Mobile Computing
Lecture 10
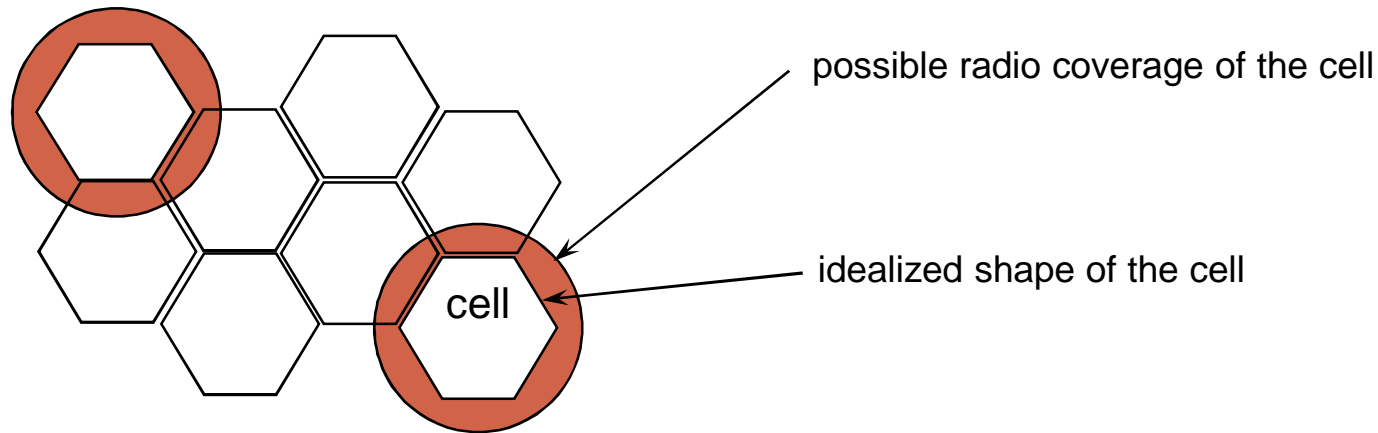# Digital Mobile Phone Systems 3

Contents

- Cellular Network
- frequency bands
- BTS, BSC
- MS
- GSM TDMA FDMA
- GSM hierarchy of frames

GSM: cellular network

segmentation of the area into cells

possible radio coverage of the cell

idealized shape of the cell

cell

- use of several carrier frequencies
- not the same frequency in adjoining cells
- cell sizes vary from some 100 m up to 35 km depending on user density, geography, transceiver power etc.
- hexagonal shape of cells is idealized (cells overlap, shapes depend on geography)
- if a mobile user changes cells handover of the connection to the neighbor cell

GSM frequency bands (examples)

| Type	Channels	Uplink [MHz]	Downlink [MHz]
GSM 850	128-251	824-849	869-894
GSM 900 classical extended	0-124, 955-1023 124 channels +49 channels	876-915 890-915 880-915	921-960 935-960 925-960
GSM 1800	512-885	1710-1785	1805-1880
GSM 1900	512-810	1850-1910	1930-1990
GSM-R exclusive	955-1024, 0-124 69 channels	876-915 876-880	921-960 921-925

- Additionally: GSM 400 (also named GSM 450 or GSM 480 at 450-458/460-468 or 479-486/489-496 MHz)
- Please note: frequency ranges may vary depending on the country!
- Channels at the lower/upper edge of a frequency band are typically not used

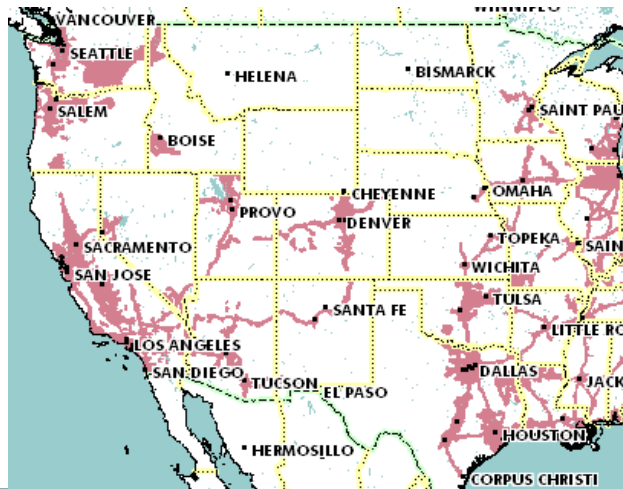# Example coverage of GSM networks (www.gsmworld.com)
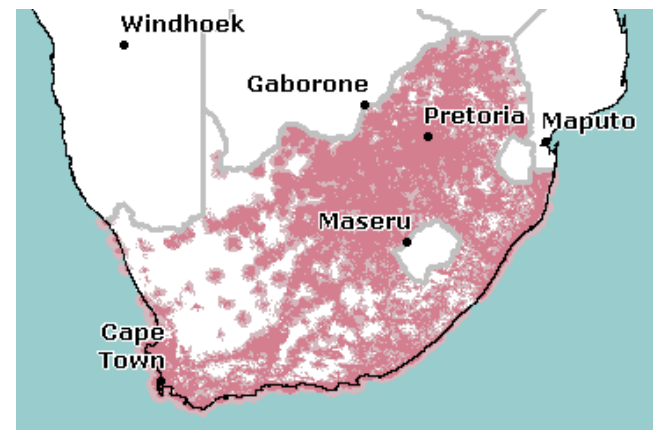
T-Mobile (GSM-900/1800) Germany
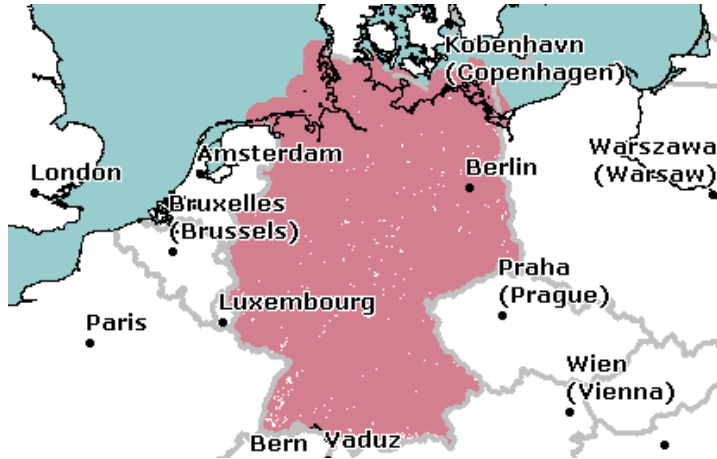
O$_2$ (GSM-1800) Germany
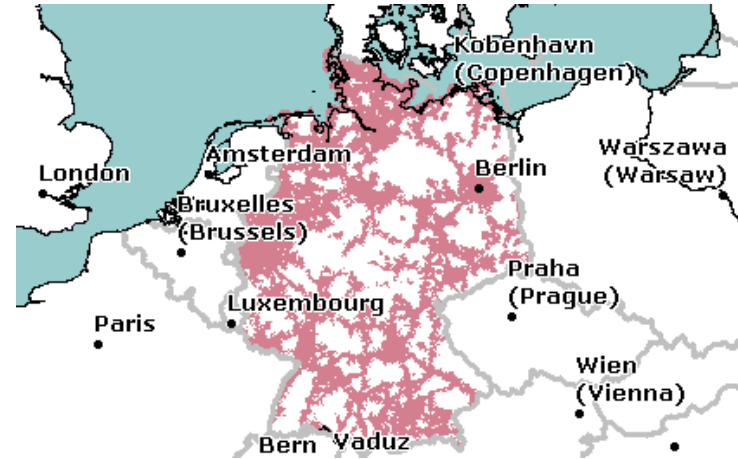
AT&T (GSM-850/1900) USA

Vodacom (GSM-900) South Africa

Base Transceiver Station and Base Station Controller

- Tasks of a BSS are distributed over BSC and BTS
- BTS comprises radio specific functions
- BSC is the switching center for radio channels

Functions	BTS	BSC
Management of radio channels		X
Frequency hopping (FH)	X	X
Management of terrestrial channels		X
Mapping of terrestrial onto radio channels		X
Channel coding and decoding	X	
Rate adaptation	X	
Encryption and decryption	X	X
Paging	X	X
Uplink signal measurements	X	
Traffic measurement		X
Authentication		X
Location registry, location update		X
Handover management		X

Mobile station

- Terminal for the use of GSM services
- A mobile station (MS) comprises several functional groups
  - MT (Mobile Terminal):
    - offers common functions used by all services the MS offers
    - corresponds to the network termination (NT) of an ISDN access
    - end-point of the radio interface (Um)
  - TA (Terminal Adapter):
    - terminal adaptation, hides radio specific characteristics
  - TE (Terminal Equipment):
    - peripheral device of the MS, offers services to a user
    - does not contain GSM specific functions
  - SIM (Subscriber Identity Module):
    - personalization of the mobile terminal, stores user parameters

```
+------+        +------+        +------+
|  TE  |--------|  TA  |--------|  MT  |----o U_m
+------+   R    +------+   S    +------+
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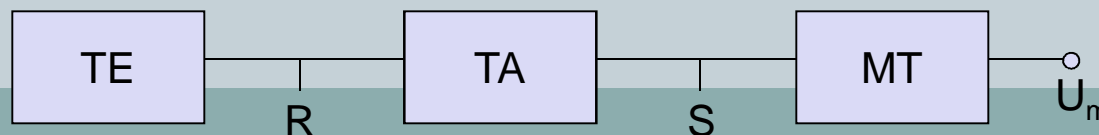
Network and switching subsystem

- NSS is the main component of the public mobile network GSM
  - switching, mobility management, interconnection to other networks, system control
- Components
  - Mobile Services Switching Center (MSC)
    controls all connections via a separated network to/from a mobile terminal within the domain of the MSC - several BSC can belong to a MSC
  - Databases (important: scalability, high capacity, low delay)
    - Home Location Register (HLR)
      central master database containing user data, permanent and semi-permanent data of all subscribers assigned to the HLR (one provider can have several HLRs)
    - Visitor Location Register (VLR)
      local database for a subset of user data, including data about all user currently in the domain of the VLR

Mobile Services Switching Center

- The MSC (mobile services switching center) plays a central role in GSM
  - switching functions
  - additional functions for mobility support
  - management of network resources
  - interworking functions via Gateway MSC (GMSC)
  - integration of several databases
- Functions of a MSC
  - specific functions for paging and call forwarding
  - termination of SS7 (signaling system no. 7)
  - mobility specific signaling
  - location registration and forwarding of location information
  - provision of new services (fax, data calls)
  - support of short message service (SMS)
  - generation and forwarding of accounting and billing information

Operation subsystem

- The OSS (Operation Subsystem) enables centralized operation, management, and maintenance of all GSM subsystems

- Components
  - Authentication Center (AUC)
    - generates user specific authentication parameters on request of a VLR
    - authentication parameters used for authentication of mobile terminals and encryption of user data on the air interface within the GSM system
  - Equipment Identity Register (EIR)
    - registers GSM mobile stations and user rights
    - stolen or malfunctioning mobile stations can be locked and sometimes even localized
  - Operation and Maintenance Center (OMC)
    - different control capabilities for the radio subsystem and the network subsystem

GSM - TDMA/FDMA

frequency

935-960 MHz
124 channels (200 kHz)
downlink

890-915 MHz
124 channels (200 kHz)
uplink

higher GSM frame structures

time

GSM TDMA frame

1	2	3	4	5	6	7	8

4.615 ms

GSM time-slot (normal burst)

guard space	tail	user data	S	Training	S	user data	tail	guard space
	3 bits	57 bits	1	26 bits	1	57 bits	3	

546.5 µs

577 µs

GSM hierarchy of frames

0	1	2	...	2045	2046	2047	3 h 28 min 53.76 s

hyperframe

0	1	2	...	48	49	50

superframe

0	1	...	24	25	6.12 s

0	1	...	24	25	120 ms

multiframe

0	1	2	...	48	49	50	235.4 ms

0	1	...	6	7	4.615 ms

frame

slot

burst 577 µs