



# College of Information Studies

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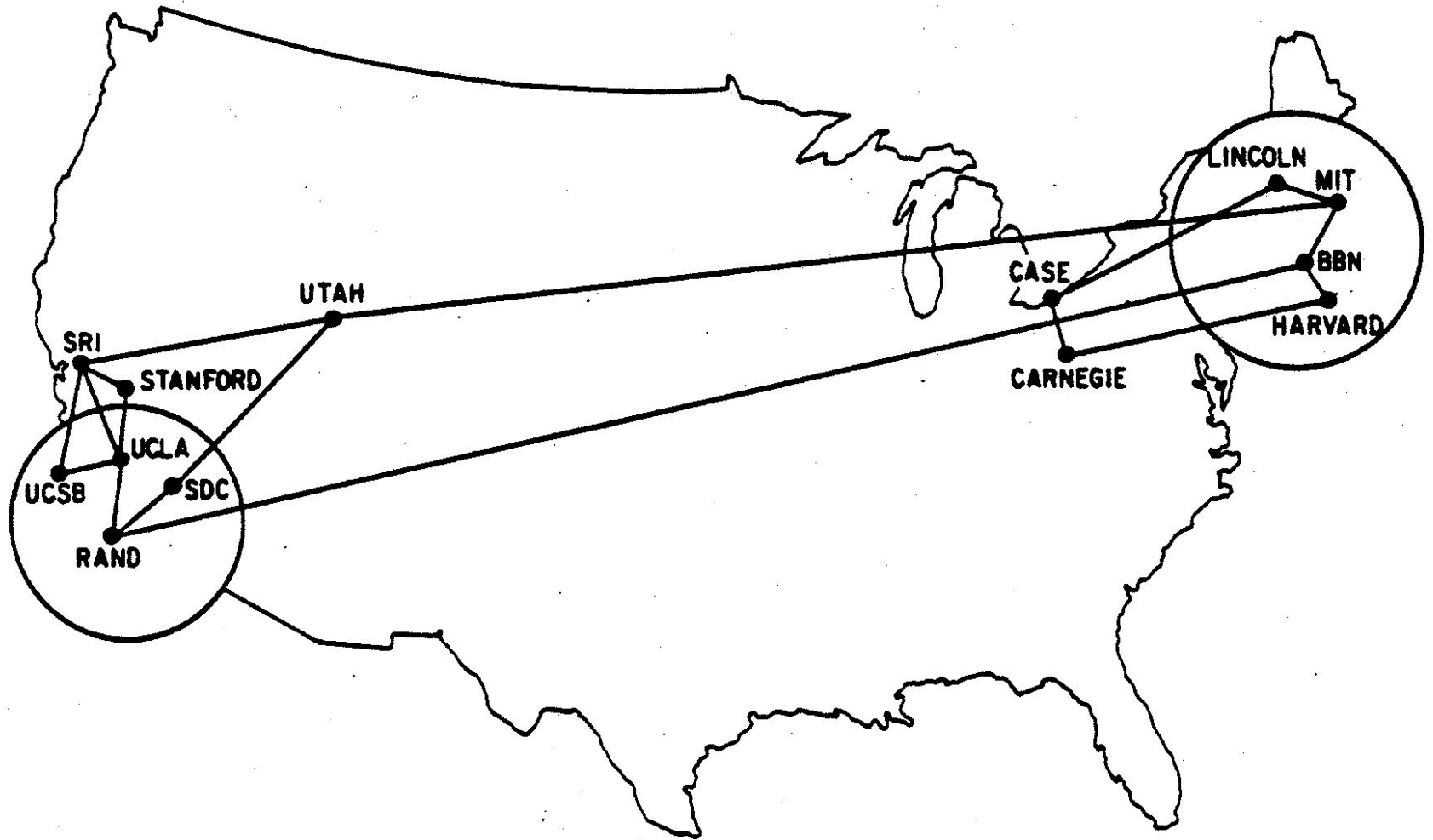
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## The Internet

Session 14

INST 346

# The ARPANET



December 1970

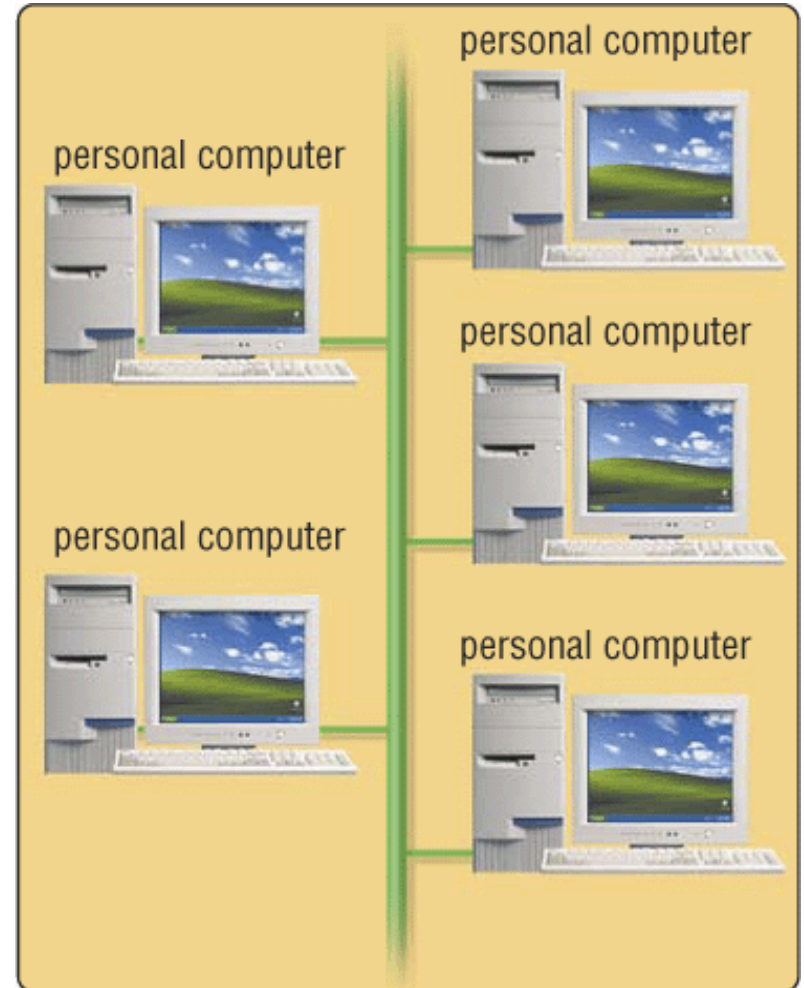
# Networks of Networks

- Local Area Networks (LAN)
  - Connections within a room, or perhaps a building
- Wide Area Networks (WAN)
  - Provide connections between LANs
- Internet
  - Collection of WANs across multiple organizations

# Ethernet

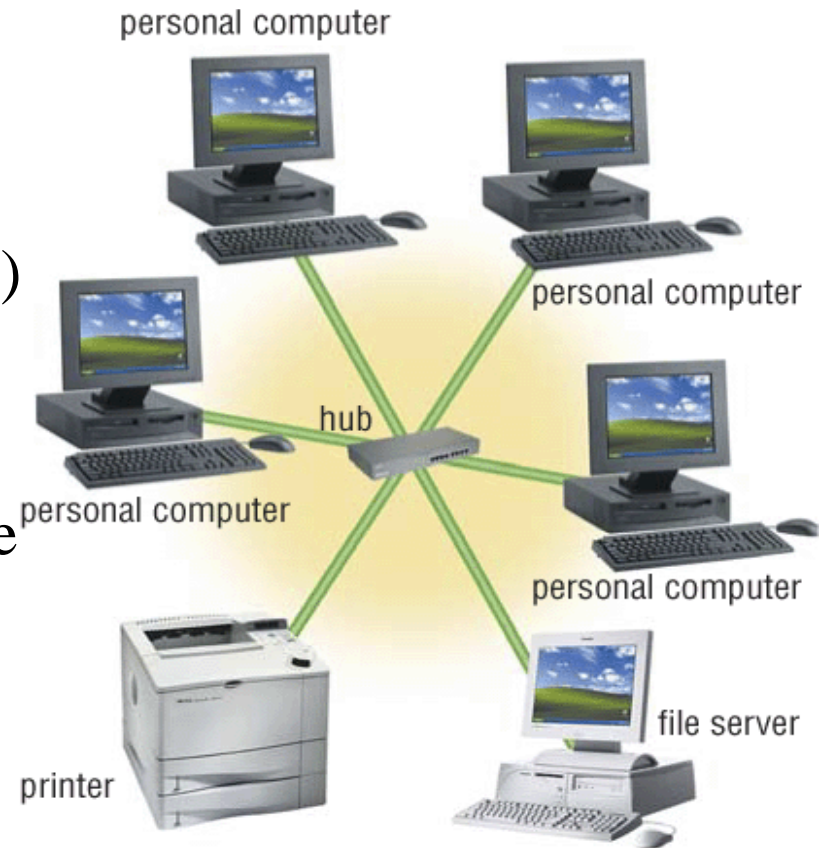
## Local Area Network (LAN)

- All attach to the same cable
  - Collision detection
  - Automatic retransmission
- Inexpensive and flexible
  - Easy to add new machines
  - Robust to computer failure
- Inefficient
  - Half the bandwidth is wasted



# Switched (“Star”) Network

- All attach directly to a hub
  - Switched Ethernet
  - Digital Subscriber Lines (DSL)
- Higher cost
  - Line from hub to each machine
  - Hub must handle every packet
- Much higher bandwidth
  - No sharing, no collisions



# Wireless Networks

- WiFi is available in several (“maximum”) speeds
  - IEEE 802.11b: 10Mb/s
  - IEEE 802.11g: 54Mb/s (required for video)
  - IEEE 802.11n: 248Mb/s
  - IEEE 802.11ac: 7 Gb/s
- “Wireless Data” plans typical speeds:
  - 3G: At least 200 kb/s
  - 4G: At least 100 Mb/sec (required for video)
- Bluetooth for peer-to-peer short range
  - At least 24 kb/s; max range is about 30 feet



# An Internet Protocol (IP) Address

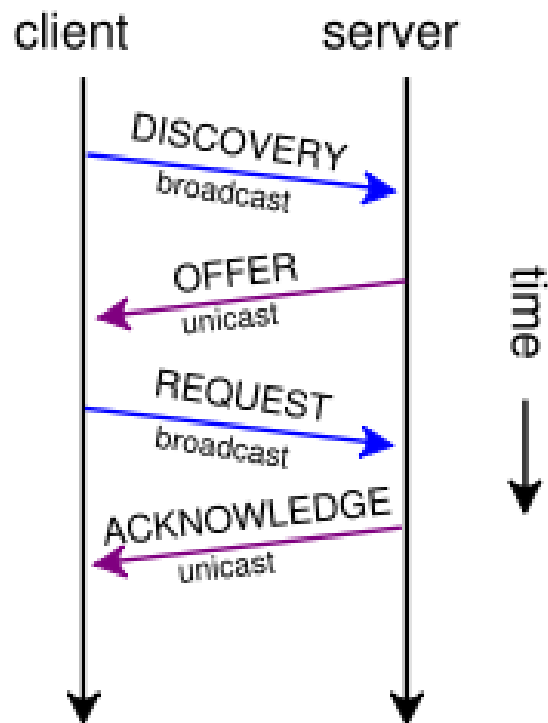
Identifies a LAN

54.84.241.99

Identifies a specific device

# “Leasing” an IP Address

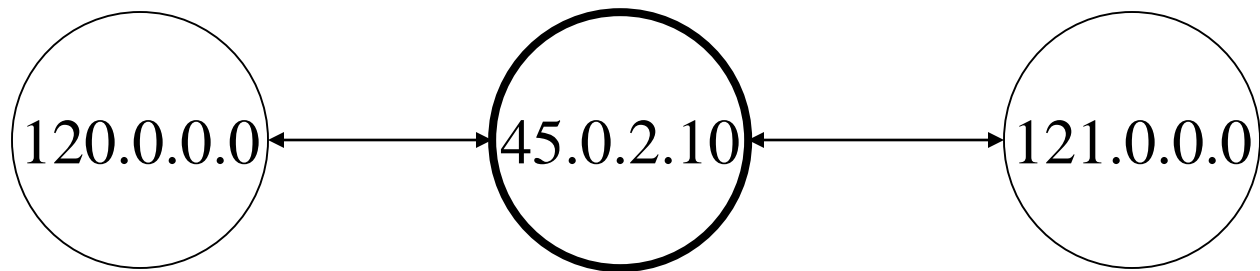
## Dynamic Host Configuration Protocol (DHCP)





# Routing Tables

IP Prefix	Next Router	Estimated Delay
216.141.xxx.xxx	120.0.0.0	18 ms
216.xxx.xxx.xxx	121.0.0.0	34 ms
101.42.224.xxx	120.0.0.0	21 ms
xxx.xxx.xxx.xxx	121.0.0.0	250 ms



Windows: route print

Mac: netstat -nr

# Wide Area Networks

- Two key ideas:
  - Unshared “point-to-point” links
  - Automatic forwarding
- Challenge: Routing is complex
  - Which paths are possible?
  - Which is shortest?
  - Which is least busy?

# Domain Name Service (DNS)

- Domain Names
  - Easier to remember than IP addresses
  - Written like a postal address: specific-to-general
- Each “name server” knows one level of names
  - “Top level” name servers know .edu, .com, .mil, ...
  - .edu name server knows umd, umbc, stanford, ...
  - .umd.edu name server knows terpconnect, ischool, ...
  - ...

# Ports

- “Well-known” ports for initial contact
  - 22 Secure Shell (SSH and SFTP)
  - 53 Domain Name Service (DNS)
  - 68 Dynamic Host Configuration Protocol (DHCP)
  - 80 Hypertext Transfer Protocol (HTTP)
  - 143 Internet Message Access Protocol (IMAP)
  - ...
- Registered ports for specialized services
  - e.g., 8080 may be a user-created HTTP server
- Ephemeral ports
  - Established as needed for ongoing interactions

# Hands-on:

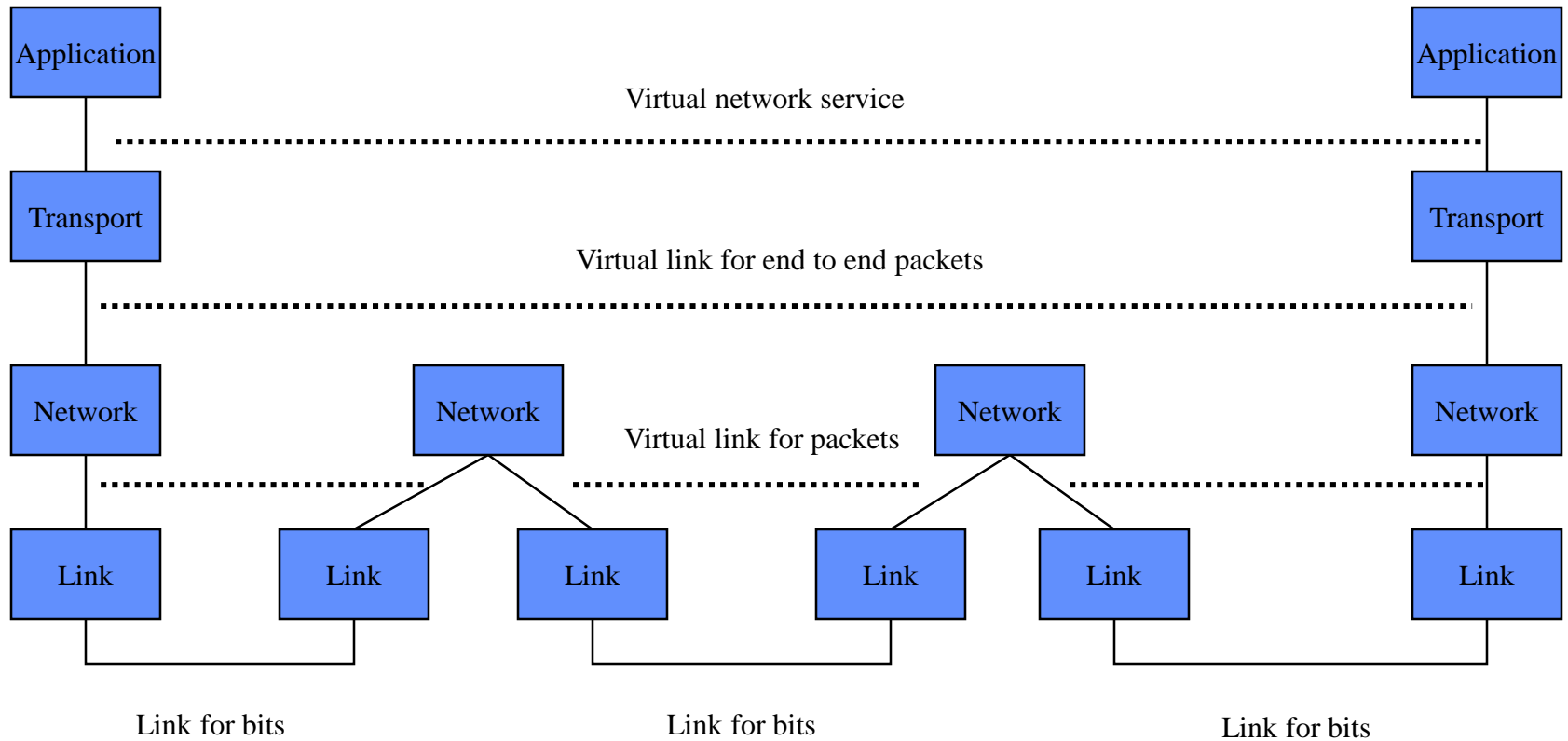
## Learn About Your IP Address

- Find your IP address
  - Launch a command shell
  - Type “ipconfig /all” (and press enter)
- See who “owns” that address
  - Use <http://remote.12dt.com/>
- See where in the world it (probably) is
  - <http://geobytes.com/iplocator/>

# Hands On: TraceRoute

- See how packets get from somewhere to you
  - Use <http://www.traceroute.org/>
- Look at the same data visually
  - <http://www.monitis.com/traceroute/>

# TCP/IP layer architecture



# Transmission Control Protocol (TCP)

- Built on the network-layer version of UDP
- Guarantees delivery all data
  - Retransmits missing data
- Guarantees data will be delivered in order
  - “Buffers” subsequent packets if necessary
- No guarantee of delivery time
  - Long delays may occur without warning



# User Datagram Protocol (UDP)

- The Internet's basic transport service
  - Sends every packet immediately
  - Passes received packets to the application
- No delivery guarantee
  - Collisions can result in packet loss
- Example: sending clicks on web browser

# Before You Go

On a sheet of paper, answer the following (ungraded) question (no names, please):

What was the muddiest point in today's class?