GSM and GPRS

MCS: GSM

Global System for Mobile Communications

GSM evolution

- GSM=Global System for Mobile Communications
- GSM Evolution:
  - 1979 the 900MHz band reserved
  - 1982 *Groupe Spécial Mobile* under CEPT (Post &Telecom European Conference)
  - 1988-89 GSM taken over by ETSI (European Telecommunication Standard Institute)
  - 1990-91
    - ‘Phase 1’ recommendations
    - DCS1800
  - 1992 first commercial GSM networks
  - 1995 ‘Phase 2’ recommendtions issued
  - 1998 3GPP (3rd Generation Partnership Project)

GSM 900, 1800, 1900

- GSM 900: 2 x 25 MHz frequency bands:
  - 890-915 MHz UL, 935-960 MHz DL
  - 124 carriers, 200 kHz each
  - Extended version: 2x35MHz 880-915MHz UL, 925-960MHz DL, 174 carriers, 200kHz each
- GSM 1800 (Digital Cellular System -DCS)
  - At the request of the UK
  - 2x75MHz frequency bands:
  - 1710-1785 MHz UL, 1805-1880 MHz DL
  - 374 carriers (200kHz/carrier)
- GSM 1900 (Personal Communication System or PCS1900)
  - North and South American version of DCS 1800
- GSM 850
  - same frequency range like AMPS, D-AMPS, IS-95 (American standards)
  - 824-890MHz UL, 869-894MHz DL, 124x200kHz carriers

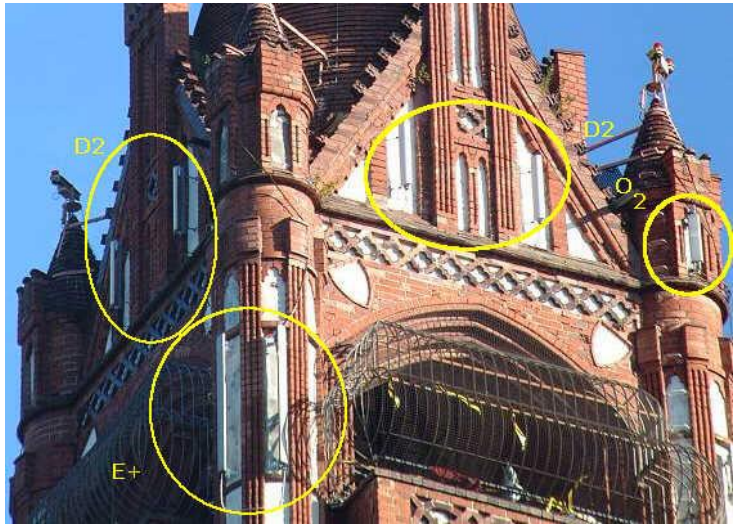
Architecture of the GSM system [JS]

- GSM is a PLMN (Public Land Mobile Network)
  - several providers setup mobile networks following the GSM standard within each country
  - components
    - MS (mobile station)
    - BS (base station)
    - MSC (mobile switching center)
    - LR (location register)
  - subsystems
    - RSS (radio subsystem): covers all radio aspects
    - NSS (network and switching subsystem): call forwarding, handover, switching
    - OSS (operation subsystem): management of the network

Ingredients 1: Mobile Phones [JS]

The visible but smallest part of the network!

Ingredients 2: Antennas [JS]



Still visible – cause many discussions…

Ingredients 3: Infrastructure 1[JS]

Base Stations

Microwave links

Cabling

Ingredients 3: Infrastructure 2[JS]

Switching units

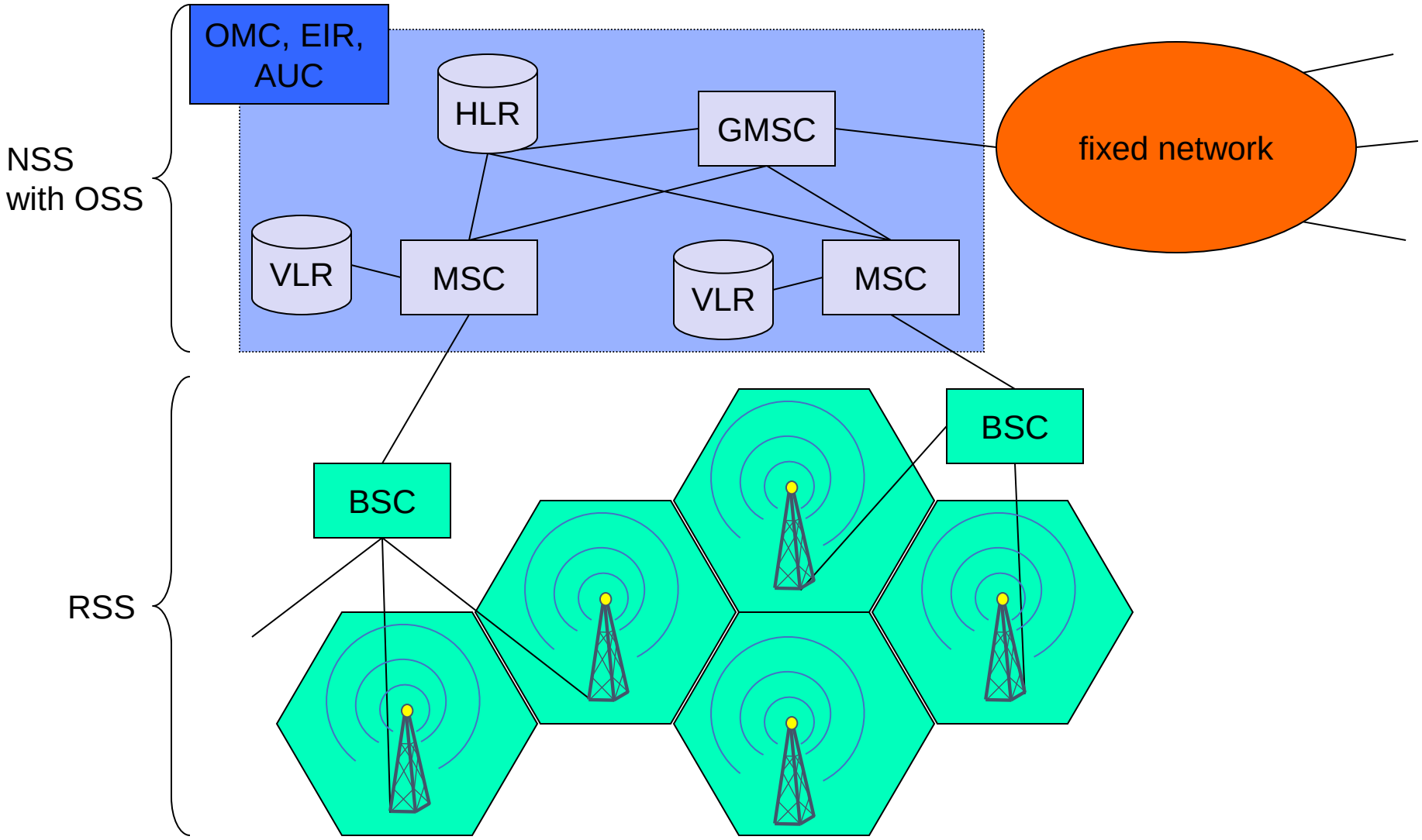
Management

Data bases

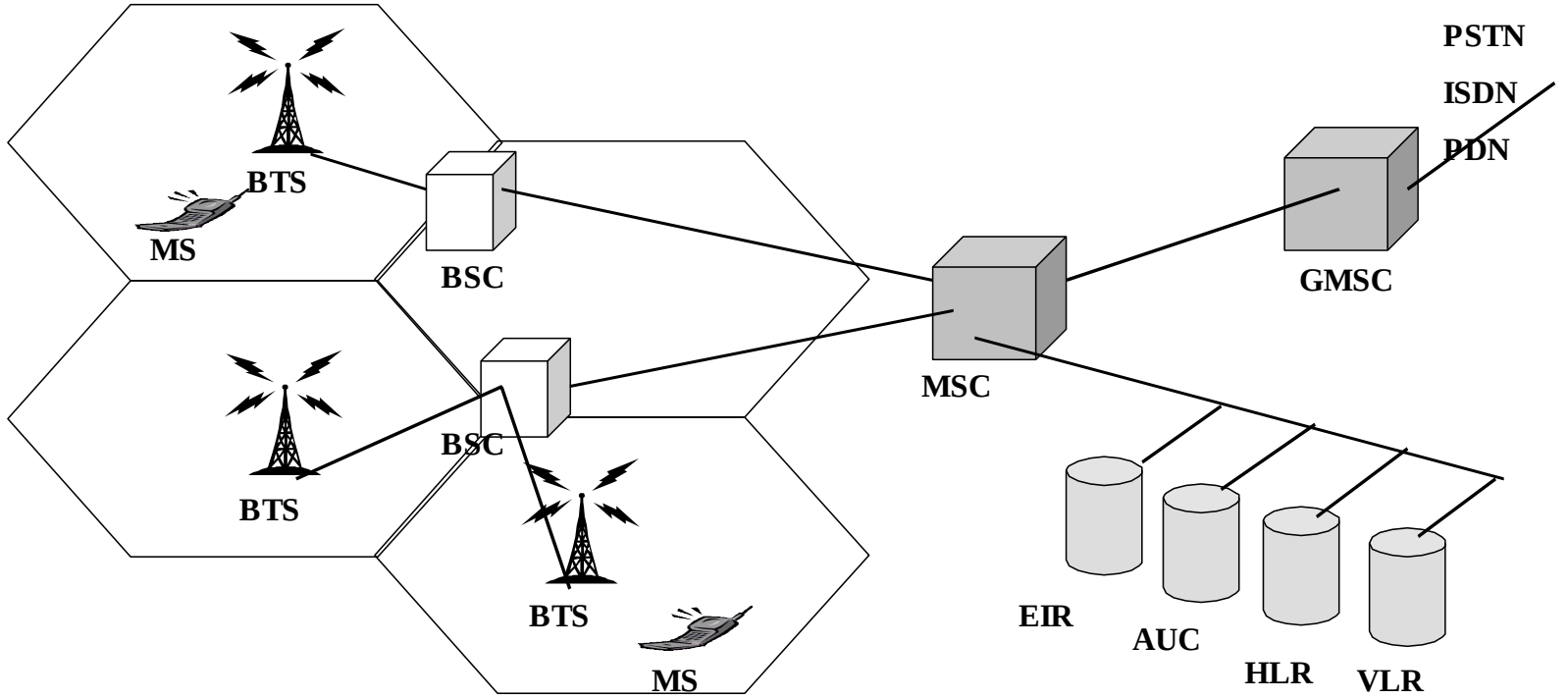
Monitoring

Not „visible“, but comprise the major part of the network (also from an investment point of view…)

GSM: overview[JS]



GSM architecture



BTS = Base Transceiver Station
BSC = Base Station Controller
BSS = Base Station Subsystem (BTS+BSC)
MSC= Mobile Switching Center
GMSC = Gateway MSC
MS = Mobile Station

HLR = Home Location Register
VLR = Visitor Location Register
EIR = Equipment Identity Register
AUC = Authentication Center
PSTN = Public Switched Telephone Network
ISDN = Integrated Services Digital Network
PDN = Packet Data Network

GSM architecture. Elements

- Radio subsystem (RSS) (mobile station + base station subsystem)
  - Used for radio access
  - If the network deals with both CS and PS traffic, their path is common in RSS
- Core network or Network Sub System (*NSS*):
  - Separate CS and PS paths, if both are available
- Operation Sub System (*OSS*) – resources used by the operator to manage the network.
  - Often called OMC (Operation and Management Center)

GSM architecture. Radio subsystem

- *MS* (Mobile Station) (or UE – user equipment)
  - used by a subscriber to call another subscriber
  - Consists of SIM (Subscriber Identity Module) and MT (Mobile Terminal)
  - SIM stores administrative and security data, location data
  - Only emergency calls can be done without SIM
  - MT: radio transmission, speech encoding/decoding, cyphering, Human machine interface, SMS, etc
- *BSS* (Base Station Subsystem), consisting of
  - *BTS* (Base Transceiver Station): sender and receiver, antenna, deals with physical channels, consists of high power elements
  - *BSC* (Base Station Controller): controlling several BTSs, manages radio resources, logical channel management, handover management
  - BSS = BSC + sum(BTS) + interconnection

GSM architecture. Core network

- MSC:
  - Main component of the public land mobile network (PLMN) of GSM
  - switch exchange with specific GSM functions regarding mobility, handover, etc
  - Covers a geographical area and manages several BSCs
- Databases:
  - HLR (home location register – permanent and semi-permanent data of all subscribers, including the current VLR)
  - VLR (located on MSC) – contains copy of HLR data for the users in the area of the MSC + location information (location area – group of cells)
- Network nodes involved in authentication process: AuC – authentication center

Data services in GSM II [JS]

- GPRS (General Packet Radio Service)
  - packet switching
  - using free slots only if data packets ready to send
    (e.g., 50 kbit/s using 4 slots temporarily)
  - standardization 1998, introduction 2001
  - advantage: one step towards UMTS, more flexible
  - disadvantage: more investment needed (new hardware)
- GPRS network elements
  - GSN (GPRS Support Nodes): GGSN and SGSN
  - GGSN (Gateway GSN)
    - interworking unit between GPRS and PDN (Packet Data Network)
  - SGSN (Serving GSN)
    - supports the MS (location, billing, security)
  - GR (GPRS Register)
    - user addresses: in HLR

MCS: GPRS

General Packet Radio Service

GPRS - motivation

- Data transmission in GSM: CSD (fixed 9.6 kbps data rate), SMS (max 256 characters/message), HSCSD High Speed Circuit Switched Data
- Drawbacks of using circuit switching for data transfer:
  - Long connection establishment duration (due to negociations for resource reservations) compared to data transfer duration
  - Network resources are reserved for the entire duration of the connection, even if there is no data to be transferred: not suited for *bursty* traffic, as it is most of the data traffic (e.g. WWW)
  - Billing is time-based, not based on the volume of data transfered
- Packet switching (PS) is much more efficient for data traffic
- GPRS: truly PS service for data transfer, implemented **over** the existing GSM networks
- Requirements: minimum costs, different services than those offered in GSM
- Applications: e-mail, FTP, WWW, multimedia, etc.

GPRS - Motivation

- General Packet Radio Service (GPRS) – mainly IP
  - Connectionless data transfer - always on-line
  - New set of interfaces - new packet switched network
  - Instantaneous bit rates can range from 8 kbps to 115 kbps
- **Dynamic allocation of resources:**
  - **a MS can use several channels, and several MS can be multiplexed on the same channel**
- Problem is not only with the air interface
- Channel path through the entire system should be different for packet data and voice
- Entire new architecture required to overlay existing GSM system
- EGPRS: uses a different modulation techniques in order to ensure higher data rates (approx 3 times higher than in GPRS)

General architecture of GPRS network

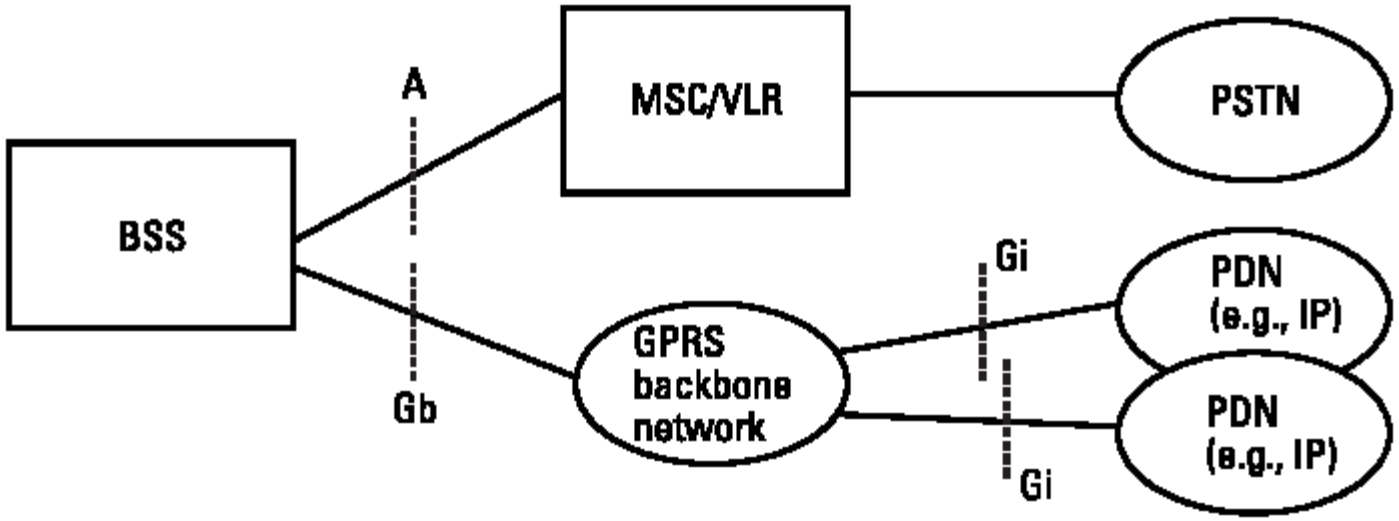
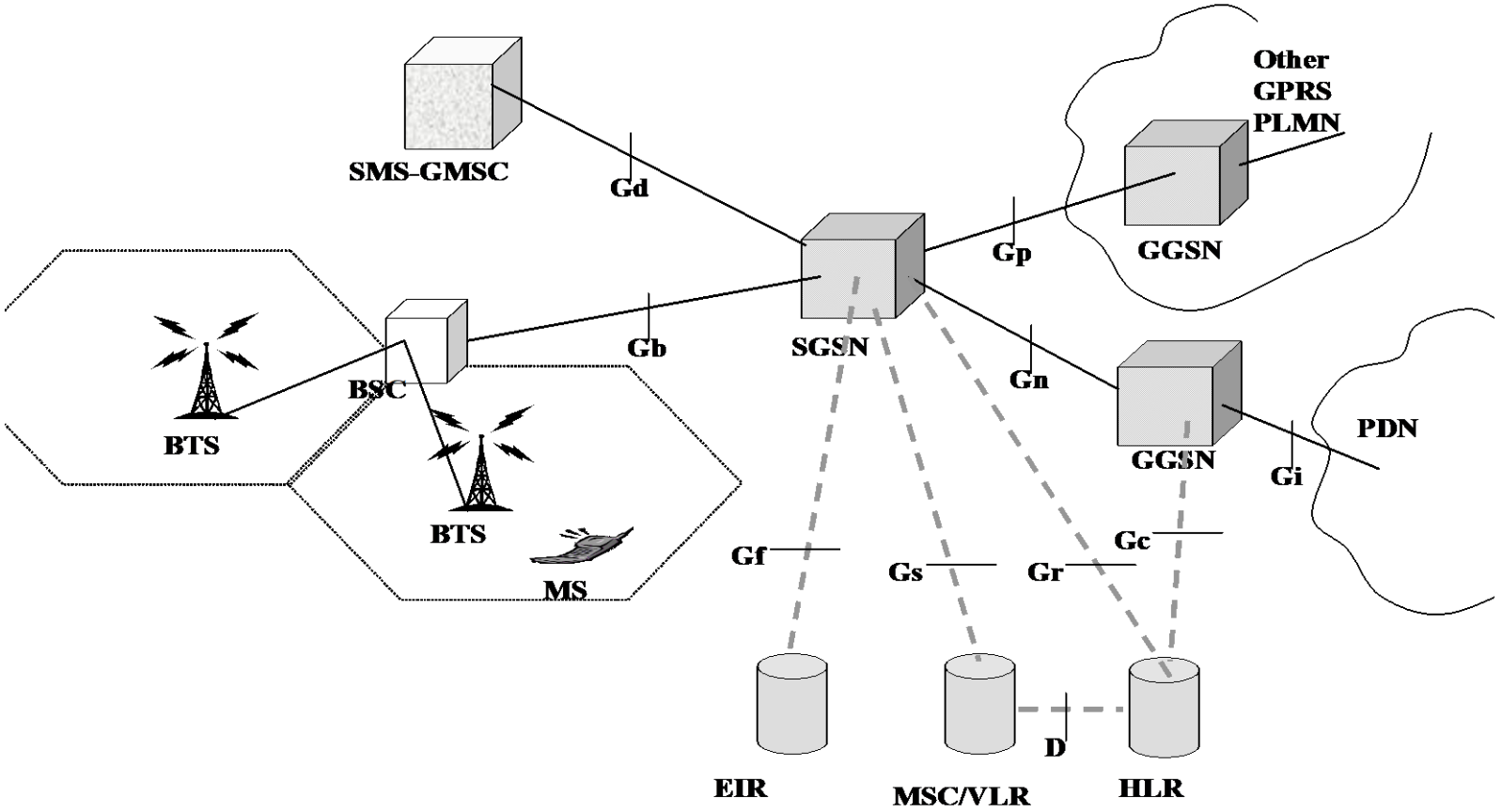


Fig. 1.1 ‘General architecture of the GPRS network’ from [SSP03]
PS traffic routed through the GPRS backbone network (GSS – GPRS SubSystem) towards the external Packet Data Networks (PDNs)

GPRS system architecture



SGSN = Serving GPRS Support Node
GGSN = Gateway GPRS Support Node
SMS-GMSC = SMS-Gateway MSC
PDN = Packet Data Network
PLMN = Public Land Mobile Network

Fig 1.2. from [Tod06]. Based on [CG97] and [BVE99]

Legend

- MS - Mobile Station
- (MN - Mobile Node: UMTS designation for MS)
- BTS - Base Transceiver Station
- BSC - Base Station Controller
- PCU - Packet Control Unit
- SGSN - Serving GPRS Support Node
- GGSN - Gateway GPRS Support Node
- PCU is part of the BSS
- BSC must communicate with an SGSN and an MSC
- Packet switched traffic and circuit switched traffic have different core networks

Overview of resource allocation in GPRS

- In GPRS, resources are allocated at different levels:
  - GPRS attach:
    - a logical link established between MS and SGSN
  - Session, or PDP context activation:
    - A route is established between MS, SGSN, GGSN and an external server outside GPRS network
  - Micro-connection (TBF establishment):
    - Between MS and BSS, in one direction and one cell
    - Radio channels are allocated to a user (a MS)
  - Radio block:
    - different users that share a PDCH are scheduled on a time basis
    - Level: MAC
    - Period: radio block period (20ms)

Main transactions. Resource allocation in GPRS

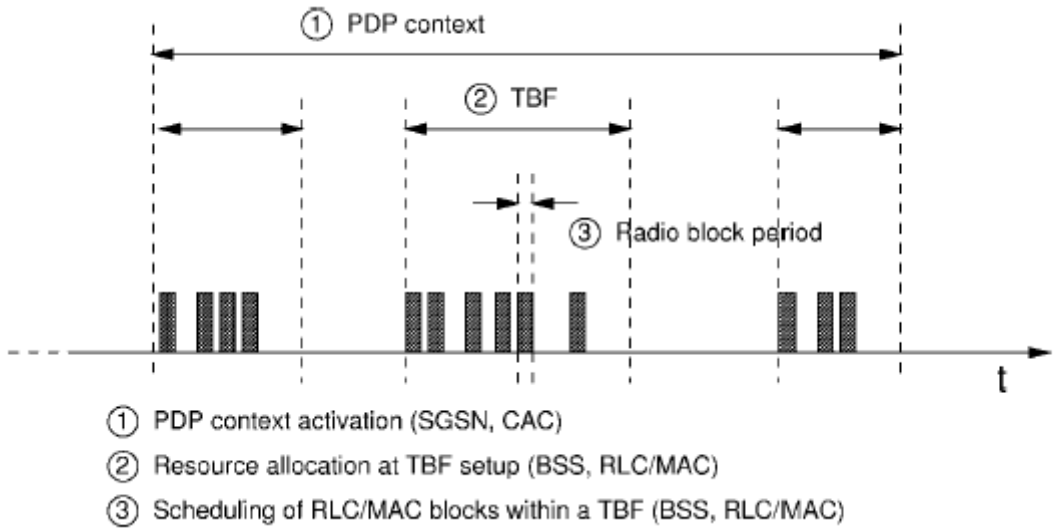


Fig. 2. ‘Three-stage QoS management’ from [SM01]

GPRS QoS specification

- Release’97:
- Characterised by:
  - The service precedence
  - Delay
  - reliability
  - Peak and mean throughput
- Problems:
  - Only 1 QoS profile per PDP context
  - BSS not involved in QoS negotiation
  - Too manny QoS classes

- Release’99:
- Same like UMTS QoS
- Characterised by traffic classes:
  - Conversational (voice, telent)
  - Streaming
  - Interactive (WWW)
  - Background (e-mail, FTP)
- Solves the problems of Rel’97 QoS specifsication