CSIS 625 Week 1

Introduction, Basic Concepts, OSI Model

I. Overview

- A. Introduction
- B. Basic Concepts of Communications
  1. Categories of Networks
  2. Point-to-point vs Multi-point
  3. Different Transmission modes
  4. Different Topologies
- C. OSI Model
  1. The 7 Layers
  2. Contrast to TCP/IP
  3. Why it is a "Model"

II. Introductory terms

A. Telecommunications
  1. The art and science of communicating over a distance.
  2. Includes telephony, telegraph, radio, television, email, etc.

B. Network
  1. A set of devices that communicate by media links
  2. Examples: Long distance network, LAN on campus

C. Node
  1. A device that communicates with another device using a network
  2. May be a person, a telephone, a computer, etc.

D. Media link
  1. The physical path by which a message is sent from a sender to a receiver.
  2. May be air, wire, fiber optic cable, radio waves, etc.

E. Bandwidth
  1. A measurement of medium capacity

III. Protocols

- A. A set of rules that describe how two nodes on a network communicate
- B. Defines the syntax of the message
  1. ASCII text,
- C. Defines the meaning of the message
  1. 1 if by Land, 2 if by sea.
- D. Defines the timing of the message

IV. Standards

- A. The thing I love about standards is that there are so many to choose from.
- B. Many organizations
  1. IEEE
  2. IETF
  3. ITU

4. ISO
5. ANSI
6. EIA
7. Telecordia (aka Bellcore)
8. ATM Form
9. Frame Relay Forum
10. etc.

C. Most equipment follows some of the rules from some set of standards.
D. Many (most?) times a number of rules are stretched, or things not implemented
E. Market pressure and sometimes regulations keep things inter-operating.

V. Categories of Networks

A. Types of Networks
1. LAN - Local Area Network
2. MAN - Metropolitan Area Network
3. WAN - Wide Area Network

B. Only difference is area that they cover
1. Gray boundaries between these categories
2. Often a WAN technology can be used in a MAN system, or a LAN technology used for a MAN system.
3. Difficult to define a technology as being strictly one type.

C. Internetworks
1. internetwork or internet – Any time two networks are connected together.
2. Internet - uppercase I - a specific internet.
    a. The global TCP/IP based network that everyone talks about.
3. Intranet – an internet using TCP/IP confined to inside an organization (within a company or campus or department)
    a. Often used as a name for an internal only company web site.
4. Extranet – an internet using TCP/IP to connect two different organizations, usually using the Internet to connect the two.
    a. Often used as a name for a restricted web site.
    b. Often used for a company to communicate with its customers, or vendors

VI. Transmission Modes

A. Simplex
1. Unidirectional communication.
2. One node can only receive and one node can only transmit

B. Half-Duplex
1. Each node can receive and transmit, but only one at a time

C. Full-Duplex
1. Each node can receive and transmit at the same time.

VII. Line Configurations

A. Point to Point - a dedicated link between two devices
B. Multipoint - More than 2 devices on a link

VIII. Topologies

A. How Nodes are connected to one another.

B. May be logical or physical
    1. Physical is how the actual cables and nodes are arranged.
    2. Logical is how nodes talk to one another at a higher layer.
    3. A logical mesh may be implemented using a physical star or bus.
        a. Many other combinations are possible.

C. Bus
    1. A multipoint media link connects all nodes together.
    2. The media link called the backbone
    3. Very efficient for adding additional nodes
        a. Just tap onto the cable
    4. Difficult to rearrange or debug.
    5. Any fault on the cable may interrupt all communications

D. Mesh
    1. Every node has a point to point connection with several other nodes
        a. Pure Mesh - every node connects with every other node directly.
        b. Generic Mesh – every node has a connection with at least 2 other nodes.
    2. With a pure mesh network, a network of n nodes, every node has n-1 connections.
        a. Does not scale well.
        b. Secure in that no other node can listen in on it's communication.
        c. Somewhat robust
            (1) Any link or node failure will only affect one communication path.
            (2) Other nodes will continue to communicate normally.
            (3) Usually does not support forwarding of messages (routing)
                (a) Makes for simpler (cheaper and faster) software
    3. Generic Mesh – more links than other formats, but less than a pure mesh.
        a. Can economically scale much larger than pure mesh
        b. Provides more robustness in that messages can be routed around any node or link failure.
            (1) More complex software to accomplish this
                (a) more costly
                (b) Complex software prone to it's own failures.
            (2) Requires more than one connection on every node to provide redundancy. More connections = higher level of redundancy, but more complexity in the routing software.

E. Star
    1. Every Node has a connection to a central point.
    2. Central point often called a hub.
    3. Scales much better than pure mesh, but the hub must support a lot of connections.

F. Tree - two kinds
    1. Multiple star networks combined.
        a. Allows Star network to scale better.
    2. Multiple branches from a bus network
        a. Allows more flexible topology of the bus network

G. Hubs
    1. A single point of failure.
    2. A single debugging point
    3. Passive hubs provide simple electrical or optical connections.

        a. Simple, Cheap, don't break often
    4. Active hubs regenerate the signal between nodes.
        a. Allows greater distances between nodes

H. Linear
    1. Each node has a point-to-point connection with each of its neighbors.
    2. Any break causes some nodes to be unable to communicate
    3. Protection lines help solve reliability
    4. Simple to build and extend

I. Ring
    1. Each node has a point-to-point connection with each of it's neighbors to form a ring of connections
    2. Like linear, but with ends connected.
    3. May have all traffic going in one direction, or traffic may go in both directions.
    4. Any fault will still allow nodes to talk in the opposite direction.

J. Hybrid
    1. Combinations of the previous methods.
    2. Very common when linking different subnetworks together
        a. One office has a 10Base2 bus Ethernet network, and another has 10BaseT star Ethernet network

IX. OSI Model

A. OSI - Open Systems Interconnection

B. A set of standards to allow any computer to speak with any other computer

C. Developed by ISO
    1. Started in 1977, basically outlined by 1978
    2. Formally accepted in 1983
    3. GOSIP - Government OSI Profile
        a. 1988 - 1994 - RIP

D. Layered approach - 7 Layers
    1. Layer 7 - Application
    2. Layer 6 - Presentation
    3. Layer 5 - Session
    4. Layer 4 - Transport
    5. Layer 3 - Network
    6. Layer 2 - Data Link
    7. Layer 1 - Physical

E. OSI - Interfaces Between Layers
    1. Each layer has to provide services to the layer above it, and rely on the layer below it.
    2. Strict definition of these interfaces allows for different protocols to be easily swapped out
    3. Model says each layer adds headers, and data link layer may add trailer as well.

F. OSI Model - Peer layers
    1. Between nodes, layer n communicates with layer n on the other system
    2. The same layer implements the same functions
    3. The same function may not be provided in the exact same way.
    4. All communications is defined by a set of protocols that must be the same between two peer nodes.

G. OSI layer-to-layer adding of headers
    1. As a packet goes from layer 7 down through the stack each adds a header to the data.
    2. The layer below treats the header and data from above as one generic chunk of data.
    3. Strickly speaking a layer doesn't know about the other layer's headers.
    4. Layer 2 typically also adds a trailer.

X. OSI – By the Layers

A. Physical Layer

1. Medium
2. How bits are physically present on the line
    a. voltage for a 1/0, light pulse, etc
3. Transmission mode
    a. Full-duplex
    b. Half-duplex
    c. Simplex
4. Physical topology
5. Data rate
6. Synchronization of bits & symbols (bytes)

B. Data Link Layer

1. Node to node delivery of frames
    a. create & recognize boundaries
2. Physical Addressing (multiple nodes in the physical network)
3. Flow Control
4. Error Control
    a. Detect errors and prevent duplication
5. MAC - Media Access Control
    a. When can different nodes transmit

C. Network Layer

1. End to end delivery of packets
2. Logical Addressing
3. Routing - path a packet takes
4. Address Translation
    a. Resolving logical addresses to physical addresses
5. Fragmenting packets
    a. One data link layer supports bigger packets than another.

D. Transport Layer

1. End to end delivery of a message
    a. multiple packets make up a message
2. Service Port addressing
3. Segmentation and reassembly of a message.
4. Flow control
5. Error Control
6. Connection Control

E. Session Layer

1. Session management
    a. May use many transport layer sessions to accomplish one overall session
2. Synchronization

        a. checkpoint a big file transfer
    3. Token Management
    4. Dialog control

F. Presentation Layer
    1. Translation
        a. Syntax and semantics of information
    2. Encryption
    3. Compression
    4. Authentication

G. Application Layer
    1. Network Virtual Terminal
        a. aka telnet
    2. File transfer, access, management (FTAM)
        a. aka FTP
    3. Mail services
    4. Directory services
        a. aka DNS, NIS, etc.

XI. OSI compared to TCP/IP

A. OSI developed model, then protocols then implementations

B. TCP/IP developed implementations, then protocols ratified, then a model.

C. Why OSI is a model
    1. There actually are OSI protocols BUT nobody uses them
    2. The library of OSI protocols is so large that it can't be understood by mere mortals
    3. Those implementations that actually exist are rarely interoperable.
    4. Session and presentation layers are ignored in everything but textbooks and bureaucracies.

D. OSI problems
    1. Protocols came out too late compared to TCP/IP protocols
    2. Error control, addressing, and flow control re-appear in multiple layers.
    3. Original pass ignored connectionless services and protocols.
        a. Too many telco people on the committees
    4. Too much of the terminology is telco oriented which doesn't make software implementers comfortable.

E. TCP/IP critique
    1. Ignores data link & physical
        a. Built on top of existing standards
    2. Some application protocols are grad student projects
        a. Not always polished
    3. Actual transport & network layer protocols have been very robust.
    4. Not really a "model