

# Pertemuan 7

# GSM Network



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# What is GSM ??

- Global System for Mobile (GSM) is a second generation cellular standard developed to cater voice services and data delivery using digital modulation.

# GSM Services

- Tele-services
- Bearer or Data Services
- Supplementary services

# Tele Services

- Telecommunication services that enable voice communication via mobile phones
- Offered services
  - Mobile telephony
  - Emergency calling

# Bearer Services

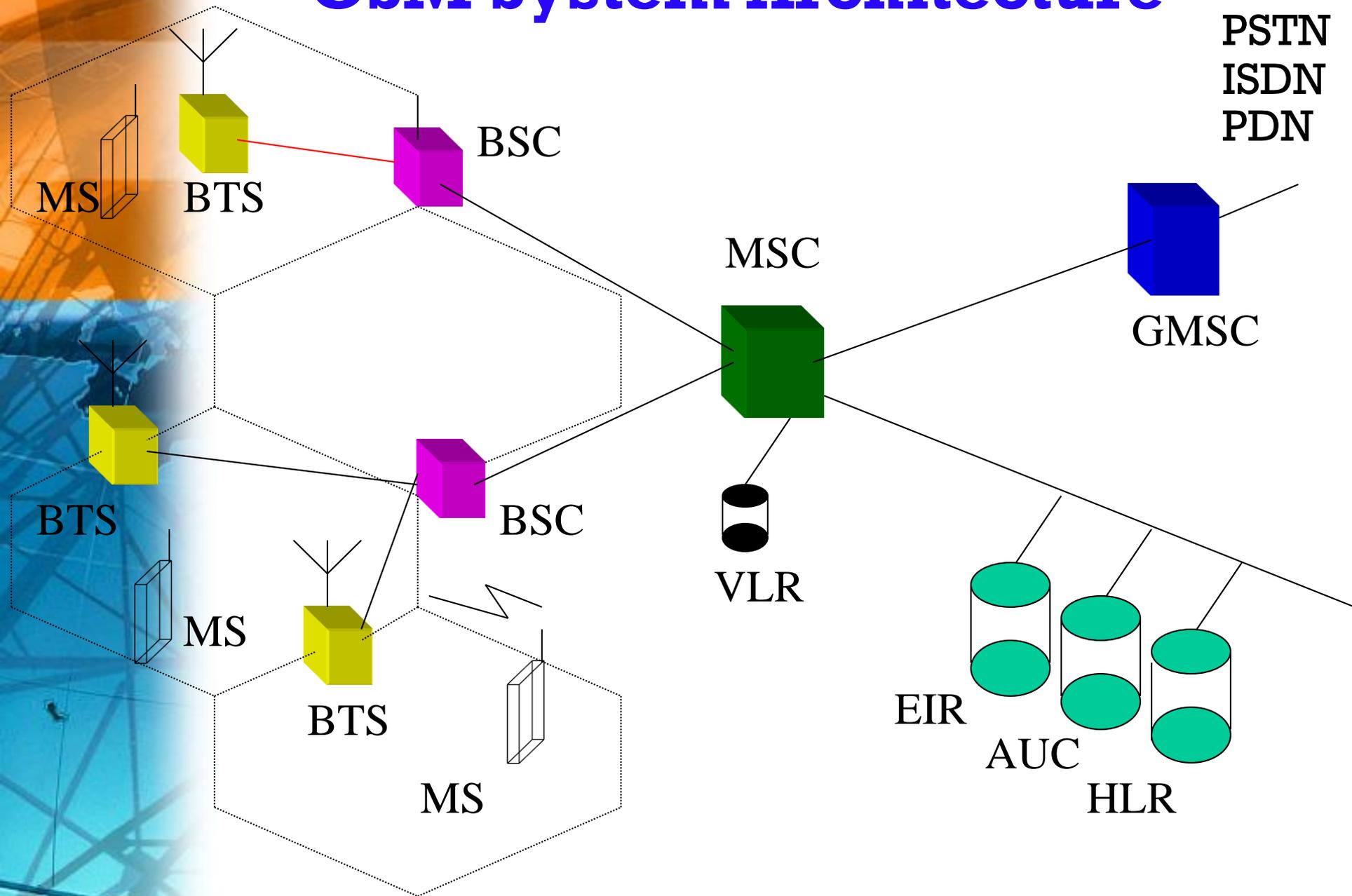
- Include various data services for information transfer between GSM and other networks like PSTN, ISDN etc at rates from 300 to 9600 bps
- Short Message Service (SMS)
  - up to 160 character alphanumeric data transmission to/from the mobile terminal
- Unified Messaging Services(UMS)
- Group 3 fax
- Voice mailbox
- Electronic mail

# Supplementary Services

Call related services :

- **Call Waiting-** Notification of an incoming call while on the handset
- **Call Hold-** Put a caller on hold to take another call
- **Call Barring-** All calls, outgoing calls, or incoming calls
- **Call Forwarding-** Calls can be sent to various numbers defined by the user
- **Multi Party Call Conferencing -** Link multiple calls together
- **CLIP –** Caller line identification presentation
- **CLIR –** Caller line identification restriction
- **CUG –** Closed user group

# GSM System Architecture



# GSM System Architecture-I

- Mobile Station (MS)

Mobile Equipment (ME)

Subscriber Identity Module (SIM)

- Base Station Subsystem (BSS)

Base Transceiver Station (BTS)

Base Station Controller (BSC)

- Network Switching Subsystem(NSS)

Mobile Switching Center (MSC)

Home Location Register (HLR)

Visitor Location Register (VLR)

Authentication Center (AUC)

Equipment Identity Register (EIR)

# Mobile Station (MS)

The Mobile Station is made up of two entities:

1. Mobile Equipment (ME)
2. Subscriber Identity Module (SIM)

# Mobile Equipment

- Portable, vehicle mounted, hand held device
- Uniquely identified by an **IMEI** (International Mobile Equipment Identity)
- Voice and data transmission
- Monitoring power and signal quality of surrounding cells for optimum handover
- Power level : 0.8W – 20 W
- 160 character long SMS.

# Subscriber Identity Module (SIM)

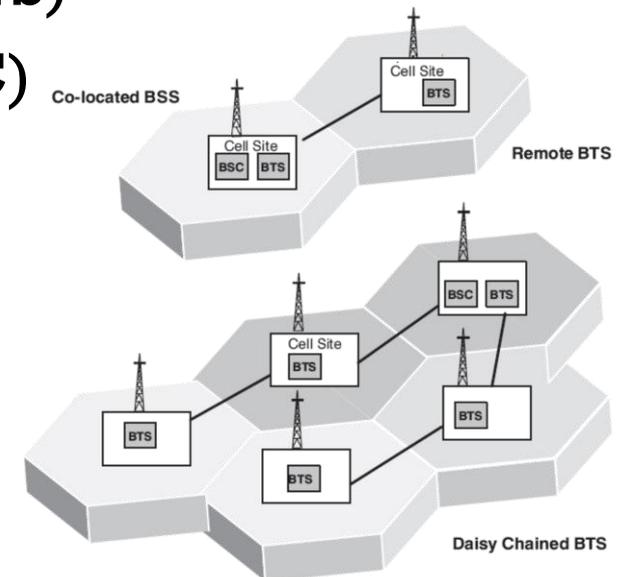
- Smart card contains the International Mobile Subscriber Identity (**IMSI**)
- Allows user to send and receive calls and receive other subscribed services
- Encoded network identification details
  - Key  $K_i$  ,  $K_c$  and  $A_3, A_5$  and  $A_8$  algorithms
- Protected by a password or PIN
- Can be moved from phone to phone – contains key information to activate the phone

# Base Station Subsystem (BSS)

Base Station Subsystem is composed of two parts that communicate across the standardized **Abis** interface allowing operation between components made by different suppliers

1. Base Transceiver Station (**BTS**)
2. Base Station Controller (**BSC**)

BSS Configurations



# Base Transceiver Station (BTS):

- **Encodes, encrypts, multiplexes, modulates and feeds the RF signals to the antenna.**
- **Frequency hopping**
- **Communicates with Mobile station and BSC**
- **Consists of Transceivers (TRX) units**

# **Base Station Controller (BSC)**

- **Manages Radio resources for BTS**
- **Assigns Frequency and time slots for all MS's in its area**
- **Handles call set up**
- **Transcoding and rate adaptation functionality**
- **Handover for each MS**
- **Radio Power control**
- **It communicates with MSC and BTS**

# Network Switching Subsystem(NSS)

- Mobile Switching Center (MSC)
- Home Location Register (HLR)
- Visitor Location Register (VLR)
- Authentication Center (AUC)
- Equipment Identity Register (EIR)

# Mobile Switching Center (MSC)

- Heart of the network
- Manages communication between GSM and other networks
- Call setup function and basic switching
- Call routing
- Billing information and collection
- Mobility management
  - Registration
  - Location Updating
  - Inter BSS and inter MSC call handoff
- MSC does gateway function while its customer roams to other network by using HLR/VLR.

# Home Location Registers (HLR)

- permanent database about mobile subscribers in a large service area (generally one per GSM network operator)
- database contains IMSI, MSISDN, prepaid/postpaid, roaming restrictions, supplementary services.

# Visitor Location Registers (VLR)

- Temporary database which updates whenever new MS enters its area, by HLR database
- Controls those mobiles roaming in its area
- Reduces number of queries to HLR
- Database contains IMSI, TMSI, MSISDN, MSRN, Location Area, authentication key

# **Authentication Center (AUC)**

- Protects against intruders in air interface
- Maintains authentication keys and algorithms and provides security triplets ( RAND,SRES,Kc)
- Generally associated with HLR

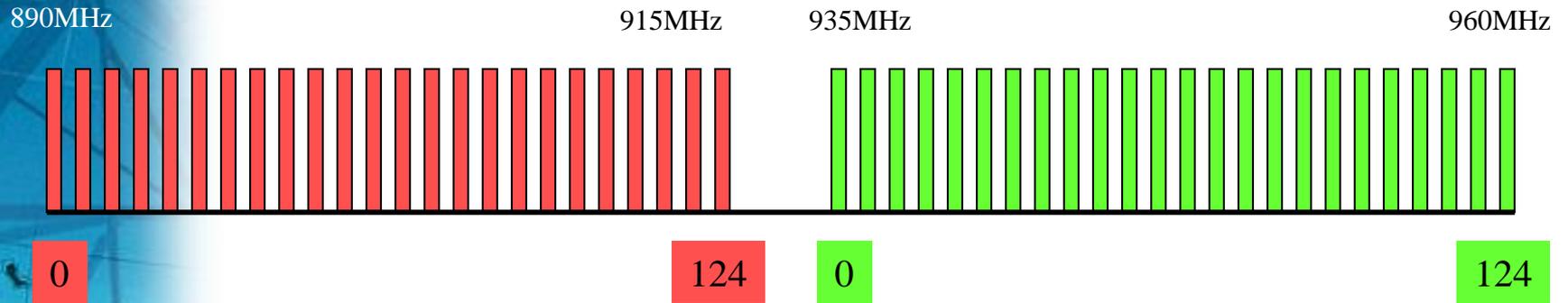
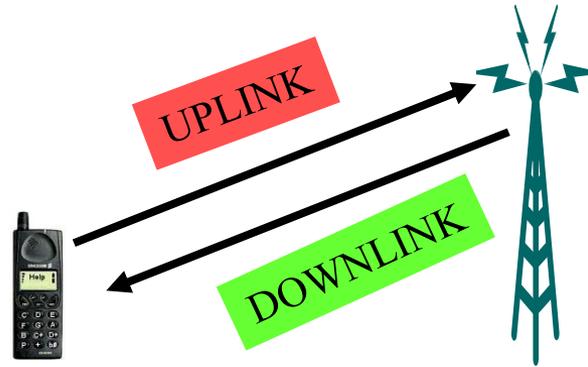
# **Equipment Identity Register (EIR)**

- Database that is used to track handsets using the IMEI (International Mobile Equipment Identity)
- Made up of three sub-classes: The White List, The Black List and the Gray List
- Only one EIR per PLMN

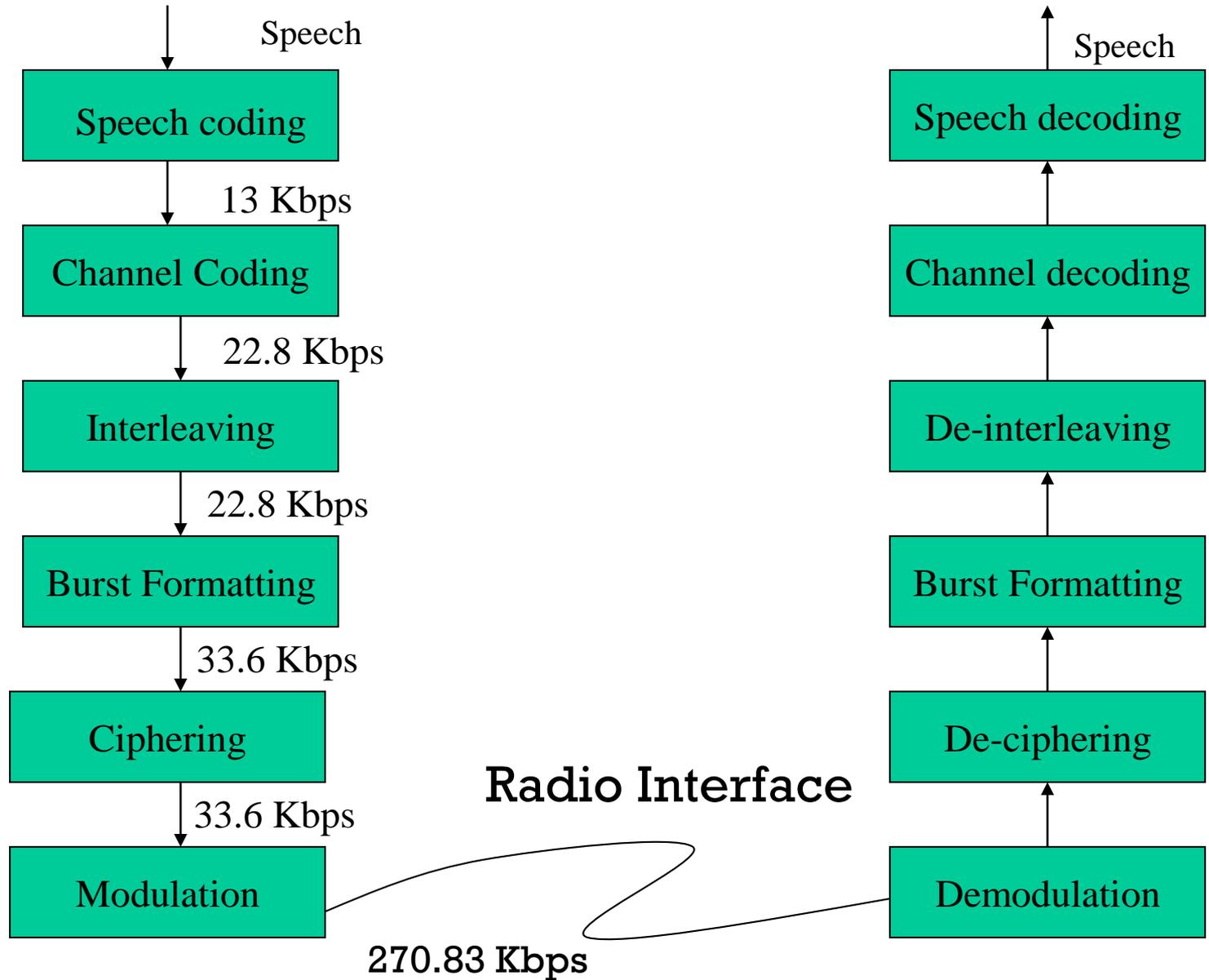
# **GSM Specification**

- **Carrier Separation : 200 Khz**
- **Duplex Distance : 45 Mhz**
- **No. of RF carriers : 124**
- **Access Method : TDMA/FDMA**
- **Modulation Method : GMSK**
- **Modulation data rate : 270.833 Kbps**

# GSM uses paired radio channels

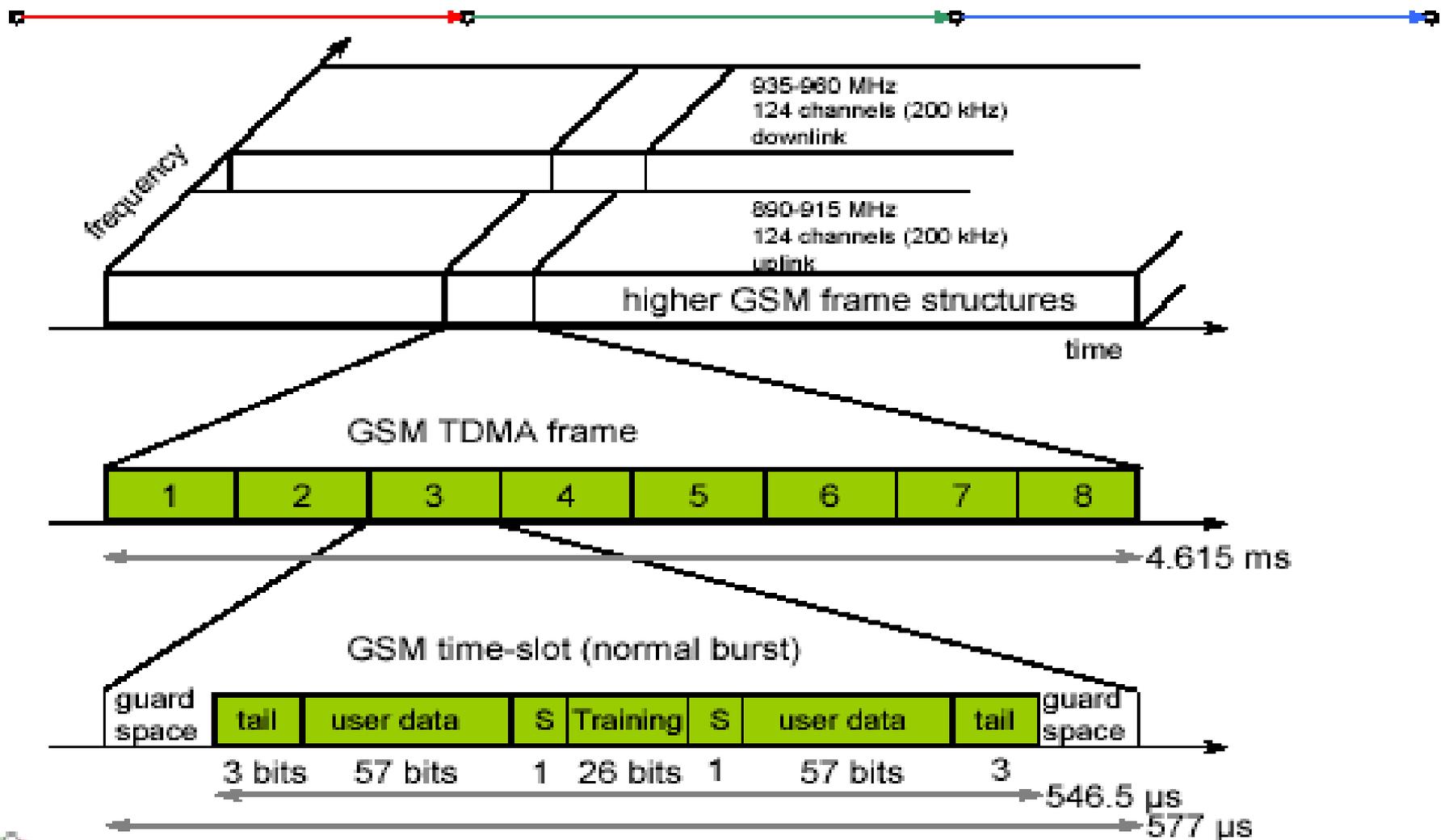


# GSM Operation

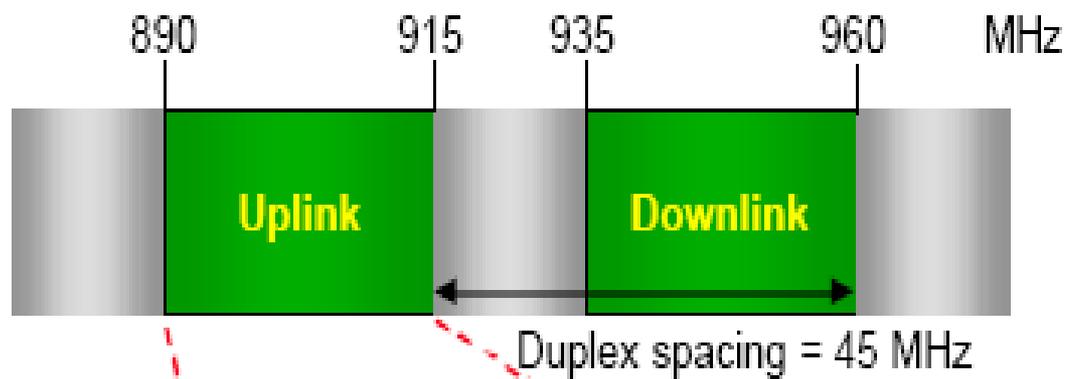


# GSM-Frame Structure

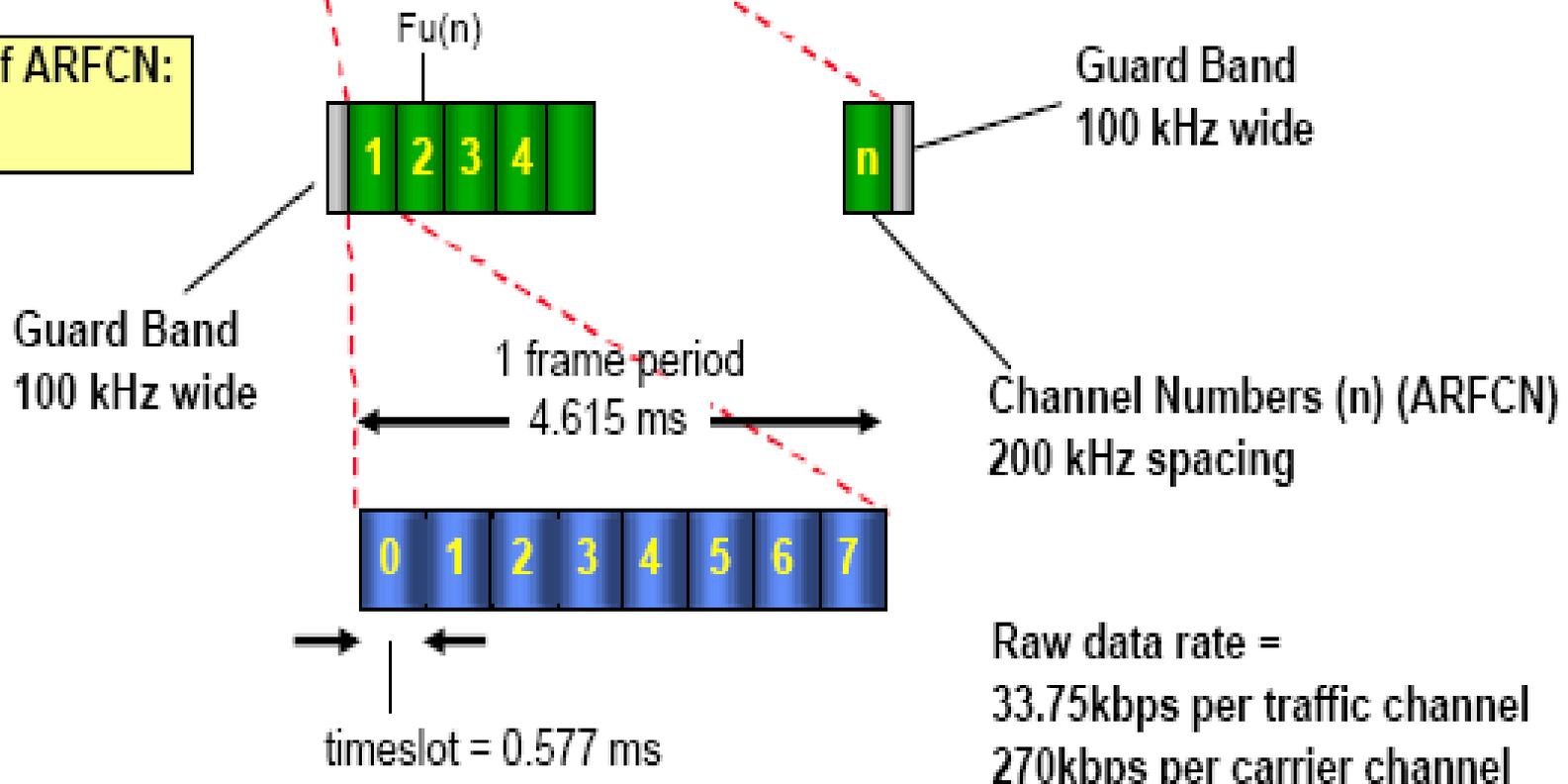
## GSM - TDMA/FDMA



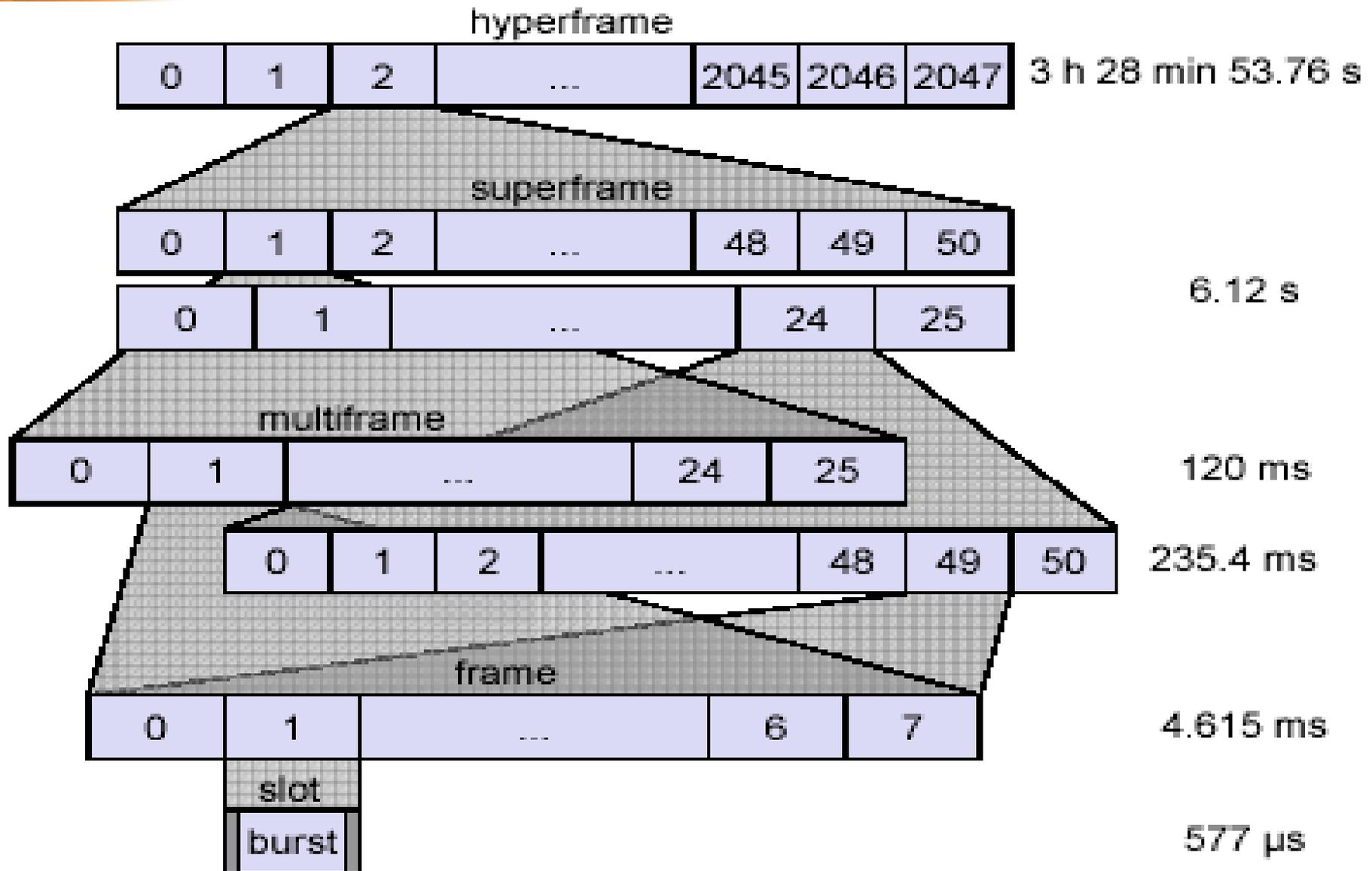
# P-GSM Physical Channels



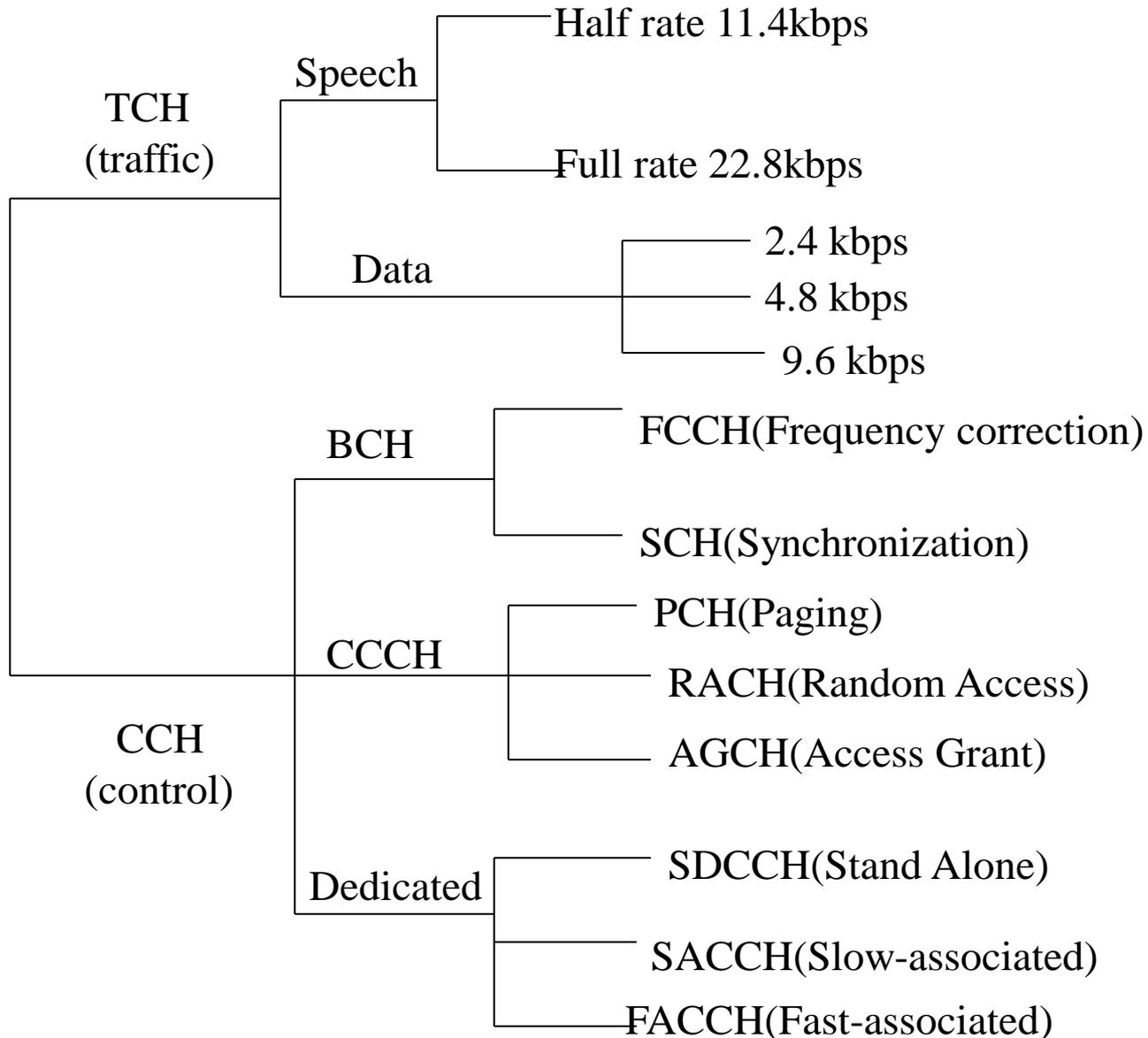
Range of ARFCN:  
1 - 124



# Physical Channel



# Logical Channels

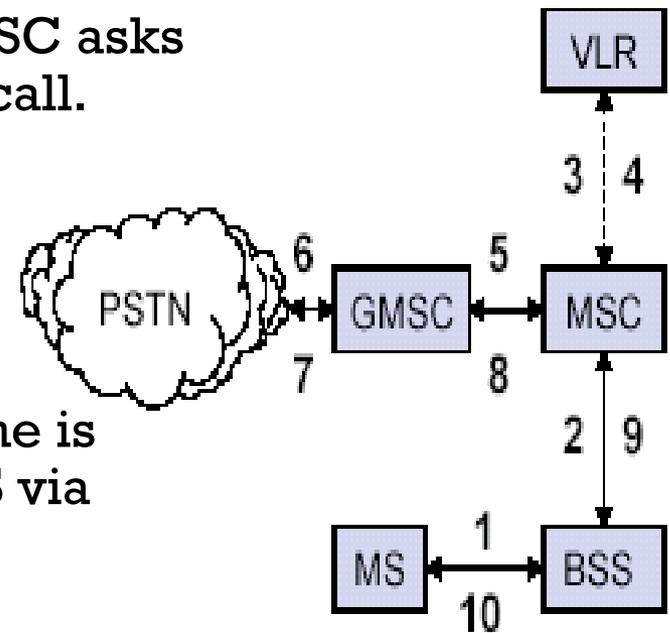


# Call Routing

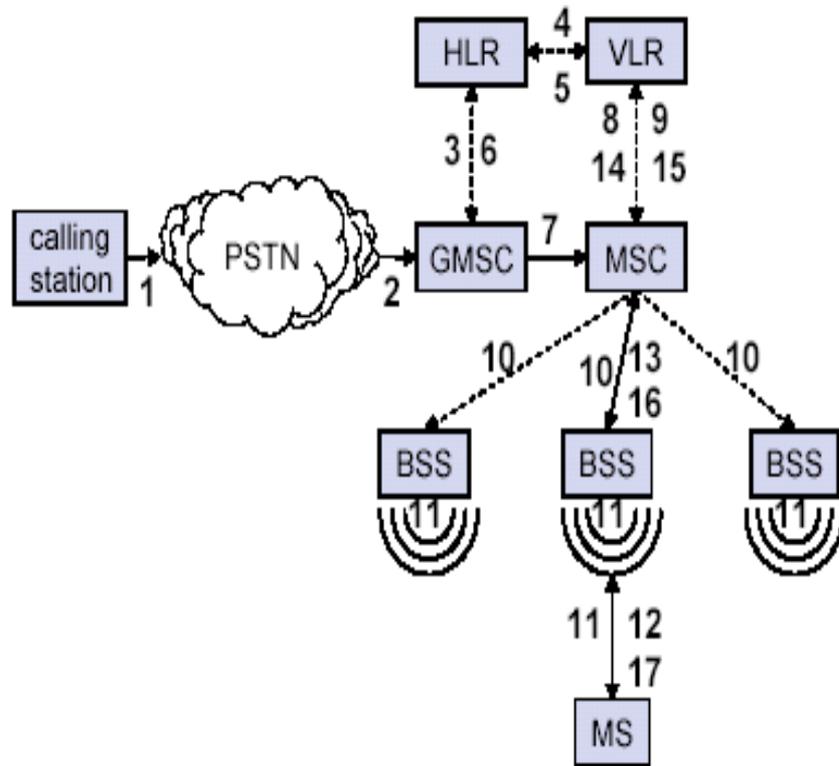
- **Call Originating from MS**
- **Call termination to MS**

# Outgoing Call

1. MS sends dialled number to BSS
2. BSS sends dialled number to MSC
- 3,4 MSC checks VLR if MS is allowed the requested service.If so,MSC asks BSS to allocate resources for call.
- 5 MSC routes the call to GMSC
- 6 GMSC routes the call to local exchange of called user
- 7, 8,
- 9,10 Answer back(ring back) tone is routed from called user to MS via GMSC,MSC,BSS

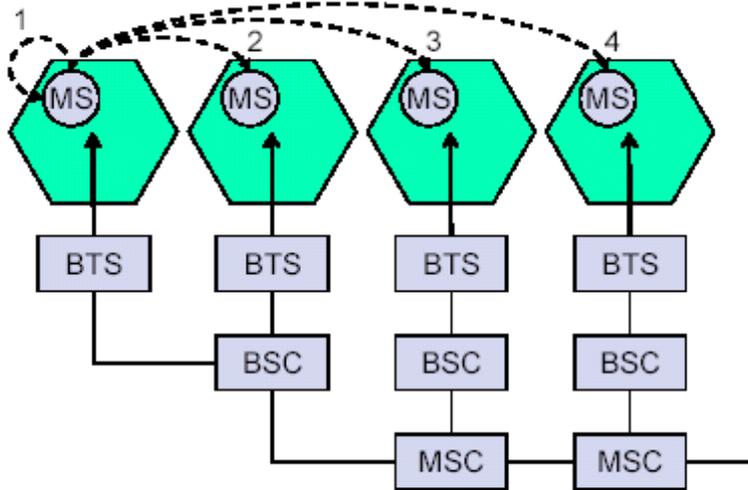


# Incoming Call



1. Calling a GSM subscribers
2. Forwarding call to GSMC
3. Signal Setup to HLR
4. 5. Request MSRN from VLR
6. Forward responsible MSC to GMSC
7. Forward Call to current MSC
8. 9. Get current status of MS
- 10.11. Paging of MS
- 12.13. MS answers
- 14.15. Security checks
- 16.17. Set up connection

# Handovers

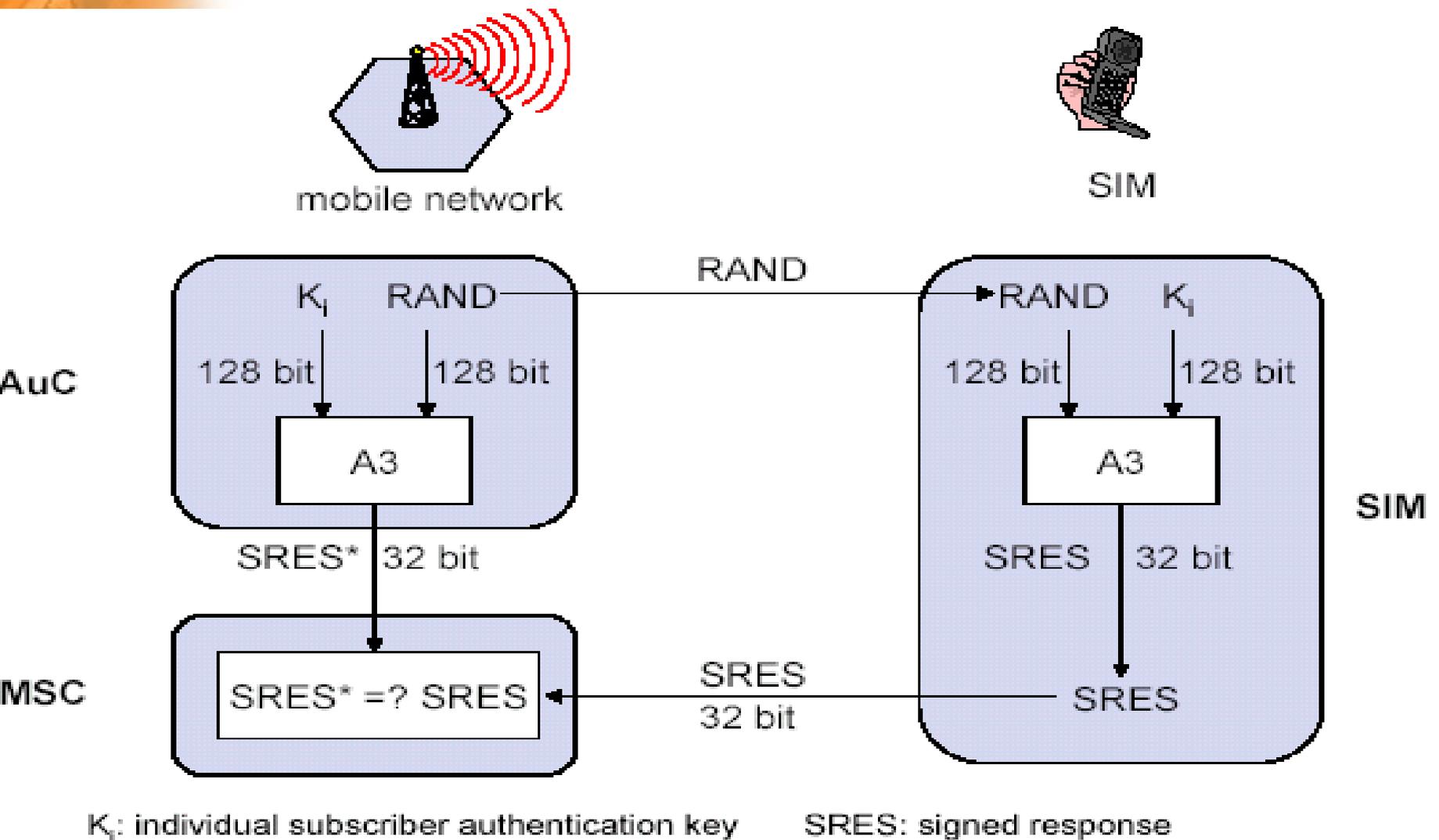


- Between 1 and 2 – Inter BTS / Intra BSC
- Between 1 and 3 – Inter BSC/ Intra MSC
- Between 1 and 4 – Inter MSC

# Security in GSM

- On air interface, GSM uses encryption and TMSI instead of IMSI.
- SIM is provided 4-8 digit PIN to validate the ownership of SIM
- 3 algorithms are specified :
  - A3 algorithm for authentication
  - A5 algorithm for encryption
  - A8 algorithm for key generation

# Authentication in GSM



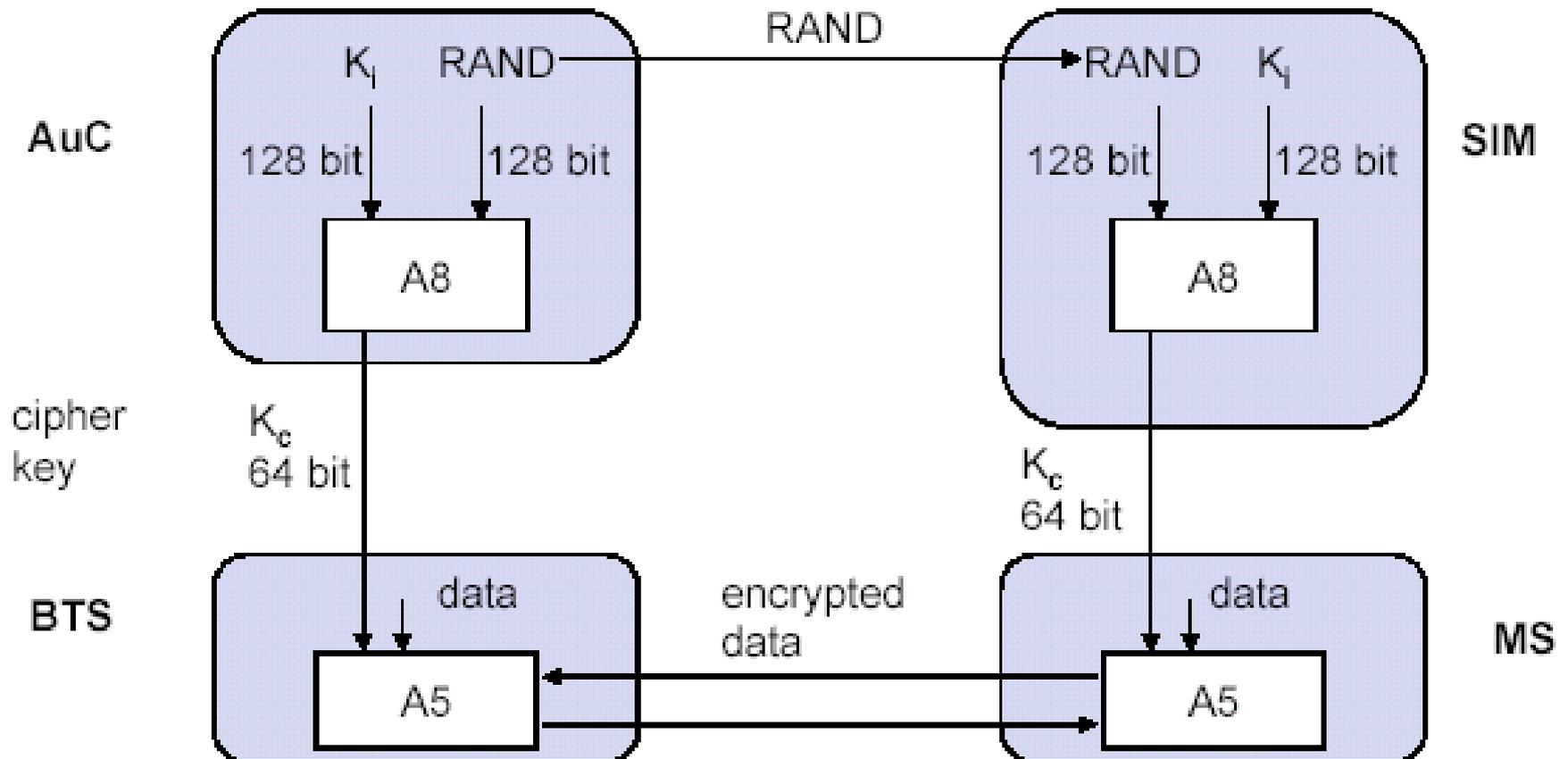
# Key generation and Encryption



mobile network (BTS)



MS with SIM



# Characteristics of GSM Standart

- Fully digital system using 900,1800 MHz frequency band.
- TDMA over radio carriers(200 KHz carrier spacing.
- 8 full rate or 16 half rate TDMA channels per carrier.
- User/terminal authentication for fraud control.
- Encryption of speech and data transmission over the radio path.
- Full international roaming capability.
- Low speed data services (upto 9.6 Kb/s).
- Compatibility with ISDN.
- Support of Short Message Service (SMS).

# Advantages of GSM over Analog system

- Capacity increases
- Reduced RF transmission power and longer battery life.
- International roaming capability.
- Better security against fraud (through terminal validation and user authentication).
- Encryption capability for information security and privacy.
- Compatibility with ISDN, leading to wider range of services

# **GSM Applications**

- Mobile telephony
- GSM-R
- Telemetry System
  - Fleet management
  - Automatic meter reading
  - Toll Collection
  - Remote control and fault reporting of DG sets
- Value Added Services

# Future Of GSM

## ❖ 2nd Generation

- ❑ GSM -9.6 Kbps (data rate)

## ❖ 2.5 Generation ( Future of GSM)

- ❑ HSCSD (High Speed ckt Switched data)

- Data rate : 76.8 Kbps (9.6 x 8 kbps)

- ❑ GPRS (General Packet Radio service)

- Data rate: 14.4 - 115.2 Kbps

- ❑ EDGE (Enhanced data rate for GSM Evolution)

- Data rate: 547.2 Kbps (max)

## ❖ 3 Generation

- ❑ WCDMA (Wide band CDMA)

- Data rate : 0.348 – 2.0 Mbps

## ❖ 4 Generation

- Data rate :



**Thanks !**