IQRA NATIONAL UNIVERSITY, PESHAWAR, PAKISTAN

TOPICS IN COMPUTER NETWORKS

Program: MSCS/PhDCS FINAL-TERM EXAM Semester: Summer 2020

Maximum Marks: 50 Time Allowed: 4 Hours

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Q1. Select the correct answer of the given ones. (10)

1) Interactive transmission of data independent of a time-sharing system may be best suited to
Answer **:(b) half-duplex lines**
2) The loss in the signal power as of an Electromagnetic signal is called
Answer **(a) attenuation**
3) Early detection of packet losses improves _____ acknowledgment performance.
(d) negative
4) Additional signal introduced in the desired signal in producing hypes is called
(b) noise
5) Token is a **__Ring__** that rotates around the ring.
6) Ring may have up to **250** (802.5) or **260** (IBM) nodes.
7) FDDI can support a maximum of **500** stations.
8) Error-correcting codes are **intelligent or smart** enough to handle all errors
9) ACK is a small **control frame** confirming reception of an earlier frame
10) Electronics are **slower** as compared to optics

Q2. Distinguish between error correction and error detection. Explain any two error detection techniques with mathematical examples other than given in slides, search from internet.

Answer **Error:** An error is a situation where the output information does not match the input information. During the transmission process, the digital signal is disturbed by noise, which can cause errors in the binary bits transmitted from one system to another. This means that bit 0 may be changed to 1 or bit 1 may be changed to 0.

Error detection

Whenever a message is sent, it may be disturbed by noise, or data may be corrupted. To avoid this situation, we use error detection codes, which are additional data added to a given digital message to help us detect whether an error occurred during the transmission of the message. A simple example of error detection code is parity

Error correction

In addition to the error detection code, we can also pass some data to find the original message from the corrupted message received. This type of code is called an error correction code. Error correction codes also use the same strategy as error detection codes, but in addition, such codes can also detect the exact location of the damaged bit.
In error correction codes, parity has a simple method to detect errors and a complex mechanism to determine the location of damaged bits. After finding the corrupted bit, its value will be restored (from 0 to 1 or 1 to 0) to get the original message.
Some popular error detection techniques are:
1. Simple parity check
2. Two-way check
3. Checksum
4. Cyclic Redundancy Check

1**. Simple parity check**: Simple parity check code is the most common error detection code. In this code, change the k-bit data word to an n-bit code word with n = k + 1. The extra bits (called parity bits) are selected so that the total number in the code word is 1. Although some implementations specify odd numbers as 1. The minimum Hamming distance for this category is dmin = 2, which means that the code is a single-bit error detection code and cannot correct any errors.The encoder uses a generator that takes a copy of a 4-bit data word (a0, a1, a2 and a3) and generates a parity bit r0. The data word bits and the parity bit create the 5-bit code word. The parity bit that is added makes the number of 1s in the code word even.
This is normally done by adding the 4 bits of the data word (modulo-2).

r0=a3+a2+a1+a0 (modulo-2)

The result is the parity bit. In other words, If the number of 1s is even, the result is 0; if the number of 1s is odd, the result is 1. In both cases, the total number of 1s in the code word is even. The sender sends the code word which may be corrupted during transmission. The receiver receives a 5-bit word. The checker at the receiver does the same thing as the generator in the sender with one exception: The addition is done over all 5 bits.

s0=b3+b2+b1+b0+ q0 (modulo-2)

For example, the sender sends the data word 1011. The code word created from this data word is 10111, which is sent to the receiver. We examine five cases:
1. No error occurs; the received code word is 10111. The syndrome is 0. The data word 1011 is created.
2. One single-bit error changes a1. The received code word is 10011. The syndrome is 1. No data word is created.
3. One single-bit error changes r0. The received code word is 10110. The syndrome is 1. No data word is created. Note that although none of the data word bits are corrupted, no data word is created because the code is not sophisticated enough to show the position of the corrupted bit.
4. An error changes r0 and a second error changes a3. The received code word is 00110. The syndrome is O. The data word 0011 is created at the receiver. Note that here the data word is wrongly created due to the syndrome value. The simple parity-check decoder cannot detect an even number of errors. The errors cancel each other out and give the syndrome a value of O.

5. Three bits-a3, a2, and a1-are changed by errors. The received code word is 01011. The syndrome is 1. The data word is not created. This shows that the simple parity check, guaranteed to detect one single error, can also find any odd number of errors.

A better approach is the two-dimensional parity check. In this method, the data word is organized in a table (rows and columns). In the following figure, the data to be sent, five 7-bit bytes, are put in separate rows. For each row and each column, 1 parity-check bit is calculated. The whole table is then sent to the receiver, which finds the syndrome for each row and each column.

Cyclic Redundancy Check

Cyclic Redundancy Check (CRC) is a technique used to detect errors in digital data. CRC is a hash function used to detect accidental changes to raw computer data commonly used in storage devices such as digital telecommunications networks and hard drives. This technology was invented by W. Wesley Peterson in 1961 and further developed by CCITT. Cyclic Redundancy Check is very easy to implement in hardware and can be easily analyzed mathematically. It is one of the better techniques for detecting common transmission errors.

It is based on binary division, also known as polynomial code checksum.

In cyclic redundancy checking, a fixed number of check bits (usually called checksums) are appended to the message to be transmitted. The data receiver receives the data and checks for errors in the parity bit. Mathematically, the data receiver checks the additional check value by looking up the remainder of the polynomial division of the transmitted content. If it seems that an error has occurred, a negative confirmation is sent and the data is requested to be retransmitted.

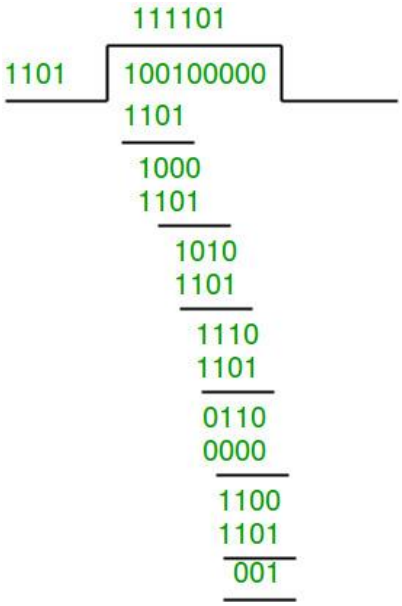
Cyclic redundancy check is also applied to storage devices such as hard disks. In this case, the parity bit is assigned to each block in the hard disk. When the computer reads a damaged or incomplete file, it will report a cyclic redundancy error. This may come from another storage device or CD/DVD. Common causes of errors include system crashes, incomplete or damaged files, or files containing many errors.

CRC polynomial design depends on the block length to be protected, error protection function, resources used for CRC implementation and performance For example

Data word to be sent - 100100

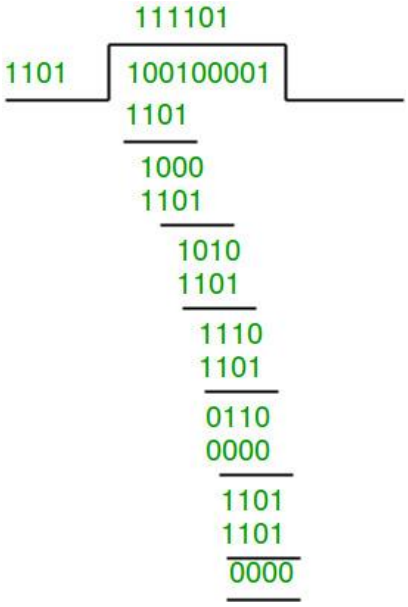
Key - 1101 [Or generator polynomial $x^3 + x^2 + 1$]

Sender Side:



Therefore, the remainder is 001 and hence the encoded data sent is 100100001.

Receiver Side:
Code word received at the receiver side 100100001



Therefore, the remainder is all zeros. Hence, the data received has no error.

Q3: What is encoding? Write down different types of encoding. Explain characteristics of AM, FM and PM with mathematical equations

Answer: Encoding is the process of converting data from one form to another. Although "encoding" can be used as a verb, it is often used as a noun, referring to a specific type of encoded data. There are several encoding types, including image encoding, audio and video encoding, and character encoding.

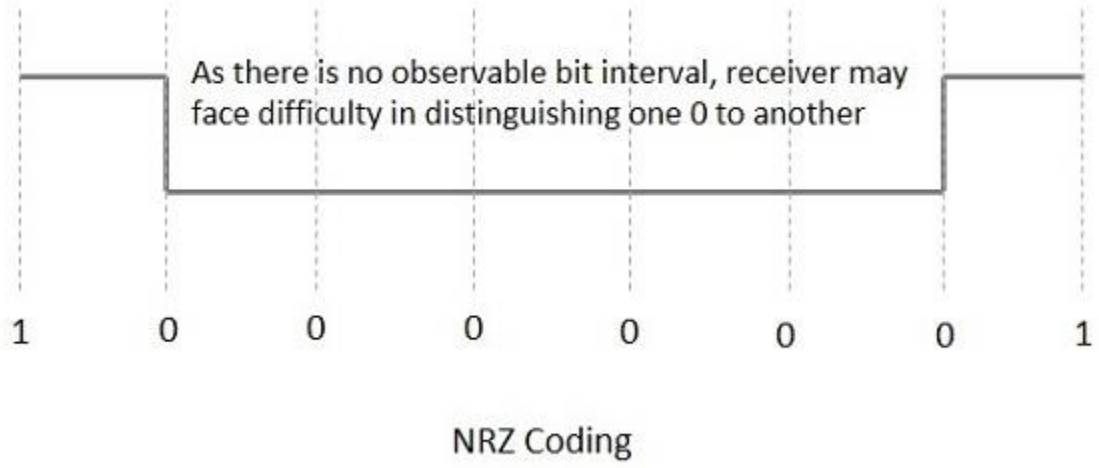
Media files are usually encoded to save disk space. By encoding digital audio, video and image files, they can be saved in a more efficient compression format.

The common types of line encoding are unipolar, polar, bipolar and Manchester.

1. Non-return to zero NRZNRZ

The high level of the NRZ code is 1, and the low level is 0. The main behavior of the NRZ code is to maintain a constant voltage level within the bit interval. If the value of the previous bit is the same as the value of the current bit, it will not indicate the end or start of the bit, and it will maintain the same voltage state.

The figure below illustrates the concept of NRZ coding.



NRZ Coding

f you consider the above example, since there is a long sequence of constant voltage levels, and due to lack of bit spacing, clock synchronization may be lost, so it is difficult for the receiver to distinguish between 0 and 1.

Bi-phase encoding From the beginning to the middle, the signal level must be checked twice for each bit time. Therefore, the clock rate is twice the data transmission rate, so the modulation rate

is also doubled. The clock comes from the signal itself. The bandwidth required for this encoding is greater.

There are two types of bi-phase encoding.

• Manchester duplex

• Manchester Difference

Biphasic Manchester

In this type of encoding, the conversion is done in the middle of the bit interval. For input bit 1, the resulting pulse transitions from high to low in the middle of the interval, while for input bit 0, it transitions from low to high.

Manchester Difference

In this type of encoding, a transition always occurs in the middle of the bit interval. If a transition occurs at the beginning of the bit interval, the input bit is 0. If no transition occurs at the beginning of the bit interval, the input bit is 1.

The following figure illustrates the waveforms of NRZ-L, NRZ-I, bi-phase Manchester and differential Manchester encoding for different digital inputs.

Block coding

Among the types of block coding, the famous 4B/5B coding and 8B/6T coding. In these two processes, the number of bits is handled in different ways.

4B/5B encoding

In Manchester encoding, to send data, a double-speed clock is required instead of NRZ encoding. As the name suggests, the code here is to map a 4-digit code to 5 digits, and there must be at least 1 digit in the group.

The clock synchronization problem in NRZ-I encoding can be avoided by allocating 5 equivalent words in each block of 4 consecutive bits. These 5 words are predetermined in the dictionary.

The basic idea of choosing a 5-digit code is that it should have a leading 0 and at most two trailing 0s. Therefore, these words are selected so that two transactions occur for each bit block

Carrier signal amplitude, frequency and phase have three attributes, therefore, there are three basic types of analog modulation.

1. Amplitude Modulation (AM)

2. Frequency modulation (FM)

3. Phase modulation (PM)

AM

Amplitude modulation or AM is the process of changing the instantaneous amplitude of the carrier signal according to the instantaneous amplitude of the message signal.

Therefore, if m(t) is a message signal, and c(t) = Acoswct, then the AM signal F(t) is written as

F(t)= Acoswct + m(t)coswct

F(t) = [A + m(t)] coswct.

AM advantage

AM is the simplest modulation type. The hardware design of the transmitter and receiver are very simple and cost-effective.

AM disadvantages:

AM is very susceptible to noise.

application:

1) AM broadcast widely broadcast is an example

FM

FM or frequency modulation is the process of changing the instantaneous frequency of the carrier signal correspondingly according to the instantaneous amplitude of the message signal. Therefore, if m(t) is a message signal and c(t) = Acoswct, then the FM signal will be

$F(t)= A\cos(wc\ t + kf\int m(\alpha)d\alpha)$

FM advantage

Modulation and demodulation will not capture any channel noise.

Advantages of FM Dis:

The circuit required for FM modulation and demodulation is more complicated than AM

application:

1) An example is the widespread broadcast of FM radio

Phase modulation (PM)

PM or phase modulation is the process of changing the instantaneous phase of the carrier signal correspondingly according to the instantaneous amplitude of the message signal. Therefore, if m(t) is a message signal and c(t) = Acoswct, then the PM signal will be

$F(t) = A\cos(wct + kpm(t))$

PM advantageModulation and demodulation do not catch any channel noise.

PM Dis-advantage:

Circuit needed for PM modulation and demodulation is bit complicated than AM and FM

Application:

1) Satellite communication.

Q4: Compare Ethernet and Token Ring concept of data networking with diagrams. Which one is better in your opinion and why?

1. Token ring: In the token ring, the token ring passes through the physical ring. The token ring is defined by the IEEE 802.5 standard. In the token ring, there is a workstation and a special frame called a token. If the station in the token ring contains tokens, data frames can be transmitted. After the data frame is successfully transmitted, it will point to (issue) the token. Token Ring is a star topology and handles priority, where some nodes may assign priority to tokens.**2. Ethernet:**

IEEE 802.3 defines Ethernet. It uses CSMA/CD mechanism. This means that if there are multiple radio stations in a simultaneous conversation, all radio stations will be turned off. To restore them, please wait for a while. Unlike Token Ring, it does not have any priority. And it is cheaper than token ring network.

The difference between Token Ring and Ethernet:-

1. In the token ring, the token passing mechanism is used. And Ethernet uses CSMA/CD (Carrier Sense Multiple Access/Collision Detection) mechanism.

2. The token ring is defined by the IEEE 802.5 standard. Ethernet is defined by the IEEE 802.3 standard.

3. Token Ring is deterministic. Although it is uncertain.

4. Token Ring is a star topology, while Ethernet is a bus topology.

5. Token Ring handles priority, where certain nodes can assign priority to tokens. The Ethernet does not use priority.

6. The cost of token ring is higher than that of Ethernet. The cost of Ethernet is 70% lower than that of Token Ring.

7. Use telephone lines in token ring. Use coaxial cables (wires) in Ethernet

8. Token Ring contains routing information. Although Ethernet does not contain routing information

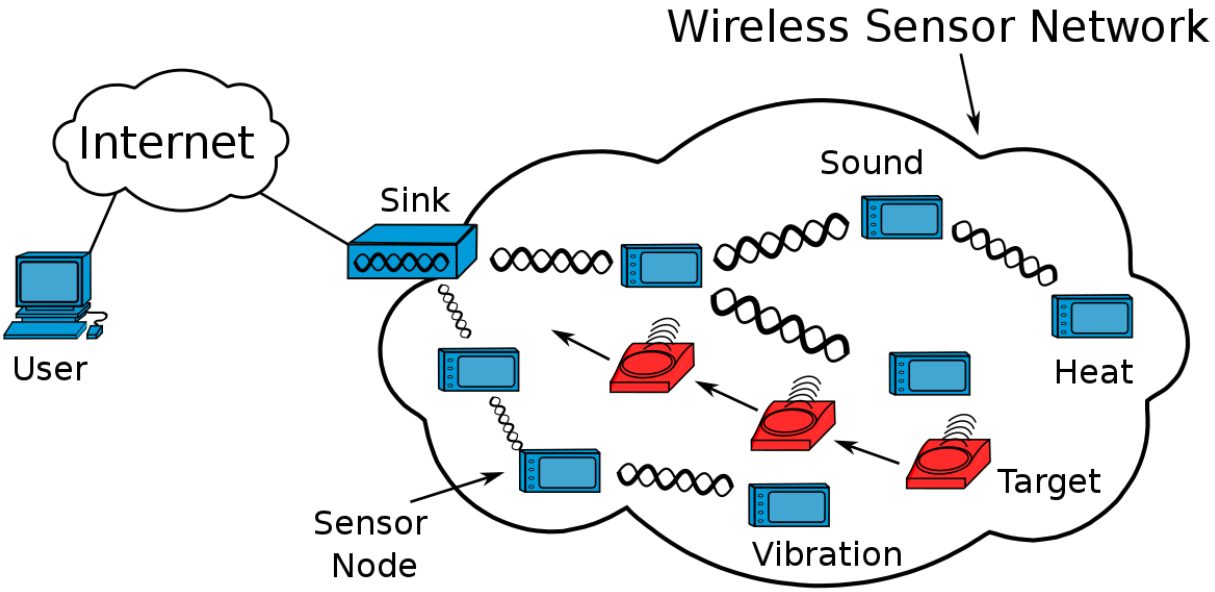
Which do you think is better and why?

In my opinion, Ethernet is better than token ring

Q4. Explain the concept and review of Reliable Transmission with diagram (from a research paper of 2019 or 2020) and its functionality. The name and reference of paper should be given.

As many as 50 billion devices will be connected to the Internet by 2020. It is predicted that the number of mobile-connected devices will exceed 11.5 billion by 2019 (nearly 1.5 mobile devices per capita), which poses a huge traffic demand for ubiquitous communications. Data rates are projected to increase by a factor of ten every five years, and with the emerging Internet of Things (IoT) predicted to wirelessly connect trillions of devices across the globe. It is anticipated that we will witness an up to 10,000- fold growth in wireless data traffic by the year 2030. Predictions evidently indicates that the growth in data traffic will cater unprecedented services and applications for machine type communication such as driverless vehicles and drone-based

deliveries, smart cities and factories, remote medical diagnosis and surgery, and artificial intelligence- based personalized assistants along with traditional human-centric communications



Coexistence of human-centric and machine-type services as well as hybrids of these will make next generation wireless networks more diverse and complex. Current wireless radio access techniques are not capable of delivering these new applications and services as they are very different from traditional human-centric communications in terms of reliability, latency, energy efficiency, security, flexibility, and connection density. Without novel approaches, future wireless mobile networks (5G and beyond) will grind to a halt unless more capacity is created, on the other hand, to cope with the challenges due to new service categories, a new look on the wireless networks is required to meet performance requirements such as massive connectivity, lower latency, higher reliability, better energy efficiency and security. To overcome the aforementioned challenges of emerging wireless communications and networks for 5G and Beyond, this special issue focuses on (but are not restricted to) the following topics: Ultra-reliable and low latency communication (URLLC); Massive machine-type communication (mMTC); New air interface design for 5G (New Radio (NR)); QoS/QoE mechanisms for wireless communications and networks; 5G wireless heterogeneous networks: design and optimization; Sensing technologies and applications for 5G; 5G wireless communications and networks for surveillance and management; 5G Cognitive networks and IoT; Experimental results, prototypes, and testbeds of 5G wireless communications and networks; Integration and

co-existence of 5G wireless communication and network technologies; Energy efficiency (harvesting and saving) wireless protocols and algorithms for 5G; Security and privacy concerns in 5G wireless communications; NOMA, full-duplex, massive MIMO; Green 5G multimedia wireless networks; AI techniques for Wireless Communication and security; MmWave Massive MIMO; and Hardware impairments affecting wireless communications.

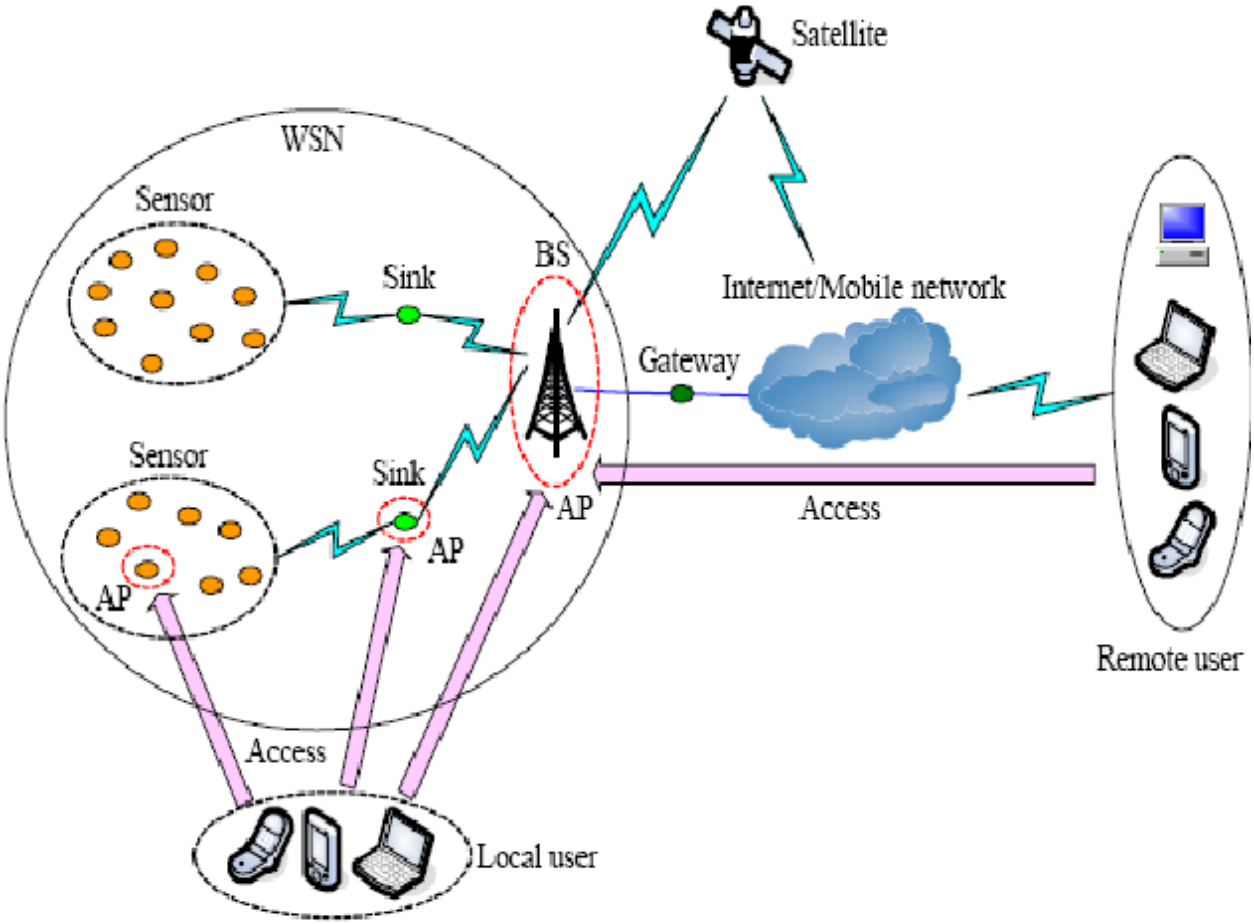


Fig 1: Access architecture of WSN

This special issue includes eight high-quality papers. In the first paper entitled “Joint User Association and Power Allocation for Millimeter-Wave Ultra-Dense Networks,” the authors consider millimeter-Wave (mmWave) communication in ultra-dense networks (UDNs), where many small-cell base stations (SBSs) are deployed. The key idea of the proposed scheme is to jointly optimize the SBS-UE association and power allocation to maximize the system energy efficiency while guaranteeing the quality of service (QoS) constraints for each user. Towards a practical application, successive convex approximation is developed to for its solution, where the

nonconvex parts are converted into the simple convex quadratic functions at each iteration. In the second paper, entitled “Coordinated Handover Signaling and Cross-Layer Adaptation in Heterogeneous

Reference: Editorial: Reliable Communication for Emerging Wireless Networks

By Trung Q. Duong1 & Chinmoy Kundu2 & Antonino Masaracchia1 & Van-Dinh Nguyen3 #