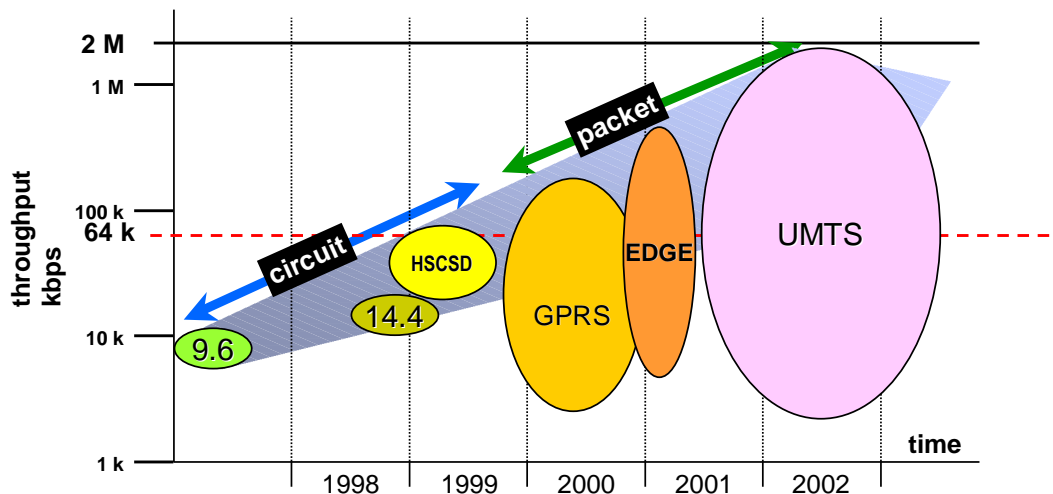


GPRS and EDGE (GSM evolutions)

RE56 Spring 2006
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Generations from GSM to UMTS



GPRS = General Packet Radio Service
HSCSD = High Speed Circuit Switched Data
EDGE = Enhanced Data rate for GSM Evolution System
UMTS = Universal Mobile Telecommunications System

GSM developments

- ✓ GSM introduced in 1991/92 and phase 1 specifications were closed in 3/95
- ✓ GSM phase 2 frozen in 10/95 and added new services
 - Multilingual, SMS, fax, supplementary services (e.g. call waiting), half-rate speech codec, EFR, multi-band
- ✓ GSM 2+ program involved annual releases
 - '96 - 14.4kbps data, **HSCSD** (*High Speed Circuit Switched Data*), CAMEL phase 1
 - '97 - **GPRS** (*General Packet Radio Service*), CAMEL 2
 - '98 - **EDGE** (*Enhanced Data-rate for GSM Evolution*), adaptive codec
 - Then issues such as JAVA on SIM
- ✓ GSM with all of the enhancements that are being generated in the 2+ program can be viewed as a generation 2.5 system
 - Data rates are higher
 - Advanced service creation (JAVA development)
 - Better speech quality
 - Roaming between GSM, DCS1800 and satellite systems



HSCSD features

1/ HSCSD
2/ GPRS
3/ EDGE

- ✓ Current GSM data services
 - 9.6kbps (GSM1) to 14.4 kbps (GSM2) on 1 TS
- ✓ *High speed circuit switched data (HSCSD) is a GSM phase 2+ enhancement*
 - **Objectives:** based on current physical layer, HSCSD offers higher rates by **using more than one full rate TCH** for a single connection
 - Functions of combining and splitting user data into separate n data streams carried as if they were independent for data relay and radio interface
 - New 14.4 kbps data channel coding offers 57.6 kbps in HR and 115.2 kbps in FR (8 TS)
- ✓ In practice
 - **Maximum rate of 64 kbps** due to limitation in Interface A (BSC-MSC)
 - Applicable to a range of applications: mobile fax, ftp, email transfer, video conferencing
 - **Charging done on basis of number of slots used**



HSCSD operation

1/ HSCSD
2/ GPRS
3/ EDGE

- ✓ **Implementation of HSCSD: preserve existing investment**
 - Software upgrade on network and terminals
 - **Data streams split at MS and recombined** at the BSC or at the inter-working function (IWF) at the G-MSC
- ✓ **Multiple channels, eventually asymmetric, allocated to a single call**
 - MS has to work with simultaneous TX/RX if more than 2 slots are used (due to 3 slots offset in TS numbering in DL and UL)
 - Today MS are 4+2 so above 50 kbps ; TS assigned might be consecutive or not
 - Symmetric HSCSD: co-allocated bi-directional TCH channel (DL/UL)
 - Asymmetric HSCSD: co-allocated uni (DL) or bi-directional TCH channel
- ✓ **SFH: same HSN and training sequence (BSIC) for all channels in HSCSD**
- ✓ **Handovers are a problem since there may be a need to use different TS**
 - TCH must be controlled by the network as **one unique radio link** for HO



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GPRS features

1/ HSCSD
2/ GPRS
3/ EDGE

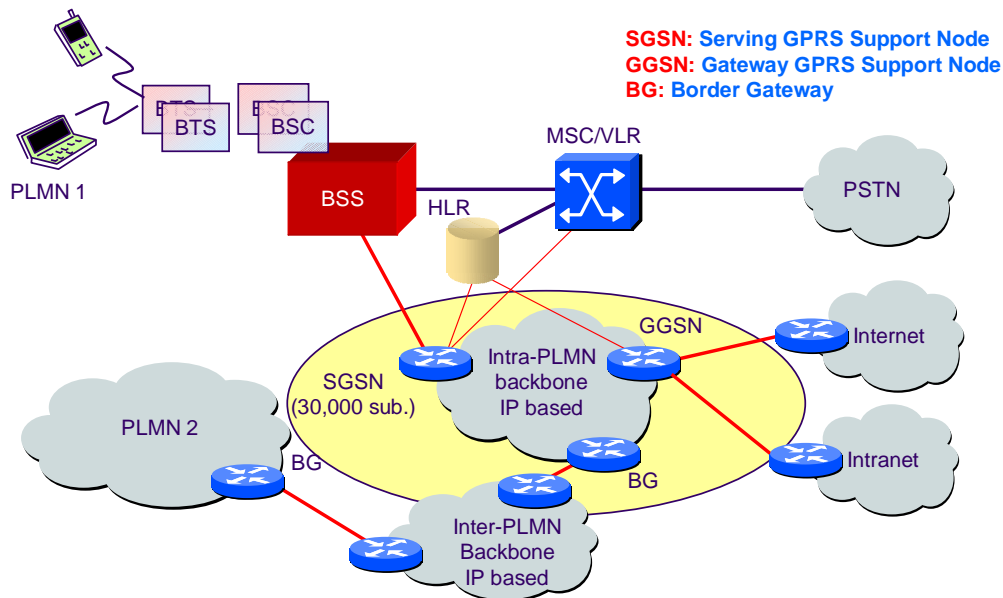
- ✓ **Objectives: offer an access to public data networks using their standard protocol addresses such TCP (*Transport Control Protocol*), IP (*Internet Protocol*) and X25**
- ✓ **Features on network**
 - **GPRS is seeing as a sub-network** while the GGSN (*Gateway GPRS Support Node*) behaves as a router and hides GPRS specific features
- ✓ **Features on radio**
 - GPRS uses an **identical frame structure and modulation frame** format as GSM => system changes are minimised
 - GPRS works within the current GSM TDMA frame structure with UL and DL channels reserved separately, but **interleaved of radio block is on 4 bursts only**
 - Timeslots are allocated to users “on-demand” and **multiple timeslots can be dynamically allocated to a single user** (up to 8)
 - GPRS shares the physical channel between packet (data) and non-packet (voice) users on a dynamic basis (packet can be sent on idle time between speech calls)



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GPRS network architecture

1/ HSCSD
2/ GPRS
3/ EDGE



SGSN: Serving GPRS Support Node
GGSN: Gateway GPRS Support Node
BG: Border Gateway

GPRS operation

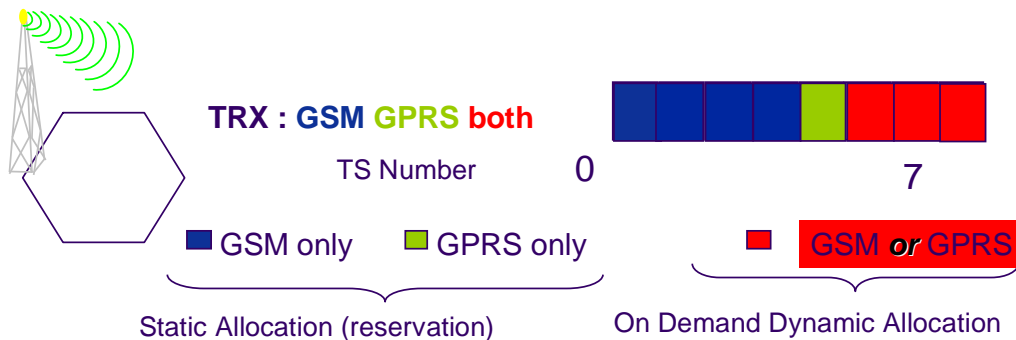
1/ HSCSD
2/ GPRS
3/ EDGE

- ✓ **GPRS provides IP based connectivity to the mobile terminal**
 - MS can have either a static (home network HLR) or dynamic (visited network VLR) data network address (*Packet Data Protocol addresses*)
 - The **static address is permanently allocated** for one subscriber pointed to the GGSN of the home network
 - The data packet will always be routed through the home network like voice call
- ✓ **GPRS is based on the dynamic allocation of time-slots to users on an “as needed” basis**
 - Maximum of 160 kbps per MS with 8 channels without error correction
 - 4 coding schemes are defined for the radio blocks carrying RLC data blocks on *Packet Data Traffic Channels (PDTCH)* ; no forward error correction in CS-4

Scheme	code rate	radio block	data rate	C/I TU3	C/I TU50 (no FH)
CS1	1/2	181 bits	9,05 kbps	13 dB	10 dB
CS2	2/3	268	13,4	15	14
CS3	3/4	312	15,6	16	16
CS4	1	428	21,4	19	23

GPRS TS management

1/ HSCSD
2/ GPRS
3/ EDGE



- ♦ Most of the BSS : only 1 GPRS TRX at the first commercial release

GPRS TS and mobility management

1/ HSCSD
2/ GPRS
3/ EDGE

- ✓ Shared TS are GPRS by default. GSM has priority on shared TS. Then:
 - When reallocation is possible on remaining GPRS TS: the throughput is decreased
 - If no more GPRS TS is available: the transfer is interrupted
 - **HO intra-cell** might be activated to release shared TS used by voice, that is speech goes from shared one to a dedicated one
- ✓ If there is no reserved GPRS TS: possibility to give priority to GPRS on the last shared GPRS
- ✓ GPRS Mobility Management
 - Cell re-selection is done by the MS or the network (Network Control mode)
 - NC0: the MS is autonomous
 - NC1: the MS is autonomous and send periodical measurement reports as in voice (every 0,48 ms)
 - NC2: the MS send periodical measurement reports and cell re-selection is commanded by the network
 - When the MS is doing voice+data, the HO has precedence over GPRS cell re-selection

Higher throughput? EDGE

1/ HSCSD
2/ GPRS
3/ EDGE

- ✓ GSM uses G-MSK modulation
 - It sends 1 bit/symbol
- ✓ EDGE involves major changes to the radio equipment and implements 8-PSK modulation (8 phase states)
 - It sends 3 bits/symbol (342 bits/burst instead of 114 in GSM)
 - Rate per TS=60 kbps instead of 21.4 kbps for G-MSK (CS4 GPRS)
 - Interleaved of radio blocks on 4 or 2 bursts only
- ✓ This, combined with multi-slot, offers higher rates than GPRS
- ✓ EDGE is a very attractive technique for incumbent operators who don't get (or want!) a 3G licence
 - Leverage more of existing 2G investment
 - Much lower cost route to 3G performance
- ✓ Compatible with GSM and D-AMPS (IS-136) and forms the basis of the UWC136HS IMT-2000 submission to the ITU
- ✓ Experimental phase: BOUYGUES 1st ; then others



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EDGE data rates and modulations

1/ HSCSD
2/ GPRS
3/ EDGE

Table 1.5 EGPRS modulation and coding schemes

Nokia 2002

Modulation and coding scheme	Code rate	Modulation	Data rate/ timeslot (kbps)	Family
MCS-9	1.0	8-PSK	59.2	A
MCS-8	0.92		54.4	A
MCS-7	0.76		44.8	B
MCS-6	0.49		29.6	A
MCS-5	0.37	GMSK	22.4	B
MCS-4	1.0		17.6	C
MCS-3	0.80		14.8	A
MCS-2	0.66		11.2	B
MCS-1	0.53		8.8	C

- ✓ 9 different combinations of modulations and coding schemes
- ✓ New G-MSK coding scheme (MCS-1 to MCS-4)
- ✓ RLC data block sizes
 - MCS-9 carries 1184 payload bits
 - MCS-6 592
 - MCS-3 296



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EDGE impact on GSM/GPRS network

1/ HSCSD
2/ GPRS
3/ EDGE

✓ 2 phases of implementation

- Changes are at the PHY layer
- Phase 1: single and multi-slot packet and circuit switched services (R99)
- Phase 2: new modulation schemes (*real time services* aligned with UMTS)

✓ Limited to *Base Station System* (BSS)

- No adaptation in core network
- Software upgrade: new protocol for packet transmission over radio interface in BSC and BTS
- Hardware upgrade: new TRX for EDGE modulation schemes in BTS

✓ Two classes of terminals

- 8-PSK on DL only
- 8-PSK on both DL/UL