* electromagnetic signal is a function of time.
* frequency domain view of a signal is more important than time domain view for data transmission
* Wavelength - Distance occupied by a single cycle, or, the distance between two points of corresponding phase of two consecutive cycles
* In general, any digital waveform using rectangular pulses will have infinite bandwidth.
* limiting the bandwidth creates distortions
* greater the bandwidth transmitted, the greater the cost

2.1 Differentiate between an analog and a digital electromagnetic signal.

**analog signal** is one in which the signal intensity varies smoothly over time.

**digital signal** is one in which the signal intensity maintains a constant level for some time and then changes to another constant level

2.2 What are three important characteristics of a periodic signal?

1. Peak amplitude - maximum value or strength of the signal over time **V**
2. Frequency - rate at which the signal repeats **Hz** \*equivalent parameter is the period\*
3. Phase - relative position in time within a single period of a signal,

2.3 How many radians are there in a complete circle of 360 degrees?

2pi radians = 360 degrees = 1 period

2.4 What is the relationship between the frequency and period of a periodic signal?

Frequency and Period are equivalent

2.5 What is the relationship between a signal’s spectrum and its bandwidth?

**spectrum** of a signal is the range of frequencies that it contains

**absolute bandwidth** of a signal is the width of the spectrum

**Difference:** Spectrum is range and bandwidth is the difference

2.6 What is a fundamental frequency?

**fundamental frequency**: all of the frequency components of a signal are integer multiples of one frequency

2.7 Define the absolute bandwidth of a signal.

**absolute bandwidth** of a signal is the width of the spectrum

2.8 What key factors affect channel capacity?

* The greater the bandwidth, the higher the information

2.9 Differentiate between infrared and microwave transmission.

**microwave frequencies** - highly directional beams, suitable for point-to-point transmission-carrying capacity, satellite communications (1GHz - 100 GHz)

**Infrared frequencies** - local point-to-point and multipoint applications within confined areas, such as a single room

**Difference:** long distance vs short distance

2.10 What are some major advantages and disadvantages of microwave transmission?

**Pros:** long-haul telecommunications service; microwave facility requires far fewer amplifiers or repeaters

**Cons:** requires line-of-sight transmission

2.11 What is a direct broadcast satellite?

In which satellite video signals are transmitted directly to the home user. DBS is now commonplace due to its low cost

2.12 Why must a satellite have distinct uplink and downlink frequencies?

* For continuous operation without interference, a satellite cannot transmit and receive on the same frequency. Thus signals received from a ground station on one frequency must be transmitted back on another.

2.13 Indicate some significant differences between broadcast radio and microwave.

**Radio:** 3 kHz to 300 GHz; UHF band VHF television and data networking applications

2.14 Why is multiplexing so cost-effective? 2.15 How is interference avoided by using frequency division multiplexing? 30 MHz to 1 GHz is an effective one for broadcast communications. Because of the longer wavelength, radio waves suffer relatively less attenuation compared to microwave

**Difference:** principal difference between broadcast radio and microwave is that the former is omnidirectional and the latter is directional. Thus broadcast radio does not require dish-shaped antennas, and the antennas need not be rigidly mounted to a precise alignment

2.16 How is efficiency improved by the byte-interleaving technique in TDM systems

* used with asynchronous and synchronous sources
* Each time slot contains one character of data. Typically, the start and stop bits of each character are eliminated before transmission and reinserted by the receiver, thus improving efficiency

3.1 Differentiate between WANs and LANs.

**WAN** Wide area networks - large geographical area; rely at least in part on circuits provided by a common carrier, implemented using circuit or packet switching

**LAN** local area networks - interconnects a variety of devices and provides a means for information exchange among those devices; scope of the LAN is small (Singlie building). LAN is owned by the same organization that owns the attached devices. network management responsibility for a LAN falls solely on the user

**MAN** Metropolitan area networks: middle ground between LANs and WANs.

3.2 Briefly state the four generic architectural components of the wired public switched telephone network.

**Subscribers**: The devices that attach to the network.

**Subscriber line**: The link between the subscriber and the network, also referred to as the local loop. length of a subscriber line is in a range from a few kilometers to a few tens of kilometers.

**Exchanges**: The switching centers in the network. A switching center that directly supports subscribers is known as an end office

**Trunks**: Trunks are the branches between exchanges. Carry multiple voice-frequency circuits using either FDM or synchronous TDM

3.3 What is the principal application that has driven the design of circuit-switching networks?

* driven by its use to carry voice traffic.

3.4 Distinguish between static and alternate routing in a circuit-switching network.

3.5 What is best effort traffic?

packets receive resources as the network finds them available and those users are generally content.

3.6 Explain the difference between datagram and virtual circuit operation.

**Datagram:** each packet is treated independently, with no reference to packets that have gone before. In some datagram networks, it is up to the destination rather than the exit node to do the reordering.

**virtual circuit**: a preplanned route is established before any packets are sent. Once the route is established, all the packets between a pair of communicating parties follow this same route through the network.

**Difference:** The difference from the datagram approach is that, with virtual circuits, the node need not make a routing decision for each packet. It is made only once for all packets using that virtual circuit.

3.7 Differentiate between interactive data traffic and non-interactive data traffic with an

appropriate example.

**Interactive Data:** exists when people wait for data to be delivered before proceeding with anything else. This might include waiting for a Web page to load or for an online transaction to complete.

**Non-Interactive Data:** occurs in the background while people are performing other activities. This would involve electronic mail or other types of batch processing or downloading activities.

3.8 If people are receiving poor quality video, what QoS requirements might not be being met?

**Streaming live video** comes from occasions such as live sporting events. This is one-way video. Some expectation of recency, say within a few second delay, is expected.

**Streaming stored video** comes from sites such as YouTube where a presentation has been stored and is played to the recipient of the data stream.

**Video conferencing** involves two-way communication. Traditionally this has involved voice, but video is now very common for both professional and personal use.

**Answer: Streaming stored video**

4.1 What is the major function of the physical layer?

* Specified the characteristics of the transmission medium, the nature of signals, the data rate, and any related matters.

4.2 What is the function of the Internet Protocol (IP)?

* Provides routing function across multiple networks

4.3 What is a port address?

4.4 What is a protocol data unit (PDU)?

* A generic name for a block of data exchanged by any protocol level

4.5 What is a protocol architecture?

* A vertical stack of broken-up subtasks, each of which is needed to communicate with another system

4.6 What is TCP/IP?

* A framework for developing computer communications standards. Broken up into the following:
  + Physical Layer
  + Network Access Layer
  + Internet Layer
  + Transport Lyaer
  + Application Layer

4.7 What are some advantages to layering as seen in the TCP/IP architecture?

* In self-contained systems, each system has a specific narrow task

4.8 What is a router?

* A device that routes information across networks

5.1 What are the parameters that differentiate signals from each other?

* Amplitude, frequency, and phase

5.2 What information is available from a radiation pattern?

* The radiation properties of an antenna, such as directions of low and high-energy

5.3 What is dynamic spectrum access?

* A spectrum that has 2 classes, primary and secondary users. If the primary users aren’t using the spectrum, secondary users can utilize it.

5.4 List the different mechanisms by which electromagnetic signals can transfer information.

* Reflection, Diffraction, Scattering, Free-space, transmission

5.5 Describe the distinct types of small-scale fading effects.

* Doppler Spread and Multipath fading. Doppler spread changes signal strength due to movement while multipath fading occurs when the same signal interacts with itself

5.6 What is the difference between flat and selective fading?

* Flat fading is when all frequency components fluctuate at the same proportions while selective fading is the opposite of flat fading

5.7 Indicate three major advantages of digital transmission over analog transmission.

* Error Correction, Higher data rates, less conversion

5.8 How are binary values represented in amplitude-shift keying?

* 0 is 0 while Acos(2pift) is 1. The presence of the carrier wave indicates 1 while no presence indicates a 0

5.9 What is intermodulation noise?

* 2 different frequencies using the same transmission medium produce the sum difference of the 2 original frequencies

5.10 What is a parity bit?

5.11 What is a MIMO system?

* Multiple input, multiple output

5.12 Why would you expect a CRC to detect more errors than a parity bit?

5.13 What two key elements comprise error control?

* Detection and correction

5.14 Explain how Go-back-N ARQ works.

* The receiving station will issue a request for a specific packet of information and will wait for that packet until it gets it and the transmitting station will continue the conversation from where the lost packet was.

5.15 Briefly define OFDM, OFDMA, and SC-FDMA.

* Orthogonal Frequency Division Multiplexing - Uses multiple carrier frequencies to transmit and receive data
* Orthogonal Frequency Division Multiplexing Access - OFDM but there specific data is only sent at certian times
* Single Carrier Frequency Division Multiplexing Access - One channel instead of multple

5.16 What is the relationship between the bandwidth of a signal before and after it has been encoded using spread spectrum?

* Bandwidth increases afterwards

5.17 List three benefits of spread spectrum.

* Harder to jam
* Harder to intercept
* Can use the same bands with out interference

Questions

Wat type of signal is a voice

* **The signals may represent analog data (e.g., voice**

A modem (i.e. modulator / demodulator) converts \_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_.

What is the Nyquist bandwidth of 80 MHz?

* **digital data to analog signals, and vice versa**

What is the optimum frequency range for satellite transmissions

* **Google: 300 MHz to 40 GHz**
* **Book: 1 GHz to 100 GHz (1,000,000,000 to 100,000,000,000) 10^9 to 10^11**

If a waveform has an infinite number of frequency components, it theoretically has infinite bandwidth. What limits bandwidth in practice?

* **This waveform has an infinite number of frequency components and hence an infinite bandwidth. However, the peak amplitude of the kth frequency component, kf, is only 1/k, so most of the energy in this waveform is in the first few frequency components.**
* **If we attempt to transmit this waveform as a signal over any medium, the transmission system will limit the bandwidth that can be transmitted.**
* **greater the bandwidth transmitted, the greater the cost**

Which two connection methods are associated with implementing WANs?

* **circuit switching and packet switching.**

How many stations can use a circuit-switched communication path at one time?

* **Communication via circuit switching implies that there is a dedicated communication path between two stations.**

What is the typical upper bound of the packet length in a packet-switched network?

* **A typical upper bound on packet length is 1500 octets (bytes)**

In a switched network, which approach treats each packet completely independent of all other packets?

* **In the datagram approach, each packet is treated independently**

All things being equal, how much slower is a wired circuit (assume a direction connection) compared to a wireless circuit?

* **For a voice connection, utilization for each direction may be about 40%, with the other 20% of the time spent on pauses between directions of the conversation**

Order each layer of the OSI model from lowest to highest, beginning with the physical layer.

Highest

* Application
* Presentation
* Session
* Transport
* Network
* Data link
* Physical

Lowest

A \_\_\_\_\_\_\_\_\_\_ and a \_\_\_\_\_\_\_\_\_\_ make a socket.

* **IP address; Port**

Given an IP address of 10.5.128.200 and a subnet mask of 255.255.0.0, what is the maximum number of other hosts on your local area network?

* **Chat: maximum of 65,534 other hosts on your local area network**
* **Calculator: Total # of Hosts: 65,536 Total # of Usable Hosts: 65,534**

What information can be learned from analyzing the first three bytes of a MAC address?

* **3-byte code, known as the organizationally unique identifier (OUI) or manufacturer ID**

Your IPv4 address is 192.168.56.100 and your subnet mask is 255.255.255.0, what CIDR address would you use to perform a ping sweep?

* **192.168.56.0/24 since the subnet mask has the notation /24 for CIDR**

What agency regulates the wireless spectrum in the United States?

* **FCC**

What is the upper bound of frequencies intended for ground wave propagation?

* **This effect is found in frequencies up to about 3 MHz**

What is the most common propagation method for most wireless frequencies?

* **Line-of-sight propagation**

The most significant bit in a byte is not needed by ASCII. the binary value of "A" is 0100 0001. Assuming even parity bit error detection, which of the following bytes contains an undetected error?

* **Any other ones that contain a total of even 1’s**

Assume a 10-bit frame (T) and a 4-bit pattern (P).

* T = 1101 1001 01
* P = 1010

The frame, T, was transmitted without error using a cyclic redundancy check, P.

* **Error remained ==9 not 0**

What is the expected probability of the XOR operation using the law of large numbers?

* **Should approach 0.5**

What is the Hamming Distance of "0110 1100" and "0001 1001"?

* **1+1+1+1+1+ = 5**

Using a forward error correction scheme of 5-bit blocks, what is the correct sequence if the received frames are 11110 11011 10101 10000 10110?

* Second to last block was changed
* 11110 11011 10101 10001 10110.

Block codes are a common error correction scheme in wireless communications. What is another common error correction scheme used in wireless communications?

* **Convolutional coding; Turbo Codes; Low-density parity check**

What mechanism allows data or transport layers to request a block of data be retransmitted?

* **automatic repeat request (ARQ)**

What IEEE specification covers the BlueTooth protocol?

* **IEEE 802.15**

What is the maximum number of devices allowed in a piconet?

* **One master device and up to 7 active slave devices**

What do you call a networked group of piconets?

* **Scatternet**

What is the individual bandwidth used by each hop of BlueTooth's frequency hopping scheme?

* **1 MHz**

According to your textbook (Dotson Ch. 7), what is the average time to identify a breach?

* **mean time to identify a breach was 197 day**

Order each phase of they Cyber Kill Chain.

1. **Reconnaissance**
2. **Weaponization**
3. **Delivery**
4. **Exploitation**
5. **Installation**
6. **Command and Control**
7. **Actions on Objective**

What are the two most important things to consider in a threat model?

* **what assets you have and who is most likely to attack them**

What is the number one source of information to watch for security purposes?

* **Logs**

When is an attack most likely?

* Nobody wants to be on call during a weekend or over a holiday. Unfortunately, attackers know this, so incidents are more likely to begin at these inconvenient times.

Where does NIST derive their authority to publish guidance such as SP 800-61r2?

* **Federal Information Security Modernization Act**

What does Section 2 of NIST SP 800-61r2 address?

* Incident Handling Overview.

Where can you find a list of suggested data to collect for each incident?

* NIST Special Publication 800-61

What protocol can be used to synchronize host clocks for event correlation?

* **NTP Network Time Protocol**

After recovering from a cyber attack incident, what is one of the most important activities?

* **redeploy all affected systems**
* **compromised cloud systems should be recreated, and the production traffic should be switched over to the new systems.**