Department of Electrical Engineering
Assignment
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Course Details

Course Title: Mobile and broadband network **Module:** 3rd
Instructor: **Sir Pir Mehr Ali Shah** **Total Marks:** 30

Student Details

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Q1.	(a)	In how many types, an optical access network can be classified explain each of them.	Marks 6
	(b)	What are the advantages of satellite communication over terrestrial communication?	Marks 4
Q2.	(a)	What are the types of wife technologies, discuss each type .	Marks 4
	(b)	Explain in details about wireless body area network along with its types.	Marks 6
Q3.	(a)	Write a comparative detail about the evolution of mobile technology from 1^{st} generation to 5^{th} generation.	Marks 6
	(b)	What is DSL? Explain its architecture along with its types.	Marks 4

Ans 1 (A) :

Types of Optical Access network

Active Optical Network

Active optical network is also known as point-to-point Ethernet, P2P, active Ethernet or something similar. There is no well defined nomenclature, but here we consider two different variants; namely star network and homerun. Note these are also known under other names. The two different variants are very similar in the sense that in both cases the optical network units (ONU's - or gateways) are connected to a switch. The main difference is that in the homerun case the switch is situated at the central office (CO) whereas for the star case the switch is placed somewhere between the CO and the ONU — often but not always the switch is placed close to the ONUs. In this case the central office functionality can be distributed among the switches. Homerun architecture in a homerun (sometimes referred to as point-to-point P2P fiber network users are connected directly to the central office (CO) by a separate fiber as depicted in Fig. 4. It is a simple architecture but not very cost effective since a dedicated transceiver and a dedicated fiber for each end user is required in the CO). Also, compared to the star architecture and a PON it requires more space at the CO due to the large number of transceivers which also leads to higher power and cooling requirements. Note that also wavelength division multiplexing PONs (WDM PONs) lead to such concerns apart from the fact that the amount of fibers is smaller. Star architecture.

In AON star architecture an active electrical (Ethernet) switch is located at the remote node (RN) between users and CO, due to active equipment at the RN, in this architecture the distance between end users and CO can be extended compared to homerun (P2P). However, the total number of transceivers in star architecture is larger than in P2P since the optical signal needs to be terminated at RN. In this architecture fiber between the CO and RN is shared by all end users resulting in the better utilization of resources compared to P2P.

Passive Optical Network (PON)

In PON the active electrical switch in AON is replaced by a passive optical component, either passive splitter or a wave- length division multiplexer (see Fig.6). Depending on the way the resources are shared one can distinguish between time-division multiplexing (TDM) PON and wavelength division multiplexing (WDM) PON. Furthermore, hybrid WDM/TDM PON is an intermediate stage in PON deployment between the currently deployed TDM PON and the future WDM PON. A hybrid PON solution can also be seen as a way to support a large number of subscribers. Initial deployments of fiber access networks around the millennium shift were based on AON homerun and star architectures, but currently various PON deployments are dominating with gigabit-capable PON (GPON) having the largest momentum worldwide today. In North America GPON is the most deployed FTTH technology, in Asia (particularly Korea and Japan) Ethernet PON (EPON) is the dominating technology whereas AON has it strongest foothold in Europe. However, even GPON is widely deployed in Europe, and there are large AON deployments in Korea and more limited deployments in for instance the US and in the Middle East. Furthermore, large operators tend to prefer PON whereas smaller operators especially in Europe have a preference for AON.Current generation PON is based on time-division multiplexing (TDM PON), such as EPON and GPON. In TDM PONs a single wavelength channel is shared by multiple users and hence, a low per subscriber cost can be offered. Along with the higher bandwidth demand, increasing number of subscribers, and advances in the wavelength division multiplexing (WDM) device technology, the WDM PON has been considered as a next-generation broadband access network. However, in order to ensure the economical viability of the access network solutions, the effort should be put on the evolution from the existing TDM PONs. Therefore, the hybrid WDM/TDM PON is envisaged for the near-future deployment. On the other hand, the importance of reliable service delivery results in development of different PON protection architectures. The evolution of protection schemes for PONs can be divided into three phases. In the first one, the standard protection architectures were defined by ITU-T [2]in 1998. They are referred to as type A, B, C and D. In type A only the feeder fiber (FF) is redundant. Type B protection duplicates the shared part of the PON, i.e., FF and optical interfaces at the optical line terminal (OLT) located at the CO. In Type B the primary optical interface at OLT is normally working while the second one is used as a cold standby. Type C is a typical 1+1 dedicated path protection with full duplication of the PON resources. In

Type C both the primary and secondary interfaces are normally working (hot standby), which allows for very fast recovery time. Type D protection specifies the independent duplication of FF and distribution fibers (DFs) and thus, it enables network provider to offer either full or partial protection referred to as Type D1or D2. Obviously, the ITU-T standard schemes Type C and Type D2with full protection are characterized by a relatively high reliability performance but unfortunately they require duplication of all network resources (and in- vestment cost). Therefore, in the second phase of the PON protection scheme evolution the effort was put on development of cost-efficient architectures in order to decrease the deployment cost. Schemes proposed in are based on neighboring protection where two neighboring ONUs protect each other using the interconnection fibers (IFs). In this way, the investment cost for burying redundant DFs to each ONU can be avoided and, consequently, the CAPEX can be reduced. Furthermore, ring protection is proposed in and.

We believe that following the trend of minimizing the cost per subscriber the third (future) phase of the PON protection schemes evolution will migrate towards the reduction of OPEX. Meanwhile, OPEX is related to both protection architecture and maintenance strategy. In this paper we compare CAPEX and OPEX along with the reliability performance of some representative fiber access network architectures. The focus is on the various PON protection schemes but AON is included as well for the comparison

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Ans 1 (B) :

- The advantages of satellite communication over terrestrial communication are as follows:
- Satellite are mainly wide area broadcast media as transmitter antenna may be designed to provide signals to service areas as small as a city or as large as a country.
- Terrestrial communication is point-to-point whereas Satellites communication is point to multipoint approach.
- Relatively fast installation. Once satellite is in position, earth station can be installed and communication can be established in days or hours. But terrestrial circuits require time consuming installations.

- The satellite costs are independent of distance whereas the terrestrial network costs are proportional to distance.
- The satellite itself is a single repeater. For terrestrial links antennas are located at a specific height to overcome obstacles and also repeaters are to be used in between the links to compensate for path losses.
- Satellite systems can provide coverage to remote places where terrestrial system fails. For communication between remote areas (hilly terrains, island etc) and the main land satellite communication is the only cost effective option
- Mobile communication is easy to achieve using satellite communication because of its broader coverage area and its flexibility in connecting mobile vehicles.
- Satellites have average low operating cost. Manufacturing of satellite is expensive but after that it would operate typically for years.
- As compared to optical fiber cable where the signal quality changes with the distance travelled by signal through the cable, satellite communication has an advantage that signal quality is independent of distance as long as the two stations fall within the same geographic coverage areas.
- Wide area of application such as whether forecasting ,search ,navigation, military.

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Ans 2 (A) :

Types of WI-FI Technologies:

Currently they are four major types of WIFI technologies.

- Wi-Fi-802.11a.
- Wi-Fi-802.11b.
- Wi-Fi-802.11g.
- Wi-Fi-802.11n.

Wi-Fi-802.11a:

802.11a is the one of a series of wireless technology. That defines the format and structure of the radio signals sent out by WI-FI networking routers and antennas.

Wi-Fi-802.11b:

802.11b is the one of a series of wireless technology. 802. 11b support bandwidth 11mbps. Signal in unregulated frequency spectrum around 2.4 GHz. This is a low frequency compared with Wi-Fi-802.11a means it is working reasonable distance. It is interference with micro owns cordless phones and other appliance. It is low-cost; signal range is good using home appliance.

Wi-Fi-802.11g:

In 2002 and 2003, This Technology supporting a newer slandered products. It is best technology of 802.11a and 802.11b. The 802.11 b support bandwidth up to 54mbps and it use a 2.4 GHz frequency for greater range. This cost is more than 802.11b. It is fast accessing and maximum speed.

Wi-Fi-802.11n:

The 802.11n is the newest WIFI technology. It was designed to improve on 802.11g .The amount of bandwidth supported by utilizing multiple wireless signals and antennas instead of one. It supports 100 mbps bandwidth and increased signal intensity.

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Ans 2 B) :

Wireless Body Area Networks (WBAN)

In today's world, wireless communication has a major application in sharing of information anywhere and at any time. We can use wireless networks in the form of WLAN or Wi-Fi in various fields such as education, healthcare and industrial sector. As the technology is growing, the demands of users as well as the demand of ubiquitous networking is increasing. WBAN

(Wireless Body Area Network) allows the user to move another without having the restriction of a cable for sharing information.

The term 'Wireless Body Area Network' was coined in 2001 by Van Dam. It basically is a network containing sensor nodes which are attached to the human body, used to measure the bio signals (heart rate, blood pressure, brain signals etc.) of humans. It has majority of applications in medical sector.

The communication in body sensor networks is of 2 types:

- In-body communication
- On-body communication

In-body communication is the communication between sensor nodes which are implanted inside human body. The MICS (Medical Implant Communication System) communication can be used only for in-body communication. On-body communication occurs between wearable devices which consist of sensor nodes. The ISM (Industrial Scientific and Medical) band and UWB (Ultra-wide band) communication can be used only for on-body communication.

WBAN requirements:

Low power consumption

Interoperability

Self-healing

Security

Low latency

WBAN architecture:

The network architecture is divided into 4 sections-

WBAN Part:

It contains several number of cheap and low-power sensor nodes, which can be used for continuous monitoring of heart rate, ECG, blood pressure etc. of a person. Being wireless in nature, this does not restrict the mobility of the person for continuous evaluation. Hence, WBAN is used in healthcare systems for patients monitoring.

CCU (Central Control Unit)

All sensor nodes provide their outputs to a central coordination node present in the CCU. CCU receives the signals from nodes and transmits it to the next section for monitoring the human body.

WBAN communication:

Receives information from CCU and acts as gateway to transfer information to the destination. For ex. mobile node is a gateway to remote station to send message to cellular network using GSM/3G/4G.

Control center:

It is responsible for storing the information of user which can be used in the future or for monitoring purpose. It consists of end node devices like mobile phones (for messaging), computer systems (for monitoring) and server (for storing information in database).

WBAN applications:

These are various application:

- **Medical Applications:**

Remote healthcare monitoring – Sensors are put on patient's body to monitor heart rate, blood pressure and ECG.

Telemedicine – Provides healthcare services over a long distance with the help of IT and communication.

- **Non-medical Applications**:

Sports – Sensors can be used to measure navigation, timer, distance, pulse rate and body temperature.

Military – Can be used for communication between soldiers and sending information about attacking, retreating or running to their base commander.

Lifestyle and entertainment – Wireless music player and making video calls.

WBAN is legal, affordable and user friendly. It is an emerging technology and is expected to have a big impact on the society.

Traffic Types

In a WBAN traffic can be divided into three categories such as :

- Normal traffic
- Emergency traffic
- On-demand traffic

Normal traffic is the data traffic which is used to monitor the normal condition of a person without any criticality and on demand events. Emergency traffic is initiated by nodes when they exceed a predefined threshold or in any emergency situation. Such type of traffic is totally unpredictable.

On-demand traffic is initiated by the authorized personnel like doctor or consultant to acquire certain information for diagnostic purpose.

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Ans 3 (A) :

1G technology:

1G technology is a very basic voice analog phone system using circuited switched technology for the transmission of radio signals. All voice calls get Frequency modulated to higher frequency of 150MHz transmitted with frequency division multiple access (FDMA) technology in the frequency band of 824-894 MHz with channel capacity of 30 KHz , which was based on a technology called advance mobile phone service (AMPS) or total access communication system (TACS). similar technologies which can support 1G are Nordic mobile telephone (NMT) standard, Radiocom 2000 (RC 2000) standard, C-450 standard, etc .It provides data rate up to 24Kbps and support mostly voice calls only.

1G technology doesn't attracted people because of the following disapproving subjects such as less capacity, handoff problems, lack of security, very poor voice connection because of only one carrier per channel, less battery life and Large size. Thus, we moved on to the next step towards 2G technology.

2G technology:

Mobile wireless system was dubbed after the invention and execution of 2G which permits data and voice services together such as short message services (SMS), multimedia message services (MMS) and e-mail with high capacity and coverage. It follows completely digital multiple accessing techniques called time division multiple access (TDMA) and code division multiple access (CDMA) standards. All the discussions were numerically encoded and thus it provides greater security. It avails the frequency band of 850- 8900MHz and uses the technologies like global system for mobile (GSM), PDC, iDEN, IS-136 or north American digital cellular system (NADC) with TDMS process and IS95 with CDMA process. GSM technology uses 8 channels in a single carrier with a net rate of 13Kbps .The core shortcoming of 2G technology is it is difficult to support complex data's such as videos. Thus, we need an improvement towards its successors.

2.5G technology:

2.5G is a cellular wireless technology established in between its precursors 2G and its inheritors 3G and it describe the 2G system with both circuit and packet switched services. The General Packet Radio Services are designated by the term "second and half generation" and it offers 56Kbit/s to 115Kbits/s data rate. It can be used for facilities such as wireless application protocol (WAP), access multimedia messaging services (AMMS), and for communication network services such as Email and World Wide Web access. It also supports SMS, MMS and WAP, Mobile games etc.

2.75G technology:

2.5G networks advanced to enhanced data rates for GSM evolution (EDGE) links with the starter of 8PSK encoding, but the symbol rate remained the same at 270.833 samples per second. Instead of three bits each symbol carried in one bit. enhanced data rates for GSM evolution (EDGE), enhanced GPRS (EGPRS), or IMT single carrier (IMT-SC) is a regressive compatible digital mobile phone technology that allows improved data transmission rates, as an extension on top of standard GSM.

3G technology:

3G technology usually referred as universal mobile telecommunications standard (UMTS) is found to be 3 times better than GSM, so called 3GSM with maximum date rate of 8Mbps. It assigns low data rate channel for voice calls and large data rate channel for video calls. To frame the International standard for 3G cellular networks, international telecommunication union (ITU) signed the international mobile telecommunications 2000 (IMT 200) in the year 1999. Thereby the 3G was supported by 2 main technologies UMTS and CDMA2000 with the support of 3GPP and 3GPP2 respectively . UMTS uses the air interface as wideband CDMA (WCDMA) often called as universal terrestrial radio access (UTRA). It is configured to support up to 2Mbps data rate with frequency division duplexing (FDD) and time division duplexing (TDD), whereas CDMA 2000 uses multiple narrowband CDMA carriers. It requires higher bandwidth that becomes the drawback of the technology.

3.5G technology:

3.5G also termed as high-speed data packet access (HSDPA) is 6 times faster than UMTS technology thereby supporting data date up to 14.4 Mbps.

3.75G technology

A high-Speed uplink packet access technology (HSUPA) is the version of UMTS/WCDMA uplink evolution technology drives the 3.75 Generation technology beyond the applications of 3G. It is established to boost the uplink data rate to 1.4 Mbps and later up to 5.8 Mbps .The two techniques HSDPA and HSUPA are complementary to each other and are directly related, whereas HSUPA has many applications with advanced data rate such as mobile e-mail, real time gaming, Various business applications etc.

3.9G technology:

Long term evolution (LTE) is thought as a lead towards the 4G technology and hence named as 3.9G technology. It uses evolved UTRA (E-UTRA) as the air interface and is supported by single carrier – frequency division multiple access (SC-FDMA) to achieve 50 Mbps data rate at the uplink. In downlink 100 Mbps data rate is achieved through Orthogonal frequency division multiple access (OFDMA)

4G technology:

4G technology is established to incorporate the major requirements such as quality of service (QoS) and data rate. This is done by small applications such as MMS, Video chat, HDTV, digital video broadcasting (DVB) and wireless mobile broadband access (WMBA) etc.It is attracted by the property of inter-operability between various networks. For a stationary user – server it provides 1Gbps data rate and for a moving user it offers 1- 100 Mbps data rate. OFDMA technique a new method which is the combination of CDMA and IS-95 is implemented in 4G by dividing the channel in narrowband to transmit data packets with greater efficiency. IEEE 802.16m and IEEE 802.16e developed the WMBA techniques to provide downlink data rate of 128 Mbps and uplink data rate of 58Mbps

There are some major issues in 4G, one is Position management and the other is handoff management .LTE and Wi Max are the driving forces of 4G technology, these two are suffering by security issues to destroy data availability, integrity, confidentiality and authentication. Wi Max is suffered by denial of service (DOS) attacks, replay attacks, Eavesdropping, Key Management and reducing Quality of service. Whereas in LTE DOS attack, Data modification and scrambling attack are the major issues

5G technology:

The number of users is increasing very rapidly and there is a necessity for simultaneous connection to be employed for the final users and the deployed sensors. And to increase coverage, spectral efficiency, data rate, security and signaling efficiency and to reduce latency we must find a new technology beyond 4G and is called as 5G technology descendant of 4G called LTE Advance (LTE-A) which supports FDD mode and TDD mode. Thus, 5G offers 1Gbps data rate and allow us to experience a real wireless world – wireless world wide web (WWWW). It follows all IP model to provide interoperability between all networks and uses packet switching rather than circuit switching . As the technology grows the requirement of spectrum increases significantly. 2G requires 8 times additional spectrum than 1G, similarly 3G requires 25 times that of 2G and 4G needs 4 times more spectrum than 3G. 5G should support ultra-high-speed data(1Gbps) and ultra-low latency (<1ms) it requires a wide bandwidth which is not very easy to provide. Thus, 5G is revolutionized with Cloud RAN/ Edge Computing and Network Slicing. Frequency permitting and spectrum organization problems might have solved

by the software defined radio link (SDR), thereby it can allow more than hundred channels simultaneously without streaming 5G can be viewed as a multi core reconfigurable technology inbuild with nanotechnology, cognitive radio networks (CRN), Cloud Computing to connect all networks such as GSM, CDMA, Wi -Max and Wire line into a single core and all the knowledges such as big data, smart grids (SG), mobile cloud computing (MCC), internet of things (IoT), internet of vehicles (IoV), augmented reality (AR), virtual reality (VR), and D2D Communication into a common network and these smart applications of 5G are listed in following figure. The major prerequisites of 5G technology, such as larger bandwidth, data rate, low latency is achieved by shifting the operating frequency towards the mm-wave frequencies. Due to the increased demand of spectrum, frequency band below 6GHz is been over crowded and 5G is research is concentrated in 10-15 GHz, local multipoint services at 28- 30GHz, 38-40 GHz, Unlicensed band 57-66 GHz, 71-76 GHz, 81-86 GHz, and 92-95 GHz . Also, the performance can be improved by mm wave beam forming, Multiple antenna technologies, device to device (D2D) communication, Simultaneous transmission and reception, network cooperation and interference management. 5G systems are more secure than the 4G. And it is done by the important techniques such as New Trust models, Modified Drivers, Regularized privacy policies, Flexible architecture and cloud computing security. Still there are many matters to be addressed in 5G system deployment such as, Scheduling, QoS Guarantee, Reliability, Security etc.

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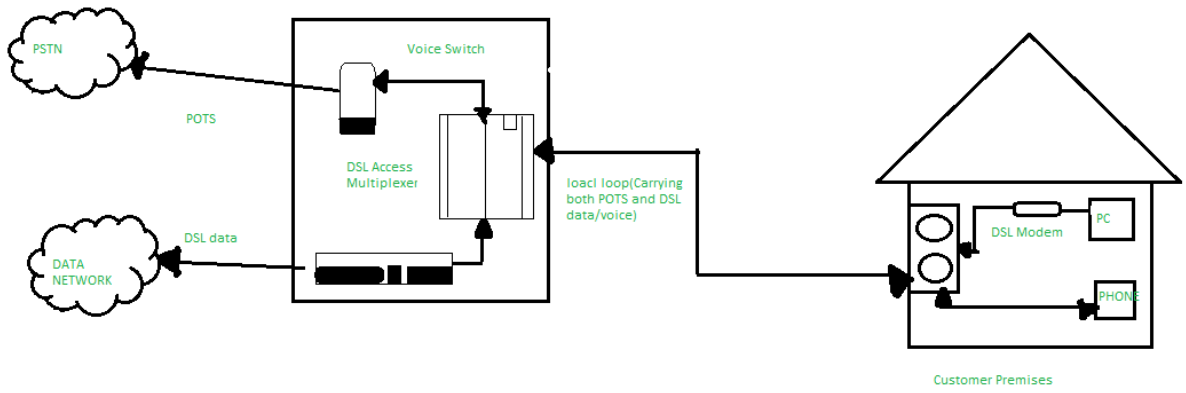
Ans 3 (B) :

Digital Subscriber Line (DSL)

Digital Subscriber Line (DSL, *originally*, **digital subscriber loop**) is a communication medium, which is used to transfer internet through copper wire telecommunication line.Along with cable internet, DSL is one of the most popular ways *ISPs* provide broadband internet access.

- Its aim is to maintain the high speed of the internet being transfered.

- If we ask that how we gonna achieve such thing i.e., both telephone and internet facility, then the answer is by using *splitters or DSL filters*(shown in below diagram).Basically, the use *splitter* is to splits the frequency and make sure that they can't get interrupted.



Benefits

- No Additional Wiring A DSL connection makes use of your existing telephone wiring, so you will not have to pay for expensive upgrades to your phone system.

- Cost Effective DSL internet is a very cost-effective method and is best in connectivity
- Availability of DSL modems by the service providers.
- User can use the both telephone line and internet at a same time.And it is because the voice is transferred on other frequency and digital signals are transferred on others.

- User can choose between different connection speeds and pricing from various providers.

DSL Internet service only works over a limited physical distance and remains unavailable in many areas where the local telephone infrastructure does not support DSL technology. The service is not available everywhere. The connection is faster for receiving data than it is for sending data over the Internet.

Types of DSL :

Asymmetric DSL

Asymmetric types of DSL connections are faster and provide more network bandwidth for downloading from the internet service provider to the subscriber's computer than for uploading in the other direction. By reducing the amount of bandwidth available upstream, service providers can offer more bandwidth downstream, which reflects the typical subscriber's needs.

Forms of asymmetric DSL include:

- ADSL (asymmetrical digital subscriber line) has a downstream rate of up to 8 Mbps and an upstream rate of 384 Kbps. It supports telephone service and data transmission at the same time.
- **ADSL 2+** delivers download speeds of up to 20 Mbps and upload speeds of up to 850 Kbps.
- **ADSL Lite** or **G.Lite** offers slower speeds of up to 1 Mbps downstream and 512 Kbps upstream.
- **R-ADSL** (rate-adaptive digital subscriber line) delivers the same transmission rates as ADSL, but the transmission speed can be adjusted by the modem.
- **VDSL** (very high bit-rate digital subscriber line) is the fastest DSL service. It offers downstream rates of up to 52 Mbps and upstream rates of up to 2.3 Mbps over a single copper wire.

Symmetric DSL

- Symmetric DSL connections provide equal bandwidth for both uploads and downloads. Business-class DSL services tend to be symmetric because companies have greater needs for transferring data than residences do.

Forms of symmetric DSL include:

- SDSL (symmetric digital subscriber line) offers equal upstream and downstream transmission speeds of up to 1.54 Mbps.

- SHDSL (symmetrical high-speed digital subscriber line) is the same technology as SDSL, but the two standards were approved separately. SHDSL was approved by the International Telecommunications Union, and SDSL was approved by the European Telecommunications Standards Institute.
- HSDL (high bit-rate digital subscriber line) was developed in the early 1990s, making it one of the oldest forms of symmetric DSL. HDSL offered data rates up to 2.048 Mbps but required multiple phone lines, which eventually made it obsolete.

Other Types of DSL

IDSL (ISDN digital subscriber line) is a hybrid DSL/ISDN technology. It was developed with other types of DSL but is rarely used due to its low speeds (144 Kbps maximum data rate). IDSL offers an always-on connection, unlike ISDN

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