Mobile Commerce

Mobile commerce, also known as m-commerce, involves buying and selling of goods and services through using wireless handheld devices like smartphones and tablets to conduct commercial transactions online, including the purchase and sale of products, online banking, and paying bills. M-commerce is a form of e-commerce that enables users to access online shopping platforms without the use of a desktop computer.

Over time, content delivery through wireless devices has become faster, more secure and scalable. As a result, mobile commerce has grown rapidly.

m-commerce or mobile commerce is nothing but an upgraded or version of e-commerce. When the commercial activities are conducted with the help of cellular devices, it is known as m-commerce. It includes browsing, buying, selling, dealing, ordering, paying and many other activities.

After the emergence of m-commerce, e-commerce has reached great heights because it has increased its accessibility, portability, and connectivity. Now, you don't need to search a place to plug-in because it just needs a wireless handheld device. The latest technology behind the success of m-commerce is Wireless Application Protocol (WAP), Short Message Service (SMS), Bluetooth, etc. It can be used in mobile ticket booking, mobile banking, money transfer via mobile and so on. Further, it allows the use of applications.

- Mobile commerce refers to business or purchases conducted over mobile devices like cell phones or tablets.
- With m-commerce, users can transact anywhere provided there's a wireless internet provider available in that area.
- Mobile commerce has increased rapidly as security issues have been resolved.
- Companies like Apple and Google have introduced their own mobile commerce services.

Examples of m-commerce use in specific industries include the following:

- **Financial services.** Mobile banking and brokerage transactions are done from mobile devices.
- **Telecommunications.** Handheld devices are used to make service changes and bill payments, and to do account reviews.
- **Service and retail.** Consumers place and pay for orders on-the-fly through online stores.
- **Information services.** Financial, sports, traffic, weather and many other news updates are accessed through mobile devices.

Applications of M-commerce?

Let's have a glance at the top ten applications of M-commerce. You will definitely get amazed after seeing how mobile commerce functions and the importance of mobile phones.

M-commerce and mobile marketing- Business organizations can advertise their products and offers by sending SMS to consumers. Also, they can give reward points to customers to increase their sales.

- **For finance-** People who use mobile phones can make transactions easily from anywhere. Even if they have to make a payment of something, they can easily do so and will also receive a receipt regarding the payment.
- **For retail and after-sale services-** Customers can view a product online to know its price and details. Also, they can buy products or can even ask for service online.
- **Hotel reservations-** Hotel rooms can be booked online through smartphones, making it more convenient for the user.
- **Healthcare and Medicine-** Apart from ordering medical supplies online, patients can send their health status to their doctors and get help, making it easier for old age people.

- **For intraoffice communication-** Salespeople often need to check the latest prices and offers on the company's products while they may not be in office. They can access all the information easily through their smartphones.
- **For gaming-** Online games are becoming very popular these days. The multiplayer games can be easily accessed by smartphones.
- **For information-** People can check the news, cricket scores etc. Also, students can check their university exam results easily.
- **Mobile entertainment-** Users can access thousands of tv shows, web series, and movies, all through their portable mobile devices.
- **Mobile Ticketing-** Tickets of flights or trains can be booked online, without the hassle of going and standing in a queue only through your mobile phones.

Types of mobile commerce
- **Browsing for stuff online on your mobile**: this type is concerned with internet shopping for groceries, daily necessaries, and electronics. Dedicated apps, optimized websites, or even social media platforms such as Facebook or Instagram which allow in-app purchases or store links.
- **Purchasing app-delivery stuff**: this type deals with services such as food shipping, car pick up, and others.
- **Mobile banking**: Mobile banking is a means of employing internet techniques to gain access to a bank's capabilities. Although several financial services organizations are currently experimenting with chatbots or messaging apps to give customer care, the transactions are completed through special apps built by apps.
- **Mobile app payments**: Google Pay or PayPal are the best examples of this type. It mainly focuses on making payment transactions through apps. Users will be required to register their credit or debit card and then use it whenever they want.
- **Purchasing or renting digital content** (Netflix, Spotify, etc) on a mobile device: Buying or renting online services is involved in this type.
- **Mobile person-to-person payment**: this type is known as sending money from one person to another, buying stuff or sending it to someone who is in need. The transactions can be made by sending money to someone's number or to their bank account directly.

Key Differences Between e-commerce and m-commerce
The major differences between e-commerce and m-commerce are explained below:
1. e-commerce is defined as the performance of business activities with the use of the internet. When any sort of commercial transaction is transacted with the use of cellular devices, it is known as m-commerce.
2. e-commerce is an older concept than m-commerce.
3. m-commerce is originally developed on the lines of e-commerce. So it can be said that m-commerce is a part of e-commerce.
4. e-commerce activities are concluded with the help of computers and laptops, whereas in m-commerce, smartphones, tablets, iPad, PDA's (Personal Digital Assistant), etc. are used.
5. In e-commerce, the use of the internet is compulsory but in the case of m-commerce the use of the internet is not mandatory.
6. The connectivity of m-commerce is comparatively larger than e-commerce.
7. m-commerce devices are easy to carry anywhere because they are light weighted which is not possible with e-commerce.

Difference between E-commerce and M-commerce in tabular form:

S.No.	E-Commerce	M-Commerce
1	Electronic Commerce in short it is called as e-commerce	Mobile Commerce in short it is called as m-commerce.
2	In general, e-commerce activities are performed with the help of desktop computers and laptops.	M-commerce activities are performed with the help of mobile devices like smartphones, tablets, PDA's (Personal Digital Assistant) etc.
3	E-commerce is an older concept.	M-commerce is an newer concept.
4	It is broad term which refers doing shopping and making payments online with help of electronic devices like Laptop and computers.	It is subcategory of ecommerce which does the same this via mobile devices.
5	In e-commerce the use of internet is mandatory	But in case of m-commerce some activities can be performed without internet also.
6	E-commerce devices are not easy to carry and portability point of view it is not so good.	M-commerce devices are easy to carry and portability point of view it is good.
7	E-commerce developed in 1970's.	M-commerce developed in 1990's.
8	Its reachability is comparatively low than the m-commerce as it is not so good in portability	Its reachability is more than that of e-commerce only due to the use of mobile devices.
9	In e-commerce location tracking capabilities are limited due to the non-portability of devices.	In m-commerce location tracking capabilities is so good as mobile apps track and identify user locations with the help of GPS technology, Wi-Fi, and so on.
10	E-commerce fails in push notification.	In m-commerce push notification can be achieved.
11	Examples of E-commerce includes Amazon, Flipkart, Quikr, Olx websites.	Examples of M-commerce includes mobile banking like paytm, in-app purchasing Amazon mobile app.

Advantages of M-commerce

As you all know that everything has advantages as well as disadvantages. So, let's catch a glimpse of some of the advantages of mobile commerce.

1. **It creates a new marketing channel-** M-commerce will help you in creating a new marketing channel as you can easily sell your products to end-users. Additionally, for your business m-commerce is very beneficial as you will give all information in your mobile app and users can easily get to know everything in just one click.

2. **It provides easy store access-** Mobile commerce makes it simple to find the items accessible in the market by using wireless gadgets. Also, you don't need to go to the store to buy your necessities, instead, you can purchase items online. This will save you time and reduce your efforts.

3. **It results in cost reduction and productivity-** M-commerce is cost-effective as you can cut marketing campaign expenses as you can reach your customer sooner with

a mobile app. Also, it has reduced the staff workload and has become more effective and productive than before.

4. **It benefits from traditional retail sales-** Mobile commerce can encourage you with traditional retail sales. Thus, m-commerce is developing day by day and it will keep on advancing, putting up a better outstanding position in the retail exchanges.

Disadvantages of M-commerce
Now, let's glance at some disadvantages of mobile commerce.

1. **Absence of services in rural areas-** In rural areas there is still a dearth of availability of mobile phones and Internet connection. Even there are people who are totally unaware of all these facilities. So, you can think that still, mobile commerce is unknown to several people.

2. **Fraud risks and security concerns-** Still there are fraud risks in mobile commerce and there are marketers who are not even prepared to handle it. Also, the security issue is still present and there are people who had a fear of losing their personal information.

3. **Connectivity issue-** If your net connection is poor then you will face an issue and also get irritated in m-commerce. The massive obstacle for M-commerce is the internet connection issue.

4. **The habit of people-** You must have heard of the people who don't want to come out of their comfort zone or you can say that they are not ready for the change. There are people who deny getting into modern technology and some take too much time in adopting new technologies.

5. **Hacking issues:** In the world of increasing technology the chances of data hacking also increases, the account details of user can also be hacked which may get him to the huge loss also.

Features of M-commerce
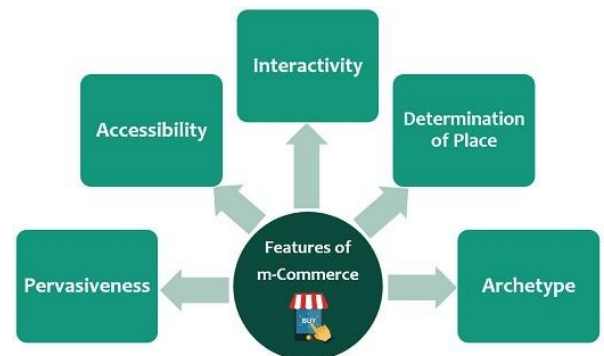Following are some of the features of M-commerce:

1. **Pervasiveness:** The term pervasiveness defines the easy accessibility of information in real-time, i.e., it is an easier way for the users to fulfill their desired products query.

2. **Accessibility:** Devices like mobile and tablets are always nearby, the user can access it according to his convenience from anywhere.

3. **Inter-activity:** Mobile system allow for fast and easy interactions. i.e. the customer will directly search for a desired category of product, there is no need for viewing all the categories of products.

4. **Determination of Place:** Targeting customers with mobile promotions within a defined geographical space.

5. **Archetype:** Creation of the services that customize the end-user experiences.

Note: Refer to other feature also:
https://buildfire.com/features-every-mobile-commerce-app-needs-to-have/
https://www.quicksprout.com/features-of-successful-mobile-commerce-app/
https://bsscommerce.com/knowledge-base/b2b-ecommerce/mobile-commerce-feature/

GSM
- It is a digital cellular technology used for transmitting mobile voice and data services-hence it is a circuit switched system.
- By being a circuit switched it divides each 200Khz channel into eight 25Khz time slots.
- GSM operates on the mobile communication bands of 900Mhz-1800Mhz in most parts of the world.
- GSM is the most widely accepted standard in telecommunications and it is implemented globally.
- It makes use of narrow band Time Division Multiple Access (TDMA) technique for transmitting signals.
- GSM was developed using digital technology. It has an ability to carry 64 kbps to 120 Mbps of data rates
- GSM digitizes and compresses data, then sends it down through a channel with two other streams of user data each in its own time slot

GSM is having 4 different sizes of cells are used in GSM :
1. Macro : In this size of cell, Base Station antenna is installed.
2. Micro : In this size of cell, antenna height is less than the average roof level.
3. Pico : Small cells' diameter of few meters.
4. Umbrella : It covers the shadowed (Fill the gaps between cells) regions.

FEATURES OF GSM THAT ACCOUNT FOR ITS POPULARITY AND WIDE ACCEPTANCE
- Improved spectrum efficiency
- International roaming
- Low cost mobile sets and base stations (BSs)
- High quality speech (Clear voice clarity)
- Ability to support multiple handheld devices.
- Compatibility with Integrated Services Digital Network (ISDN) and other telephone company services
- Ease of accessing network
- Support for new services

GSM Architecture
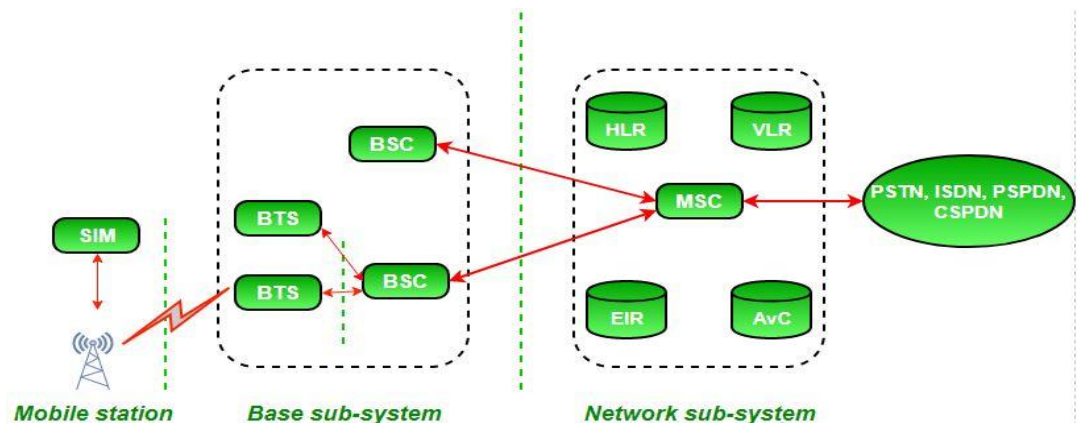
A GSM network has
three major subsystems which comprises of many functional units.
➢ Mobile Station (MS)
➢ Base Station Subsystem (BSS)
➢ Network Switching Subsystem (NSS)
➢ The Operation Support Subsystem (OSS)

Mobile Station (MS)
The mobile station (MS) consists of the physical equipment used by a PLMN(Public Land Mobile Network) subscriber to connect to the network. It comprises of the Mobile Equipment (ME) and Subscriber Identity Module. (SIM)
  - Mobile Equipment can be dispositive portable, mounted on a vehicle, or held in hand. ME forms part of the Mobile Termination (MT) which depending on the application and services.
  - Subscriber Identity Module (SIM) stores permanent and temporary data about the mobile, the subscriber and the network. It permits the **user A** to send a call to a **user B** under subscribed service.

Base Station Subsystem (BSS)
  - Consists of a Base Station Controller (BSC) and one or more Base Transceiver Stations (BTS).
  - Base Station Controller allocates a channel for the duration of a call, maintains the call, monitors quality, controls the power transmitted by BTS or MS and generates a handover to another cell when required.
  - Base Transceiver Station provide access to the mobile station and manage radio access aspects of the system. It contains Radio Transmitter / receiver (TRX), Signal processing and control equipment **and** feeder cables and antennas.

Network Switching Subsystem (NSS)
  - The NSS is responsible for the network operation. It provides the link between the cellular networks and the public switched telecommunication network (PSTN, ISDN, or Data Networks). The NSS controls the handoffs between cells in different BSS, authenticates user and validates their accounts and includes functions for enabling worldwide roaming of mobile suscribers.

The Switch System consists of:
  - Mobile Switch Centre (MSC)
  - Home Location Register (HLR)
  - Visitor Location Register (VLR)
  - Authentication Center (AuC)
  - Equipment Identity Register (EIR)
  - Interworking Functions (IWF)

Mobile Switch Centre
  - Switch calls, controlling calls and logging calls
  - Interface with PSTN, ISDN, PSPDN
  - Mobility management over the radio networks and other networks.
  - Radio management resources and handovers between BSCs
  - Billing information

Home Location Register
  - It is a database software that handles the management of the mobile subscriber account. It stores the subscriber address, service type, current location, forwarding address, authentication/ciphering keys and billing information.
  - The HLR is the reference database that permanently store data related to subscribers, including subscribers' service profile, location information and activity status.

Visitor Location Register

Is the temporary database software similar to the HLR identifying the mobile subscribers visiting inside the coverage area of the MSC. The location register maintains the information about the mobile subscriber that is currently physically in the range covered by the switching center. When a mobile subscriber roams from LA(Local Area) to another, current location automatically updated in the VLR. When the mobile station roams into a new MSC area, if the old and new LAs are under the control of two different VLRs, The VlR connected to the MSC will request the data about the mobile stations from the HLR. The entry on the old VLR is deleted and entry is created in the new VLR by copying the database from the HLR.

Authentication Center

The AuC database holds different algorithms that are used for authentication and encryption of the mobile subscriber information that verify the mobile user identity and ensures the confidentiality of each call.

Equipment Identity Register (EIR)

The EIR is another database that keep the information about the identity of the mobile equipment such as the International Mobile Equipment Identity (IMEI) that reveals the details about the manufactureir, country of production, and device type. This information is used to prevent call being misused, to prevent unauthorized or defective MSs, to report stolen mobile phones or check if the mobile is operating according to the specifications of its type

The Operation Support Subsystem (OSS)

The operations and maintenance center (OMC) is connected to all equipment in the switching system and to the BSC. The implementation of OMC is called the operation and support system (OSS). Here are some of the OMC functions−

- Administration and commercial operation (subscription, end terminals, charging, and statistics).
- Security Management.
- Network configuration, Operation, and Performance Management.
- Maintenance Tasks.

The operation and Maintenance functions are based on the concepts of the Telecommunication Management Network (TMN), which is standardized in the ITU-T series M.30.

Interfaces Used For GSM Network

i.   Um Interface – Used to communicate between BTS and MS.
ii.   Abis Interface – Used to communicate BSC and BTS.
iii. A interface – Used to communicate BSC and MSC
iv.   Singling Protocol – Used to communicate MSC with other network.
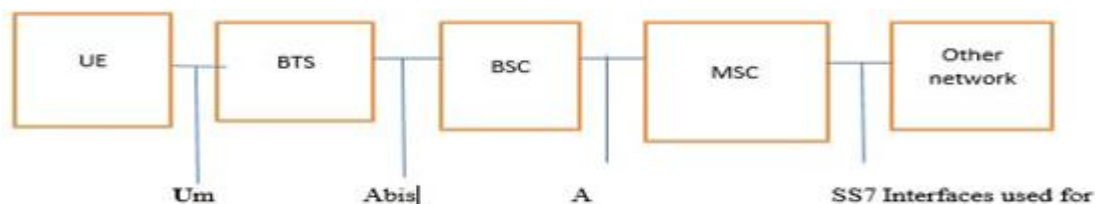
GSM CONCEPTUAL BLOCK DIAGRAM

Fig 2 GSM network Interfaces

APPLICATIONS OF GSM

Access control devices: Now access control devices can communicate with servers and security staff through SMS messaging. Complete log of transaction is available at the head-office Server instantly without any wiring involved and device can instantly alert security personnel on their mobile phone in case of any problem. You can achieve high security any reliability.

Transaction terminals: EDC machines, POS terminals can use SMS messaging to confirm transactions from central servers. The main benefit is that central server can be anywhere in the world. Today you need local servers in every city with multiple telephone lines. You save huge infrastructure costs as well as per transaction cost.

Supply Chain Management: Today SCM require huge IT infrastructure with leased lines, networking devices, data centre, workstations and still you have large downtimes and high costs. You can do all this at a fraction of the cost with GSM M2M technology. A central server in your head office with GSM capability is the answer, you can receive instant transaction data from all your branch offices, warehouses and business associates with nil downtime and low cost.

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GPRS (General Packet Radio Service)

General packet radio service (GPRS) is a mobile communications standard that operates on 2G and 3G cellular networks to enable moderately high-speed data transfers using packet-based technologies.

GPRS is an up-gradation of GSM features over the basic features to obtain much higher data speeds and simple wireless access to packet data networks than standard GSM. It is the standard-bearer of the 2.5G technologies. GPRS is a packet-switched network. In GPRS, billing is based on the amount of data transferred. It allows direct connection to the internet. MMS (Multimedia Messaging Service) is one of the popular features. It can not be offered to all countries as it is confined to developed areas with a proper network connection.

Key Features

Following three key features describe wireless packet data:

- It overlays on the existing GSM network to provide high-speed data service depending on the which type of coding method is used. It is possible to have a data rate up to 150 kbps with GPRS.
- The GPRS system has the ability to offer a data speed of 14.4 kbps to 171.2 kbps that allow comfortable internet access.
- GPRS supports point to pint packet transfer service and points to multipoint packet service.
- The operator does not have to replace equipment; rather, the GPRS system is added on top of the existing infrastructure.
- GPRS based networks have a high bandwidth.
- GPRS is designed to support a bursty application like email, traffic, telemetry, telecommunication, broadcast services, and web browsing.
- GPRS offers a fast connection set up the mechanism to offer a perception of being "always on" connection device. Hence GPRS devices are referred to as the "always connected device".
- The security services provided by GPRS are users Authentication, user access control, user information confidentiality, user identity security.
- GPRS is the packet data score network of 3G systems EDGE and WCDMA.
- GPRS system is independent of the characteristics of the radio channel. GPRS provides the following types of data services like MMS, SMS, WAP

Goals of GPRS
GPRS is the first step toward an end-to-end wireless infrastructure and has the following goals:
- Open architecture
- Consistent IP services
- Same infrastructure for different air interfaces
- Integrated telephony and Internet infrastructure
- Leverage industry investment in IP
- Service innovation independent of infrastructure

GPRS provides the services listed below:
- Broadcasting and SMS messaging
- Cellular-based push-to-talk
- Presence and instant messaging
- Service for multimedia messaging
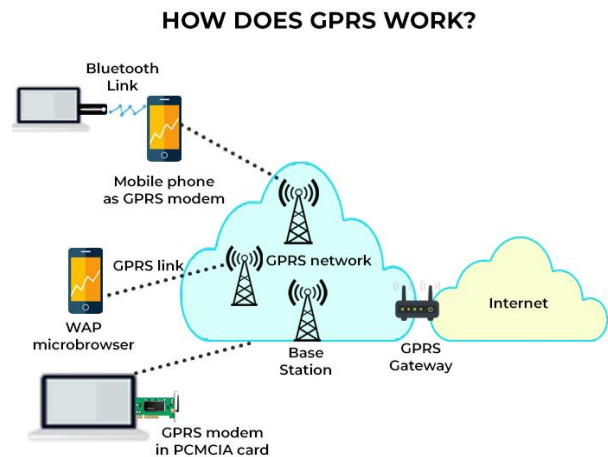- Services such as point-to-point and point-to-multipoint

Requirements to use GPRS
Due to the more advanced infrastructure than traditional 2 G wireless technology, GPRS is considered as 2.5 G technology, but it does not satisfy the need for 3 G developments.
- A service that includes GPRS modem.
- A network of GSM / GPRS.
- A GPRS-aided SIM card.
- A remote location that has internet connectivity or a GPRS network.

How GPRS Establishes a Connected Mobile Environment for IoT Applications

- The communication between the modem and the server is initiated by the GPRS modem (client), and the server responds to the modem by sending back feedback or accepting communication. The modem side and the server side jointly form an application system based on GPRS and INTERNET network communication. Compared with the modem side, the server side installs more complicated application programs, it can accept any communication request initiated by the modem and detect the communication status in the link at all times, thus realizing real-time data collection, database service and other applications.
- The modem needs to know the IP address and port number of the server in advance, and then can initiate a communication request. Once the communication is established, there is no difference between the server and the modem.
- The IP address of the server can be either a public IP address (fixed IP) or a dynamic domain name obtained through a domain name resolution server.
- The port number of the server usually corresponds to a specific application running on the server, for example, port number TCP 21 is used by the FTP service, and TCP 80 is used by the hypertext server (https). That is, the server-side application supports sending and receiving data through a specific port number.

Difference between GSM and GPRS :

S.No	GSM	GPRS
1	GSM stands for Global Systems for Mobile.	GPRS stands for General Packet Radio Service.
2	GSM is a cellular standard for mobile phone communications to cater to voice services and data delivery using digital modulation where SMS has a profound effect on society	GPRS is an up-gradation of GSM features over the basic features to obtain much higher data speeds and simple wireless access to packet data networks than standard GSM.
3	System generation is 2G.	System generation is 2.5G
4	The frequency bands used in the GSM system are 900 and 1800 MHz.	The frequency bands used in the system are 850, 900, 1800 and 1900 MHZ.
5	The type of connection is a circuit-switched network.	Here the type of connection is a packet-switched network.
6	It provides data rates of 9.6 kbps.	It provides data rates of 14.4 to 115.2 kbps.
7	In GSM billing is based on the duration of the connection.	In GPRS billing is based on the features amount of data transferred.
8	It does not allow direct connection to the internet.	It allows direct connection to the internet.
9	It is based on system TDMA	It is based on system GSM.
10	In GSM, single time slot is allotted to a single user.	In GPRS, multiple time slots can be allotted to a single user.
11	It takes long time to connect.	It provides faster connection.
12	In this location area concept is used.	In this routing area concept is used.
13	SMS (Short Messaging Service) is one of the popular features.	MMS (Multimedia Messaging Service) is one of the popular features.

Benefits of GPRS

- GPRS gives higher speed of data transfer compared with fixed telecommunication networks. Its prime speed is 171.2 kbps, almost three times the speed of set-telecommunications.
- It provides immediate fast communication and quick transfer of information.
- GPRS is highly cost efficient.
- GPRS applications are unique and of high standard. It offers web apps over mobile phones and also makes web surfing, IM messages, e-commerce and so on simpler.
- It allows people to connect to the web even when other service providers, including 3 G or HSDPA, are not accessible.

Advantages of GPRS :

- Provide high-speed data service
- Support bursty application like email, traffic, telemetry, broadcast service, and web browsing
- GPRS offers fast connection set up a mechanism to offer a perception of being always on hence the GPRS devices are referred to as always connected
- GPRS based network has high bandwidth
- Provide point to point services
- Mobility provides wireless internet access
- GPRS is not possible to troubleshoot in case of issues
- Deployment is easier
- Communication via GPRS is cheaper than through the regular GSM networks
- Constant connection to the internet

- GPRS provides wireless access to the internet from any location where there is a network signal so that you can surf the internet on your laptop or phone, even in remote areas
- GPRS is still faster than the old WAP (Wireless Application Protocol) data is transferred at speeds ranging from 9.6 kilobytes per second up to 114 kbps
- When you surfing the internet it doesn't block incoming calls enables you to make or receive voice calls while you are browsing the internet or downloading data. So that users can have both voice call and data call together

Disadvantages of GPRS :
- Limited capacity for all users
- Speed much lower in reality
- Data rates supported are slower compared to the latest wireless standards such as LTE or LTE-advanced.
- A mobile station using GPRS can't receive direct GPRS calls
- A network can be affected when a large number of users in the same area utilize the GPRS services at the same time.
- Users may decide to charge based on time rather than volume
- GPRS could be consumed by the public during the public emergency
- Can have high latency, especially text messaging
- Can not troubleshoot means works or doesn't
- Expensive to add terminal above 4
- Slower 72 Kbps vs 11 Mbps
- Transit delay

Application of GPRS

GPRS stands for General Packet Radio Service includes a variety of new and unique services to the mobile wireless subscriber. A wide range of corporate and consumer applications are enabled by nonvoice mobile services such as GPRS will introduce those that are particularly suited to them. Some characteristics of GPRS following below which cause many applications in non-voice mobile services.

1. **Mobility** - GPRS provides constant voice and data communication while on the move.
2. **Immediacy** - GPRS allows the subscriber to obtain connectivity when needed. Not to worry about the location you are in and from where you are logged in.
3. **Localization**:GPRS gives information relevant to their current location on the facility they can get from.

A number of applications are developed using the above three characteristics and provided to the mobile subscriber. All the applications are divided into two high-level categories such as corporation and consumer.

Both two categories again have an application which is listed below.

- **Communication** - Unified messaging, Fax, E-mail, Internet, etc.
- **E-commerce** - Retail applications like Amazon, ticket purchasing using UPI, banking, and financial and trading like balance checking and money transfer between bill payment, overdraft alert, accounts, etc.
- **Value-added services** - Information services and other games include gaming applications.
- **Location-based applications** - Navigation, airlines, rail schedules, location finder, updated traffic conditions.
- **Vertical applications** - Delivery, fleet management, and sales force automation, etc
- **Advertising** - Using location-based application and advertising

Nowadays GPRS applications like chat, multimedia message, networks, personal information management, vehicle positioning, location-based services, and telematics.

Advanced business applications :
- Tracking of taxes and credit card validation for customer payment.
- Localization of stolen cars.
- Control of the position of trucks for transportation companies.
- Support for security and monitoring system.
- Distribution of specific message to a selected group of users.

What Does "G" Mean?

G refers to generation. Several years ago, your cell phone started displaying 4G instead of 3G. We are entering the fifth generation (5G) of specifications that define mobile technology standards. Standards, set by the International Telecommunications Union (ITU), include minimum and maximum speeds, hardware and software, IT protocols, frequencies, and spectrum. . The lifespan of these generations has typically been about a decade.

The first generation was built on analog technology, which enabled cellular voice calls to be made. Then, 2G leaped to using digital infrastructure, which enabled the transmission of multimedia files, SMS texts, and digitally encrypted phone calls over the network.

SECOND GENERATION (2G)
2G refers to the second generation of mobile networks based on GSM. The radio signals used by the 1G network were analog, while 2G networks were digital. 2G capabilities were achieved by allowing multiple users on a single channel via multiplexing. During 2G, cellular phones were used for data along with voice. Some of the key features of 2G were:
- Data speeds of up to 64 kbps
- Use of digital signals instead of analog
- Enabled services such as SMS and MMS (Multimedia Message)
- Provided better quality voice calls
- It used a bandwidth of 30 to 200 KHz

THIRD GENERATION (3G)

- The 3G standard utilises Universal Mobile Telecommunications System (UMTS) as its core network architecture. 3G network combines aspects of the 2G network with new technologies and protocols to deliver a significantly faster data rate. By using packet switching, the original technology was improved to allow speeds up to 14 Mbps. It used Wide Band Wireless Network that increased clarity. It operates at a range of 2100 MHz and has a bandwidth of 15-20 MHz. Some of the main features of 3G are:

- When 3G networks first came online in 2002 The average speed of 3G connections is 3 megabits per second (Mbps), which was 30 times faster than 2G average speed of 100 kilobits per second (or 0.1 Mbps). 3G networks kept features introduced in 2G such as web browsing, streaming, SMS, and roaming, while also offering improved connectivity, speed, and call quality. Although Motorola and Nokia released 3G capable phones as early as 2002, it was not widely adopted as the standard until 2008. The most notable moment was the release of Apple's second iPhone, the iPhone 3G.
- Technologies enabled: Mobile maps and directions, web surfing, 24/7 internet connection, video conferencing, multimedia streaming, simultaneously accessing voice and data.
- To sum up the enhancements made on 3G technology in comparison to the previous mobile technologies, here are its significant features:
    - ✓ 10 times data speed
    - ✓ Improved audio and video streaming
    - ✓ Supports video-conference
    - ✓ Faster Web and WAP browsing
    - ✓ Supports IPTV (TV through the Internet)

FOURTH GENERATION (4G)

- We are currently at the tail end of the 4th generation of mobile data technology. The first 4G networks began to come online in 2011, but carriers did not achieve full 4G coverage until 2014. 4G networks are based on all-Internet Protocol (IP) network to achieve up to 1GB download speeds. This network has essentially the same core protocols as the internet.
- The ITU standardized the capacity of 4G to allow for "highly mobile data," which is the internet connection of 100Mbps achieved while a device moves at high-speed like on a train or in a car. Stationary or more local connections can achieve peak speeds of 1GB. However, these rates are seldom, if ever, achieved by devices on 4G networks. The average download speed on 4G currently sits around 14Mbps (almost five times faster than 3G), and the average upload is close to 8Mbps.
- It would take roughly 40 minutes on 4G to download two full seasons of The Office, which is 5GB in size. It would take over 2 hours to download on 3G. 5G reduces the time it would take to 35 seconds. 4G boasts peak speeds clocking in at 150Mbps upload and 50Mbps download speeds. These are vast improvements over 3G, yet the full promise of 4G has never been realized.
- The main difference between 3G and 4G is the data rate. There is also a huge difference between 3G and 4G technology. The key technologies that have made 4G possible are MIMO (Multiple Input Multiple Output) and OFDM (Orthogonal Frequency Division Multiplexing). The most important 4G standards are WiMAX and LTE. While 4G LTE is a major improvement over 3G speeds, it is technically not 4G. What is the difference between 4G and LTE?
- Even after it was widely available, many networks were not up to the required speed of 4G. 4G LTE is a "fourth generation long term evolution", capable of delivering a very fast and secure internet connection. Basically, 4G is the predetermined standard for mobile network connections. 4G LTE is the term given to the path which has to be followed to achieve those predefined standards. Some of the features of 4G LTE are:
    - ✓ Support interactive multimedia, voice, video.
    - ✓ High speed, high capacity and low cost per bit (Speeds of up to 20 Mbps or more.)
    - ✓ Global and scalable mobile networks.
    - ✓ Ad hoc and multi-hop networks.

Technologies enabled: HD streaming, video game streaming, mobile browsing overtook desktop browsing.

FIFTH GENERATION (5G)

Major mobile phone carriers are deploying 5G wireless networks, with expected 6.5 billion users by 2026. 5G has the potential to be faster than current home broadband, transforming the digital services and internet speeds offered to consumers.

5G has the capability of Low-band (<1GHz), Mid-band (<6GHz), and High-band spectrum (>6GHz). Higher frequencies can move more significant amounts of data faster. In theory, the peak speeds of 5G will be 20 times faster than the theoretical peak speed of 4G (20Gbps on 5G vs. 1Gbps on 4G). Advancements in technology allow 5G antennae to use less power because of their ability to send highly directional signals instead of multidirectional signals like 4G. Thus, it wastes less power, blasting signals only in the direction of its intended target.

Another advantage of 5G is that it can support up to 1,000 more devices per meter than 4G. With more and more internet-connected objects such as smart ovens, robot vacuums, and Alexa coming online, this is a welcome upgrade. 5G will also lower the latency of wireless transmissions to less than ten milliseconds. This upgrade in reliability, coupled with the potential to provide

speeds 20 times faster than current broadband offerings, is why 5G is being touted as a groundbreaking technology with the potential to replace most current home broadband.

2G vs 3G vs 4G vs 5G
Each generation in some way has improved over its predecessor. There is a lot of ground to compare the cell networks over. Following is the comparison between 2G, 3G, 4G, 5G.
The comparison of 2G, 3G, 4G, and 5G clearly shows the differences in the technologies. The comparison of 2G, 3G, 4G, and 5G also makes it evident that 5G is going to be one of the most ambitious leaps in the history of cell network technologies.

Comparision	2G	3G	4G	5G
Introduced in Year	1993	2001	2009	2018
Technology	GSM	WCDMA	LTE,WiMAX	MMO,mmWAVES
Access System	TDMA,CDMA	CDMA	CDMA	OFDM,BDMA
Switching Type	Circuit switching for voice and packet switching for data.	packet switching except for air interference	packet switching	packet switching
Internet Service	Narrowband	Broadband	Ultra broadband	Wireless World Wide Web
Bandwidth	25MHz	25MHz	100 MHz	30 GHz to 300GHz
Advantage	Multimedia features (SMS,MMS), Internet Access and SIM introduced	High security, international roming	Speed, high speed handoffs, global mobility	Extremly high speeds, low latency
Application	Voice call, short message	Video conferencing, mobile TV, GPS	High speed applications, mobile TV, wearable devices	High resolution video streaming, remote control of vehicles,robots and medical procedures

What are the challenges of 5G?
While its use of higher frequencies allows it to push more significant amounts of data faster, there is a trade-off between shorter distance connections and higher absorption rates of the signals. This means that to achieve blanket 5G coverage, carriers will need to deploy many more antennas than previous generations. It also means that they will need to deploy more of these antennas closer to end devices. The frequencies at the higher end of the spectrum are also affected more by environmental factors such as rain, wind, and physical obstructions (like buildings, trees, and mountains) that block the line of sight. Higher frequency signals have less ability to penetrate these obstructions, and more of the signal is lost. 4G operates at a lower end of the spectrum, thus allowing for greater signal penetration and coverage.

Other Technologies
Addressing the lack of high-speed broadband access in rural areas will most likely require a combination of technologies, including cellular such as 4G LTE and 5G, fiber, and satellite internet service providers. The satellite broadband service Starlink is an encouraging option to tackle the rural access issues. Starlink leverages a network of over 1,300 satellites in low Earth orbit to deliver internet service to rural areas. Starlink boasts of download speeds between 50Mbps to 150Mbps. So far, beta testing in the rural UK and the U.S. is seeing an average of 70Mbps. This is almost triple the FCC's standard for broadband of 25Mbps download speeds.