# GSM
# Evolutions from GSM

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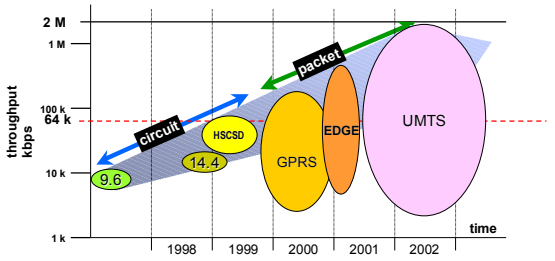
## Generations from GSM to UMTS




GPRS = General Packet Radio Service
HSCSD = High Speed Circuit Switched Data
EDGE = Enhanced Data rate for GSM Evolution
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:
  - 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
  - Better speech quality
  - Roaming between GSM, DCS1800 and satellite systems



## HSCSD features

- Current GSM data services offer 9.6 kbps on 1 TS
- High speed circuit switched data (HSCSD) is a GSM phase 2+ enhancement
- 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 is 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

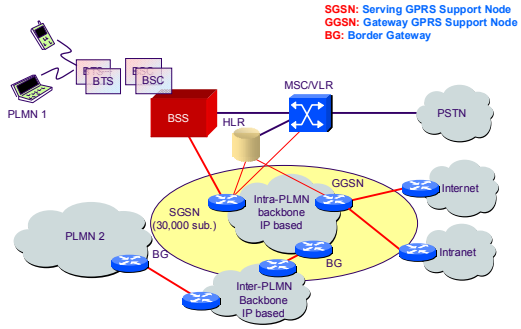
- HSCSD can be implemented with just a software upgrade on network and terminals
- Goal was to preserve existing investment: data streams split at MS and recombined at the BSC or the interworking function (IWF) at the G-MSC
- Multiple channels allocated to a single call - can be asymmetric
  - MS has to work with simultaneous TX/RX if more than 2 slots are used (due to 3 slots offset in TS numbering)
  - 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 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



## GPRS features

- Offer an access to public data networks using their standard protocol addresses such as TCP (Transport control protocol), IP (Internet protocol) and X25
- GPRS is seeing as a sub-network while the GGSN (Gateway) behaves as a router and hides GPRS specific features
- GPRS works within the current GSM TDMA frame structure with UL and DL channels reserved separately
- 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)
- Uses an identical frame structure and modulation/ frame format as GSM so changes to the system are minimised

## GPRS implementation





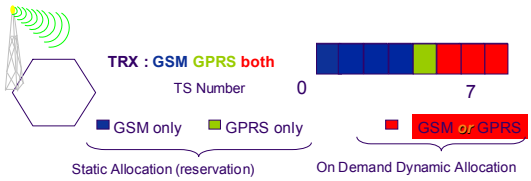

## GPRS operation

- GPRS provides IP based connectivity to the mobile terminal
  - MS can have either a static (home network) or dynamic (visited network) 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
- 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 | ½ | 181 bits | 9,05 kbps | 13 dB | 10 dB |
| CS2 | 2/3 | 268 | 13,4 | 15 | 14 |
| CS3 | ¾ | 312 | 15,6 | 16 | 16 |
| CS4 | 1 | 428 (on 456 bits) | 21,4 | 19 | 23 |



## GPRS TS management




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



## GPRS TS and mobility management

- Shared TS are GPRS by default. GSM has priority on shared TS. Impact on GPRS:
  - When reallocation is possible on remaining GPRS TS: the throughput is decreased
  - If no more GPRS TS is available: the transfer is interrupted
- If no reserved GPRS TS: possibility to give priority to GPRS on the last shared GPRS
- HO intra-cell might be activated to release shared TS used by voice, that is speech goes from shared one to a dedicated one
- 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



## EDGE evolution of GPRS

- GSM uses G-MSK modulation
  - It sends 1 bit/symbol
- EDGE involves major changes to the radio equipment and implements 8-PSK modulation
  - It sends 3 bits/symbol
  - Rate per TS=68.4 kbps instead of 22.8 kbps for G-MSK
- This, combined with multi-slot, offers high rates
- EDGE is a very attractive technique for incumbent operators who don't get (or want!) a 3G licence
  - Leverage more out 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
- No development but some experiments



## EDGE evolution of GPRS

**Table 1.5** EGPRS modulation and coding schemes

| 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 | | 22.4 | B |
| MCS-4 | 1.0 | GMSK | 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 modulation and CS
- 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