



GSM, GPRS, UMTS *(IMT 2000 Architecture)*

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Advanced Computer Networks

[Outline]

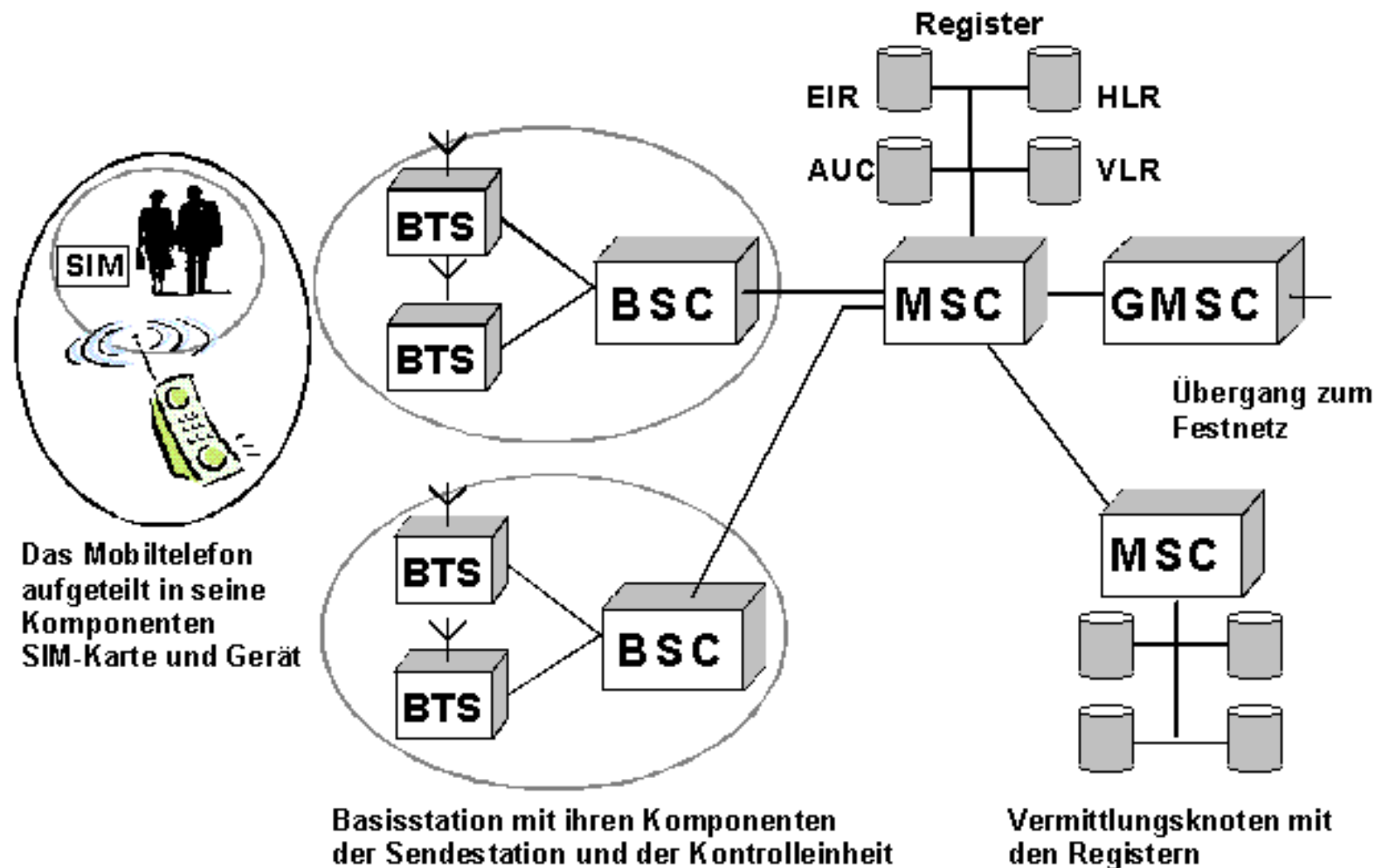
- GSM
- HSCSD, GPRS, EDGE
- IMT-2000
- UMTS



GSM

Global System for Mobile
communications

GSM-Architecture



[GSM-Architecture (2)]

- MS Mobile Station
 - SIM - **S**ubscriber **I**ntity **M**odule
- Basestation Subsystem
 - BTS - **B**ase **T**ransceiving **S**tation
 - BSC - **B**ase **S**tation **C**ontroller
- Network node
 - MSC - **M**obile **S**witching **C**enter
 - Registers
- GMSC- Gateway Services Switching Center

[GSM-Architecture (3)]

- Registers

- **HLR** - **H**ome **L**ocation **R**egister
- **VLR** - **V**isitor **L**ocation **R**egister
- **AUC** - **A**uthentication **C**enter
- **EIR** - **E**quipment **I**ntity **R**egister

[GSM - Frequencies]

- GSM-900:
 - Uplink: 890,2 MHz – 915 MHz (25 MHz)
 - Downlink: 935,2 MHz – 960 MHz (25 MHz)
 - Uplink-Downlink distance: 45 MHz
- Frequency Division Multiple Access
 - Channels are 200 kHz wide.
 - 124 pairs of channels
- Time Division Multiple Access
 - 8 connections each channel
 - Theoretical $124 \times 8 = 992$ channel to use.

[GSM - Frequencies (2)]

- GSM-1800:
 - Uplink: 1725,2 - 1780,4 MHz
 - Downlink: 1820,2 - 1875,4 MHz
 - Uplink-Downlink distance: 95 MHz
 - 384 pairs of channels

[GSM-Link]

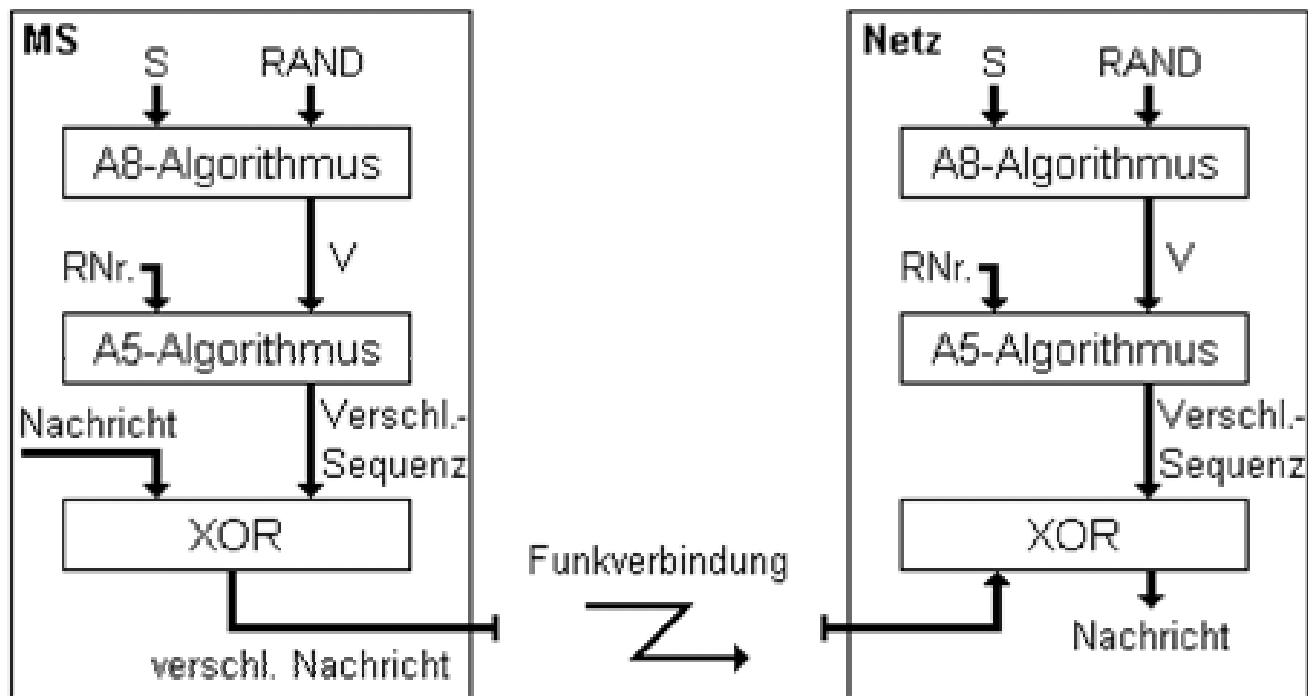
- Fullrate-Channel (Speech)
 - 13 kBit/s
- Halfrate-Channel (Speech)
 - 6,5 kBit/s
- GSM-Data-Channel
 - 9,6 kBit/s

[GSM-Security]

- User Authentication (Challenge-Response-Method)
 - AUC generates RAND -> transfers to MS
 - SIM of MS has secret Key and A3-Algorithm
 - SIM calculates SRES (signed response) from RAND -> transfer to AUC
 - AUC has secret Key and A3-Algorithm
 - AUC calculates SRES too -> compares it with response
 - if identical AUC authorizes the network access

[GSM-Security (2)]

- GSM Communication Encrypting





HSCSD, GPRS, EDGE

Enhancing the GSM-Standard

[HSCSD]

- **H**igh **S**peed **C**ircuit **S**witched **D**ata
- Enhancement of GSM Standard
- Channeloriented Data Service (Channelbundle)
- New Channelcoding: 14.4 kBit/s
- Maximum speed: 57 kBit/s

[GPRS – Key features]

- **General Packet Radio Service**
- GSM Infrastructure Enhancement
- Packetoriented Data Service
- Allows IP packets to be sent and received across mobile networks.
- Theoretical maximum speed: 171.2 kbps using all 8 time slots.

[GPRS – Networking]

- Information is split into separate but related "packets".
- GPRS radio resources are used only when users are actually sending or receiving data.
- More efficient for Networkoperator

[GPRS – Networking (2)]

- Some time slots on some frequencies are reserved for packet traffic.
- Time slots are dynamically managed by base station.
- Time slots are divided into several logical channels used for different purposes.

[GPRS - Limitations]

- GPRS does impact a network's existing cell capacity.
 - Only limited resources.
 - Use for one purpose precludes simultaneous use for another.

[GPRS - Limitations (2)]

- Maximum speed of 171.2 kbps only theoretically.
 - Single user would need all 8 time slots.
 - Network operator would never allow that.
 - Bandwidth limited.

-> EDGE, UMTS

[GPRS - Applications]

- Chat
- Textual and visual information
- Still & moving images
- Web browsing
- Document sharing/Collaborate working
- Audio
- Email, File Transfer...

[EDGE-Standard]

- Enhanced Datarate for Global Evolution
- GSM/GPRS-Network Enhancement
- Datarate compareable to UMTS Network (384 kBit/s and more)
- Less efficient than WCDMA of UMTS
 - Based on GSM Multiplexmethod (TDMA/FDMA)
- Changing GSM Modulation from GFSK to 8PSK
- Much cheaper than UMTS(existing network)



UMTS

Universal Mobile
Telecommunication System

[IMT-2000]

- 1992 ITU issued blueprint about 3rd generation mobile telephony called IMT-2000
 - International Mobile Telecommunications
 - 2000 meant:
 - Year it was supposed to go into service
 - Frequency to operate in MHz
 - Bandwidth in kHz

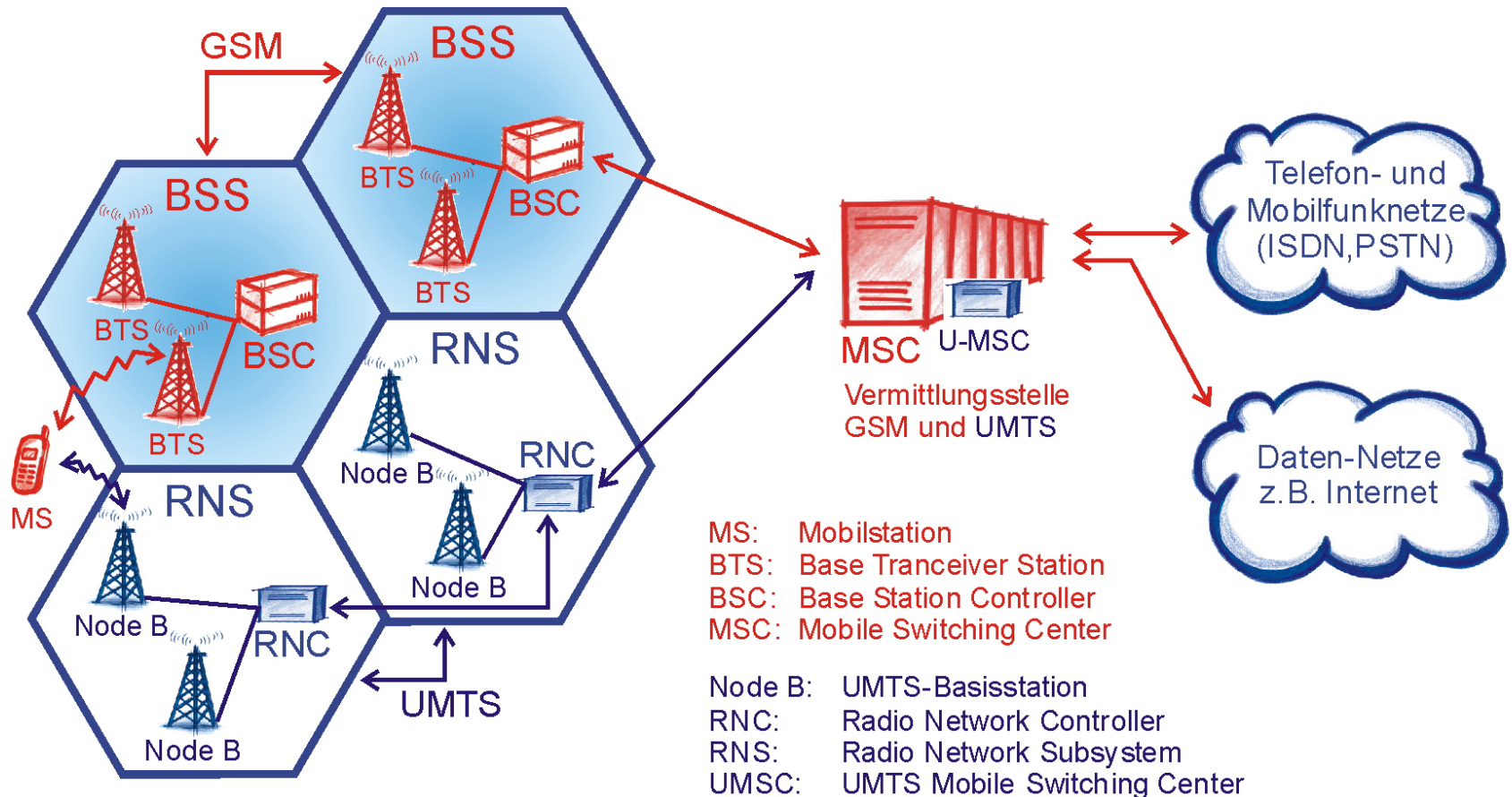
[IMT-2000 (2)]

- In 2000 none of the three was achieved.
- Basic services of IMT-2000 network:
 - High-quality voice transmission
 - Messaging (e-mail, fax, sms, chat...)
 - Multimedia (playing music, videos,...)
 - Internet access (surfing)
- -> 3G

[UMTS]

- UMTS based on complete new Network (UTRAN)
- W-CDMA (Wideband Code Division Multiple Access)
- Including QoS
- Offered data rate targets are:
 - 144 kbits/s satellite and rural outdoor
 - 384 kbits/s urban outdoor
 - 2048 kbits/s indoor and low range outdoor

UMTS - Architecture



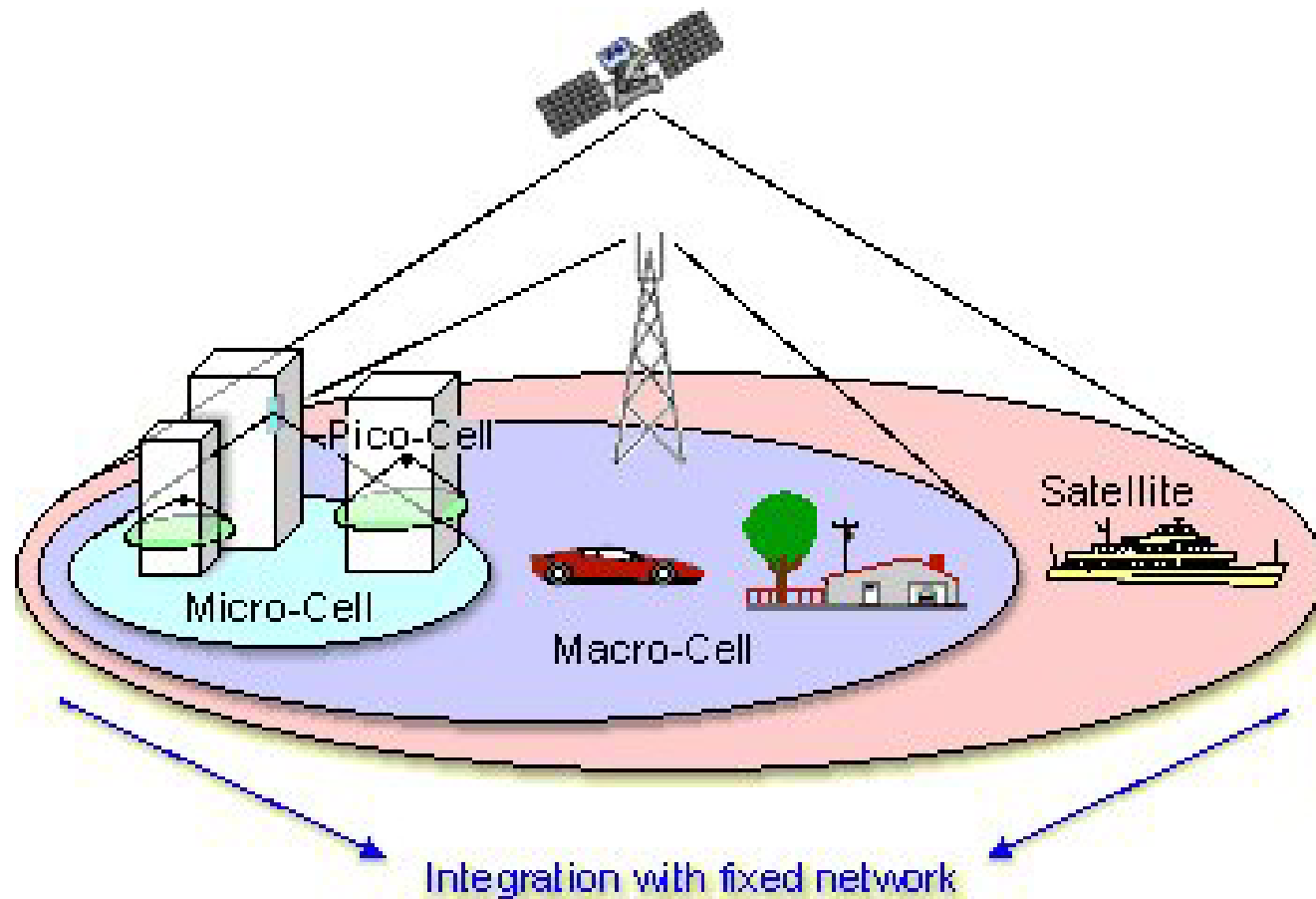
[UMTS – Architecture (2)]

- MS Mobile Station
 - USIM – UMTS **S**ubscriber **I**dentity **M**odule
- UTRAN - UMTS Terrestrial Radio Access Network
 - RNS - Radio Network Subsystem
 - RNC - Radio Network Controller
 - Node B - Base station
- Network node
 - UMSC - UMTS Mobile Switching Center
 - Registers
- GMSC- Gateway Services Switching Center

[UTRAN – radio access]

- UMTS Modulation is 4PSK
- UMTS Multiplexing
 - Wideband CDMA for air interface.
 - Orthogonal Spreadingcode for each user
 - Orthogonal Scramblingcode (Goldcode) between cells
- 5 MHz bandwidth
- Hierarchical cell structure:
 - Satellite
 - Macro-cells
 - Micro-cells
 - Pico-cells

[UMTS – Cell layers]



[UMTS – frequency spectrum]

- Up/Downlink Frequency
 - Uplink: 1920 - 1980MHz
 - Downlink: 2110 - 2170MHz
- Own subband for satellite service:
 - Uplink: 1980 MHz to 2010 MHz
 - Downlink: 2170 MHz to 2200 MHz

[UMTS - Advantages]

- Broad offer of services
- Speed, variety and user-friendliness of a service significantly improved compared with GSM.
- Only bearer services are standardized
- Actual application is called teleservice

[UMTS - teleservices]

- Teleservice created individually by a service provider using bearer services.
- Only 4 teleservices standardized:
 - Speech
 - Fax
 - SMS
 - Emergency call

[UMTS - Applications]

- Fast Internet / Intranet
- Streaming / Download (Video, Audio)
- Videoconferences
- Multimedia-Messaging, E-Mail
- Mobile E-Commerce (M-Commerce)
- Location Based Services
- Mobile Entertainment (Games,...)

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