Network Reading Group

The Design Philosophy of the DARPA Internet Protocols

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Tuesday, 22 Feb 2005

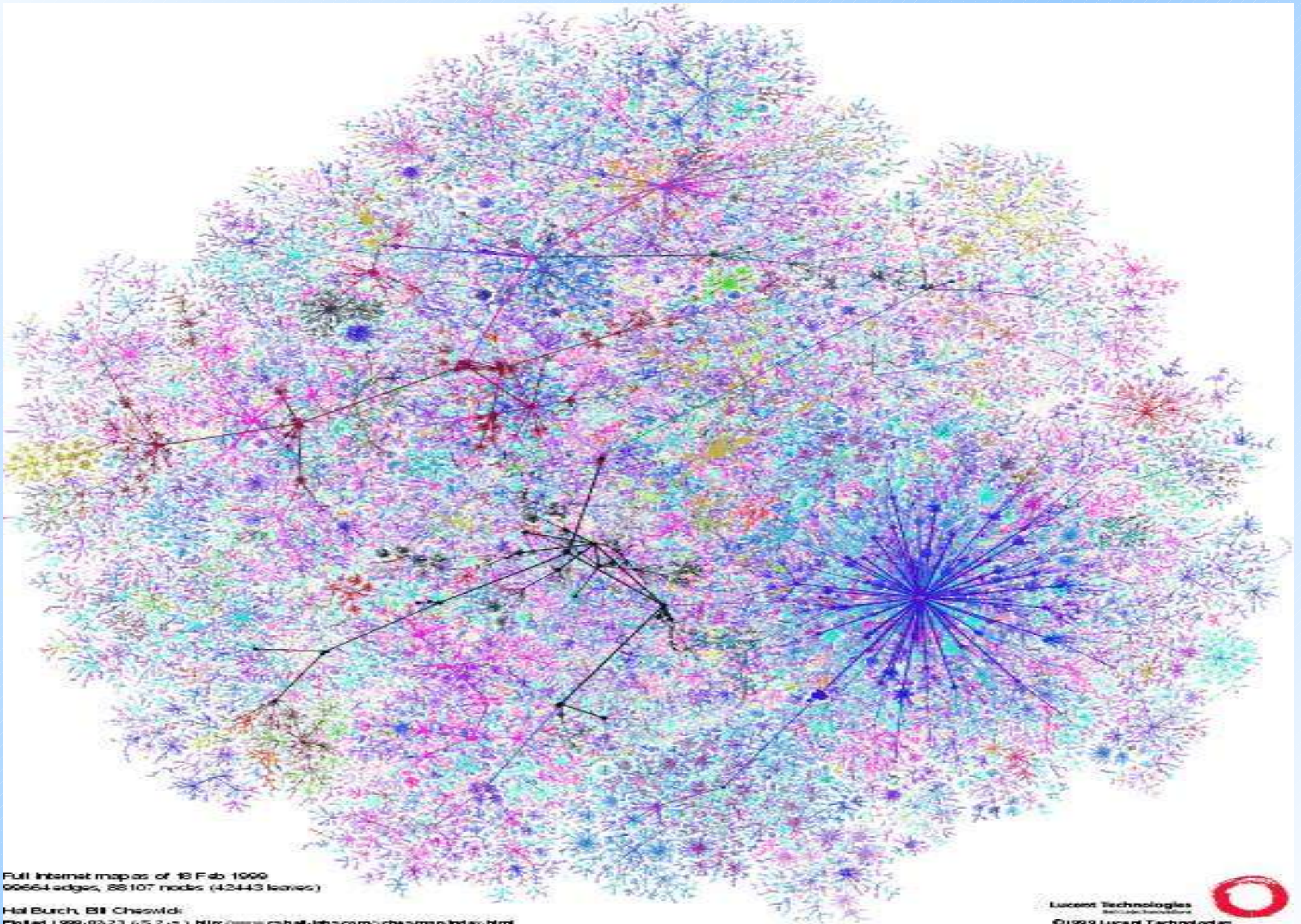http://home.iitk.ac.in/~chebrolu/net-read.html

What is Communication?

- *Communication: The exchange of thoughts, messages, or information, as by speech, signals, writing, or behavior.*

- Before Computer Age
  - Using doves/pigeons
  - Postal System
  - Telephone/Telegraph

- Inter-Network (Internet)
  - Connect different networks
  - Mechanism to disseminate information

History of the Internet

- 1961-62: Packet-switching as a concept
- 1969: Four host computers on ARPANET
- 1972: E-mail application launched
- 1973: TCP/IP suite proposed
- 1980s: LANs, PCs, Workstations
- Until 1985: Internet used by researchers/developers

The Internet as of 1999

Full Internet map as of 18 Feb 1999
99664 edges, 88107 nodes (42443 leaves)

Hal Burch, Bill Cheswick
Plotted 1999-02-23 (rS 2 -s) http://www.cs.bell-labs.com/~ches/map/index.html

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Fundamental Goal

- Interconnecting existing networks to provide some larger service

- Structure of Internet: "Networks interconnected by *Gateways* which implement a store and forward packet forwarding algorithm"

- An alternate architecture: Design a unified system
  - Prevents reuse of existing networks
  - Difficult to integrate separately administrated networks
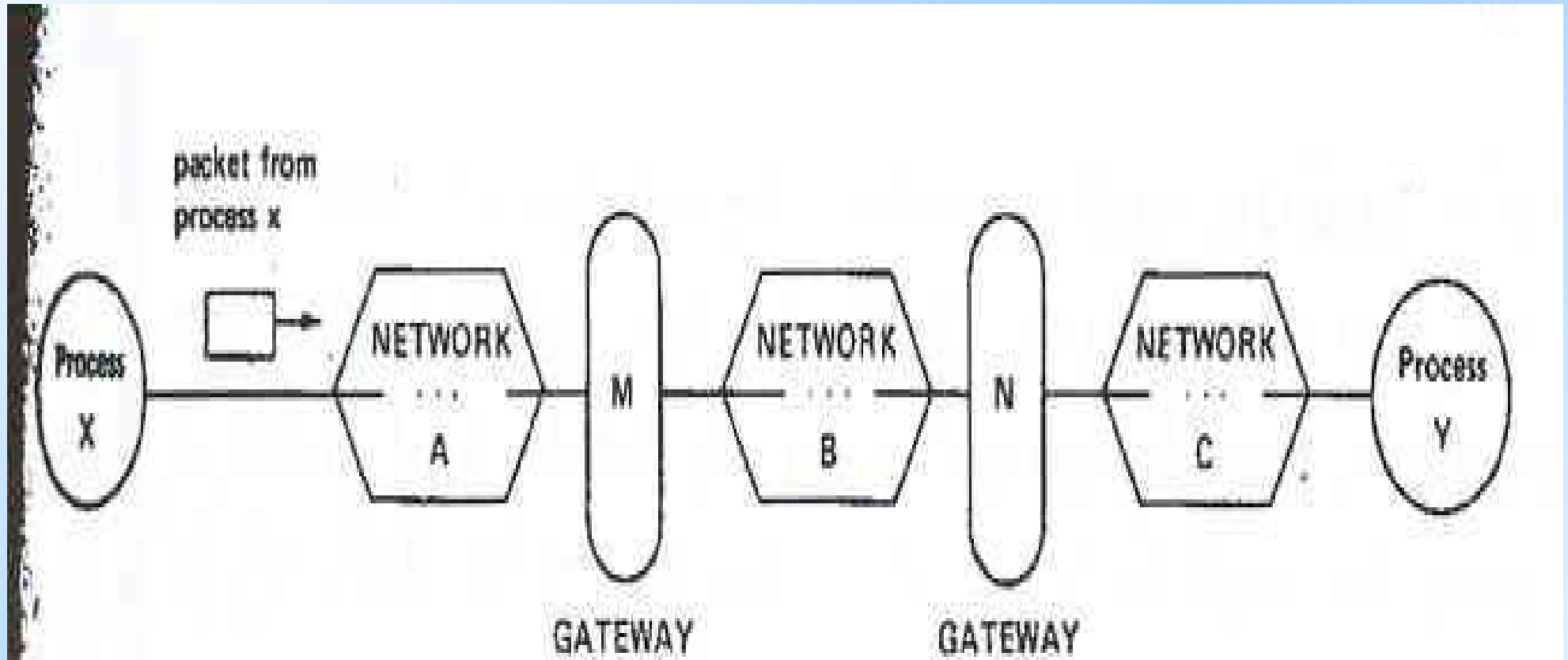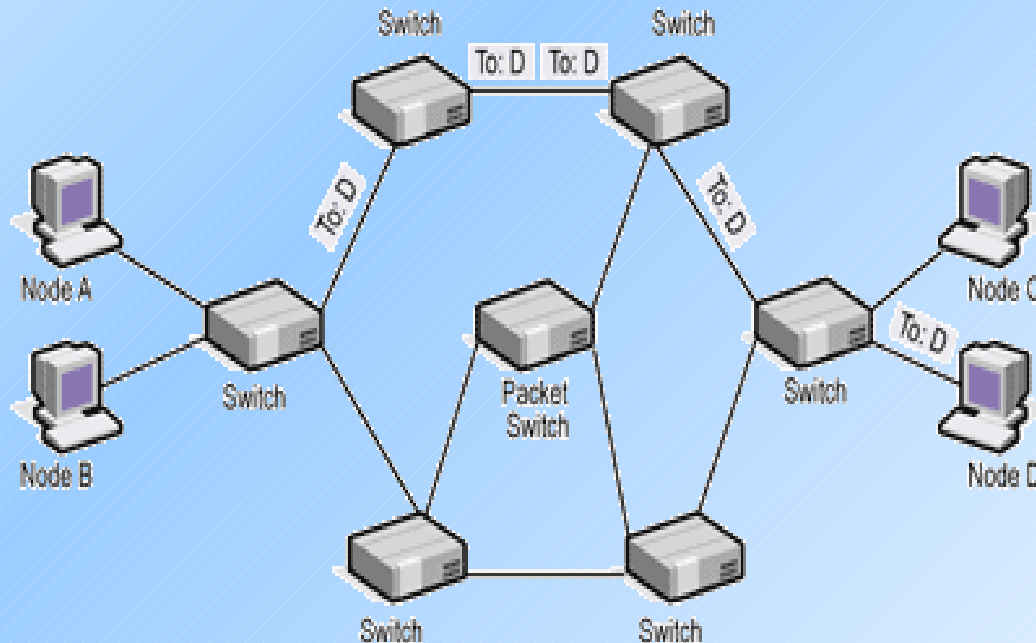
Architecture

Fig. 2. Three networks interconnected by two GATEWAYS.

Source: [CK74]

Circuit Switching

- A dedicated channel (circuit) is dedicated for the connection

  - Example: Telephone system

  - Advantages: delay guarantees

  - Disadvantages: Inefficient use of capacity

Packet Switching

- Data stream is divided into packets

- Each packet is transmitted individually

- The packets can take different routes to the destination

  - Advantages: Statistical multiplexing
  - Disadvantages: Supports only best effort
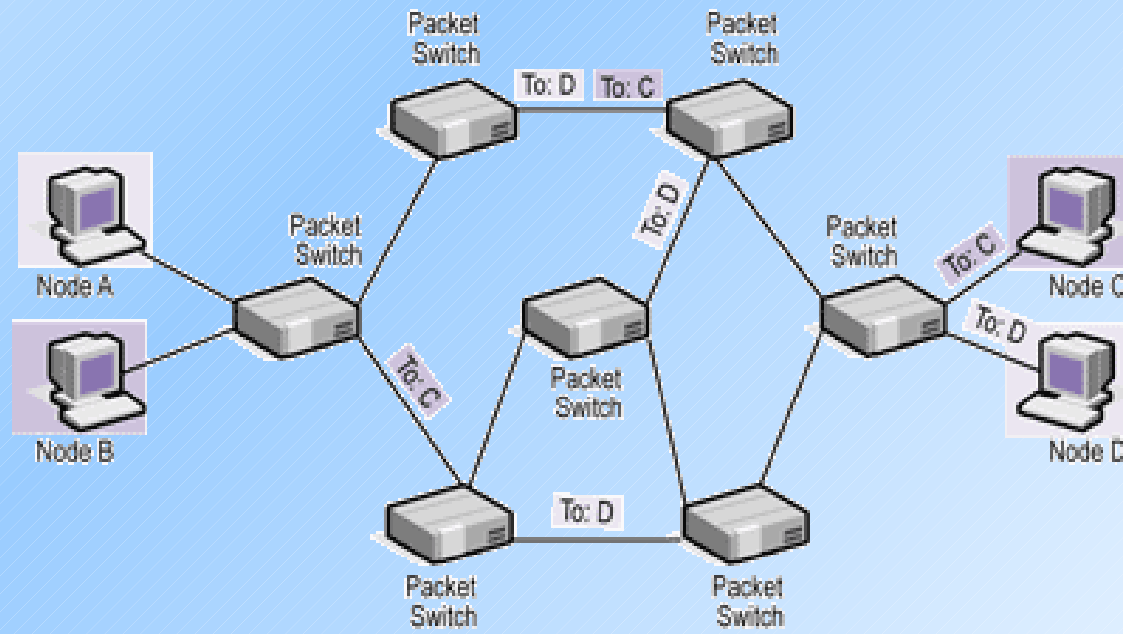
Second Level Goals

- Communication in the presence of failures
- Multiple types of service
- Accommodate different networks
- Distributed management
- Cost effective
- Dynamic host attachment, removal
- Resource accounting

Survivability in the Face of Failure

- *"If two entities are communicating, a reconfiguration after a failure in the Internet should still permit the two entities to communicate without reset of state information"*
    - The architecture provides no facility to communicate to the client of failure
    - State information should be protected against loss
- Alternative: Replicate state information in the switches of the network
    - Distributed replication is difficult
    - Protects only against a certain number of failures
-

Cont..

- Fate Sharing: Store information at the host using the communication service
  - Acceptable to lose information when the entity itself is lost

- Consequences:
  - Packet switches are "stateless" -- datagram network
  - More trust on the host machine than on the network

Types of services

- Types of service distinguished by speed, latency, reliability
  - remote login needs low delay
  - Ftp transfer needs high speed
- This goal caused TCP/IP protocol to be split into separate layers
  - TCP provides reliable sequenced data stream
  - IP provides a basic building block (datagram) out of which other services (e.g UDP) can be built

Varieties of Networks

- Internet operates over long-haul (ARPANET), LANs, satellite, packet radio, serial links etc

- This is possible because the Internet architecture provides just minimum functions
  - The network will transport a packet
  - Packet size be reasonable (100 bytes)
  - The network will provide reasonable reliability
  - The network has some suitable addressing mechanism

Cont...

- The Internet does not provide
  - reliable sequence delivery
  - network level broadcast/multicast
  - priority ranking of packets
  - internal knowledge of speeds,failures, delays etc
- The services can be engineered at the host

Other Goals

- Distributed Management:
  - Permits Inter and Intra domain routing
  - Lacks sufficient tools for distributed management
- Cost-Effectiveness:
  - Large headers
  - Retransmission mechanism
- Host Attachment:
  - Higher than other architectures
  - Required services are implemented on the host
- Accounting: Internet has very few tools for this

Importance of Datagrams

- Datagrams eliminate need for connection state in intermediate switching nodes
    - Internet can be reconfigured after failure without concern for state
- Datagrams provide a basic building block from which a variety of services can be implemented

Cont...

- Datagrams represent minimum network service assumption which permits a wide variety of networks to be integrated

- Pigeon-powered Internet takes flight
  - Takes 1hr. 42 minutes to transfer 64 bytes

http://www.ietf.org/rfc/rfc1149.txt

http://news.com.com/2100-1001-257064.html?legacy=cnet
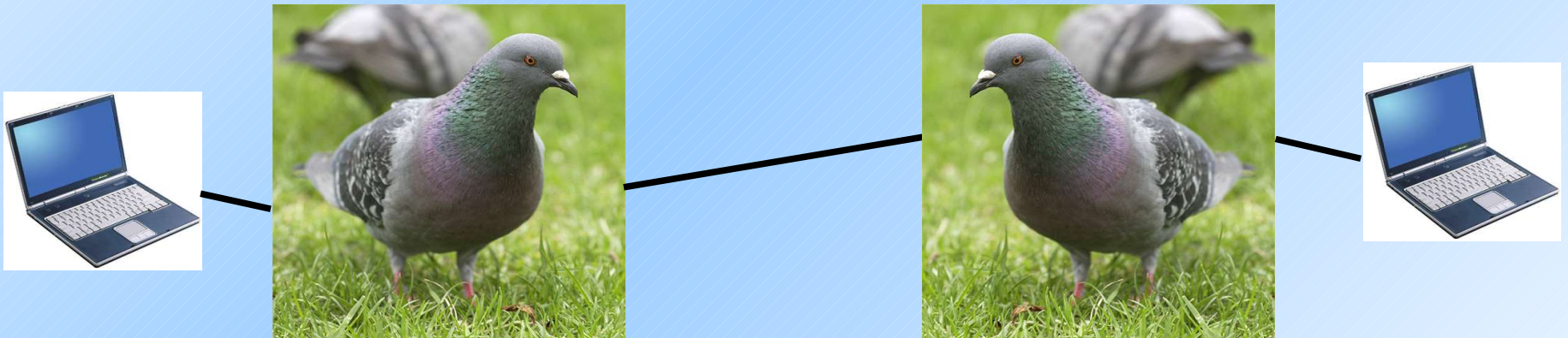
Next Meeting

H. Zimmermann, "OSI Reference Model -- The ISO Model of Architecture for Open Systems Interconnection", IEEE Transactions on Communications, 28(4), April, 1980.

March 1, 2005: Tue 5.30pm-6.30pm