

# Internet Access by GSM & GPRS

At the end of the wired universe...

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# Prolog

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When you like

- slow links
- expensive connection fees
- complicated installation and configuration
- ... just like you have done it '94 & '95 in the wired Internet

then you are right here:

*Welcome back into the future!*

# Outline

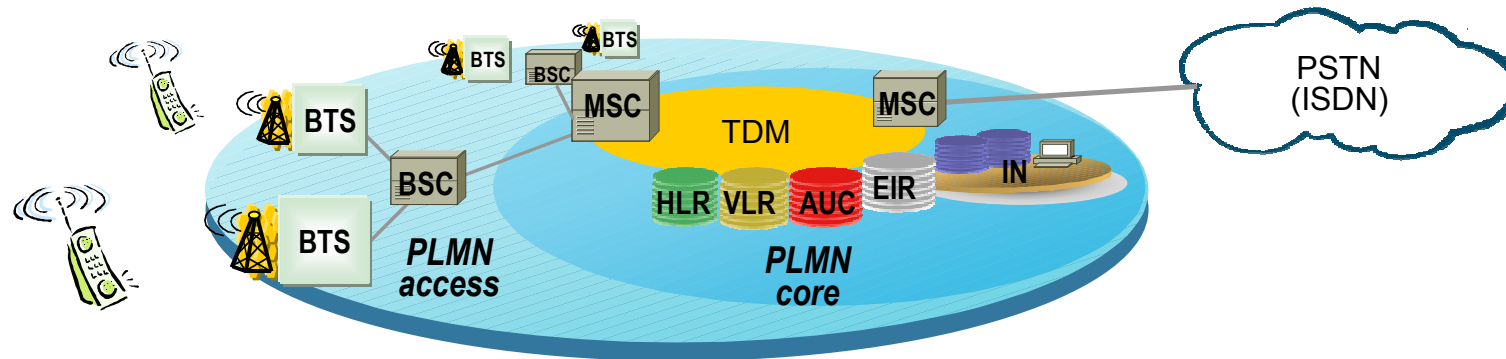
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- ❑ GSM system overview
- ❑ Circuit switched data
- ❑ Internet access over GSM
- ❑ High Speed Circuit Switched Data
- ❑ GPRS system overview
- ❑ Comparison of CSD, HSCSD and GPRS
- ❑ Links

# GSM (Global System for Mobile communications)

- ❑ GSM standard was adopted by ETSI in 1991
- ❑ Now used in 135++ countries by about 400 mio users
- ❑ Benefits:
  - Support for international roaming
  - Distinction between user and device identification
  - Excellent speech quality
  - Wide range of services
  - Interworking (e.g. with ISDN, DECT)
  - Extensive security features
- ❑ Services:
  - Telephony
  - Asynchronous and synchronous data services (2.4/4.8/9.6 kbit/s)
  - Access to packet data network (X.25)
  - Telematic services (SMS, fax, videotext, etc.)
  - Many value-added features  
(call forwarding, caller ID, voice mailbox)

# GSM system architecture



PLMN  
Public Land Mobile Network

BTS  
Base Transceiver Station

BSC  
Base Station Controller

MSC  
Mobile Switching Center

PSTN  
Plain Standard Telefon Network

HLR  
Home Location Register

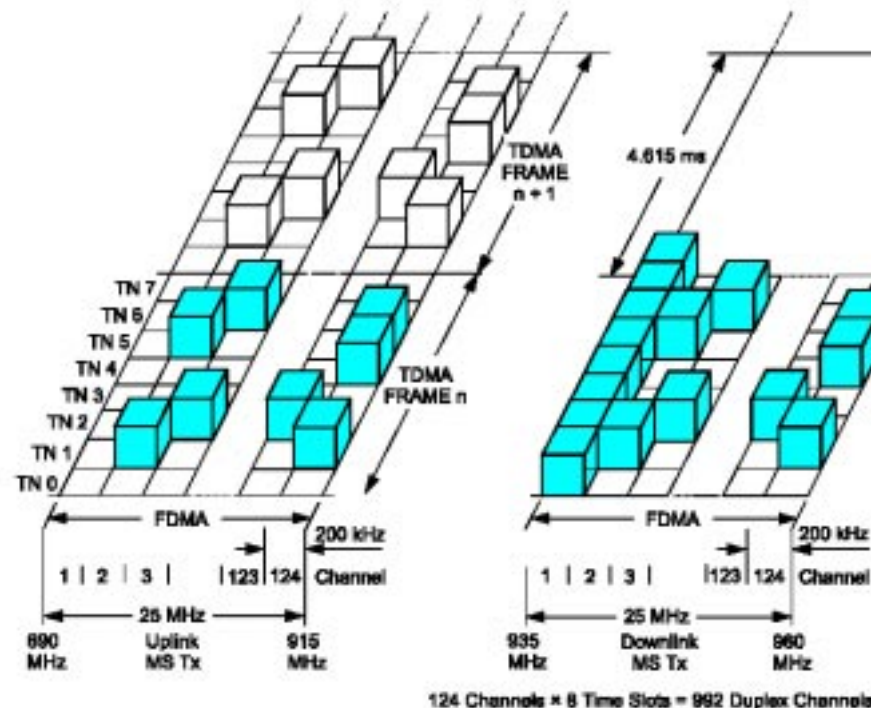
VLR  
Visited Location Register

AUC  
Authentication Center

EIR  
Equipment Identity Register

IN  
Intelligent Network

# GSM radio interface



- ❑ GSM900  
Up: 890-915 MHz  
Down: 935-960 MHz
- ❑ GSM1800  
Up: 1710-1785 MHz  
Down: 1805-1880 MHz
- ❑ GSM1900  
Up: 1850-1910 MHz  
Down: 1930-1990 MHz

- ❑ One channel transfers 114 information bits / time slots  
One channel occupies 24 time slots / 120ms  
One channel has a raw data rate of 22,8 kbit/s (full rate)
- ❑ Half a channel might be used for one connection (half rate)
- ❑ The bearer service for data communication provides 9,6 kbit/s

# GSM CSD (Circuit Switched Data)

## *non-transparent*

- ❑ Most widely used: non-transparent data rate of 9.6 kbit/s.
  - Error correction and flow control ("non-transparent")
  - RTT is typically around 0.5s (GSM1800) and 1s (GSM900)
- ❑ Non-transparent mode utilises a special GSM network-based error correction facility called "Radio Link Protocol" (RLP) that ensures more robust transmission.
- ❑ Transmitter gets an acknowledgement from the receiver that data has been error-free received.
- ❑ "forward correction" technique is used to ensure uninterrupted data transmission throughout.
- ❑ Call can be started on V.110 (link a ISDN data call; fast set-up) or on V.32.( like in a PSTN modem; slow set-up).
- ❑ RLP causes a small additional delay.

# GSM CSD (Circuit Switched Data)

## *transparent*

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- ❑ No GSM error correction supplied over the air interface.
- ❑ Standard for G3 fax transmission is a transparent protocol.
- ❑ Most GSM networks support both non transparent and transparent data communications.
- ❑ Can be started on V.110 (link a ISDN data call) or on V.32.( like in a PSTN modem).
- ❑ Transparent mode causes only minimal delay but does not guarantee error free transmission.  
Real time requirements are better fulfilled by transparent mode.



## Configuration: CSD AT Strings

- ❑ For ISDN connection use the following initialisation strings:  
AT+CBST=71,0,1 (for most newer handsets)
- ❑ The +CBST string is defined as "select bearer service type" in GSM 07.07. The full definition is:

AT+CBST=<speed>,<name>,<ce>

<speed>	Meaning
0	autobauding
7	9600 V32
12	9600 V34
14	14400 V34 (HSCSD 1 timeslot)
15	19200 V34 (HSCSD 2 timeslots)
16	28800 V34 (HSCSD 2 timeslots)
71	9600 V110
75	14400 V110 (HSCSD 1 timeslot)
79	19200 V110 (HSCSD 2 timeslots)
80	28800 V110 (HSCSD 2 timeslots)

<name>	Meaning
0	data circuit asynchronous
1	data circuit synchronous

<ce>	Meaning
0	transparent
1	non-transparent
2	both, transparent preferred
3	both, non-transparent preferred

# Mobile Internet access in Germany

- ❑ Most mobile phones are equipped with modem functionality
- ❑ Connection to the computer might be realized by cable or IrDA
- ❑ Getting mobile internet access needs just the configuration of a new internet connection on the computer.

	T-D1	D2-privat	e-plus	Viag Interkom
Phone number	4122	229000	123100	464638
Username	will be provided after sign up	don't care	empty	<i>go@mobil.de</i>
Password		don't care	empty	<i>internet</i>
Cost per minute [DM]	0.39	0.19 (22-06) 0.39 (06-22)	0.19 (18-09) 0.39 (09-18)	0.29

- ❑ More economic connection fees might be possible by local dial-in numbers (<http://www.holpert.de/christian/internet-by-call/Ortstarif.html>)
- ❑ Most MNOs provide direct dial-in numbers for other online-services.

# HSCSD (High Speed Circuit Switched Data)

- ❑ Maximum user data rate per GSM time slot 14.4 kbit/s
  - New coding scheme with less error protection capabilities
  - 14.4 kbit/s bearer not possible at GSM900
- ❑ Up to four time slots can be allocated for one data call.
- ❑ Both, 9.6 kbit/s and 14.4 kbit/s bearers, can be used.
  - max. 38.4 kbit/s with 9.6 kbit/s bearer
  - max. 57.6 kbit/s with 14.4 kbit/s bearer
- ❑ Non-transparent service:
  - Number of timeslots can be changed during the call
  - Asymmetric allocation possible
- ❑ Transparent service:
  - Fixed number of timeslots during a particular call
- ❑ Simple upgrade of existing GSM networks

## Configuration: HSCSD AT Strings

- ❑ The most common HSCSD configurations are:
  - AT+CHSN=2,1,1,8      want single slot 14k4
  - AT+CHSN=2,1,1,12      want single slot 14k4 but will accept 9k6
  - AT+CHSN=4,2,2,8      want double slot 28k8
  - AT+CHSN=4,2,2,12      want double slot 28k8 but will accept 19k2
- ❑ The actual format of the command is defined in GSM07.07 as:

AT+CHSN=<wAiuR>,<wRx>,<topRx>,<codings>

<wRx> and <topRx> are the wanted and maximum number of receive timeslots.

<wRx>=0: the handset should calculate the correct value from <wAiuR> and <codings>.

<topRx>=0: the handset will not request a change in timeslots allocated during the call.

<wAiuR>	Meaning
0	0 default - take speed from AT+CBST
1	9600
2	14400
3	19200
4	28800
5	38400
6	43200
7	57600

<coding>	Meaning
1	4800 full rate data traffic timeslot
4	9600 full rate data traffic timeslot
8	14400 full rate data traffic timeslot

These values are additive, e.g.

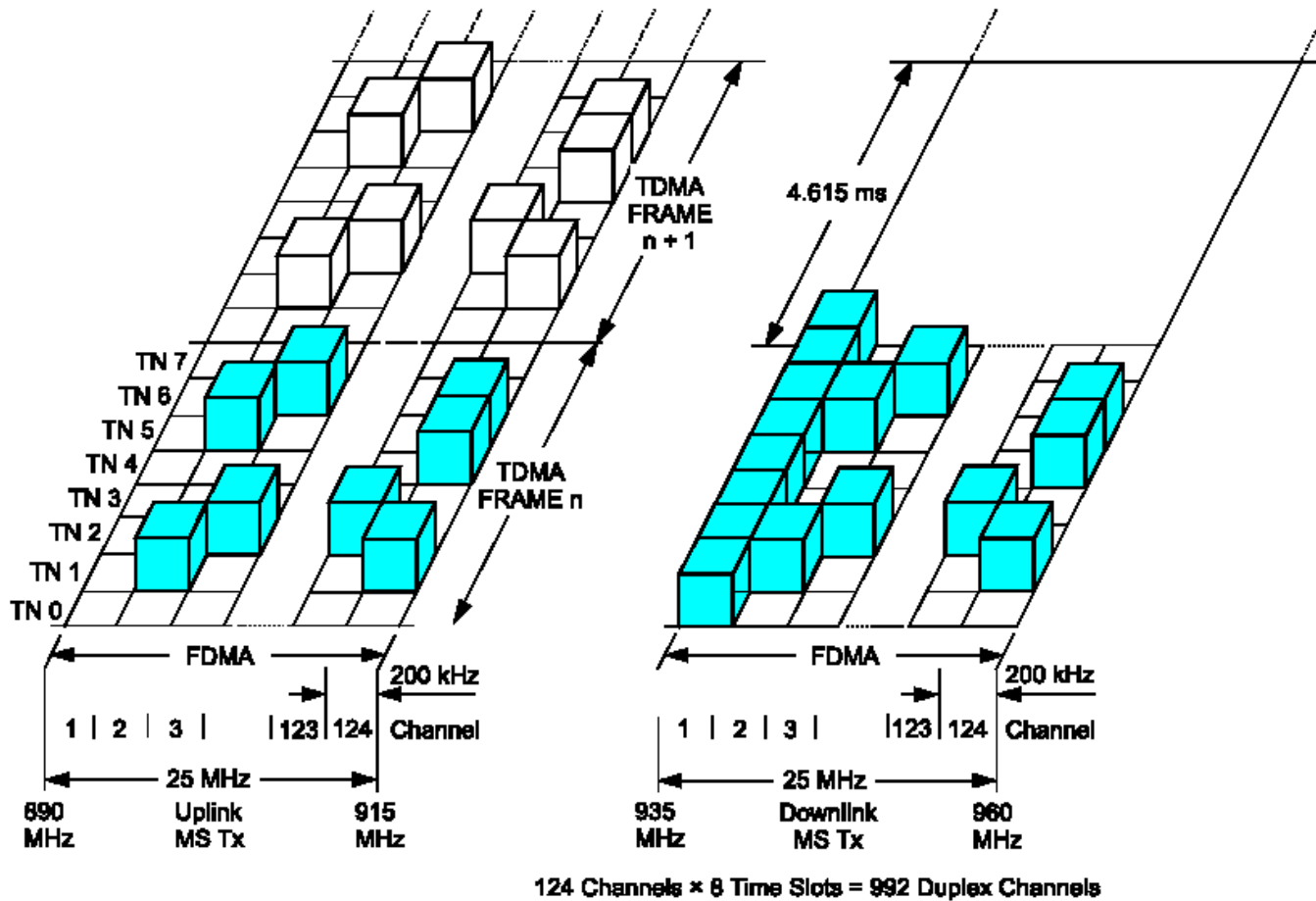
12 means 9600 or 14400 are acceptable

# GPRS (General Packet Radio Service)

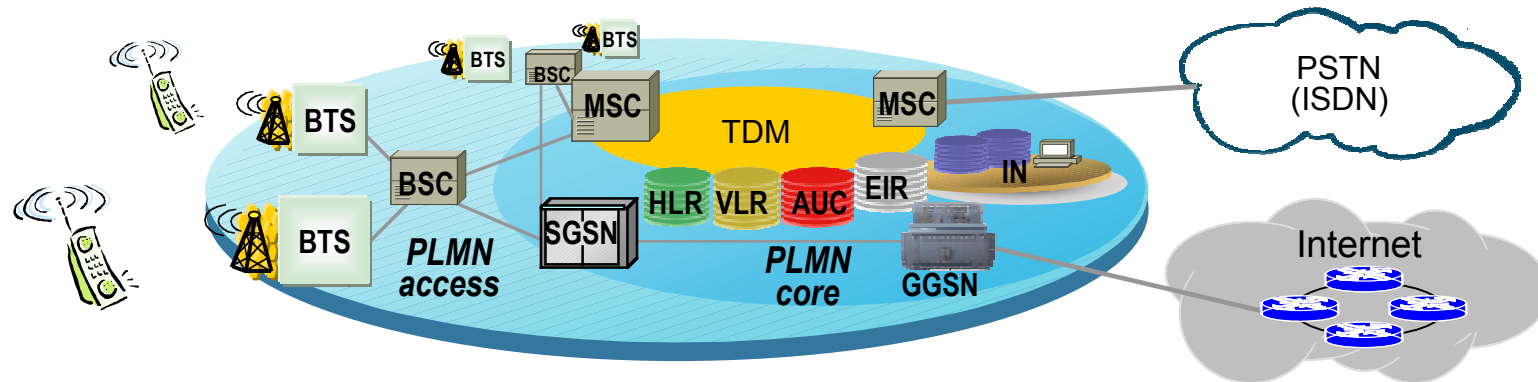
- ❑ Designed for bursty data traffic
  - Stays connected without wasting radio resources
  - introduction of packet switching to the GSM network
  - Reuse of the GSM radio network infrastructure
  - Multi slot combining traffic technology for bandwidth-on-demand
- ❑ Up to 4 (theoretically 8) timeslots for uplink and downlink
- ❑ 4 different coding schemes CS with different capacities.
  - Capacity ranges from 9.05 kbit/s (CS 1) to 21.4 kbit/s (CS 4)
  - Theoretical maximum speed is  $21.4 \times 8 = 171.2$  kbit/s
- ❑ Dynamic option of GPRS:
  - GSM voice traffic is prioritised
  - Packet switched data traffic only on timeslots not in use for voice

=> Reuse of otherwise wasted bandwidth

# GPRS: dynamic allocation of time-slots



# GPRS system architecture



## SGSN

(Serving GPRS Support Node)

- ❑ Packet data handler towards BSC providing authentication, mobility management, logical link management, packet routing and transfer
- ❑ Interworking with the HLR and the GPRS packet control unit located in the BSC or a BTS.

## GGSN

(Gateway GPRS Support Node)

- ❑ Interworking function with external packet data networks.
- ❑ Acting as an access server
- ❑ Setting up the logical link to the mobile station through the SGSN.
- ❑ Translation of data formats and signalling protocols

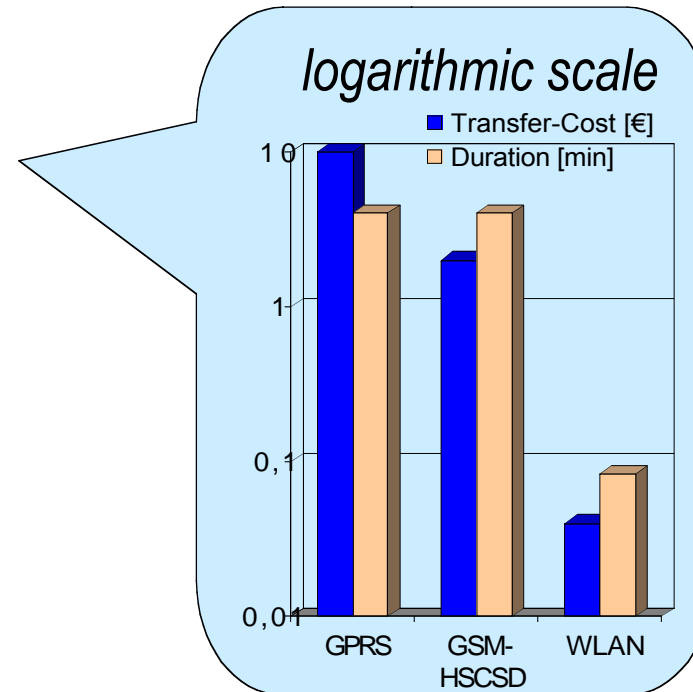
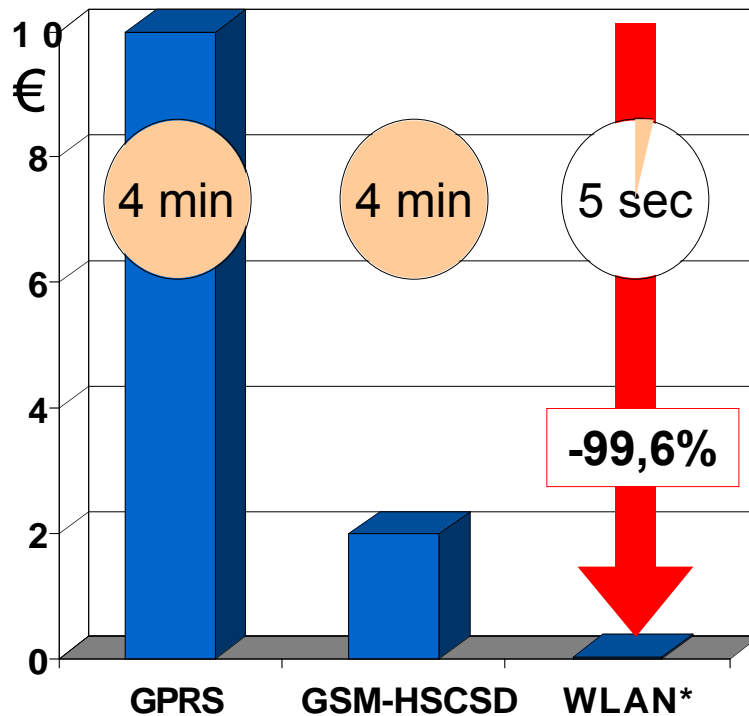
## Bandwidth - delay comparison

	CSD	HSCSD	GPRS
Bandwidth (Up / Down) [kbit/s]	9.6 / 9.6	9.6 / 38.4 14.4 / 57.6	CS1: 9.05 / 36.2 CS2: 13.4 / 53.6 CS3: 15.6 / 62.4 CS4: 21.4 / 85.6
Delay	1s (GSM900) 0.5s (GSM1800)	1s (GSM900) 0.5s (GSM1800)	QoS class 1: 128B: mean 0.5s (95% 1.5s) 1kB: mean 2s (95% 7s) QoS class 2: 128B: mean 5s (95% 25s) 1kB: mean 15s (95% 75s) QoS class 3: 128B: mean 50s (95% 250s) 1kB: mean 75s (95% 375s)



# Mobile Networks are expensive

Transfer cost/duration of an 1 Mbytes .ppt/.doc/.xls File...



\* based on current IP volume prices of 40€ /GByte.  
Time based pricing results in similar costs,  
e.g. MobileStar Pulsar pricing plan: \$0,10/min

## Links

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- ❑ „Internet-Zugang aus den Mobilfunknetzen“  
<http://www.teltarif.de/i/datawww.html>
- ❑ „Internet zum Ortstarif“  
<http://www.holpert.de/christian/internet-by-call/Ortstarif.html>
- ❑ Going online with the communicator  
(also very informative for non-Nokia Communication users)  
<http://www.9110.net/internet.shtml>
- ❑ „Mit Laptop und Handy ins Internet“  
<http://www.de.tomshardware.com/praxis/00q4/001109/index.html>
- ❑ Overview of the Global System for Mobile Communications  
<http://www.mdi-ng.org/es53061/overview.htm>
- ❑ Mobilfunk FAQs  
<http://www.gajek.de/>