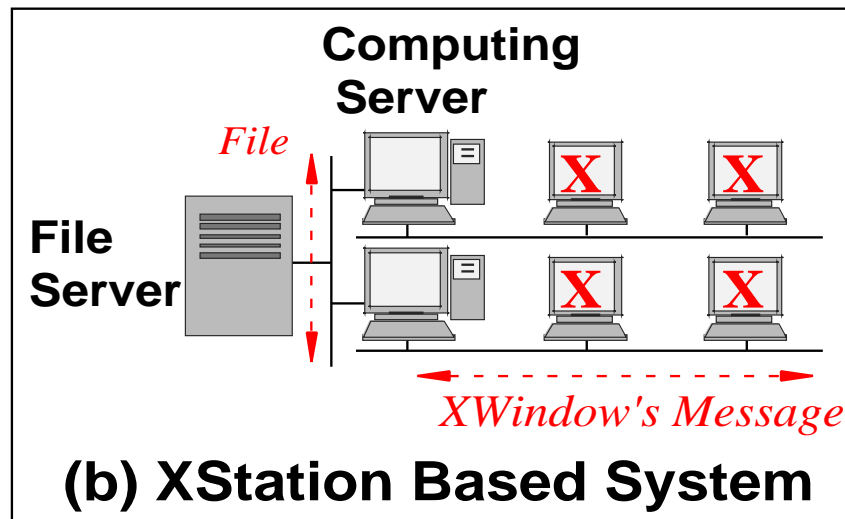
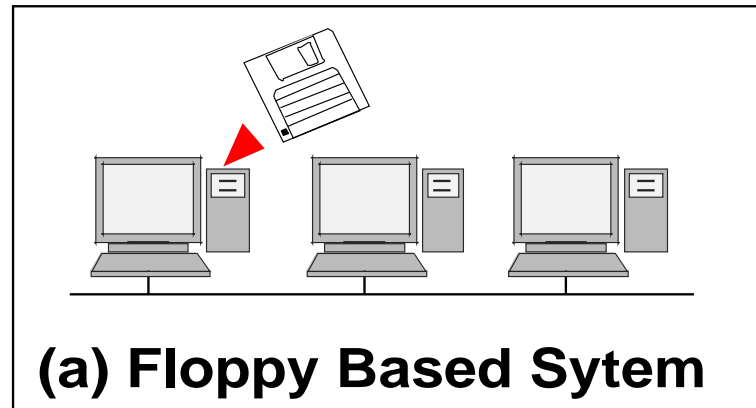
## ◆ FTP

- Works on TCP
- Reliability is offered by TCP



# Examples of Educational Systems

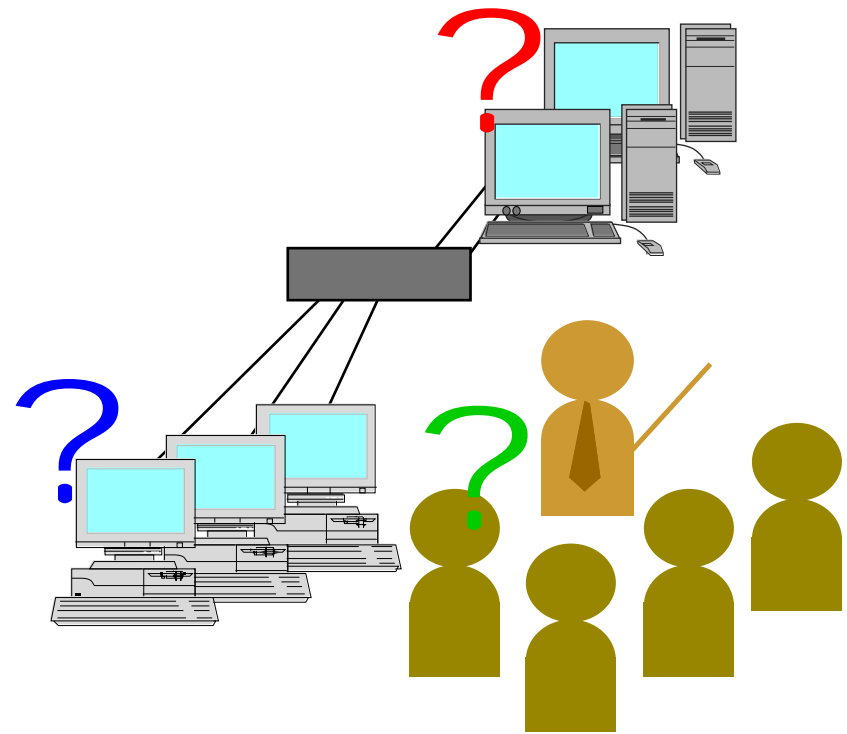
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# Problems in Designing Networks

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- ◆ How many stations are suitable for an Ethernet collision domain?
- ◆ How many stations are suitable for a file server?
- ◆ How do students behave in educational computer systems?



# *SimNET*

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## *Supports...*

- ◆ **Cable and HUB Delay on Ethernet**
- ◆ **CSMA/CD algorithm**
- ◆ **All Packet Transmissions**
- ◆ **Retransmission Strategies**
- ◆ **User Actions**