Course Title

Advanced Wireless Communication

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Course Code: CSE 5114

Course Title: Advanced Wireless Communication

Distribution	Marks
Class attendance	10
In-course/tutorial exam/ assignment	30
Semester-Final Exam	60
Total	100

WHAT IS WIRELESS Communication?

- The word wireless is dictionary defined “having no wires ” .
- In networking terminology , wireless is the term used to describe any computer network where there is no physical wired connection between sender and receiver, but rather the network is connected by radio waves and or microwaves to maintain communications.
- Wireless networking utilizes specific equipment such as NICs and Routers in place of wires (copper or optical fibre).

How Wireless Communication Works

- Information → signals
- Signals → EM waves
- Travel through air/space

Electromagnetic Spectrum

- Radio waves
- Microwaves
- Infrared
- Visible light
- UV, X-rays, Gamma rays

Why Wireless Communications?

Freedom from wires:

- ❖ No cost of installing wires or rewiring
- ❖ No bunches of wire running here and there
- ❖ Instantaneous communication without physical connection set up e.g Bluetooth, WiFi

Global Coverage:

- ❖ Communications can reach where wiring is infeasible or costly, e.g rural areas, old buildings, battlefields, vehicles, outer space (through communication satellite)

Stay Connected:

- ❖ Roaming allows flexibility to stay connected anywhere, any time

Flexibility:

- ❖ Services reach you wherever you go (Mobility). You don’t have to go to your lab to check your email.

Types of Wireless Communications

❑ Infrared (IR) Communication

Uses infrared light for communication over short distances. Infrared waves cannot penetrate walls.

Example: TVs, air conditioners, and other household devices use IR for contro

❑ Bluetooth

A short-range wireless technology standard for exchanging data between fixed and mobile devices over short distances.

Example: Wireless keyboards, mice, headphones, and data transfer between smartphones and computers.

❑ Wi-Fi (Wireless Fidelity)

A wireless networking technology that uses radio waves to provide high-speed internet and network connections.

Example: Home and office internet networks, public hotspots, smartphones, and IoT devices.

❑ Cellular Networks (4G/5G)

Cellular networks provide voice and data communication for mobile phones and other wireless devices. They operate on different frequencies depending on the generation (e.g., 3G, 4G, 5G).

Example: Voice calls, SMS, mobile internet, video calls, and streaming.

❑ Satellite Communication

Involves the use of satellites to send signals over large distances, often across continents.

Example: Satellite TV, GPS, satellite phones, and internet services in remote areas.

❑ Li-Fi (Light Fidelity)

A wireless communication technology that uses visible light to transmit data. It is faster than Wi-Fi but requires direct line-of-sight between the devices.

1G TECHNOLOGY

- 1G refers to the first generation of wireless telephone technology, mobile telecommunications which was first introduced in 1980s and completed in early 1990s.
- It's Speed was upto 2.4kbps.
- It allows the voice calls in 1 country.
- 1G network use Analog Signal.
- Advanced Mobile Phone System (AMPS) was first launched in USA in 1G mobile systems.



DRAWBACKS OF 1G

- Poor Voice Quality
- Poor Battery Life
- Large Phone Size
- No Security
- Limited Capacity
- Poor Handoff Reliability



1G Wireless System

2G TECHNOLOGY

- 2G technology refers to the 2nd generation which is based on Global System for Mobile Communication (GSM).
- It was launched in Finland in the year 1991.
- 2G network use digital signals.
- It's data speed was upto 64kbps.



Features Includes:

- It enables services such as text messages, picture messages and MMS (multi media message).
- It provides better quality and capacity .

DRAWBACKS OF 2G

- 2G requires strong digital signals to help mobile phones work. If there is no network coverage in any specific area , digital signals would weak.
- These systems are unable to handle complex data such as Videos.



2.5G TECHNOLOGY

- 2.5G is a technology between the second (2G) and third (3G) generation of mobile telephony.
- 2.5G is sometimes described as 2G Cellular Technology combined with General Packet Radio Service (GPRS).



Features Includes:

- ✓ Phone Calls
- ✓ Send/Receive E-mail Messages
- ✓ Web Browsing
- ✓ Speed : 64-144 kbps
- ✓ Camera Phones
- ✓ Take a time of 6-9 mins. to download a 3 mins. Mp3 song

3G TECHNOLOGY

- 3G technology refer to third generation which was introduced in year 2000s.
- Data Transmission speed increased from 144kbps- 2Mbps.
- Typically called Smart Phones and features increased its bandwidth and data transfer rates to accommodate web-based applications and audio and video files.



3G TECHNOLOGY

Providing Faster Communication

- ✓ Send/Receive Large Email Messages
- ✓ High Speed Web / More Security

Video Conferencing / 3D Gaming

- ✓ TV Streaming/ Mobile TV/ Phone Calls
- ✓ Large Capacities and Broadband Capabilities
- ✓ 11 sec – 1.5 min. time to download a 3 min Mp3 song.



DRAWBACKS OF 3G TECHNOLOGY

Expensive fees for 3G Licenses Services

- ✓ It was challenge to build the infrastructure for 3G
- ✓ High Bandwidth Requirement
- ✓ Expensive 3G Phones.
- ✓ Large Cell Phones



4G TECHNOLOGY (Anytime ,Anywhere)

4G technology refer to or short name of fourth Generation which was started from late 2000s.
Capable of providing 100Mbps – 1Gbps speed.

One of the basic term used to describe 4G is MAGIC.
MAGIC:

Mobile Multimedia
Anytime Anywhere
Global Mobility Support
Integrated Wireless Solution
Customized Personal Services
Also known as Mobile Broadband Everywhere.



4G TECHNOLOGY (Anytime ,Anywhere)

The next generations of wireless technology that promises higher data rates and expanded multimedia services.
Capable to provide speed 100Mbps-1Gbps.
High QOS and High Security
Provide any kind of service at any time as per user requirements, anywhere.



Features Include:

- ✓ More Security
- ✓ High Speed
- ✓ High Capacity
- ✓ Low Cost Per-bit etc.

DRAWBACKS OF 4G

Battery uses is more
Hard to implement
Need complicated hardware
Expensive equipment required to implement next generation network.



COMPARISON BETWEEN 3G Vs 4G

Technology	*3G*	*4G*
Data Transfer Rate	***3.1 MB/sec***	***100 MB/sec***
Internet Services	Broadband	Ultra Broadband
Mobile-TV Resolution	Low	High
Bandwidth	***5-20 MHz***	***100MHz***
Download and upload	***5.8 Mbps***	***14 Mbps***

5G TECHNOLOGY

- 5G technology refer to short name of fifth Generation which was started from late 2010s.
- Complete wireless communication with almost no limitations.
- It is highly supportable to WWWW(Wireless World Wide Web).



BENEFITS OF 5G TECHNOLOGY

- ✓High Speed, High Capacity
- ✓5G technology providing large broadcasting of data in Gbps .
- ✓Multi - Media Newspapers, watch T.V programs with the Clarity as to that of an HD Quality.
- ✓Faster data transmission that of the previous generations.
- ✓Large Phone Memory, Dialing Speed, clarity in Audio/Video.
- ✓Support interactive multimedia , voice, streaming video, Internet and other
- ✓5G is More Effective and More Attractive.



Why 6G Network is need?

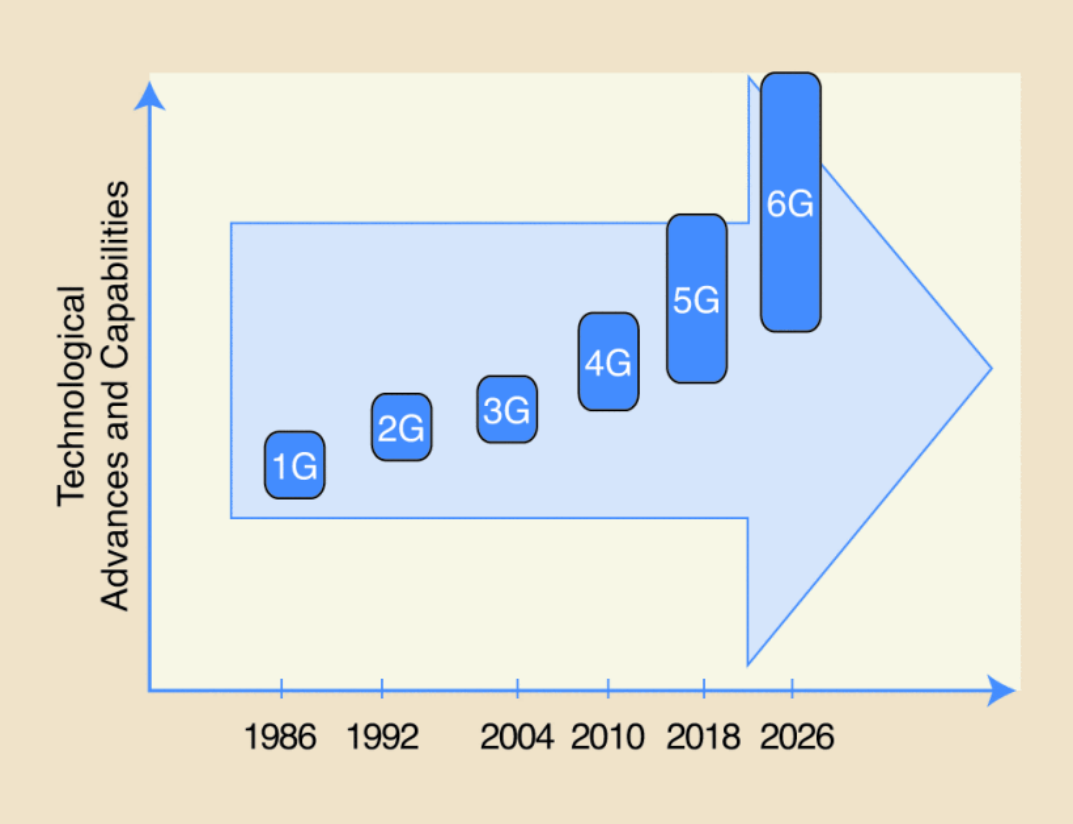


Fig. The emergence and development of mobile communication systems.[3]

So, we've always been on a path to a 6G world.

Comparing the market entry of past and current mobile communication systems, we expect 6G to start entering the market by 2026

[3]. K. David and H. Berndt, “6G Vision and Requirements: Is There Any Need for Beyond 5G?,” IEEE Veh. Technol. Mag., vol. 13, Sept. 2018, pp. 72–80.

6G Technology

- 5G, speeds of up to 1 Gbps. Where 6G will absolutely top that, but **How much is still in question**?

✓We might see

  - **several hundred gigabit per second speeds, even ranges in the terabytes.**

- How 6G will be faster than 5G?

✓Ultra high frequency bands, such as **terahertz band** of the radio spectrum.

✓the higher you go up the radio spectrum, the more data you can carry.

✓Reach extremely high frequency levels of 300 GHz, or even terahertz ranges

- 6G will improve weaknesses and limitations of 5G.

6G Technology (Cont.…)

6G will be more requirements specified as follows:

- Very **high data rates**, up to 1 Tb/s;
- Very **high energy efficiency**, with the ability to support battery-free IoT devices;
- **Massive low-latency** control (less than 1 msec);
- Very **broad frequency bands** (e.g., 73GHz-140GHz and 1THz-3THz);
- Broadband global network coverage by integrating t**errestrial wireless with satellite systems**;
- Connected intelligence with machine learning capability.

[4]. Khaled B. Letaief ; Wei Chen ; Yuanming Shi ; Jun Zhang ; Ying-Jun Angela Zhang,"The Roadmap to 6G: AI Empowered Wireless Networks",0163-6804/19/$25.00 © 2019 IEEE

Wireless System Definitions

Mobile Station

A station in the cellular radio service intended for use while in motion at unspecified locations. They can be either handheld personal units (portables) or installed on vehicles (mobiles)

Base station

A fixed station in a mobile radio system used for radio communication with the mobile stations. Base stations are located at the center or edge of a coverage region. They consists of radio channels and transmitter and receiver antennas mounted on top of a tower.

[4]. Khaled B. Letaief ; Wei Chen ; Yuanming Shi ; Jun Zhang ; Ying-Jun Angela Zhang,"The Roadmap to 6G: AI Empowered Wireless Networks",0163-6804/19/$25.00 © 2019 IEEE

Wireless System Definitions

Control Channel
Radio channel used for transmission of call setup, call request, call initiation and other beacon and control purposes.

Forward Channel
Radio channel used for transmission of information from the base station to the mobile

Reverse Channel
Radio channel used for transmission of information from mobile to base station

[4]. Khaled B. Letaief ; Wei Chen ; Yuanming Shi ; Jun Zhang ; Ying-Jun Angela Zhang,"The Roadmap to 6G: AI Empowered Wireless Networks",0163-6804/19/$25.00 © 2019 IEEE

Wireless System Definitions

Simplex Systems
Communication systems which provide only one-way communication
Keyboard-Monitor

Half Duplex Systems
Communication Systems which allow two-way communication by using the same radio channel for both transmission and reception. At any given time, the user can either transmit or receive information.
walkie-talkie

Full Duplex Systems
Communication systems which allow simultaneous two-way communication. Transmission and reception is typically on two different channels (FDD).
Telephone

Wireless System Definitions

Handoff
The process of transferring a mobile station from one channel or base station to an other.

Mobile Switching Center
Switching center which coordinates the routing of calls in a large service area. In a cellular radio system, the MSC connections the cellular base stations and the mobiles to the PSTN (telephone network). It is also called Mobile Telephone Switching Office (MTSO)

Subscriber
A user who pays subscription charges for using a mobile communication system

Transceiver
A device capable of simultaneously transmitting and receiving radio signals

[4]. Khaled B. Letaief ; Wei Chen ; Yuanming Shi ; Jun Zhang ; Ying-Jun Angela Zhang,"The Roadmap to 6G: AI Empowered Wireless Networks",0163-6804/19/$25.00 © 2019 IEEE

Current Wireless Systems

- Current Cellular Systems
- Wireless LANs
- Satellite Systems
- Paging Systems
- PANs (Bluetooth)