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General Packet Radio Service (GPRS): Mobility- and Session Management

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ITG-Fachgruppe 5.2.4 "IP und Mobility„
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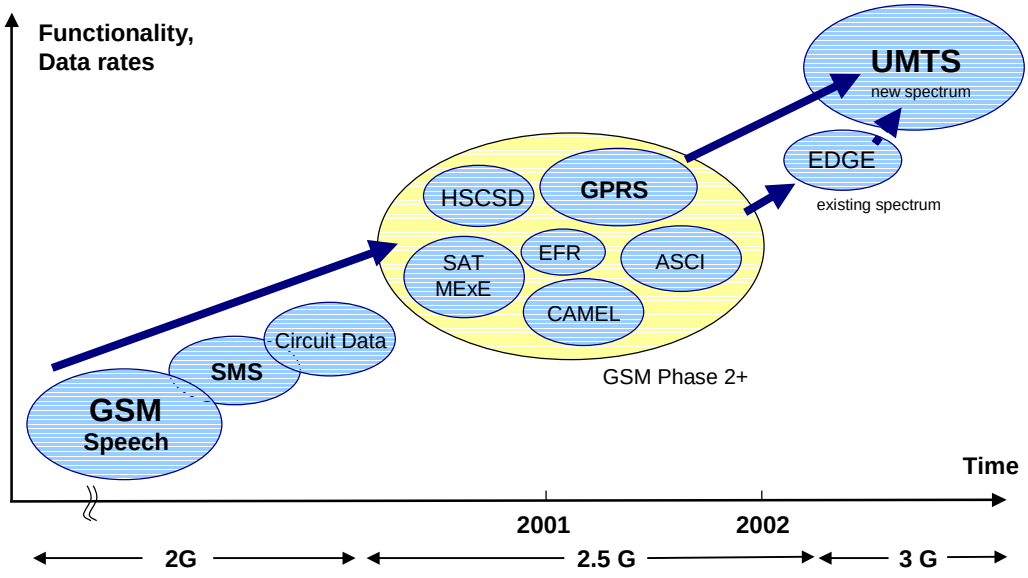
Outline of Talk

Evolution of GSM toward UMTS



General Packet Radio Service (GPRS)

... is a new GSM bearer service (GSM Phase 2+), introduced in 2000.

... improves and simplifies wireless access to packet data networks (Internet, X.25).

... offers packet switched bearer service at air interface.

... allows direct routing between mobile stations and packet switched networks.

... offers shorter access times and higher data rates.

	conventional GSM	GPRS
connection setup	several seconds	< 1 second
data rate	9.6 kbit/s	ISDN like (30..50 kbit/s)

Circuit switching vs. packet switching

	Circuit Switching	Packet Switching
Channel Allocation	for entire call period one user uses complete traffic channel	only if needed (capacity on demand) several users share one traffic channel (statistical multiplexing)
User pays for ...	duration of call	amount of transmitted data
For bursty traffic	Inefficient	Efficient

2 GPRS System Architecture

General GSM Concept: Some GSM Addresses

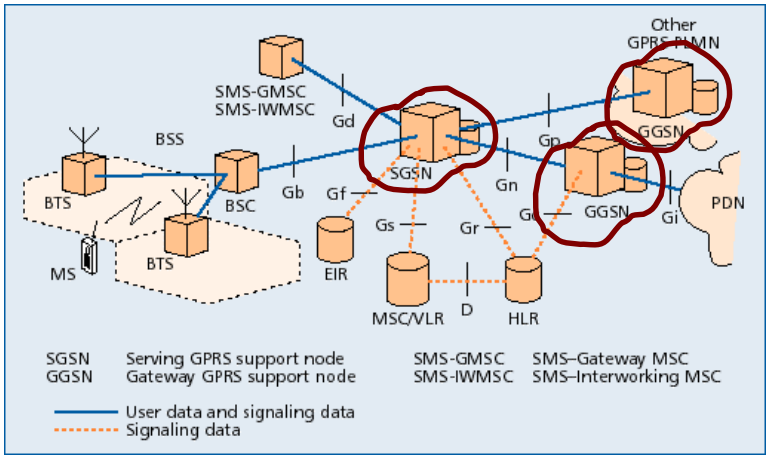
Mobile Station

IMEI International Mobile Station Equipment Identity

Mobile Subscriber

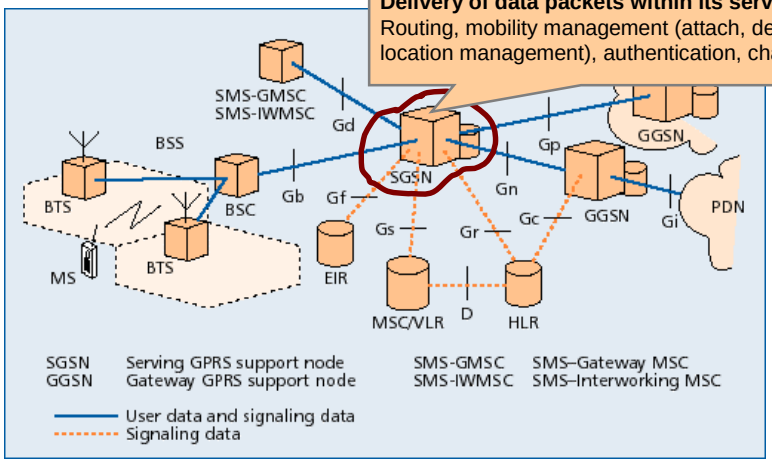
IMSI International Mobile Subscriber Identity
TMSI Temporary Mobile Subscriber Identity
MSISDN Mobile Station ISDN Number

GPRS Support Nodes (GSN): SGSN and GGSN



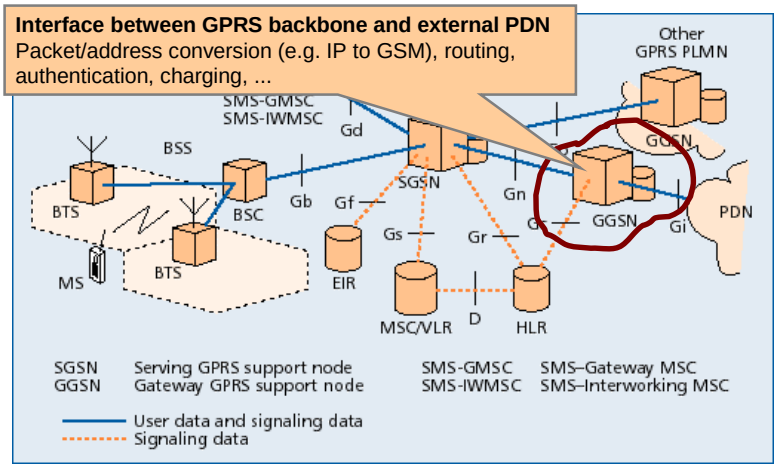
Serving GPRS Support Node (SGSN)

Delivery of data packets within its service area.
Routing, mobility management (attach, detach, location management), authentication, charging, ...



Gateway GPRS Support Node (GGSN)

Interface between GPRS backbone and external PDN
Packet/address conversion (e.g. IP to GSM), routing, authentication, charging, ...



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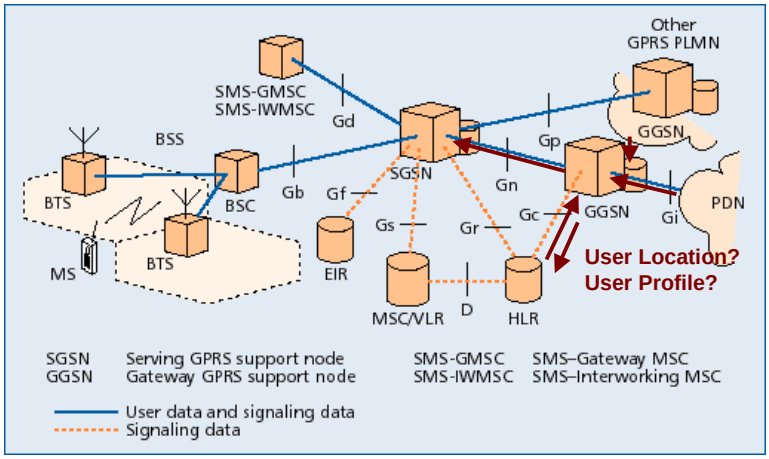
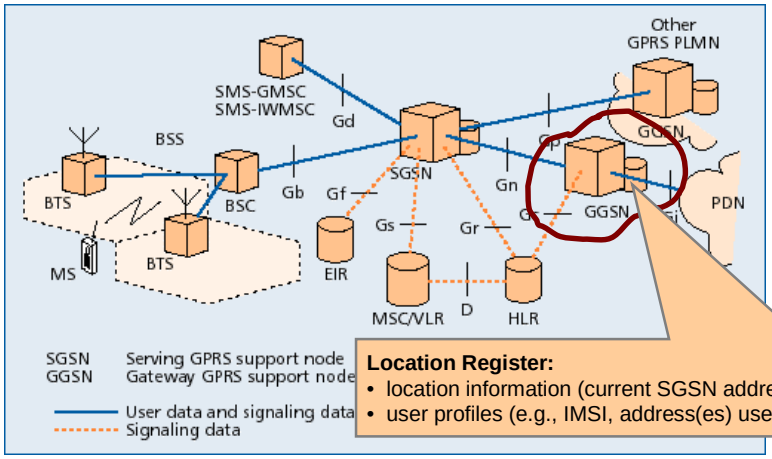
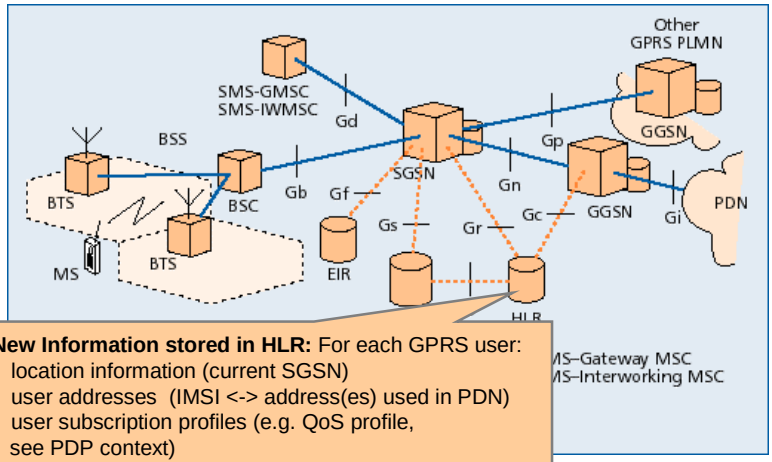


Gateway GPRS Support Node (GGSN)



HLR (Home Location Register): GPRS impacts



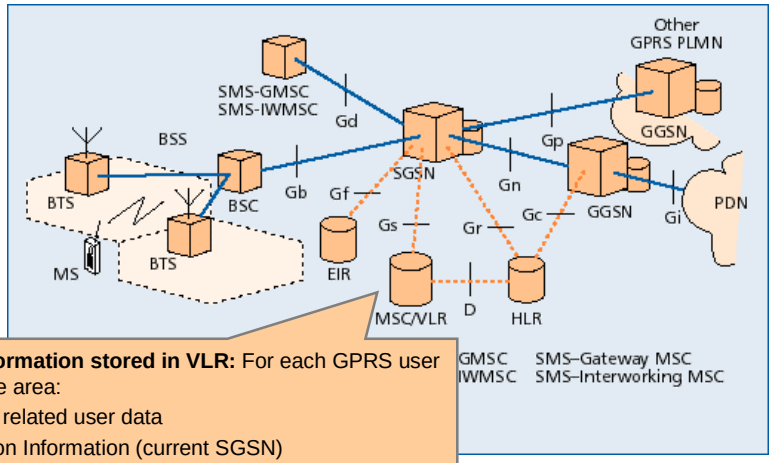
New Information stored in HLR: For each GPRS user:
- location information (current SGSN)
- user addresses (IMSI <-> address(es) used in PDN)
- user subscription profiles (e.g. QoS profile, see PDP context)

Additional functions (new MAP functions)

⇒ **More memory and performance needed**

New interfaces Gr and Gc

VLR (Visited Location Register): GPRS impacts

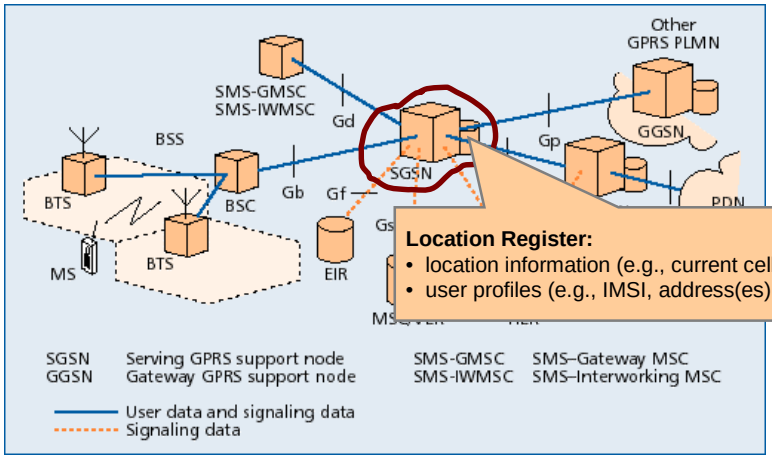


New information stored in VLR: For each GPRS user in service area:
- GPRS related user data
- Location Information (current SGSN)

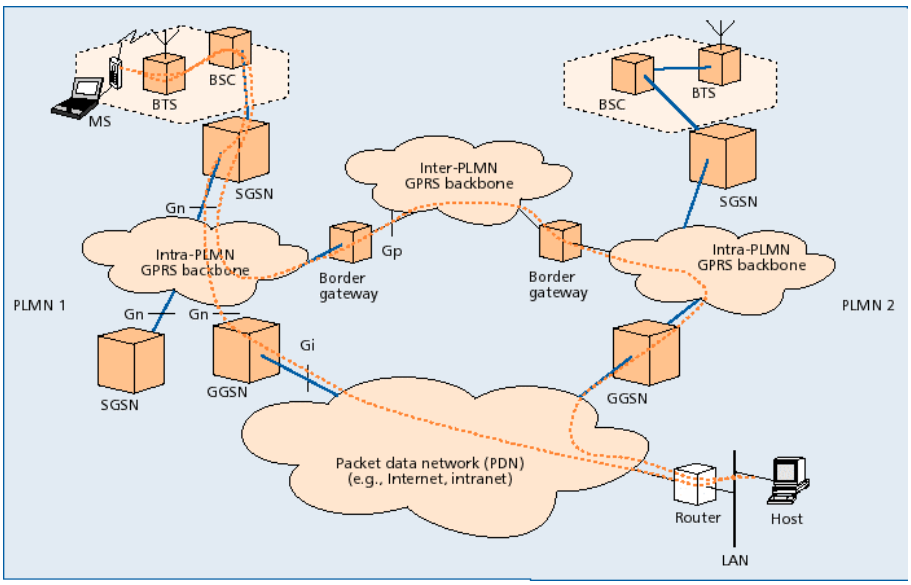
New functions & register entries for combined location management and paging

New interface Gs

Serving GPRS Support Node (SGSN)

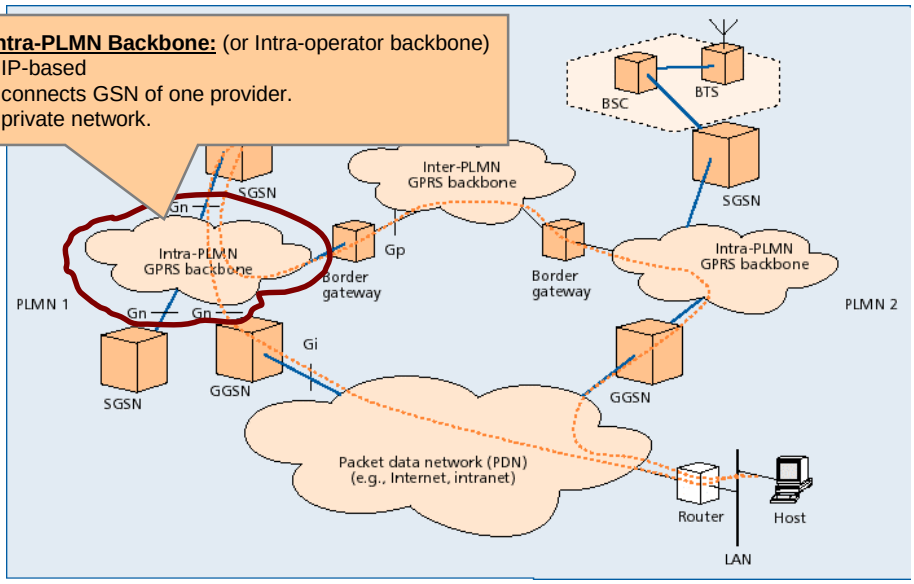


GPRS System Architecture



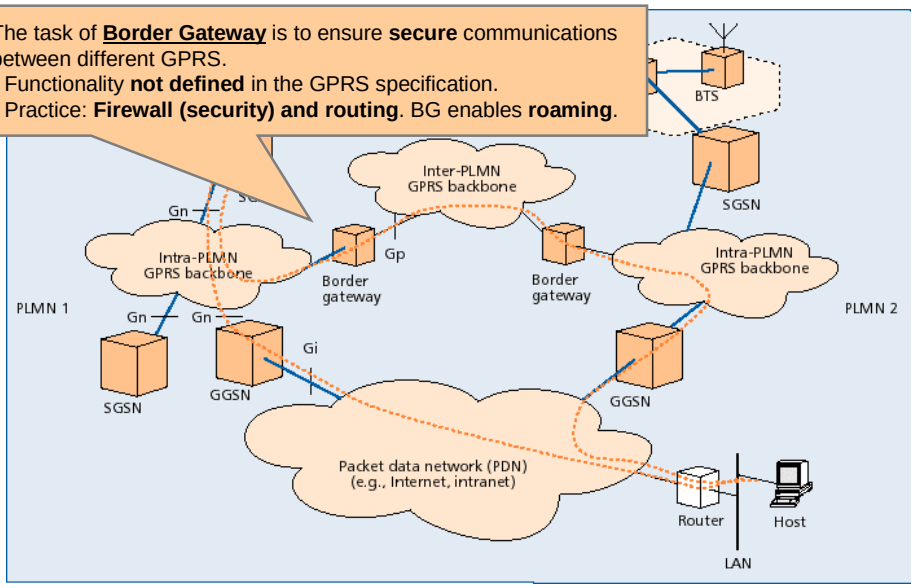
Intra-PLMN Backbone

Intra-PLMN Backbone: (or Intra-operator backbone)
- IP-based
- connects GSN of one provider.
- private network.

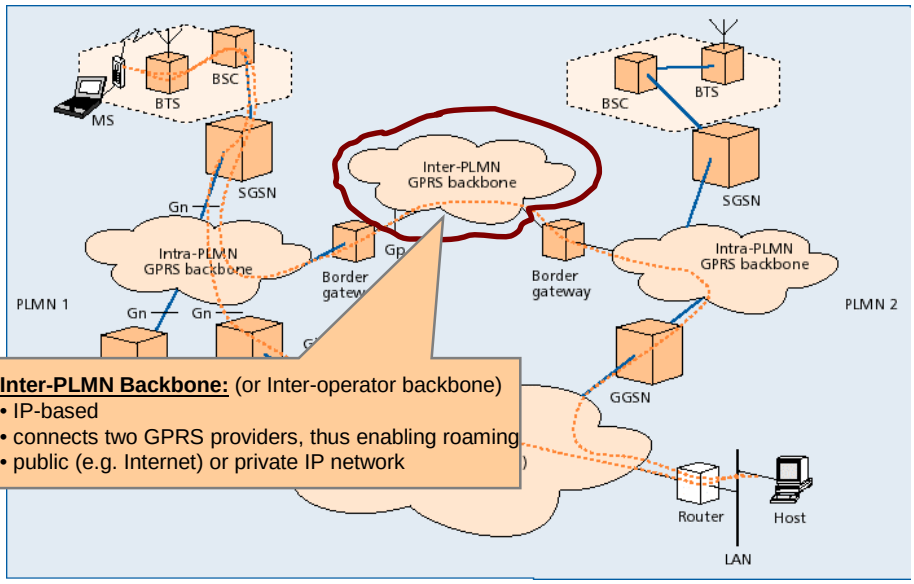


Border Gateway

The task of **Border Gateway** is to ensure **secure** communications between different GPRS.
- Functionality **not defined** in the GPRS specification.
- Practice: **Firewall (security) and routing**. BG enables **roaming**.



Inter-PLMN GPRS Backbone



Inter-PLMN Backbone: (or Inter-operator backbone)
- IP-based
- connects two GPRS providers, thus enabling roaming
- public (e.g. Internet) or private IP network

3 Session Management, Mobility Management, and Routing

GPRS Attach and Detach

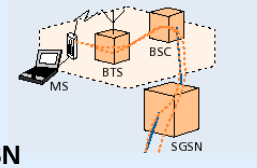
To use GPRS services

⬇

MS must **attach** to network

⬇

MS / user registers with an SGSN



SGSN:

- Checks if user and MS are authorized to use network?
- Copies user profile from HLR.
- Assigns a P-TMSI (Packet-TMSI) to user.

Also possible: Combined GPRS/IMSI attach for GSM and GPRS

PDP Address and PDP Context

To exchange packets with PDN after attach

⬇

MS applies for address used in the PDN

⬇

Packet Data Protocol Address (PDP Address) e.g. IP address

PDP Context: describes characteristics of session

- PDP Type (e.g., IPv4)
- PDP Address (e.g., 129.187.222.10)
- requested QoS
- address of GGSN which is access point to PDN

Active PDP context: MS is “visible” for the external PDN (can send and receive packets)

PDP Address and PDP Context

Address Mapping: PDP Address ⟺ GSM Address of MS in GGSN

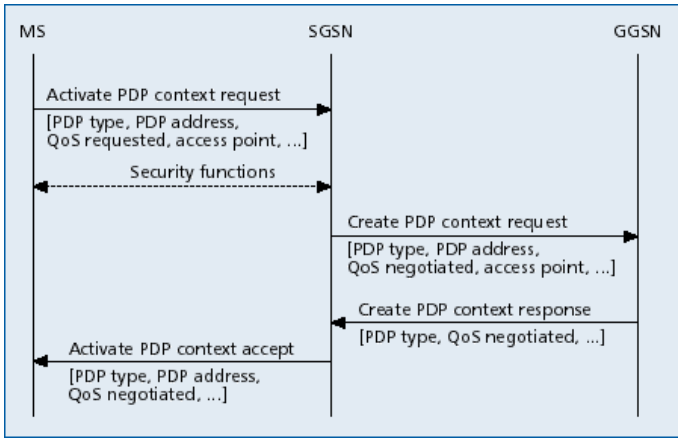
Simultaneous PDP Contexts: One user may have several PDP contexts active at a given time

Static or dynamic PDP context activation (Example IP)

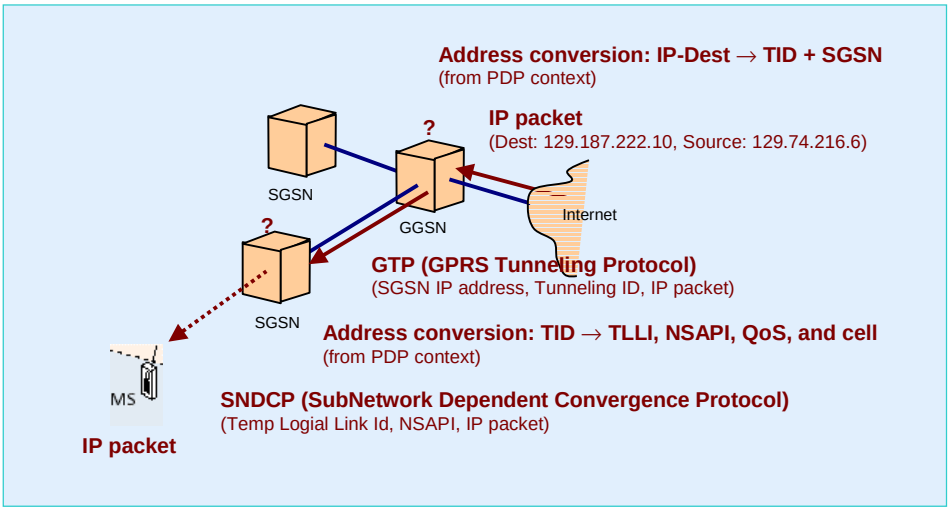
static IP address

dynamic IP address
- dynamic Home-PLMN IP address
- dynamic Visited-PLMN IP address

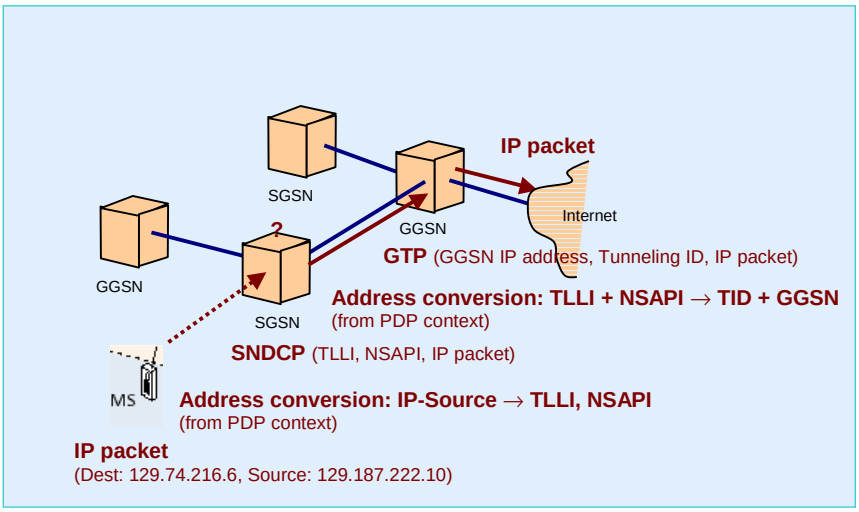
PDP Context Activation



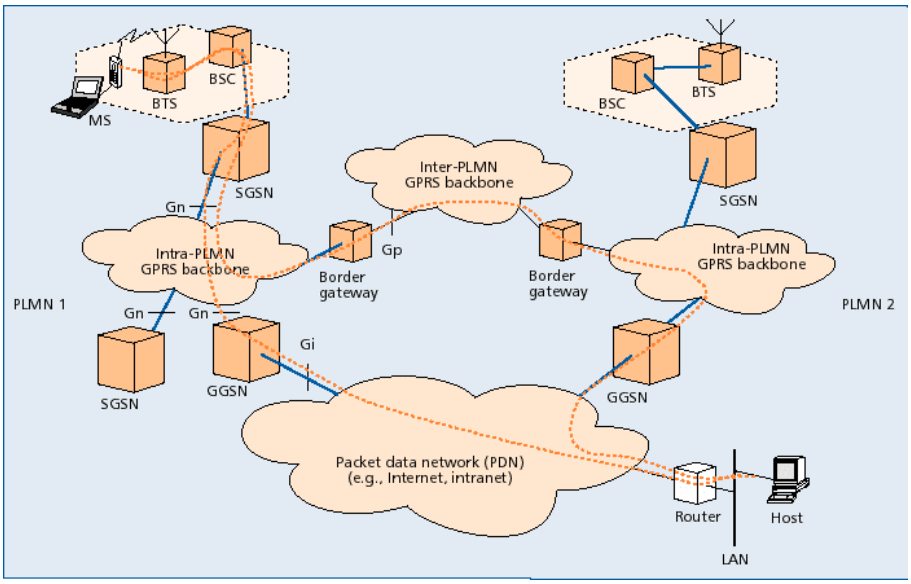
Routing Example: Incoming IP packet (MT)



Routing Example: Outgoing IP packet (MO)



Routing Example



Location Management

Problem Statement: For incoming calls/packets we must know the location (cell, service area) of the MS.

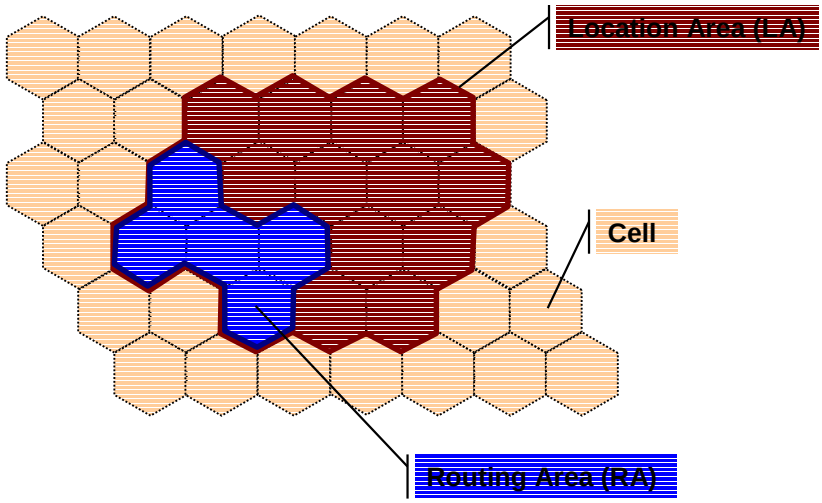
Location Updating:

- MS sends *Location Updates* to SGSN.
- SGSN informs GGSN and HLR about current location.

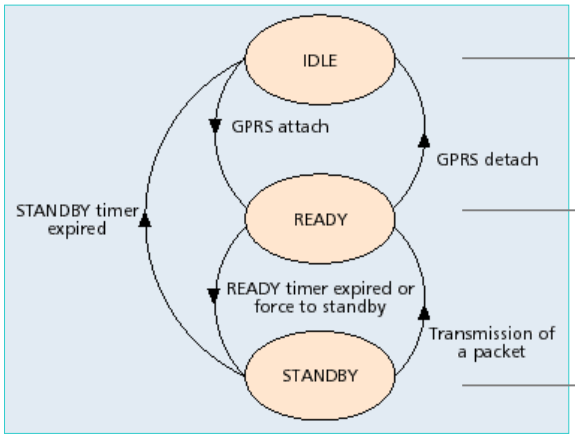
Question: How often should MS send a *Location Update*?

- Save battery of MS!
- Minimize radio usage!
  - Paging in Downlink
  - Location Updates & Paging Responses in Uplink

Cell ∈ Routing Area ∈ Location Area



Location Management: State Model



No location management; MS not reachable

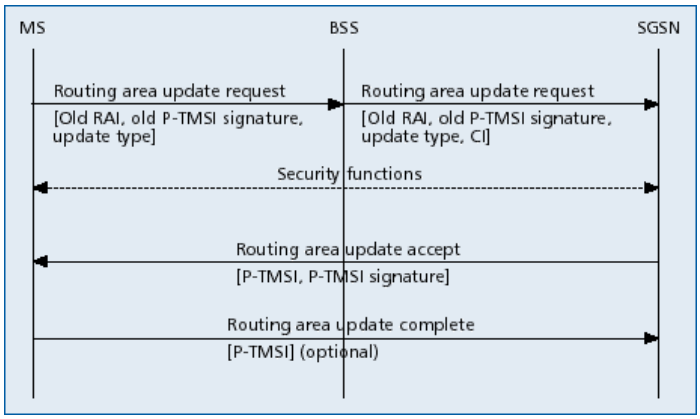
MS sends *Location Update* to SGSN when it changes **cell**.

MS sends *Location Update* to SGSN when it changes **routing area**.

Routing Area Update: Intra-SGSN and Inter-SGSN

Intra-SGSN routing area update	MS moves to an RA that is administered by the **same** SGSN as the old RA.
	SGSN has stored user profile Assigns new P-TMSI
Inter-SGSN routing area update	MS moves to an RA that is administered by a **different** SGSN as the old RA.
	New SGSN requests profile from old SGSN SGSN informs all GGSNs, HLR, and VLR

Intra-SGSN routing area update



Location Management: Summary

Two levels

Micro Mobility Management	Macro Mobility Management
tracks current RA or cell	tracks current SGSN and stores it in GGSN, HLR, and VLR

Location Management: Routing Area Planning

LA > RA > Cell, but: What is the best size and form?

Location Update when MS changes	„big area“	cell
Comp. with GSM	like in GSM when no call	like in GSM during call
Radio capacity: downlink	⊖ MS‘s location is not known exactly paging required for every downlink packet	⊕ MS‘s location is kown exactly ⊕ No paging needed
Radio capacity: uplink	⊕ not wasted for mobility m. ⊖ wasted for paging responses	⊖ wasted for mobility manag.
Data delivery	⊖ delayed significantly	⊕ very fast
Battery	⊕ saves battery	⊖ consumes batteries

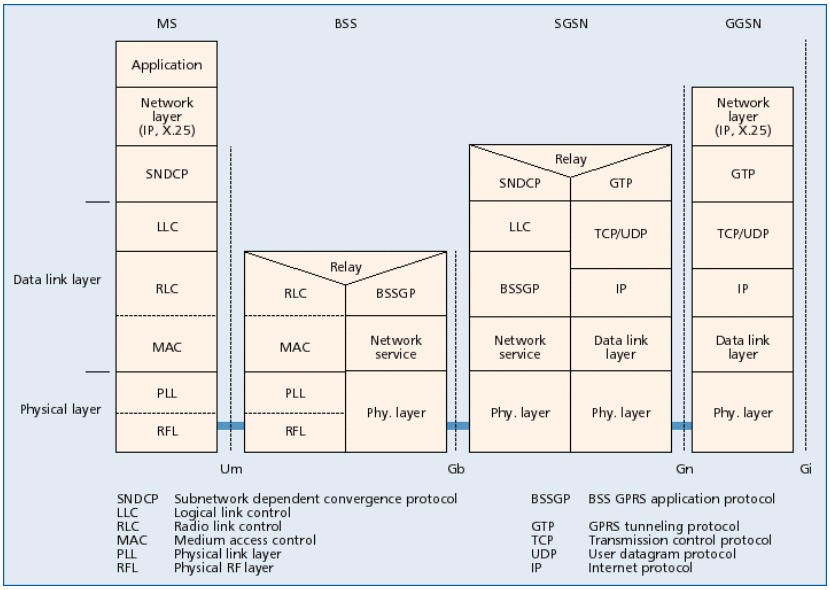
Tradeoff! Optimal design depends on: Environment (Office, Pedestrian Zone, Streets, ...), User mobility, Traffic, ...

4 Protocol Architecture

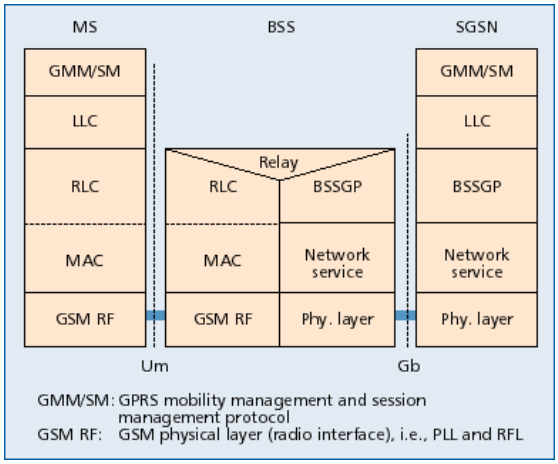
Transmission Plane

Signaling Plane

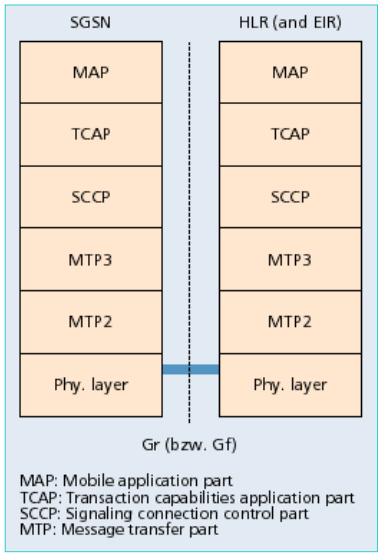
GPRS Protocol Architecture: Transmission Plane

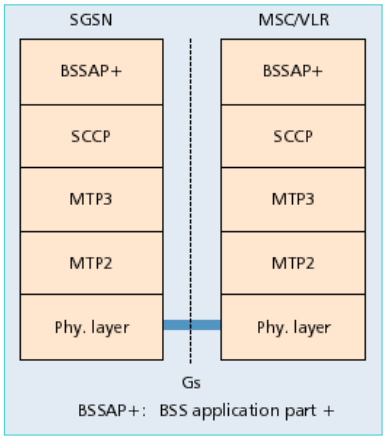


GPRS Protocol Architecture: Signaling Plane



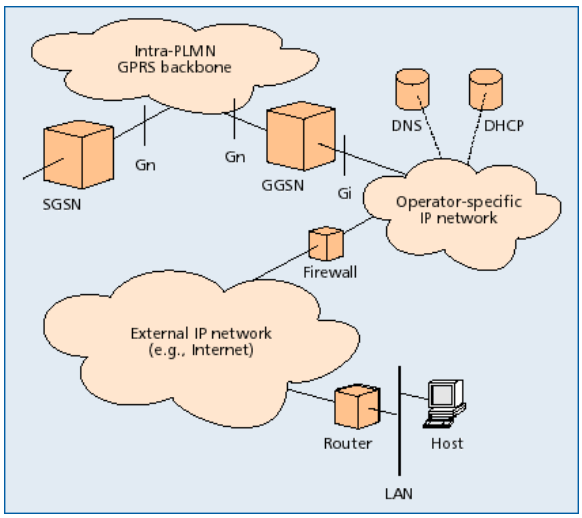
GPRS Protocol Architecture: Signaling Plane





5 Interworking Scenmario with IP Networks

Interworking with IP Networks



Other (non-GPRS) 2G mobile packet data technologies

GPRS-136:
- for TDMA/136
- slightly modified version of GPRS for GSM

Advantages of GPRS compared to CDPD:
- QoS parameters
- CDPD needs separate set of databases for subscriber profiles and mobility management

  GPRS allows coordination between circuit switched and packet switched mobility management
- dynamic IP address allocation

Survey-like Literature on GPRS

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