



Mobile Networks : **Introduction**

History overview



- 80's : analog networks
 - Proprietary or national solutions :
 - ✓ No compatibility
 - ✓ NMT (Nordic Mobile Telephone) in Sweden, adapted in France for SFR
 - ✓ Radiocom 2000 for France Telecom
 - Lack of confidentiality
 - Very expensive for the user
 - Very low penetration
- 79 : 900 Mhz is reserved
- 82 : Creation of "Groupe Spécial Mobile" within the European Conference of Postal and Telecommunications Administrations (CEPT)
- 88-89 : First publication of GSM recommendations (draft).
- 90-91 : The GSM Phase 1 recommendations are frozen
- 92 : First GSM networks in operation
- 94 : GSM Phase 2 recommendations publication
- 97 : GPRS
 - EDGE
- 2000 : UMTS
 - 2005 : HSDPA-HSUPA
- 2010 ? : LTE/SAE

Cellular network concepts (1/2)



→ Network composed :

- Base Stations
- Base Station are aggregated on Controllers
- Controllers are connected to Core Network nodes

→ A cell is defined as the area where a Mobile Station is able to communicate with the Base Station

- Cells are grouped in "registration areas"
 - ✓ LA : location area
 - ✓ RA : routing area

→ Mobility is supported between cells

- In Idle Mode (no active call) : **Roaming**
- In Connected Mode (during a call or session) : **Handover**

Cellular network concepts (2/2)



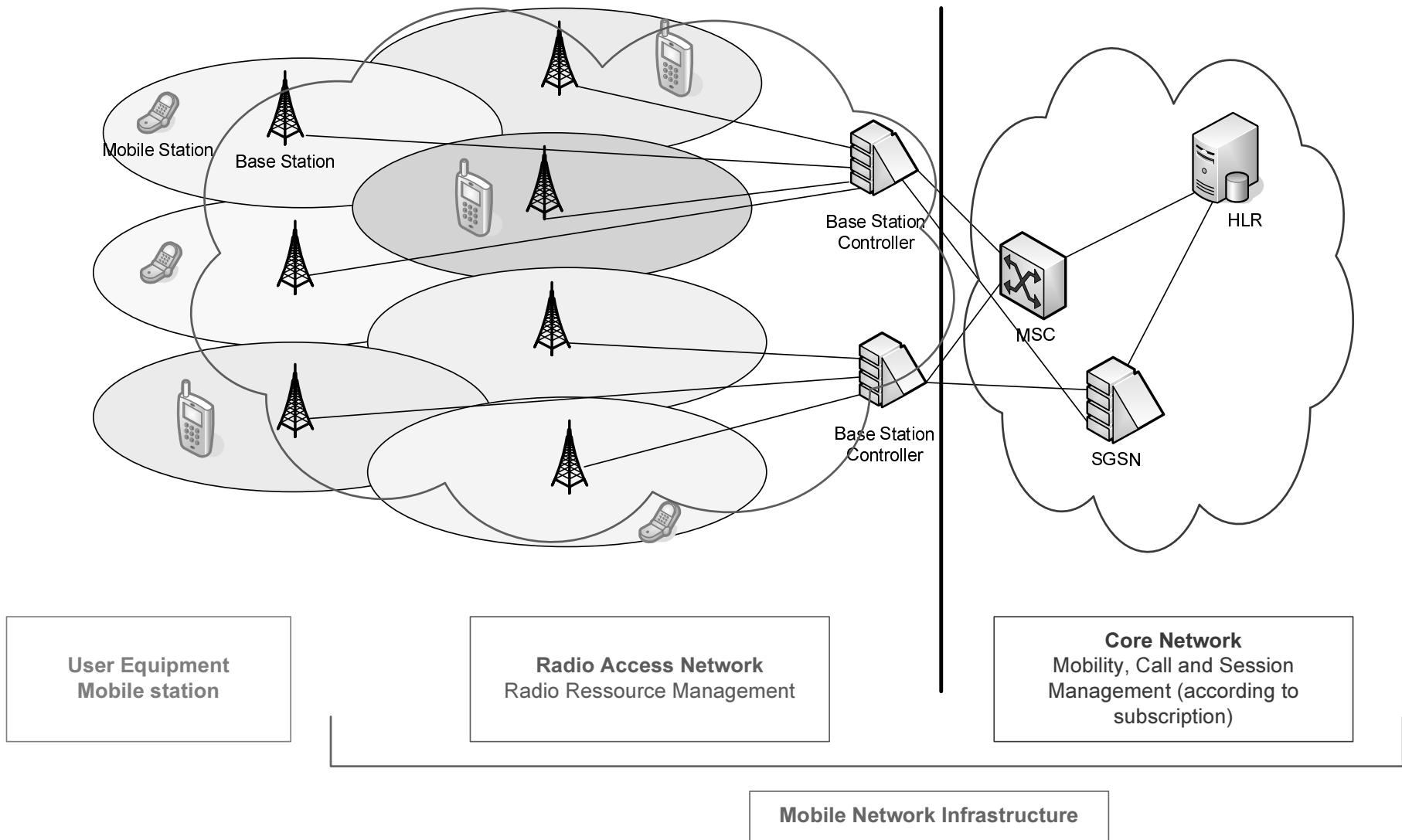
→ Radio Access Network and Core Network

- RAN : Radio resource management
- CN : User Management & Service Delivery
(Location Update, Authentication, Calls, PS sessions, SMS, ...)

→ SIM : Subscriber Identity Module

- Smart card put in the mobile handset
- Used for authentication, and user subscription is linked to the SIM and not to the terminal

Cellular network concept



Mobile networks constraints



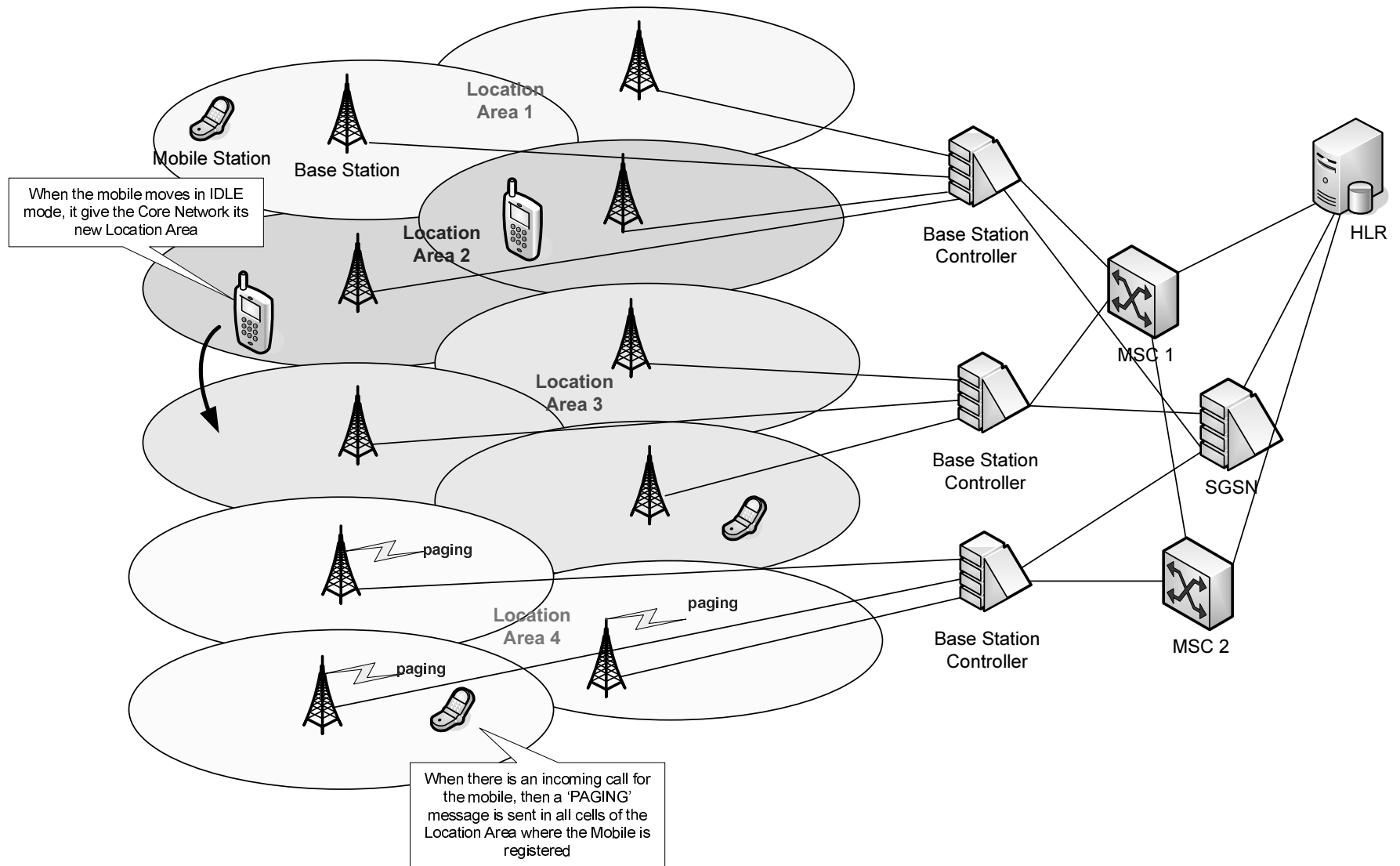
- ➔ Need to cope with interferences
- ➔ Shared resources between users
 - Need to manage multiple access
 - ✓ TDMA, CDMA
- ➔ Radio signal can be intercepted (broadcast)
 - Need for confidentiality
- ➔ Radio resources are rare and expensive
 - Need to save these resources
 - ✓ Modulation & coding
 - ✓ Need to limit bandwidth
 - Signalling
 - Codecs (narrowband codecs)
- ➔ Planification required for antenna deployment
 - ✓ For neighbour cell differentiation
 - ✓ For mobility support

Mobility Principles



- Cells are grouped into Location Area
- The network know the cell of the mobile station when it is active, otherwise the network knows the Location Area where the MS is camping
- In IDLE mode, the mobile station informs the network when it changes of Location Area
 - When there is an incoming call or SMS, the PAGING procedure is performed in all cells of the Location Area where the MS was registered
 - The MS also 'refreshes' its location information periodically
- In CONNECTED mode, Handover is controlled by the network
 - The network asks the MS to measure neighbour cells
 - In function of measures from the MS (sent to the network), the network initiates the handover towards a more suitable cell

Mobility principles



GSM (1/2)



→ Global System for Mobile Communications

- Initially "Groupe Spécial Mobile"
- Called 2G : 2nd Generation
- First 'global' system
 - ✓ All system standardized (not only radio interface)
 - ✓ Possibility to roam in other countries (interconnection or networks)

→ GSM radio characteristics

- Access technology : TDMA (Time Division Multiple Access)
- Frequency bands : 900 MHz
 - ✓ 25 MHz bands : 895-915 (UL) & 935-960 (DL)
 - ✓ Space between carriers : 200 kHz
- Other band 1800 MHz (initially called DCS)
 - ✓ Bands : 1710-1785 / 1805-1880
 - ✓ Smaller cells than 900 cells
- GSM access network : BSS (Base Station Subsystem)
 - ✓ BTS : Base Transceiver Station
 - ✓ BSC : Base Station Controller

GSM (2/2)



→ GSM "Phase 2+"

- Interoperability between GSM 900 and DCS 1800
- Pro-active SIM
- New Intelligent Network services

→ Services :

- Teleservices
 - ✓ Voice
 - ✓ Emergency calls
 - ✓ Fax
 - ✓ SMS (Short Message Service)
- Supplementary Services (CLIP, CLIR, CH, CW, Call Forwarding...)
- Bearer Services
 - ✓ CSD (Circuit Switched Data) : up to 14,4 kbit/s
 - ✓ HSCSD (High Speed Circuit Switched Data) : N x 14,4

GPRS



- General Packet Radio Service
 - 3GPP Release 97
 - Sometimes called 2,5G
- Same Access Network as GSM
- New Core network for offering data services (IP services)
- In a cell, ressources are shared between different users having an active GPRS session

- EDGE (Enhanced Data rate for GSM Evolution)
 - New modulation, for higher data rates

- GPRS Services :
 - Packet Data Connectivity: IP
 - ✓ GPRS Data rates :
 - In theory : up to 170 kbit/s at radio level, 115 kbit/s at application level
 - In reality : 40-60 kbit/s at application level in market MS
 - ✓ E-GPRS Data rates :
 - In theory : up to 384 kbit/s in optimal radio conditions
 - In reality : about 200 kbit/s at application level in market MS
 - Short-Message support

UMTS (1/2)



→ Universal Mobile Telecommunications System

- Called 3G: 3rd Generation
- Standardization finished in 1999-2000
- First UMTS equipments in 2002

→ Network Elements in UTRAN (UMTS Terrestrial Radio Access Network)

- NodeB (3G BTS)
- RNC : Radio Network Controller
 - ✓ New interface between RNC : IuR

→ UTRAN specificities

- Based on W-CDMA (WideBand Code Division Multiple Access)
- Two modes of multiplexing on radio interface for UMTS : FDD & TDD (Frequency / Time Division Duplex)
- Macro diversity : the UE can 'talk' to multiple NodesB
- Soft Handover (no transmission interruption during handover)

UMTS (2/2)



→ GSM and GPRS Core Network are re-used : 2 domains for UMTS

- UMTS-CS (circuit switched) CN
- UMTS-PS (packet switched) CN

→ Services : improvements from GSM & GPRS

- Support of video calls (CS mode)
- Simultaneous access to the CS and PS domains
- Quality of Service
 - ✓ 4 classes : Conversational, Streaming, Interactive, Background
- Higher data rates
 - ✓ Up to 384 kbps in FDD
 - ✓ Up to 2 Mbps in TDD

→ HSDPA/HSUPA

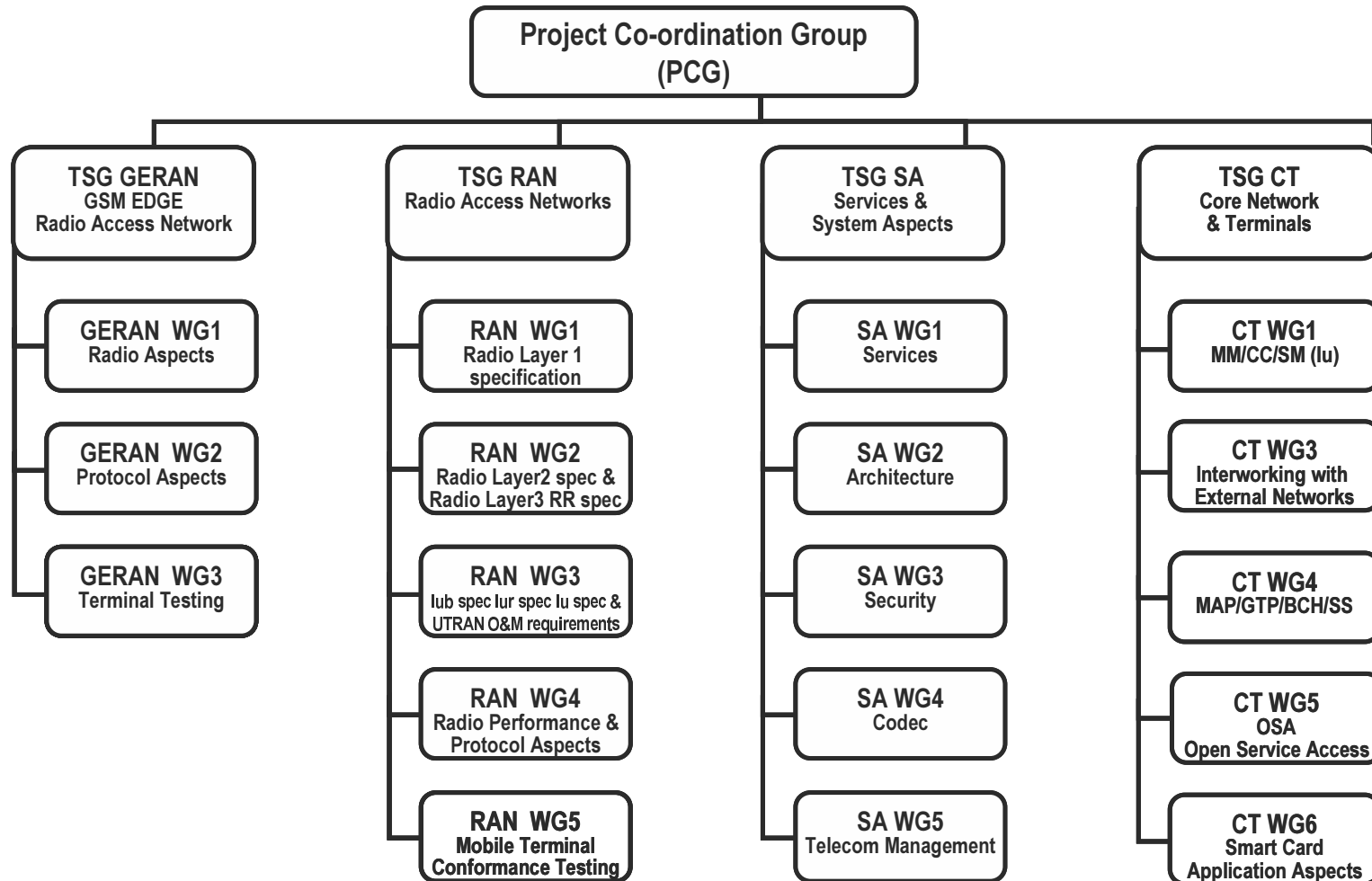
- Different modulation and scheduling on radio interface
- Higher data rates : up to 14,4 Mbps in DL, 5,8Mbps in UL

3GPP Standardisation



→ 3GPP centralizes all standardisation of mobile networks

3GPP ORGANIZATION



References



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- X. Lagrange, P. Godlewski, S. Tabbane
- Editions Hermes Science

→ UMTS : les origines, l'architecture, la norme

- P. Lescuyer
- Editions Dunod

→ 3GPP web site

- <http://www.3gpp.org>