REDS
Reconfigurable & embedded Digital Systems

heig-vd
Haute Ecole d'Ingénierie et de Gestion du Canton de Vaud

Architecture and Drivers for Smartphones
Smartphone as telecommunication device

Cours APS

Salvatore Valenza

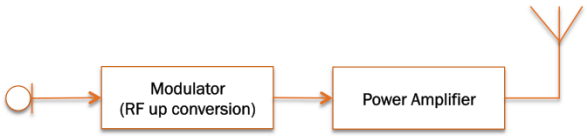
Version 1.0 (2012-2013)

Plan

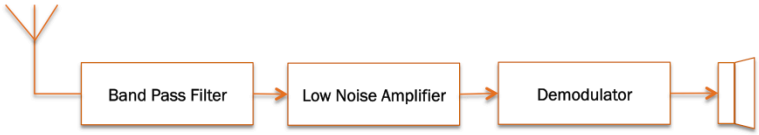
- Systèmes de transmission radio
- Systèmes de communication cellulaires
- Procédures principales pour les portables

Systèmes de communication radio

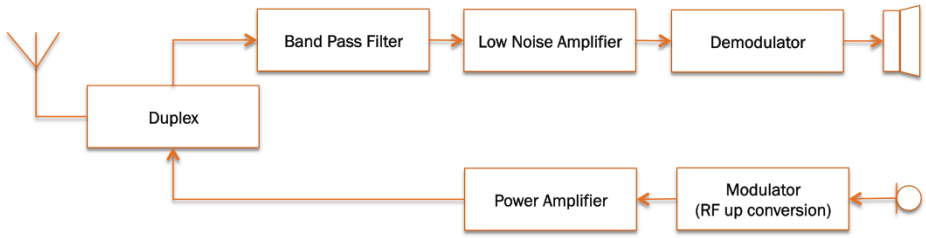
Analog Transmitter



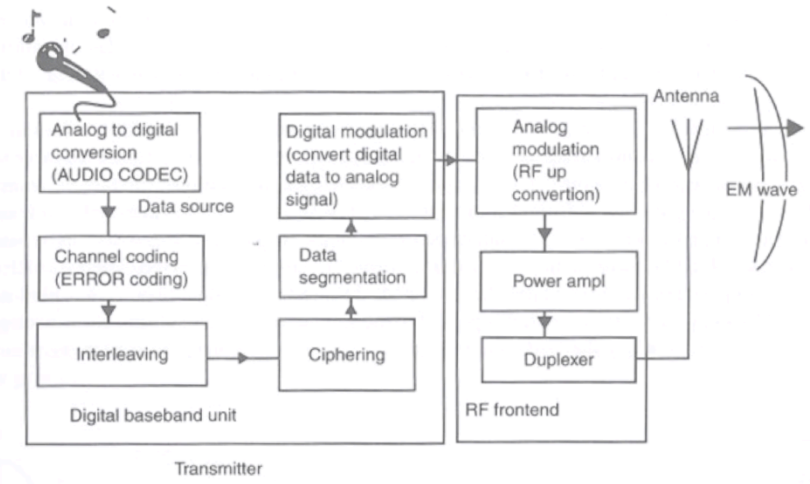
Analog Receiver



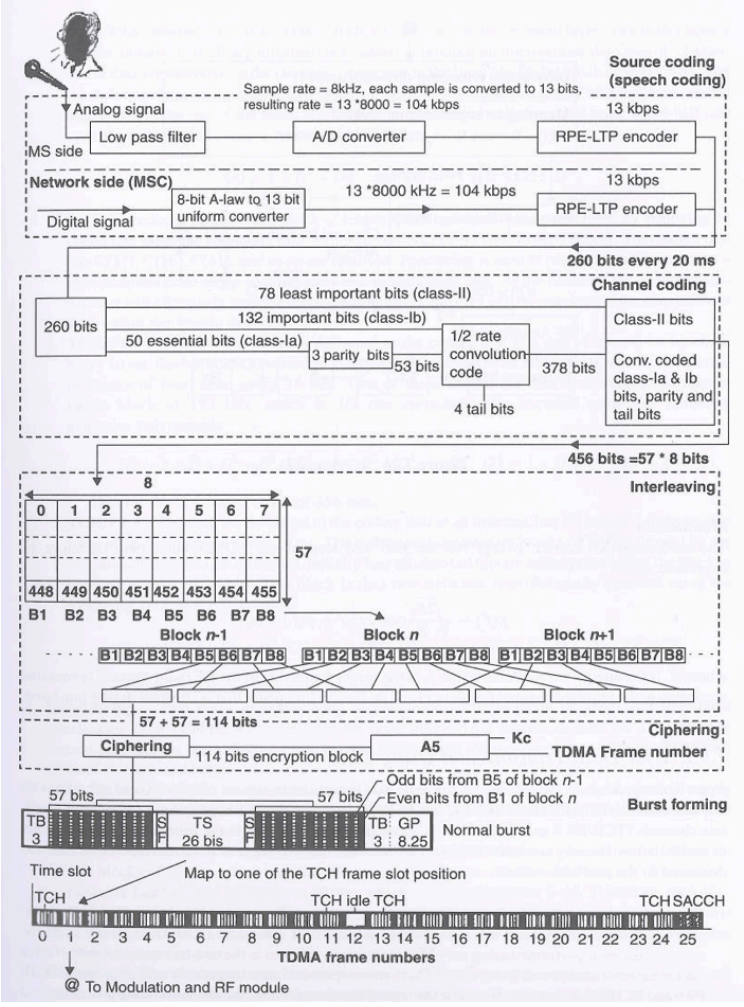
Analog Transmitter and Receiver



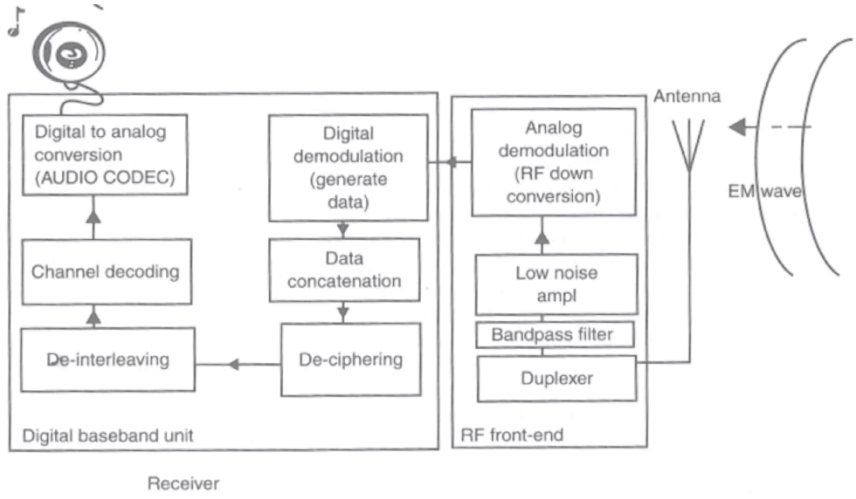
Digital Transmitter



Exemple: GSM transmitter détails



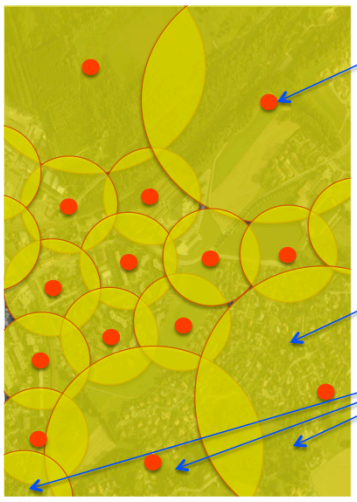
Digital Receiver



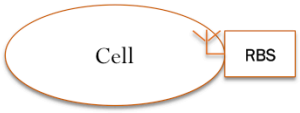
Receiver

Systèmes de communication cellulaires

Cellular System Overview

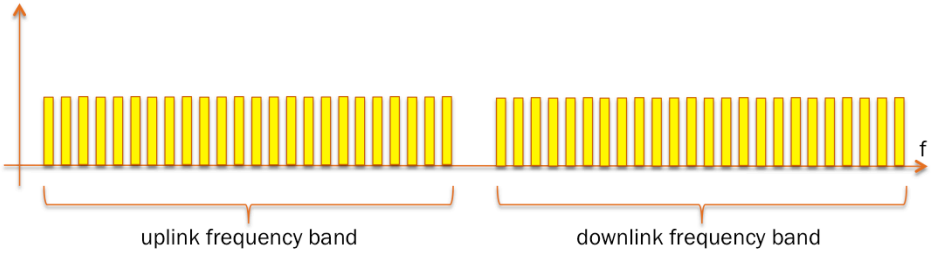


1st Generation Cell



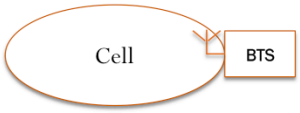
Access Technique:

- FDMA (Frequency Division Multiple Access)
- 1 ***Analog*** Traffic Channel per frequency used
- Multiple Frequencies managed by the same Radio Base Station



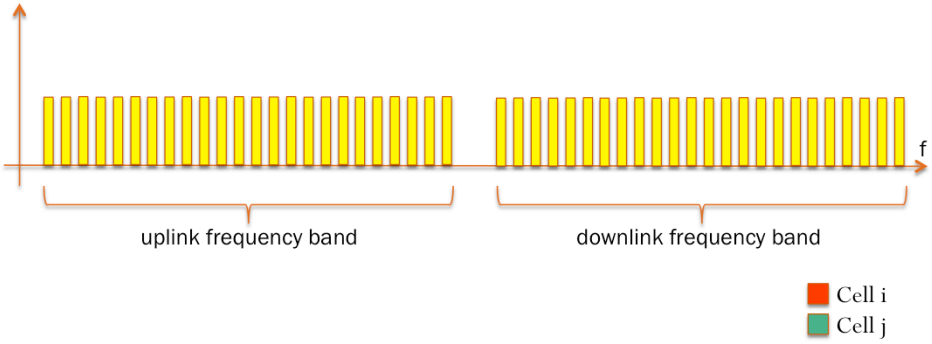
Cell i
Cell j

2nd Generation Cell (1/2)



Access Technique:

- FDMA (Frequency Division Multiple Access)
- TDMA (Time Division Multiple Access)
- 8 or 16 Digital Traffic Channel per frequency used
- Multiple Frequencies managed by the same BTS



2nd Generation Cell (2/2)

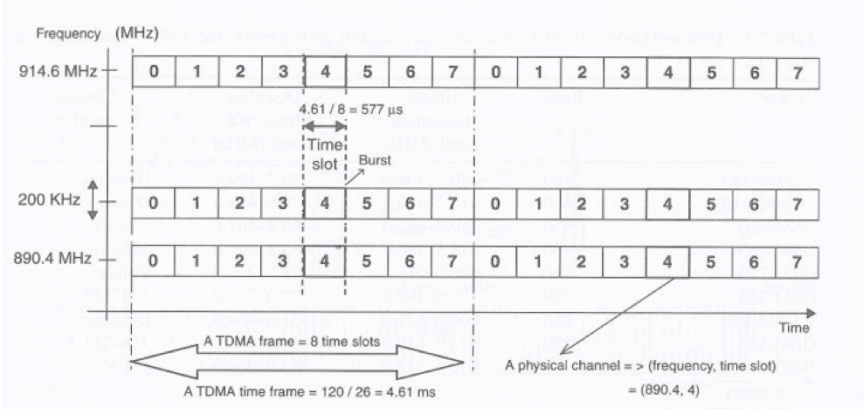


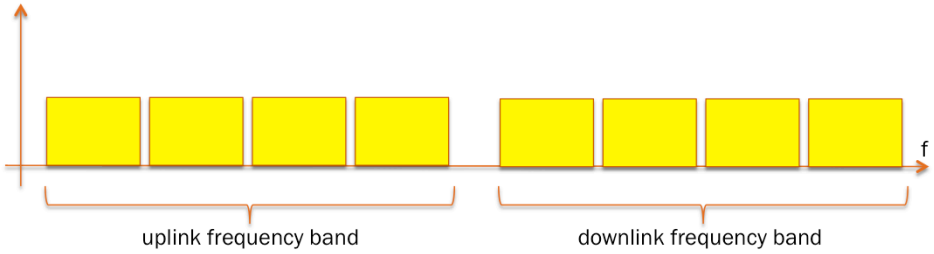
Figure 7.2 Time division multiplexing

Figure 7.3 Uplink and downlink separation by approximately three time slots

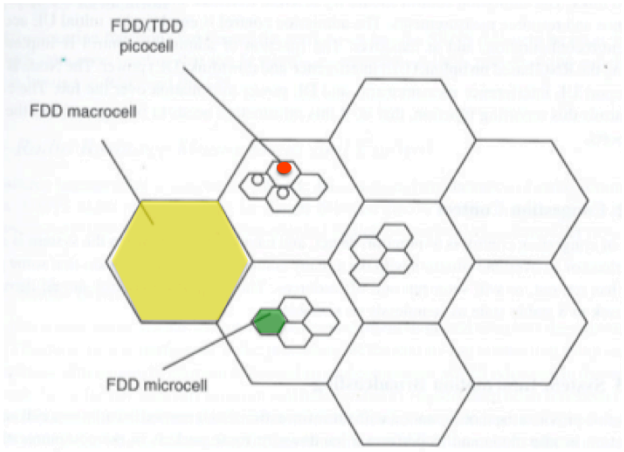
3rd Generation Cell (1/2)

Access Technique:

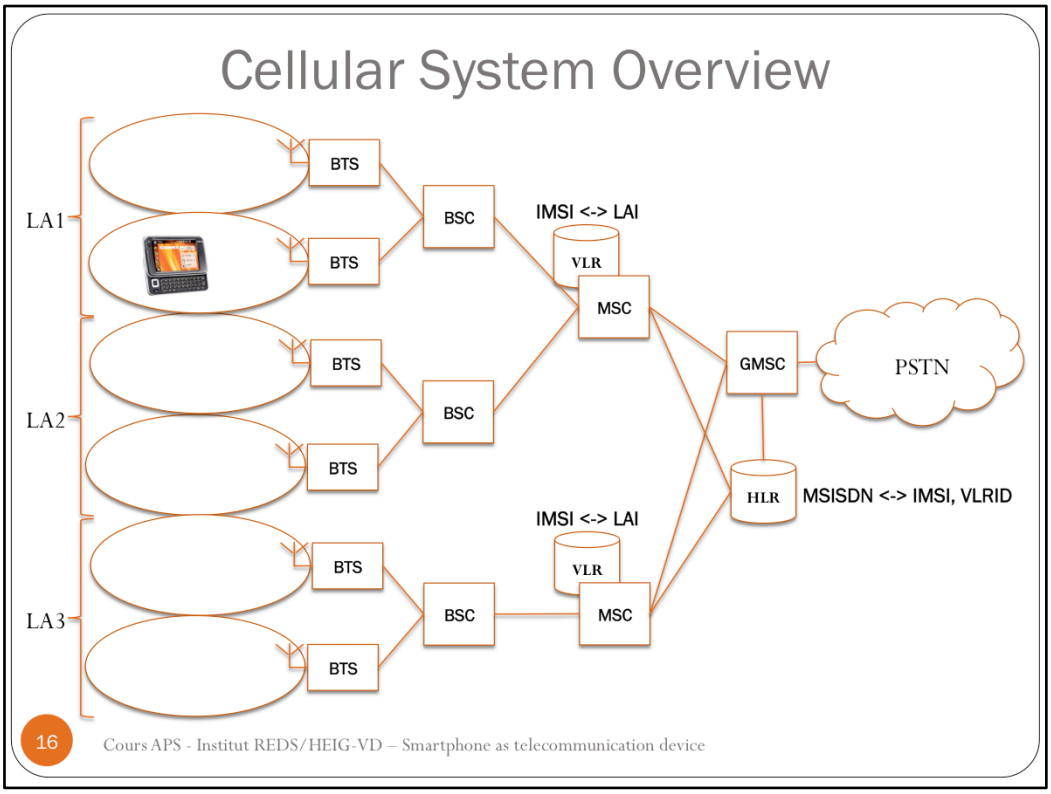
- WCDMA (Wideband Code Division Multiple Access)
- 1 ***Digital*** Traffic Channel per orthogonal code
- Multiple Codes (Channels) per frequency used
- 1 Frequency managed by 1 NodeB



3rd Generation Cell (2/2)

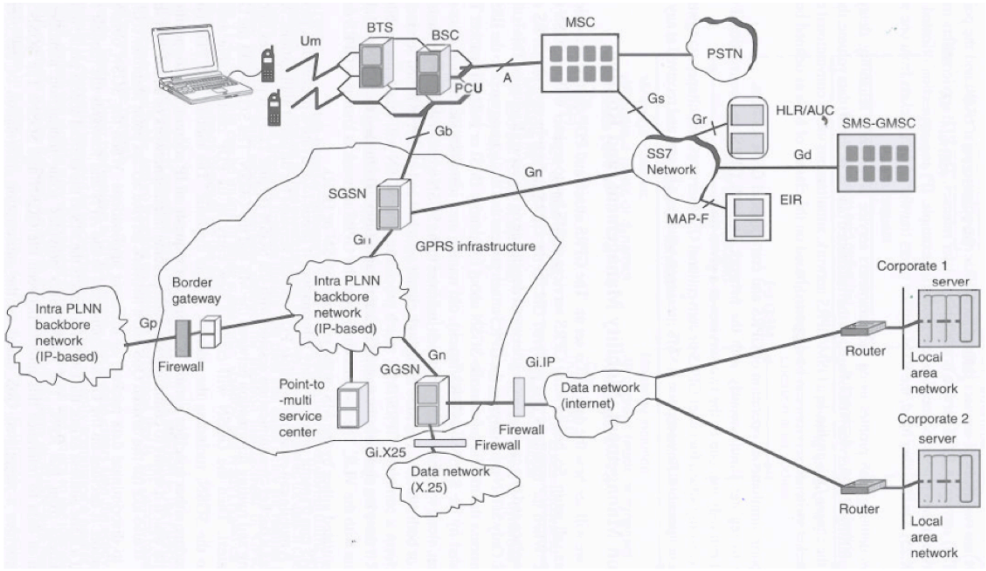


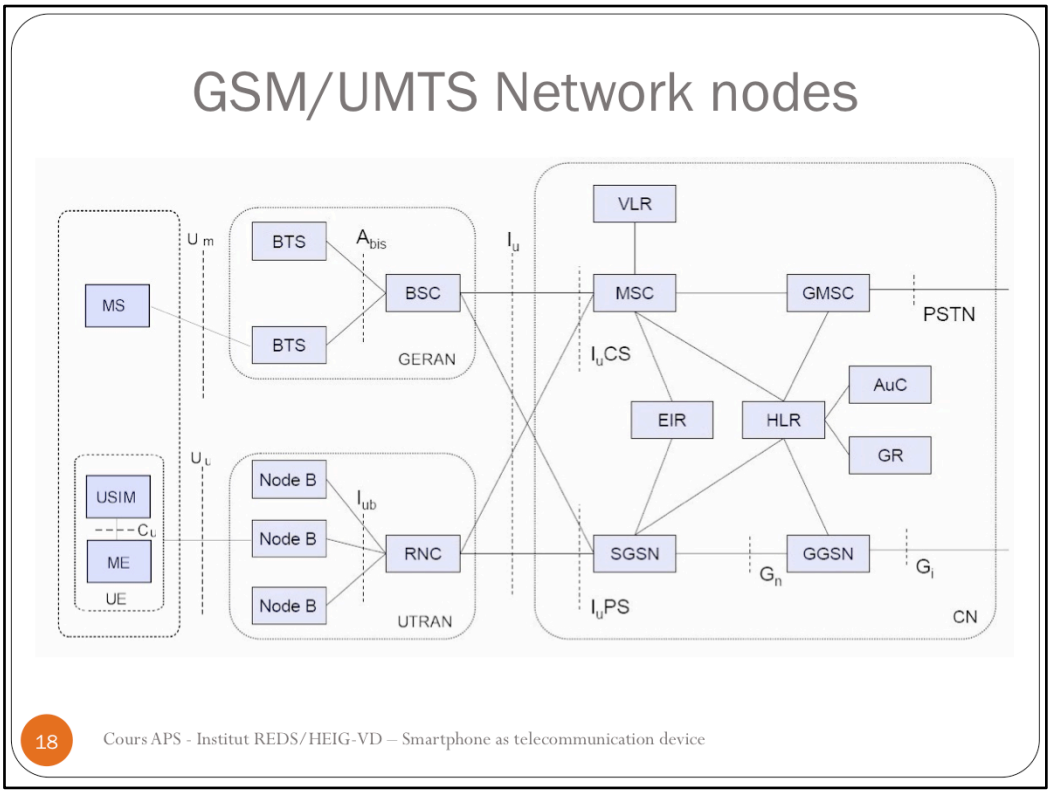
Cell type	Radius	Mobility	Max. available data rate
Macro	≥10 km	High	384 kbps
Micro	0.1–1 km	High/low	384 kbps
Pico	<100 m	Low	2 Mbps



LA = Local Area
IMSI = International Mobile System Identifier
MSISDN = Mobile System ISDN Number (phone number)
BTS = Base Transceiver Station
BSC = Base System Center
MSC = Mobile Switching Center
GMSC = Gateway MSC
HLR = Home Location Register
VLR = Visitors Location Register
PSTN = Public Switching Telephone Network

Circuit + Packet Switch Network overview





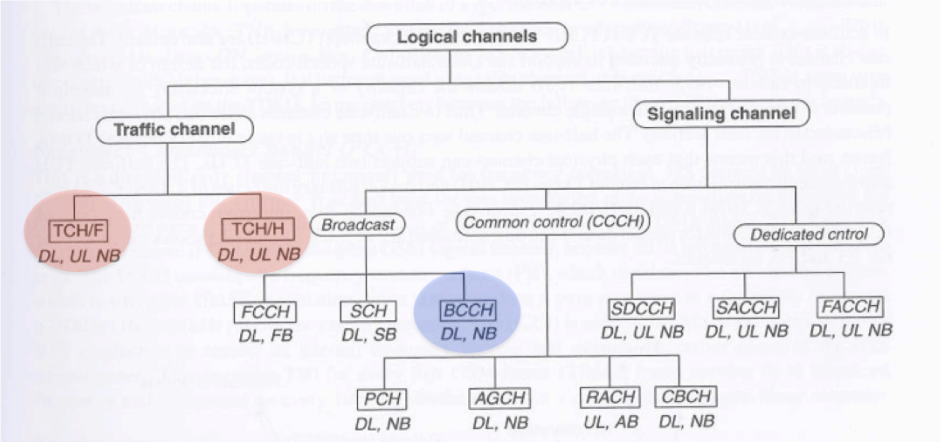
MS = Mobile System
UE = UMTS Equimpent
USIM = UMTS Subscriber Identification Module
ME = Mobile Equipment
GERAN = GSM – EDGE Radio Access Network
UTRAN = UMTS Radio Access Network
AuC = Authentication Center
EIR = Equipment Identification Register
SGGN = Servicing GPRS Service Node
GGSN = Gateway GPRS Service Node

Procédures principales

Procédures Principales

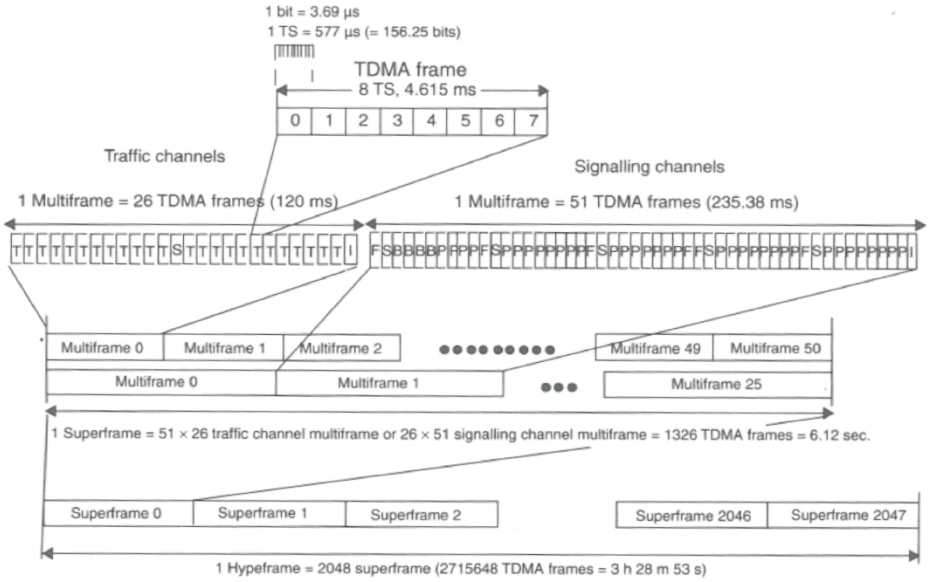
- Beacon scanning at boot
- Mobile Originating Call
- Mobile Terminating Call
- Paging
- Handovers
- SMS transmit/receive

Cellular Typical Digital Channels

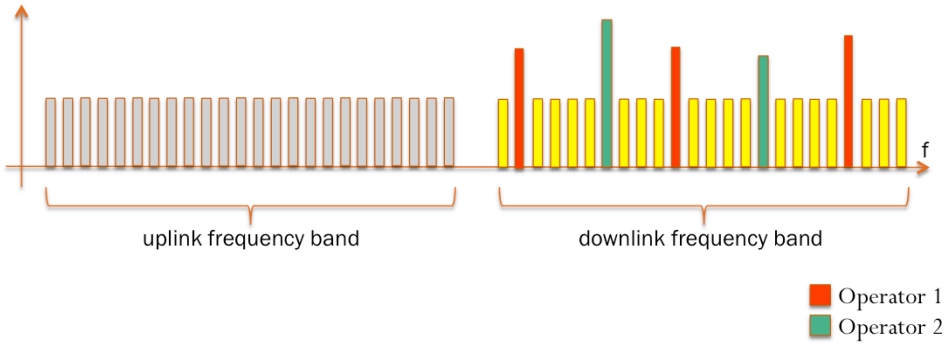


TCH: Traffic Channel
TCH/F: Traffic Channel Full rate
TCH/H: Traffic Channel Half rate
FCCH: Frequency Correction CHannel
SCH: Syncronization Channel
BCCH: BroadCast CHannel
CCCH: Common Control CHannel
PCH: Paging CHannel
AGCH: Access Grant CHannel
RACH: Random Access CHannel
CBCH: Cell Broadcast CHannel
SDCCH: Standalone Dedicated Control CHannel
SACCH: Slow Associated Control CHannel
FACCH: Fast Associated Control CHannel

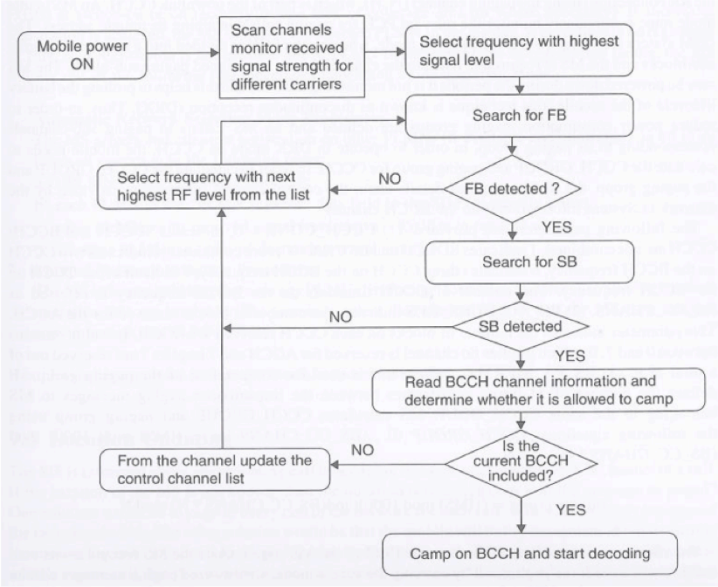
Channel multiplexing (example GSM)



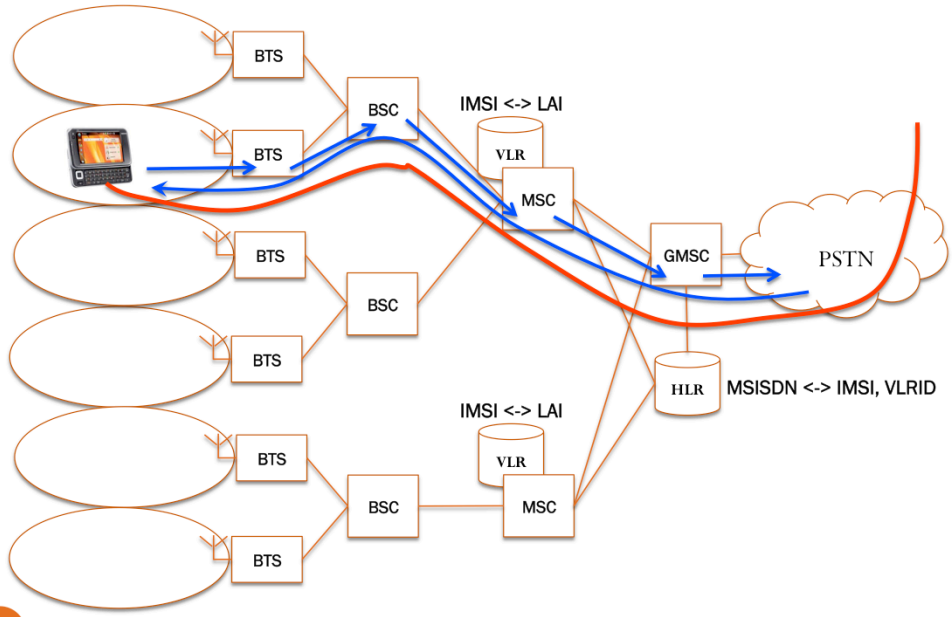
Network scan at boot (1/2)



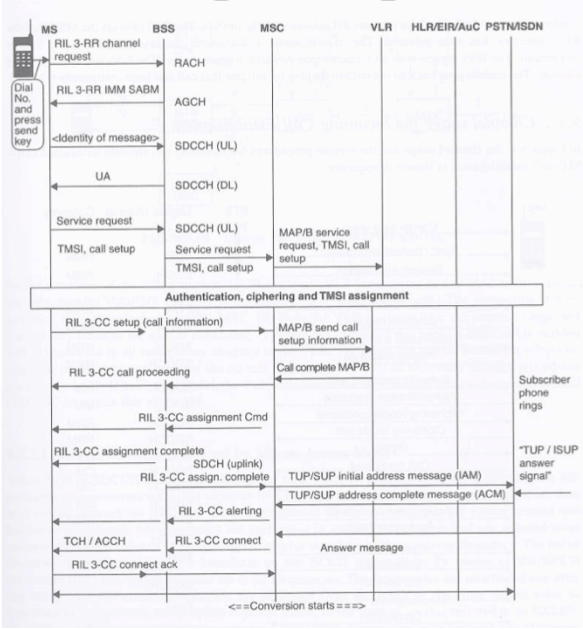
Network scan at boot (2/2)



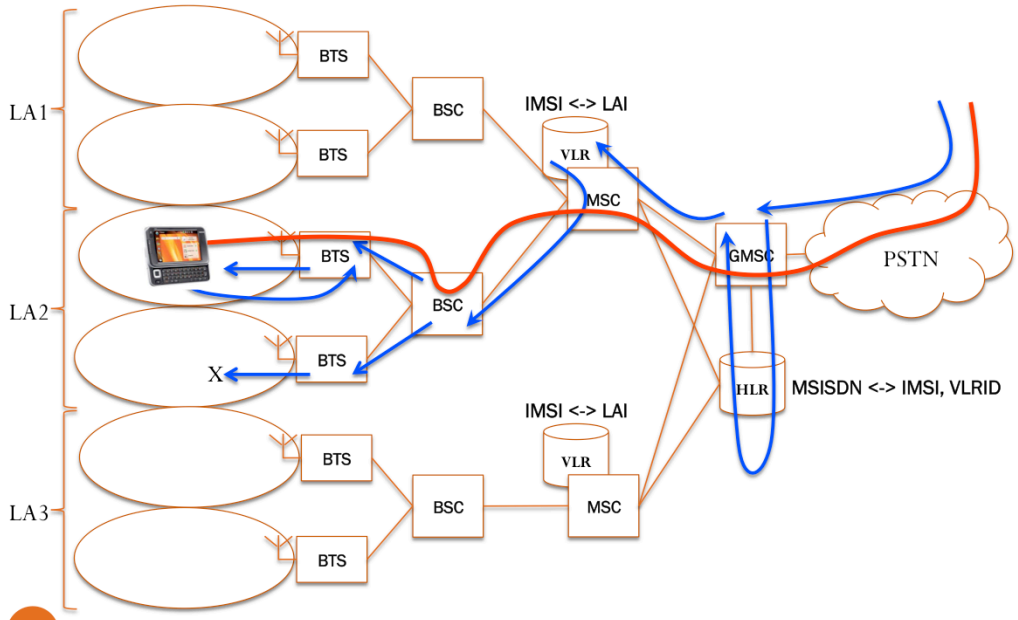
Mobile Originating Calls (1/2)



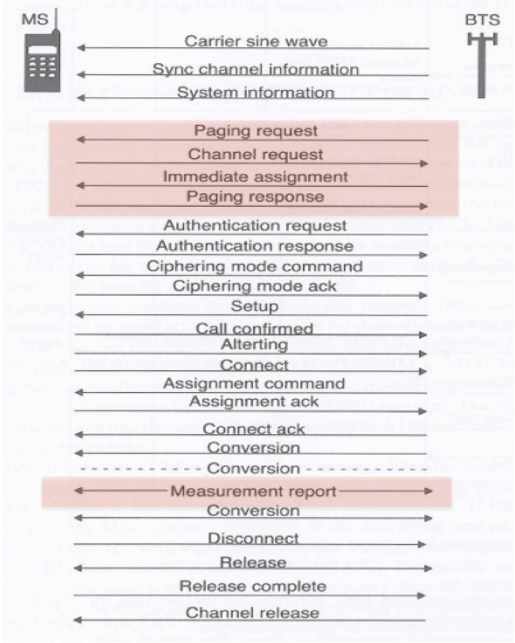
Mobile Originating Calls (2/2)



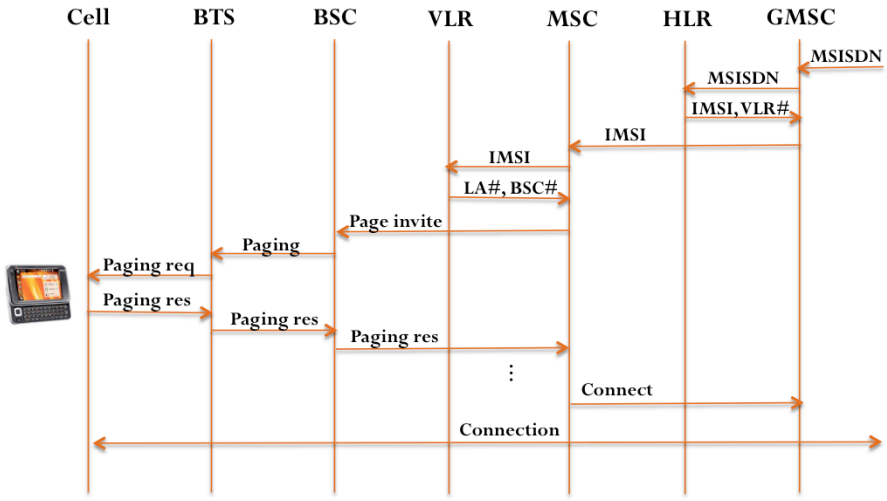
Mobile Terminating Calls (1/2)



Mobile Terminating Calls (2/2)

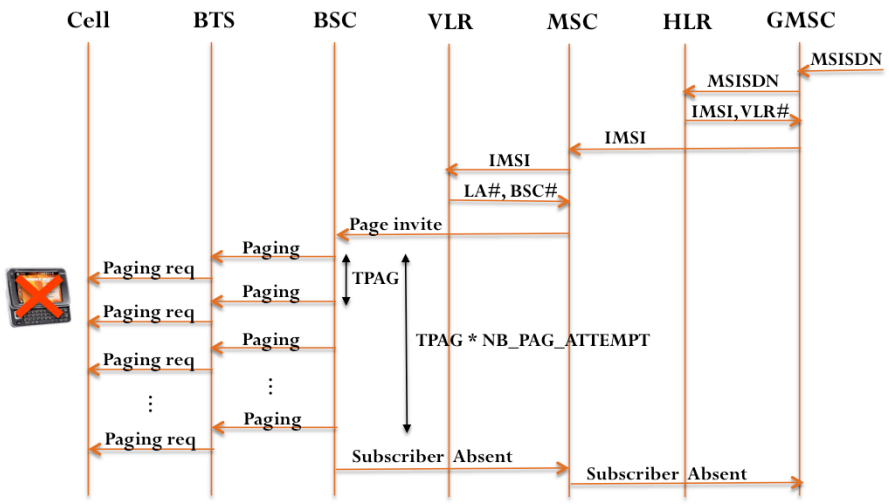


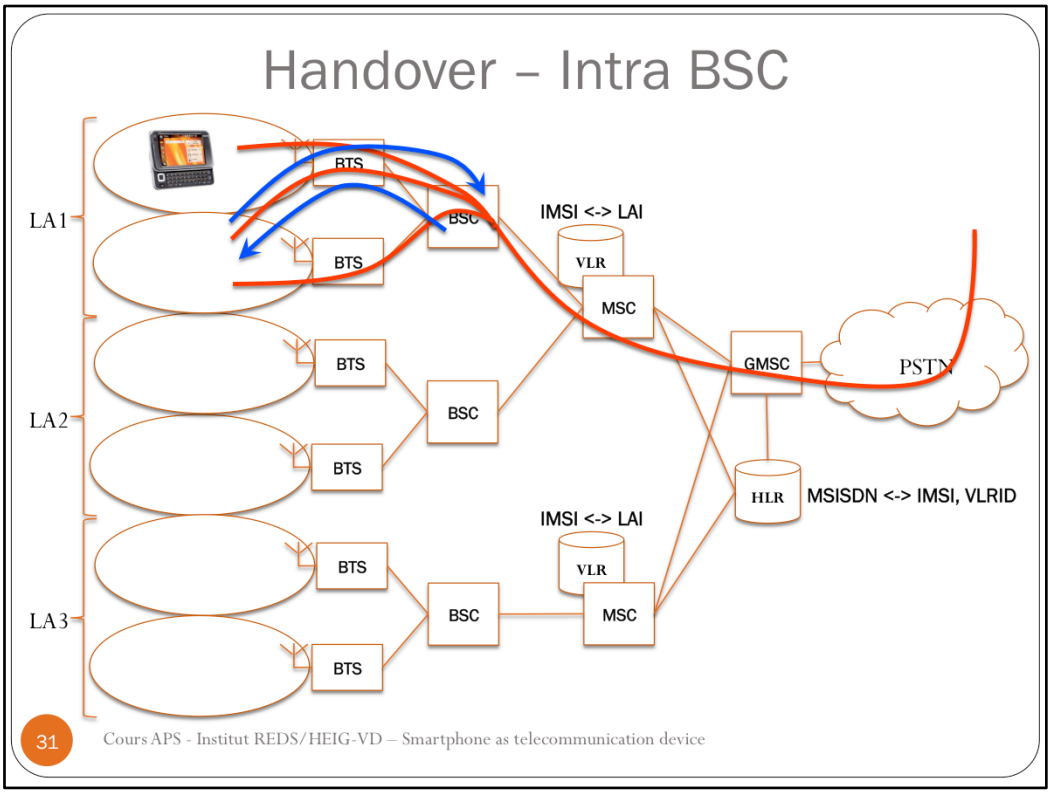
Paging (1/2)
Portable dans la celle



Paging (2/2)

Portable pas dans la celle




Handover – Intra BSC
LA1
LA2
LA3
BTS
BTS
BTS
BTS
BTS
BTS
BSC
BSC
BSC
IMSI <-> LAI
VLR
MSC
IMSI <-> LAI
VLR
MSC
GMSC
PSTN
HLR
MSISDN <-> IMSI, VLRID
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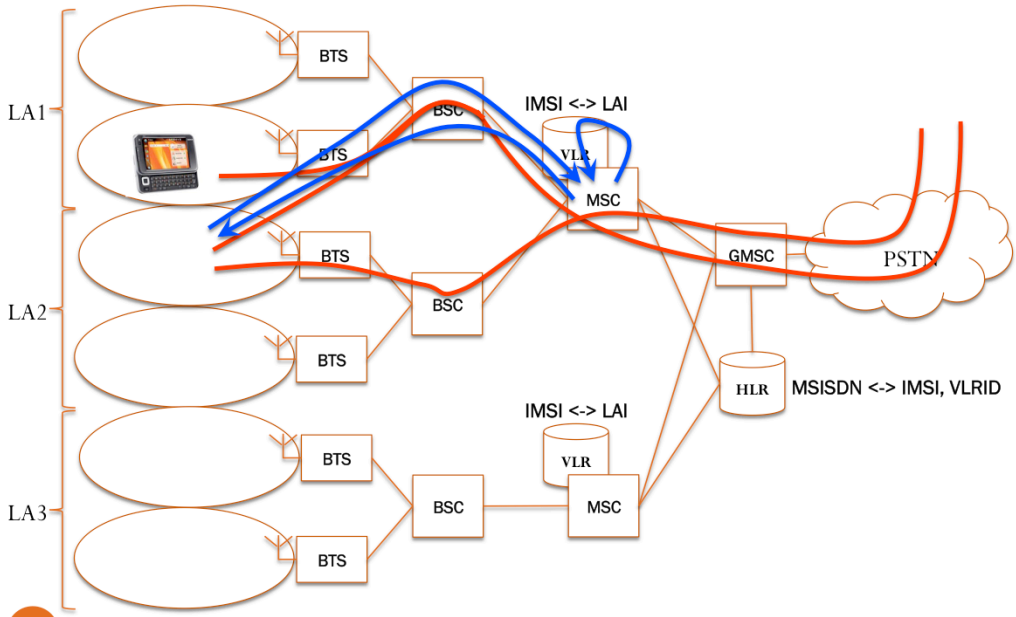
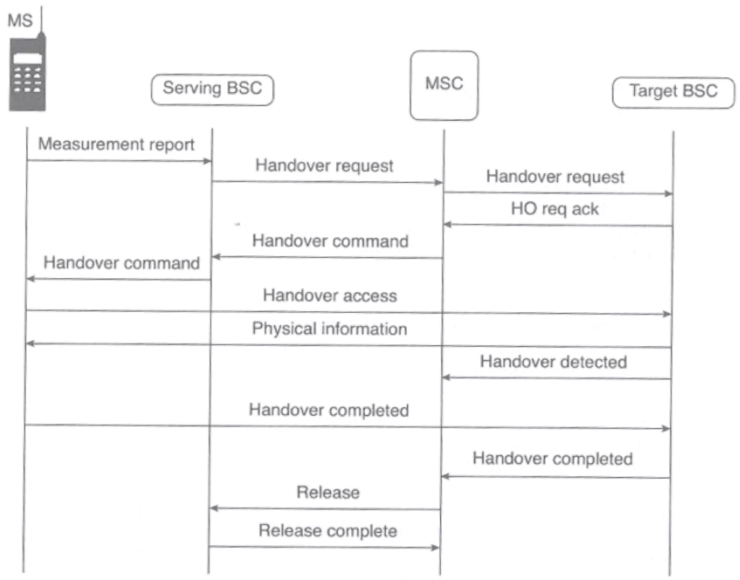
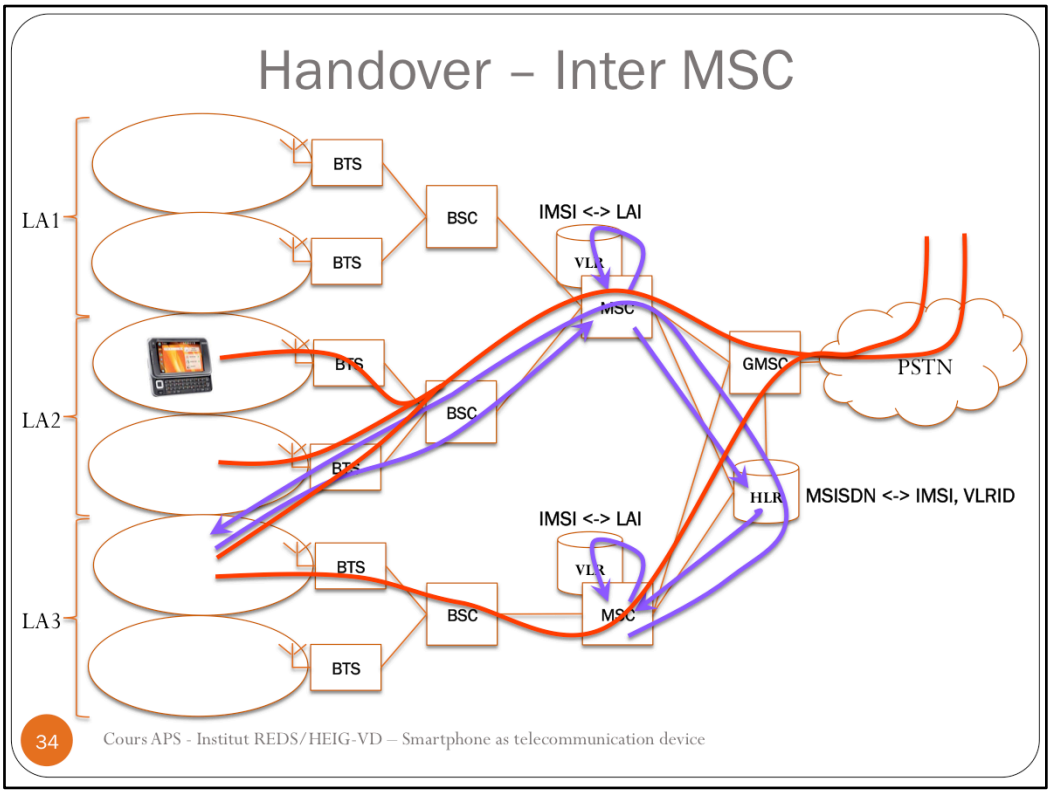
Handover – Intra MSC



Intra MSC Handover




Handover – Inter MSC
LA1
LA2
LA3
BTS
BTS
BTS
BTS
BTS
BTS
BSC
BSC
BSC
IMSI <-> LAI
IMSI <-> LAI
VLR
VLR
MSC
MSC
GMSC
PSTN
HLR
MSISDN <-> IMSI, VLRID
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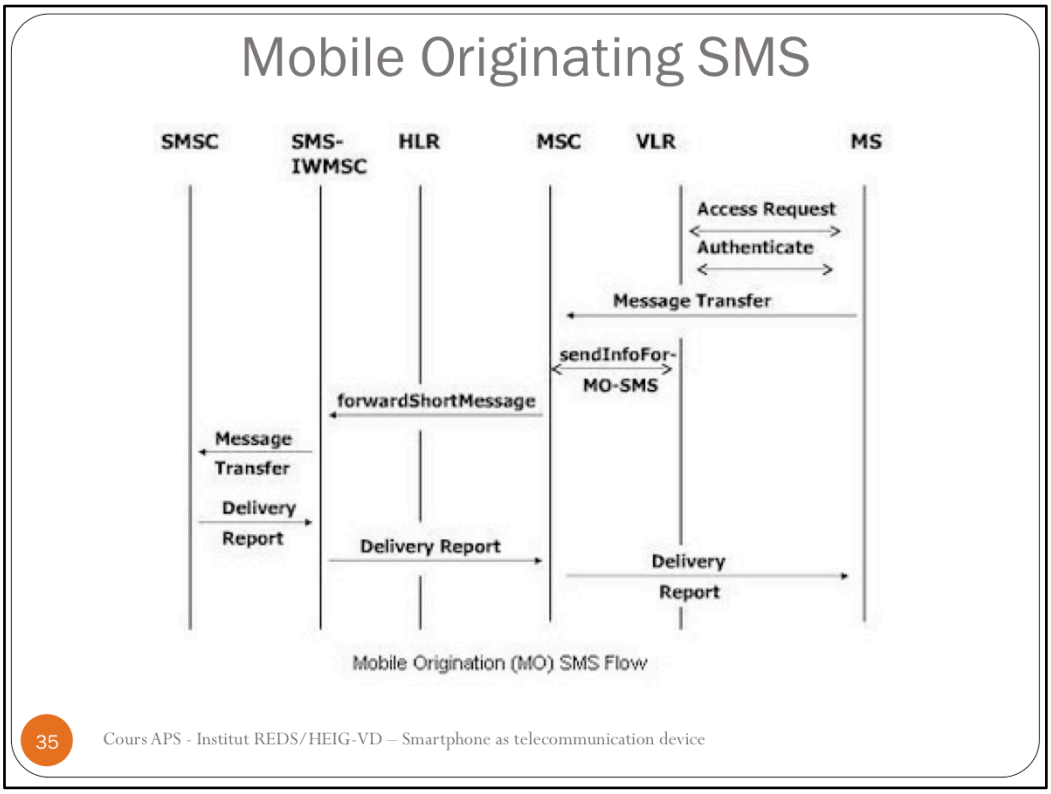
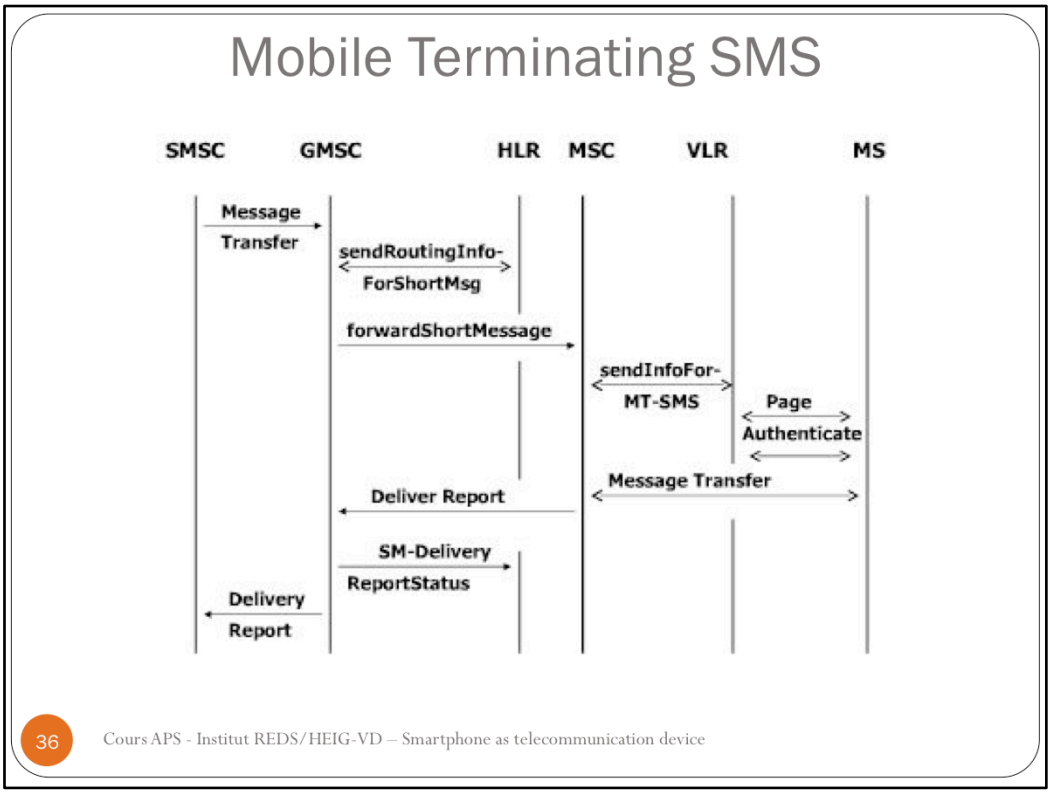


SMS MO Call Flow :

1. The mobile station transfers the short message to the MSC.
2. The MSC queries the VLR to verify that the message transfer does not violate the supplementary services invoked or the restrictions imposed on the subscriber.
3. The MSC sends the short message to the SMS-IWMSC (*Inter-Working MSC for SMS*) using the "*forward Short Message*" operation.
4. The SMS-IWMSC delivers the short message to the SMSC (*Short Message Service Centre*).
5. The SMSC acknowledges the successful outcome of the "*forward Short Message*" operation to the MSC.
6. The MSC returns the outcome of the short message operation to the mobile station.



SMS MT Call Flow :

1. The Short Message is transferred from SMSC to SMS-GMSC.
2. SMS-GMSC queries the HLR (SRI) & receives the routing information for the mobile subscriber (SRI-ACK).
3. The SMS-GMSC sends the short message to the MSC using *"Forward Short Message"* (FSM) operation.
4. The MSC retrieves the subscriber information from the VLR. This operation may include the Authentication Procedure.
5. The MSC transfers short message to the Mobile Station (MS).
6. The MSC returns the outcome of the *"Forward Short Message"* operation to the SMS-GMSC (FSM-ACK).
7. If requested by the SMSC, it returns a status report indicating Delivery of the Short Message.

Références

- Sajal K. Das, Mobile Handset Design, Wiley