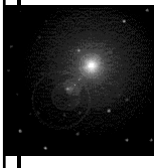
CS 4/54201

Computer Network

Kent State University
Computer Science

www.cs.kent.edu/~javed/

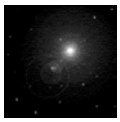


A Course on Networking and

Computer Communication

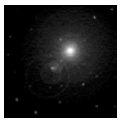
Leonardo, acknowledged as the father of automation. He had invented automations, especially in theatre scenery, resembling animals (horses, lion dragons, etc.). Among his drawings there is a a mechanism scheme regarding a robot with mediaval armour which seemed to be used not only for theatrical purposes but also for a real welcome in which many robots in line for training would higher their arms for a salute to the King, thanks to a special drive.

Courtesy: **University of Venice, Dept of Mechanical Engineering**



COMPUTER COMMUNICATION NETWORK

Network Software Architecture



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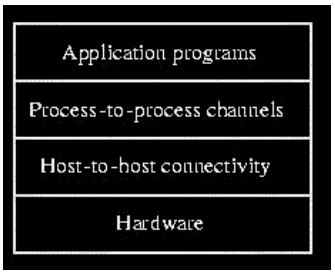
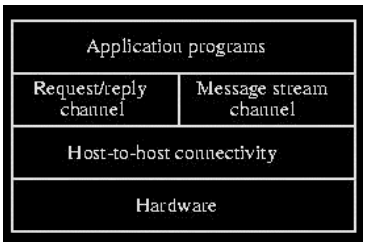
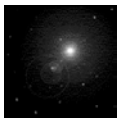
Layering

- Use abstractions to hide complexity
- Abstraction naturally leads to layering



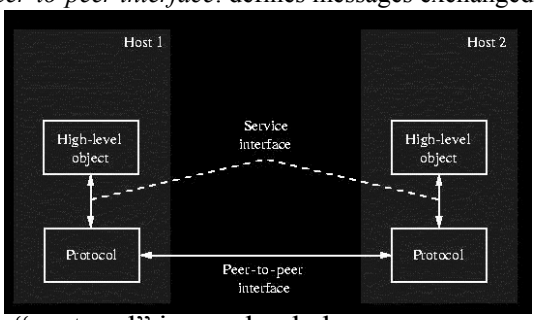


- Can have alternative abstractions at each layer

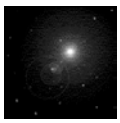


Protocols

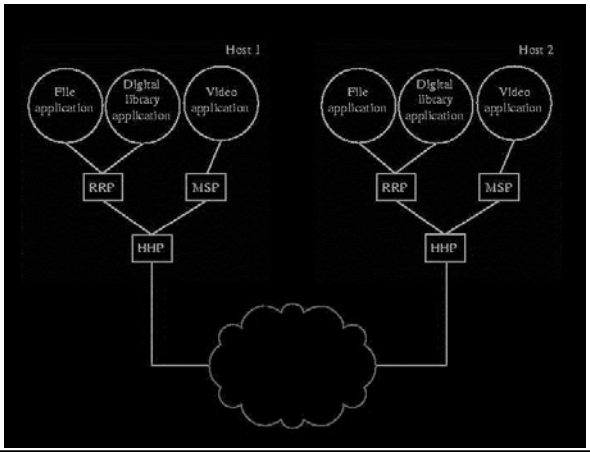
- Building blocks of a network architecture
- Each protocol object has two different interfaces
  - *service interface*: defines operations on this protocol
  - *peer-to-peer interface*: defines messages exchanged with peer

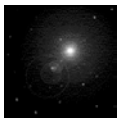


- Term "protocol" is overloaded
  - specification of peer-to-peer interface
  - module that implements this interface

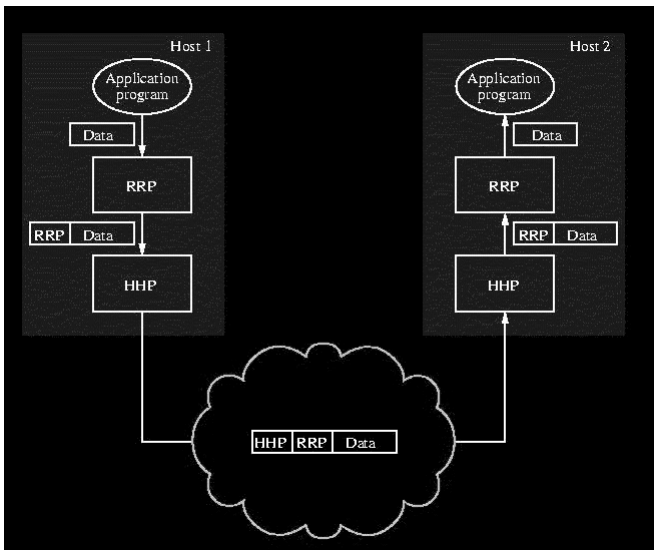


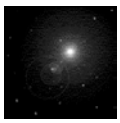
- Protocol Graph
  - collection of protocols and their dependencies
  - most peer-to-peer communication is indirect
  - peer-to-peer is direct only at hardware level



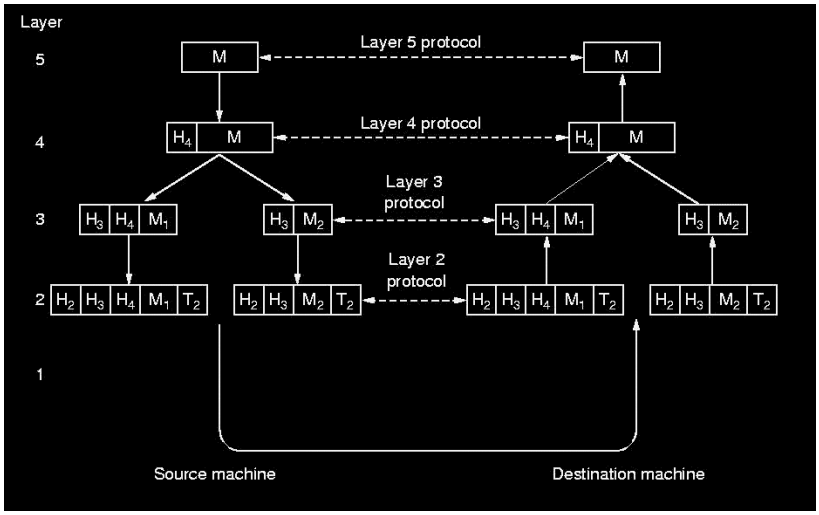


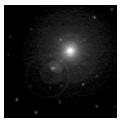
- Multiplexing and Demultiplexing (demux key)
- Encapsulation (header/body)





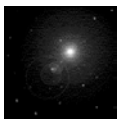
Encapsulation

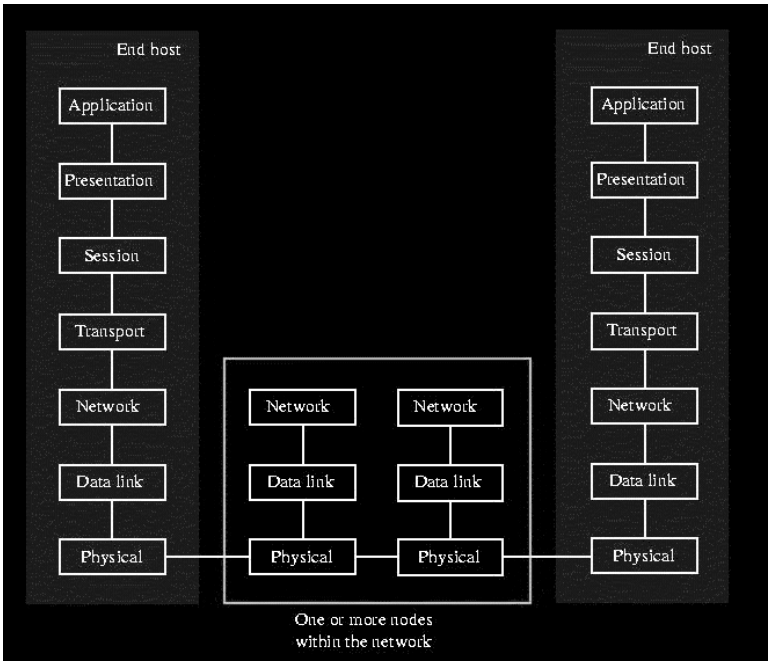


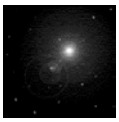


Standard Architectures

- Open Systems Interconnect (OSI) Architecture
  - International Standards Organization (ISO)
  - International Telecommunications Union (ITU); formerly CCITT
  - "X dot" series: X.25, X.400, X.500
  - Reference Model

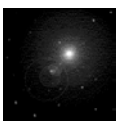






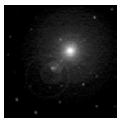
Physical Layer

- It is concerned with raw bit transmission. It ensures that a signal level of 1 sent is also received as 1 not as a 0.
- Typical design issue is electrical, electrical and procedural interfaces and physical transmission media.



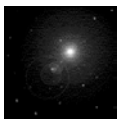
Data Link Layer

- How send a collection of bits from one end to other end correctly. It uses frames.
- Uses acknowledgement, special encoding, frame boundary delineation, retransmission etc. to ensure that a logical collection of bits are sent correctly. Avoids duplication and loss of frame.
- It also deals about the speed difference between the transmitter and receiver.
- Deals with half/full duplex communication.
- For broadcast media, deals with channel access.



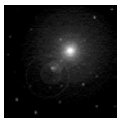
Network Layer

- The key design issue is how the packets can find its way to destination- or routing.
- It uses route tables, addressing,
- Uses various signal messaging to know about the paths and network topology.
- It can also help in billing, traffic monitoring, and analysis.



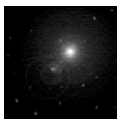
Transport Layer

- It accepts data from session layer and split into smaller units as required and then passes it to network layer.
- Each application stream gets an abstract connection. It can maintain multiple network connection or multiplex.
- It maintains the start and end of connections.
- Identifies the application end-point who should receive the data.
- Determined the type of service- reliable, error free, short messaging, continuous bit stream.
- It ensures end-to-end flow control.



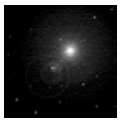
Session Layer

- It allows users on different machines to establish session between them. In some enhanced service it is meaningful.
- Remote login.
- Token based synchronization (which side gets to talk) in a complex communication.
- If a session crashes- it might help to restart file transfer without going to the beginning. It can do so by inserting checkpoints.



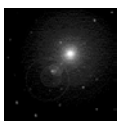
Presentation Layer

- Presentation layer is intended to perform operation that is requested too frequently by multiple users.
- A typical example will be encoding data in a standard agreed upon way. (ASCII vs Unicode translation). Etc. It can also manage abstract data structures.



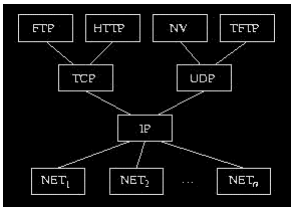
Application Layer

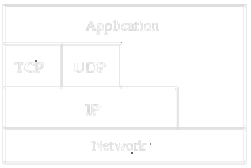
- Supports a variety of protocols which allows a program to provide some user services.
- FTP
- HTTP
- Telnet



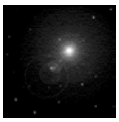
TCP/IP Reference Model

- Internet Architecture
  - Internet Engineering Task Force (IETF)

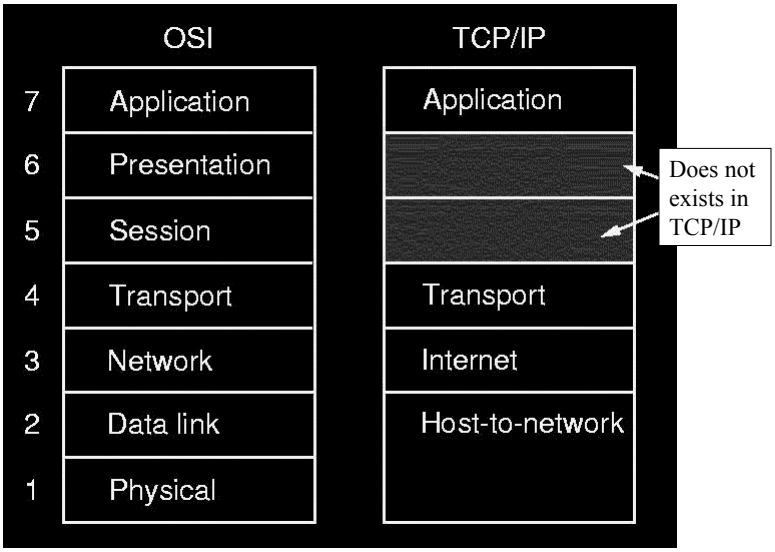


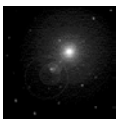


  - Application vs Application Protocol (FTP, HTTP)
  - Features
    - does not imply strict layering
    - hourglass shape
    - design and implementation go hand-in-hand



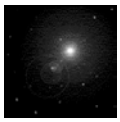
Comparison of TCP/IP and OSI Layers





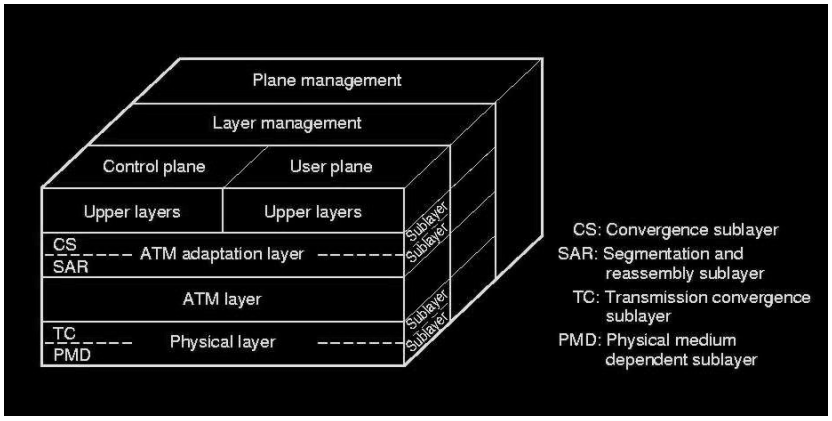
Model Critique

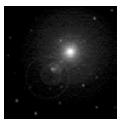
- OSI
  - Thin session and presentation layers
  - Thick network and data link layers
  - Extremely complex
  - Duplication of error/flow control
  - Could not decide placement of encryption, and data security
  - Framework for understanding network architecture
- TCP/IP
  - It is more of a description of protocols than model.
  - Does not distinguish between concepts of service, interface and protocol.
  - No distinction between physical and data link layers.



COMPUTER COMMUNICATION NETWORK

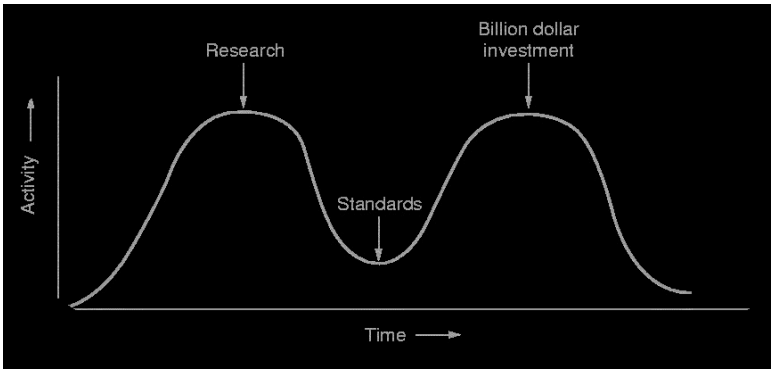
ATM Layers

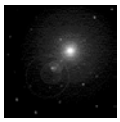




COMPUTER COMMUNICATION NETWORK

Two Elephants



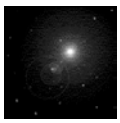


COMPUTER COMMUNICATION NETWORK

Example of Networks

- Novell NetWare
  - The most popular network system in the PC world. It is a client server design which can support file services, database services, and other services to a collection of clients.

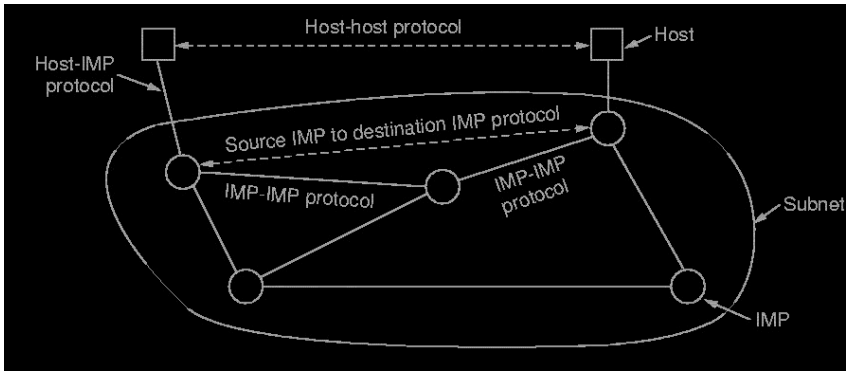
Layer			
Application	SAP	File server	. . .
Transport	NCP	SPX	
Network	IPX		
Data link	Ethernet	Token ring	ARCnet
Physical	Ethernet	Token ring	ARCnet

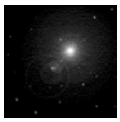


COMPUTER COMMUNICATION NETWORK

Example of Networks (more..)

- The ARPANET
  - The predecessor of TCP/IP. Introduced the idea of packet switching.



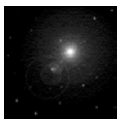


ARPANET

1969 - The Department of Defense Advanced Research Projects Agency creates an experimental network called ARPANET. This network provides a test-bed for emerging network technologies.

ARPANET originally connected four universities

Node 1: UCLA - (September)
Node 2: SRI - Stanford Research Institute (October)
Node 3: UCSB
Node 4: University of Utah



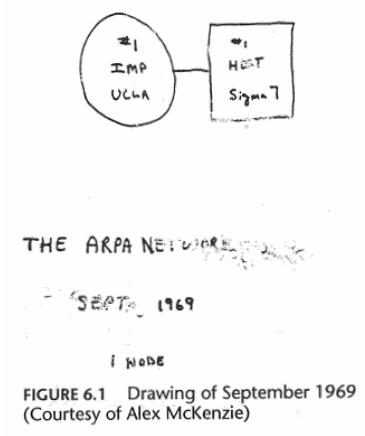


FIGURE 6.1 Drawing of September 1969 (Courtesy of Alex McKenzie)

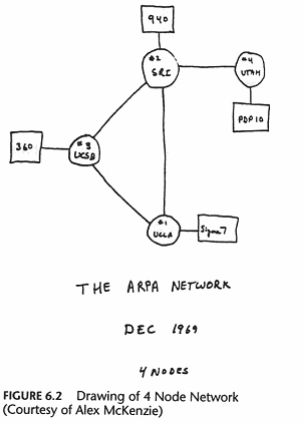
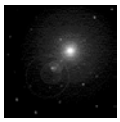


FIGURE 6.2 Drawing of 4 Node Network (Courtesy of Alex McKenzie)

The first node on ARPANET at University California Los Angeles (UCLA) on the 2nd of September 1969. (Source : "Casting the Net", page 55) UCLA was the home of Len Kleinrock's Network Measurement Center. Doug Engelbart's Network Information Center resided at SRI. And some of the earliest graphics work was being done at Santa Barbara and Utah.

By the end of the year there are four nodes on the "ARPA NETWORK", as shown in schematic above. (Source : "Casting the Net", page 56. See also The Computer Museum Timeline.)



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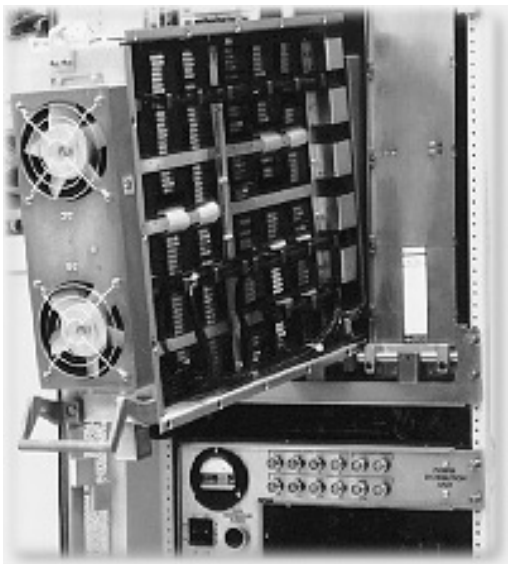
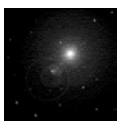
IMP

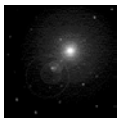




COMPUTER COMMUNICATION NETWORK

Example of Networks (more ..)

- Gigabit test-bed Networks
  - Aurora
  - Blanca
  - CASA
  - Nectar
  - VISTAnet

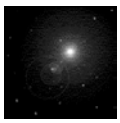


COMPUTER COMMUNICATION NETWORK

Example Communication Services

- Distribute Queue Dual Bus (DQDB)
- Switched Multi megabyte Data Service (SMDS)
- X.25 Networks
- Frame Relay
- B-ISDN and ATM

Issue	DQDB	SMDS	X.25	Frame Relay	ATM AAL
Connection oriented	Yes	No	Yes	Yes	Yes
Normal speed (Mbps)	45	45	.064	1.5	155
Switched	No	Yes	Yes	No	Yes
Fixed-size payload	Yes	No	No	No	No
Max payload	44	9188	128	1600	Variable
Permanent VCs	No	No	Yes	Yes	Yes
Multicasting	No	Yes	No	No	Yes



COMPUTER COMMUNICATION NETWORK

Next Class

- Theory
  - How to represent a signal?
  - How many bits can be sent via a medium using what type of signal?