GSM Network and Services

GPRS

 - sharing of resources

What is the problem?

- Many data applications are very bursty in its traffic pattern: http, smtp, pop, telnet, ...

- Why reserve physical resources at the radio interface if they will be mostly idle?

- Why reserve full duplex channels when traffic is mostly half duplex?

- Note:
  - increased capacity is solved by HSCSD
 - its resource sharing that is the problem

GPRS – General Packet Radio Service

- Dynamic and flexible allocation of traffic channels.

- Allocation of more than one timeslot in a frame to allow for temporary high capacity.

- More flexible paging procedures since mobile will be paged more often.

- New coding schemes (same radio modulation!) to increase capacity.

GPRS nodes

PSTN

BSC

MSC

HLR

SGSN

MS

PDN

Serving GPRS Support Node

GGSN

Gateway GPRS Support Node
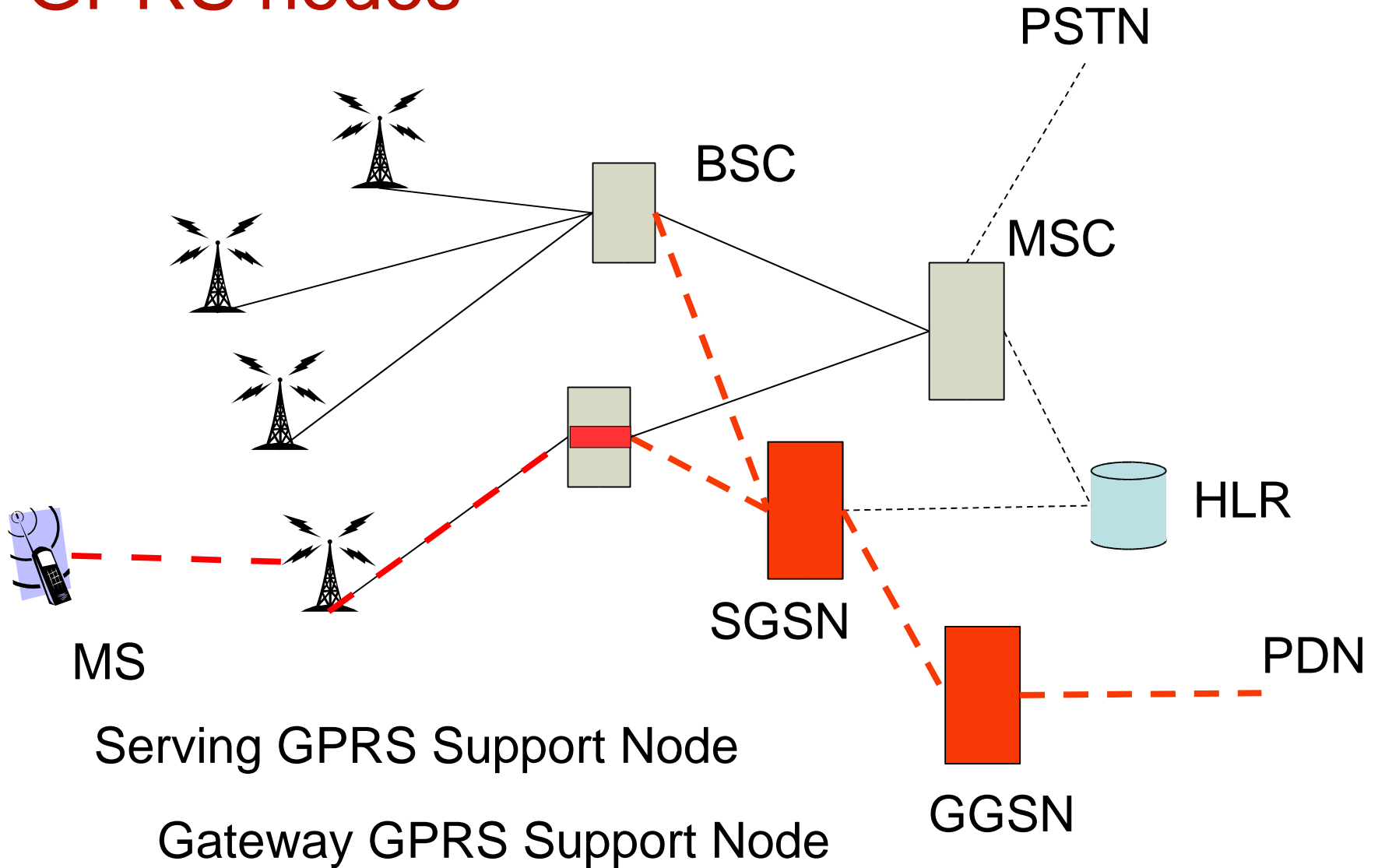
New nodes

- **SGSN** – serving GPRS support node
    - the "MSC" of GPRS
    - mobility management, session control, authentication, encryption, charging
- **GGSN** – gateway GPRS support node
    - the point of presence on the Internet
    - located in your home PLMN
- **CGSN** – combined GPRS support node
    - the two nodes in one cabinet

Why two nodes?

PLMN 1

GGSN

SGSN

Internet

PLMN 2

SGSN

GGSN
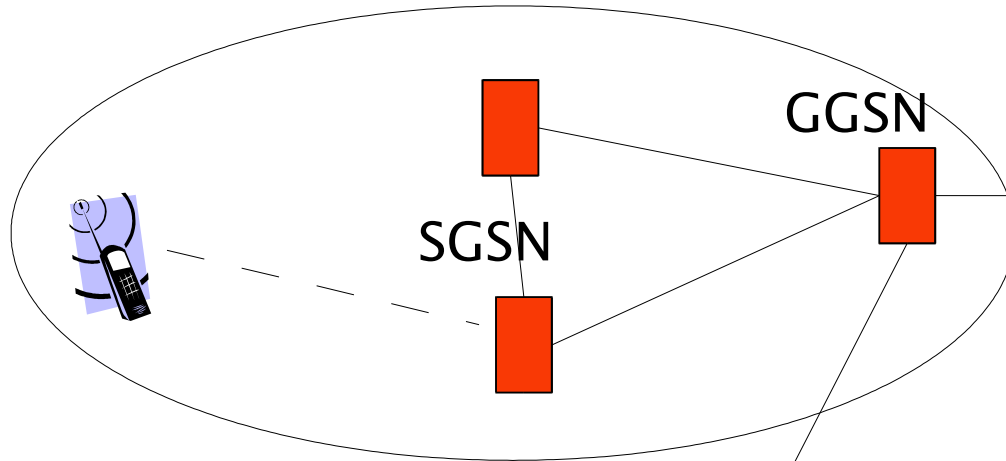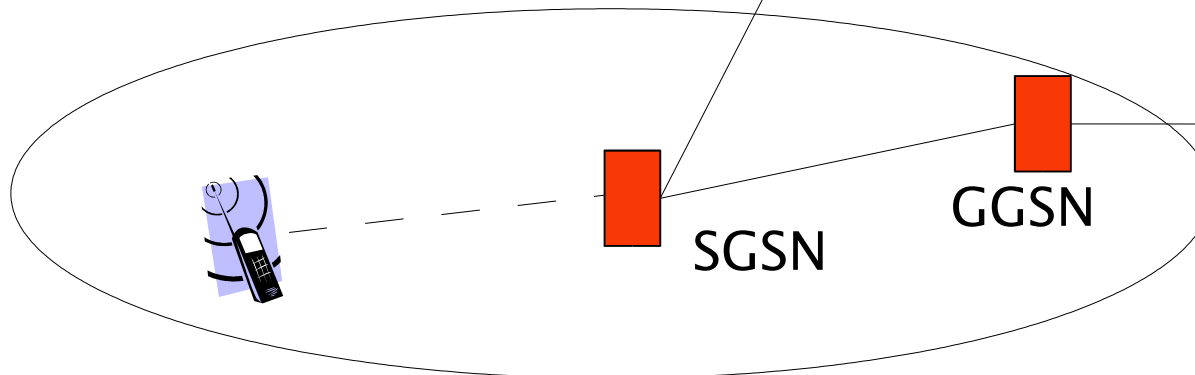
Additional upgrade

- Mobiles have to have GPRS support; most GSM mobiles sold today have it.

- The BSC has to be upgraded with a Packet Control Unit (PCU) that supports the GPRS link control and forwards the packets to the SGSN.

- BTS need only software upgrade.

Mobiles

- Class

  - A: handles both GSM and GPRS simultaneously (only one or two models on the market)

  - B: handles both GSM and GPRS but not simultaneously (regular phone)

 - C: only GSM or only GPRS (old/cheap phone or a PC card)

Mobiles

- Multislot class; the number of downlink, uplink and total timeslots the mobile can handle.
- Total of 29 multislot classes but in reality only a few are seen on the market:
  - 8 : 4 down / 1 up, 5 max (ok phone)
  - 10 : 4 down / 2 up, 5 max (better)
- Coding scheme: CS-1, CS-2, CS-3, CS-4
  - more on this later

Idle – Ready – Standby

Idle

attach

detach

ready

time out

time out

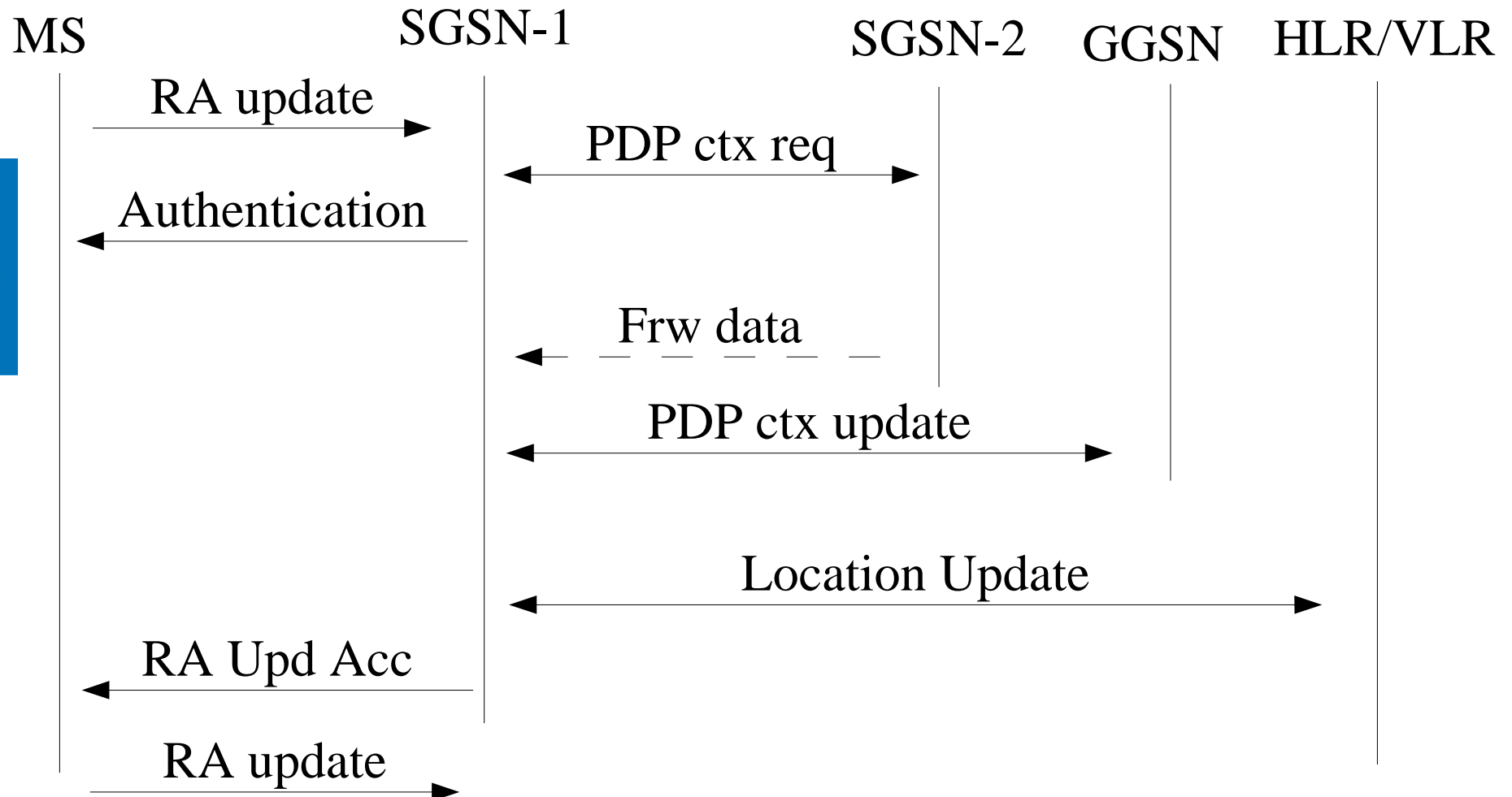page
request
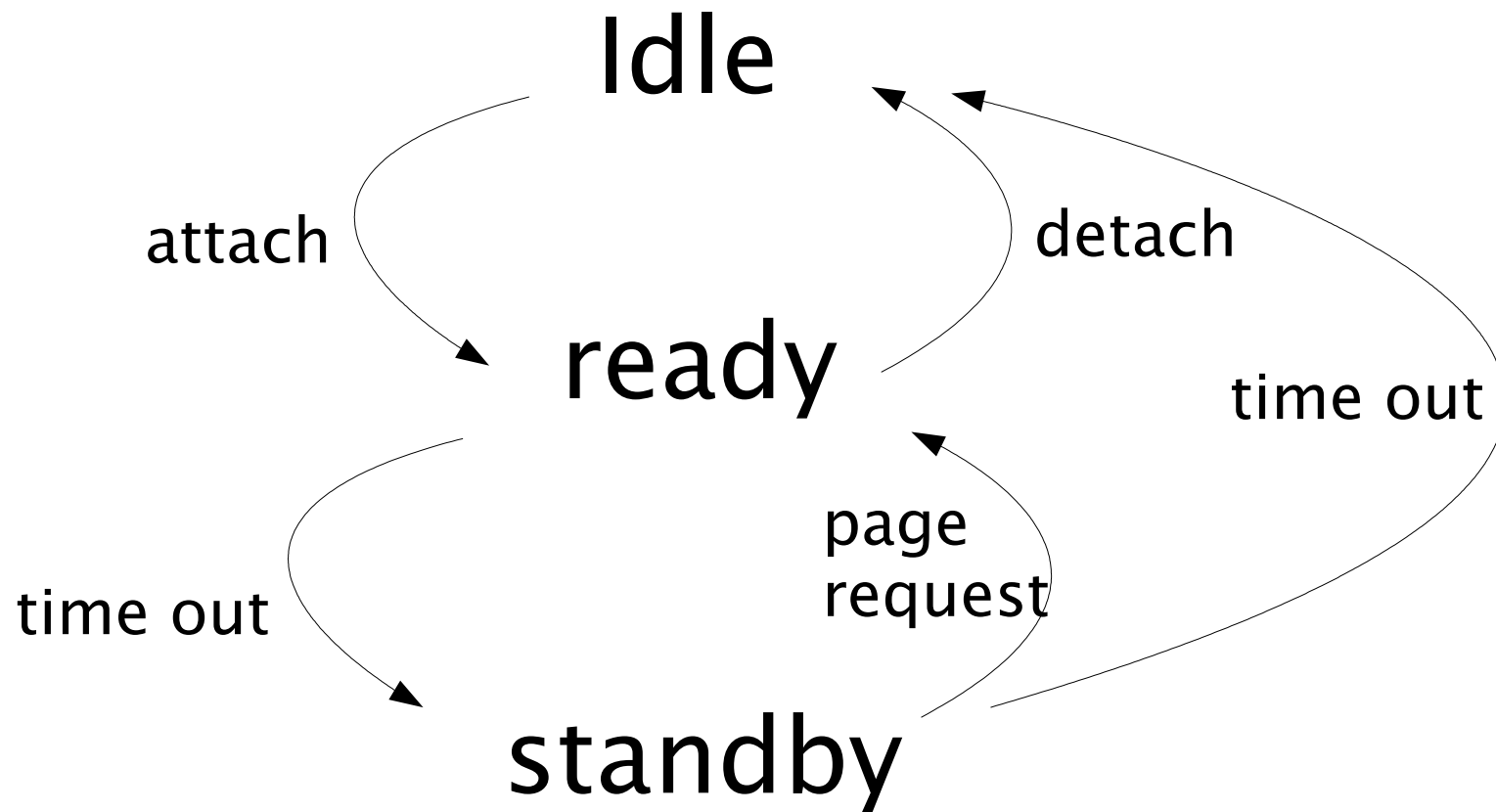
standby

Idle – Ready – Standby

- Idle
  - mobile is not registered with the SGSN
- Ready
  - mobile will inform the SGSN of every cell change
  - it can activate a PDP context to communicate with the Internet
- Standby
  - only report change in Routing Area.
  - can still have a PDP context

Routing Area

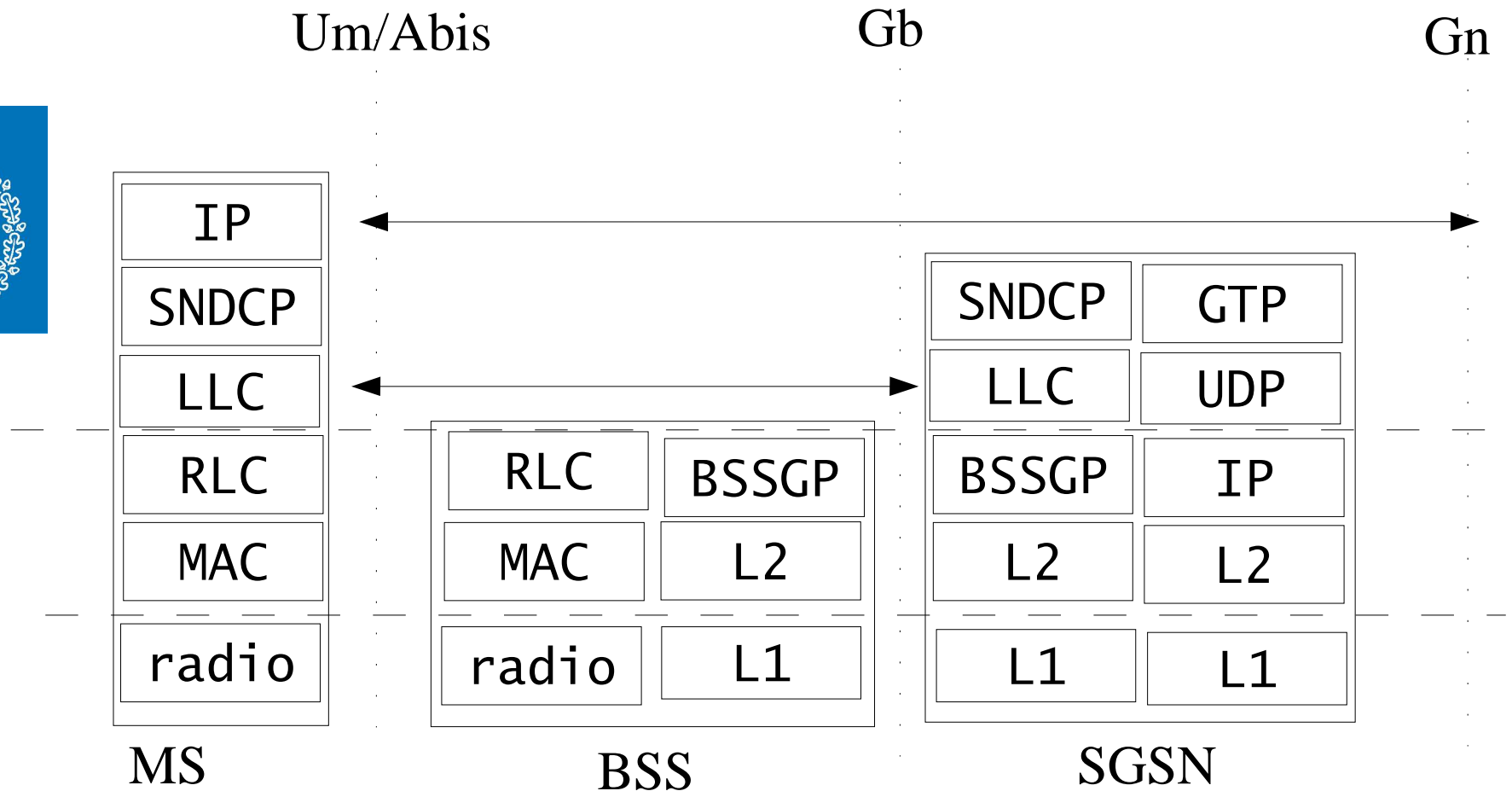- A GSM location area is divided into smaller routing areas. RAI is equal to LAI + RAC (routing area code)

- The current routing area is known by the SGSN. The HLR knows which SGSN that handles the mobile station.

- SGSN allocates a P-TMSI (packet temporary mobile subscriber identity) to hide the identity of the subscriber.

- Why have a smaller routing area, why not use the regular location area?

GPRS location update

GPRS transport protocol stack

Um/Abis · Gb · Gn

MS	BSS	SGSN
IP		
SNDCP		SNDCP / GTP
LLC		LLC / UDP
RLC	RLC / BSSGP	BSSGP / IP
MAC	MAC / L2	L2 / L2
radio	radio / L1	L1 / L1

SNDCP – subnetwork dependent convergence protocol

- Multiplexing of several PDP context into one LLC connection. Uses NSAPI to address PDP context.

- Segmentation and reassembly (this could be handled by the IP layer)

- Compression
  - of data using V.42bis
  - of TCP/IP headers using RFC 1144 and 2507
  - you can set this on you mobile

LLC – Logic Link Control

- A reliable (if requested) link from MS to SGSN.
  - Acknowledge mode, ARQ
    - erroneous or lost frames are retransmitted
  - Unacknowledged
    - Erroneous frames are discarded
    - Protected: frame check sequence
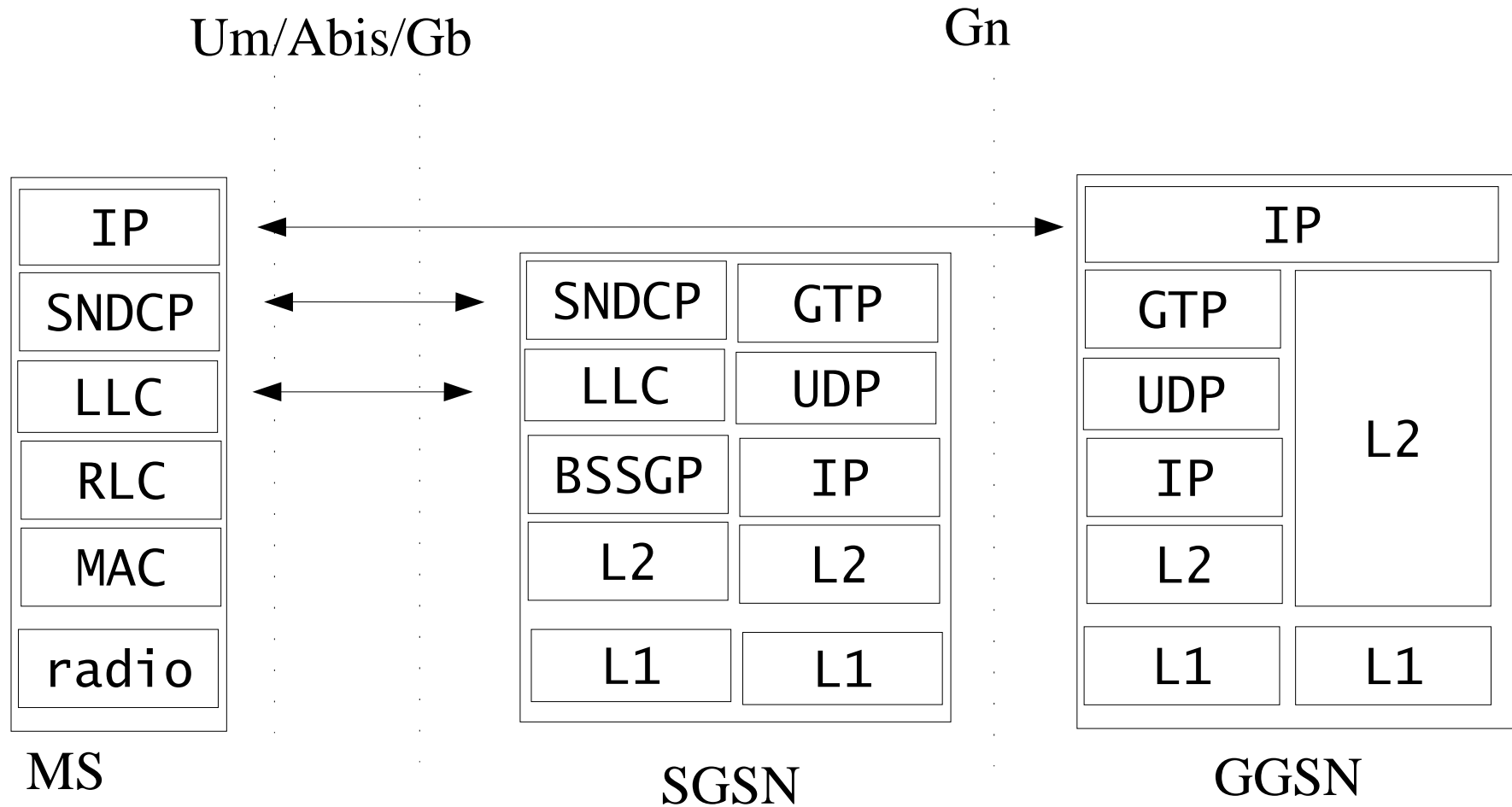   - Unprotected: header check sequence

LLC – Logic Link Control

- Provides encryption
  - Uses a similar algorithm to regular GSM encryption, GEA – GPRS Encryption Algorithm
- Keys are derived in the same way as regular GSM
- Note, MS will have two different Kc keys, one for GSM and one for GPRS
- What are the implications of encrypting at a higher layer?

GPRS transport protocol stack

Um/Abis/Gb   Gn

MS
IP
SNDCP
LLC
RLC
MAC
radio

SGSN	
SNDCP	GTP
LLC	UDP
BSSGP	IP
L2	L2
L1	L1

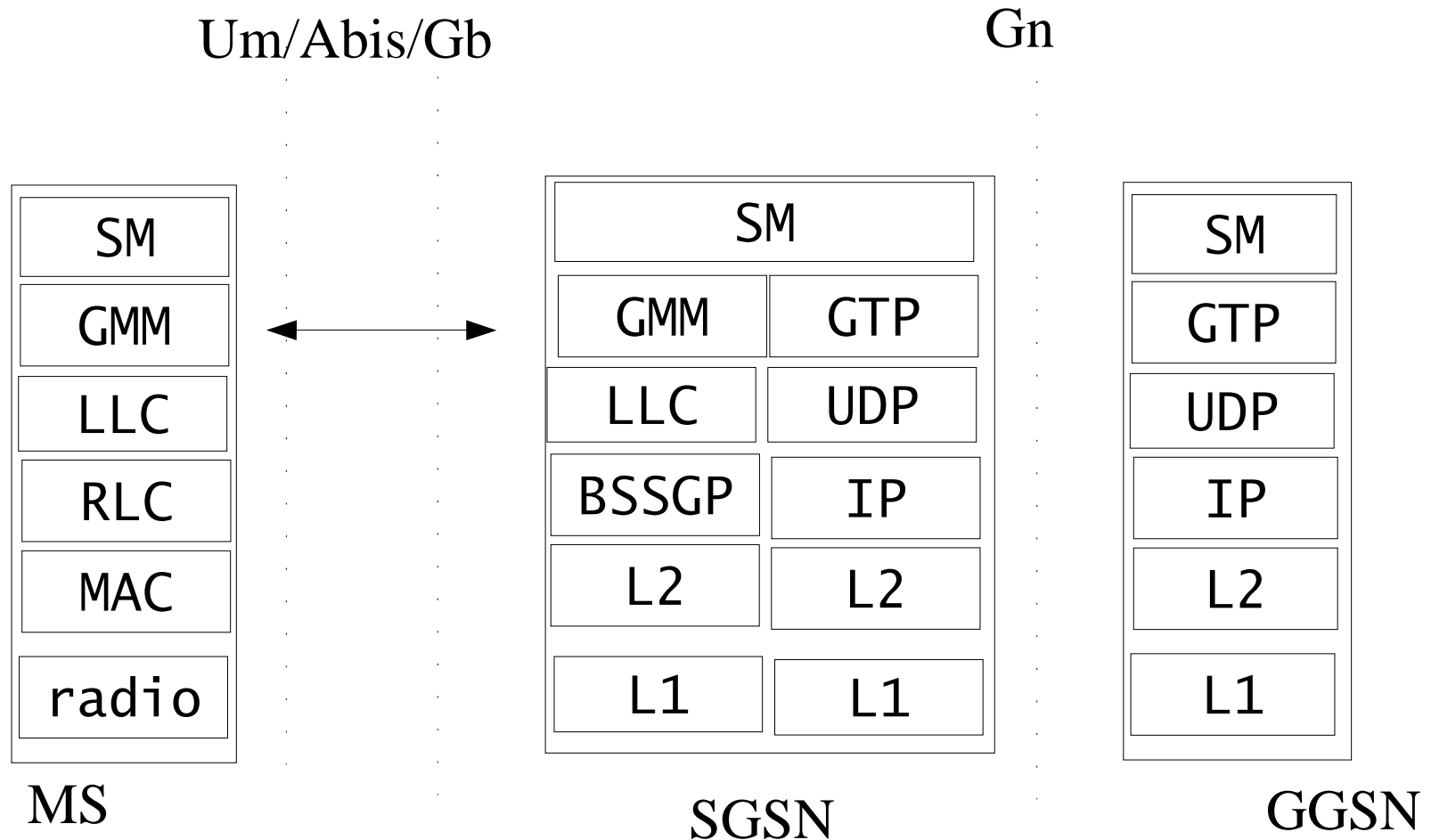| GGSN	
IP	
GTP	
UDP	L2
IP	
L2	
L1	L1

GTP – GPRS Tunnel Protocol

- A IP over UDP tunnel (could be TCP if requested).
- Converts SNDCP to GTP e.g. the GGSN can address a specific PDP context through GTP.
- Versions:
  - GTP-C for signaling
  - GTP-U for user data
- GGSN functions as a router on the Internet.

GPRS signaling protocol stack

Um/Abis/Gb

Gn

MS
SM
GMM
LLC
RLC
MAC
radio

SGSN

SM	
GMM	GTP
LLC	UDP
BSSGP	IP
L2	L2
L1	L1

GGSN

SM
GTP
UDP
IP
L2
L1

MS

GMM – GPRS Mobility Management

- Attach / detach procedures
- Responsible for routing area management.
- Paging of mobiles
- Authentication, ciphering, identification
- PTMSI allocation

SM – Session Management

- Creating and handling of PDP context
- PDP context
  - The point of presence of the mobile in the external network (Internet). Holds the IP address.
  - Shared state between GGSN and SGSN.
  - Holds information about the QoS, mobile terminal capabilities etc.

Logical Channels

- PBCCH - Packet Broadcast Control Channel
  - Serves the same purpose as BCCH
- PCCCH
  - PRACH – Packet random access channel
  - PAGCH - Packet Access Grant Channel
  - PPCH – Packet Paging Channel
  - PNCH – Packet Notification Channel

Logical Channels

- PDTCH - Packet Data traffic channel
- PDCCH - Packet Dedicated Control Channel
  - PACCH – associated control channel
  - PTACH – timing advance channel