Fundamentals of Networking

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Trend: Networking is Critical

❑ Communication more critical than computing
  ⟹ Bus performance vs ALU speed
  ⟹ I/O performance vs SPECMarks
❑ User Location:
  ❑ 1960: Computer room   1970: Terminal room
  ❑ 1980: Desktop   1990: Mobile
❑ System Extent:
  ❑ 1980: 1 Node within 10 m
  ❑ 1990: 100 nodes within 10 km

❑ Last 10 years: Individual computing
Next 10 years: Cooperative computing

❑ Past: Corporate networks
Future:

  ❑ Inter-corporate networks

  ❑ National Info Infrastructures

  ❑ International Info Infrastructures

Trend: Exponential Growth
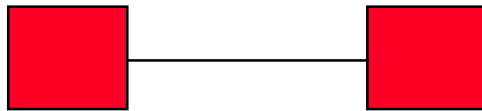

Number of Hosts
on the Internet
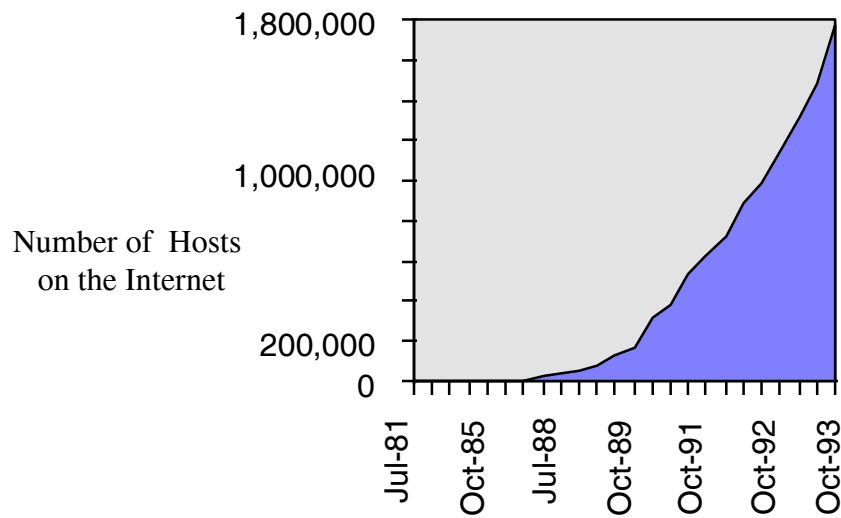
Networking in Social Fabric

❑ USENET: Ten million news articles/month

❑ 18 on-line coffee houses in San Francisco

❑ National Public Radio Program

❑ Supreme court decision within one day

❑ Real estate, on-line catalog

❑ 137 countries reachable via Email

Data Communication vs Networking

❑ Communication: Two Nodes.

❑ Networking: Two or more nodes
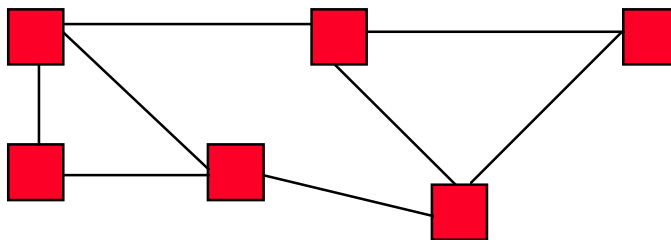
Distributed Systems vs Networks

❑ Distributed Systems:
   ❑ Users are unaware of underlying structure.
     E.g., trn instead of \n\bone\0\trn
   ❑ Mostly operating systems issues.
   ❑ Nodes are generally under one organization's control.
❑ Networks: Users specify the location of resources.
   http:\\www.cis.ohio-state.edu\~jain\
   ❑ Nodes are autonomous.

Server
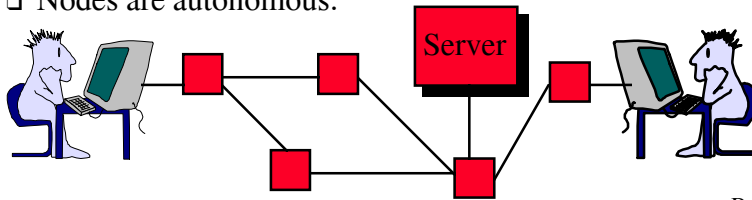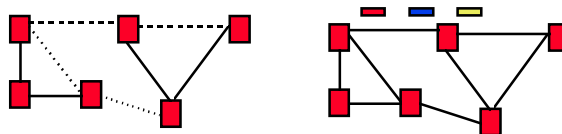

Types of Networks

❑ Point to point vs Broadcast

WAN   LAN
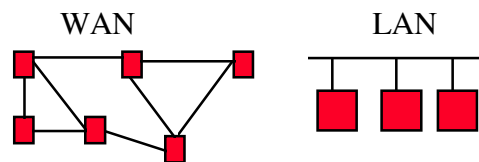
❑ Circuit switched vs packet switched

❑ Local Area Networks (LAN) 0-2 km, Metropolitan Area
   Networks (MAN) 2-50 km, Wide Area Networks (WAN)
   50+ km

Protocol Layers

❑ Problem: Philosophers in different countries speak different languages. The Telex system works only with English.

I believe there is a God!

Philosopher

Translator

Secretary
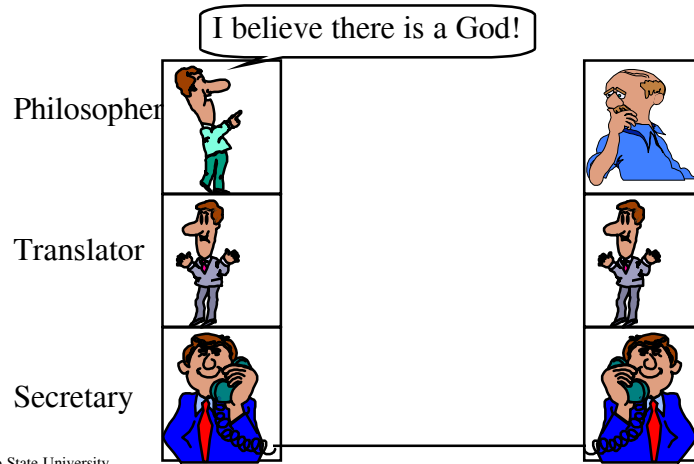
ISO/OSI Reference Model

3	Application — File transfer, Email, Remote Login
	Presentation — ASCII Text, Sound
	Session — Establish/manage connection
2	Transport — End-to-end communication: TCP
	Network — Routing, Addressing: IP
1	Datalink — Two party communication: Ethernet
	Physical — How to transmit signal: Coding
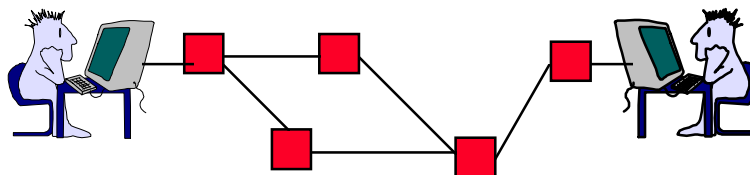
Layering

FTP	Telnet	Web	Email
TCP		UDP	
IP		IPX	
Ethernet		Token Ring	
Copper		Fiber	

← Same Interfaces

❑ Protocols of each layer have to perform a set of functions

❑ All alternatives for a row have the same interfaces

❑ Choice of protocols at each layer is independent of those of at other layers. E.g., TCP works over IP or IPX (Novell's IP) UDP = User Data Protocol

❑ Need one component of each layer ⇒ Null components

❑ Nth layer control info is passed as N-1th layer data.

Protocol Data Unit (PDU)

Application	APDU, Message ←→	Application
Presentation	PPDU ←→	Presentation
Session	SPDU ←→	Session
Transport	TPDU ←→	Transport
Network	NPDU, Packet ←→	Network
Datalink	DPDU ←→	Datalink
Physical	PhPDU, Frame ←→	Physical

Service Data Unit (SDU)

```
        ┌─────────────────┐
        │   Application    │
        └────────┬────────┘
                 │ PSDU
        ┌────────▼────────┐
        │  Presentation    │
        └────────┬────────┘
                 │ SSDU
        ┌────────▼────────┐
        │     Session      │
        └────────┬────────┘
                 │ TSDU
        ┌────────▼────────┐
        │    Transport     │
        └────────┬────────┘
                 │ NSDU
        ┌────────▼────────┐
        │     Network      │
        └────────┬────────┘
                 │ DSDU
        ┌────────▼────────┐
        │    Datalink      │
        └────────┬────────┘
                 │ PhSDU
        ┌────────▼────────┐
        │    Physical      │
        └─────────────────┘
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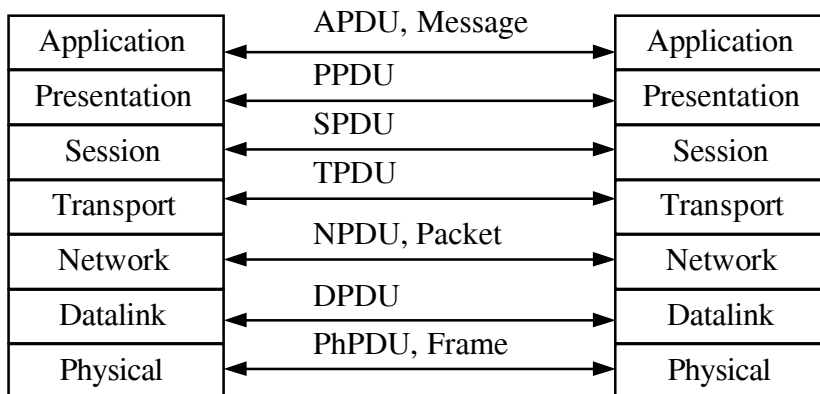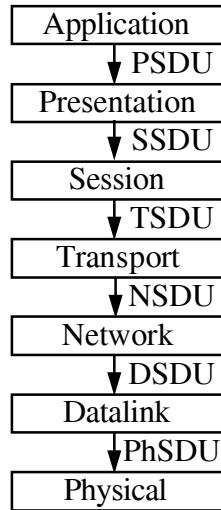
TCP/IP Reference Model

❏ TCP = Transport Control Protocol

❏ IP = Internet Protocol (Routing)

| Application	FTP	Telnet	HTTP		Application
					Presentation
Transport	TCP		UDP		Session
					Transport
Internetwork	IP				Network
Host to Network	Ether net	Packet Radio	Point-to-Point		Datalink
					Physical

ODN's Four-Layer Model

❏ ODN = Open Data Networks

❏ Bearer Service: Bit level transport service

   ❏ Includes links, switches, routers, network management

❏ Transport Layer: Enhanced end-to-end services

   ❏ May include reliable, sequenced delivery, flow control

   ❏ Can be realize either in the network or in the end nodes

   ❏ Not a core part of the bearer service

❏ Middleware: Common higher level functions

   ❏ file system support, privacy, authentication, name service, directory service

❏ Applications: Email, Airline reservation

Four Layer Model
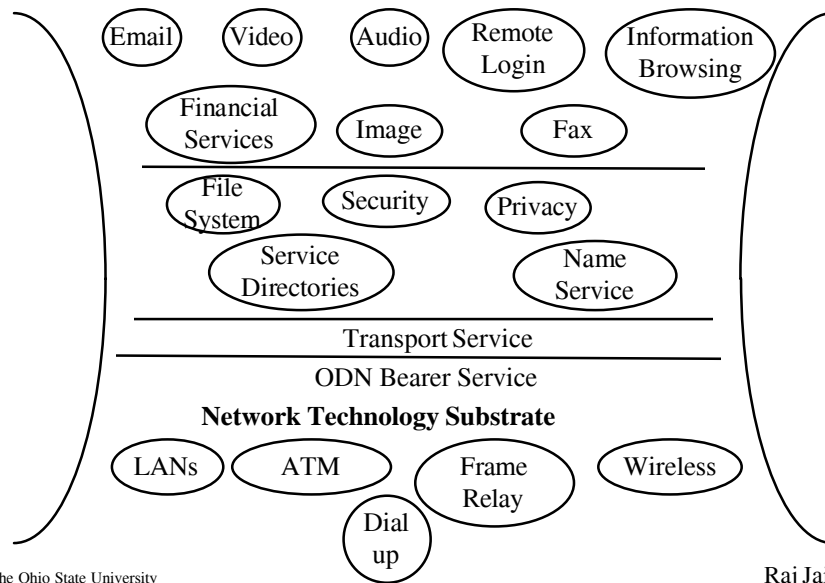
Summary
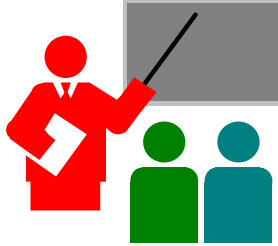
- Networking is growing exponentially
- Communication, Networks, and Distributed systems
- ISO/OSI's 7-layer reference model
- TCP/IP has a 4-layer model

Reading Assignment

- Read Chapter 1 of Stallings, particularly
  - Table 1.2
  - Section 1.4, 1.5
- Optional: You may want to read ahead Chapter 2.