Chapter 4: General Radio Packet System (GPRS)

(16 Marks)

GPRS Architecture
GPRS Networks Nodes
GPRS Network Operations
Data Services in GPRS
Applications and Limitations of GPRS.
Introduction to 3G and 4G Technologies - UMTS, CDMA 2000

Following is the GPRS Architecture diagram:
GPRS architecture works on the same procedure like GSM network, but, has additional entities that allow packet data transmission.

This data network overlaps a second generation GSM network providing packet data transport at the rates from 9.6 to 171 kbps.

Along with the packet data transport the GSM network accommodates multiple users to share the same air interface resources concurrently.

GPRS is usually attempts to reuse the existing GSM network elements as much as possible.

There are new entities called GPRS that supports nodes (GSN) which are responsible for delivery and routing of data packets between mobile stations and external packets networks. There are two types of GSNs,
- Serving GPRS Support Node (SGNS)
- Gateway GPRS Support Node (GGNS)

There is also a new database called GPRS register which is located with HLR. It stores routing information's and maps the IMSI to a PDN (Packet Data Network) address.

**GPRS Mobile Stations**

New Mobile Stations (MS) are required to use GPRS services because existing GSM phones do not handle the enhanced air interface or packet data.

These mobile stations are backward compatible for making voice calls using GSM.

**GPRS Base Station Subsystem**

Each BSC requires the installation of one or more Packet Control Units (PCUs) and
a software upgrade.
- The PCU provides a physical and logical data interface to the Base Station Subsystem (BSS) for packet data traffic.
- The BTS can also require a software upgrade but typically does not require hardware enhancements.
- When either voice or data traffic is originated at the subscriber mobile, it is transported over the air interface to the BTS, and from the BTS to the BSC in the same way as a standard GSM call.
- However, at the output of the BSC, the traffic is separated; voice is sent to the Mobile Switching Center (MSC) per standard GSM, and data is sent to a new device called the SGSN via the PCU over a Frame Relay interface.

**GPRS Support Nodes (GSN)**
- A GSN is a network node which supports the use of GPRS in the GSM core network.
- All GSNs should have a $G_N$ interface and support the GPRS tunnelling protocol. There are two key variants of the GSN, namely Gateway and Serving GPRS support node.
- There are two new components, called Gateway GPRS Support Nodes (GGSNs) and, Serving GPRS Support Node (SGSN) are added.

**Gateway GPRS Support Node (GGSN)**
- The Gateway GPRS Support Node acts as an interface and a router to external networks.
- It contains routing information for GPRS mobiles, which is used to tunnel packets through the IP based internal backbone to the correct Serving GPRS Support Node.
- The GGSN also collects charging information connected to the use of the external data networks and can act as a packet filter for incoming traffic.

**Serving GPRS Support Node (SGSN)**
- The Serving GPRS Support Node is responsible for
  a. Authentication of GPRS mobiles,
  b. Registration of mobiles in the network,
  c. Mobility management, and
  d. Collecting information on charging for the use of the air interface.
- At higher speeds GPRS is designed to provide packet-data Services at higher speeds than those available with standard GSM circuit switched data services.
- In theory GPRS could provide speeds of upto 171 kbps over the air interface, although such speeds are never achieved in practical network. In fact, the practical maximum speed is a little over 100 kbps.

**GPRS Data Services**
- Wide range of corporate and consumer applications are enable by GPRS services. GPRS Service include all normal GSM services but in more efficient way. It also support services like
  a. Email
  b. Web browsing
  c. Enhanced short message
  d. Wireless imaging with instant picture
e. Video service
f. Document and information sharing

- A user is likely to use either of the two modes of the GPRS network. These are
  1. Application mode
  2. Tunneling mode
     1. Application Mode
     - In this mode the user will be using the GPRS mobile phone to access the application running on the phone itself.
     - The phone here acts as the end user devices.
     - All GPRS phone have web browser as embedded application.
     - This browser allows browsing of web sites.
     - Some GPRS device support mobile execution environment.
     2. Tunneling Mode
     - This mode is for mobile computing where the user will use the GPRS interface as an access to the network.
     - The end user device will be a large footprint device like laptop computer or small footprint device like PDA's.
     - The MS will be connected to the device and used as a modem to access the wireless data network.

**GPRS Bearer Services:**

GPRS is a wireless extension of data networks. It can access to data networks, such as IP-based networks (public internet, private intranet, and IPv4 and IPv6 protocols) and X.25 based networks.

GPRS upgrades GSM data services and provides the following services

1. **Point-to-point (PTP) service**: internetworking with the Internet (IP protocols) and X.25 networks.
2. **Point-to-multipoint (PTM) service**: point-to-multipoint multicast and point-to-multipoint group calls.
3. **SMS service**: Bearer for SMS
4. **Anonymous service**: Anonymous access to predefined services
5. **Future Enhancements**: Flexible to add new functions, such as more capacity, more users, new accesses, new protocols, new radio networks.

**GPRS Applications, Limitations**

**Applications:**

- Mobility - The ability to maintain constant voice and data communications while on the move.
- Immediacy - Allows subscribers to obtain connectivity when needed, regardless of location and without a lengthy login session.
- Localization - Allows subscribers to obtain information relevant to their current location.
Limitations:
- **Limited Cell Capacity for All Users**
  - GPRS does impact a network's existing cell capacity. There are only limited radio resources that can be deployed for different uses.
- **Speeds Much Lower in Reality**
  - Achieving the theoretical maximum GPRS data transmission speed of 172.2 kbps would require a single user taking over all eight timeslots without any error protection.
- **Transit Delays**
  - GPRS packets are sent in all different directions to reach the same destination. This opens up the potential for one or some of those packets to be lost or corrupted during the data transmission over the radio link.

**UMTS Universal Mobile Telecommunications System (UMTS)**

1. UMTS (Universal Mobile Telecommunications Service) is a third-generation (3G) broadband, packet-based transmission of text, digitized voice, video, and multimedia at data rates up to 2 megabits per second (Mbps).
2. Universal Mobile Telecommunications System (UMTS) is a wireless interface standard and has evolved since late 1996 under the European Telecommunications Standards Institute (ETSI).
3. UMTS is an upgrade from GSM via GPRS or EDGE.
4. The standardization work for UMTS is carried out by the Third Generation Partnership Project (3GPP).
5. UMTS offers a consistent set of services to mobile computer and phone users, which is not depend on the location.
6. Users will get access to the internet via a combination of terrestrial wireless and satellite transmissions.
7. The 3G W-CDMA air interface standard had been designed for “always-on” packet based wireless service, so that computers, entertainment devices, and communication devices all share the same wireless network and be connected to the Internet, anytime, anywhere.
8. W-CDMA is used to transfer packet up to 2.048 Mbps per user (if the user is stationary), thereby allowing high quality data, multimedia, streaming audio, streaming video and broadcast-type services to consumers.
9. Future versions of W-CDMA will support stationary user data rates in excess of 8 Mbps.
10. W-CDMA designers contemplate that broadcasting, mobile commerce (m-commerce), games, interactive video, and virtual private networking will be possible throughout the world, all from a small portable wireless device.
11. UMTS also makes it possible to provide new services like alternative billing methods or calling plans. For instance, users can choose to pay-per-bit, pay-per-session, flat rate, or asymmetric bandwidth options.
12. The higher bandwidth of UMTS also enables other new services like video conferencing.
13. UMTS may allow the Virtual Home Environment (VHE) to fully develop, where a roaming user can have the same services to either at home, in the office or in the field through a combination of transparent terrestrial and satellite connections.
4G (LTE stands for Long Term Evolution)
1. Next Generation Mobile broadband technology
2. LTE, an abbreviation for Long-Term Evolution, commonly marketed as 4G LTE, is a standard for wireless communication of high-speed data for mobile phones and data terminal.
3. The standard is developed by the 3GPP (3rd Generation Partnership Project).
4. Promises data transfer rates of 100 Mbps while moving and 1 Gbps while stationary.
5. Based on UMTS 3G technology
6. Optimized for All-IP traffic
7. It is based on the GSM/EDGE and UMTS/HSPA network technologies, increasing the capacity and speed using a different radio interface together with core network improvements.
8. LTE is the natural upgrade path for carriers with both GSM/UMTS networks and CDMA2000 networks.
9. The different LTE frequencies and bands used in different countries will mean that only multi-band phones will be able to use LTE in all countries where it is supported.

Advantages of LTE

- 3G vs. 4G
- Less Complexity, Faster Transmission
- Unlike the 3G networks which are a combination of circuit switched and packet switched networks, 4G will be based on packet switching only. This will allow low-latency data transmission.

Advantages of 4G:
- Quickly download files over a wireless network
- Extremely high voice quality
- Easily access Internet, IM, Social Networks, streaming media, video calling, etc.
- Higher bandwidth
- 4G is 10 times faster than 3G
Disadvantages of 4G:

- New frequencies means new components in cell towers.
- Higher data prices for consumers
- Consumer is forced to buy a new device to support the 4G
- It is impossible to make your current equipment compatible with the 4G network
- 4G is only currently available in certain cities

**CDMA2000**

- It is a 3rd generation version of CDMA ONE or IS-95.
- It addresses the specification for indoor, indoor to outdoor, pedestrian & vehicular environment.
- CDMA 2000 can operate in wide range of environments viz,
  - Indoor / Outdoor picocell (<50 m radius)
  - Indoor / Outdoor microcell (upto 1km radius. E.g shopping mall)
  - Outdoor macrocell (1-35 km radius)
  - Outdoor megacell (>35 km radius)
  - Wireless in Local loop (WILL)
- Two types of data services are currently under consideration for CDMA 2000.
  - These are packet data and high speed circuit switched data.
- Packet data will be used for burst traffic like internet of mails.
- The circuit switched data can be used for delay sensitive real time traffic.
- Video applications are potential candidates for circuit switch data as they need a dedicated channel for the duration of the call.

**Questions**

1. Describe data services used in GPRS. (4M S-15)
2. Explain UMTS in detail (4M S-15)
3. Give application and limitation of GPRS (4M S-15)
4. Explain GPRS architecture in detail with neat sketch. (8M S-15 / W-15)
5. List and explain in short types of bearers services in GPRS (4M W-15).
6. Describe CDMA 2000 technology
7. List bearer services provided in GPRS and describe each of them.