Introduction of Wireless Communication

Unit: 1

Wireless Communication
KEC 076

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ECE

Course Details
(B. Tech 7th Sem)

WIRELESS COMMUNICATION

Course Contents / Syllabus

UNIT-I	**Introduction of Wireless Communication**	8 Hours
History and evolution of mobile radio systems, General Model of Wireless Communication Link, Types of mobile wireless services/systems- Cellular, WLL, Paging, Satellite Systems, Future trends in personal wireless systems.		
UNIT-II	**Cellular Concepts and System Design Fundamentals**	8 Hours
Cellular Infrastructure, Cellular System Components, Antennas for Cellular Systems, Operation of Cellular Systems, frequency reuse, channel assignment, handoff strategies, Interference and system capacity.		
UNIT-III	**Mobile Radio Propagation Models**	8 Hours
Radio wave propagation issues in personal wireless systems, Propagation models, Channel Noise and Losses, Fading in Land Mobile Systems, Multipath Fading, Fading Effects on Signal and Frequency, Shadowing; Wireless Channel Modeling: AWGN Channel, Rayleigh Channel,		
UNIT- IV	**Equalization, Diversity Techniques & Multiple Access Techniques**	8 Hours
Equalization, Rake receiver concepts, Diversity Techniques, Linear predictive coders and channel coding. Multiplexing and Multiple Access: FDMA, TDMA, CDMA, OFDMA, Multiple Access for Radio Packet Systems: Pure ALOHA, Slotted ALOHA, CSMA and their versions; Packet and Pooling Reservation Based Multiple Access Schemes.		
UNIT-V	**Wireless Systems & Standards**	8 Hours
GSM system for mobile Telecommunication, General Packet Radio Service, Edge Technology; CDMA 2000, IMT 2000 and UMTS, Long Term Evolution (LTE), Introduction to Mobile Adhoc Networks, Li-Fi Communication, Ultra-Wideband Communication, Mobile data networks, Introduction to 4G, 5G and concept of NGN.		

WIRELESS COMMUNICATION

Course Outcomes: After completion of this course students will be able to		
CO 1	Explain with various generations of mobile communications.	K1, K2
CO 2	Explain concept of cellular communication.	K2
CO 3	Describe the basics of wireless communication.	K2
CO 4	Explain and differentiate contention free and contention based multiple access techniques.	K2,K4
CO 5	Explain Various modern wireless technologies.	K2

WIRELESS COMMUNICATION

Text Books:	
1. T.S. Rappaport, "Wireless Communication-Principles and practice", Pearson Publications, Second Edition.	
2. Upena Dalal, "Wireless Communication and Networks", Oxford Press Publications.	
3. T L Singal ,"Wireless Communications ", McGraw Hill Publications.	
Reference Books:	
1. Andrea Goldsmith, "Wireless Communications", Cambridge University Press.	
2. S. Haykin & M. Moher, "Modern wireless communication", Pearson, 2005.	
NPTEL/ YouTube/ Faculty Video Link:	
Unit 1	https://youtu.be/JCGMP37-2EA
Unit 2	https://youtu.be/f2wlHL1Sok8 https://youtu.be/0PWILK-hqbQ
Unit 3	https://youtu.be/SFcRtZ30rqs https://youtu.be/BKf2mN9W6Nk https://youtu.be/tePZhxRLsjE
Unit 4	https://youtu.be/GLmF3YB0pQU https://youtu.be/QHqZwBoTJRY
Unit 5	https://youtu.be/t3FVP5wuG4g https://youtu.be/ixY0Cau4mBM

Content

- History and evolution of mobile radio systems
- General Model of Wireless Communication Link
- Types of mobile wireless services/systems-Cellular
- WLL
- Paging
- Satellite Systems
- Future trends in personal wireless systems.
- Faculty Video Links, YouTube and NPTEL Video Links, and Online course details
- Daily Quiz
- Weekly Assignment
- MCQs
- Expected Questions for University Exam

Course Objective

1. To make students familiar with fundamentals of mobile communication systems.
2. To choose system (TDMA/FDMA/CDMA) according to the complexity, installation cost, speed of transmission, channel properties etc.
3. To identify the requirements of mobile communication as compared to static communication.
4. To identify the limitations of 2G and 2.5G wireless mobile communication and use design of 3G and beyond mobile communication systems.
5. To identify various modern wireless technologies.

Unit Objective

In this unit students will be able :

- To familiar with fundamentals of mobile communication systems.
- To study various fading models.
- To study Cellular system and its architecture.

Course Outcome

- After completion of the course student will be able to

CO1. Explain various generations of mobile communications.

CO2. Explain the concept of cellular communication.

CO3. Describe the basics of wireless communication.

CO4. Explain and differentiate contention-free and contention-based multiple access techniques.

CO5. Explain Various modern wireless technologies.

CO-PO and PSO Mapping

- Mapping of Course Outcomes and Program Outcomes:

S.No	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	KEC-076.1	2	2	1	1	2	2	2	2	2	2	1	3
2	**KEC-076.2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**1**	**2**
3	**KEC-076.3**	**3**	**1**	**2**	**1**	**2**	**2**	**1**	**1**	**2**	**3**	**2**	**2**
4	KEC-076.4	3	1	1	1	3	3	2	1	1	3	1	2
5	KEC-076.5	2	1	2	2	3	3	2	1	2	3	2	2
6	KEC-076.6	3	2	2	2	2	3	2	1	2	3	1	2

CO-PO and PSO Mapping

- Mapping of Program Specific Outcomes and Course Outcomes:

S.No	Course Outcome	PSO1	PSO2	PSO3
1	KEC-076.1	3	2	1
2	**KEC-076.2**	**3**	**3**	**1**
3	**KEC-076.3**	**3**	**3**	**1**
4	KEC-076.4	2	2	1
5	KEC-076.5	3	3	1
6	KEC-076.6	3	3	1
	Average	2.83	2.66	1

Prerequisite and Recap

- Basics of communication
- Model of communication.

Topic Objective

Name of Topic	Objective of Topic	Mapping with CO
Introduction	Students will learn about basics of communication system	CO2

Evolution of mobile radio communication

- The term ‘mobile’ has completely revolutionized communication by opening up innovative applications that are limited to one's imagination.
- Today, mobile communication has become the backbone of the society. All the mobile system technologies have improved the way of living.
- Its main plus point is that it has privileged a common mass of society.

Evolution of mobile radio communication

The history and evolution of mobile radio systems is a fascinating journey that spans over a century. These systems have played a pivotal role in shaping modern communication and have gone through several generations of development. Here's a brief overview of their history and evolution:

1.Early Radios (Late 19th Century - Early 20th Century): The concept of wireless communication dates back to the late 19th century, with inventors like Guglielmo Marconi and Nikola Tesla making significant contributions. Marconi's experiments with wireless telegraphy laid the foundation for long-distance radio communication.

2.**AM Radio and Commercial Broadcasting (1920s):** The 1920s saw the emergence of amplitude modulation (AM) radio broadcasting. This technology allowed for the transmission of voice and music over long distances. It was primarily used for broadcasting and not mobile communication.

Evolution of mobile radio communication

3. world War II and Two-Way Radios (1930s - 1940s): During World War II, two-way radio communication became crucial for military operations. This period saw advancements in portable radios and the development of walkie-talkies.

4.**Analog Mobile Radios (1940s - 1950s):** After World War II, mobile radio systems started to gain popularity in the civilian sector. These systems used analog technology and were primarily used by businesses, taxis, and emergency services.

5. **Cellular Concept (1947):** The concept of cellular communication was proposed by Bell Labs engineer Douglas H. Ring in 1947. It laid the groundwork for the development of modern cellular networks.

6.**First-Generation Mobile Systems (1G) - 1980s:** The 1980s saw the introduction of the first-generation mobile systems, such as Advanced Mobile Phone System (AMPS) in the United States. These systems were analog and allowed for voice calls.

Evolution of mobile radio communication

7. Second-Generation Mobile Systems (2G) - 1990s: The 1990s marked the transition to digital technology with the introduction of 2G systems like GSM (Global System for Mobile Communications) and CDMA (Code Division Multiple Access). These systems offered improved voice quality, encryption, and the ability to send text messages (SMS).

8. **Third-Generation Mobile Systems (3G) - Early 2000s:** 3G systems, like UMTS (Universal Mobile Telecommunications System) and CDMA2000, brought faster data speeds, enabling mobile internet access and video calls.

9.**Fourth-Generation Mobile Systems (4G) - Late 2000s:** 4G LTE (Long-Term Evolution) technology revolutionized mobile communication with even faster data speeds, low latency, and support for high-quality multimedia streaming.

Evolution of mobile radio communication

10. Fifth-Generation Mobile Systems (5G) - Late 2010s: 5G represents the latest evolution of mobile radio systems. It promises significantly higher data speeds, reduced latency, and support for a massive number of connected devices. It's expected to enable technologies like the Internet of Things (IoT) and autonomous vehicles.

11. Beyond 5G and Future Developments: Research and development in mobile communication continue, with a focus on improving spectral efficiency, energy efficiency, and enabling new applications like augmented reality (AR) and virtual reality (VR).

The history of mobile radio systems is a testament to human ingenuity and our ever-growing need for faster, more reliable, and versatile communication methods. Each generation of mobile technology has built upon the successes and limitations of its predecessors, driving innovation and connectivity to new heights.

Evolution of mobile radio communication

Mobile Wireless Networks - Evolution

Radio transmission techniques

- Simplex System: Simplex systems utilize simplex channels i.e.; the communication is unidirectional.

- Half Duplex System: Half duplex radio systems that use half duplex radio channels allow for non-simultaneous bidirectional communication.

- Full Duplex System: Full duplex systems allow two way simultaneous communications.

General Model of Wireless Communication Link

A general model of a wireless communication link involves several key components and parameters that describe how information is transmitted wirelessly from a transmitter to a receiver. Here is an overview of the general model of a wireless communication link:

1.Transmitter (Tx): The transmitter is the device responsible for encoding, modulating, and transmitting the information (data) to be sent over the wireless channel. It typically includes a data source, a source encoder, a channel encoder, a modulator, and a power amplifier.

1. **Data Source:** This is the original data to be transmitted, which can be voice, video, text, or any other form of information.
2. **Source Encoder:** Data compression and coding are performed to reduce redundancy and improve transmission efficiency.
3. **Channel Encoder:** Channel coding adds redundancy to the data to make it more robust against errors during transmission.

General Model of Wireless Communication Link

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4. Modulator: The modulator converts the digital signal from the source and channel encoders into a suitable analog waveform for transmission. Common modulation schemes include amplitude modulation (AM), frequency modulation (FM), and various forms of digital modulation (e.g., QPSK, QAM).

5. Power Amplifier: This component boosts the signal's power before transmission to ensure it can cover the desired communication range.

2. Channel: The wireless channel is the medium through which the signal travels from the transmitter to the receiver. The channel can be subject to various impairments, including noise, interference, fading, and multipath propagation.

1. **Noise:** Noise is any unwanted signal that corrupts the transmitted data. It can result from thermal effects in electronic components or interference from other wireless sources.
2. **Interference:** Interference occurs when signals from other sources in the environment interfere with the intended communication.

General Model of Wireless Communication Link

3. Fading: Fading is the variation in signal strength and phase caused by multipath propagation, which occurs when signals take multiple paths to reach the receiver due to reflections and scattering.

3. Receiver (Rx): The receiver is responsible for demodulating the received signal, decoding it, and reconstructing the original data.

1. **Demodulator:** The demodulator extracts the transmitted information from the received signal, reversing the modulation process.
2. **Channel Decoder:** Channel decoding is the process of correcting errors introduced during transmission using channel coding techniques.
3. **Source Decoder:** If source coding is applied at the transmitter, the source decoder reverses the source encoding process.

General Model of Wireless Communication Link

4. Channel State Information (CSI): In some wireless systems, the receiver may feed back information about the channel's state to the transmitter. This feedback helps the transmitter adapt its transmission parameters, such as power and modulation, to optimize communication performance.

5. **Propagation Model:** The propagation model describes how the wireless signal propagates through the environment, accounting for factors like path loss, shadowing, and multipath fading. Different propagation models are used for different wireless environments, such as free space, urban, or indoor scenarios.

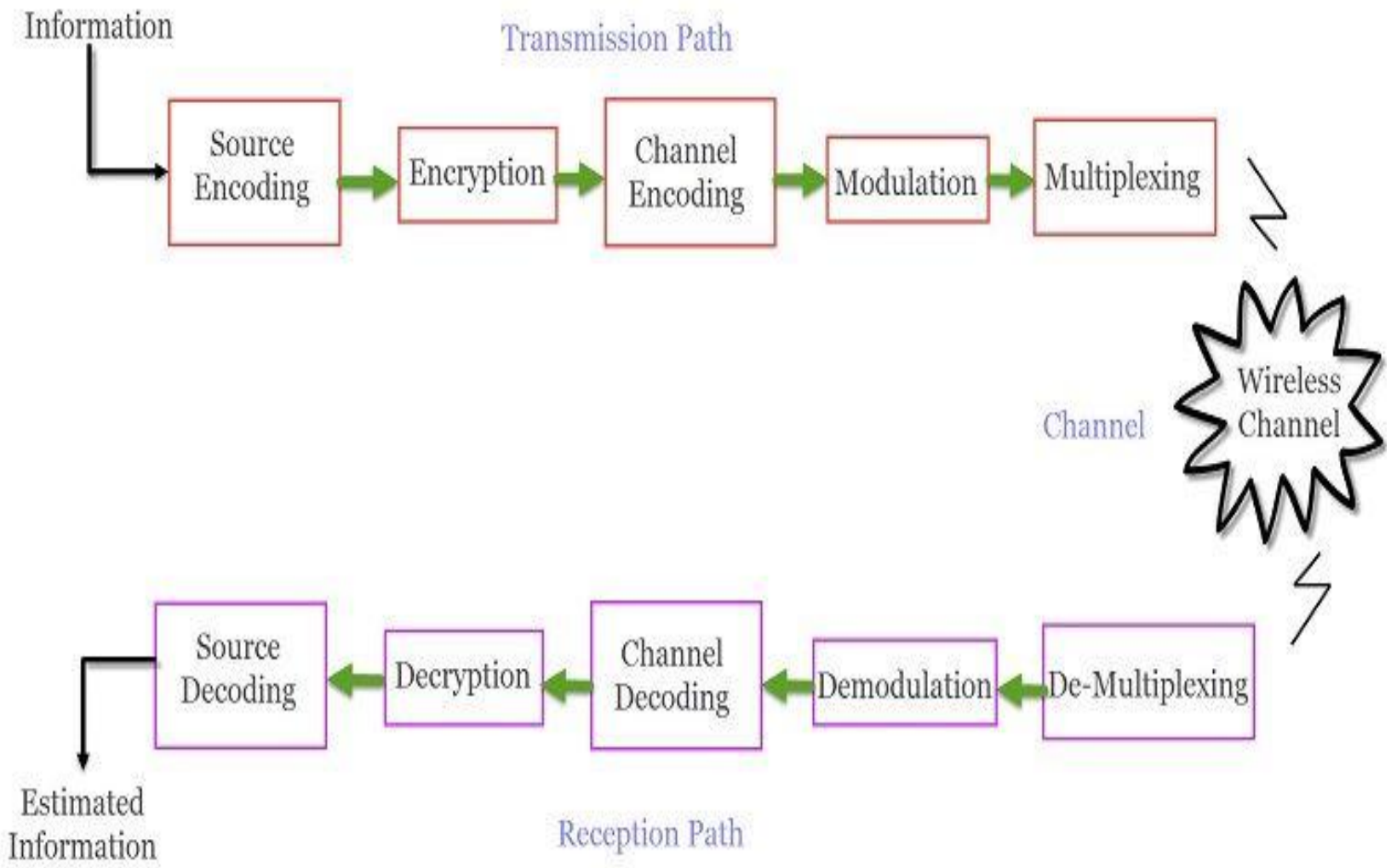
General Model of Wireless Communication Link

6. Antennas: Antennas at both the transmitter and receiver play a crucial role in signal transmission and reception. Antenna design can impact the coverage, gain, and directionality of the wireless link.

7. Signal Quality Metrics: Various metrics, such as signal-to-noise ratio (SNR), bit error rate (BER), and packet error rate (PER), are used to assess the quality and reliability of the wireless link.

8. Wireless Standards and Protocols: Wireless communication systems often adhere to specific standards and protocols, like Wi-Fi, Bluetooth, 4G LTE, or 5G NR, which define the rules for communication, including modulation schemes, frequency bands, and protocol stacks.

General Model of Wireless Communication Link



Types of mobile wireless services/systems-Cellular

- **There are several types of wireless technologies used in mobile devices[12]**:

- Cellular communication
- 4G networking
- Wi-Fi
- Bluetooth connections
- Cordless telephones

Current wireless phones include 3 and 4G networks, Bluetooth, and Wi-Fi technologies[2].

Types of mobile wireless services/systems-Cellular

- **Goals of a Cellular System :**
  - High capacity
  - Large coverage area
  - Efficient use of limited spectrum
- Reuse of radio channel
- Enable a fix number of channels to serve an arbitrarily large number of users by reusing the channel throughout the coverage region

- **What is cell ?**
- **Each cellular base station is allocated a group of radio channels** within a small geographic area called a *cell*.

Types of mobile wireless services/systems-Cellular

Cellular mobile wireless services/systems refer to the various generations and technologies used in mobile telecommunications. These systems have evolved over time, providing increased speed, capacity, and functionality. As of my last knowledge update in September 2021, here are the major types of cellular mobile wireless services/systems:

1. **1G (First Generation):** The first-generation cellular systems were introduced in the 1980s and were analog-based. They provided basic voice services and had limited capacity. AMPS (Advanced Mobile Phone System) is a 1G system example.

2. **2G (Second Generation):** 2G systems marked the shift from analog to digital communication. They introduced digital voice compression, which improved call quality and allowed for text messaging (SMS) services. GSM (Global System for Mobile Communications) and CDMA (Code Division Multiple Access) are examples of 2G technologies.

Types of mobile wireless services/systems-Cellular

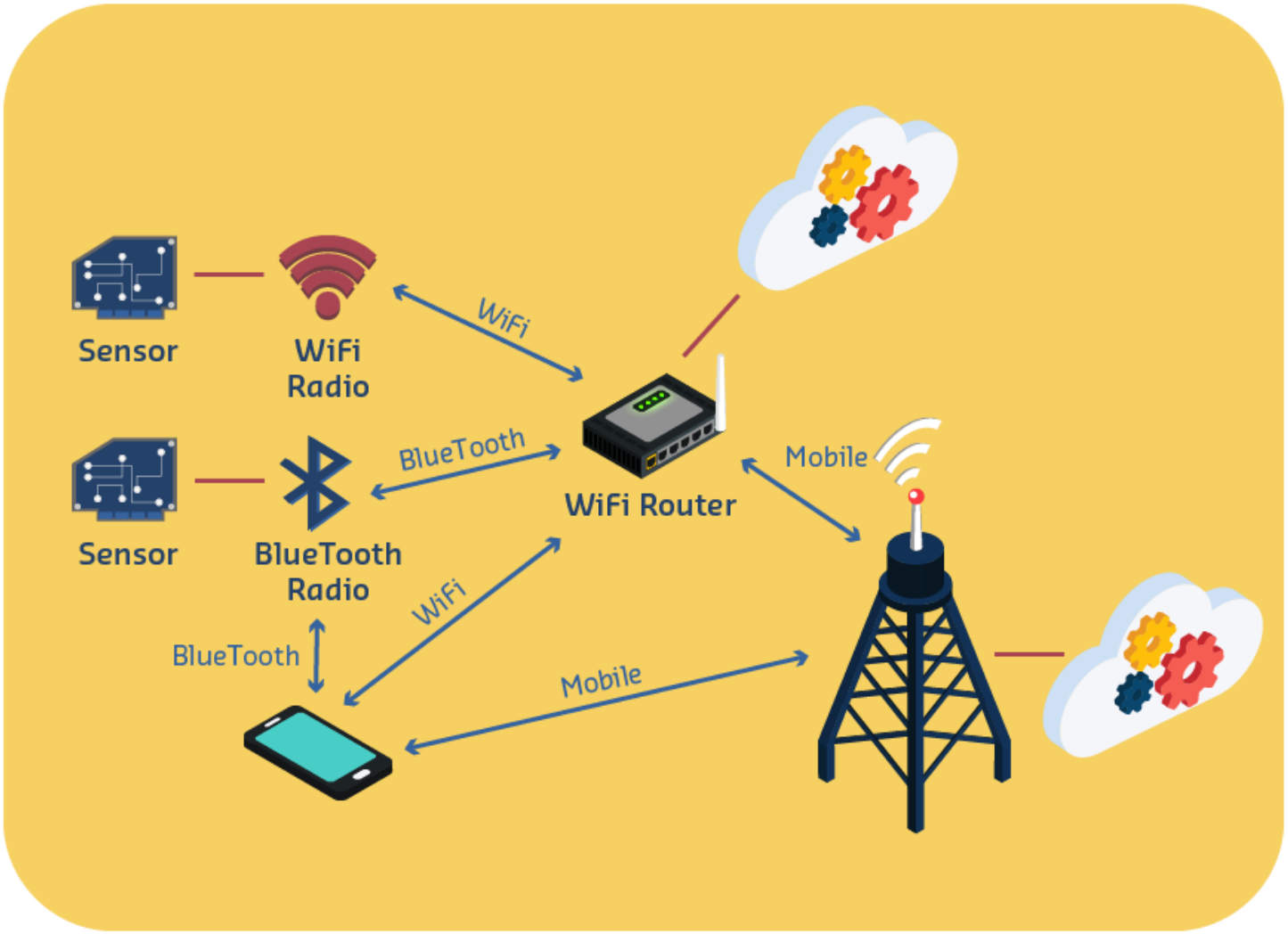
3. **2.5G (2.5 Generation):** These systems were transitional and offered data services like GPRS (General Packet Radio Service) and EDGE (Enhanced Data rates for GSM Evolution). They provided faster data transfer rates compared to 2G but were not true 3G systems.
4. **3G (Third Generation):** 3G systems brought broadband data capabilities to mobile devices. They supported faster data transfer speeds, enabling services like video calling and mobile internet access. Technologies like UMTS (Universal Mobile Telecommunications System) and CDMA2000 are examples of 3G systems.
5. **4G (Fourth Generation):** 4G networks represented a significant data speed and efficiency leap. They provided high-speed mobile internet, better video streaming, and low-latency communication. LTE (Long-Term Evolution) and WiMAX are examples of 4G technologies.

Types of mobile wireless services/systems-Cellular

6. **4.5G (LTE-Advanced) and 4.9G (LTE-Advanced Pro)** are intermediate stages between 4G and 5G, offering enhanced data speeds and capacity. They provided better support for IoT (Internet of Things) devices and improved network performance.
7. **5G (Fifth Generation):** 5G is the latest generation of cellular technology as of my last update. It promises ultra-fast data speeds, low latency, and massive device connectivity. It's designed to support emerging technologies like autonomous vehicles, augmented reality (AR), and virtual reality (VR).
8. **6G (Sixth Generation, Future):** While not widely deployed yet, research and development for 6G has started. It is expected to further advance wireless communication capabilities, providing even faster speeds, more reliable connections, and support for futuristic applications.

Please note that the wireless telecommunications industry is continually evolving, and new generations and technologies may have emerged since my last update in September 2021. It's essential to stay informed about the latest developments in the field of mobile wireless services/systems.

Types of mobile wireless services/systems-Cellular



Wireless Local Loop (WLL)

A local loop is a circuit line from a subscriber's phone to the local central office (LCO).

But the implementation of the local loop of wires is risky for the operators, especially in rural and remote areas due to a smaller number of users and increased cost of installation.

Hence, the solution for it is the usage of wireless local loop (WLL) which uses wireless links rather than copper wires to connect subscribers to the local central office.

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Wireless Local Loop (WLL)

- **WLL Architecture:**

- The Wireless Local Loop (WLL) architecture replaces traditional copper wires with wireless links, connecting subscribers to the local central office.

- It consists of several components, including the PSTN (Public Switched Telephone Network), Switch Function, WANU (Wireless Access Network Unit), and WASU (Wireless Access Subscriber Unit).

Wireless Local Loop (WLL)

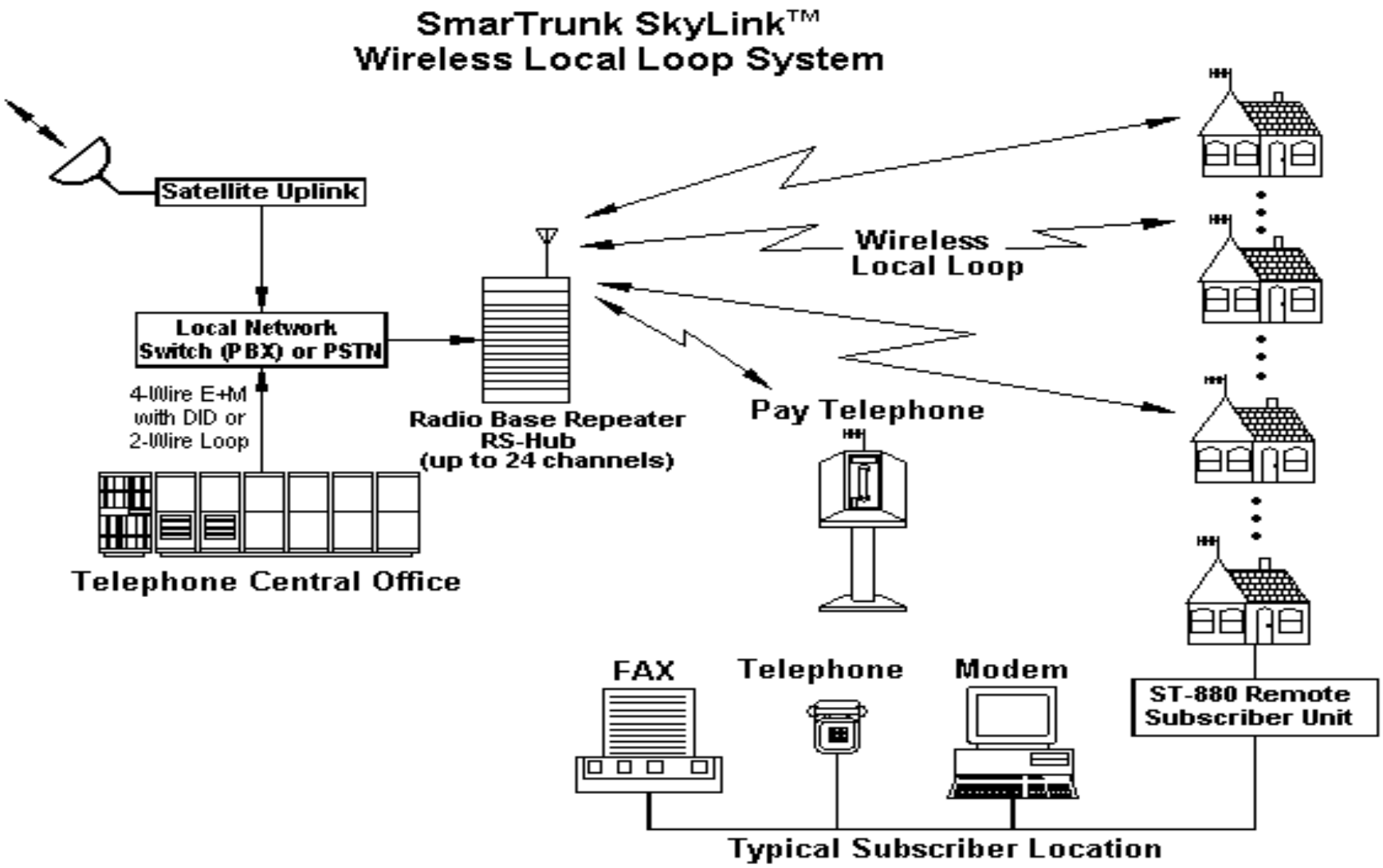
The PSTN serves as a circuit-switched network, while the Switch Function manages connections between WANUs.

The WANU takes care of authentication, operation, routing, and data transmission, whereas the WASU is installed at the subscriber's location.

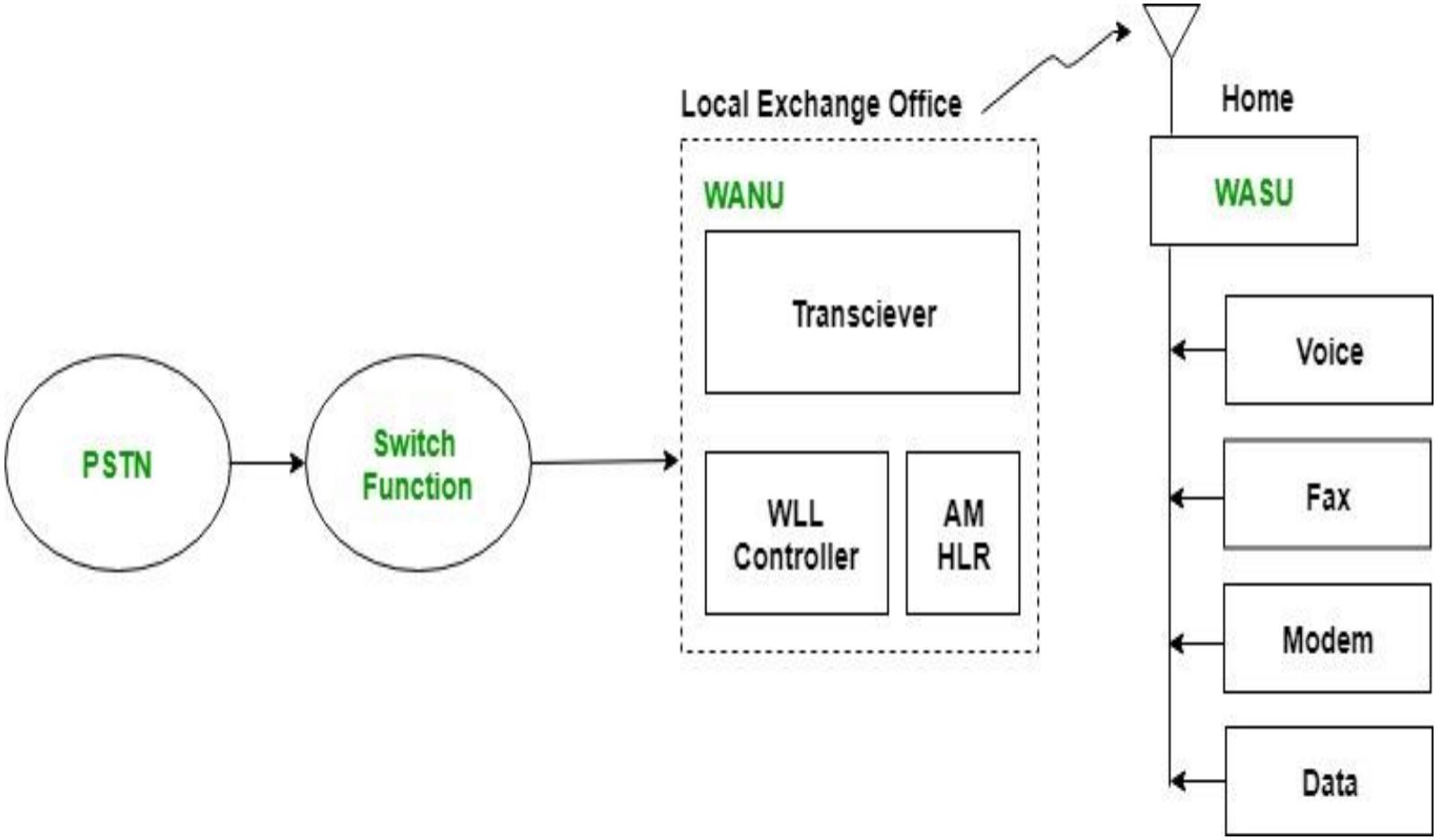
With its cost-effectiveness, enhanced security through digital encryption, scalability options, and various features like internet access, voice services, data transfer capabilities, and fax services.

WLL proves to be a dependable solution for telecommunication requirements specifically in remote or rural areas.

Wireless Local Loop (WLL)



Wireless Local Loop (WLL)



Wireless Local Loop (WLL)

WLL components:

1.PSTN: It is a Public Switched Telephone Network which is a circuit-switched network. It is a collection of the world's interconnected circuit-switched telephone networks.

2.Switch Function: Switch Function switches the PSTN among various WANUs.

Wireless Local Loop (WLL)

3.WANU:

It is short for Wireless Access Network Unit. It is present at the local exchange office. All local WASUs are connected to it. Its functions include Authentication, Operation and maintenance, Routing, and receiving voice and data. It consists of the following sub-components:

3. Transceiver: It transmits/receives data.
4. WLL Controller: It controls the wireless local loop component with WASU.
5. AM: It is short for Access Manager. It is responsible for authentication.
6. HLR: It is short for Home Location Register. It stores the details of all local WASUs.

4.WASU:

It is short for Wireless Access Subscriber Units. It is present at the house of the subscriber. It connects the subscriber to WANU and the power supply for it is provided locally.

Wireless Local Loop (WLL)

Advantages of WLL:

6. It eliminates the first mile or last mile construction of the network connection.
7. Low cost due to no use of conventional copper wires.
8. Much more secure due to digital encryption techniques used in wireless communication.
9. Highly scalable as it doesn't require the installation of more wires for scaling it.

Features of WLL:

7. Internet connection via modem
8. Data service
9. Voice service
10. Fax service

Wireless Local Loop (WLL)

Capacity comparison for 5 MHz spectrum allocation

Detail	IS-95 CDMA		IS-136 TDMA		ETSI (GSM)	
	Mobile	WLL	Mobile	WLL	Mobile	WLL
Chan. BW (kHz)	1250	1250	30	30	200	200
# channels	4	4	167	167	25	25
E_b/N_0	7 dB	6dB	18dB	14dB	12dB	12dB
Freq. Reuse	1	1	7	4	3	3
Effective Chan. Per sect.	4	4	7.95	13.92	2.78	2.78
Erlangs per cell Per MHz	38.3	48.7	9.84	19.6	9.12	9.12

Wireless Local Loop (WLL)

WLL	Mobile Wireless	Wireline
Good LOS component	Mainly diffuse components	No diffuse components
Rician fading	Rayleigh fading	No fading
Narrowbeam directed antennas	Omnidirectional antennas	Expensive wires
High Channel reuse	Less Channel reuse	Reuse Limited by wiring
Simple design, constant channel	Expensive DSPs, power control	Expensive to build and maintain
Low in-premises mobility only, easy access	High mobility allowed, easy access	Low in-premises mobility, wiring of distant areas cumbersome
Weather conditions effects	Not very reliable	Very reliable

Paging Systems

Paging systems are communication systems that send brief messages to a subscriber. Depending on the type of service, the message may be either a numeric message, an alphanumeric message, or a voice message.

Paging systems are typically used to notify a subscriber of the need to call a particular telephone number or travel to a known location to receive further instructions.

In modern paging systems, news headlines, stock quotations, and faxes may be sent. A message is sent to a paging subscriber via the paging system access number (usually a toll-free telephone number) with a telephone keypad or modem. The issued message is called a *page*.

The paging system then transmits the page throughout the service area using base stations which broadcast the page on a radio carrier.

Paging

Paging systems vary widely in their complexity and coverage area. While simple paging systems may cover a limited range of 2 to 5 km, or may even be confined to individual buildings, wide-area paging systems can provide worldwide coverage.

Though paging receivers are simple and inexpensive, the transmission system required is quite sophisticated.

Wide area paging systems consist of a network of telephone lines, many base station transmitters, and large radio towers that simultaneously broadcast a page from each base station (this is called *simulcasting*).

Paging

Simulcast transmitters may be located within the same service area or in different cities or countries.

Paging systems are designed to provide reliable communication to subscribers wherever they are; whether inside a building, driving on a highway, or flying in an airplane.

This necessitates large transmitter powers (on the order of kilowatts) and low data rates (a couple of thousand bits per second) for maximum coverage from each base station. Figure 1.3 shows a diagram of a wide-area paging system.

Paging

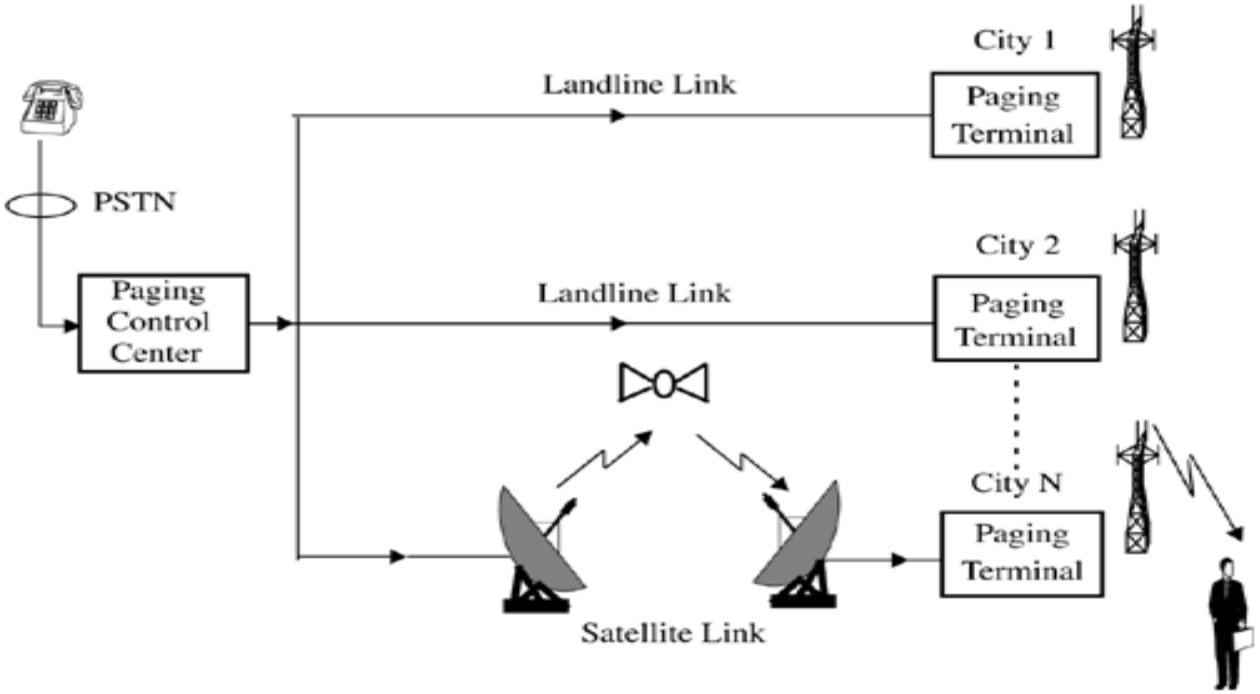


Fig. A wide area paging system. The paging control center dispatches pages received from the PSTN throughout several cities at the same time.Fig

Paging

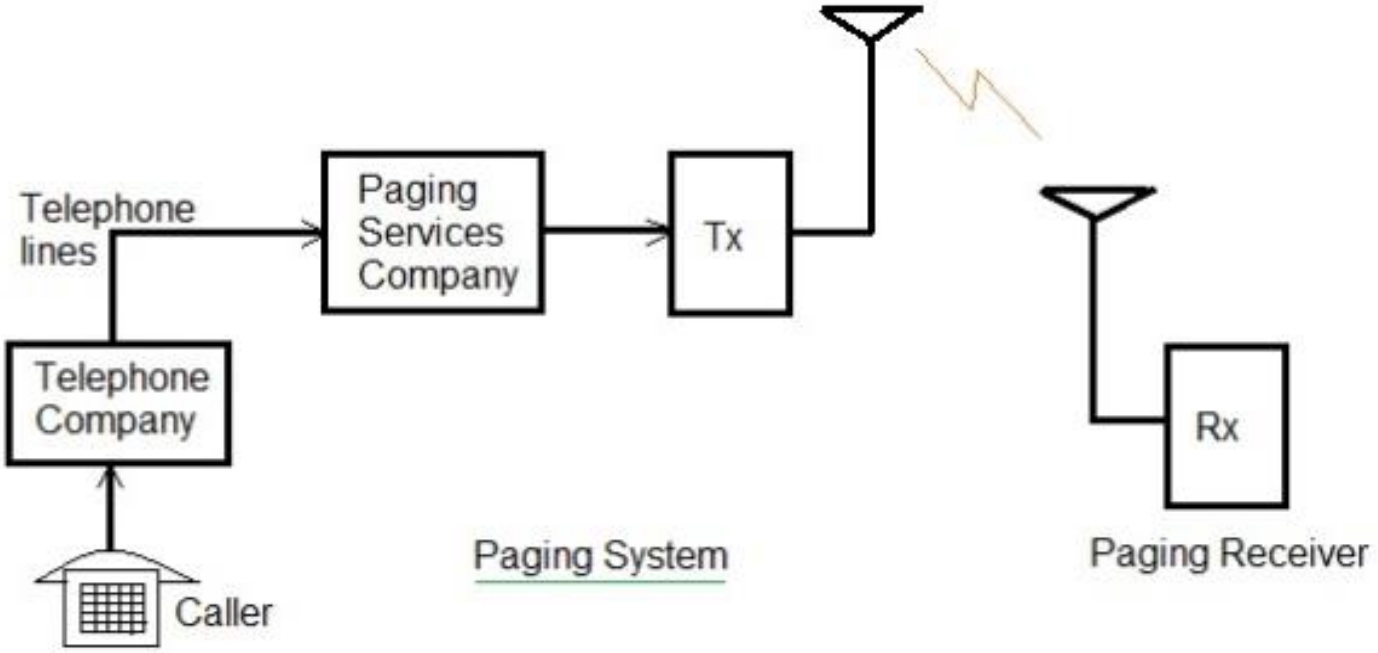


Fig. Paging System

Satellite Communication

1.Satellites and Their Functions:

1. A satellite is an object that revolves around another object. For example, the Earth is a satellite of the Sun, and the Moon is a satellite of the Earth.
2. Communication satellites are microwave repeater stations in space used for telecommunication, radio, and television signal transmission.

2.Satellite Communication Process:

1. Two Earth stations communicate through a relay station, a satellite.
2. The Earth station transmits a signal to the satellite at the uplink frequency.
3. The satellite's transponder converts and sends the signal to a second Earth station at the downlink frequency.
4. The second Earth station communicates with the first one in the same way.

3.Advantages of Satellite Communications:

1. Wide coverage area compared to terrestrial systems.
2. Transmission cost is independent of the coverage area.
3. Higher bandwidths are possible.

4. Disadvantages of Satellite Communications:

1. Launching satellites into orbit is costly.
2. Bandwidths are gradually used up.
3. High propagation delay compared to terrestrial systems.

5. Satellite Frequency Bands:

1. Commonly used frequency bands for satellite communication include C-band, Ku-band, and Ka-band.
2. Antenna size depends on transmission frequency.

6. Earth Orbits:

1. Satellites must be placed in specific orbits for their intended purposes.
2. Earth orbits include geosynchronous, geostationary, medium Earth, and low Earth orbits.

7. Geo-synchronous Earth Orbit (GEO) Satellites:

1. Placed at an altitude of 22,300 miles above Earth.
2. Synchronized with a sidereal day (23 hours, 56 minutes).
3. Can be circular and in the plane of the equator, known as geostationary orbits.
4. Used for weather forecasting, satellite TV, satellite radio, and global communications.

8. Medium Earth Orbit (MEO) Satellites:

1. Orbit at around 8000 miles from Earth's surface.
2. Shorter transmission distance results in improved signal strength and lower transmission delay.
3. Operating frequency range is 2 GHz and above.

9. Low Earth Orbit (LEO) Satellites:

1. Classified into little LEOs, big LEOs, and Mega-LEOs.
2. Orbit at 500 to 1000 miles above Earth.
3. Very low transmission delay (0.05 seconds) and higher operating frequencies.
4. Suitable for real-time, low-delay video transmission.

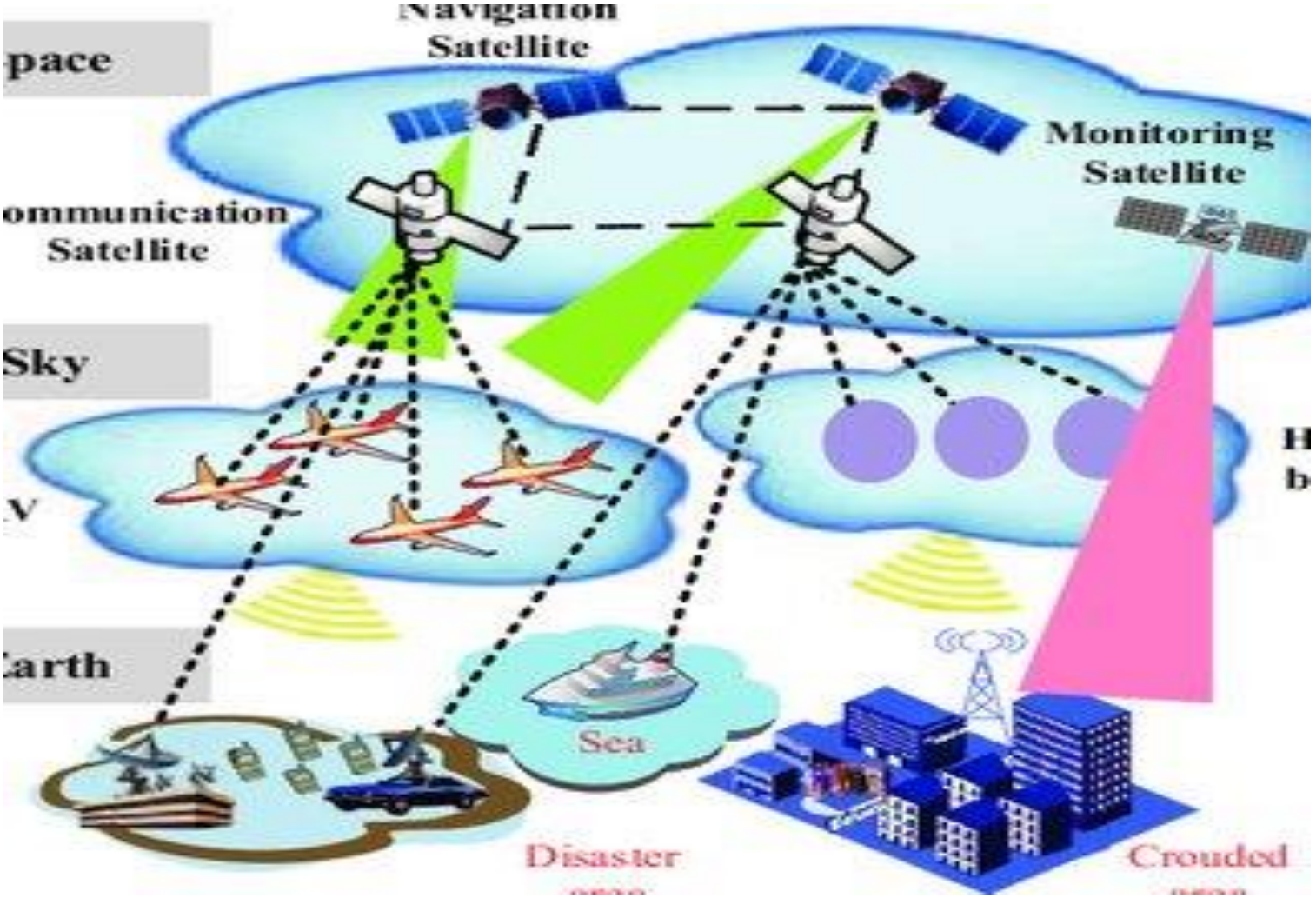
10. High Altitude Long Endurance (HALE) Platforms:

1. Lightweight airplanes with communication equipment.
2. Act as low Earth orbit geosynchronous satellites.
3. Offer minimal transmission delay at altitudes of 70,000 feet.

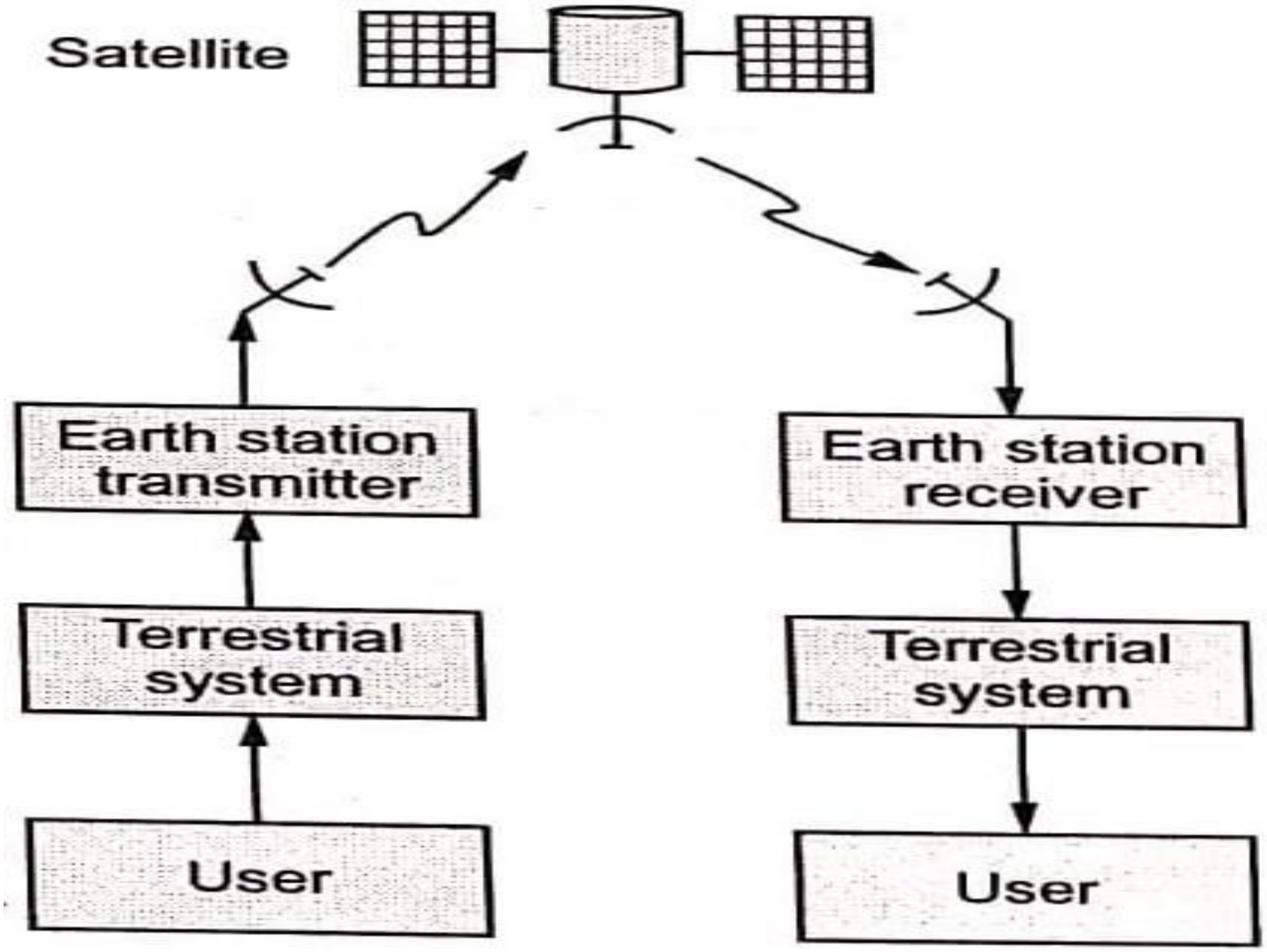
11. Orbital Slots:

1. International regulatory bodies like the ITU and national organizations like the FCC designate specific locations in geosynchronous orbit called orbital slots.
2. These slots are specified in degrees of longitude and are allocated to prevent satellite interference.

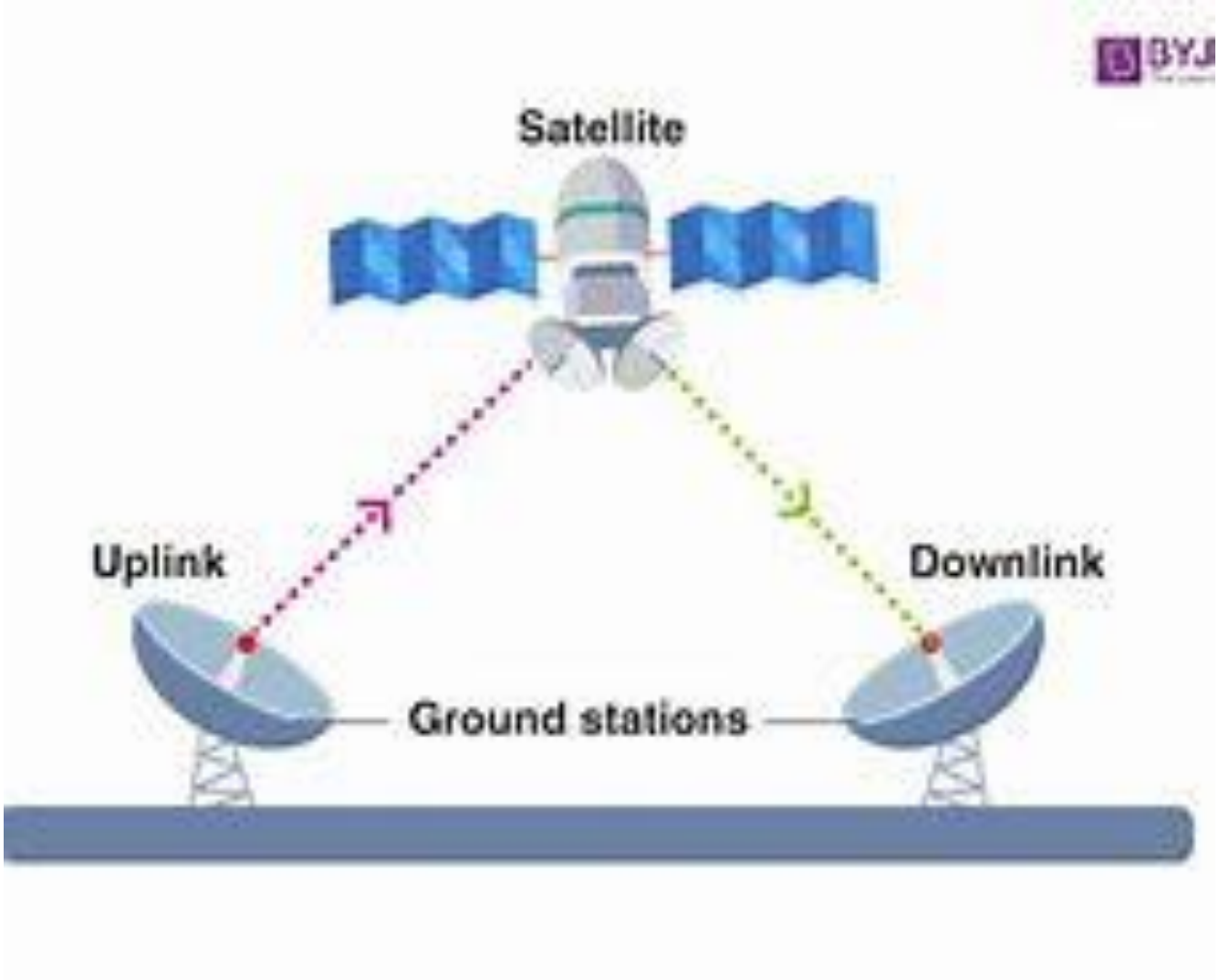
Satellite Communication



Satellite Communication



Satellite Communication



Future trends in personal wireless systems

Wireless technology plays a key role in today's communications, and new forms of it will become central to emerging technologies including robots, drones, self-driving vehicles and new medical devices over the next five years.

"Business and IT leaders need to be aware of these technologies and trends now," said Nick Jones, distinguished research vice president at Gartner. "Many areas of wireless innovation will involve immature technologies, such as 5G and millimeter wave, and may require skills that organizations currently don't possess.

Future trends in personal wireless systems

EA and technology innovation leaders seeking to drive innovation and technology transformation should identify and pilot innovative and emerging wireless technologies to determine their potential and create an adoption roadmap."

Gartner, Inc. has identified the top 10 wireless technology trends for enterprise architecture (EA) and technology innovation leaders.

Future trends in personal wireless systems

1.Wi-Fi

1. Wi-Fi remains the primary networking technology for homes and offices.
2. It finds new roles, such as in radar systems and two-factor authentication.

2.5G Cellular

1. 5G deployment begins in 2019-2020, with a complete rollout taking several years.
2. Complements Wi-Fi, especially in large sites like ports, airports, and factories.
3. Evolving for Internet of Things (IoT) and low-latency applications.

3.Vehicle-to-Everything (V2X) Wireless

1. Enables communication between vehicles and infrastructure.
2. Provides safety, navigation support, and infotainment.
3. Expected to become a legal requirement for new vehicles.

Future trends in personal wireless systems

4. Long-Range Wireless Power

1. New technologies can charge devices at distances of up to one meter.
2. Aims to eliminate power cables from devices like laptops and kitchen appliances.

5. Future trends in personal wireless systems Support IoT applications with low bandwidth and long battery life.

1. Covers large areas like cities or entire countries.
2. Includes technologies like NB-IoT, LTE-M, LoRa, and Sigfox.

6. Wireless Sensing

1. Uses wireless signals for sensing, e.g., indoor radar for robots.
2. Enhances performance in applications like virtual assistants.
3. Integral to IoT applications, medical diagnostics, and smart homes.

Future trends in personal wireless systems

7. Enhanced Wireless Location Tracking

1. Wireless systems sense device locations with high precision.
2. Enabled by the IEEE 802.11az standard and future 5G standards.
3. Essential for applications like indoor robots and drones.

8. Millimeter Wave Wireless

1. Operates at high frequencies (30-300 GHz) for short-range, high-bandwidth communications.
2. Used in technologies like 4K and 8K video streaming.

9. Backscatter Networking

1. Sends data with very low power consumption, ideal for small networked devices.
2. Important in areas with high wireless signal saturation.
3. Useful for IoT devices, like sensors in smart homes and offices.

Future trends in personal wireless systems

10. Software-Defined Radio (SDR)

1. Shifts signal processing from hardware to software.
2. Supports multiple frequencies and protocols.
3. Expected to gain popularity as new protocols emerge, enabling legacy support.

These trends highlight the evolving landscape of wireless technology and its critical role in various emerging applications and industries. Organizations need to stay informed and consider these trends when planning for innovation and technology transformation.

Trendy Wireless Technologies

- WiFi
- Long-range wireless power
- Wireless sensing
- Millimetre wave wireless
- 5G cellular
- Vehicle-to-everything (V2X) wireless
- Low-power wide-area (LPWA) networks
- Enhanced wireless location tracking
- Backscatter networking
- Software-defined radio (SDR)

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- https://youtu.be/cjP4j31468Q
- https://youtu.be/vJcyC1tJvD0

Daily Quiz

1. What were the earliest forms of mobile radio communication?
2. How did the concept of cellular networks evolve over time?
3. What role did the military play in the development of mobile radio systems?
4. Who were some key figures in the history of mobile radio technology?
5. How did the transition from analog to digital mobile communication systems occur?
6. What were the major milestones in the development of mobile phones?
7. How did the introduction of 2G, 3G, and 4G networks change mobile communication?
8. What impact did the invention of the smartphone have on mobile radio systems?
9. What are the basic components of a wireless communication link?
10. How does modulation and demodulation work in wireless communication?

Daily Quiz

1. How does modulation and demodulation work in wireless communication?
2. What is the significance of frequency bands and channels in wireless communication?
3. Explain the concept of multiplexing in wireless communication.
4. What are the challenges of signal propagation in wireless communication?
5. What is the difference between cellular and ad-hoc wireless networks?
6. How do 4G and 5G networks differ in terms of architecture and capabilities?
7. What are the key features of Wireless Local Loop (WLL) systems?
8. How does paging technology work, and what are its applications?
9. What are the advantages and limitations of satellite-based mobile systems?
10. What are the expected benefits and innovations of 6G wireless technology?

Daily Quiz

1. How are the wireless systems classified? State the major changes in the classified wireless system.
2. Explain the term evolution of mobile radio communication fundamentals.

Weekly Assignment

History and Evolution of Mobile Radio Systems:

1.Who is credited with making the first mobile phone call?
a) Alexander Graham Bell b) Thomas Edison c) Martin Cooper d) Nikola Tesla

2.What was the weight of the first commercially available handheld mobile phone?
a) Less than 1 pound b) 2-3 pounds c) 5-6 pounds d) Over 10 pounds

3.Which company introduced the concept of the "bag phone" for mobile communication? a) Motorola b) Nokia c) Apple d) Samsung

4.In which decade did the transition from analog to digital mobile communication systems occur? a) 1950s b) 1970s c) 1990s d) 2000s

5.What was the primary limitation of early mobile radio systems? a) Limited coverage area b) High cost c) Large size d) Short battery life

Weekly Assignment

General Model of Wireless Communication Link:

6.What is the primary function of a transmitter in a wireless communication link?
a) To receive signals b) To amplify signals c) To extract information from signals d) To generate and send signals

7.Which of the following is NOT a key component of a wireless communication link?
a) Receiver b) Modulator c) Antenna d) Router

8.What does modulation refer to in wireless communication?
9.a) Signal amplification b) Signal encryption c) Signal conversion to radio waves d) Signal error correction

9.What type of communication allows data transmission in both directions but not simultaneously? a) Simplex b) Half-duplex c) Full-duplex d) Multiplex

10.How does signal propagation work in wireless communication?
a) Signals travel through physical wires b) Signals are sent via satellite c) Signals propagate through the air or space d) Signals are converted to digital form for transmission

Weekly Assignment

Types of Mobile Wireless Services/Systems:

11.What is the primary purpose of cellular networks?
a) Data storage b) Voice communication c) Video streaming d) GPS navigation
12.What is a base station in a cellular network?
a) A mobile phone store b) A central call center c) A tower that communicates with mobile devices d) A network security system
13.Wireless Local Loop (WLL) systems are designed to provide:
a) Long-distance wireless communication b) Local telephone service via wireless connections c) Internet access through satellites d) Radio broadcasting services
14.In the context of mobile communication, what does "paging" refer to?
a) Searching for available Wi-Fi networks b) Sending short text messages c) Locating and alerting mobile devices d) Tracking GPS coordinates

Weekly Assignment

Satellite Systems:

15.Which type of satellite orbits the Earth at the same speed that the Earth rotates, maintaining a fixed position relative to the Earth's surface?
a) Geostationary satellite b) Low Earth Orbit (LEO) satellite c) Medium Earth Orbit (MEO) satellite d) Polar satellite
16.What is the primary advantage of satellite-based mobile systems?
a) Low latency b) Global coverage c) High data transfer rates d) Low cost
17.Which satellite system is commonly used for satellite radio broadcasting?
a) GPS b) Inmarsat c) XM Satellite Radio d) Iridium

Weekly Assignment

Types of Mobile Wireless Services/Systems:Future Trends in Personal Wireless Systems:

18.What is one of the expected benefits of 6G wireless technology?
a) Slower data speeds b) Reduced energy efficiency c) Increased latency d) Faster and more reliable connectivity
19.How might artificial intelligence (AI) impact future personal wireless systems?
a) Decrease network security b) Improve battery life in mobile devices c) Reduce the need for wireless networks d) Decrease the demand for data
20.Which technology is often associated with the Internet of Things (IoT) in personal wireless systems?
a) Dial-up modems b) Bluetooth c) Fax machines d) Satellite phones

Weekly Assignment

Types of Mobile Wireless Services/Systems:s

Answers:

1.c) Martin Cooper
2.b) 2-3 pounds
3.a) Motorola
4.c) 1990s
5.a) Limited coverage area
6.d) To generate and send signals
7.d) Router
8.c) Signal conversion to radio waves
9.b) Half-duplex
10.c) Signals propagate through the air or space
11.b) Voice communication
12.c) A tower that communicates with mobile devices
13.b) Local telephone service via wireless connections
14.c) Locating and alerting mobile devices
15.a) Geostationary satellite
16.b) Global coverage
17.c) XM Satellite Radio
18.d) Faster and more reliable connectivity
19.b) Improve battery life in mobile devices
20.b) Bluetooth

Old Question Papers

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B. Tech.

(SEM. VIII) THEORY EXAMINATION, 2014-15

WIRELESS & MOBILE COMMUNICATION

Time : 3 Hours] [Total Marks : 100

Note : Attempt all questions.

1 Attempt any four parts : 5×4=20

(a) Explain the term Evolution of mobile radio communication fundamentals.

(b) A transmitter has a power output of 150 watt at a carrier frequency of 32.5 MHz. It is connected to an antenna with gain of 12 dBi. The receiving antenna is 10 km away and has gain of 5 dBi. Calculate the power delivered to the receiver, assuming free space propagation. Assume also that there are no losses or mismatches in the system.

(c) Define the Brewster angle. Calculate the Brewster angle for a sine wave imping on the ground having a permittivity of $\varepsilon r = 4$.

(d) Explain the term multipath measurement using relevant diagram.

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Old Question Papers

(e) Explain the outdoor models given below :
(i) Durkin's Model
(ii) Okumura Model.

2 Attempt any four parts : 5×4=20
(a) Draw the block diagram of survey of equalization and explain it.
(b) Derive the impulse response model of multipath channel.
(c) What is the basic mechanism of vocoder and explain any two types of vocoders.
(d) Explain the different type of equalization techniques used in wireless communication with support of mathematics and block diagram.
(e) Explain the different type of diversity techniques used in wireless communication system.

3 Attempt any two parts : 10×2=20
(a) What are the different methods used for improving coverage and capacity in cellular system ? Describe all the method in detail with support of figures.
(b) Define frequency reuse concept. And explain the different type of channel assignment strategies and hand-off strategies in communication system.

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(c) Given a cellular system with a total bandwidth of 30 MHz which uses two 25 kHz simplex channels to provide full duplex voice channels and control channels. Assuming that system uses a nine cell reuse pattern and 1 MHz of the total bandwidth is allocated for control channel :
(i) Calculate the total available channel
(ii) Determine the number of control channels
(iii) Determine the number of voice channels per cells.
(iv) Discuss the strategies for distribution of control and voice channels in each cell.

4 Attempt any two parts of the following : 10×2=20
(a) Describe the Forward CDMA channel and reverse CDMA channel using proper block diagram.
(b) Explain the GSM architecture and frame structure in mobile radio communiction using system in detail.
(c) A FDD cellular communication system uses a total of 945 radio channels available for handling traffic. The total area of entire system is 2450 sqkm with the 7 sqkm as the area of a cell :
(i) Calculate the system capacity if the cluster size is 7.
(ii) Calculate the system capacity if the cluster size is 4.

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Thank You