LIS565 Lecture 1

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2001–09–20

Reading & structure

Tanenbaum: chapter 1, Comer: chapter 1, Hall: chapter 1

- fundamentals about network
- network design
- Internet archeology
- Internet standardization

What is a computer network

- A computer network is a collection of autonomous computers
- The distributed nature of the system is apparent to the user

Computer networks for organizations

- Resource sharing
- Increase reliability
- Improve scalability
- Money savings through use of PCs

Computer networks for communication

- Access to remote information
  - software
  - data sources
  - e-commerce
  - video on demand
- Person to person communication
  - email
  - video conferencing
  - interactive television

Types of Networks by transmission technology

- Broadcasting or multicasting network
  - static
  - dynamic
    - centralized control networks
    - decentralized control networks
- Point-to-point network
  - circuit-switched
  - packet-switched

Size classification of networks

- LAN
- MAN/WAN
- internet

LAN or MAN

- bounded size
- usually one cable that links all machines
  - bus e.g. Ethernet
  - ring e.g. IEEE 802.5
- high speed
- low delay
- high reliability

WAN

- Span a whole area or country
- Interconnects a large number of hosts
- Irregular topology
- divided into subnets
- consists of
  - transmission lines
  - switching elements (router)

Network architecture

- Architecture is a set of layers & protocols
- Purpose of layer is to carry out services for the higher layer in a way that is transparent to the higher layer.
- Layers communicate with their peers according to known protocols.
- Between layers in the same machine there is an interface.

Design issues for layers

- layers needs to identify senders and receivers
- layers need to have rules for communication
  - simplex
  - half duplex
  - duplex
- layers need to be aware of errors
- layers need to have conventions about speed
- layers need to know about routes

Service types

- Connection-oriented
  - reliable
    - message stream
    - byte stream
  - unreliable
- Connection-less
  - reliable
    - acknowledged datagram
    - request-reply
  - unreliable

Service elements (instructions)

- Request
  an entity wants a service to do some work
- Indication
  an entity is to be informed about action of the other
- Response
  an entity wants to respond to a request
- Confirm
  an entity confirms the response to a request

Example set of service primitives

- Connect.Request
- Connect.Indication
- Connect.Response
- Connect.Confirmation
- Data.Request
- Data.Indication
- Disconnect.Request
- Disconnect.Indication

Example architecture: the OSI reference model

This is a reference model thought out by network theorists (mainly in Europe) in the 70s and 80s. The protocols and interfaces have all been written down, but never had a significant take-up because they are too involved to set up.

But the model is still an important conceptual reference to this day.

OSI Layer 1: the physical layer

This layer concerns all the physical devices on the network. These may be cables, cards, the jacks, phone lines, radio and satellite devices. This layer sets out what types of device may be used.

OSI Layer 2: the data-link layer

This layer concerns the transport of data across the physical layer. For each physical device, the data-link layer sets out rules in which it has to be used. If there are problems in the physical layer, then the data-link layer must sure that they are being dealt with.

OSI Layer 3: the network layer

This layer concerns the addressing of the entities on the network, and the transport of data between entities that have different addresses. The network layer does not need to ensure that the delivery is reliable.

OSI Layer 4: the transport layer

This layer is responsible for making the network layer reliable. If the network layer can not transport, the network layer either tries again or reports an error to the layer above.

OSI Layer 5: the session layer

This layer establishes connections between entities on the network. Once the upper layer has finished, the session layer releases the connection.

OSI Layer 6: the presentation layer

This layer provides a consistent set of user interfaces that the applications can use. For example, there can be windows, characters etc.

OSI Layer 7: the application layer

This layer is concerned with the actual applications that run on the network, like a mail client, a web client, and the corresponding servers.

Why OSI never took of

- bad timing
  the apocalypse of the two elephants
- bad technology
  session layer little use, presentation layer empty
- bad implementation
- bad politics

Example network model: TCP/IP

- TCP/IP is not quite a model, but a protocol stack
- Initially used for the ARPANET at a time when satellite and radio services were added
- Set up for a wide variety of physical devices
- Should be robust to a partial destruction because it was military research

TCP/IP "reference model"

- Application layer
  telnet ftp smtp http nntp dns .
- Transport layer
  TCP UDP
- Internet layer
  IP
- Host to network layer
  NSFNET, LANs

critique of TCP/IP reference model

- does not distinguish service, protocol and interface
- it is not a general model
- ad hoc application protocols

Internet Origins

- 1957: USSR launches the Sputnik
- US worried about command and control structure after a nuclear attack
- Early 60s Paul Baran promotes packet switching rather than circuit switching.
- Mid 60s: Pentagon says that it wants this, gives grants to ARPA.

ARPAnet initial design

- Network nodes have hosts and IMP
- Host sends messages smaller than 8061 bits
- IMP breaks it up into packets smaller than 1008 bits
- IMP connected by transmission lines
- Each IMP connected to 2 other IMPs
- store and forward principle

Implementation

- 12k times 16 bit words memory minicomputer without hard disk as IMPs
- Connected by 56kbps leased phone lines *draw design*
- life with four hosts in 1969–12
- over 30 hosts in 1972–09
- protocol research leads to TCP/IP in 1974
- integrated into Berkeley UNIX, freely available
- Internet research group developing protocols
- 1979: Internet research group reorganized to Internet Control and Configuration Board

NSFnet

- 1980: MILNET split off the ARPAnet
- CSNET set up to link researchers at non-ARPA contract institutions to the ARPAnet
- ran on a single box with dial-up lines since late 70s
- 1984 NSF links adds a fuzzball to it supercomputers, sets up NSFnet, the first purely TCP/IP network, on 56kbps.
- additional funding for (eventually 20) regional networks to be connect to the backbone
- 1990 ANS (MERIT,MCI,IBM) take over NSFnet

The Internet

- integration of other networks like SPAN, HEPNET, BITNET, EARN
- commonality through the TCP/IP protocol stack

Internet Architecture Board

- formed out of the ICCB in 1983
- with the growth of the Internet beyond NSFnet, it became an autonomous organization
- reorganized in 1989
  - board
    - IRTF
    - IETF
      - IESG, coordinates areas and working groups
- IANA

RFC

- A list of numbered reports
- anything issued April 1 is a joke
- 75 were never issued
- famous one: 822, defining smtp

Internet standard

according to RFC2026 "a specification that is stable and well-understood, is technically competent, has multiple, independent and interoperable implementations with substantial operational experience, enjoys significant public support and is recognizably useful in some or all parts of the Internet."

RFC categories

- standard setting documents
  - required, recommended, elective, limited use, not recommended
- off-track documents
  - informational, historical, experimental, best common practice, for your information