Networking Principles: Midterm Review Guide

Protocol

* Properties

-Specifies how to handle one aspect of communication

-Can specify:

-Low level details (such as voltage and frequency)

-High level details(such as format visible to a user)

* Specification

-Syntax:

-Format of each message

-Representation of data items

-Encoding of bits in electromagnetic signals

-Semantics:

-Meaning of each message

-Procedures used to exchange messages

-Actions to take when an error occurs

* Design

-The steps in protocol design:

-look at the facilities the underlying hardware provides

-Imagine an abstract communication mechanism as a user would like it to work

-Design an efficient implementation of the abstraction

-The key to success= **Choose a good abstraction**

-Why its difficult

- Multiple implementations of a protocol will exist

-Key Tradeoffs:

-A specification that dictates all possible details restricts implementations

-A specification that does not specify enough details is ambiguous and leads to incompatible implementations

Internet Protocol

TCP/IP model:

* 4-layer model:

Layer 1 = Network Access Layer

-Function:

-Defines how to use the network to transmit a frame(data)

-Exchange data between the computer and the physical layer

-Help deliver data b/w 2 devices of the same network

Layer 2 = Internet Layer

-Function:

-Communicates between computer across an internet addressing model

Layer 3 = Transport Layer

-Function: Communicates between applications

Layer 4 = Application Layer

-Function: Formats the representation of data and messages

* 5-layer model:

Layer 1 = Physical Layer

-Function: Handles host to host communication; transmission of media, hardware, and signals

-Data = “bits”

Layer 2 = Network Interface

-Function: communication between computer and network hardware;

allows computer to access the wire, wireless, or fiber optic network infrastructure and send data to other computers

-Data = “frame”

Layer 3 = Internet Layer

-Function: communication between computers across an internet addressing models, forwarding packets; responsible for logical transmissions of data packets over the internet

-Data = “packet”

Layer 4 = Transport Layer

-Function: communication between a pair of applications; to effectively control communications between two hosts

-Data = “datagram”

Layer 5 = Application Layer

-Function: methods for requesting and transferring data; provides the interfaces and the protocols needed by the users

-Data = “message” / ”information”

OSI model:

Layer 1 = Physical Layer

-Function: transmits raw bit stream over the physical medium

Layer 2 = Data Link Layer

-Function: defines the format of the data on the network

Layer 3 = Network layer

-Function: decides which physical path the data will take

Layer 4 = Transport Layer

-Function: transmits data using transmission protocols including TCP and UDP

Layer 5 = Session Layer

-Function: maintains connections and is responsible for controlling ports and sessions

Layer 6 = Presentation Layer

-Function: ensures that data is in a usable format and is where data encryption occurs

Layer 7 = Application Layer

-Function: Human-like computer interaction layer, where applications can access the network services

**Chapters 3&4**

DNS

-Means “Domain Name System

internetworking

-Interconnecting many packet switching technologies into a functioning whole

-Provides the basis of the global Internet

-More powerful than a single networking technology because the approach permits new technologies to be incorporated at any time without requiring the wholesale replacement of old technologies

Transport Layer

Client Server

-A network medium of which clients access resources and services from a central computer

P2P

-A group of computers linked together with equal permissions and responsibilities for processing data.

**Chapters 5,6,7**

Data Communication Framework

-Encryptor:

-Also known as a “scrambler”

-Function: transforms data into and unintelligible form to prevent unauthorized use of the data

-Encoder:

-Makes sure that there’s no errors nor redundancies

-Adds “noises” to your signal

-Converts streams of data bits into a predefined “code”(which are groupings of bits used to make a predictable pattern that is recognized by the sender and the receiver).

-Modulator:

-Simplifies multiple signals

-Combining multiple signals into one

-Decryptor:

-Extracts and converts the garbled data and transforms it into words/images that is understandable by the reader and the system

-Decoder:

-Converts the data into its original format

-Demodulator:

-Recovers the ‘information content’ from the modulated carrier wave

-Multiplexor:

-Makes it possible for multiple input signals to share one device

-Demultiplexor:

-Reconverts a signal that contains multiple signals(analog or digital) into its original separate and unrelated signals

Analog Signal

-Sine wave characteristics:

-Amplitude = “Height”; the difference b/w the maximum and minimum signal height

-Frequency = the number of oscillations per unit time

-Phase = how far the start of the sine wave is shifted from a reference time

-Fourier Analysis:

-Method of decomposing a composite signal into its constituent(basic) parts

-Analog bandwidth

-The difference between the highest and lowest frequency of its components.

-Frequency domain:

-Allows to observe several characteristics of a signal that wasn’t easy to see nor visible

-Adv: A frequency domain representation is both small and easy since each sine wave occupies a single point

Digital signal

-A fixed set of valid levels and each change consists of an instantaneous move from one valid level to another.

Analog to Digital Conversion:

-2 approaches:

- Pulse code modulation

-Delta modulation

-Pulse modulation: A technique where the level of an analog signal is measured repeatedly at fixed time intervals and converted to digital form.

-Delta modulation: Instead of measured repeatedly and at fixed intervals, measured once since its in a 1-bit data stream

Digital to Analog Conversion:

-Approximation: involves building a composite signal from only a few sine waves

Synchronization:

-Deals with the problem of disturbing time and frequency among spatially remote locations

-To be able to extract original source from sender

Transmission media:

-Guided:

-Twisted pair: 2 insulated copper wires twisted to reduce interference from other pairs

-Is twisted to have no interference with other wires

-Coaxial: copper core surrounded by insulating material and a braided outer conductor

-Fiber optic: glass fiber carrying light pulses; most popular

-Unguided:

-Infrared: A form of electromagnetic radiation that behaves like visible light but falls outside the range that is visible to a human eye

-Best suited where the path between sender and receiver is short and free from obstruction

-Laser: Similar to infrared however, does not cover a broad area.

-Due to its narrow beam of light, the transmission of sender and receiver must be aligned precisely.

-Terrestrial radio: communication uses equipment such as radio or microwave transmitters that is relatively close to the earth’s surface.

-Typical locations for antennas: top of hills, man-made towers, tall buildings

-Satellite:

-3 types: low-Earth orbit(LEO), medium-Earth orbit(MEO), Geostationary-Earth orbit(GEO)

-LEO: Has the adv. of low delay; disadv: satellite appears to move across the sky(from an observer’s POV on the Earth)

-MEO: An elliptical orbit used to provide communication from South and North Poles

-GEO: Adv: orbital period is exactly the same rate at which the earth rotates

Disadv: being farthest away can cause delay to some applications

Wireless transmission:

-Most popular to use is electromagnetic energy in the Radio Frequency range

Radio transmission:

-Using radio waves from an antenna?(Just think like this…)

Measuring transmission media:

-Propagation Delay: Time required for a signal to traverse a medium

-Nyquist’s Theorem: Gives a theoretical limit on the channel capacity of transmission media when no noise is present

-Theoretical maximum data transmission rate

-Shannon’s Theorem: Specifies the channel capacity in realistic situations when noise is present

-Capacity of data channels with noise

**Chapter 13**

LAN technologies

-“LAN” = “Local Area Network”

-A type of packet switch category

-Key ideas to Wired LANs:

-Minimize the number of connections by sharing them among many computer

-Relatively low cost

-High “thoughput?”

-Limited to short distances

- Dominant wire LAN standard: Ethernet

-LAN operations---------🡪 between Physical and Network Interface layer (in TCP/IP model)

Network Topologies

-Bus

Diagram

Description automatically generated

-Single cable to which computers attach

-Problem: If cable breaks down, all will break down

-Token ring

Diagram

Description automatically generated

-Same as Bus, but in a circle

-Has same problem as Bus

Diagram

Description automatically generated-Star

-All computers attaching to central point(hub)

-The best since losses is less drastic than others

-Hub: consists of an electronic device that accepts data from a sending computer and delivers it to the appropriate destination

Diagram

Description automatically generated-Mesh

-Direct connection between each pair of computers

-Disadvantage: costly to employ

**Chapters 15,21,23**

Ethernet

-A single long cable of which computer attach

-Serves as a medium

-Transmits signals down a cable instead of broadcasting radio frequency through atmosphere

-Allows all communication to proceed across the shared cable

IP Addressing

-A unique identifier that each computer is assigned

-Has information about which LAN a host is on

-In Internet Layer

-Each 1 digit = 8 bits

DHCP

-“DHCP” = “Dynamic Host Configuration Protocol”

-Goal = Host dynamically get its IP address from a server when it joins the network

-Allows a computer to move to a new network and obtain configuration information, without requiring an administrator to make manual changes to a server database

CIDR

-“CIDR” = “Classless Inter-Domain Routing”

-Only specifies addressing and forwarding

-A set of Internet protocol standards that is used to create unique identifiers for networks and individual devices

- This: /#

ARP

-“ARP” = “Address Resolution Protocol”

-Used by computer on the physical network

-Allows a computer to find the MAC address of another computer

-Operates at Network Interface layer(Layer 2)

**Chapters 9,10,11**

Transmission Modes

-Parallel:

-Multiple bits sent on multiple waves

-Serial:

-One bit at a time

-Asynchronous: Can occur anytime with an arbitrary delay between the transmission of two data items

-Synchronous: Occurs continuously with no gap between the transmission of two data items

-Isochronous: Occurs at regular intervals with a fixed gap between the transmission of two data items.

-Ethernet Transmission order:

-Big-endian: A system that sends the Most Significant Bit (MSB)

-Little-endian: A system that sends the Least Significant Bit (LSB)

-Unicast: Identifies a single host

-Multicast: Identifies a group of hosts

-Broadcast: All hosts

Modulation

-Analog: The process of transferring an analog baseband (low frequency) signal

-Digital: The process of encoding a digital information signal into the amplitude, phase, or frequency of the transmitted signal

Multiplexing and demultiplexing

-FDM: (“Frequency Division Multiplexing”); technique for sending two or more signals over the same phone line or medium.

-WDM: (“Wavelength Division Multiplexing”); the application of frequency division multiplexing to optical fiber

-TDM: (“Time Division Multiplexing”); multiplexing in time = transmitting an item from one source, then transmitting an item from another source, and so on.

-CDM: (“Code Division Multiplexing”); facilitates various signals to occupy a single transmission channel

-Optimizes the use of available bandwidth

Access Technologies

-Dialup:

-Uses telephone lines to access the Internet

-Slow

-Requires a telephone connection

-Broadband:

-Uses fiber optic cable

-Fast

-Does not require require telephone connection or connection