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Lecture 2

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STEPS TO NETWORKING

OBJECTIVES

- Understand networks objectives
- Explain steps to networking
- Explain common network issues and how to resolve them
- Describe network layering

What is the Objective of Networking?

- Communication between applications on different computers
- Must understand application needs/demands
  - Traffic data rate
  - Traffic pattern (bursty or constant bit rate)
  - Traffic target (multipoint or single destination, mobile or fixed)
  - Delay sensitivity
  - Loss sensitivity

Four Steps to Networking

- Communicating across a link
- Connecting together multiple links (internetworking)
- Finding and routing data to nodes on internetwork
- Matching application requirements

A First Step

- Creating a link between nodes
- Link: path followed by bits
  - Wired or wireless
  - Broadcast or point-to-point (or both)
- Node: any device connected to a link

Types of Links

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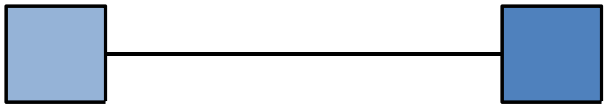
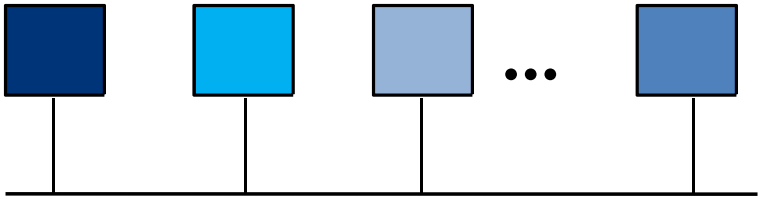
Point-to-Point



Multiple Access

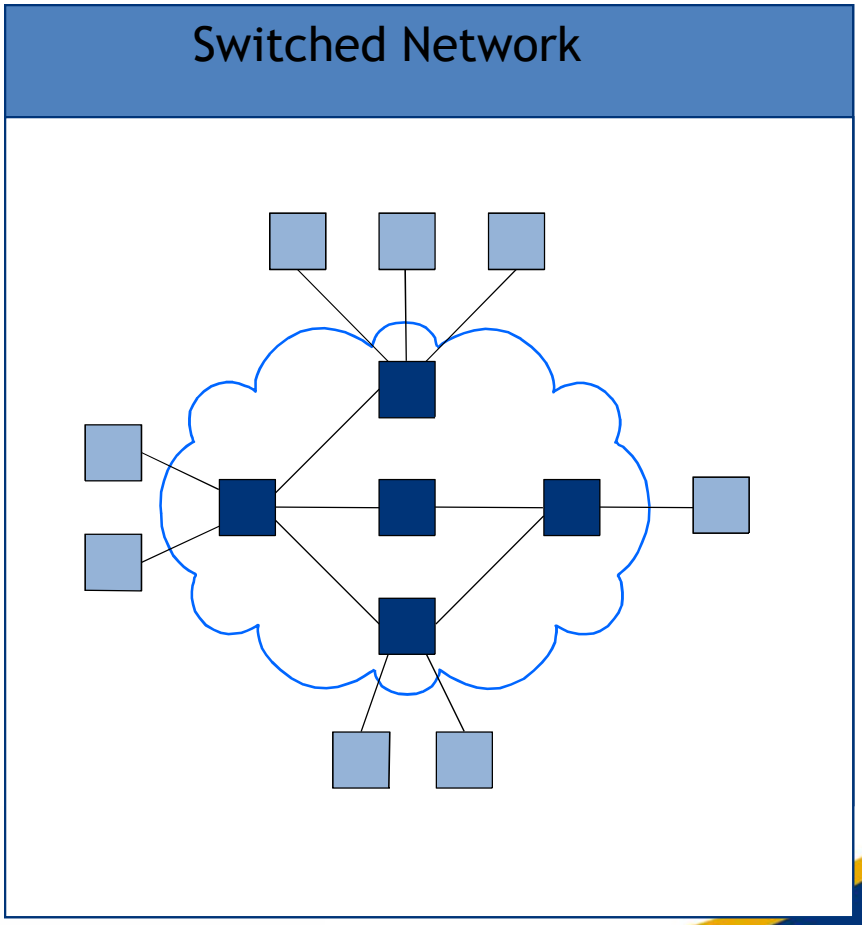


Packet Transmission Modes

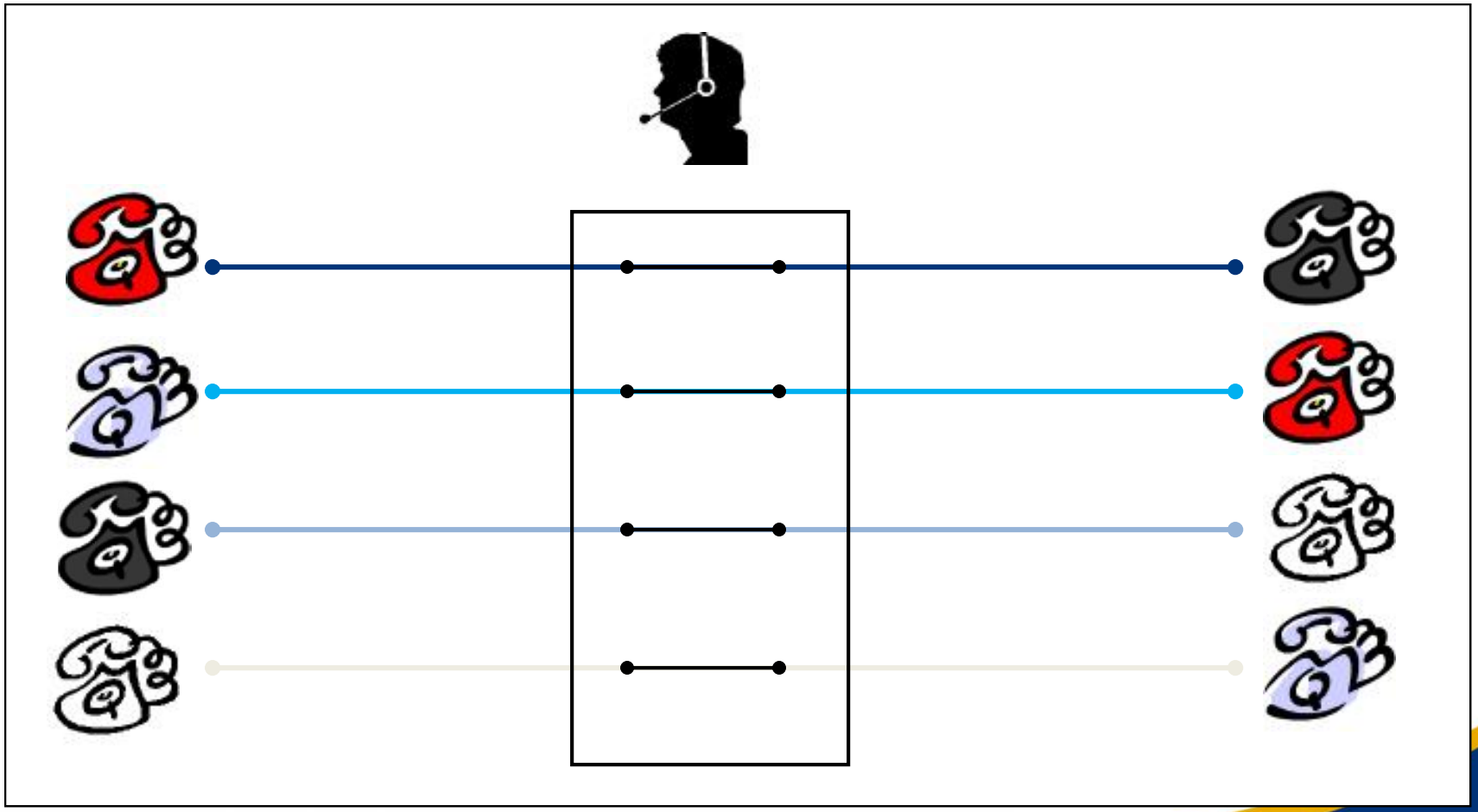
- Unicast
  - Transmission to single specific receiver
- Broadcast
  - Transmission to all network nodes
- Multicast
  - Transmission to specific subset of nodes
- Anycast
  - Transmission to one of a specific subset of nodes

What are Switched Networks?

- Switch: moves bits between links
  - Packet switching
  - Circuit switching

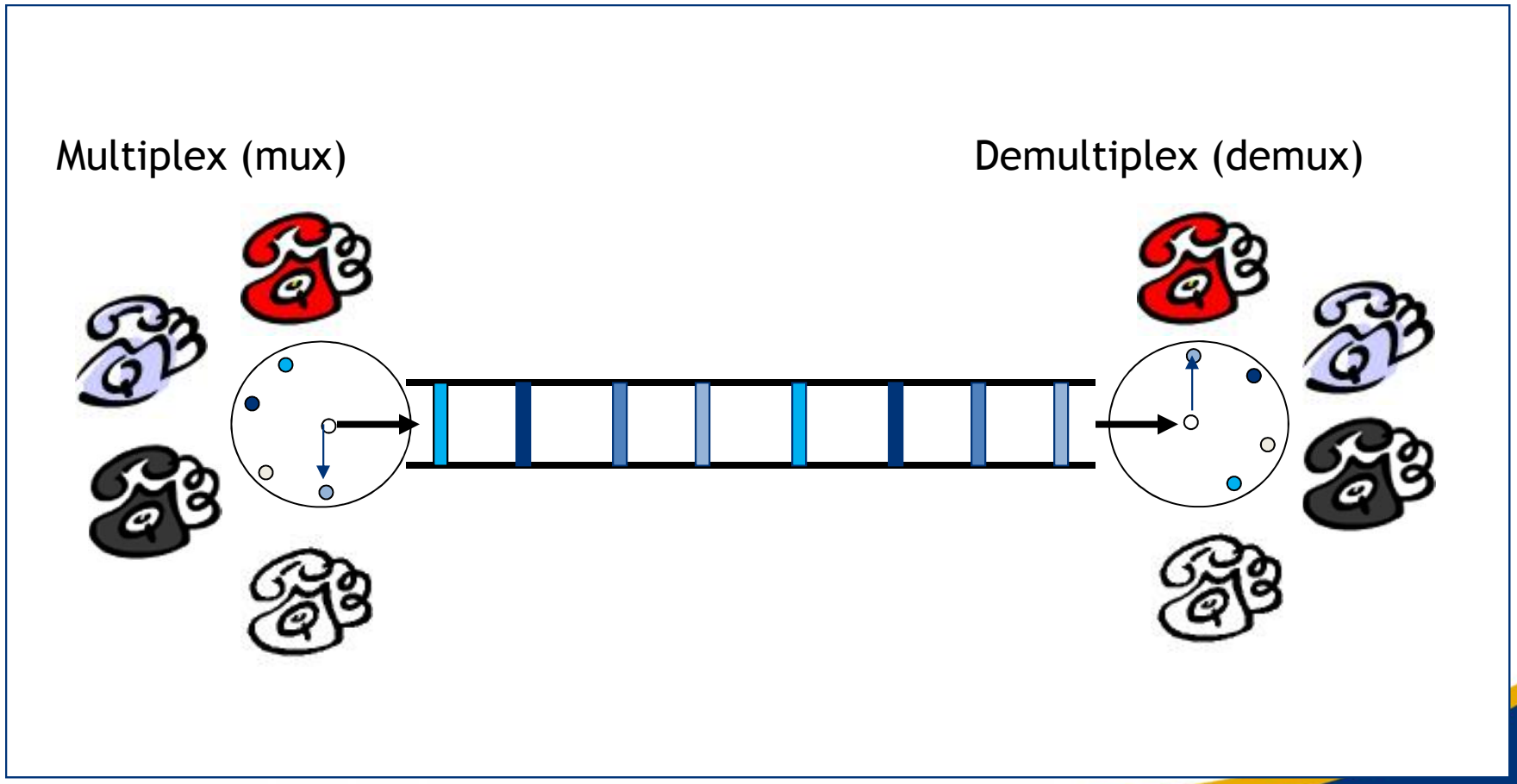


Back in the Old Days…

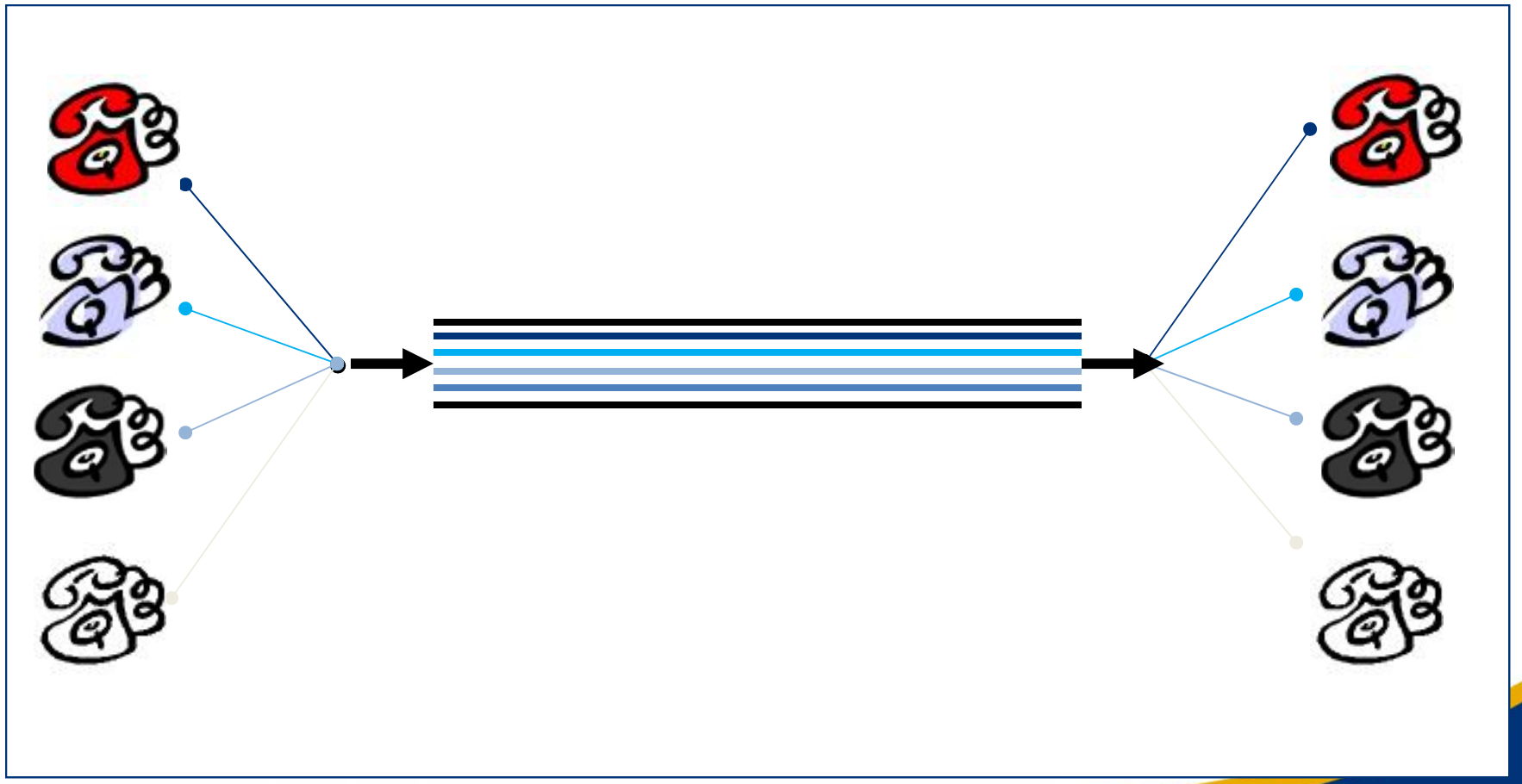


Then Came TDM…

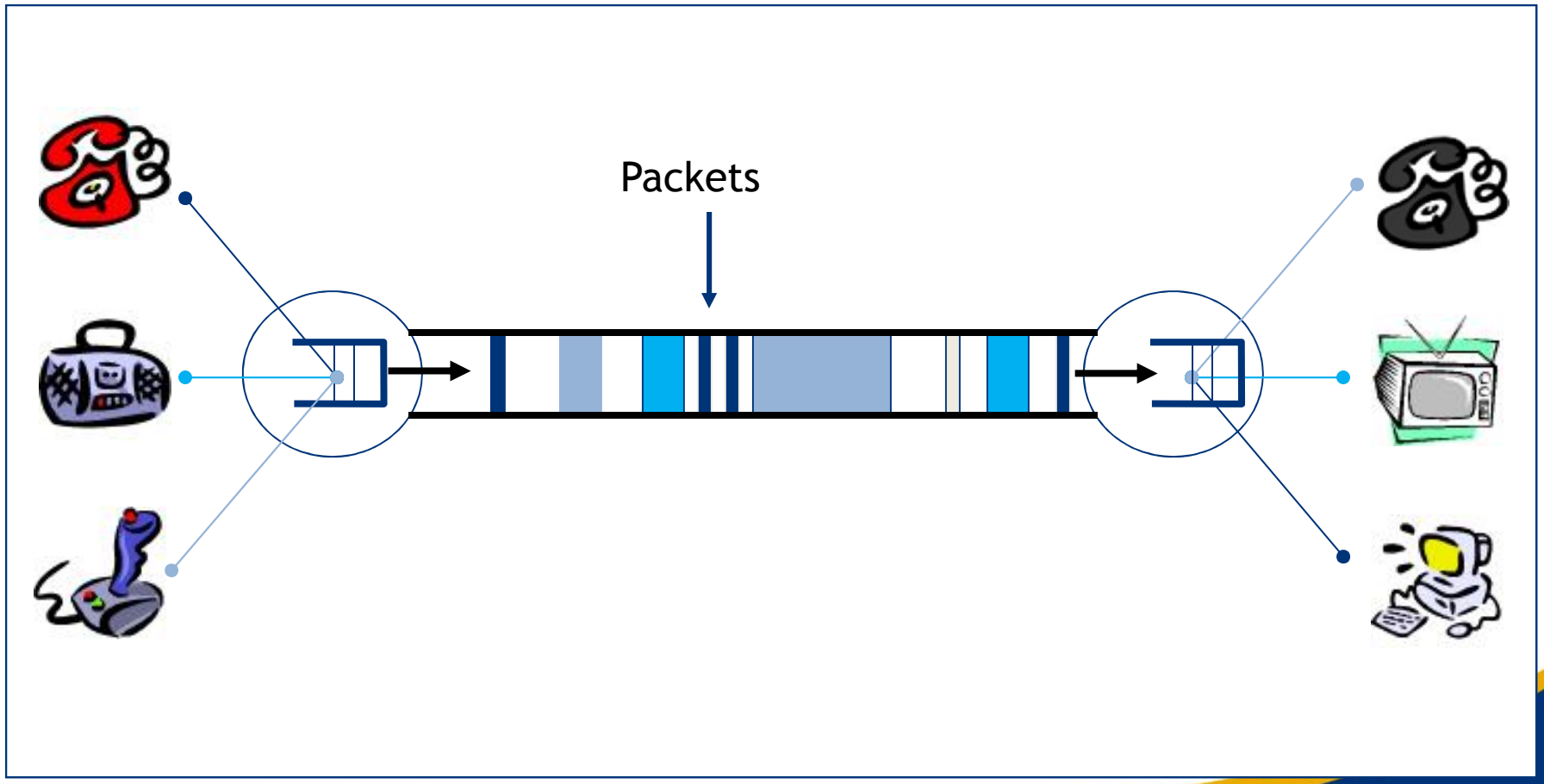
- Synchronous time division multiplexing



TDM Logical Network View



Packet Switching (Internet)



Packet Switching

- Interleave packets from different sources
- Efficient: resources used on demand
  - Statistical multiplexing
- General
  - Multiple types of applications
- Accommodates bursty traffic
  - Addition of queues

Statistical Multiplexing Gain

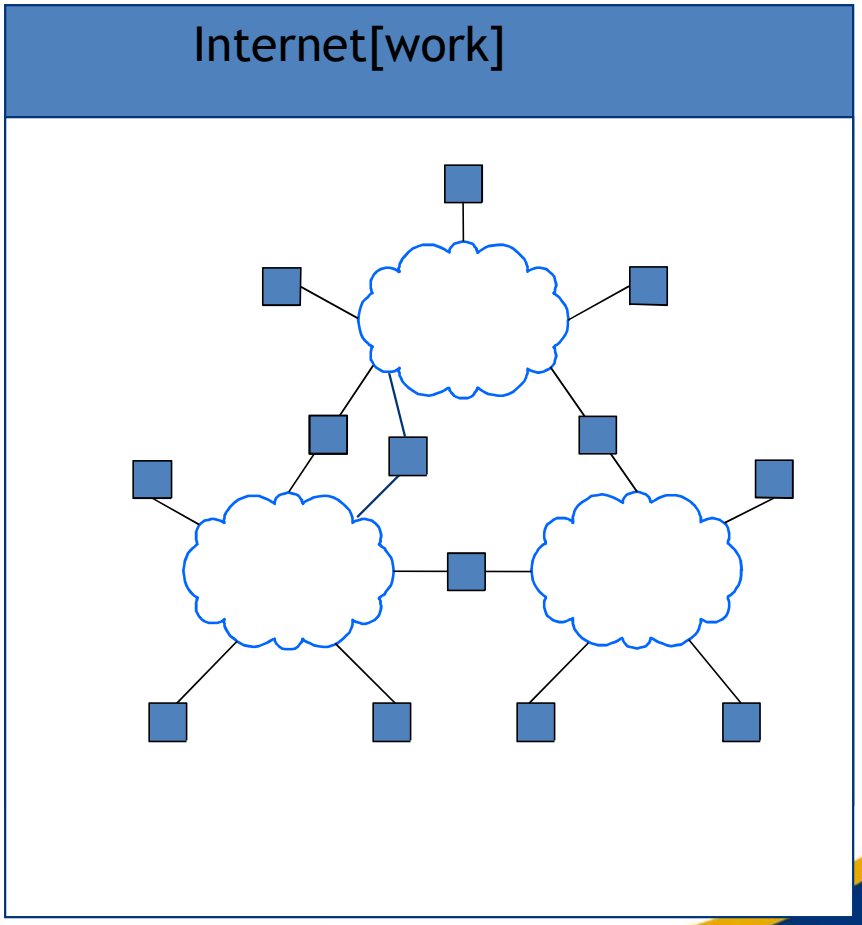
- 1 Mbps link; users require 0.1 Mbps when transmitting; users active only 10% of the time
- Circuit switching: can support 10 users
- Packet switching: with 35 users, probability that >=10 are transmitting at the same time < 0.0017

Characteristics of Packet Switching

- Store and forward
  - Packets are self contained units
  - Can use alternate paths – reordering
- Contention
  - Congestion
  - Delay

Second Step: Internet[work]

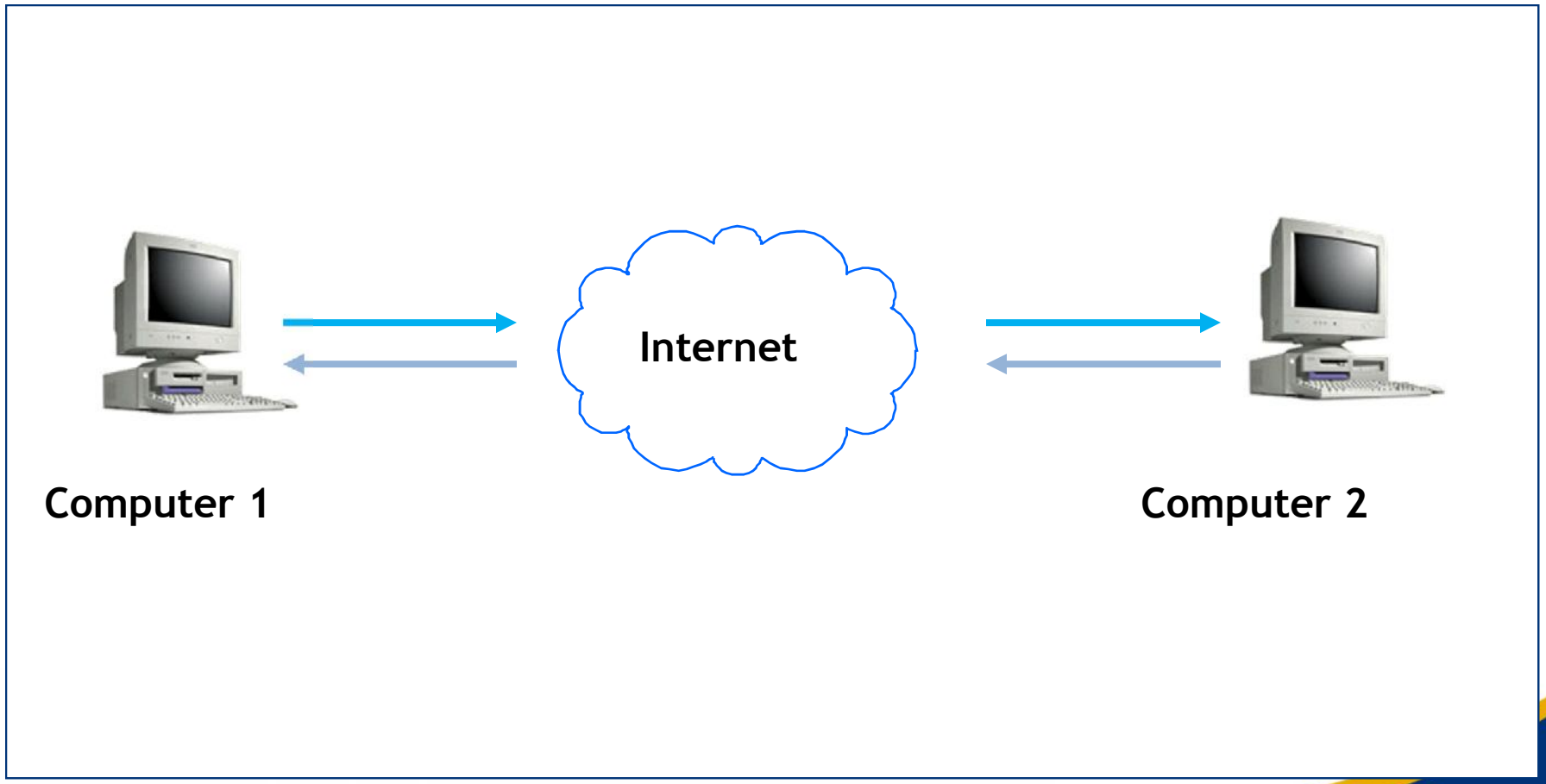
- A collection of interconnected networks
- Host: network endpoints (computer, PDA, light switch, …)
- Router: node that connects networks
- Internet vs. internet



Challenge

- Many differences between networks
  - Address formats
  - Performance – bandwidth/latency
  - Packet size
  - Loss rate/pattern/handling
  - Routing
- How to translate between various network technologies

Third Step: How To Find Nodes?



Naming

- Humans use readable host names
  - E.g. www.strathmore.edu
  - Globally unique (can correspond to multiple hosts)
- Naming system translates to physical address
  - E.g. DNS translates name to IP Address (e.g. 128.2.11.43)
  - Address reflects location in network

Domain Name System

What's the IP address for www.cmu.edu?

It is 128.2.11.43

Computer 1

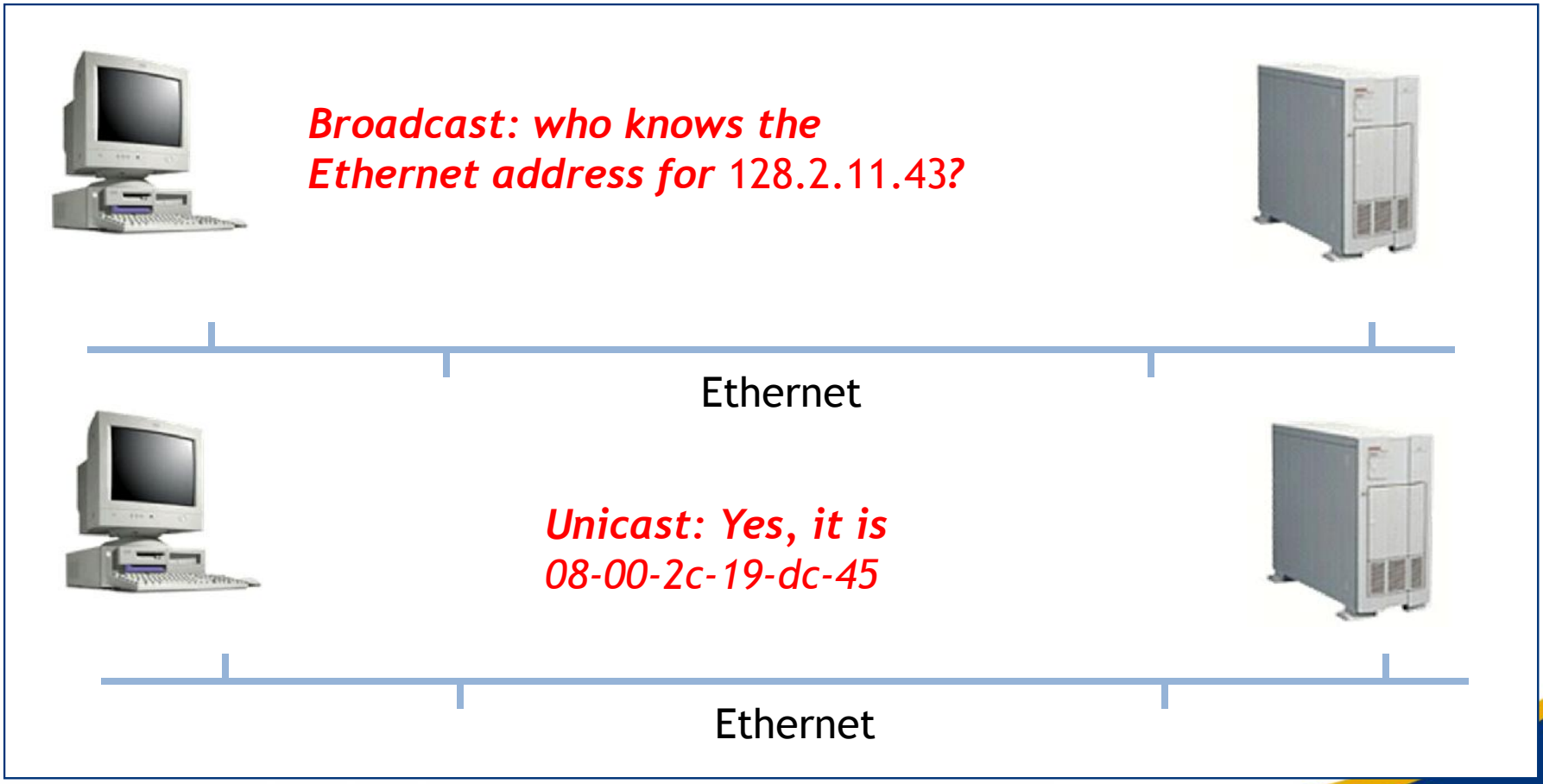
Local DNS Server

DNS server address manually configured into OS

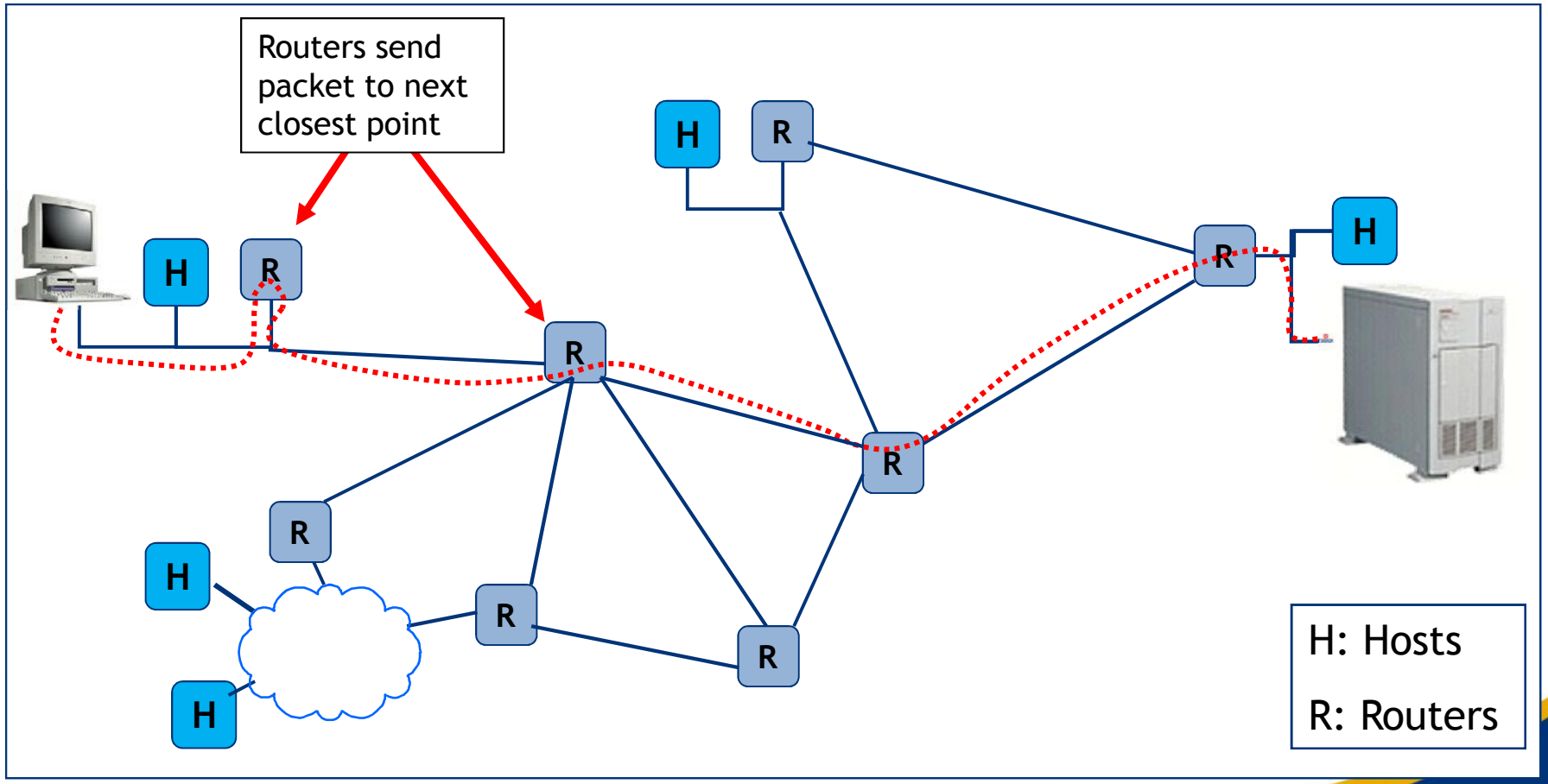
Packet Routing/Delivery

- Each network technology has different local delivery methods
- Address resolution provides delivery information within network
  - E.g., ARP maps IP addresses to Ethernet addresses
  - Local, works only on a particular network
- Routing protocol provides path through an internetwork

Network:Address Resolution Protocol



Internetwork: Datagram Routing



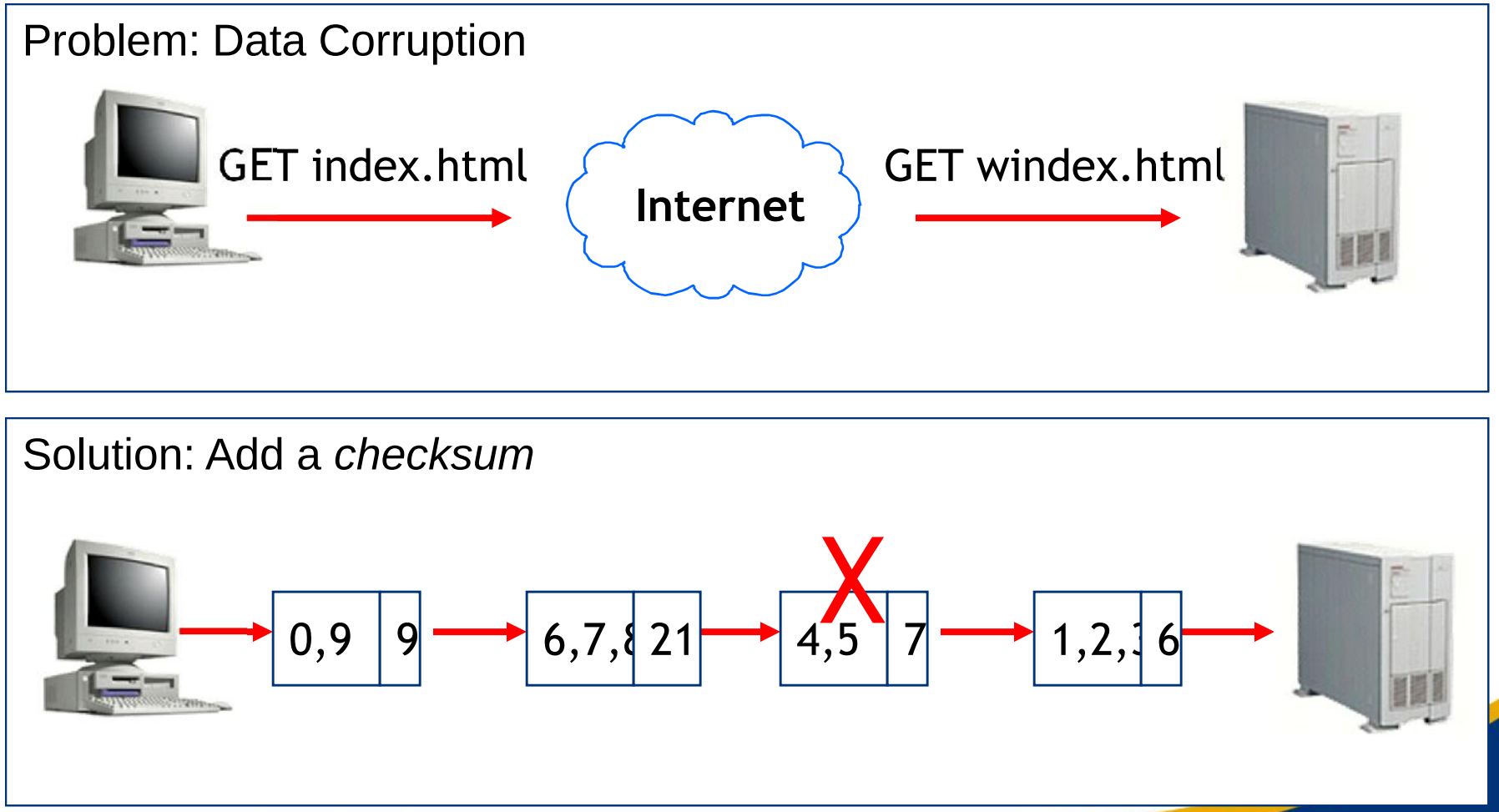
Routing

- Forwarding tables at each router populated by routing protocols.
- Original Internet: manually updated
- Routing protocols update tables based on "cost"
  - Exchange tables with neighbors or everyone
  - Use neighbor leading to shortest path

Fourth Step: Application Demands

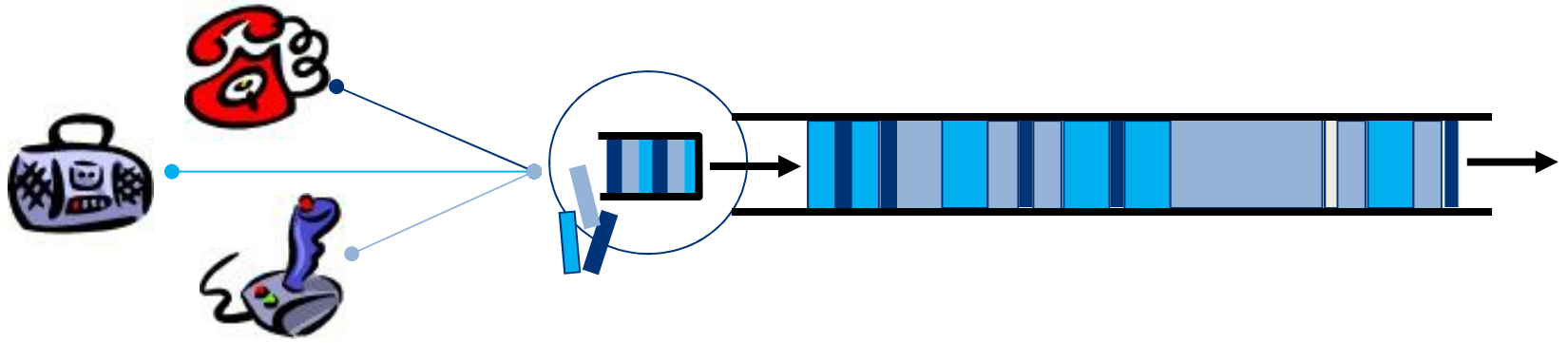
- Reliability
  - –Corruption
  - –Lost packets
- Flow and congestion control
- Fragmentation
- In-order delivery
- Etc…

What if the Data gets Corrupted?



What if Network is Overloaded?

Problem: Network Overload



Solution: Buffering and Congestion Control

- Short bursts: buffer
- What if buffer overflows?
  - Packets dropped
  - Sender adjusts rate until load = resources
- Called “congestion control”

What if the Data gets Lost?

Problem: Lost Data

GET index.html

Internet

Solution: Timeout and Retransmit

GET index.html

GET index.html

Internet

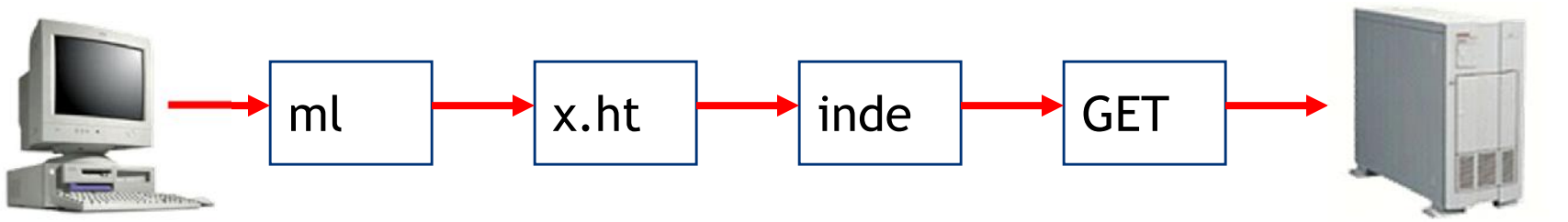
GET index.html

What if the Data Doesn't Fit?

Problem: Packet size

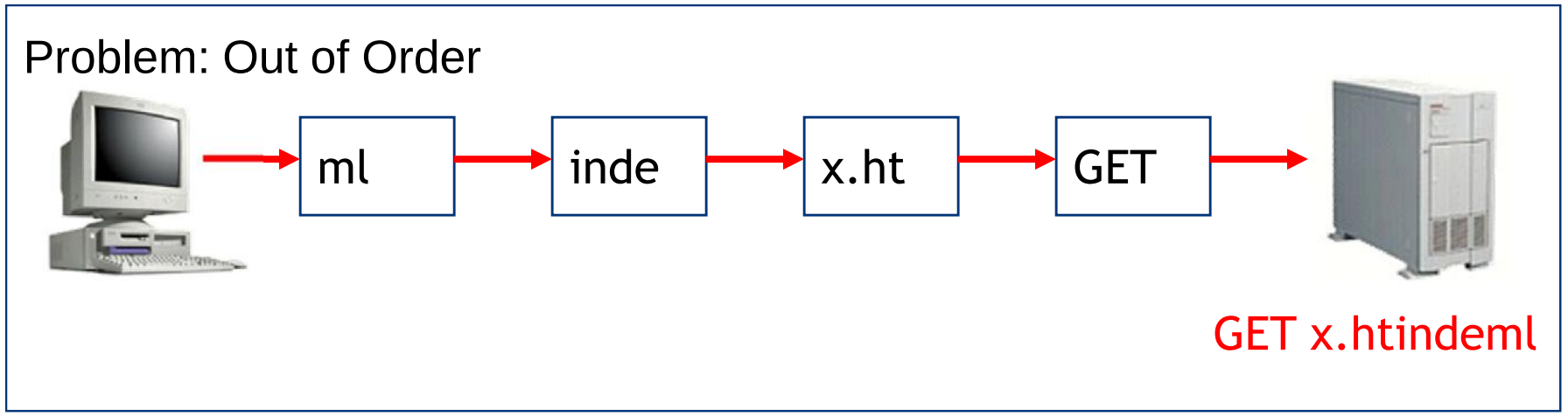
- On Ethernet, max IP packet is 1.5kbytes
- Typical web page is 10kbytes

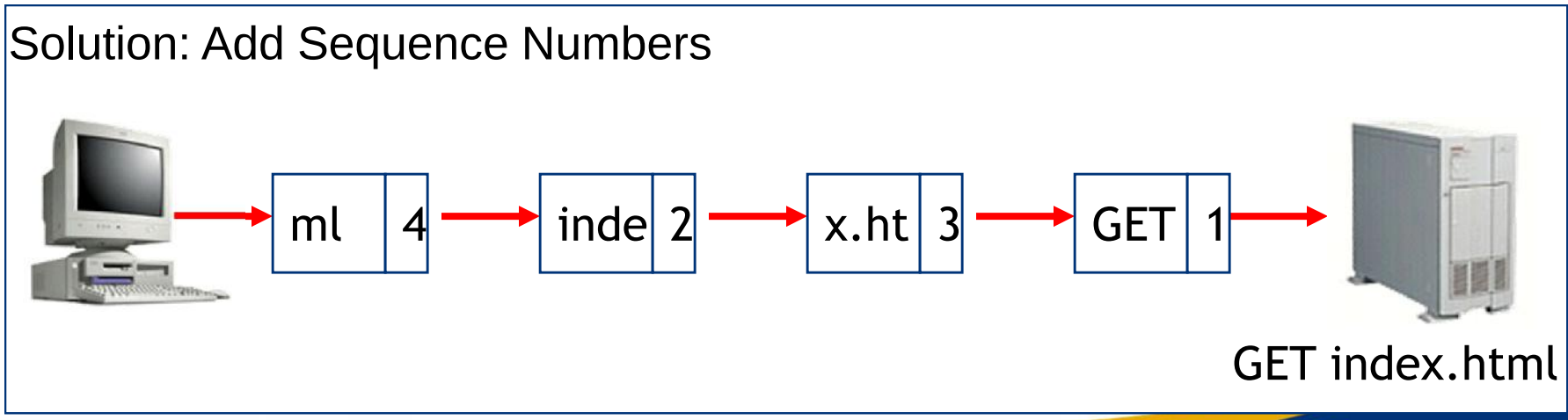
Solution: Fragment data across packets



GET index.html

What if the Data is Out of Order?





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Summary

- Network is set up for various purposes
- For a network to operate the way it does their exist other underlying technologies other than just hardware and software
- Networks operate using layering approach


DISCUSSION

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