The TCP/IP Reference Model

- The TCP/IP Model
- Comparison to OSI Model
- Example Networks

The TCP/IP Model

- Origins from ARPANET, DoD research network
- ARPA - Advanced Research Projects Agency
- Reliability was the primary concern of design

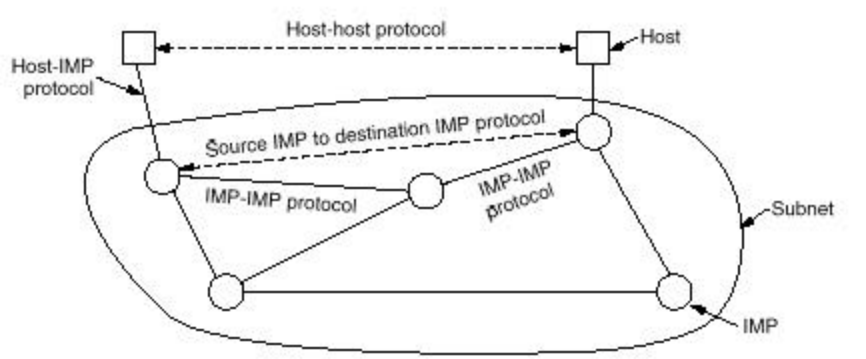


Fig. 1-24. The original ARPANET design.

  - IMP - interface message processor
- The TCP/IP Model defined in 1974 for the first time

Figure from book Computer Networks 3rd ed., by A.S. Tanenbaum

The TCP/IP Reference Model

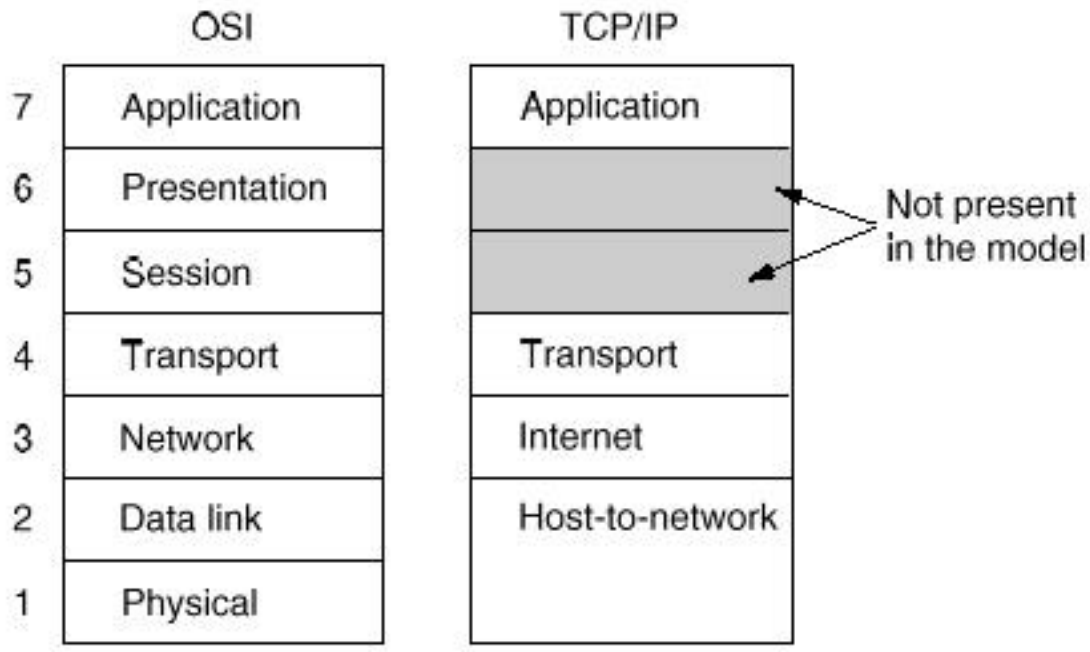


Fig. 1-18. The TCP/IP reference model.

The Internet Layer

- Packet-switching, connectionless service
- Each packet is independently routed from source to destination
- Packet ordering issue
- Defines packet format
- Defines protocol - Internet Protocol (IP)

The Upper Layers

- Two end-to-end protocols in **Transport** layer:
  - **Transmission Control Protocol (TCP) -** reliable connection oriented protocol
  - **User Datagram Protocol (UDP) -** unreliable, connectionless protocol
- The Application layer initially
  - Remote login protocol **- Telnet**
  - File transfer protocol **- FTP**
  - Electronic mail **- SMTP**
  - Domain name service **- DNS**

Initial TCP/IP protocols

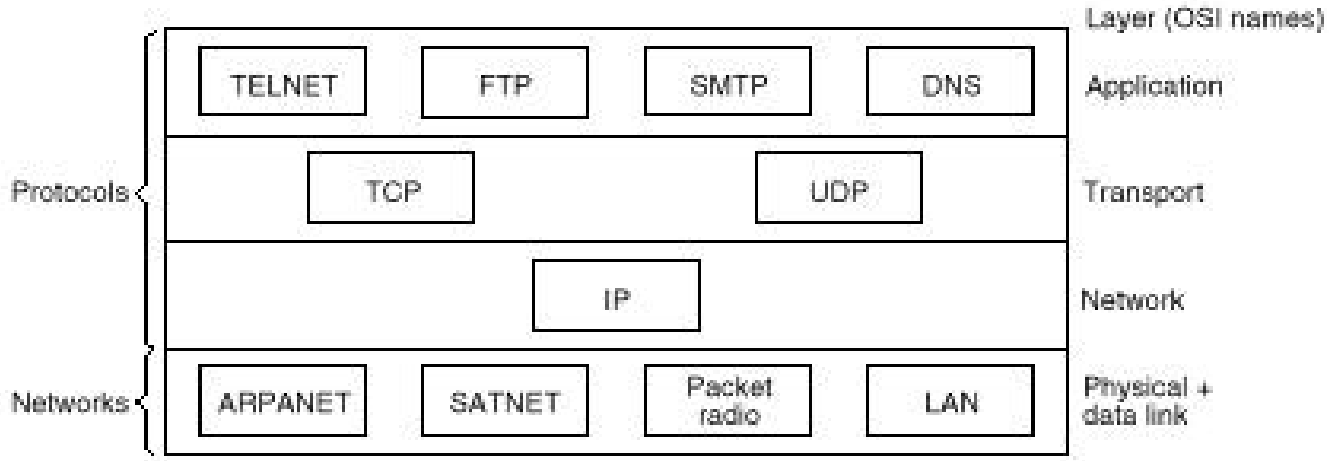


Fig. 1-19. Protocols and networks in the TCP/IP model initially.

Figure from book Computer Networks 3rd ed., by A.S. Tanenbaum

Comparison of OSI and TCP/IP

OSI	TCP/IP
Introduces concepts of: 1. Services 2. Interfaces 3. Protocols	No explicit definitions of service, interface and protocol
• Is more general than TCP/IP • Model built before protocols	• Model describes protocols • Suitable only for TCP/IP networks
Connection-oriented transport l. Network layer – both c/o and c/l	Transport – both c/o and c/l Network layer - connectionless

A Critique of The OSI Model and Protocols

- Bad timing

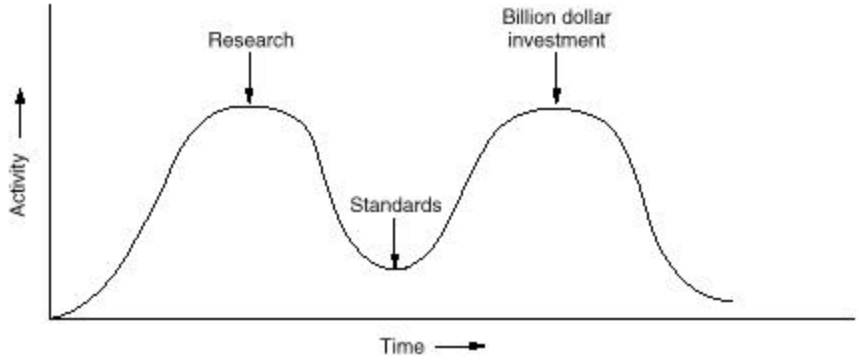


Fig. 1-20. The apocalypse of the two elephants.

- Bad technology - too complex, redundant, etc.
- Bad implementations - complex, inefficient
- Bad politics

Figure from book Computer Networks 3rd ed., by A.S. Tanenbaum

A Critique of The TCP/IP Model and Protocols

- No definitions of general networking concepts
- Not a general reference model
- Host-to-network layer is rather an interface
- No definition of data link nor physical layers
- Some application layer protocols were designed and implemented ad hoc

The Hybrid Model

- ISO/OSI - good model, poor protocols
- TCP/IP - poor model, protocols - standards de facto
- The hybrid model:
  - Application layer
  - Transport layer
  - Network layer
  - Data link layer
  - Physical layer

The Novell NetWare Reference Model

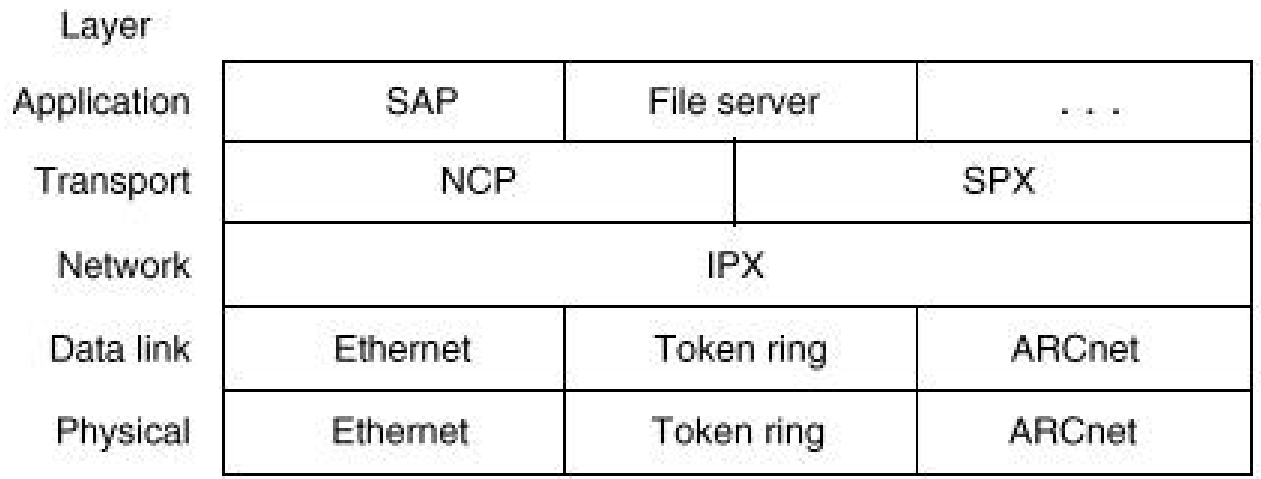


Fig. 1-22. The Novell NetWare reference model.

Figure from book Computer Networks 3rd ed., by A.S. Tanenbaum

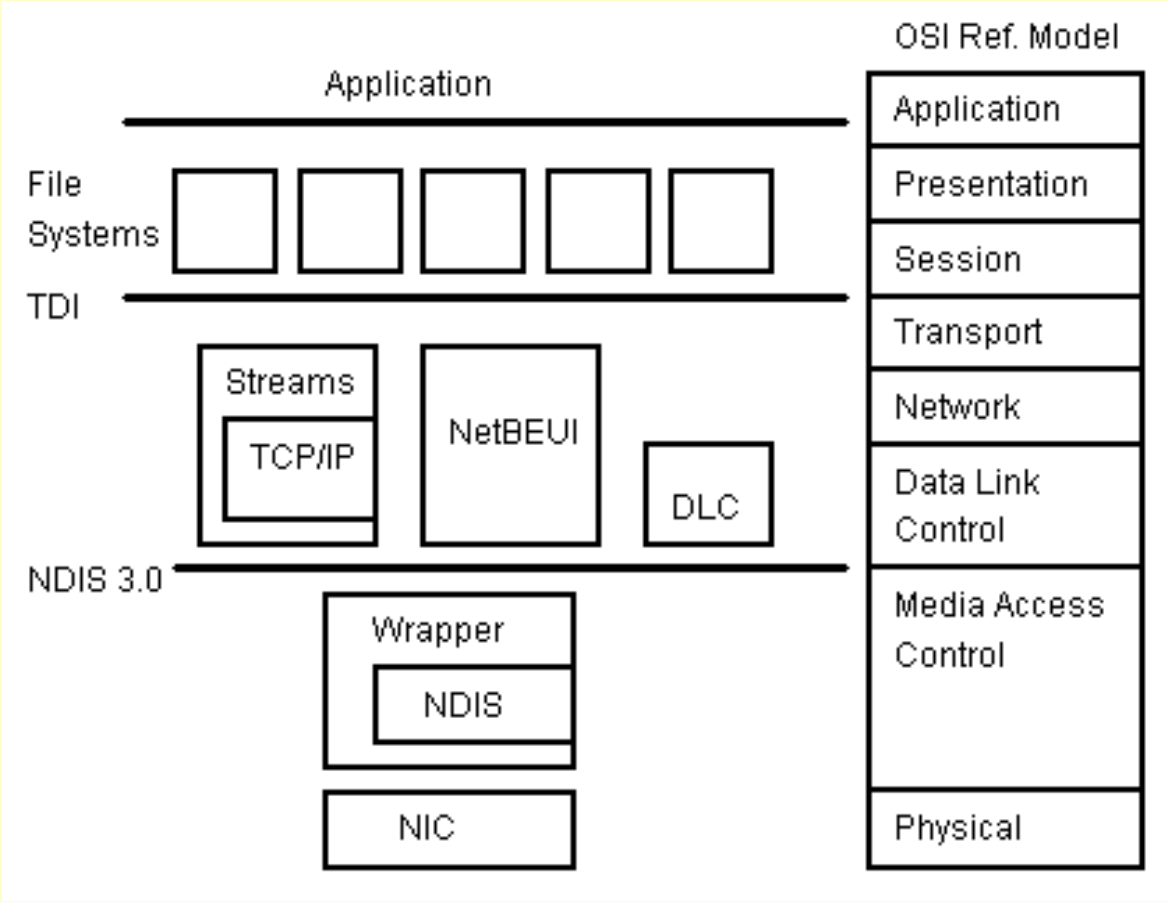
Novell NetWare Networks

- Designed for LAN's of IBM PC compatible computers
- Proprietary network operating system
- Network and transport protocols similar to those in TCP/IP networks
- Client-Server model
- Centralized architecture:
  - Dedicated servers
  - Client portions in different operating systems

Novell NetWare Networks

- Open Data Link Interface (ODI) encapsulates services of device drivers
- Services provided
  - File services
  - Printing services
  - Communication services:
    - routing
    - remote access
    - gateway services
  - Third party services:
    - Database
    - Application servers

Microsoft Windows NT Networking Model



Microsoft Windows NT Networking

- Network Device Interface Specification (NDIS) encapsulates services of device drivers
- TCP/IP and NETBEUI transport protocols are provided
- NETBEUI features:
  - fast, low overhead single logical subnet LAN protocol
  - non-routable
  - provides network name abstraction
- Common Transport Driver Interface
- File, Printing, Communication services

The NETBEUI Protocol