Introduction to Wireless Networks

Chapter 5: Introduction to GPRS

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Data services in GSM I

Data transmission standardized with only 9.6 kbit/s

- advanced coding allows 14,4 kbit/s
- not enough for Internet and multimedia applications

HSCSD (High-Speed Circuit Switched Data)

- mainly software update
- bundling of several time-slots to get higher AIUR (Air Interface User Rate) (e.g., 57.6 kbit/s using 4 slots, 14.4 each)
- advantage: ready to use, constant quality, simple
- disadvantage: channels blocked for voice transmission

AIUR [kbit/s]	TCH/F4.8	TCH/F9.6	TCH/F14.4
4.8	1		
9.6	2	1	
14.4	3		1
19.2	4	2	
28.8		3	2
38.4		4	
43.2			3
57.6			4

Data services in GSM II

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

GPRS quality of service

Reliability class	Lost SDU probability	Duplicate SDU probability	Out of sequence SDU probability	Corrupt SDU probability
1	10^{-9}	10^{-9}	10^{-9}	10^{-9}
2	10^{-4}	10^{-5}	10^{-5}	10^{-6}
3	10^{-2}	10^{-5}	10^{-5}	10^{-2}

Delay class	SDU size 128 byte		SDU size 1024 byte	
	mean	95 percentile	mean	95 percentile
1	< 0.5 s	< 1.5 s	< 2 s	< 7 s
2	< 5 s	< 25 s	< 15 s	< 75 s
3	< 50 s	< 250 s	< 75 s	< 375 s
4	unspecified			

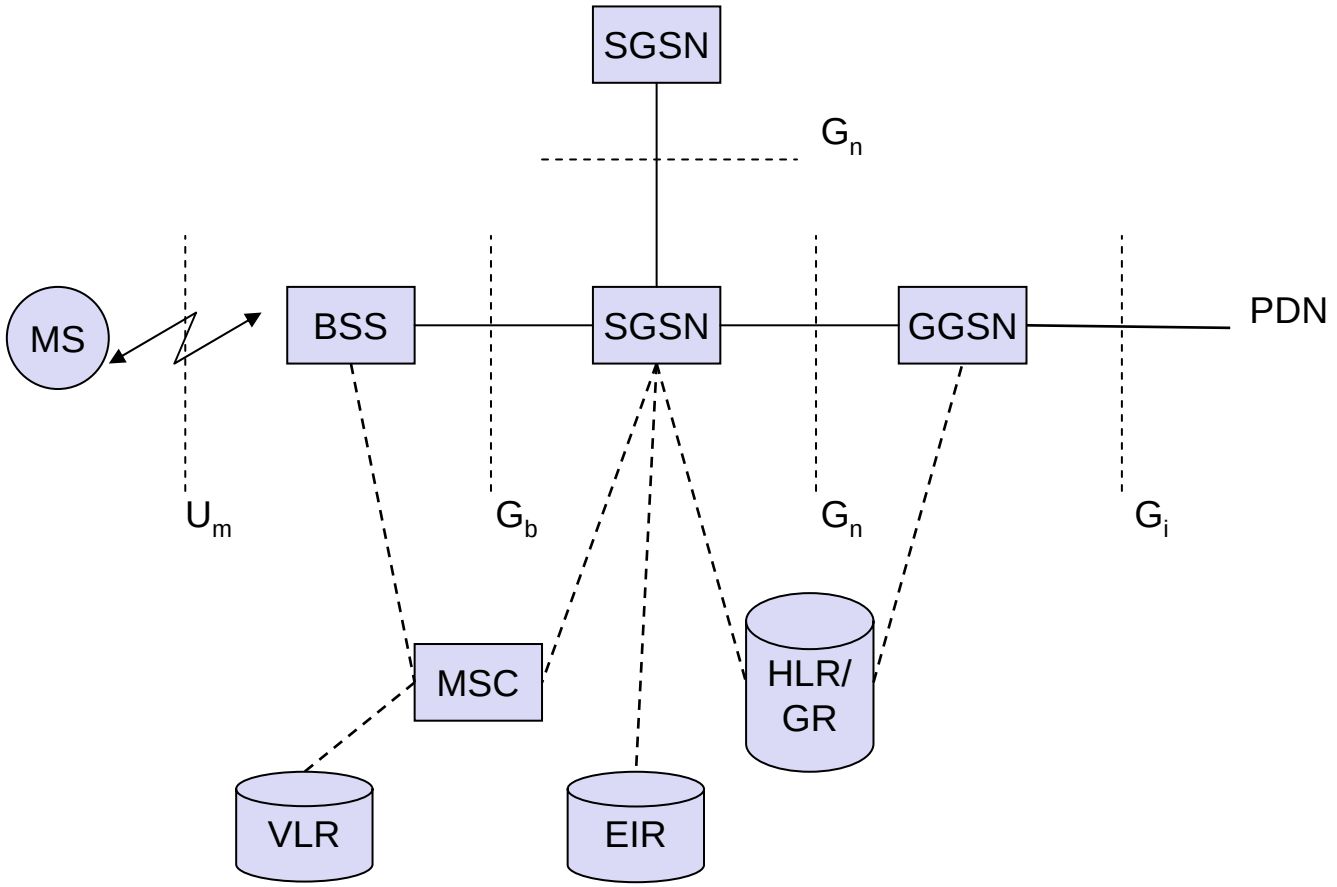
Examples for GPRS device classes

Class	Receiving slots	Sending slots	Maximum number of slots
1	1	1	2
2	2	1	3
3	2	2	3
5	2	2	4
8	4	1	5
10	4	2	5
12	4	4	5

GPRS user data rates in kbit/s

Coding scheme	1 slot	2 slots	3 slots	4 slots	5 slots	6 slots	7 slots	8 slots
CS-1	9.05	18.2	27.15	36.2	45.25	54.3	63.35	72.4
CS-2	13.4	26.8	40.2	53.6	67	80.4	93.8	107.2
CS-3	15.6	31.2	46.8	62.4	78	93.6	109.2	124.8
CS-4	21.4	42.8	64.2	85.6	107	128.4	149.8	171.2

GPRS architecture and interfaces



GPRS architecture

The GPRS architecture introduces two new network elements, **GPRS support nodes (GSN)**

- The **gateway GPRS support node (GGSN)** is the interworking unit between the GRPS network and external **packet data networks (PDN).**
- **The serving GPRS support node (SGSN)** which supports the MS via Gb interface.

- The GGSN contains routing information for GPRS users, performs address conversion, and tunnel data to a user via encapsulation.
- The GGSN is connected to external networks (e.g. IP or X.25) via the Gi interface and transfers packets to the SGSN via an IP-based GPRS backbone network (Gn interface).

Cont.

As shown in Fig. (page 5.7), packet data is transmitted from a PDN, via the GGSN and SGSN directly to the BSS and finally to the MS.

The MSC, which is responsible for data transfer in the traditional circuit-switched GSM, is only used for signaling in the GPRS scenario.

Before sending any data over GRPS network, an MS must attach to it, following the procedures of the **mobility management**.

GPRS protocol architecture

All data within the GPRS backbone, i.e., between the GSNs, is transferred using the GPRS tunnelling protocol (GTP).

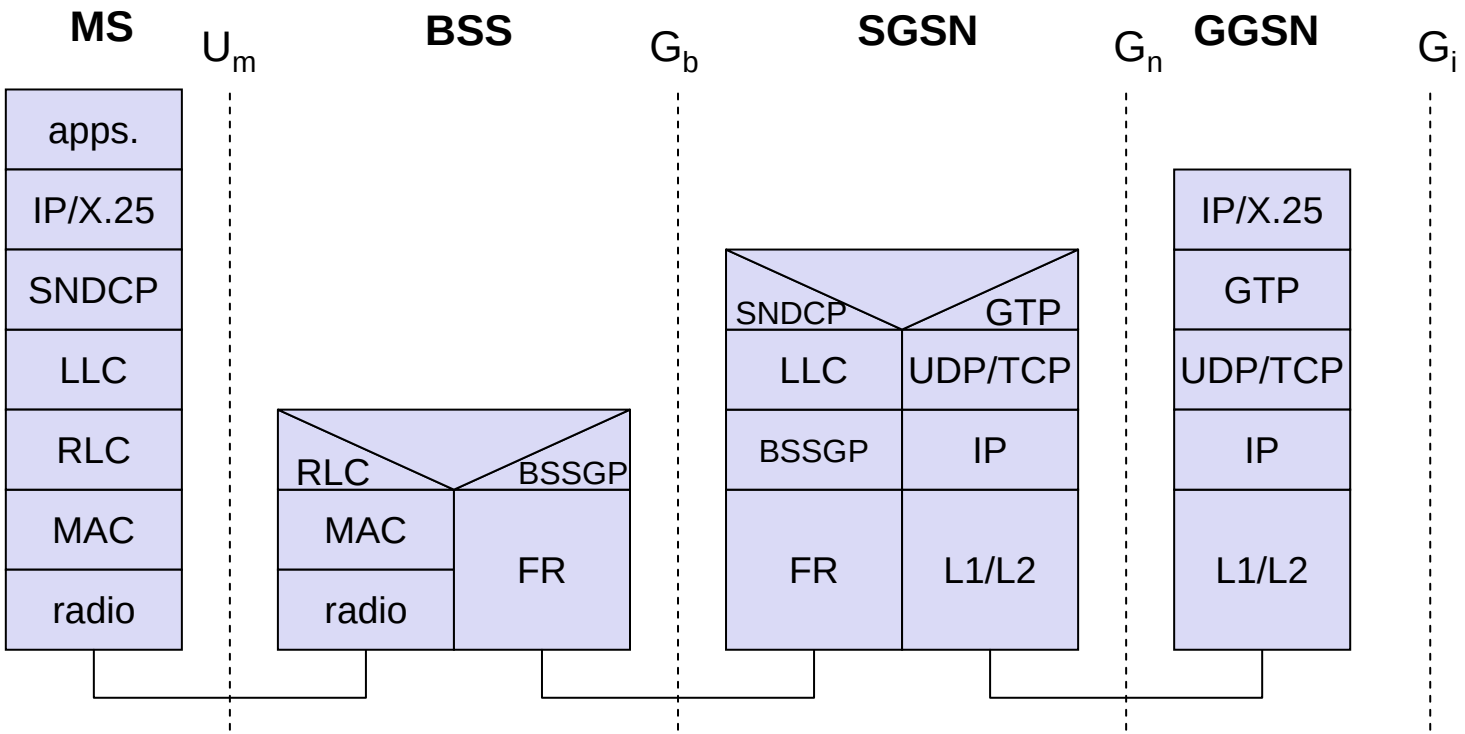
GTP can use two different transport protocols, either reliable TPC (needed for reliable transfer of X.25 packets) or non-reliable UDP (needed for IP packet).

The subnetwork dependent convergence protocol (SNDCP) is used between SGSN and MS.

On the top of SNDCP and GTP, user packet data is tunneled from the MS to the GGSN and vice versa.

To achieve a high reliability of packet transfer between SGSN and MS, a special LLC is used.

GPRS protocol architecture

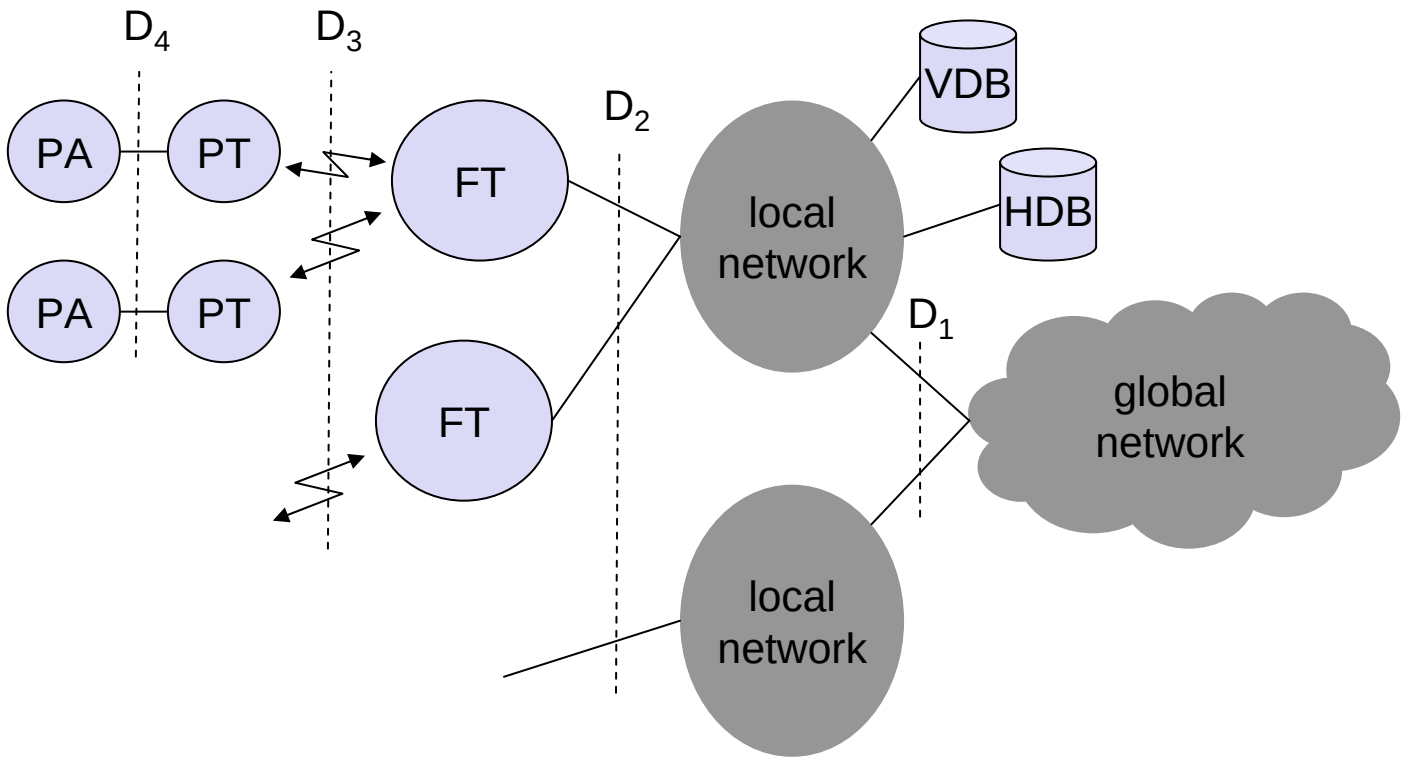


DECT

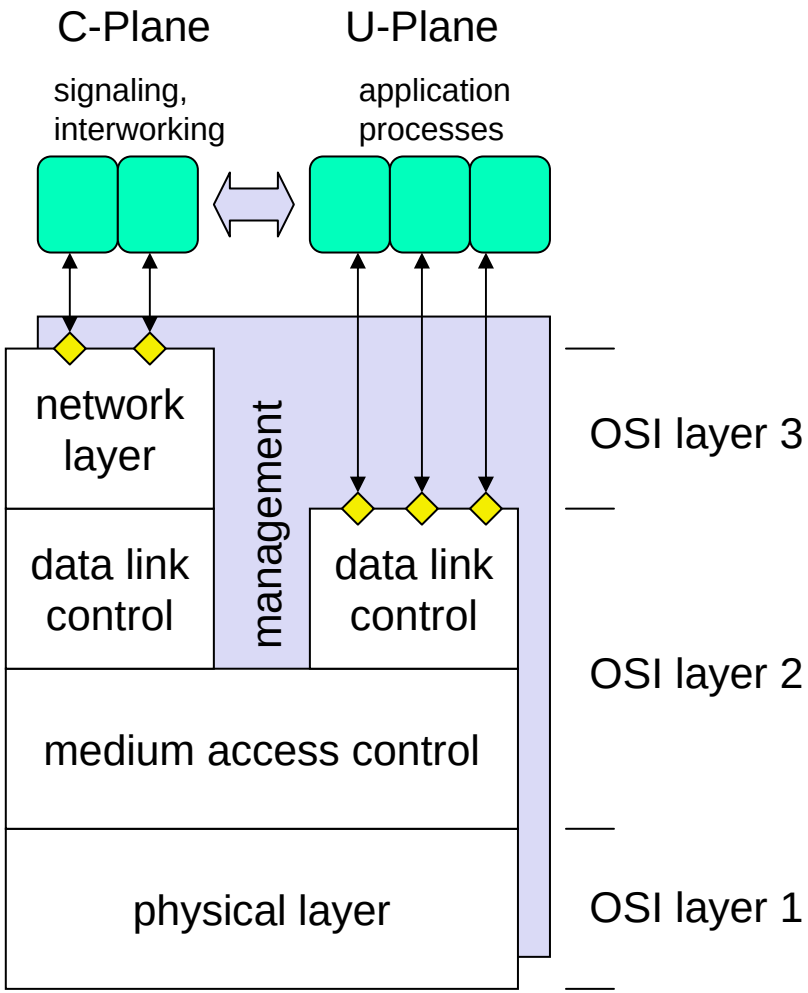
DECT (Digital European Cordless Telephone) standardized by ETSI (ETS 300.175-x) for cordless telephones

- standard describes air interface between base-station and mobile phone
- DECT has been renamed for international marketing reasons into „Digital Enhanced Cordless Telecommunication“
- Characteristics
  - frequency: 1880-1990 MHz
  - channels: 120 full duplex
  - duplex mechanism: TDD (Time Division Duplex) with 10 ms frame length
  - multplexing scheme: FDMA with 10 carrier frequencies, TDMA with 2x 12 slots
  - modulation: digital, Gaußian Minimum Shift Key (GMSK)
  - power: 10 mW average (max. 250 mW)
  - range: approx. 50 m in buildings, 300 m open space

DECT system architecture reference model



DECT reference model

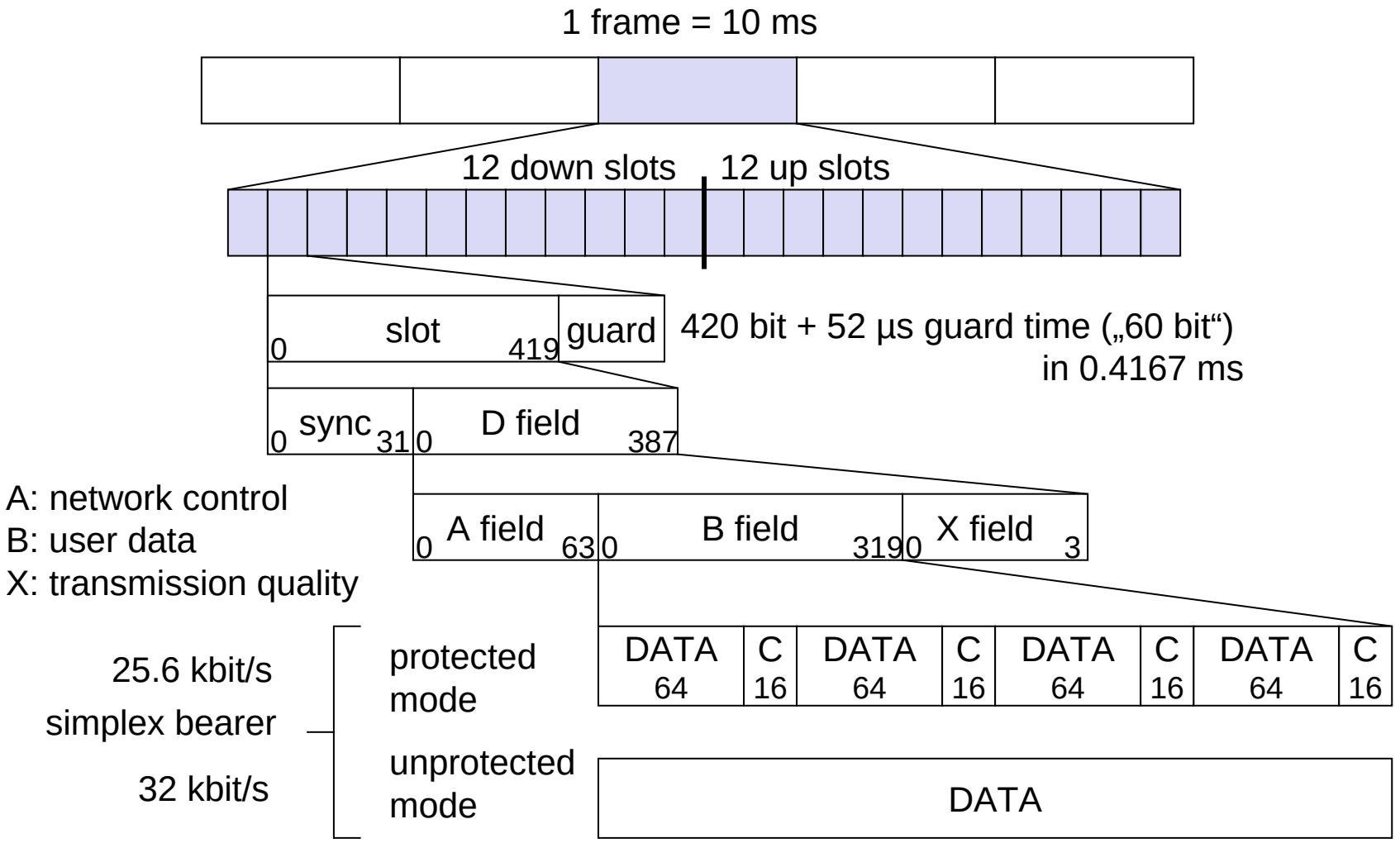


- close to the OSI reference model
- management plane over all layers
- several services in C(ontrol)- and U(ser)-plane

DECT layers I

- Physical layer
  - modulation/demodulation
  - generation of the physical channel structure with a guaranteed throughput
  - controlling of radio transmission
    - channel assignment on request of the MAC layer
    - detection of incoming signals
    - sender/receiver synchronization
    - collecting status information for the management plane
- MAC layer
  - maintaining basic services, activating/deactivating physical channels
  - multiplexing of logical channels
    - e.g., C: signaling, I: user data, P: paging, Q: broadcast
  - segmentation/reassembly
  - error control/error correction

DECT time multiplex frame



DECT layers II

- Data link control layer
  - creation and keeping up reliable connections between the mobile terminal and basestation
  - two DLC protocols for the control plane (C-Plane)
    - connectionless broadcast service:
      paging functionality
    - Lc+LAPC protocol:
      in-call signaling (similar to LAPD within ISDN), adapted to the underlying MAC service
  - several services specified for the user plane (U-Plane)
    - null-service: offers unmodified MAC services
    - frame relay: simple packet transmission
    - frame switching: time-bounded packet transmission
    - error correcting transmission: uses FEC, for delay critical, time-bounded services
    - bandwidth adaptive transmission
    - „Escape“ service: for further enhancements of the standard

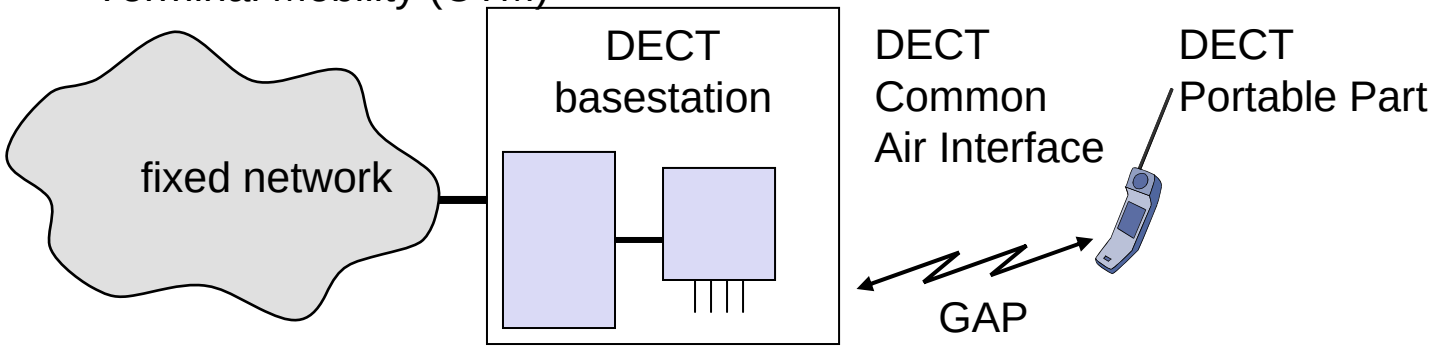
DECT layers III

- Network layer
  - similar to ISDN (Q.931) and GSM (04.08)
  - offers services to request, check, reserve, control, and release resources at the basestation and mobile terminal
  - resources
    - necessary for a wireless connection
    - necessary for the connection of the DECT system to the fixed network
  - main tasks
    - call control: setup, release, negotiation, control
    - call independent services: call forwarding, accounting, call redirecting
    - mobility management: identity management, authentication, management of the location register

Enhancements of the standard

Several „DECT Application Profiles“ in addition to the DECT specification

- GAP (Generic Access Profile) standardized by ETSI in 1997
  - assures interoperability between DECT equipment of different manufacturers (minimal requirements for voice communication)
  - enhanced management capabilities through the fixed network: Cordless Terminal Mobility (CTM)



- DECT/GSM Interworking Profile (GIP): connection to GSM
- ISDN Interworking Profiles (IAP, IIP): connection to ISDN
- Radio Local Loop Access Profile (RAP): public telephone service
- CTM Access Profile (CAP): support for user mobility

TETRA - Terrestrial Trunked Radio

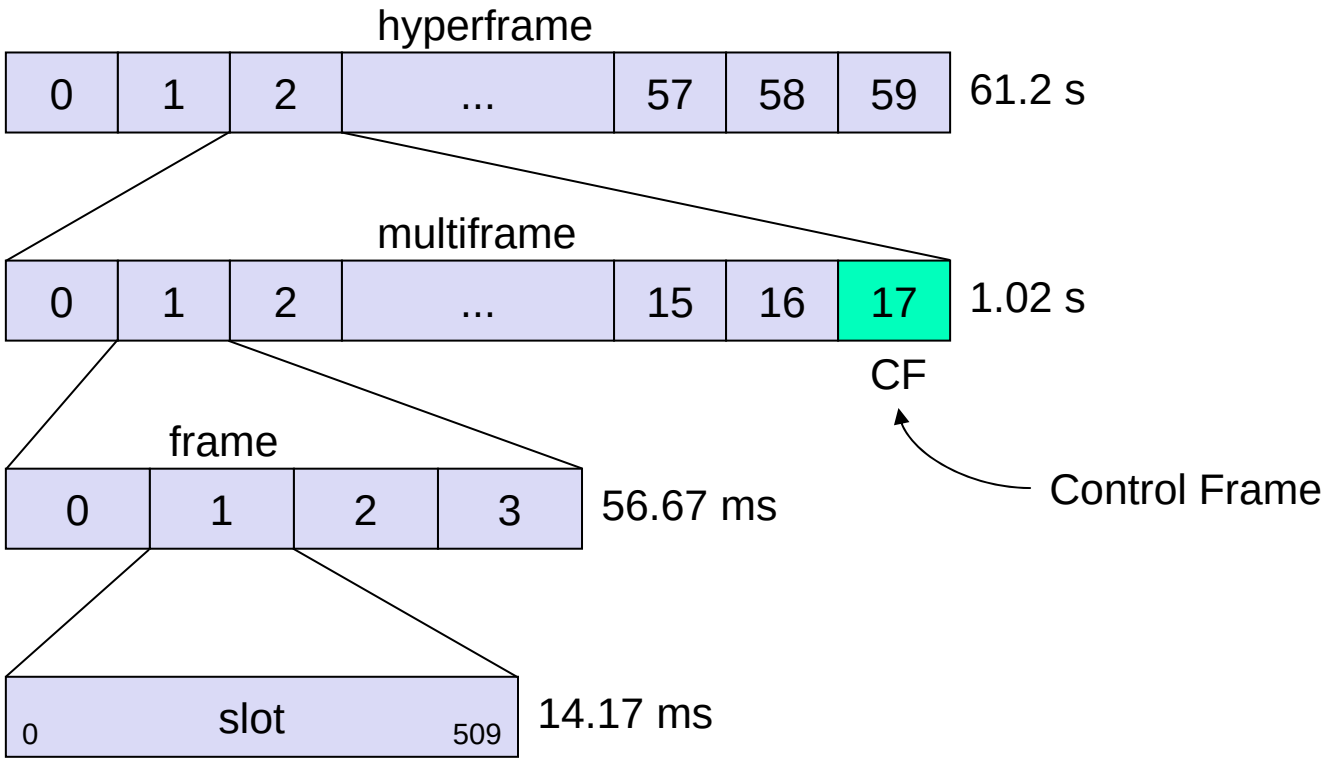
Trunked radio systems

- many different radio carriers
- assign single carrier for a short period to one user/group of users
- taxi service, fleet management, rescue teams
- interfaces to public networks, voice and data services
- very reliable, fast call setup, local operation

TETRA - ETSI standard

- formerly: Trans European Trunked Radio
- offers Voice+Data and Packet Data Optimized service
- point-to-point and point-to-multipoint
- ad-hoc and infrastructure networks
- several frequencies: 380-400 MHz, 410-430 MHz
- FDD, DQPSK
- group call, broadcast, sub-second group-call setup

TDMA structure of the voice+data system



Homework #5:

1. What's the GPRS architecture ?
2. What's the detailed function of GGSN and SGSN ?
3. What's the GPRS protocol stack ?