GENERAL PACKET RADIO SERVICE (GPRS)

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AP/CSE

What is GPRS?

- A new bearer service for GSM that greatly improves and simplifies wireless access to external Packet Data Networks(PDN), e.g to the internet.
- General Packet Radio Service
  - General → not restricted to GSM use
  - Packet Radio → enables packet mode communication over air ie. packet switching
  - Service, not System → existing BSS (partially also NSS) infrastructure is used

What is GPRS?

- Billing
  - GSM→ Based on time duration of connection
  - GPRS → Based on amount of transmitted data rather duration of connection
- GPRS allows broadcast, multicast, and unicast.
- In GPRS no connection has to setup prior to data transfer.
- GPRS needs additional network elements ie. The hardware and the software.
- Requires many new network elements into NSS
- Provides connections to external packet data networks (Internet, X.25)

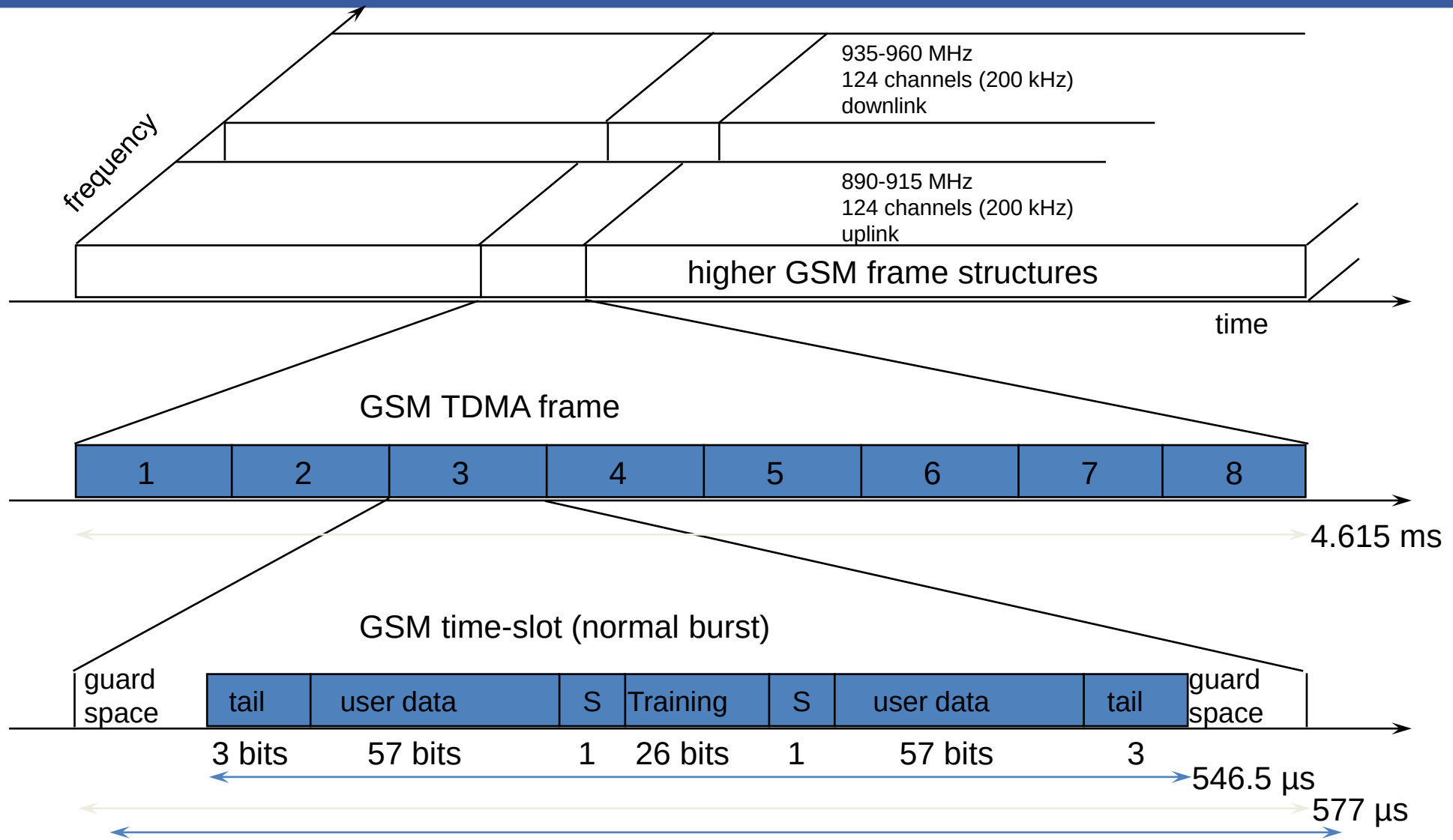
What is GPRS?

- Main benefits
  - Resources are reserved only when needed and charged accordingly
  - Connection setup times are reduced
  - Enables new service opportunities
- Advantage: More flexible
- Disadvantage: More investment needed (new hardware and software)

GPRS Time Slots

- GSM allocates time slots between 1 and 8 within a TDMA frame for a GPRS.
- Time slots are not allocated in a fixed, predetermined manner but on demand.
- All time slots can be shared by the active users..
- Uplink and downlink are allocated separately.
- Data transfer rate is upto 170kbps
- Operators usually reserve atleast a time slot per cell to guarantee a minimum data rate.
- Channel characteristics and the type of channel and does not limit the maximum data rate.
- All GPRS services can be used in parallel to conventional services.

GSM Time slot



GPRS user data rates in kbps

Coding scheme	1 slot	2 slots	3 slots	4 slots	5 slots	6 slots	7 slots	8 slots
CS-1	9.05	18.1	27.15	36.2	45.25	54.3	63.35	72.4
CS-2	13.4	26.8	40.2	53.6	67	80.4	93.8	107.2
CS-3	15.6	31.2	46.8	62.4	78	93.6	109.2	124.8
CS-4	21.4	42.8	64.2	85.6	107	128.4	149.8	171.2

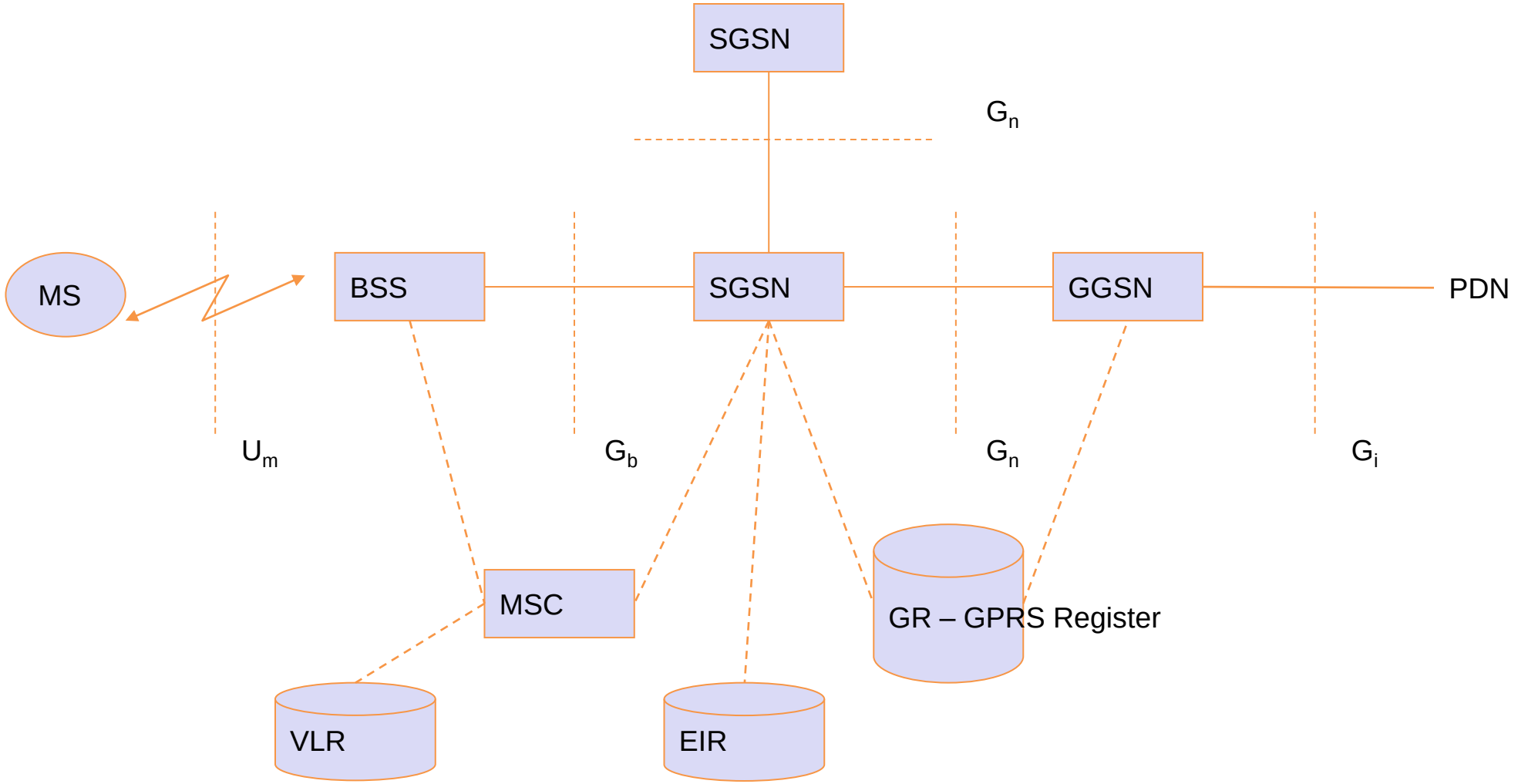
Examples for GPRS device classes

Class	Receiving slots	Sending slots	Maximum number of slots
1	1	1	2
2	2	1	3
3	2	2	3
5	2	2	4
8	4	1	5
10	4	2	5
12	4	4	5

GPRS Services

- Point-to-Point Service
  - Between 2 users.
  - Connection less or Connection oriented
  - Toll road system, UIC train control system
- Point-to-Multipoint Service
  - Multicast, Broadcast
  - Weather info, road traffic info, news, fleet management

GPRS Architecture



GPRS Architecture

GSM Network Element	**Modification or Upgrade Required for GPRS.**
Mobile Station (MS)	New Mobile Station is required to access GPRS services. These new terminals will be **backward compatible with GSM for voice calls**.
BTS	A **software upgrade** is required in the existing base transceiver site.
BSC	The base station controller (BSC) requires a **software upgrade** and the installation of new hardware called the **packet control unit (PCU).** The PCU directs the data traffic to the GPRS network and can be a separate hardware element associated with the BSC.
GPRS Support Nodes (GSN)	The deployment of GPRS requires the installation of new core network elements called the serving GPRS support node (SGSN) and gateway GPRS support node (GGSN).
Databases (HLR,VLR etc)	All the databases involved in the network will require **software upgrades** to handle the new call models and functions introduced by GPRS.

Interfaces

- Gb
  - Interface between the BSS and the SGSN the transmission protocol could be Frame Relay or IP.
- Gn
  - IP Based interface between SGSN and other SGSNs and (internal) GGSNs
- Gi
  - IP based interface between the GGSN and a public data network (PDN) either directly to the Internet or through a WAP gateway

GPRS Mobile Stations

- Mobile Station with GPRS services is needed. Because old GSM phones do not handle the enhanced air interface or packet data.
- A variety of MS can exist, including a high-speed version of current phones to support high-speed data access
- These mobile stations are backward compatible for making voice calls using GSM.

GPRS BSS

- The BTS requires a software upgrade but typically does not require hardware enhancements.
- 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.
- When either voice or data traffic is originated at the Mobile Station, 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

- Following two new components, called GPRS support nodes (GSNs), are added:
  - Gateway GPRS support node (GGSN)
  - Serving GPRS support node (SGSN)

Gateway GPRS Support Node

- The Gateway GPRS Support Node acts as an interface and a router to external networks.
- The GGSN 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 can act as a packet filter for incoming traffic.

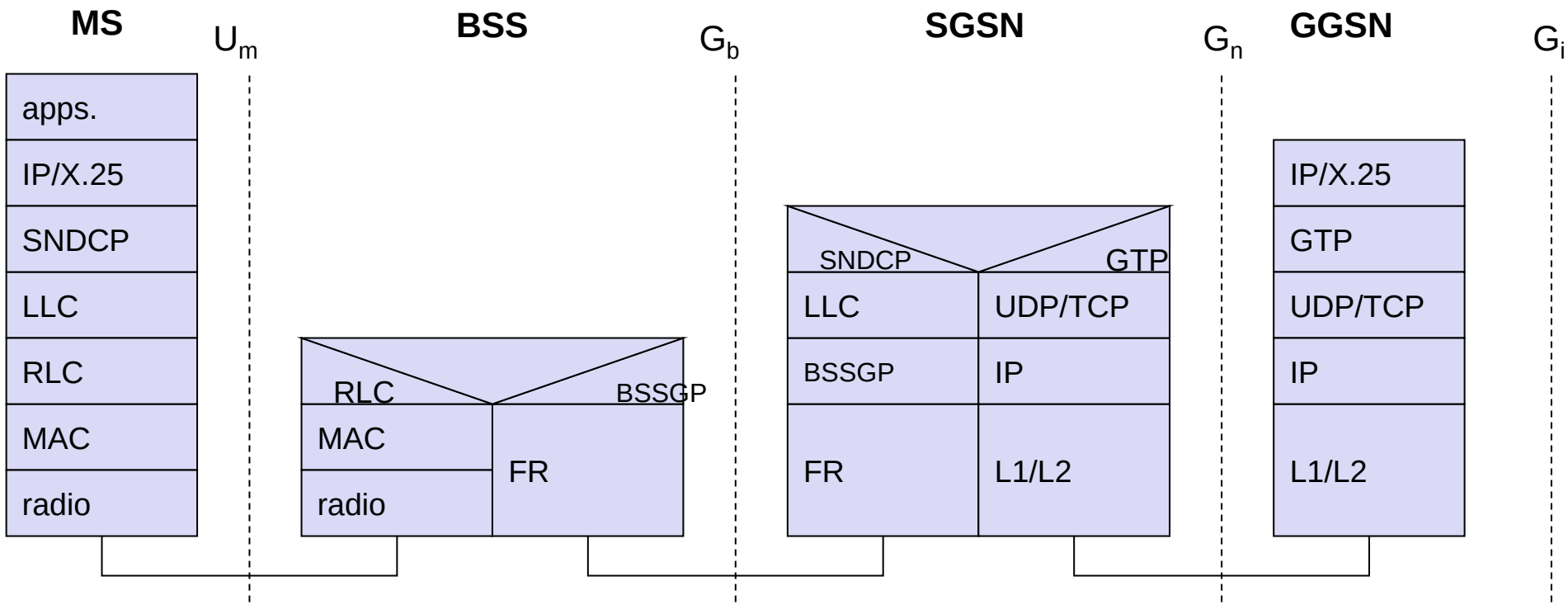
Serving GPRS Support Node

- The Serving GPRS Support Node is responsible for
  - authentication of GPRS mobiles,
  - registration of mobiles in the network,
  - mobility management, and
  - collecting information for charging for the use of the air interface.

Internal Backbone

- The internal backbone is an IP based network used to carry packets between different GSNs.
- Tunneling is used between SGSNs and GGSNs, so the internal backbone does not need any information about domains outside the GPRS network.
- Signaling from a GSN to a MSC, HLR or EIR is done using SS7

GPRS protocol architecture



GPRS protocol architecture

- **GPRS Tunnellling Protocol (GTP)**
  - All data within the GPRS backbone, i.e., between the GSNs, is transferred using GTP
  - GTP use two different transport protocols:
    - The reliable **TCP (needed for reliable transfer of X.25 packets)**
    - The non-reliable **UDP (used for IP packets).**
- The network protocol for the GPRS backbone is **IP (using any lower layers)**
- X.25 → Packet switched n/w for WAN
- Framerelay → Physical and Datalink layers for WAN

GPRS protocol architecture

- **Subnetwork dependent convergence protocol (SNDCP)**
  - To adapt to the different characteristics of the underlying networks, **SNDCP** is used between an SGSN and the MS
- On top of SNDCP and GTP, user packet data is tunnelled from the MS to the GGSN and vice versa.
- **Logical Link control (LLC)**
  - To achieve a high reliability of packet transfer between SGSN and MS
  - Comprises ARQ and FEC mechanisms for PTP (and later PTM) services

GPRS protocol architecture

- **Base station subsystem GPRS protocol (BSSGP)**
  - Conveys **routing and QoS-related information** between the BSS and SGSN.
  - BSSGP does not perform error correction and works on top of a frame relay (FR) network
- **Radio link protocol (RLC)**
  - to transfer data over the U_m interface.

Quality of Service

- Service Precedence:
  - The service precedence is the priority of a service in relation to another service.
  - There exist three levels of priority: high, normal, and low.
- Reliability:
  - The reliability indicates the transmission characteristics required by an application.
  - Three reliability classes are defined, which guarantee certain maximum values for the probability of loss, duplication, mis-sequencing, and corruption of packets.

Quality of Service

- Delay
  - The delay is defined as the end-to end transfer time between two communicating mobile stations or between a mobile station and the Gi interface to an external packet data network.
  - This includes all delays within the GPRS network, e.g., the delay for request and assignment of radio resources and the transit delay in the GPRS backbone network.
  - Transfer delays outside the GPRS network, e.g., in external transit networks, are not taken into account.

Quality of Service

- Throughput
  - The throughput specifies the maximum/peak bit rate and the mean bit rate.
- Using these QoS classes, QoS profiles can be negotiated between the mobile user and the network for each session, depending on the QoS demand and the current available resources.
- The billing of the service is then based on the transmitted data volume, the type of service, and the chosen QoS profile.

Summary

- Why GPRS?
- GPRS Architecture
- GPRS Quality of Service

Test your Knowledge

- Mention the advantages of GPRS over GSM.
- Without GPRS whether packet data can be transmitted over GSM???

References

Jochen H. Schller, “Mobile Communications”, Second Edition, Pearson Education, New Delhi, 2007.