GSM and GPRS

無線通訊課程補充教材

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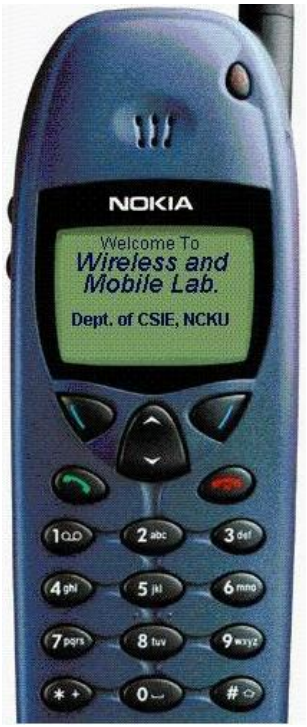


Outline

- 第2代 (GSM)
- 第 2.5代行動網路 (GPRS)

Global System for Mobile Communications (GSM)

GSM 歷史延革

- 1982年，CEPT 開始在其內部建立一個 Groupe Special Mobile來發展無線網路
- 1987年，MoU（Memorandum of Understanding）被歐洲政府提出來實現在歐洲的GSM網路，並且建立一個GSM MoU的機構
- 1989年， GSM變成ETSI的一個技術機構
- 1990年， GSM900 phase 1告一段落而開始DCS1800的研究
- 1991年， DCS1800第一個系統正式啟用
- 1995年， GSM900 phase 2被提出

GSM 硬體架構和介面(I)

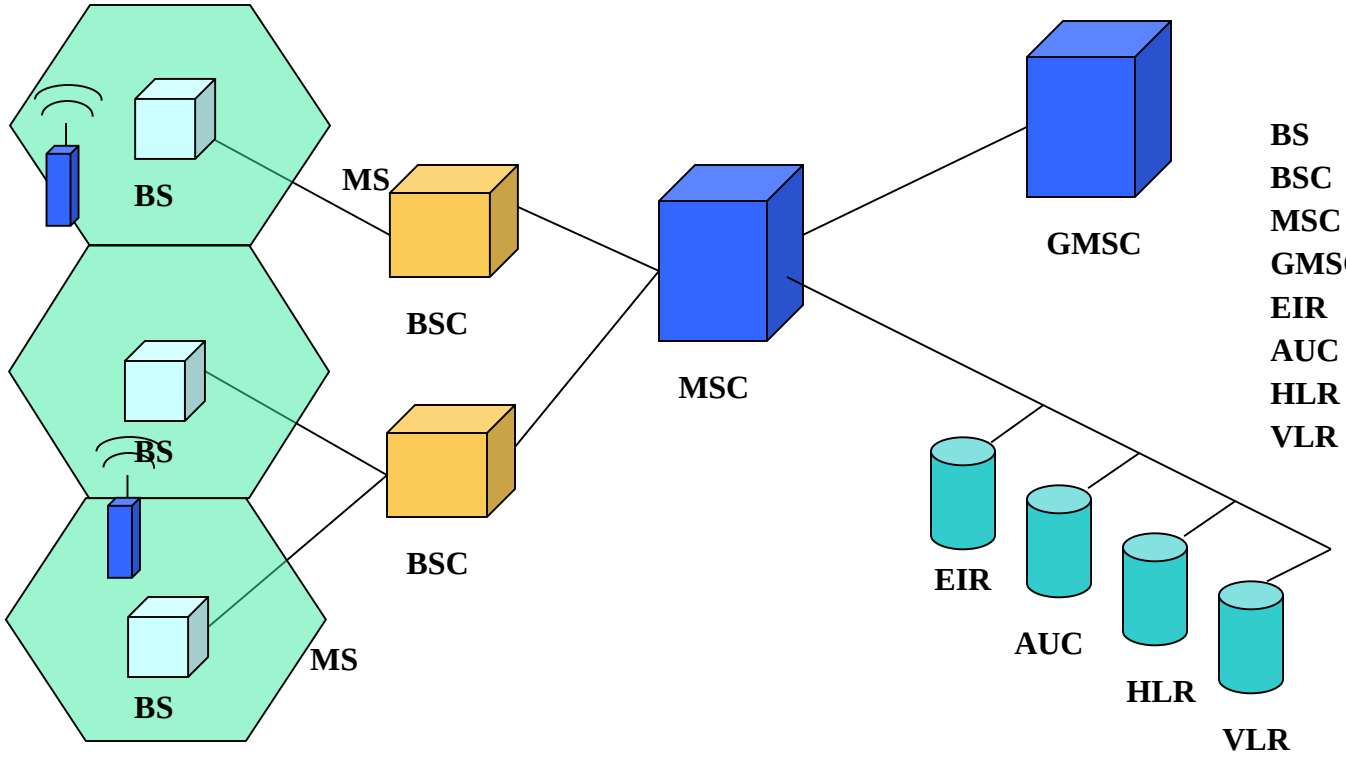
- 基地台子系統（BSS）
  - MS（Mobil Station）移動台／移動用戶
  - BS（Base Station）基地台
  - BSC（Base Station Controller）基地台控制器
  - BTS（base Transceiver Station）基地收發信台

GSM 硬體架構和介面(II)

- 網路子系統（NSS）
  - MSC (Mobile Switch Center) 移動交換中心
  - VLR (Visitor Location Register) 拜訪位置暫存器
  - HLR (Home Location Register) 所屬位置暫存器
  - AuC (Authentication Center) 權限中心
  - EIR (Equipment Identity Register) 設備識別暫存器
  - OMC (Operation & Maintenance Center) 操作維護中心

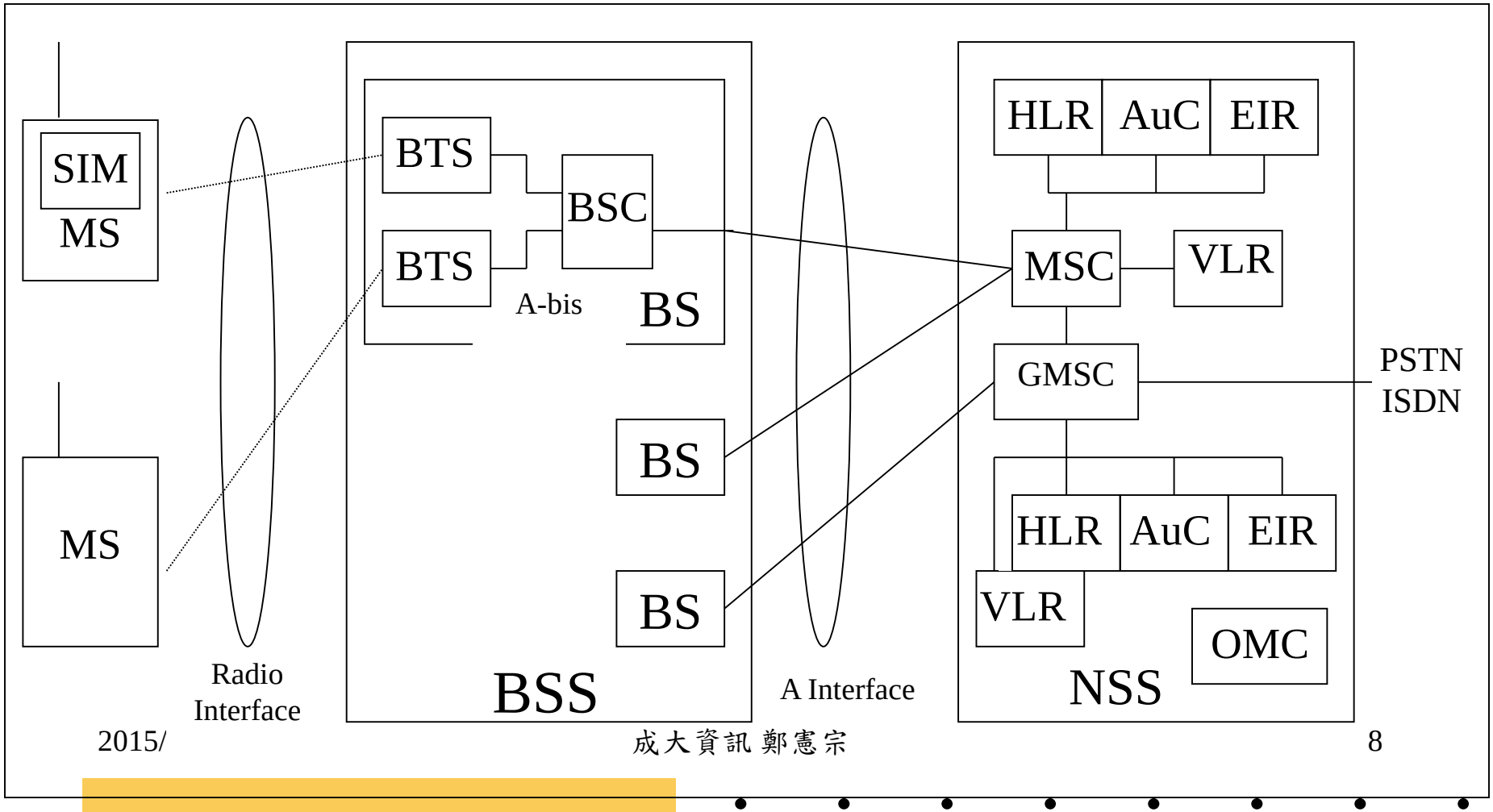
GSM Architecture

- GSM system architecture with essential components.



BS	Base Station
BSC	Base Station Controller
MSC	Mobile Switching Center
GMSC	Gateway MSC
EIR	Equipment identity register
AUC	Authentication Center
HLR	Home Location Register
VLR	Visitor Location Register

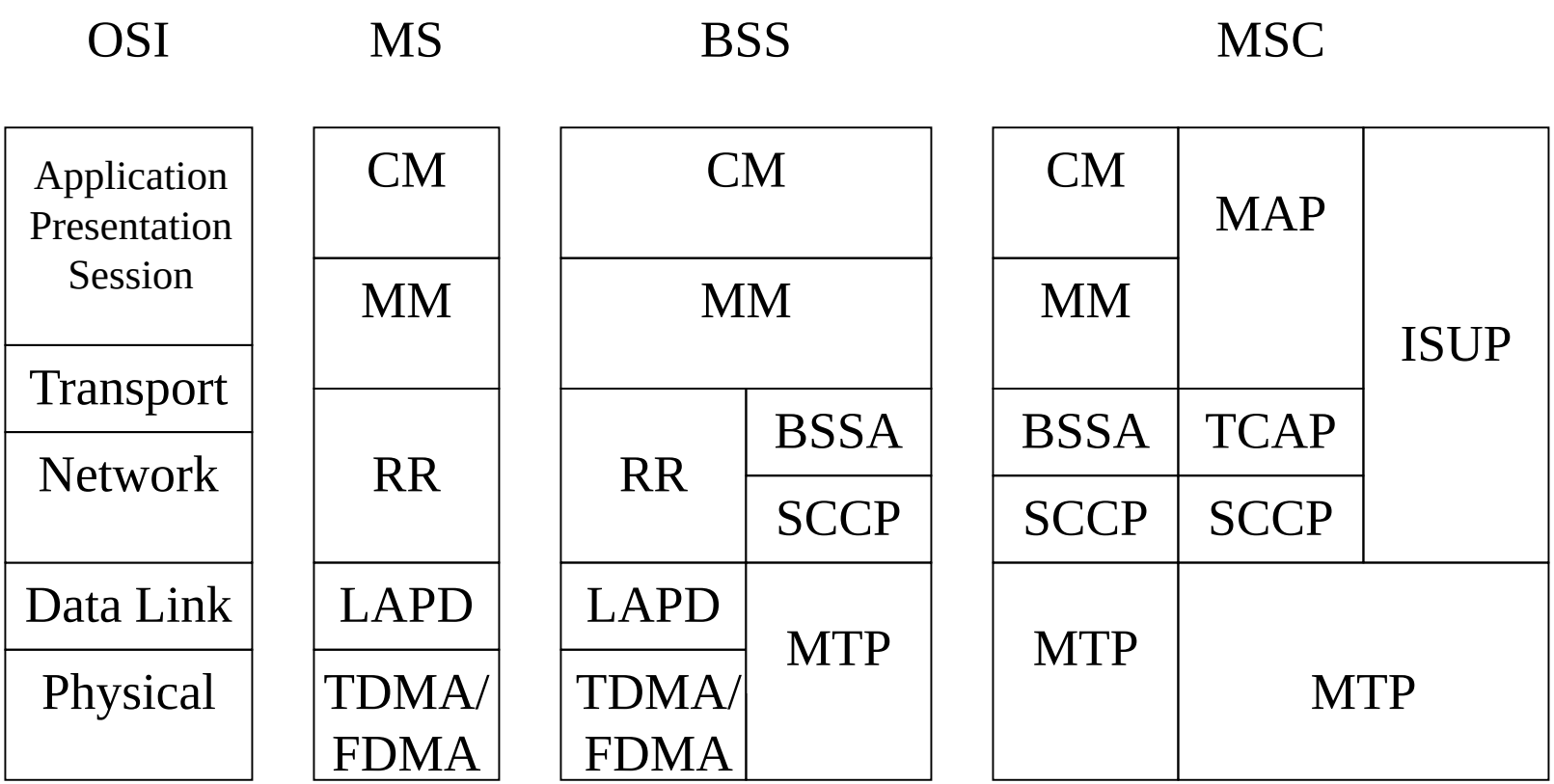
GSM 硬體架構圖


SIM
MS
MS
Radio
Interface
BTS
BTS
BSC
A-bis
BS
BS
BS
BSS
A Interface
HLR
AuC
EIR
MSC
VLR
GMSC
PSTN
ISDN
HLR
AuC
EIR
VLR
OMC
NSS

GSM 提供之服務

- 通話服務
- 多人通訊及有關的服務(Multi-party comm., phase II)
- 通用無線封包服務
- 短訊息服務

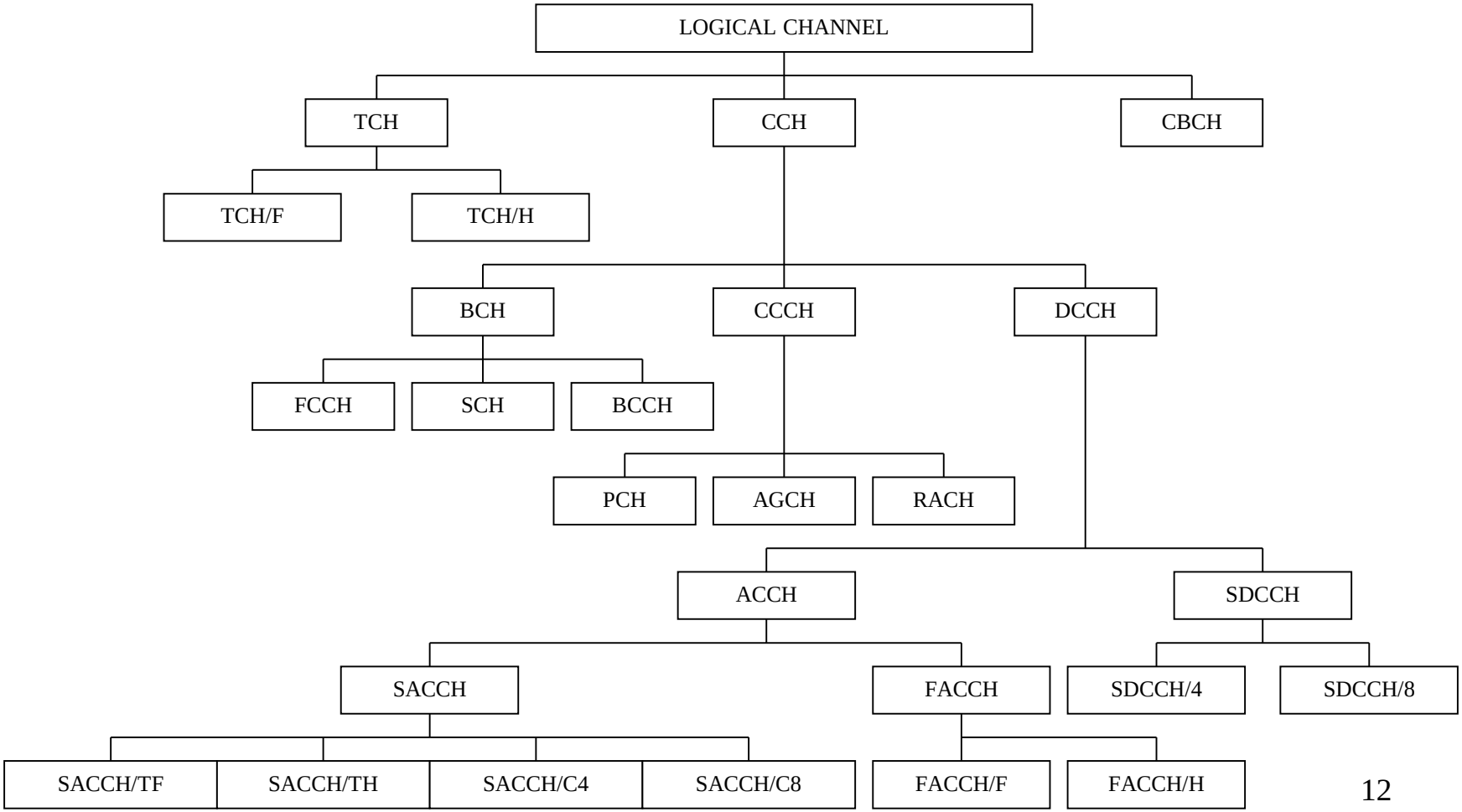
GSM 通訊協定架構


OSI
MS
BSS
MSC
Application
Presentation
Session
Transport
Network
Data Link
Physical
CM
MM
RR
LAPD
TDMA/
FDMA
CM
MM
RR
BSSA
SCCP
LAPD
TDMA/
FDMA
MTP
CM
MM
BSSA
SCCP
MAP
TCAP
SCCP
ISUP
MTP
MTP

GSM通訊協定第一層

- 實際通訊頻道 (Physical Channel)
  - 時槽（Time Slot）做單位來傳送，而每個時槽扣除末端8.25 bit的Guard Time（通常是空白的，用來確保兩相鄰的時槽傳送時不會重疊）稱為一個Burst。
  - 8個Time Slots可以合成一個Frame，26個Frames可以合成一個Multiframe，26個Multiframes可以合成一個Super Frame，51個Super Frames可以合成一個Hyper Frame，最多有2048個連續的Hyper Frames。
- 邏輯通訊頻道 (Logical Channel)

GSM 邏輯通訊頻道一覽表



GSM 邏輯通訊頻道

- 服務頻道（TCH）: TCH/F 與 TCH/H
- 控制頻道 (CCH)
  - 廣播頻道 (BCH)
    - 頻率校正頻道（FCCH）
    - 同步頻道（SCH）
    - 廣播控制頻道（BCCH）
  - 公共控制頻道 (CCCH)
    - 尋呼頻道（PCH）
    - 隨機使用頻道（RACH）/ 允許使用頻道（AGCH）

GSM 邏輯通訊頻道 (cont.)

- 專用控制頻道（DCCH）
  - 獨立專用控制信道（SDCCH）
  - 慢速聯合控制頻道（SACCH）
  - 快速聯合控制頻道（FACCH）

GSM通訊協定第三層

- RR (radio resource) 無線電頻道資源子層
  - 初始化
  - 傳送管理
  - 交接處理
  - 電力控制
  - 預測時間
  - 無線頻道管理
- MM (mobility management) 行動管理子層
  - 管理位置更正、註冊程序
  - 提供認證、與保密的服務

GSM通訊協定第三層 (cont.)

- CM (connection management) 連接管理子層
  - 手機端產生的呼叫建立程序
  - 送到手機端的呼叫建立程序
  - 質問程序
  - 呼叫釋放
  - 短訊息

Summary Remarks

- GSM represents a first approach to personal communication at any time, anywhere, to anyone.
- Differentiation and Generality of GSM network architecture forms a basis for next generation of mobile communication technology.

General Packet Radio Service (GPRS)

Outline

- GPRS Objectives
- System architecture
- GPRS Service
- Session management,mobility management,and routing
- Air interface – physical layer
- Protocol architecture
- Why GPRS

GSM Data Limitations

- Uplink and downlink channels allocated for a user entire call period
- Low bandwidth per user (9.6 Kpbs)
- User pays based on duration,not based on volume
- GSM is designed for speech,not data

GPRS Objectives

- GPRS uses packet switched resource allocation
- Dynamic channel allocation
  - 1 to 8 time slots
  - Available resources shared by active users
  - Up and down link channels reserved separately
  - GPRS and circuit switched (GSM) services can use same time slots alternatively
- Efficient delivery of SMS over the GPRS air interface
- Connections with data networks
  - IP network,X.25,GPRS own protocols

GPRS Applications

- Applications
  - Standard data network protocol based
    - TCP/IP protocol applications
      - WWW,FTP,Telnet etc
    - X.25 (connection-oriented) based applications
  - GPRS specific protocol based
    - Point-to-Point (PTP) applications
    - Pont-to-multipoint (PTM) applications

GPRS Characteristics

- Transmission modes
  - Send and receive data in packet transfer mode
  - Cost effective and efficient use of network resources
- Traffic characteristics
  - Transient bursty data transmissions
  - Frequent transmission of small amount of data
  - Infrequent transmission of larger amount of data
- Transmission
  - Four level of radio priorities and five classes of QOS supported
  - PTP and PTM

GPRS Services

- Existing GSM services versus GPRS
  - GSM services
    - Connections with circuit switched networks
    - Continuous flow of data in both direction
  - GPRS services
    - Connection with external packet data networks
    - Typical connection can last several hours
    - Data transmission bursty
    - Uplink and downlink transmissions independent
    - Packets are small

GPRS Services

- GSM services
  - Every MT call causes query to HLR
  - All services activated at IMSI attach
  - Charging is based on time
- GPRS services
  - Every network element knows where to rout packet further
  - No need to access HLR for every GPRS packet
  - User can activate each service separately
  - Charging is based on amount of transmitted data

GPRS Services

- Bearer services and supplementary services
  - Point-to-point service (PTP)
  - Point-to-multipoint service (PTM)
    - Using the multicast service PTM-M
    - Using the group call service PTM-G
  - SMS service
  - Anonymous service

QoS on GPRS

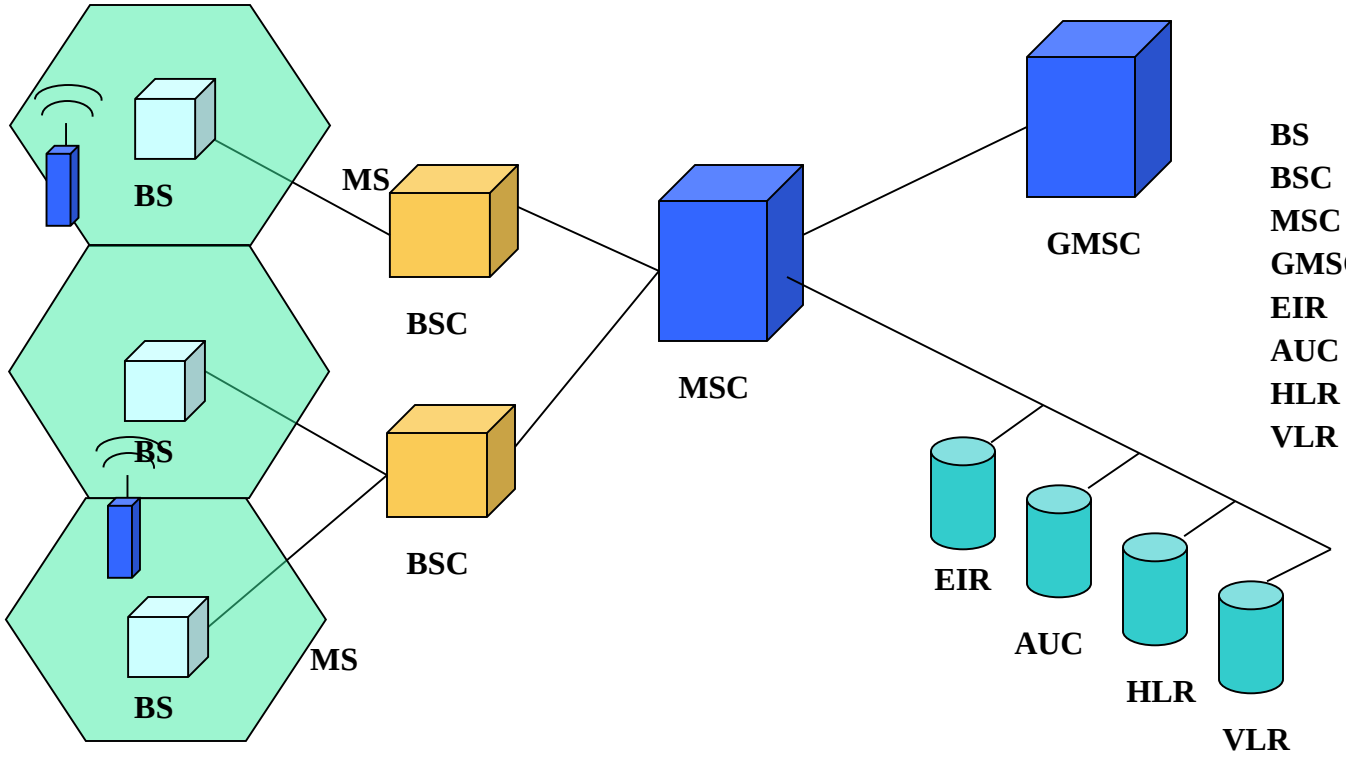
- Service precedence : the priority of a service in relation to another service (high, normal, low)
- Reliability : indicates the transmission characteristics required by an application (three classes are defined)
- Delay Parameters : defines maximum values for the mean delay and the 95-percentile delay
- Throughput : specifies the maximum/peak bit rate and mean bit rate

System Architecture

- GSM Architecture
- GPRS Architecture

GSM Architecture

- GSM system architecture with essential components.



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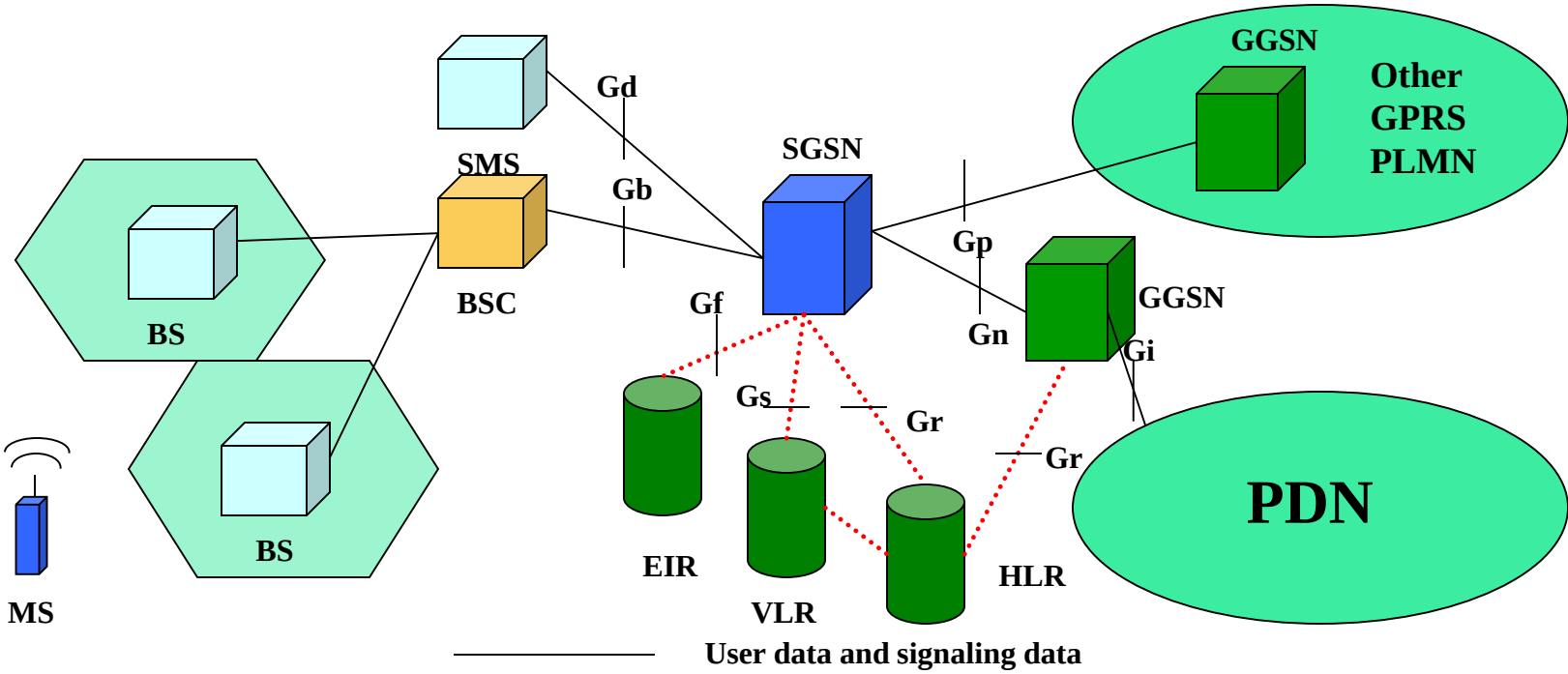
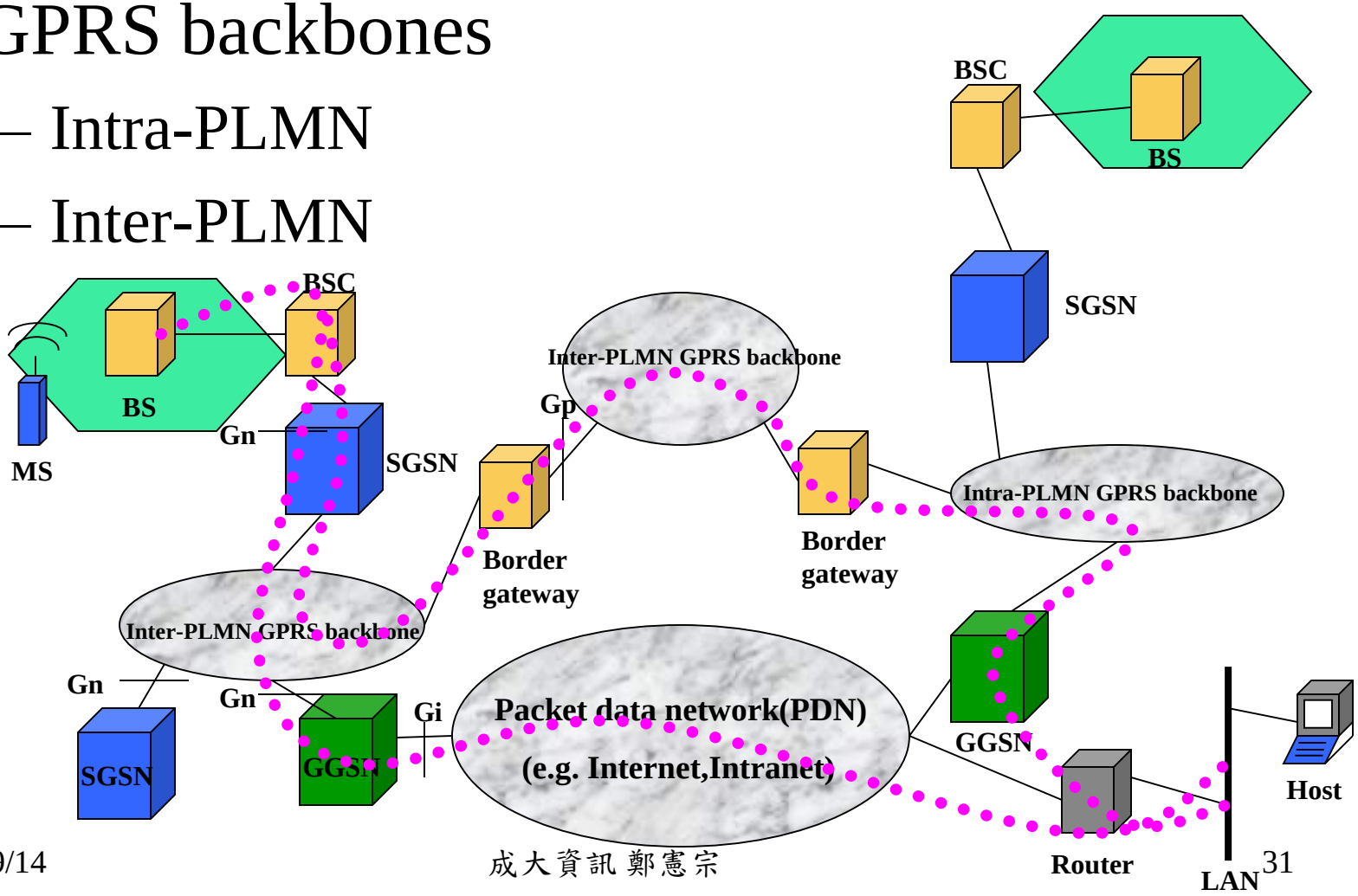
GPRS Architecture

- Service GPRS support node(SGSN)
- Gateway GPRS support node(GGSN)



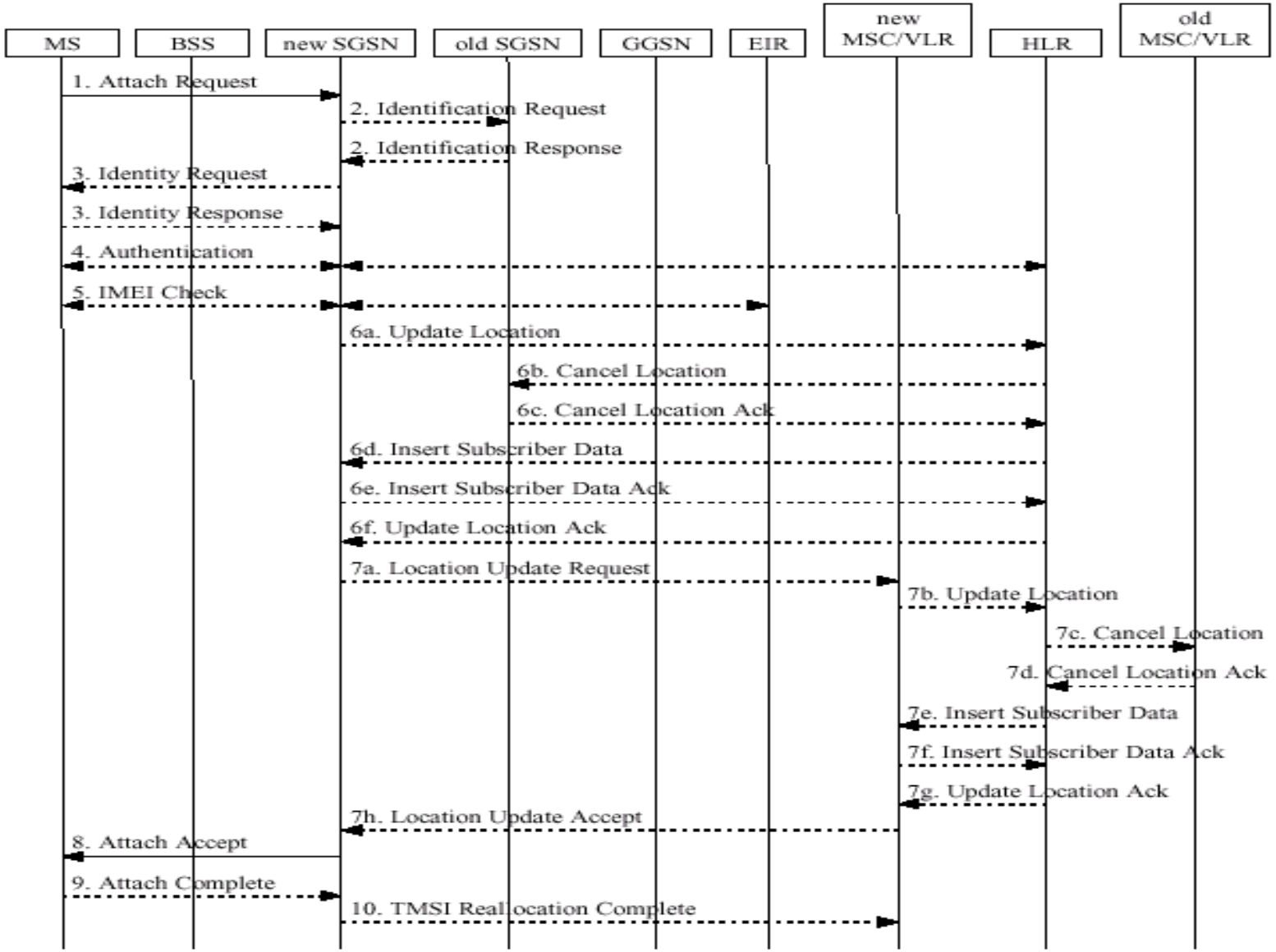
GPRS Architecture

- GPRS backbones
  - Intra-PLMN
  - Inter-PLMN

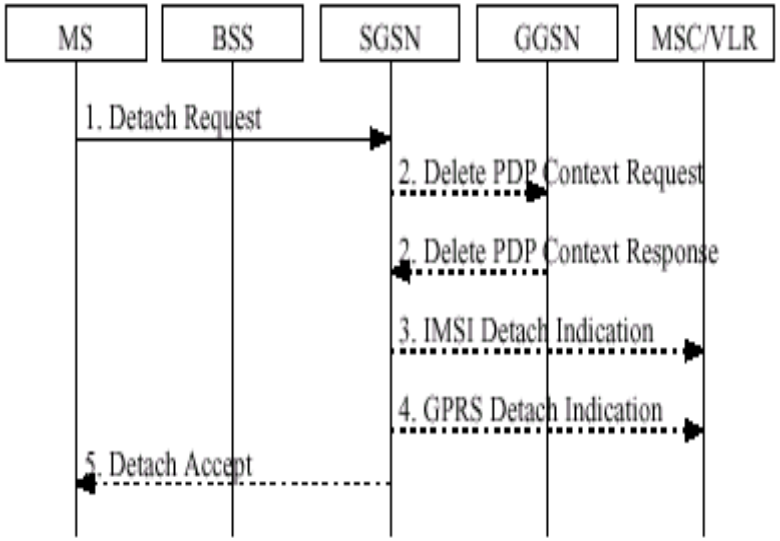


Attachment and Detachment Procedures

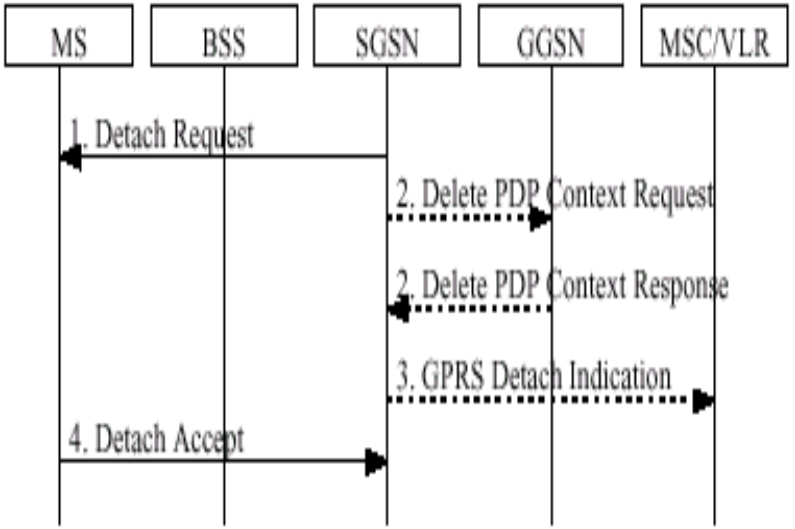
- Routing (參考上一頁)
- Attachment procedure (參考下一頁)
- Detachment procedure
  - IMSI detach,GPRS detach,IMSI/GPRS combine detach
  - MS-Initiated detach,Network-Initiated detach



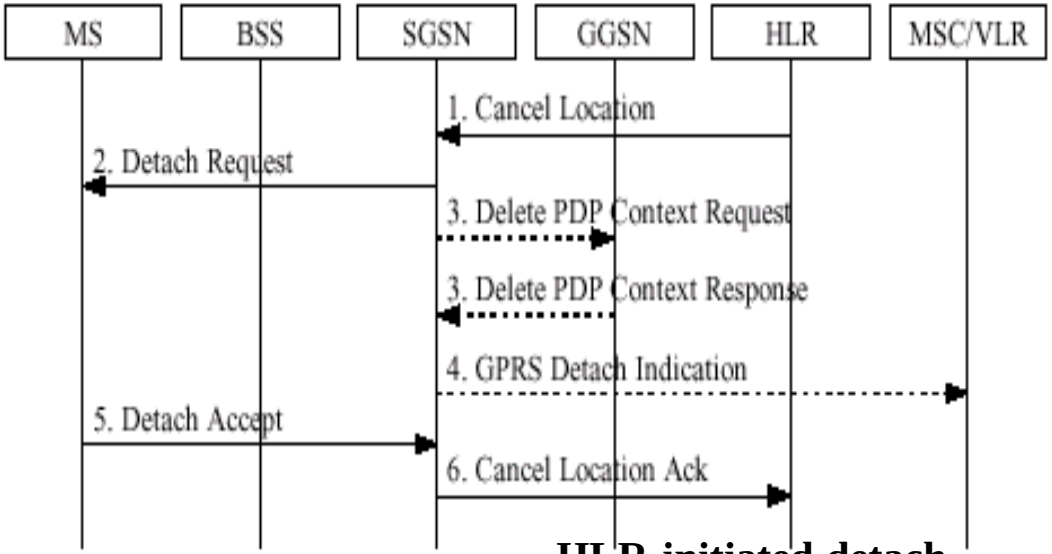
Attachment procedure



MS-initiated detach



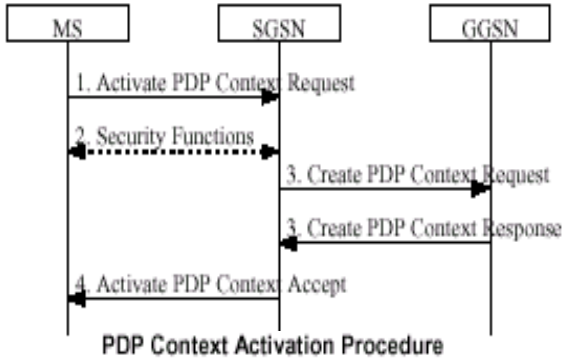
SGSN-initiated detach



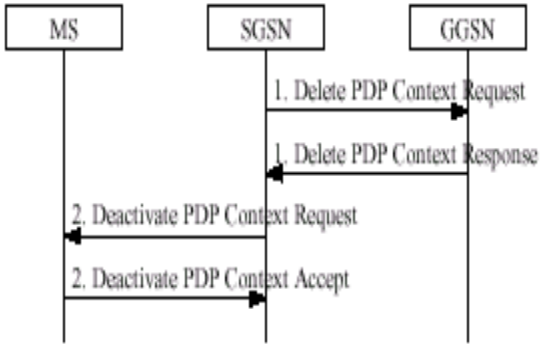
HLR-initiated detach

Session Management

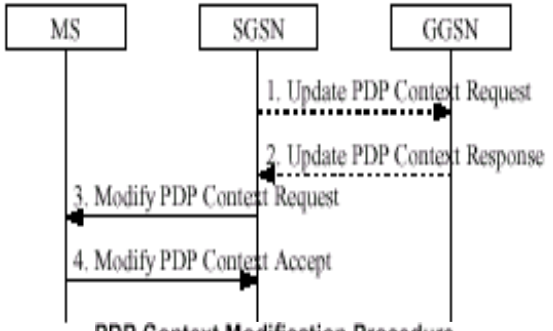
- PDP context activation,Modification,and Deactivation Function



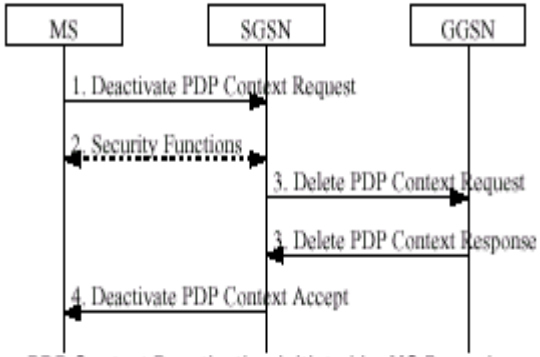
PDP Context Activation Procedure



PDP Context Deactivation Initiated by SGSN Procedure



PDP Context Modification Procedure



PDP Context Deactivation Initiated by MS Procedure

Session Management

– PDP address in PDP Context

- Static address

  user's home PLMN permanently assigns a PDP address to the MS

- Dynamic address

  the GGSN is responsible for the allocation and the activation/deactivation of PDP addresses

Location Management

- Main task

  to keep track of the user's current location

  – MS sends updates seldom,it's location is not know exactly and paging is necessary for each downlink packet,result in significant delay

  – MS sends quite a lot of updates,uplink radio capacity and battery power is consumed for mobility management in this case.

Mobility Management

- IDLE state

  The subscriber is not attach to GPRS mobility management

- STANDBY state

  The subscriber is attached to GPRS mobility management.
  Receive paging via SGSN
  MS performs GPRS Routing Area(RA) Update.

- READY state

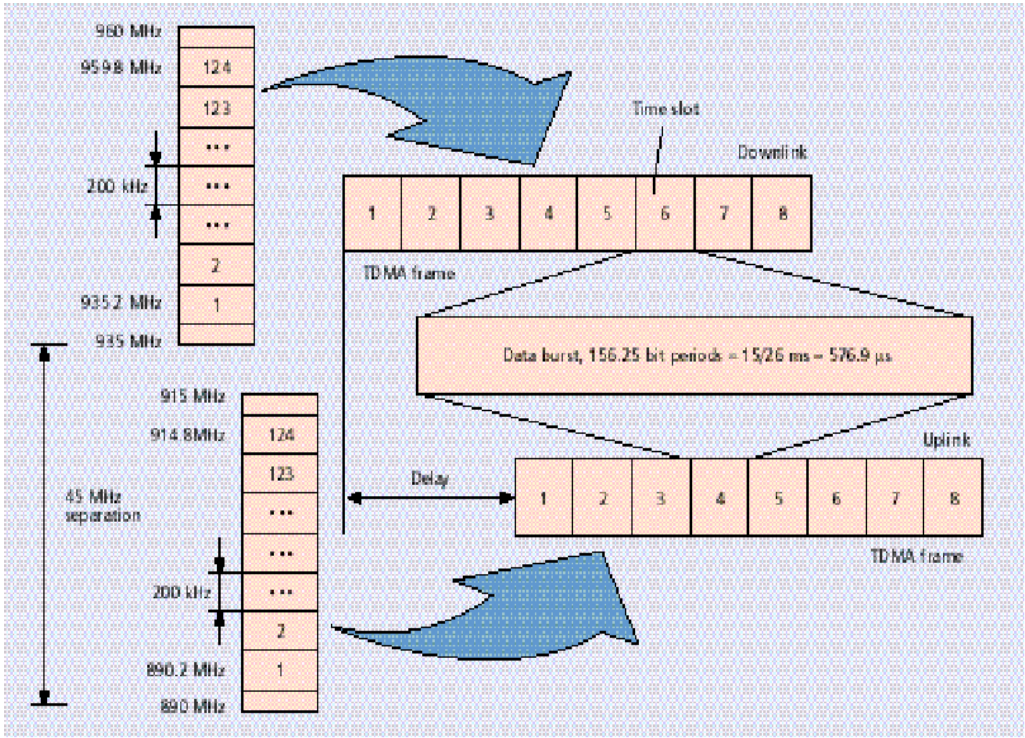
  The subscriber is attached to GPRS Mobility management.
  GPRS cell selection and reselection is Done locally by the MS
  MS performs Location Area(LA) Update

MM State Model of MS

MM State Model of SGSN

Air Interface – Physical Layer

- Radio Resource(RR) Management Principle
  - FDMA
  - TDMA



Air Interface – Physical Layer

- Logical Channels In GPRS
  - Packet data traffic channel (PDTCH)

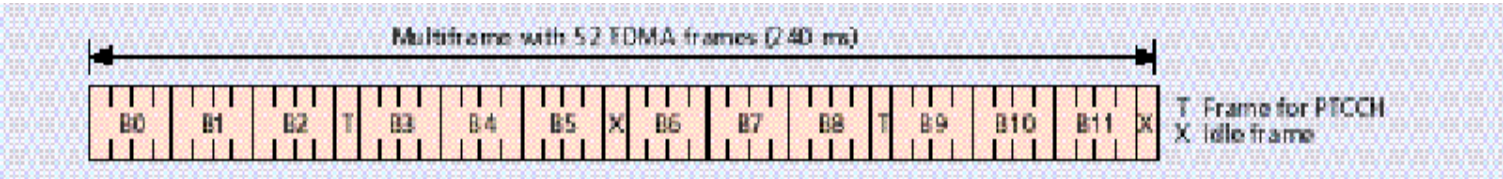
    Be employed for transfer of user data
  - Packet broadcast control channel(PBCCH)

    Broadcast control
  - Packet common control channel(PCCCH)
    - The packet random access channel(PRACH)
    - The packet paging channel(PPCH)
    - The packet access grant channel(PAGCH)
    - The packet notification channel(PNCH)
  - Packet dedicated control channels
    - The packet associated control channel(PACCH)
    - The packet timing advance control channel(PTCCH)

Air Interface – Physical Layer

- Mapping Of Packet Data Logical Channels Onto Physical Channels
  - Mapping in frequency
  - Mapping in time
  - For Exp:

    A Multiframe structure for PDCHs consisting of 52 TDMA frame.Four consecutive TDMA frames form one block,two TDMA frames are reserved for transmission of the PBCCH,and the remaining two frames are idle frames

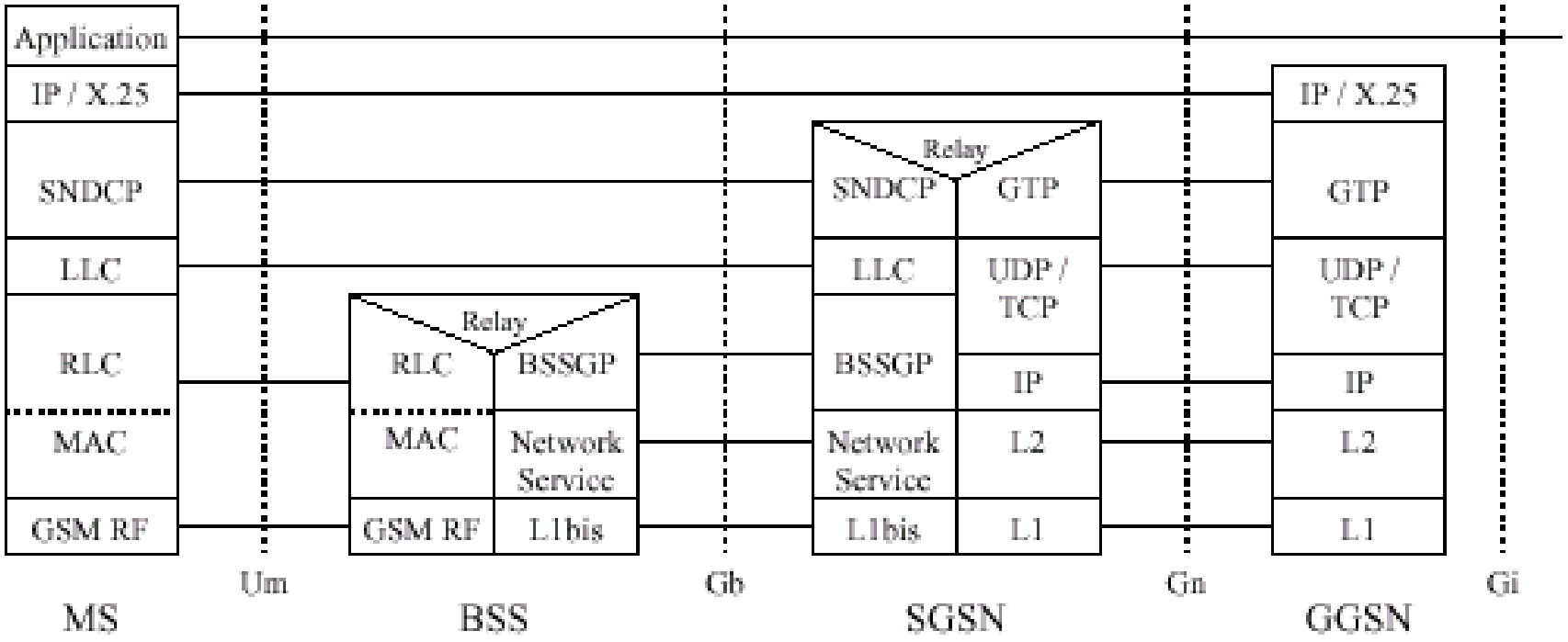


Protocol Architecture

- Transmission Plane
- Signaling Plane

Transmission Plane

- GPRS backbone:SGSN-GGSN

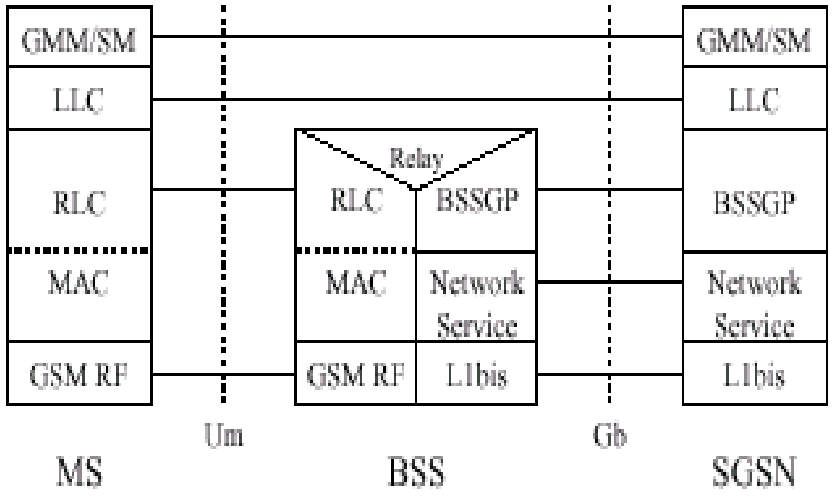


Transmission Plane

- GPRS Tunneling Protocol(GTP)
  - This protocol tunnels user data and signal between GPRS Support Nodes in the GPRS backbone network
- Logical Link Control(LLC)
  - This layer provides a highly reliable ciphered logical link

Signaling Plane

- MS-SGSN
- SGSN-HLR
- SGSN-MSC
- SGSN-EIR
- SGSN-SMS
- GSN-GSN
- GGSN-HLR



Signalling Plane MS - SGSN