

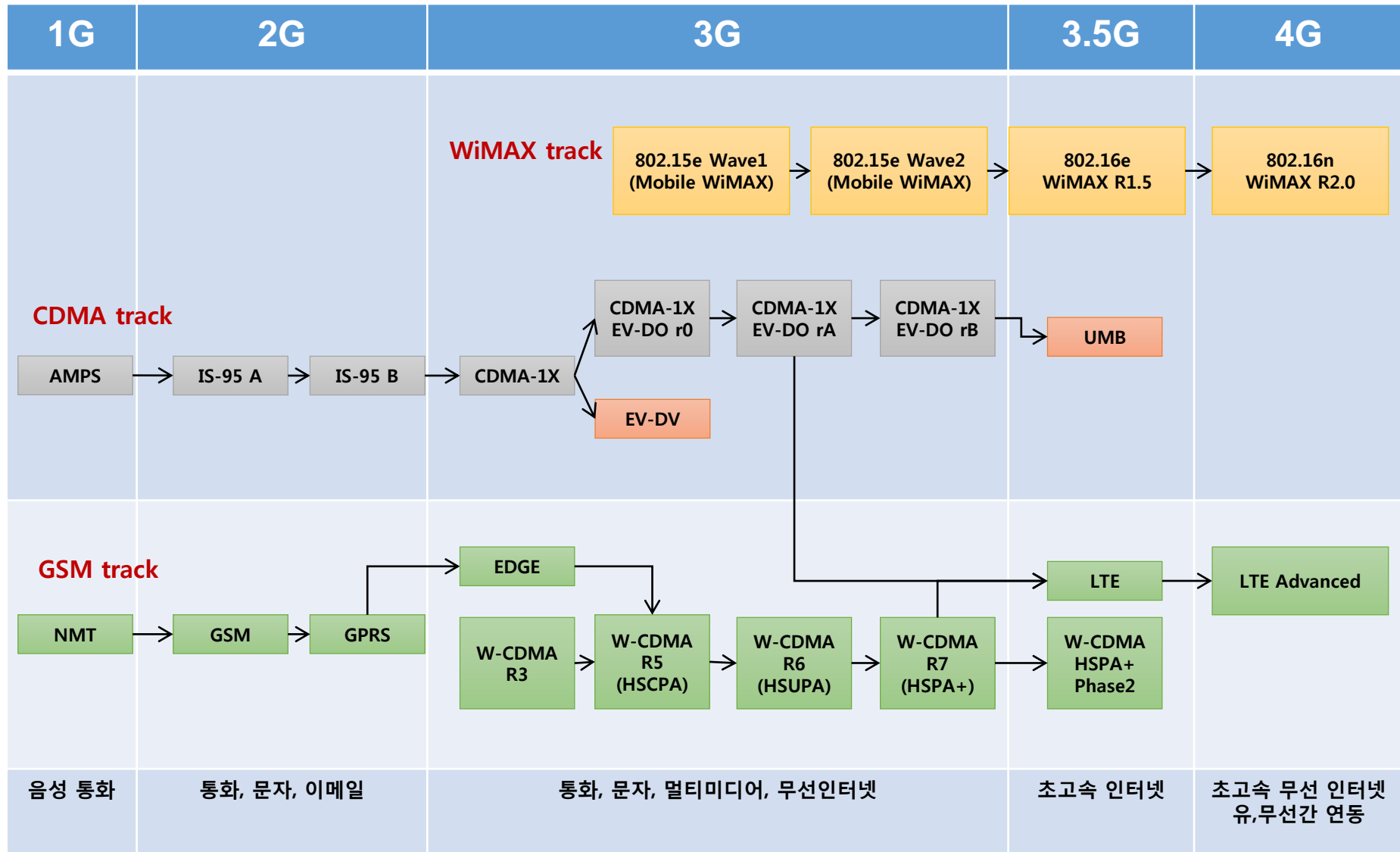


Telecommunication Basics

(GPRS Network)

Software Engineering Lab - 김영기 책임

Remember Again !!!



What is GPRS ?

❖ GPRS (General Packet Radio Service)

- ✓ General = Not restricted to GSM use
- ✓ Packet Radio = Enable Packet mode communication over air
- ✓ Service = Not System, Existing BSS (Partially also NSS) infrastructure is used

- Part of GSM phase 2+
- Required many new network elements into NSS
- Provides connections to external packet data networks (Internet, X.25)

❖ Benefits

- Resources are reserved only when needed and charged accordingly
- Connection setup times are reduced
- Enables new services opportunities

GPRS Characteristics

❖ GPRS uses packet switched resource allocation

- Resource allocated only when data is to be sent/received

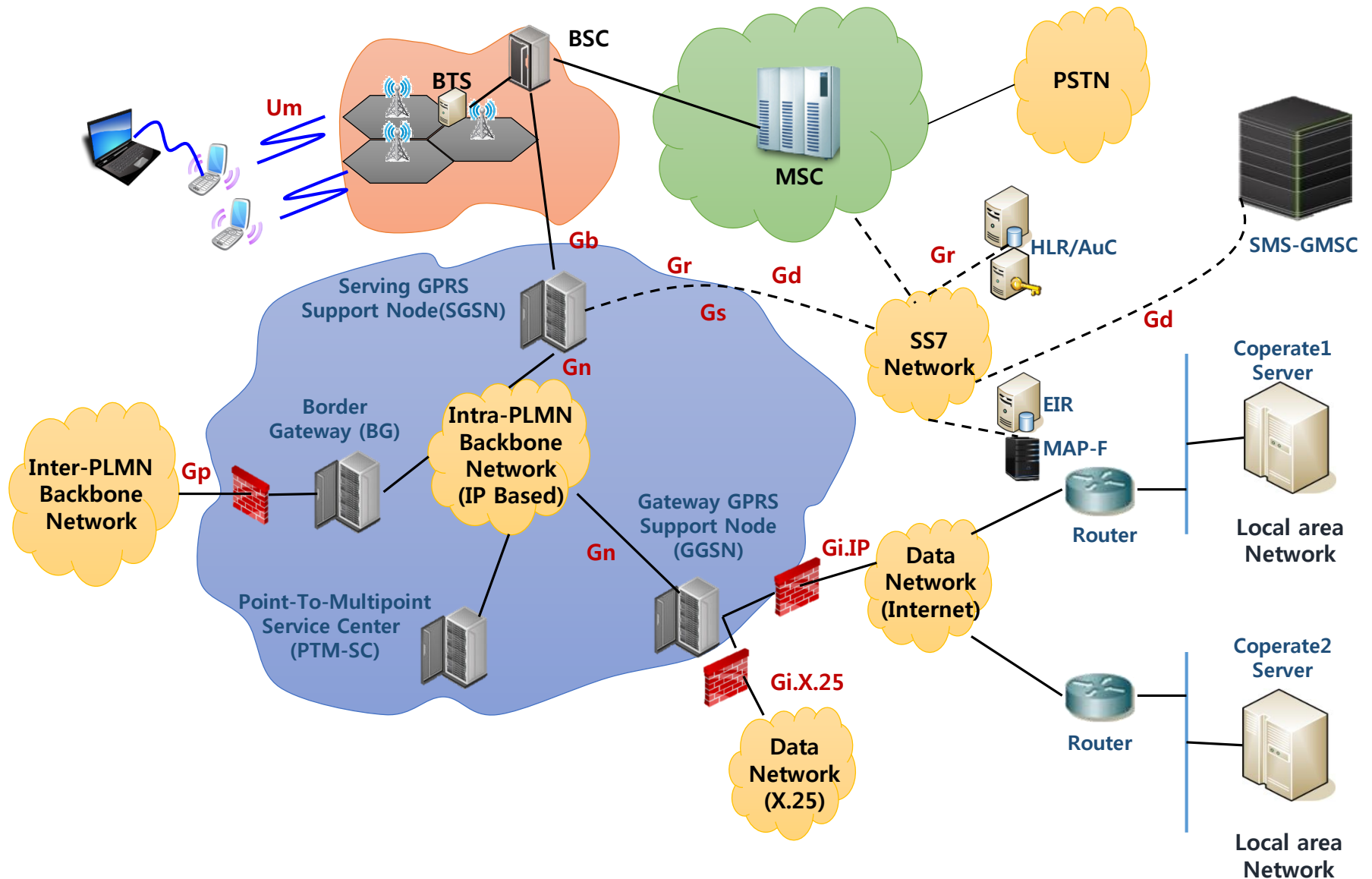
❖ Flexible channel allocation

- One to eight 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

❖ Traffic characteristics suitable for GPRS

- Intermittent, busty data transmissions
- Frequent transmissions of small volumes of data
- Infrequent transmission of larger volumes of data

GPRS Architecture



GSM to GPRS

Element	Software	Hardware
MS	Upgrade required	Upgrade required
BTS	Upgrade required	No Change
BSC	Upgrade required	PCU Interface
TRAU	No Change	No Change
MSC/VLR	Upgrade required	No Change
HLR	Upgrade required	No Change
SGSN	New	New
GGSN	New	New

Interfaces

Interface	Description
Gb	<ul style="list-style-type: none">▪ Connects BSC with SGSN
Gn	<ul style="list-style-type: none">▪ SGSN-SGSN/GGSN (in the same network)
Gp	<ul style="list-style-type: none">▪ SGSN-GGSN (in different networks)
Gf	<ul style="list-style-type: none">▪ For equipment querying at registering time
Gi	<ul style="list-style-type: none">▪ Connects PLMN with external Packet Data Network (PDNs)
Gr	<ul style="list-style-type: none">▪ To exchange User profile between HLR & SGSN
Gs	<ul style="list-style-type: none">▪ To exchange Data between SGSN & MSC
Gd	<ul style="list-style-type: none">▪ Interface between SMS & GPRS

Radio Interface Protocols

❖ 2 Plane

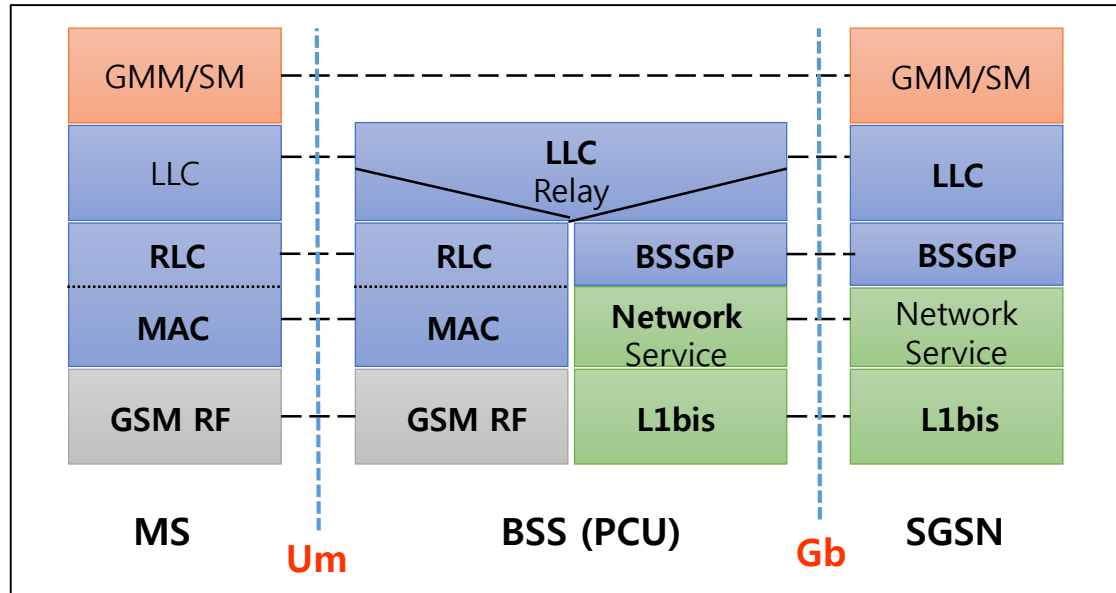
- User plane
- Control Plane

❖ 3 Layers

- Layer 1 : Physical (PHY)
- Layer 2 :
 - ✓ Data Link
 - ✓ Media Access Control (MAC)
 - ✓ Radio Link Control (RLC)
 - ✓ Packet Data Convergence Protocol (PDCP)
- Layer 3 :
 - ✓ Radio Resource Control (RRC) for Iu mode
 - ✓ Radio Resource (RR) for A/Gb mode

Protocol Stack

❖ GPRS Control Plane Protocol Stack

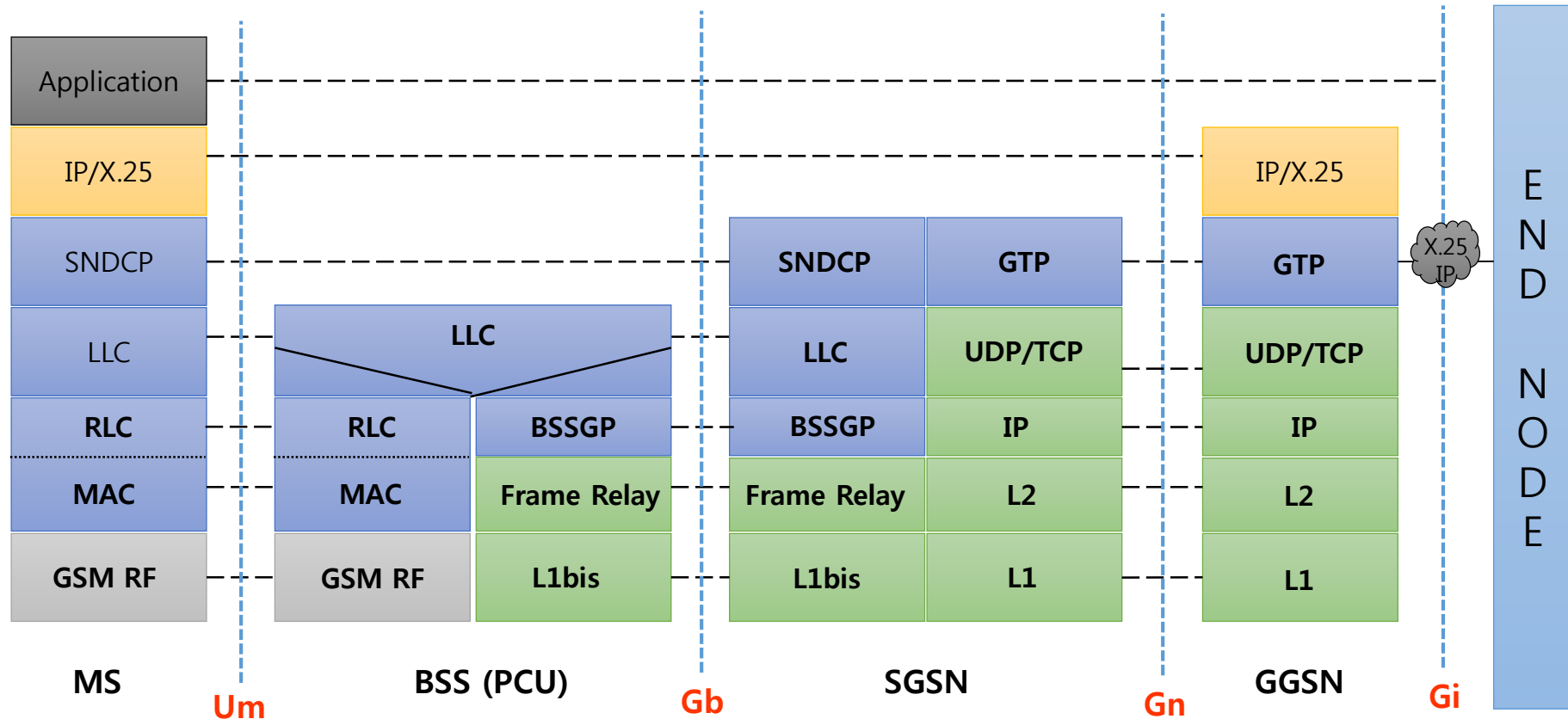


● GMM/SM (New in GPRS)

- ✓ GPRS Mobility Management and Session Management
- ✓ GPRS Attach/Detach
- ✓ PDP Context 구성 및 해제
- ✓ GPRS 단말 위치 갱신 – Routing Area Update/Location Update
- ✓ 인증
- ✓ Radio Resource Assign

Protocol Stack

❖ GPRS Traffic Protocol Stack



Assignment of functions

Function	MS	BSS	SGSN	GGSN	HLR
Network Access Control					
Registration					✓
Authentication and Authorization	✓		✓		✓
Admission Control	✓	✓	✓		
Message Screening				✓	
Charging Data Collection		✓	✓		
Packet Routing & Transfer					
Relay	✓	✓	✓	✓	
Routing	✓	✓	✓	✓	
Addressing Translation and Mapping	✓		✓	✓	
Encapsulation	✓		✓	✓	
Tunneling			✓	✓	
Compression			✓		
Ciphering	✓		✓		✓
Mobility Management	✓		✓	✓	✓
Logical Link Management					
Logical Link Establishment	✓		✓		
Logical Link Maintenance	✓		✓		
Logical Link Release	✓		✓		
Radio Resource Management					
Um Management	✓	✓			
Cell Selection	✓	✓			
Um-T ranx	✓	✓			
Path Management		✓	✓		

Gateway GPRS Support Node

- ❖ Typically located at one of the MSC sites
- ❖ One (or few) per operator
- ❖ Main functions
 - Interface to external data networks
 - Resembles to a data network router
 - Forwards end user data to right SGSN
 - ✓ Converts the GPRS packets from SGSN to the PDP format
 - Routes mobile originated packets to right destination
 - ✓ Converts PDP addresses change to GSM addresses of the destination user
 - Filters end user traffic
 - Collects charging information for data network usage
 - Data packets are not sent to MS unless the user has activated the PDP address
 - Performs authentication
 - Many-to-many relations among SGSNs & GGSNs

Serving GPRS Support Node

- ❖ **Functionally connected with BSC, physically can be at MSC or BSC site**
- ❖ **One for few BSCs or one (or few) per every BSC**
- ❖ **One SGSN can support BSCs of several MSC sites**
- ❖ **Main functions**
 - Delivers data packets to mobile stations & vice-versa
 - Authenticates GPRS mobiles / Maintain user profile
 - Handles mobile's registration in GPRS network
 - Handles mobile's mobility management / Packet Routing, Transfer
 - Relays MO and MT data traffic
 - ✓ TCP/IP header compression, V.42bis data compression, error control MS- SGSN (ARQ)
 - Collect charging information of air interface usage

Other Elements

Entity	Functionality
BG (Border Gateway)	<ul style="list-style-type: none">▪ Not defined within GPRS▪ Routes packets from SGSN/GGSN of one operator to a SGSN/GGSN of an other operator▪ Provides protection against intruders from external networks
DNS (Domain Name Server)	<ul style="list-style-type: none">▪ Translates addresses from ggsn1.oper1.fi-format to 123.45.67.98 format
Charging Gateway	<ul style="list-style-type: none">▪ Collects charging information from SGSNs and GGSNs
PTM-SC (Point to Multipoint-Service Center)	<ul style="list-style-type: none">▪ PTM Multicast (PTM-M)<ul style="list-style-type: none">- Downlink broadcast, No subscription, No Ciphred▪ PTM Group call (PTM-G)<ul style="list-style-type: none">- Closed or open groups, Down/Up link, Ciphred▪ Geographical area limitation

GPRS Backbones

❖ GPRS Backbones

- Enables communication between GPRS Support Nodes based on private IP Network
 - ✓ IPv6 is the ultimate protocol
 - ✓ IPv4 can be used as an intermediate solution
- Intra-PLMN backbone
 - ✓ Connect GPRS Support Nodes of one operator
 - ✓ Operator decides the network architecture
 - LAN, Point-to-Point links, ATM, ISDN, ...
- Inter-PLMN backbone
 - ✓ Connects GPRS operators via BGs
 - ✓ Provides international GPRS roaming
 - ✓ Operators decide the backbone in the roaming agreement

Physical Channels

❖ FDMA + TDMA

- Defined by timeslot (0~7) and Radio frequency channel

❖ Shared Basic Physical Sub Channel

- Shared among several users (up to 8)
- Uplink Stage Flag (USF) controls multiple access

❖ Dedicated Basic Physical Sub Channel

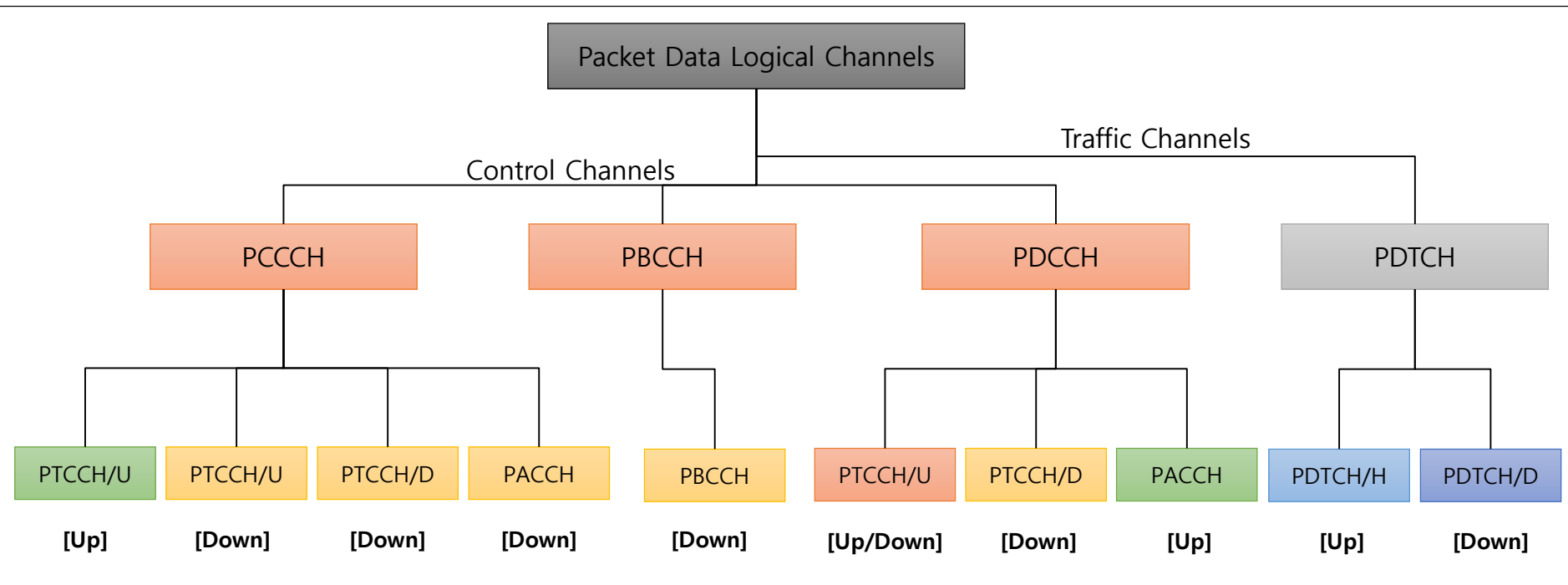
- One user support

❖ Packet Data Channel (PDCH)

- Dedicated to packet data traffic from logical channels (Refer Next Slide)
- Control
- User data

Logical Channels

- Mapped by the MAC to physical channels
- Control channels for control, synchronization and signaling
 - ✓ Common/Dedicated/Broadcast
- Packet Traffic Channels
 - ✓ Encoded speech/Encoded data



PCCCH = Packet Common Control Channel
PBCCH = Packet Broadcast Control Channel
PDCCH = Packet Dedicated Control Channel
PDTCH = Packet Traffic Channel
PRACH = Packet Random Access Channel

PPCH = Packet Paging Channel
PAGCH = Packet Access Grant Channel
PNCH = Packet Notification Channel
PACCH = Packet Associated Control Channel
PTCCH = Packet Timing Advance Control Channel

Up = Uplink Direction
Down = Downlink Direction

Control Channels

❖ Packet Common Control Channel (PCCCH)

- Paging (PPCH)
- Random Access (PRACH)
- Grant (PAGCH)
- Packet Notification (PNCH)

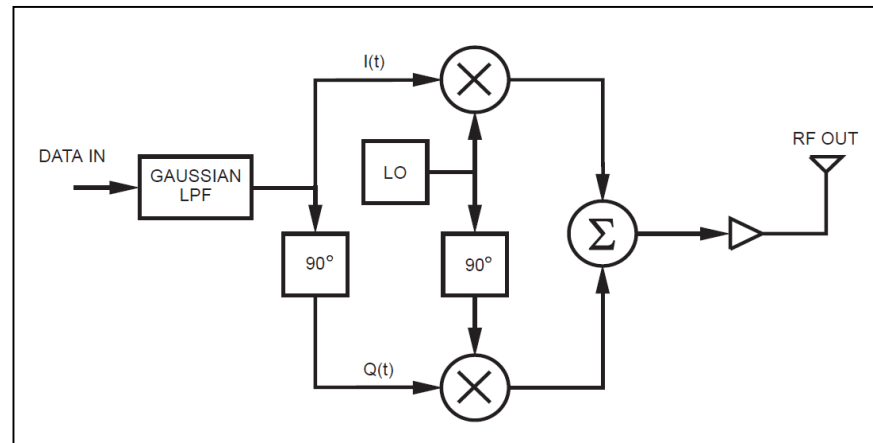
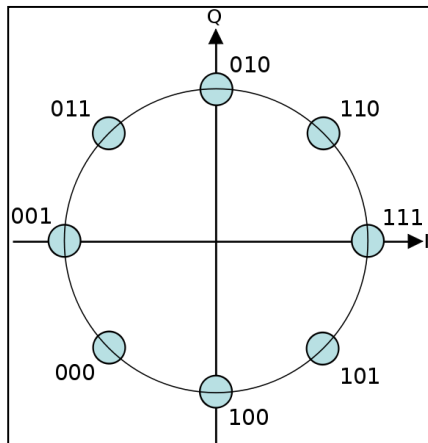
❖ Packet Broadcast Control Channel (PBCCH)

- Frequency correction channels
- Synchronization channel (MS freq. vs. BS)
- Broadcast control channel for general information on the base station
- Packet broadcast channels
 - ✓ Broadcast parameters that MS needs to access network for packet transmission

Packet Traffic Channels

❖ TCH

- Traffic Channels (TCH)
- Encoding of speech or user data
- Channels are either predetermined multiplexed or multiplexing determined by MAC
- Full rate / Half rate
- On both SBPSCH and DBPSCH
- Modulation techniques
 - ✓ GMSK (Gaussian Minimum Shift Keying) = MSK + Gaussian filter
 - ✓ 8-PSK



GPRS Mobile Types

❖ A/Gb mode

Class	Description
Class A	<ul style="list-style-type: none">▪ Simultaneous GPRS and conventional GSM operation▪ Supports simultaneous circuit switched and GPRS data transfer
Class B	<ul style="list-style-type: none">▪ Can be attached to both GPRS and conventional GSM services simultaneously▪ Can listen circuit switched and GPRS pages (via GPRS)▪ Supports either circuit switched calls or GPRS data transfer but not simultaneous communication▪ Most common for handsets today
Class C	<ul style="list-style-type: none">▪ Alternatively attached in GPRS or conventional GSM▪ No simultaneous operation▪ 'GPRS only' mobiles also possible (e.g. for telemetric applications)▪ E.g. expansion cards for laptops

❖ lu mode

Mode	Description
CS/PS	<ul style="list-style-type: none">▪ Same as Class A in A/Gb mode
PS	<ul style="list-style-type: none">▪ MS can only operate packet switched services
CS	<ul style="list-style-type: none">▪ MS can only operate circuit switched services

Service Types

❖ Point-to-Point

- Internet access by user

❖ Point-to-Multipoint

- Delivery of information (e.g. news) to multiple locations or interactive conference applications

❖ IP Multimedia Subsystem

- Simultaneous access to multiple different types of real-time and non-real-time traffic
- IMS provides synchronization between such components

Mobility Management (1/2)

❖ 3 different state

- 🕒 Data can only be transmitted in the ACTIVE state

State	Description
IDLE	<ul style="list-style-type: none">▪ No logical PDP context activated▪ No network address (IP) registered for the terminal▪ No routing of external data possible▪ Only multicast messages to all GPRS handsets available
STANDBY	<ul style="list-style-type: none">▪ Only routing area is known<ul style="list-style-type: none">- RA is defined by operator → allows individual optimizations▪ When downlink data is available, packet paging message is sent to routing area▪ Upon reception, MS sends it's cell locations to the SGSN and enters the ACTIVE state
ACTIVE	<ul style="list-style-type: none">▪ SGSN knows the cell of the MS▪ PDP contexts can be activated/deactivated▪ Can remain in this state even if not data is transmitted (controlled by timer)

Mobility Management (2/2)

❖ Mobility Management Message

- Cell update
 - ✓ When MS changes the cell within a Routing Area in READY state
- Routing Area update
 - ✓ When MS changes the cell between Routing Area in READY or STANDBY state
 - ✓ Two types of Routing Area Updates
 - from MS's point of view only one type
 - Intra-SGSN Routing Area Update
 - Inter-SGSN Routing Area Update
- Periodic Routing Area updates are applicable

PDP Contexts

❖ Packet Data Protocol (PDP)

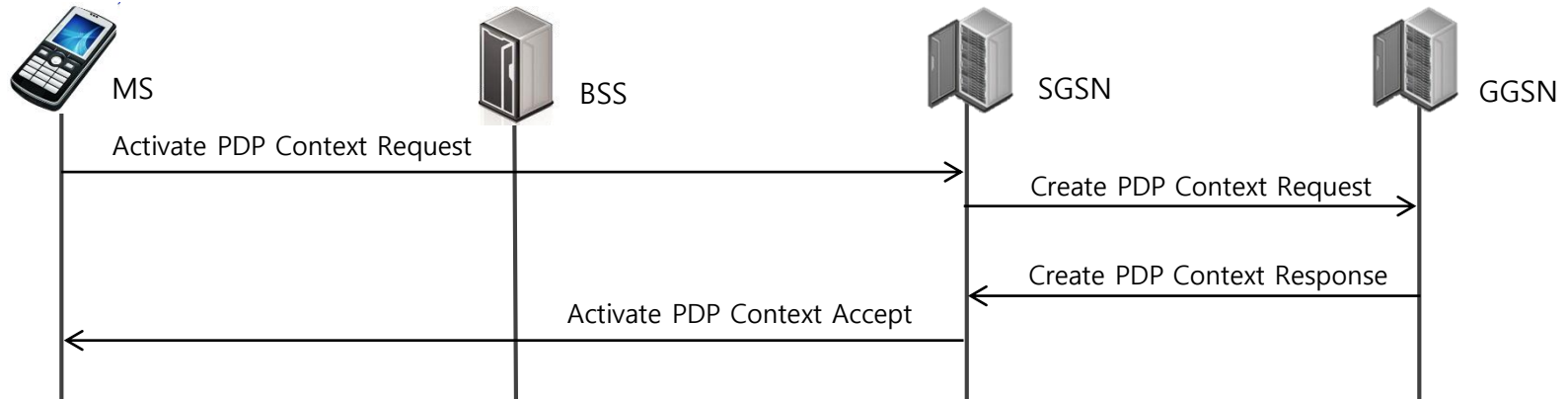
- Session
- Logical tunnel between MS and GGSN
- Anchored GGSN for Session

❖ PDP activities

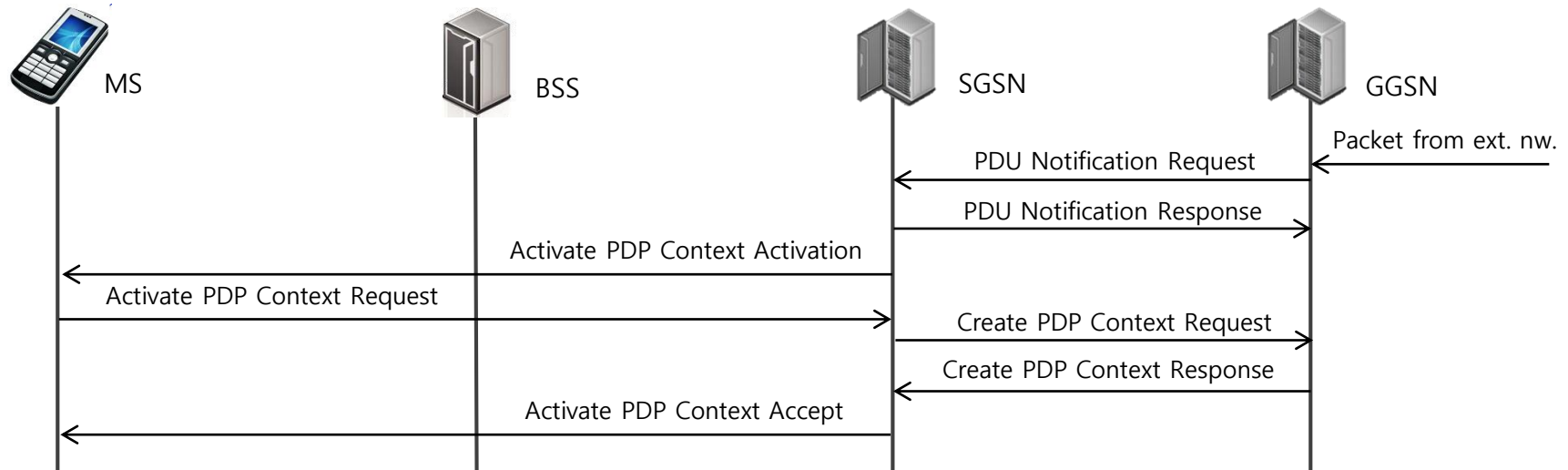
- Activation
 - ✓ GGSN에게 단말의 존재를 알림
 - ✓ GPRS Data 수신/전송을 위해 (Session 이용을 위해), 반드시 IP 할당이 필요하며, IP 주소 등을 할당하는 과정
- Modification
- Deactivation

PDP Context Procedures

❖ MS initiated

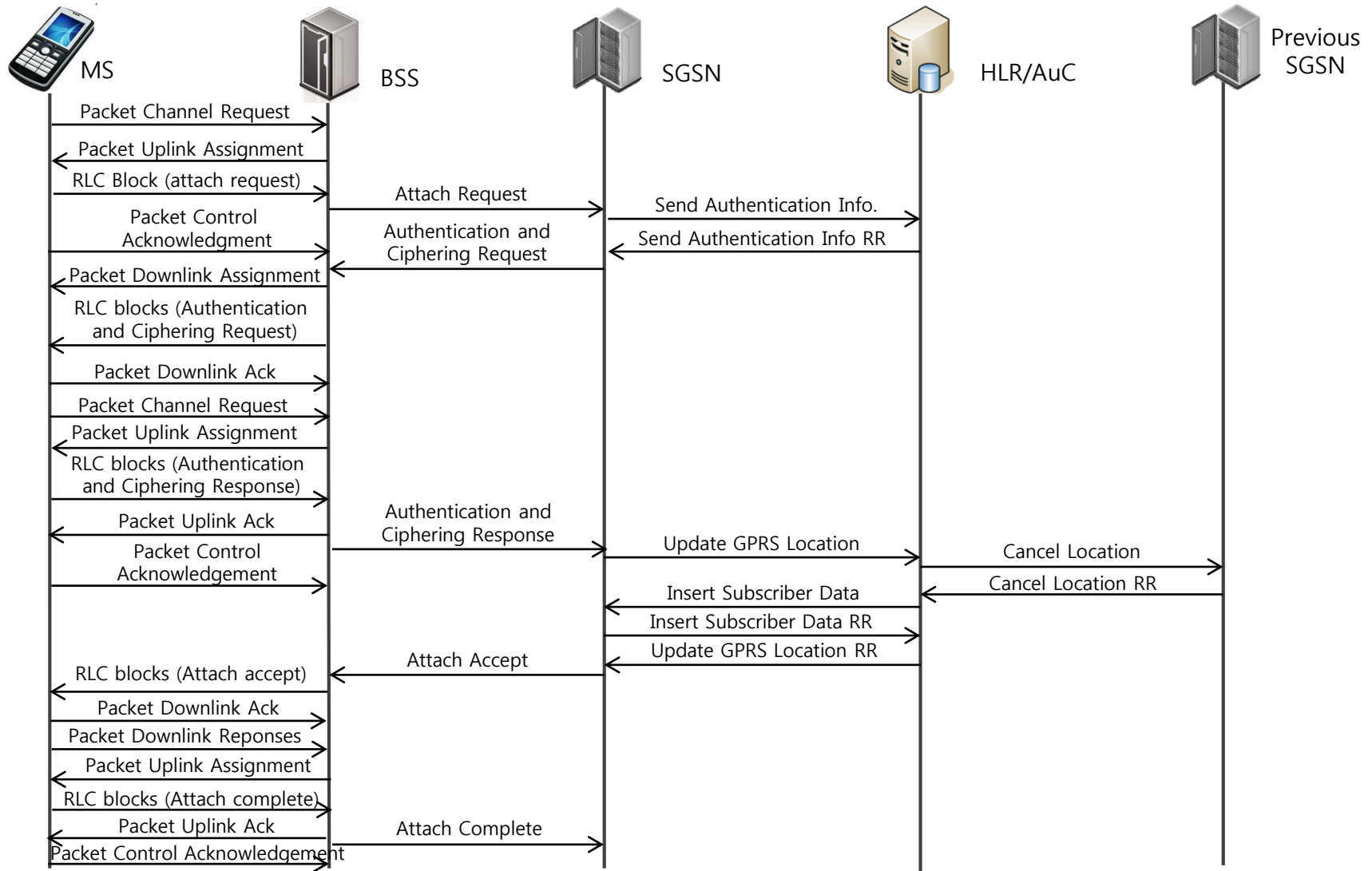


❖ GGSN initiated



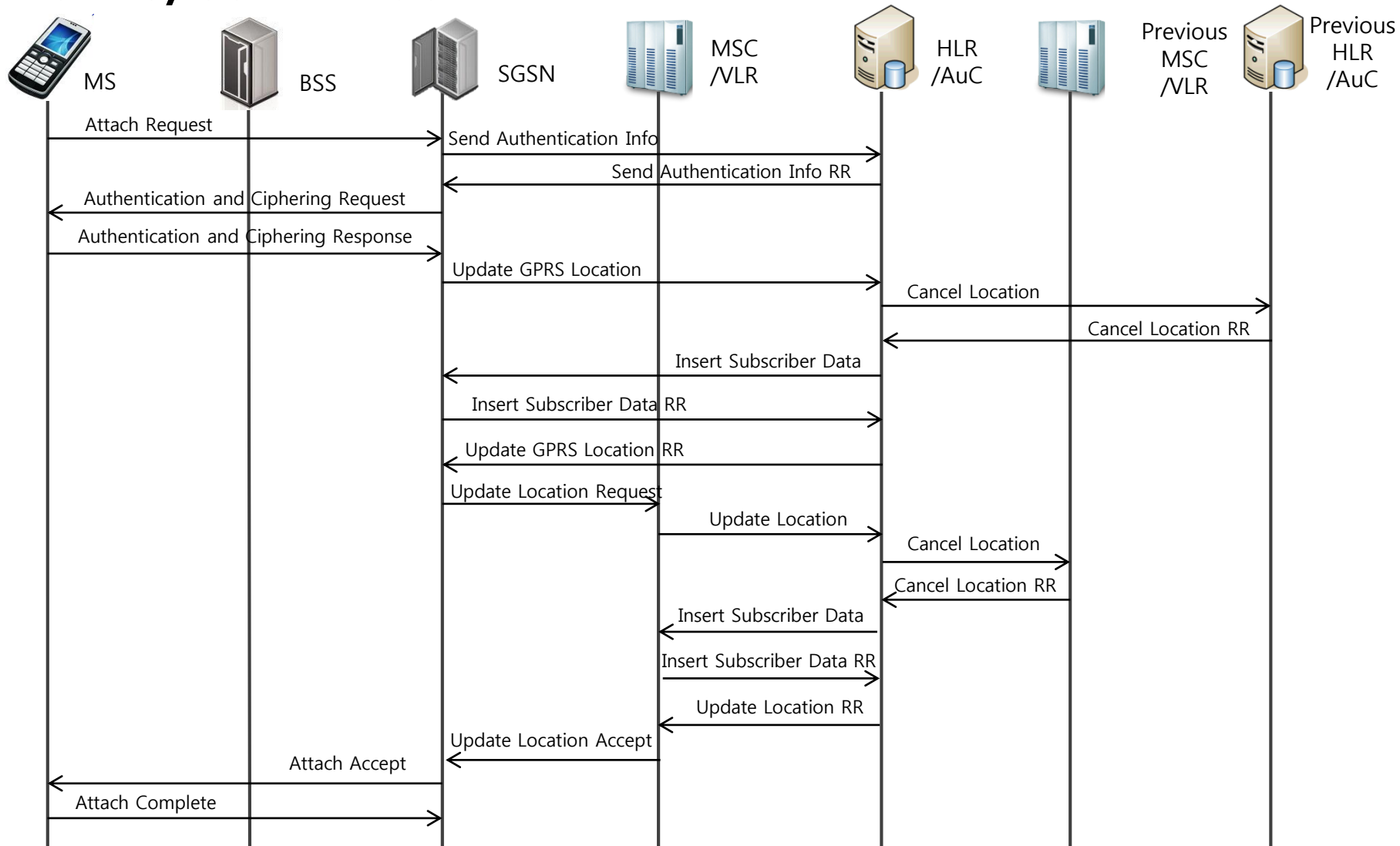
GPRS Call Scenario 1

❖ GPRS Attach



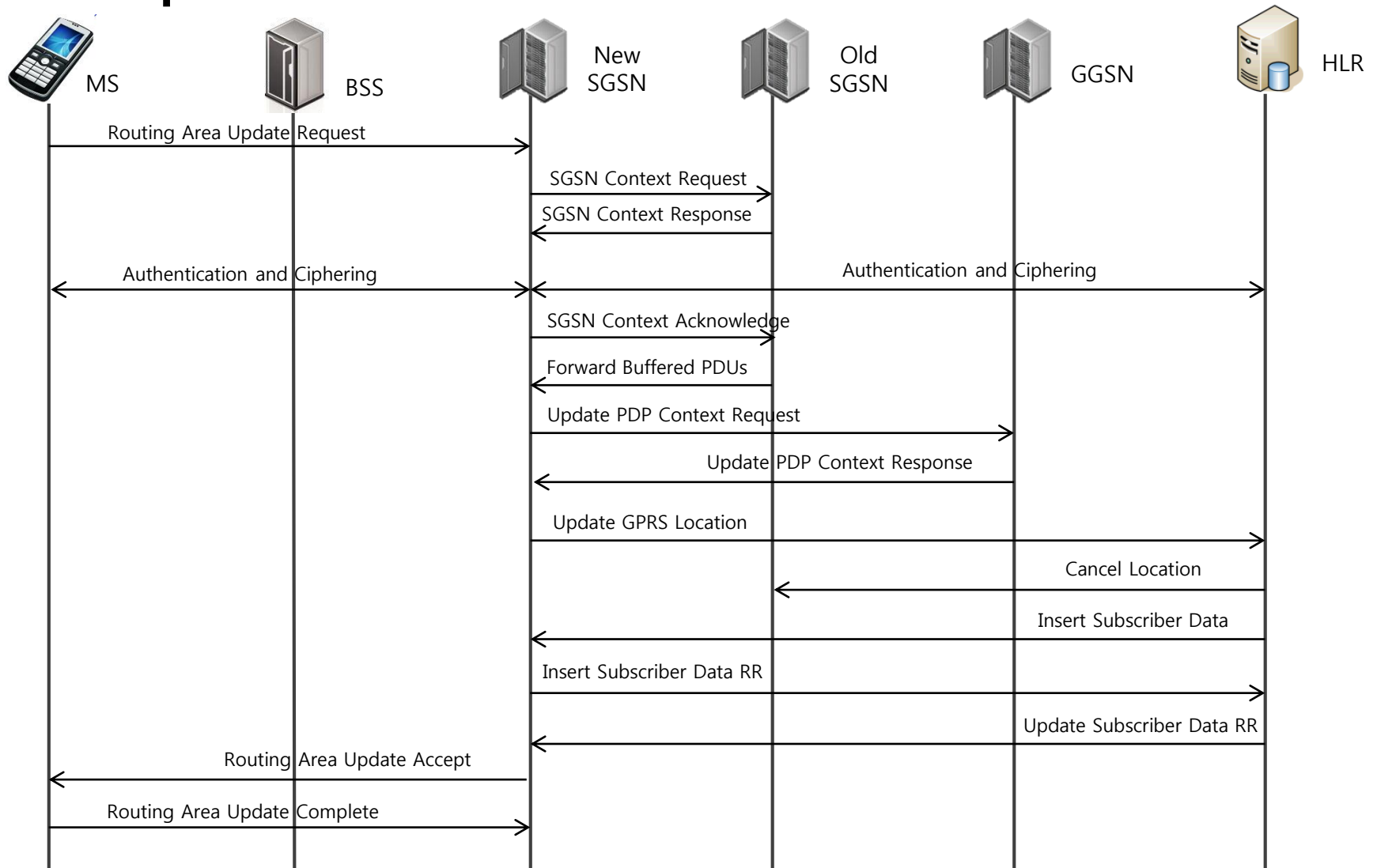
GPRS Call Scenario 2

❖ GPRS/GSM Attach



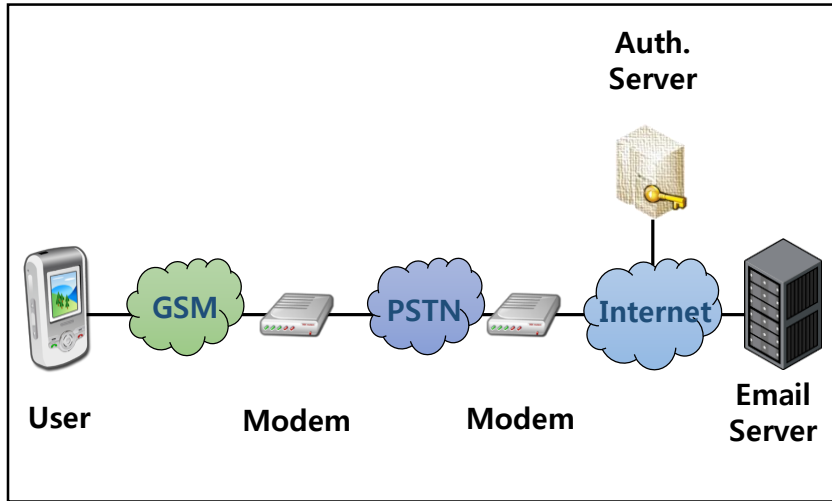
GPRS Call Scenario 3

❖ RA update

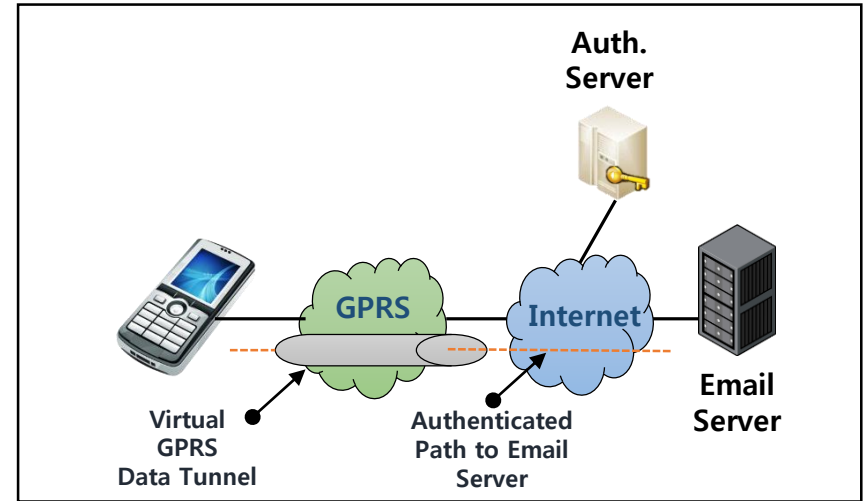


[별첨] GSM vs. GPRS

Email via GSM



Email via GPRS



Initial Call Process	Time (s)
GSM Call	4
Train Model	30
Login and Authenticate	11
Download mail	180
Total	3min 45s
Subsequent Call	
Repeat Above	3min 45s

Initial Call Process	Time (s)
GPRS Call	4
Login and Authenticate	11
Download mail	180
Total	3min 45s
Subsequent Call	
Not applicable – Permanent Virtual Circuit	0



Thank You !