FOUNDATIONS OF THE GLOBAL SYSTEM FOR MOBILE COMMUNICATION (GSM)

ECE 416 – DIGITAL COMMUNICATION SYSTEMS

Friday, March 19, 2021

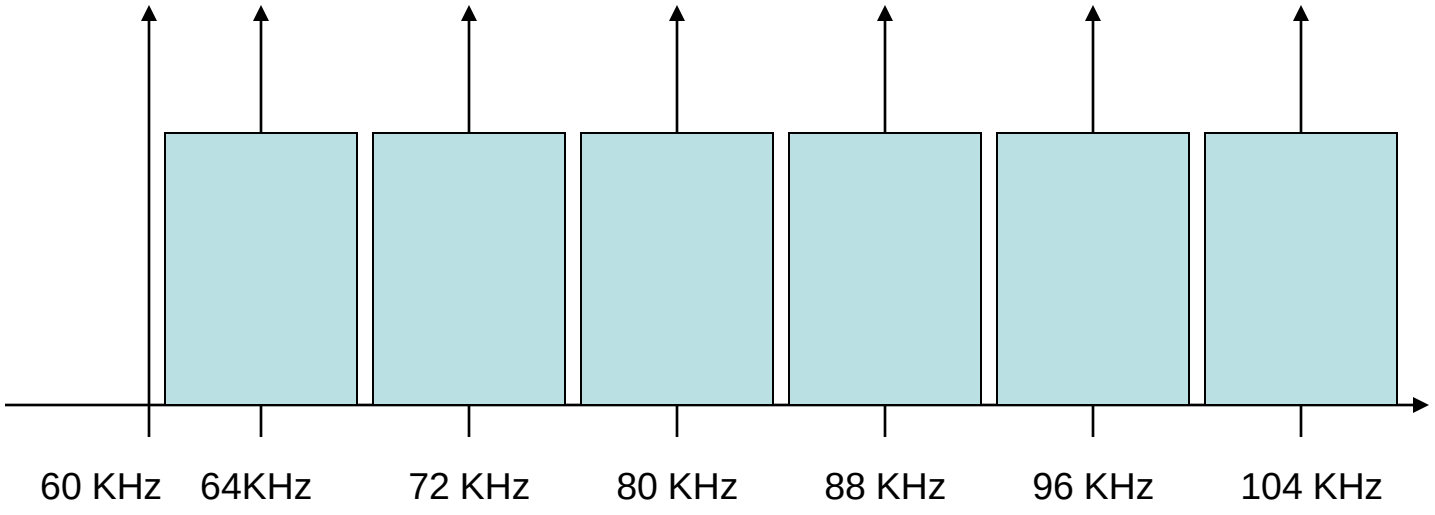
FDM DESIGN EXAMPLE

1. Design a frequency plan for analog multiplexing telephone channels each with a bandwidth of 4KHz over a frequency band between 60KHz and 108 KHz using:
   a) Double-sideband amplitude modulation.
   b) Single Sideband Amplitude Modulation

SOLUTION (1)

a) Bandwidth of DSB AM signal is 2x4KHz = 8KHz.

- Number of channels is therefore (108-60)/8 = 6 channels and frequency plan is as shown below.



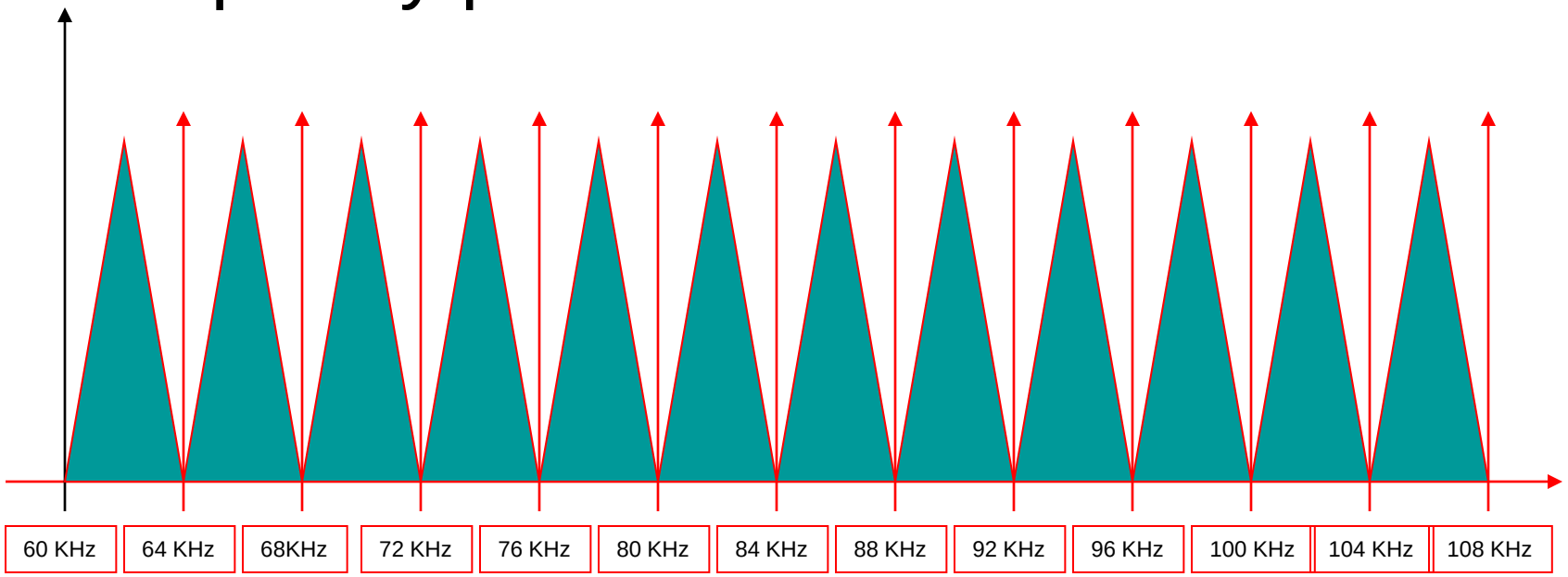
SOLUTION (2)

Bandwidth of SSB AM signal is 4KHz

Number of channels is therefore:

$$N = \frac{108 - 60}{4} = 12\ channels$$

The frequency plan is as shown below.



WHAT IS GSM?

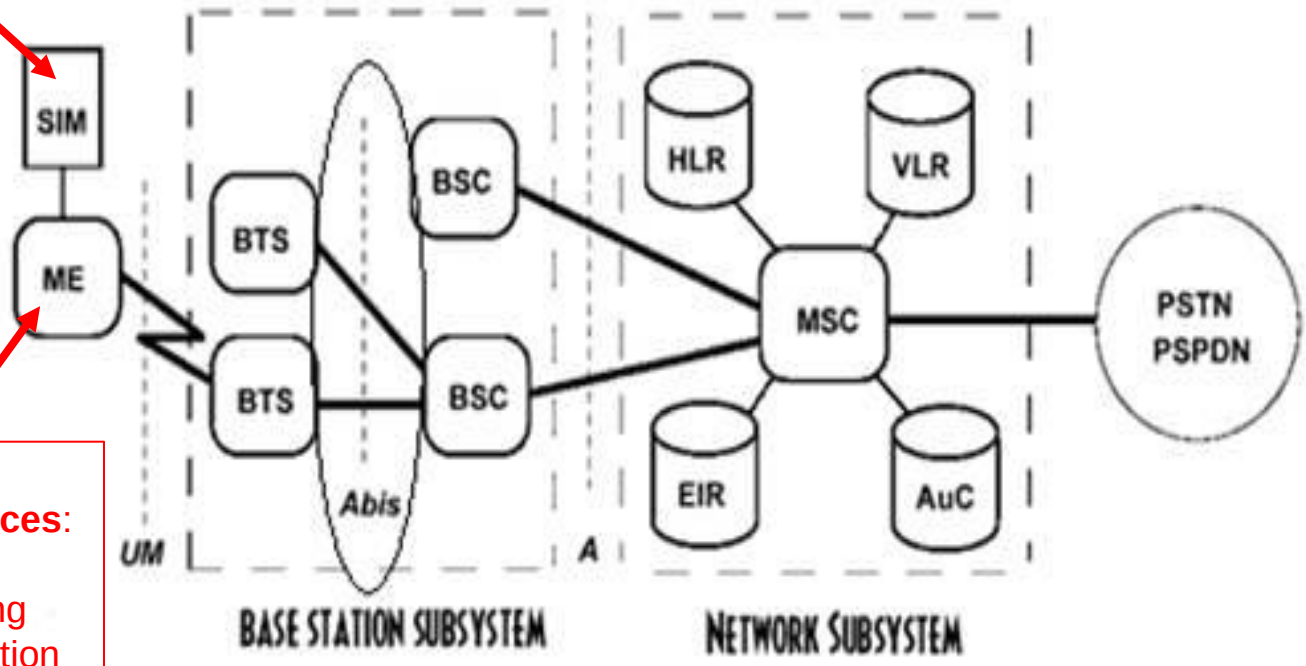
- **GSM (Global System for Mobile Communications, originally Groupe Spécial Mobile),** is a second generation digital communication standard.
- It was developed by the European Telecommunications Standards Institute (ETSI).

- GSM was first deployed in Finland in July 1991.

GSM ARCHITECTURE (1)

SIM

- User identity,
- Phone number,
- Network authorization data,
- Personal security keys,
- Contact lists
- Stored text messages



MOBILE EQUIPMENT

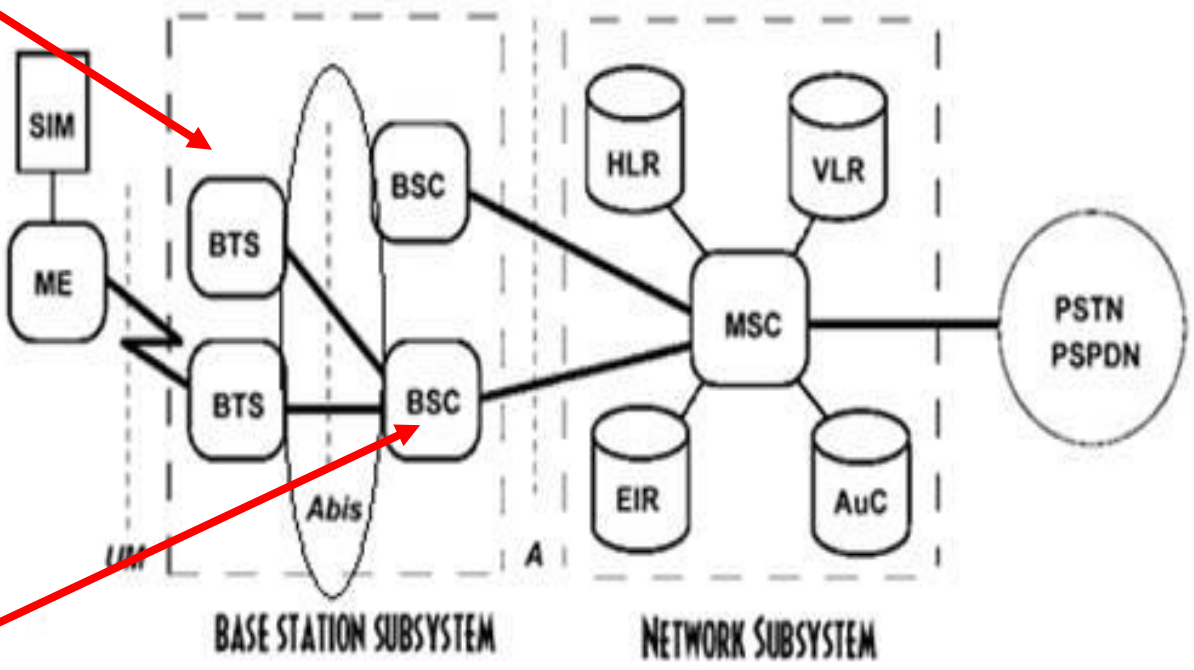
1. **Mobile termination services**: radio Transmission and handover, speech encoding and decoding, Error detection and correction, signalling and access to the SIM, and IMEI code.
2. **Terminal equipment,** i.e devices connected to the MS offering non-GSM services to the user.

GSM ARCHITECTURE (2)

BASE TRANSCEIVER STATION

Function: Transmitting and receiving radio signals (transceivers), antennas, and equipment for encrypting and decrypting communications with the base station controller (BSC).

Contents: Has several transceivers (TRXs) serving different frequencies (ARFCNs) and different sectors of the cell



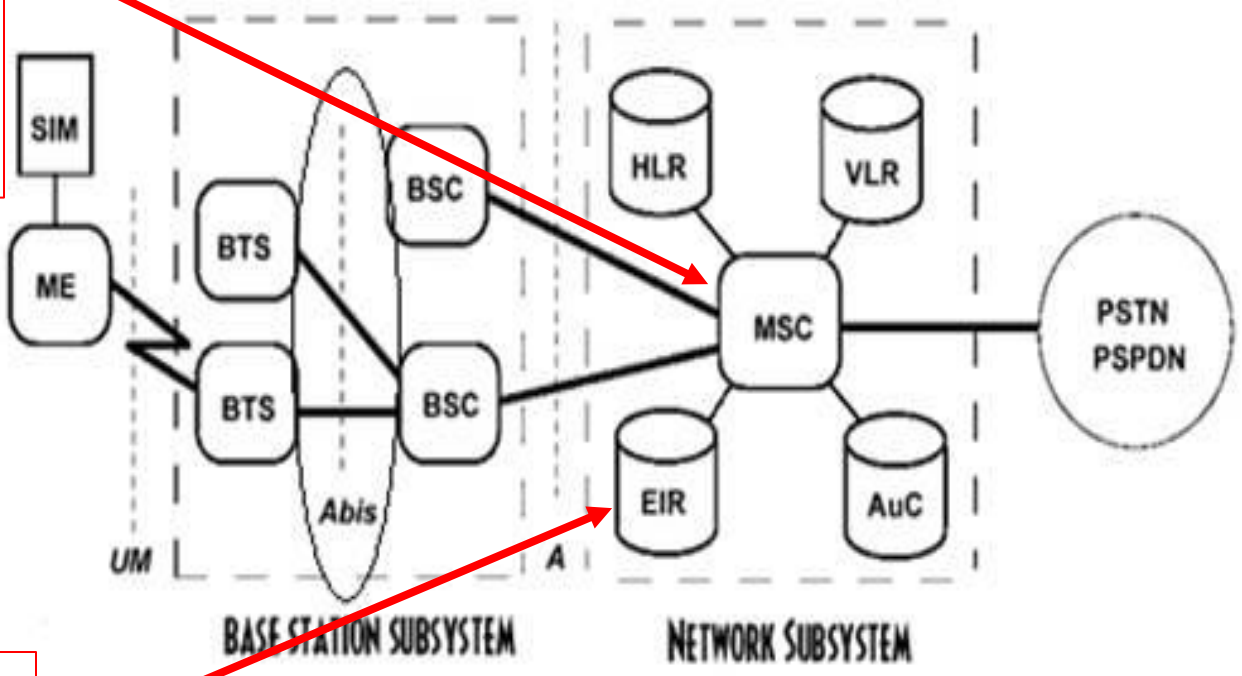
BASE STATION CONTROLLER

1. Allocation of radio channels,
2. Radio channel measurements
   Handovers from BTS to BTS

GSM ARCHITECTURE (3)

MOBILE SWITCHING CENTRE

- call set-up,
- Release
- Routing
- conference calls
- Links to other networks



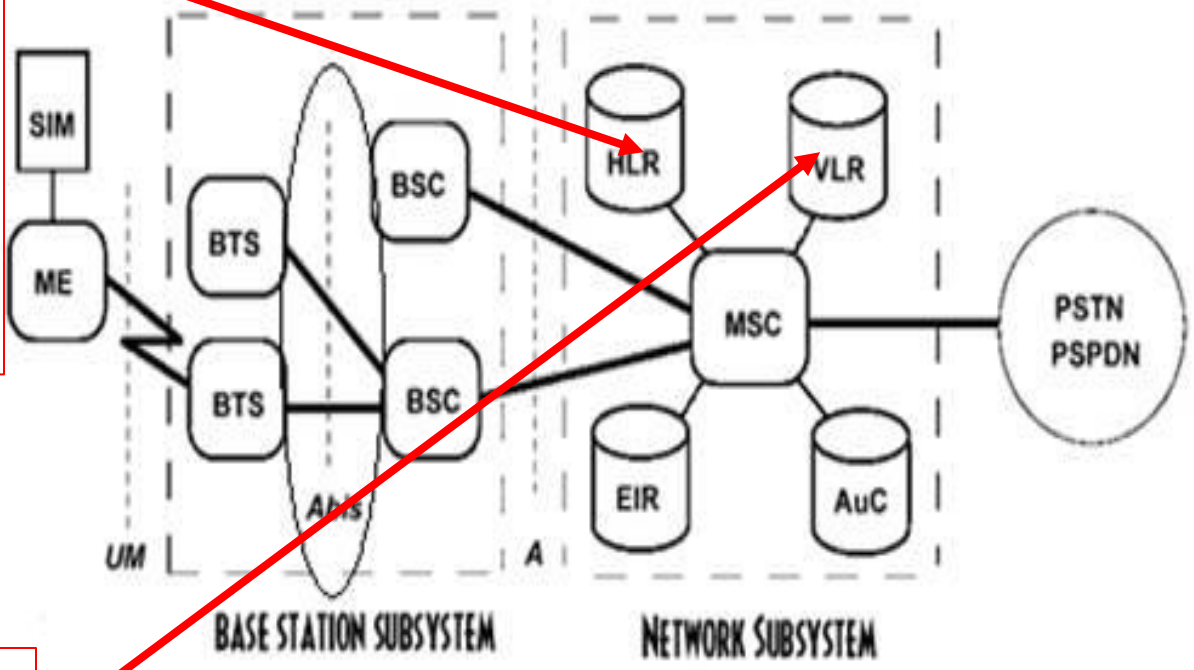
EQUIPMENT IDENTITY REGISTER

- All the mobile stations (MS)that are allowed in a network
- All equipment that is banned, e.g. because it is lost or stolen or malfunctioning

GSM ARCHITECTURE (4)

HOME LOCATION REGISTER

1. International mobile subscriber identity (IMSI)
2. GSM services that a subscriber is allowed to access
3. GPRS settings to allow the subscriber to access packet services.
4. Current location of subscriber
5. Call divert settings

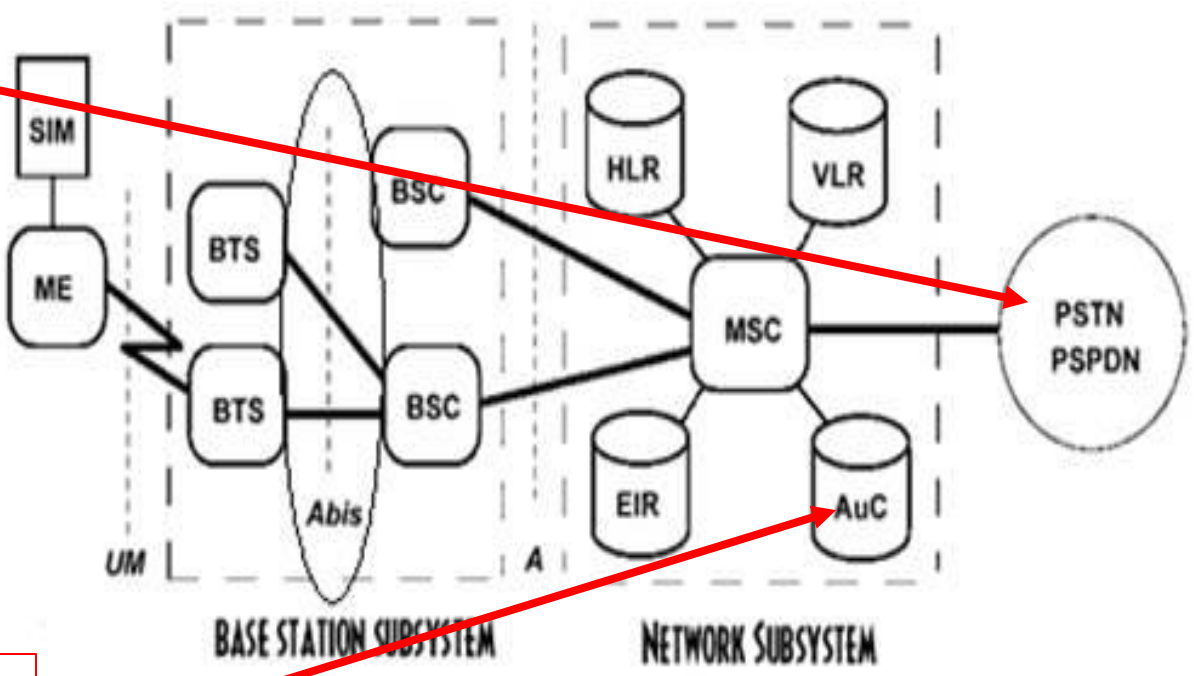


VISITOR LOCATION REGISTER

1. Subscriber's phone number
2. IMSI (the subscriber's identity number)
3. Authentication data
4. GSM services that the subscriber is allowed to access
5. access point (GPRS) subscribed
6. HLR address of the subscriber

GSM ARCHITECTURE (5)

PUBLIC SWITCHED TELEPHONE NETWORK (PSTN)
The MSC routes traffic to other public switched networks, e.g. Safricom to Airtel



AUTHENTICATION CENTRE

1. Allows or blocks each SIM card that attempts to connect to the GSM core network.

2. Stores/generates authentication keys ki and kc

GSM SERVICES

GSM provides a wide range of services including:

1. Voice telephony
2. Asynchronous and synchronous data services (2.4/4.8/9.6/14.4 kbit/s)
3. Access to packet data network - X.25 and General Packet Radio Service (GPRS)
4. Telematic services (SMS, fax, videotext, etc.)
5. Many value-added features (mobile money transfer, call forwarding, caller ID, voice mailbox)

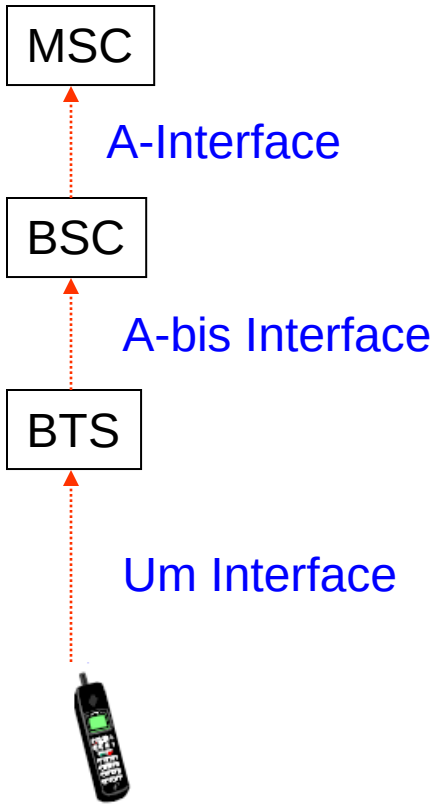
ADVANTAGES OF GSM SYSTEMS

The benefits of GSM include:

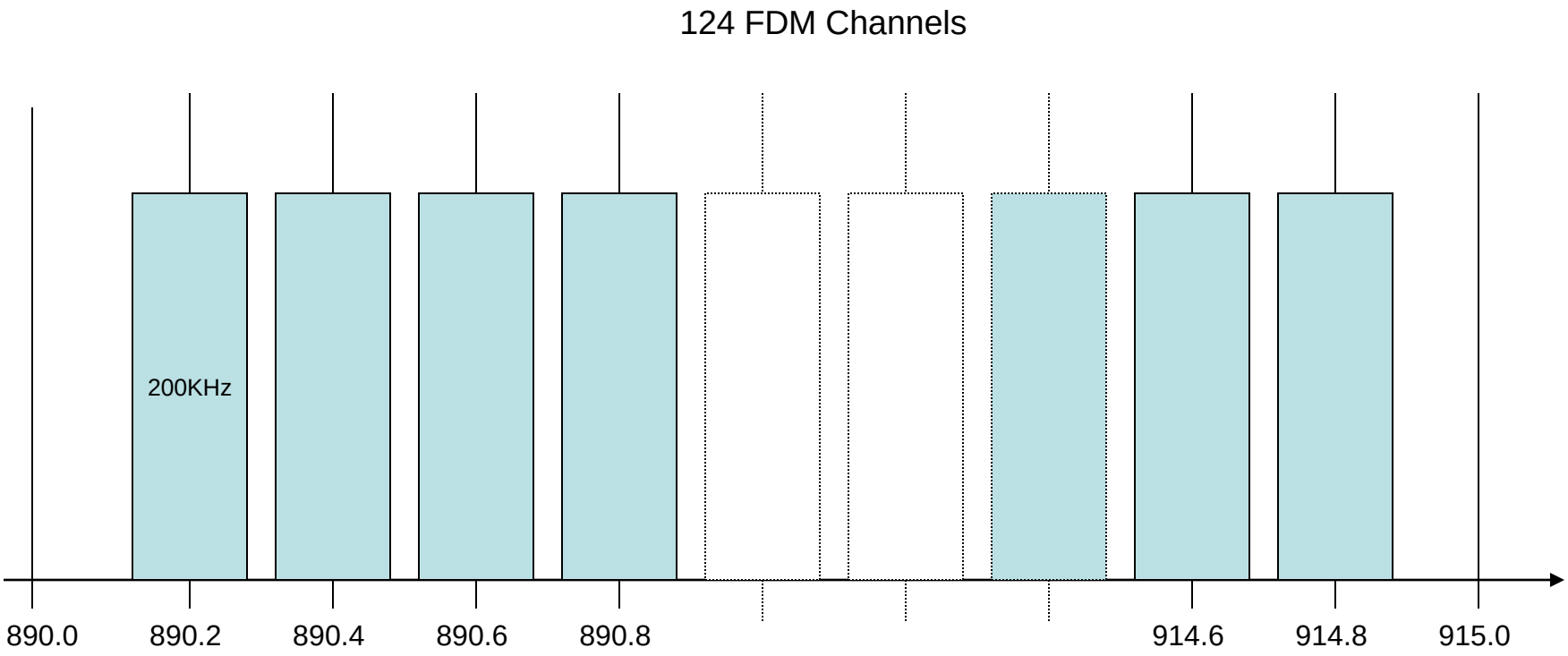
1. Support for international roaming
2. Distinction between user and device identification
3. Excellent speech quality
4. Wide range of services
5. Interworking with other systems e.g. with ISDN
6. Extensive security features

SUMMARY OF GSM INTERFACES

1. **Um interface:** The "air" or radio interface standard that is used for exchanges between a mobile (ME) and a base station (BTS / BSC).
2. **Abis interface:** This is a BSS internal interface linking the BSC and a BTS. The Abis interface allows control of the radio equipment and radio frequency allocation in the BTS.
3. **A interface:** The A interface is used to provide communication between the BSS and the MSC. The interface carries information to enable the channels, timeslots and the like to be allocated to the mobile equipments being serviced by the BSSs.



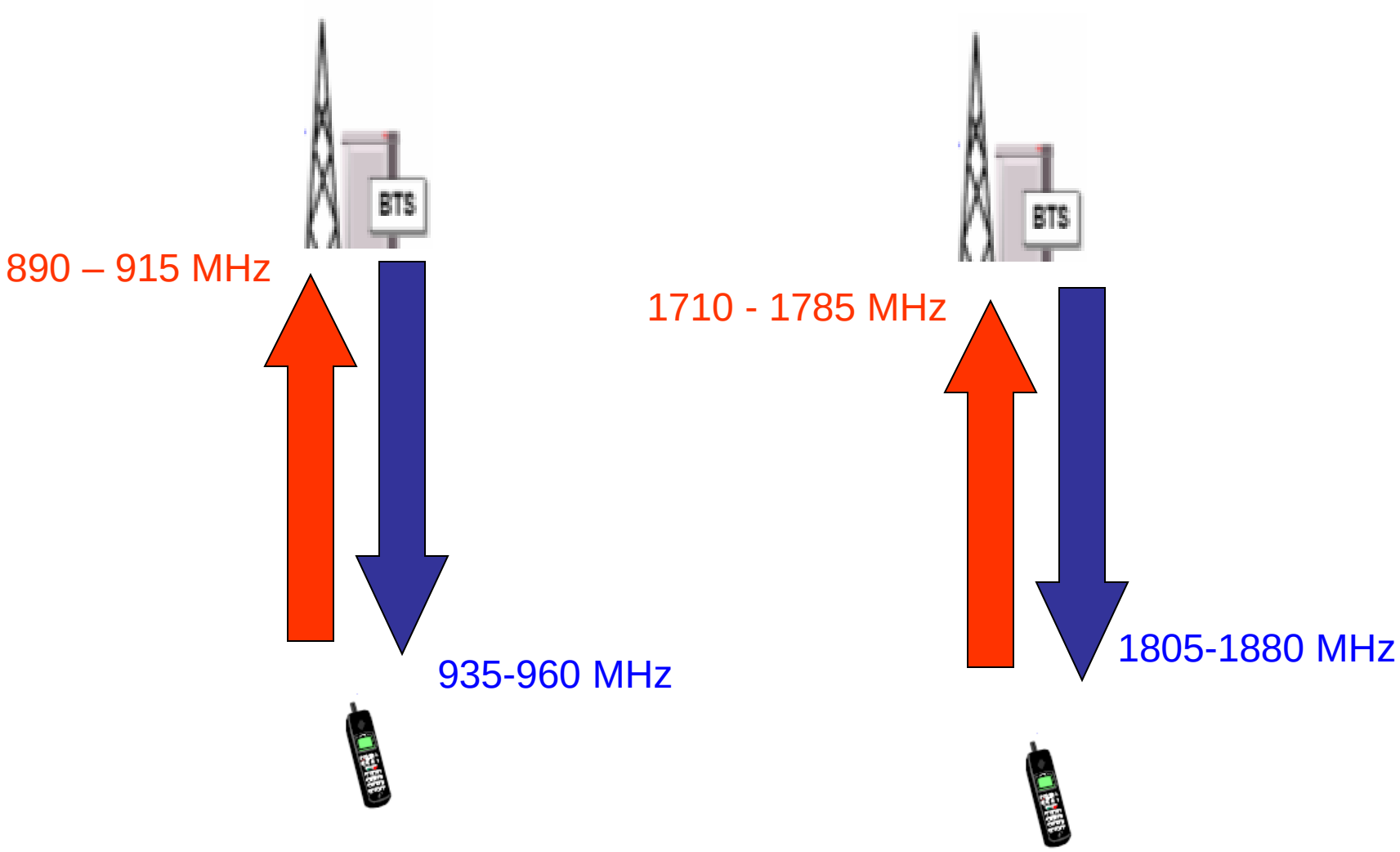
FREQUENCY PLAN FOR GSM 900MHZ UPLINK



USE OF FREQUENCY DIVISION MULTIPLEXING AT THE UM INTERFACE

1. Each BTS is allocated different radio frequency channels
2. Mobiles in the same cell (or adjacent cells) can operate at the same time but on different frequencies.
3. There are 124 FDM channels in the 900MHz band
4. There are 374 FDM channels in the 1800MHz band

GSM UM INTERFACE FREQUENCY BANDS



BASIC 900 MHZ FREQUENCY PLAN

CHANNEL	UPLINK (MHZ)	DOWNLINK (MHZ)
1	890.2±0.1	935.2±0.1
2	890.4±0.1	935.4±0.1
3	890.6±0.1	935.6±0.1
4	890.8±0.1	935.8±0.1
124	914.8±0.1	959.8±0.1

Duplex Frequency = 45MHz

1800 MHZ FREQUENCY PLAN

CHANNEL	UPLINK (MHZ)	DOWNLINK (MHZ)
1	1,710.2±0.1	1,805.2±0.1
2	1,710.4±0.1	1,805.4±0.1
3	1,710.6±0.1	1,805.6±0.1
4	1,710.8±0.1	1,805.8±0.1
374	1,784.8±0.1	1879.8±0.1

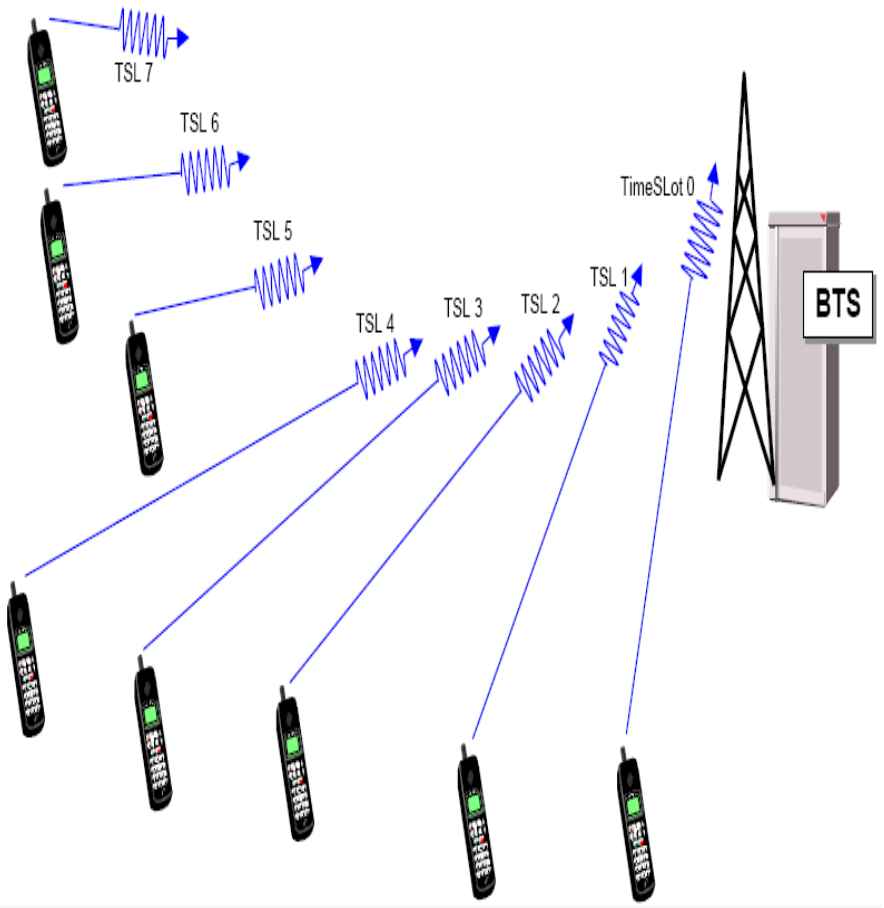
Duplex Frequency = 95MHz

USE OF TIME DIVISION MULTIPLEXING IN UM INTERFACES

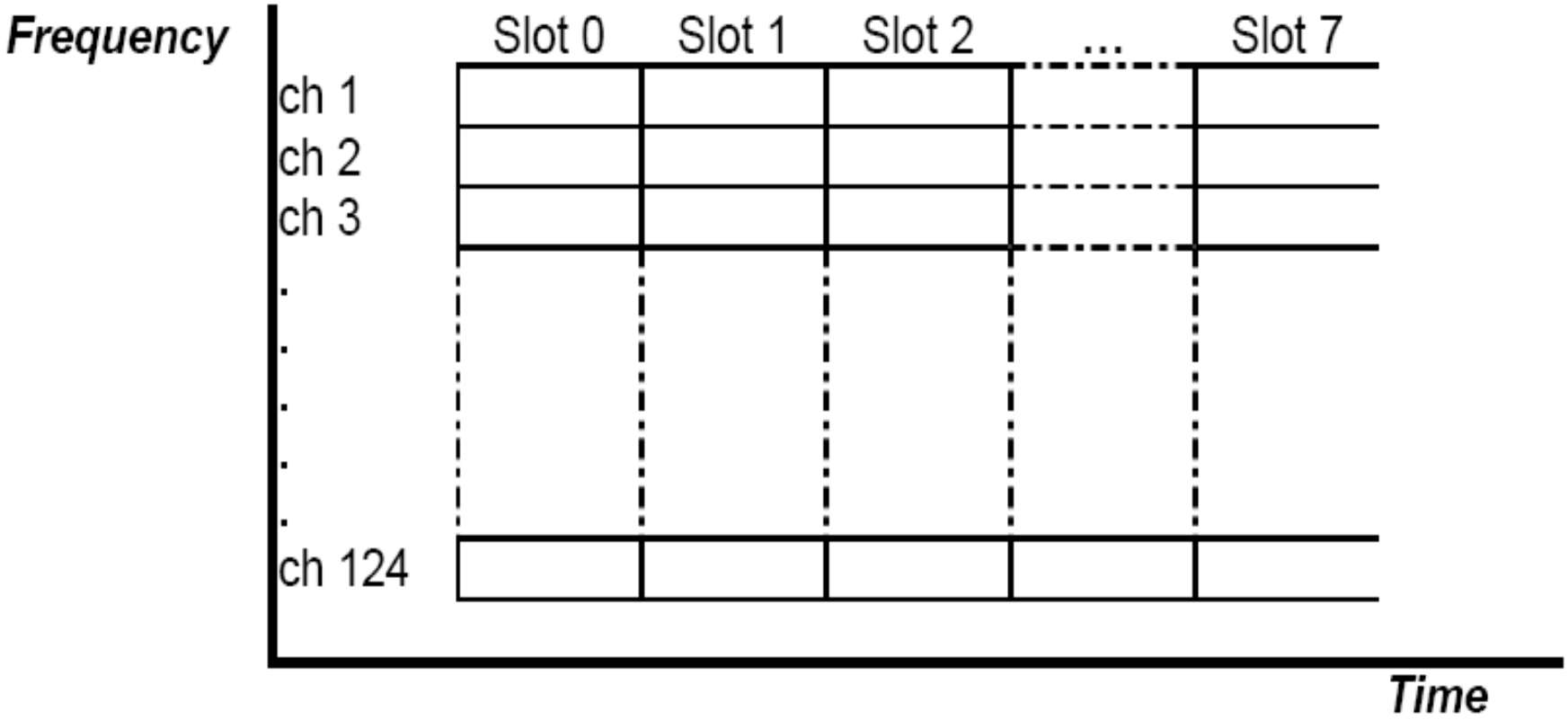
1. A specific time slot is allocated to each user.

2. Each user receives or transmits bursts of information in an allocated time slot.

3. Time slots are allocated for:
   a) speech,
   b) Signaling
   c) location updates

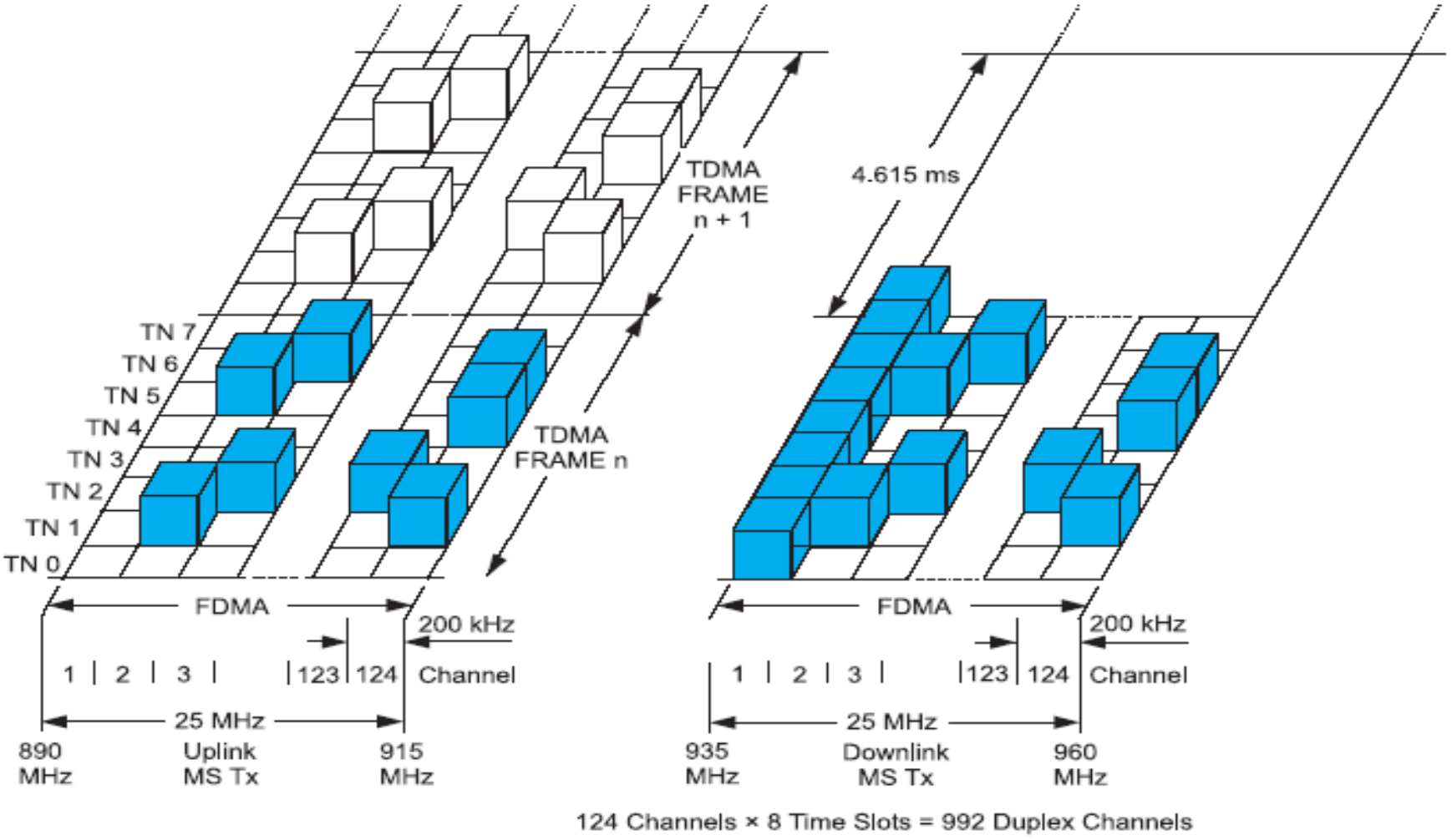


COMPLETE GSM UM INTERFACE MULTIPLEX



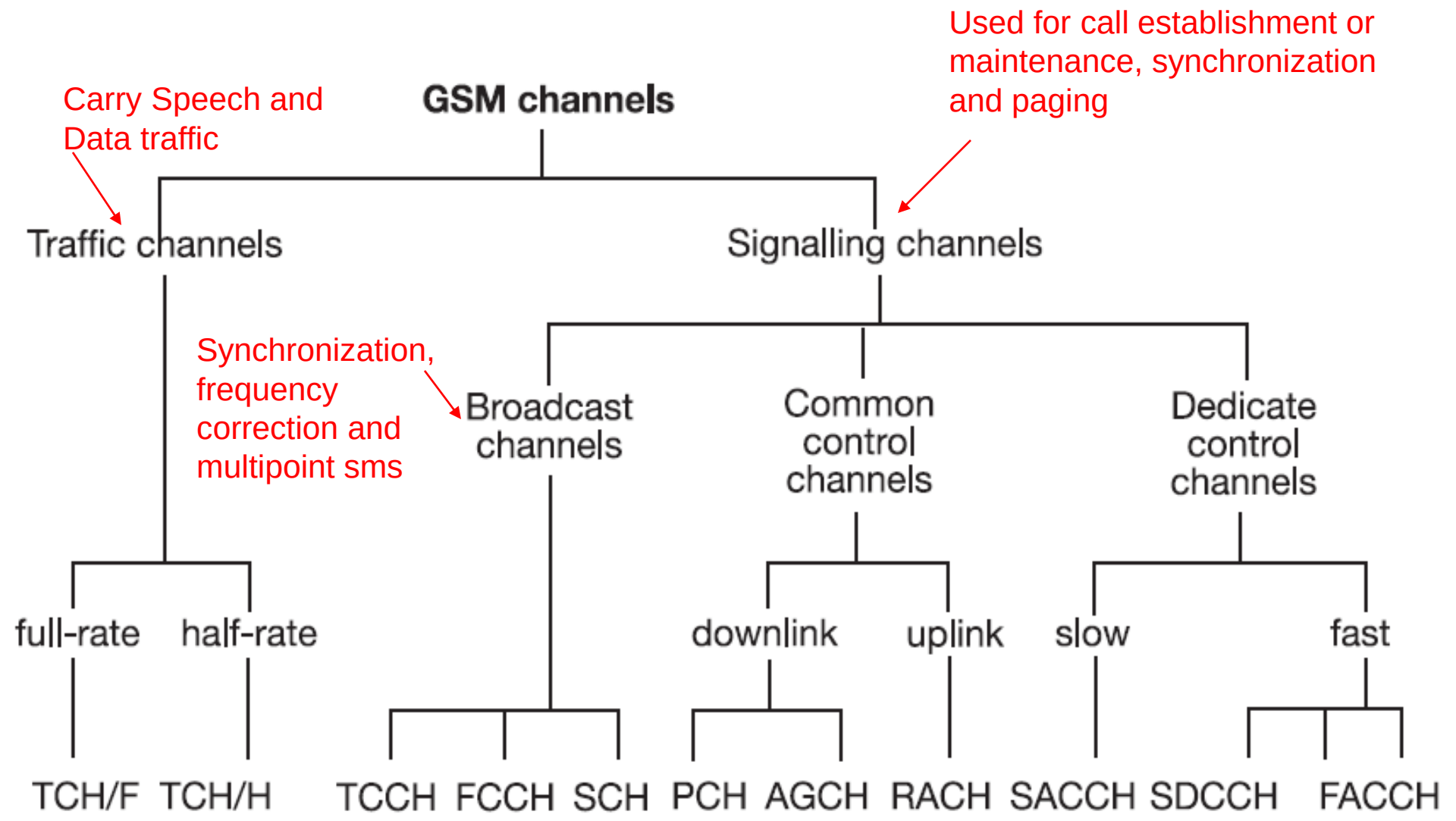
1 Frame = 8 timeslots
Frame duration = 4.615 ms
timeslot duration = 0.577 ms

900MHZ MULTIPLEX - PICTORIAL



124 Channels × 8 Time Slots = 992 Duplex Channels

GSM CHANNEL STRUCTURE



FROM SPEECH TO RADIO WAVES