

GSM Channels



Physical & Logical Channels



**Traffic and Control
Multiframeing**



Frame Structure

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Radio Interface

- The radio interface is the general name of the connection between the mobile (MS) and the base transceiver station (BTS).
- It utilizes the TDMA concept with one TDMA-frame per carrier frequency.
- Each frame consists of eight time slots (TS).
- The direction from BTS to MS is defined as the downlink and the opposite direction as the uplink.

Physical channels

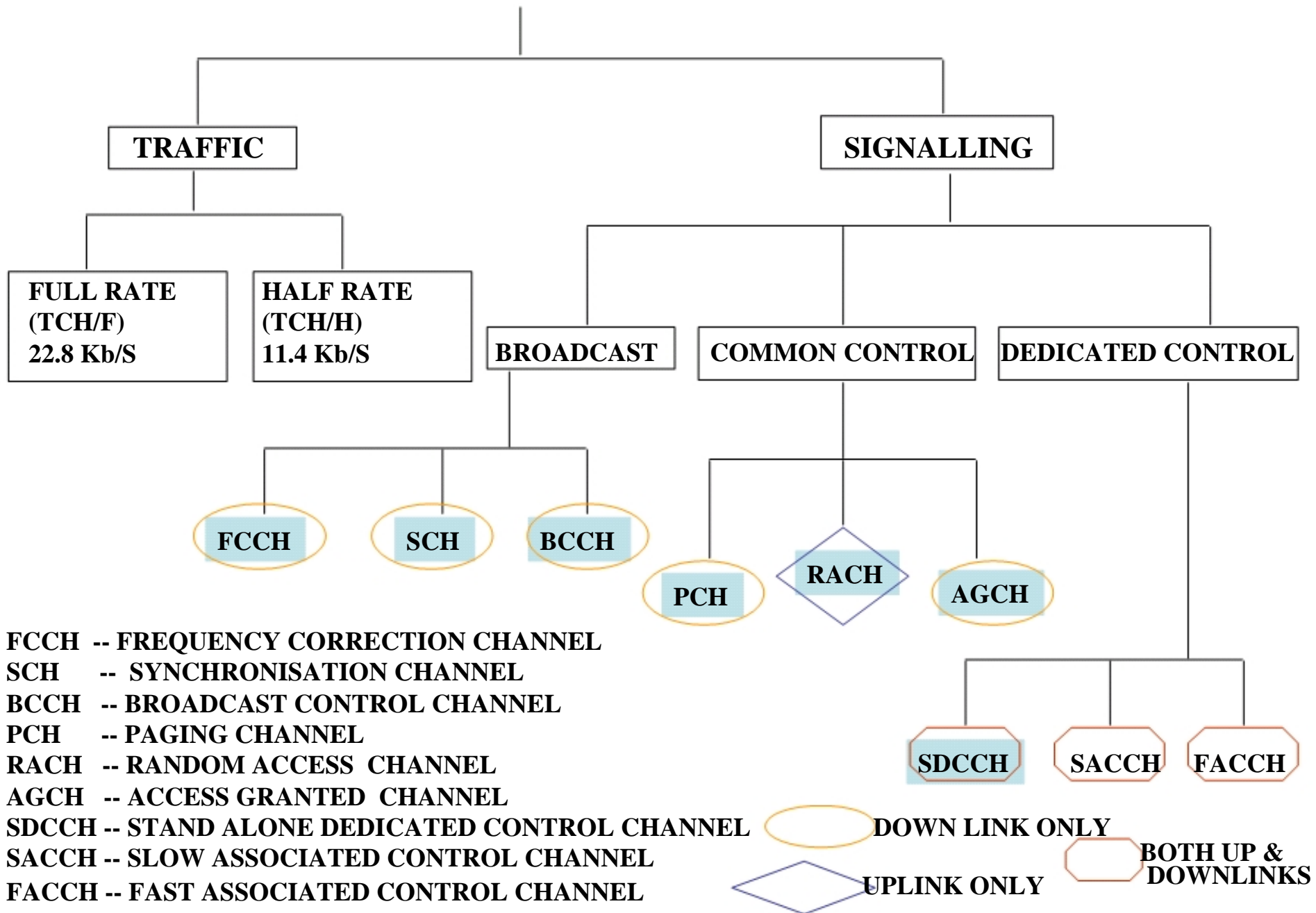
- When an MS and a BTS communicate, they do so on a specific pair of radio frequency (RF) carriers, one for the up-link and the other for the down-link transmissions, and within a given time slot. This combination of time slot and carrier frequency forms what is termed a *physical channel*.
- One RF channel will support eight physical channels in time slots zero through seven.

Logical Channels

- The data, whether user traffic or signaling information, are mapped onto the physical channels by defining a number of *logical channels* .
- A logical channel will carry information of a specific type and a number of these channels may be combined before being mapped onto the same physical channel.
- For example speech is sent on the logical channel “Traffic channel” which during the transmission is allocated a certain physical channel, say TS 6 on carrier 0. The logical channels are divided into two groups; control channels and traffic channels.

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LOGICAL CHANNELS



Channel Types

Traffic channels (TCHs)

The traffic channels are intended to carry encoded speech or user data.

Control Channels (CCHs)

The control channels are intended to carry signaling and Synchronization data between the base station and the Mobile station.

Logical are used by the system and the MS for different purposes

Traffic Channels

- Traffic channels are intended to carry encoded speech and user data.
 - Full rate traffic channels at a net bit rate of 22.8 Kb/s (TCH/F)
 - Half rate traffic channels at a net bit rate of 11.4 Kb/s (TCH/H)

Speech Channels

Speech channels are defined for both full rate and half rate traffic channels.

Data Channels

Data channels support a variety of data rates (2.4, 4.8 and 9.6 Kb/s) on both half and full rate traffic channels. The 9.6 Kb/s data rate is only for full rate application

Control Channels

- Control channels carry signaling information between an MS and a BTS. There are several forms of control channels in GSM, and they can generally be divided into three categories according to the manner in which they are supported on the radio interface and the type of signaling information they carry.

1. Broadcast control channel
2. Common control channel
3. Dedicated control channel

Broadcast control channels

- Broadcast control channels are transmitted in downlink direction only i.e. only transmitted by BTS.
- The *broadcast channels* are used to broadcast synchronization and general network information to all the MSs within a cell.
Such as Location Area Identity (LAI) and maximum output power.

It has three types

1. FCCH FREQUENCY CORRECTION CHANNEL
2. SCH SYNCHRONISATION CHANNEL
- 3 BCCH BROADCAST CONTROL CHANNEL

FCCH

- Frequency Correction Channel (FCCH)
 - Used for the frequency correction / synchronization of a mobile station.
 - The repeated (every 10 sec) transmission of Freq Bursts is called FCCH.

This serves two purposes; one is to make sure this is the BCCH-carrier, the other is to allow the MS to synchronize to the frequency. FCCH is transmitted on the downlink, point-to-multipoint.

- Frequency Correction Burst

SCH

- Synchronization Channel (SCH)
- Allows the mobile station to synchronize time wise with the BTS.
- Repeated broadcast (every 10 frames) of Synchronization Bursts is called (SCH)
- The MS receives the TDMA frame number and also the Base Station Identity Code, BSIC, of the chosen base station. BSIC can only be decoded if the base station belongs to the GSM network. SCH is transmitted on the downlink, point to multipoint.
- Synchronization Burst

BCCH

- The *broadcast control channel*(BCCH) is used to broadcast control information to every MS within a cell.
- This information includes details of the control channel configuration used at the BTS, a list of the BCCH carrier frequencies used at the neighboring BTSs and a number of parameters that are used by the MS when accessing the BTS.
 - Use normal burst.

Broadcast Control channel, BCCH include the Location Area Identity (LAI), maximum output power allowed in the cell and the BCCH-carriers for the neighboring cells, on which the MS will perform measurements. BCCH is transmitted On the downlink, point-to-multipoint.

BCCH (Contd)

Now the MS is tuned to a base station and synchronized with the frame structure in this cell. The base stations are not synchronized to each other, so every time the MS decides to camp on another cell, its FCCH, SCH and BCCH have to be read.

Common Control Channels

- The *common* control channels are used by an MS during the paging and access procedures. Common control channels are of three types.

1. PCH PAGING CHANNEL

2. RACH RANDOM ACCESS CHANNEL

3. AGCH ACCESS GRANTED CHANNEL

PCH

- Within certain time intervals the MS will listen to the Paging channel, PCH, to see if the network wants to get in contact with the MS. The reason could be an incoming call or an incoming Short Message. The information on PCH is a paging message, including the MS's identity number (IMSI) or a temporary number (TMSI). PCH is transmitted on the downlink, point-to-point.
- Use normal burst.

RACH

- If listening to the PCH, the MS will realize it is being paged. The MS answers, requesting a signalling channel, on the Random Access channel, RACH. RACH can also be used if the MS wants to get in contact with the network, e.g. when setting up a mobile originated call. RACH is transmitted on the uplink, point-to-point.

It is termed 'random' because there is no mechanism to ensure that no more than one MS transmits in each RACH time slot and there is a finite probability that two mobiles could attempt to access the same RACH at the same time.

- Use Access Burst.

AGCH

- The *access grant channel* (AGCH) is carried data which instructs the mobile to operate in a particular physical channel (Time slot or ARFCN). The AGCH is used by the network to grant, or deny, an MS access to the network by supplying it with details of a dedicated channel, i.e. TCH or SDCCH, to be used for subsequent communications. The AGCH is a down-link only channel.
- Use normal burst.

Dedicated Control Channels

- Signaling information is carried between an MS and a BTS using associated and dedicated control channels during or not during a call, They are of three types.
 1. SACCH SLOW ASSOCIATED CONTROL CHANNEL
 2. FACCH FAST ASSOCIATED CONTROL CHANNEL
 3. SDCCH STAND ALONE DEDICATED CONTROL CHANNEL

SACCH

- Non-urgent information, e.g. transmitter power control, is transmitted using the *slow associated control channel* (SACCH).

On the uplink MS sends averaged measurements on own base station (signal strength and quality) and neighboring base stations (signal strength). On the downlink the MS receives system information, which transmitting power and what timing advance to use. It is transmitted at 13th Frame of TCH. As seen, SACCH is transmitted on both up- and downlink, point-to-point.

- This channel is always present when a dedicated link is active between the MS and BTS, and it occupies one timeslot in every 26. • SACCH messages may be sent once every 480ms, i.e. approximately every 2 s.
- Use normal burst.

FACCH

- More urgent information, e.g. a handover command, is sent using time slots that are 'stolen' from the traffic channel.

If, suddenly, during the conversation a handover must be performed the Fast Associated Control channel, FACCH, is used. FACCH works in stealing mode, meaning that one 20 ms segment of speech is exchanged for signalling information necessary for the handover. The subscriber will not recognize this interruption in speech since the speech coder will repeat the previous speech block. This channel is known as the fast associated control channel (FACCH) because of its ability to transfer information between the BTS and MS more quickly than the SACCH.

- a complete FACCH message may be sent once in every 20 ms.
- Use normal burst.

SDCCH

- In some situations, signaling information must flow between a network and an MS when a call is not in progress, e.g. during a location update.

This could be accommodated by allocating either a full-rate or half-rate TCH and by using either the SACCH or FACCH to carry the information.

This would, however, be a waste of the limited radio resources. So a low data rate channel about 1/8 of TCH/F is defined. Also used in call setup process.

- The channel is termed 'stand-alone' because it may exist independently of any TCH.
 - SDCCH is transmitted on both up- and downlink, point-to-point.
 - The MS is on the SDCCH informed about which physical channel (frequency and time slot) to use for traffic (TCH).
- Use normal burst.

Channel Mapping

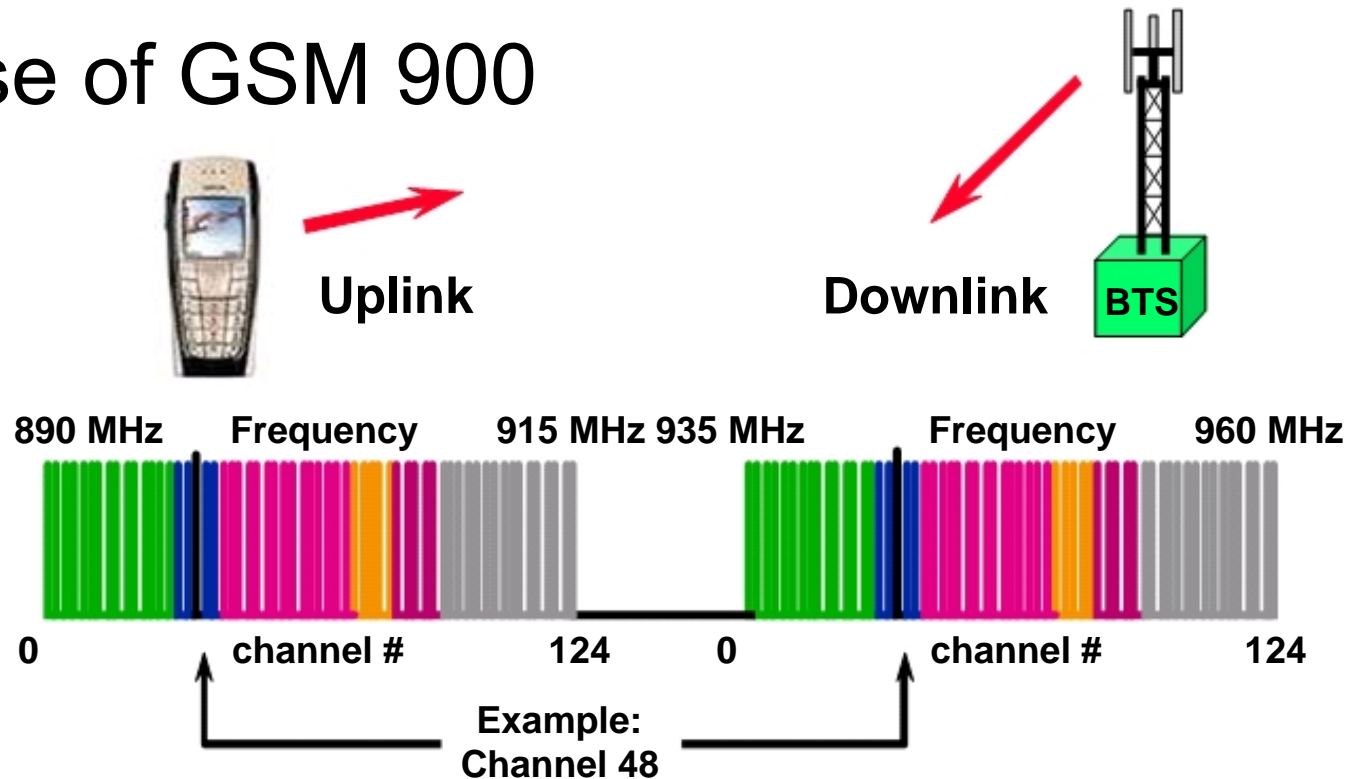
1. When the MS is turned on it will listen to the FCCH in order to syn to the carrier frequency
2. Then the MS listen to the SCH to get info on the TDMA frame structure
3. The MS will then listen to the BCCH to get info such as location area, Max allowed O/P power & neighboring cells
4. The MS will periodically listen to the PCH to determine if someone is trying to call it.
5. If the MS hears a page it will use the RACH to ask for access to the system in order to respond to the incoming call

Channel Mapping

6. The sys will give access using the AGCH
7. The sys uses the AGCH to tell the MS which SDCCH to use for complete the Call Setup .
8. When the MS gets the SDCCH, it also gets a SACCH. Which the system uses to regulates the O/P power of the MS & gives it timing advance info .
9. The MS is given a TCH to use by the SDCCH. The MS tunes to it during the call.
10. During a call if a handover is required to a neighboring cell, the FACCH will be used to exchange the necessary info.

GSM Uses Paired Radio Channels

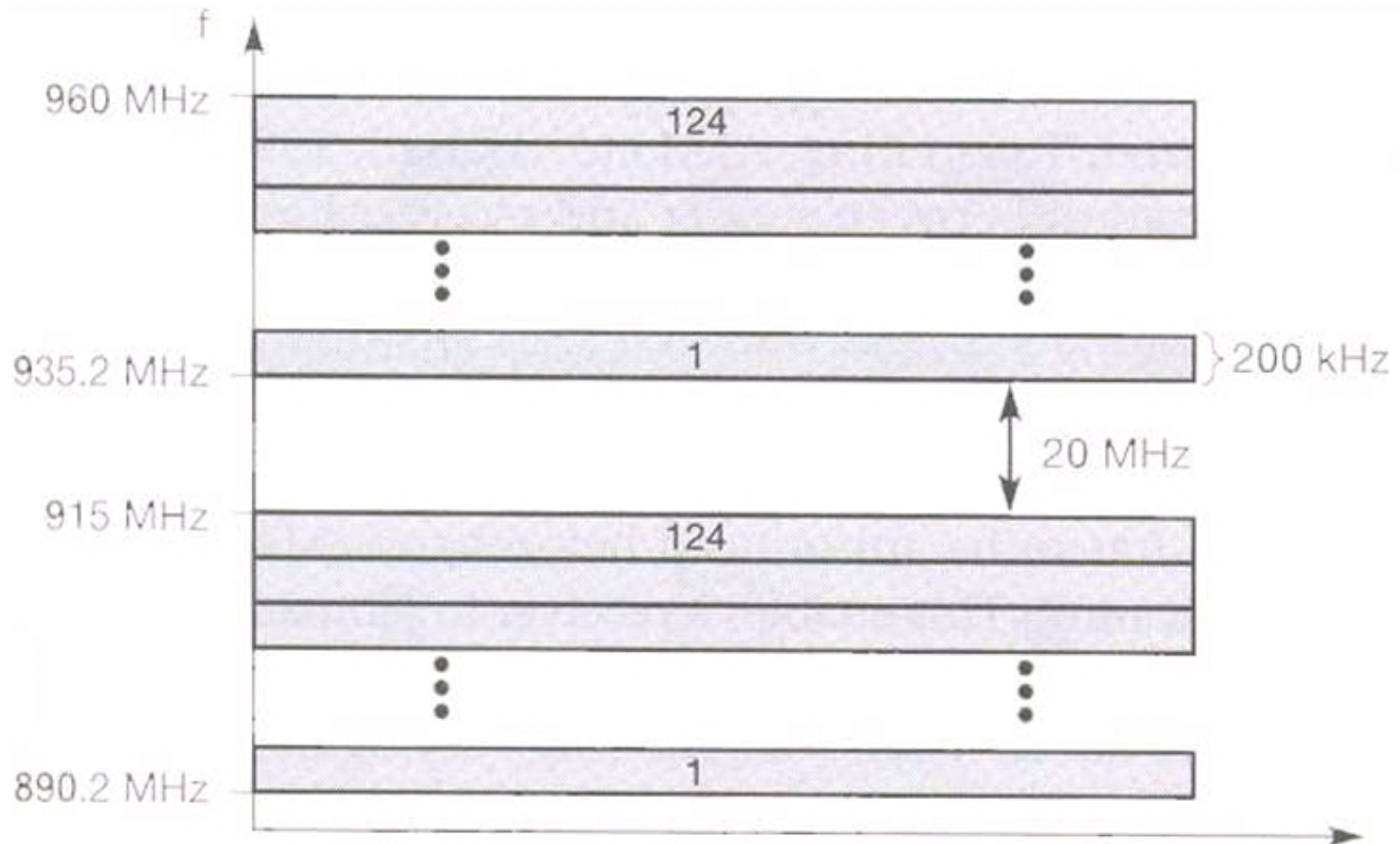
- Case of GSM 900



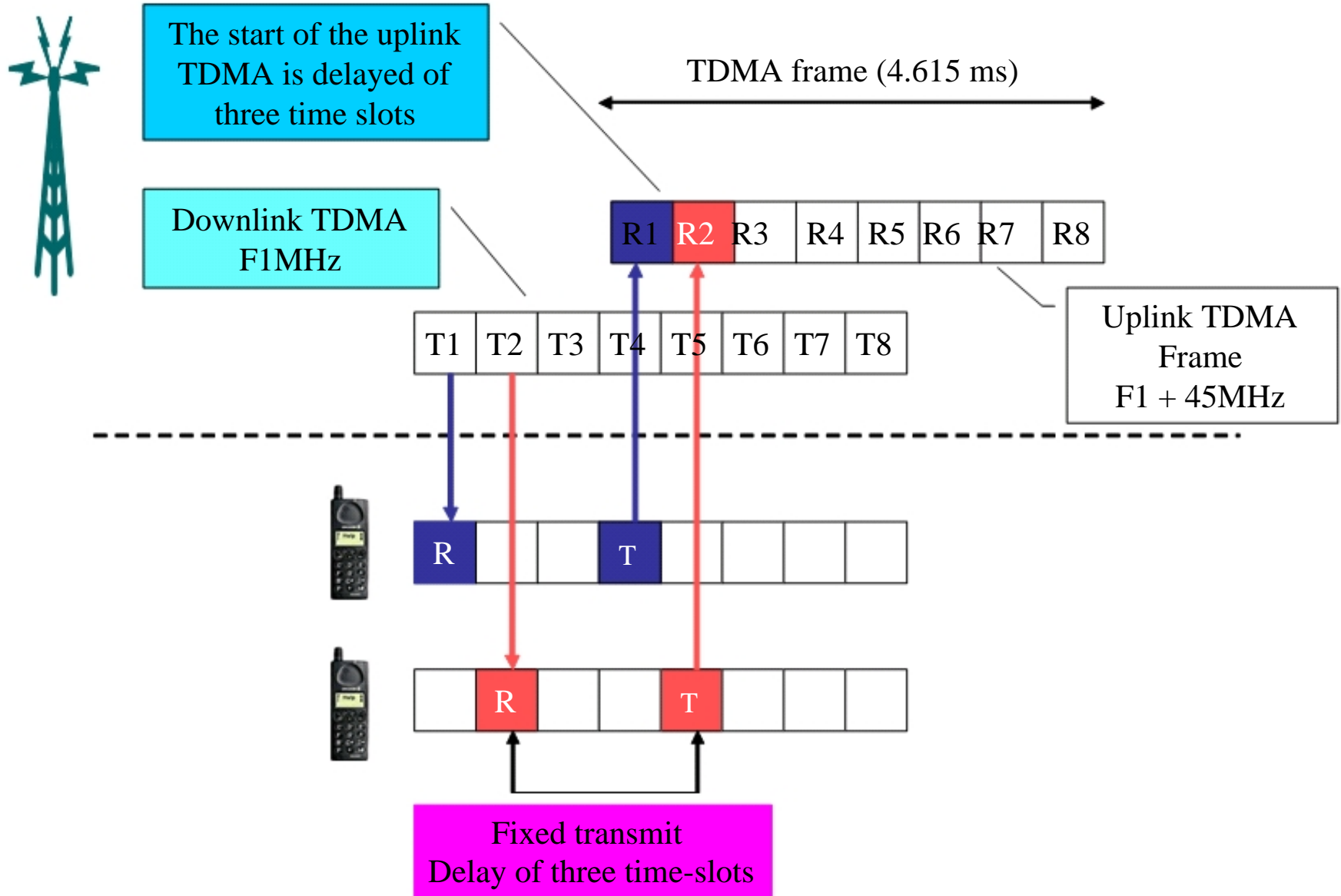
Duplex spacing = 45 MHz

Frequency band spectrum = 2 x 25 MHz
Channel spacing = 200 kHz

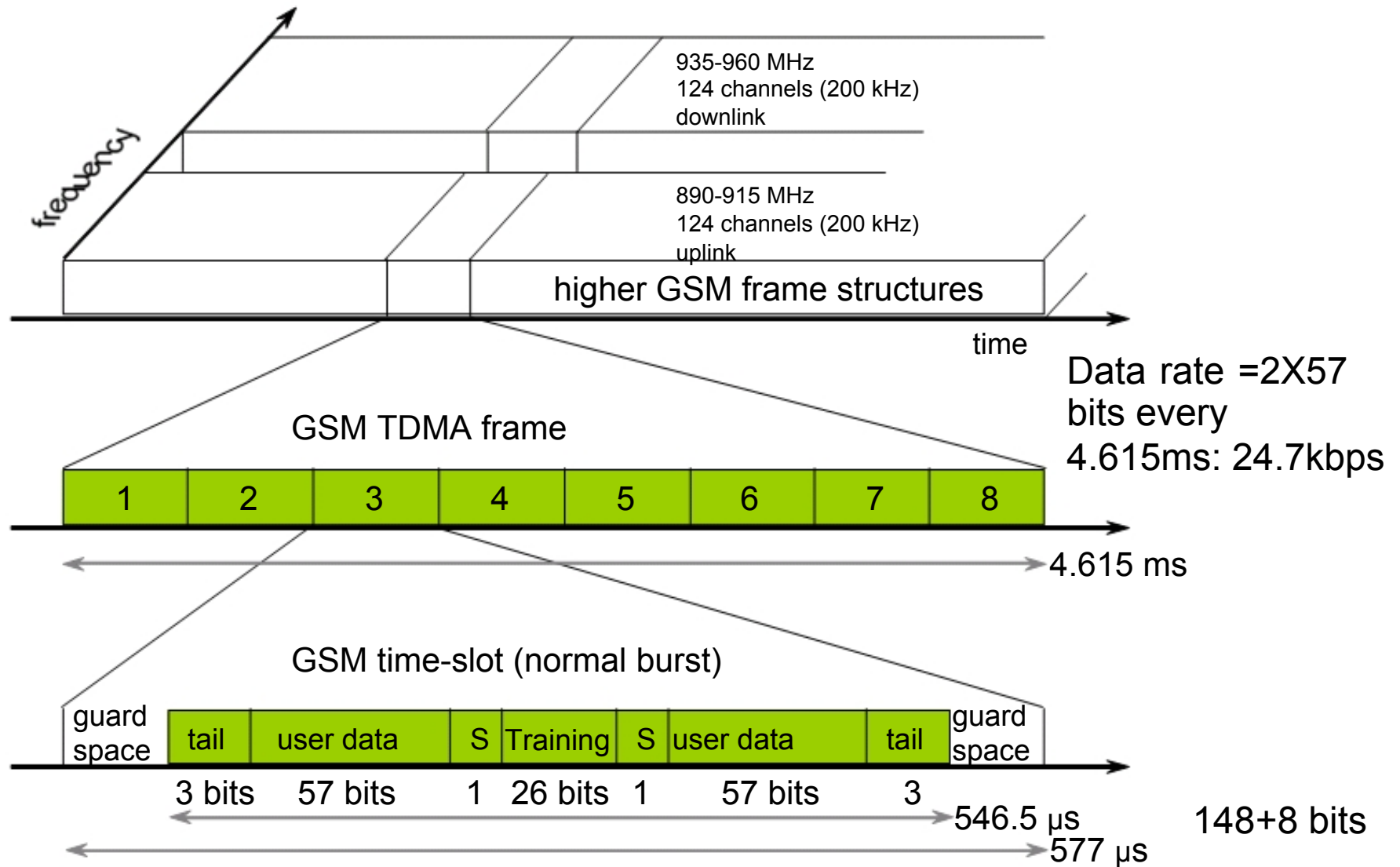
GSM FDM



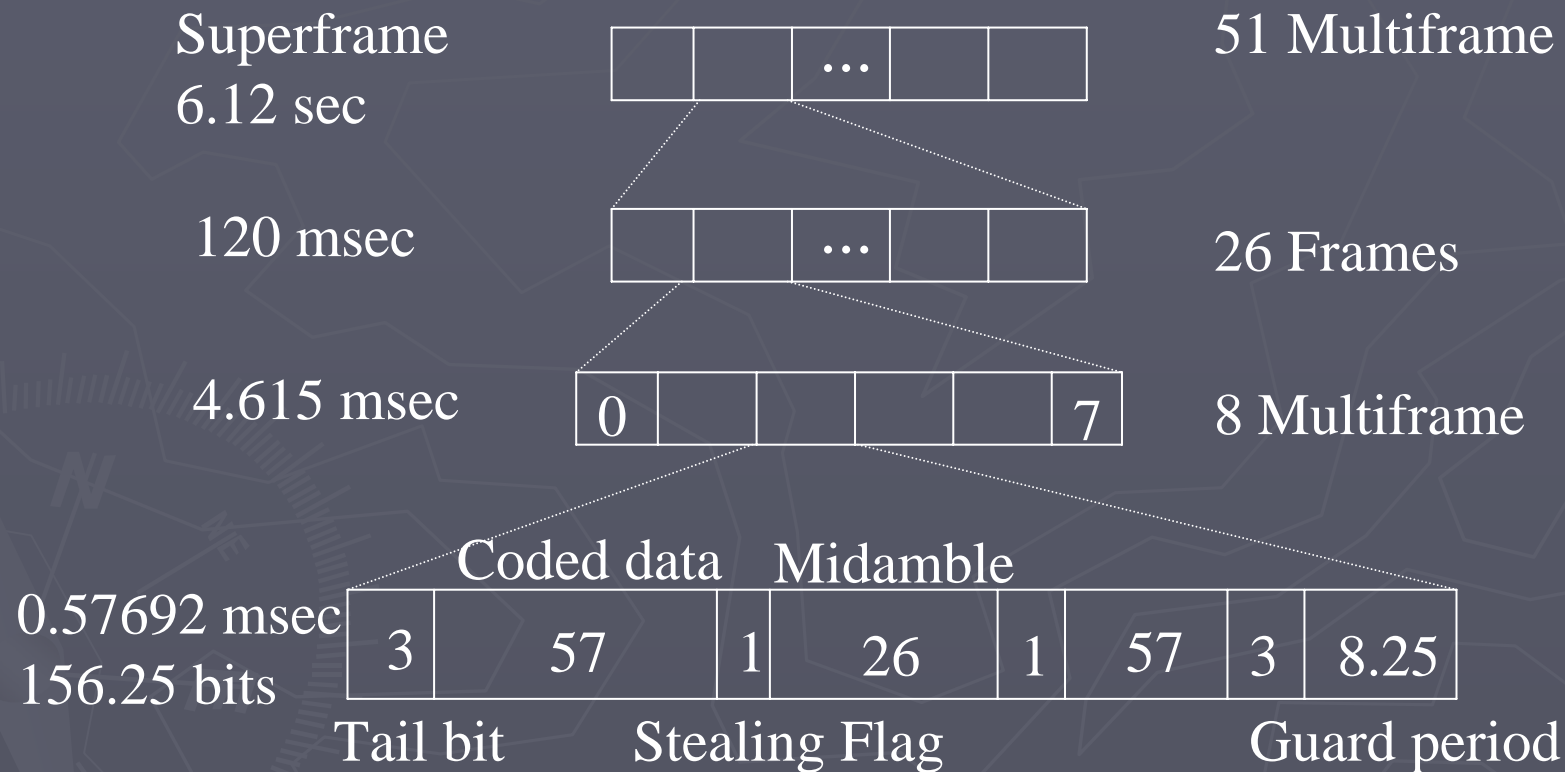
GSM delays uplink TDMA frames



GSM - TDMA/FDMA



GSM Frame Structure

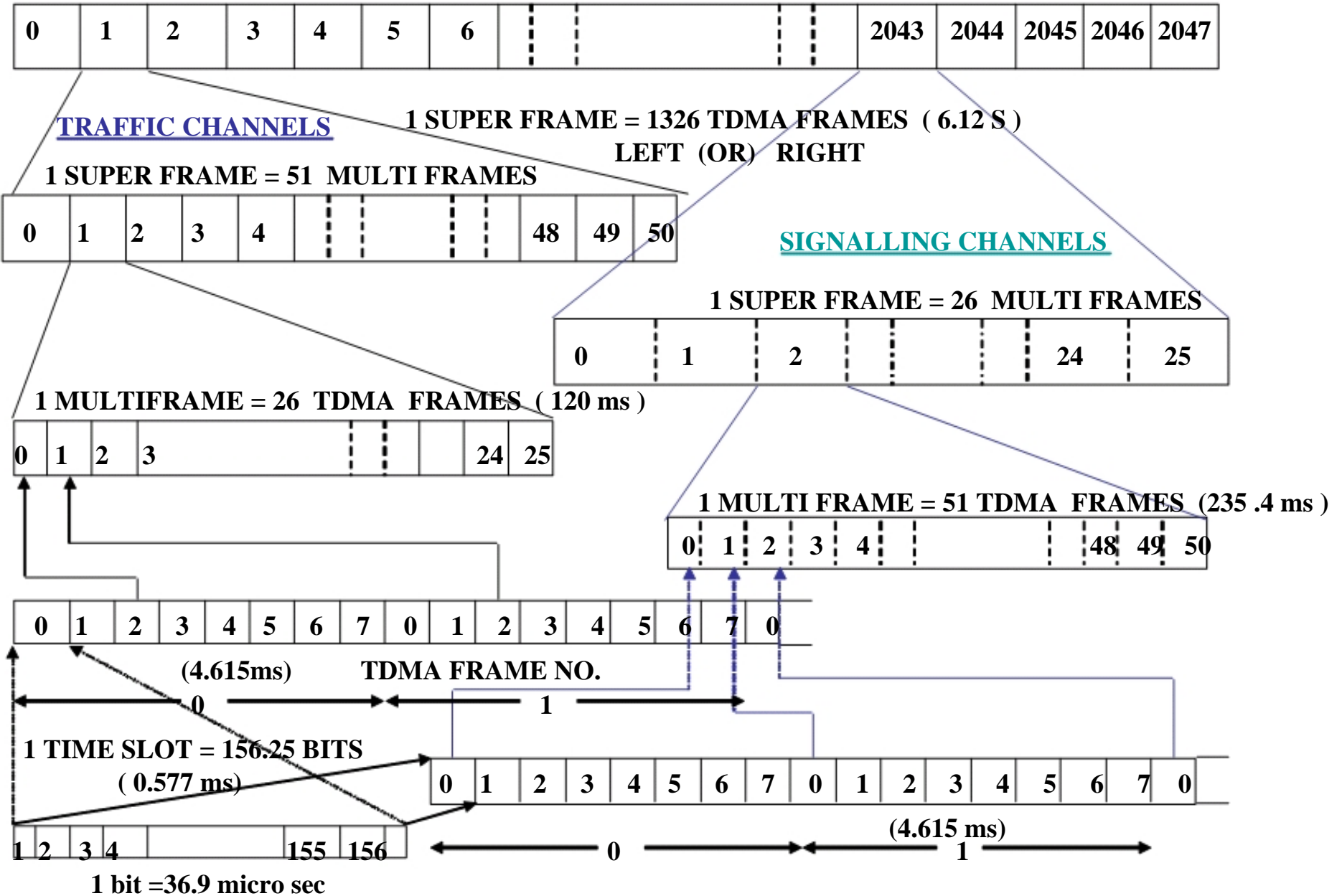


Frame Types

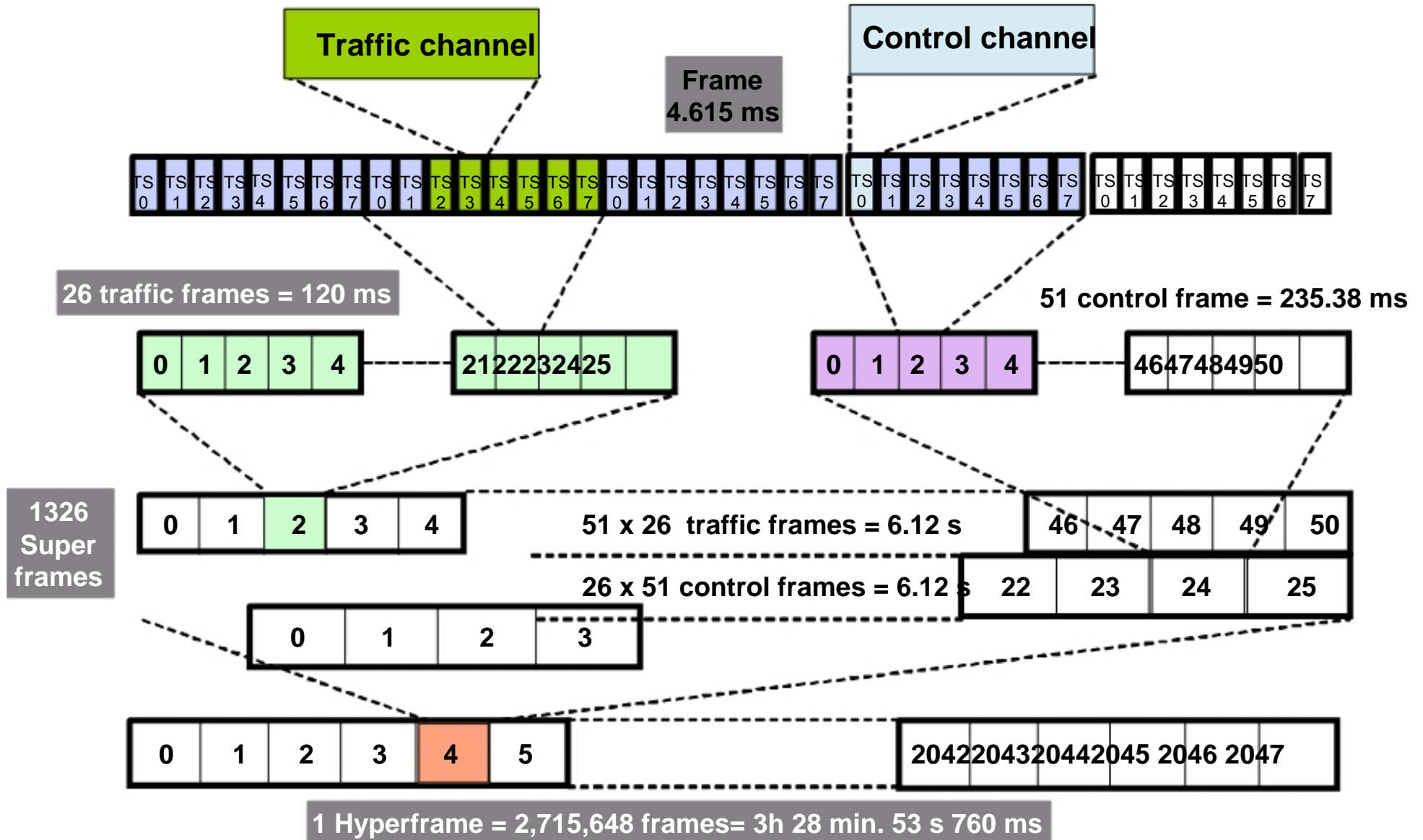
- ▶ There are two types of multiframe
 - **26 TDMA-frame multiframe** is used to carry TCH, SACCH and FACCH
 - **51 TDMA-frame multiframe** is used to carry BCCH, CCH, SDCCH and SACCH

HIERARCHY OF FRAMES

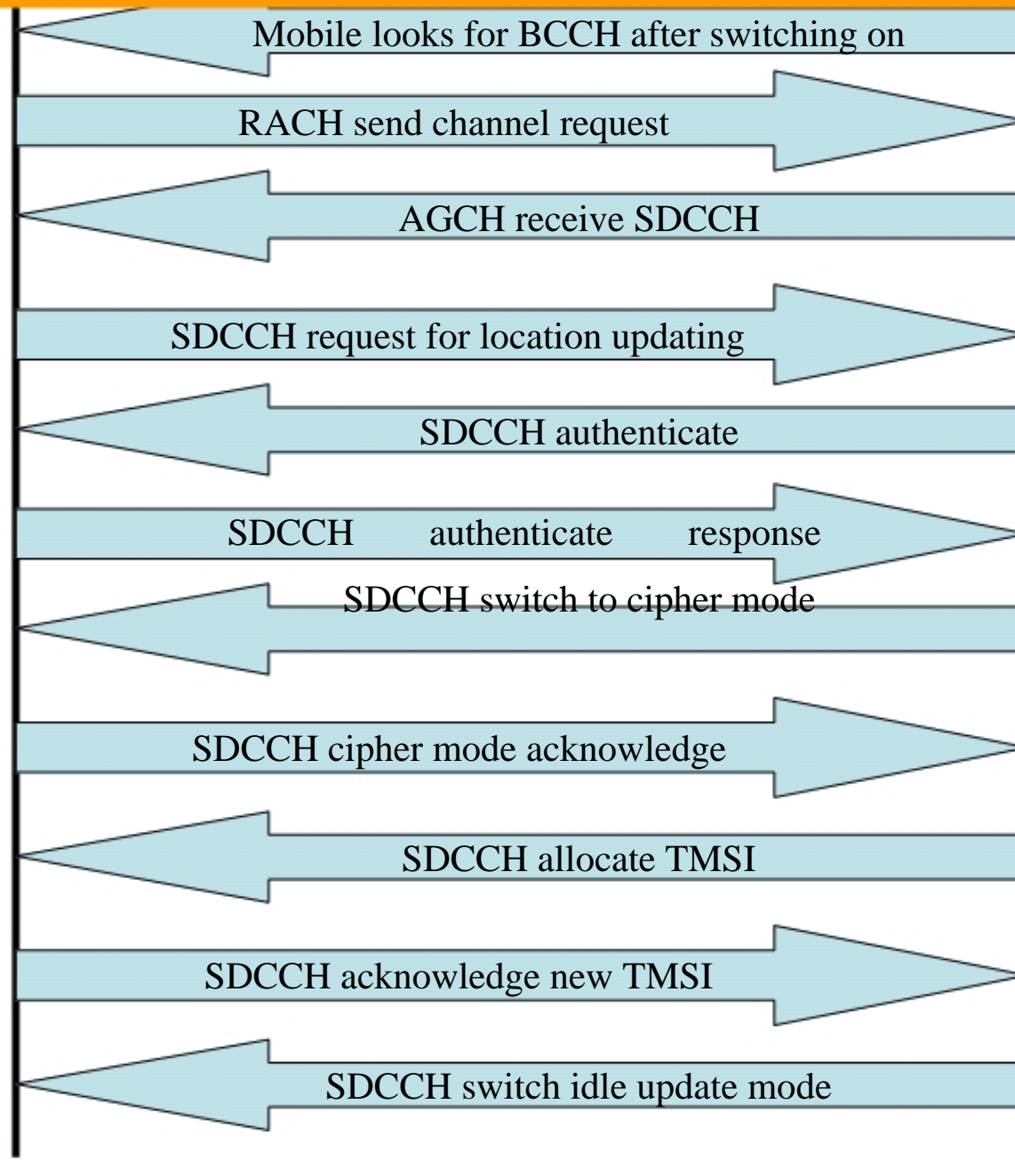
1 HYPER FRAME = 2048 SUPERFRAMES = 2 715 648 TDMA FRAMES (3 H 28 MIN 53 S 760 MS)



Traffic and Control Multi-Framing

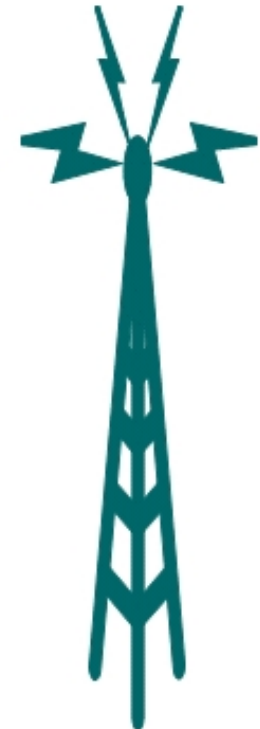
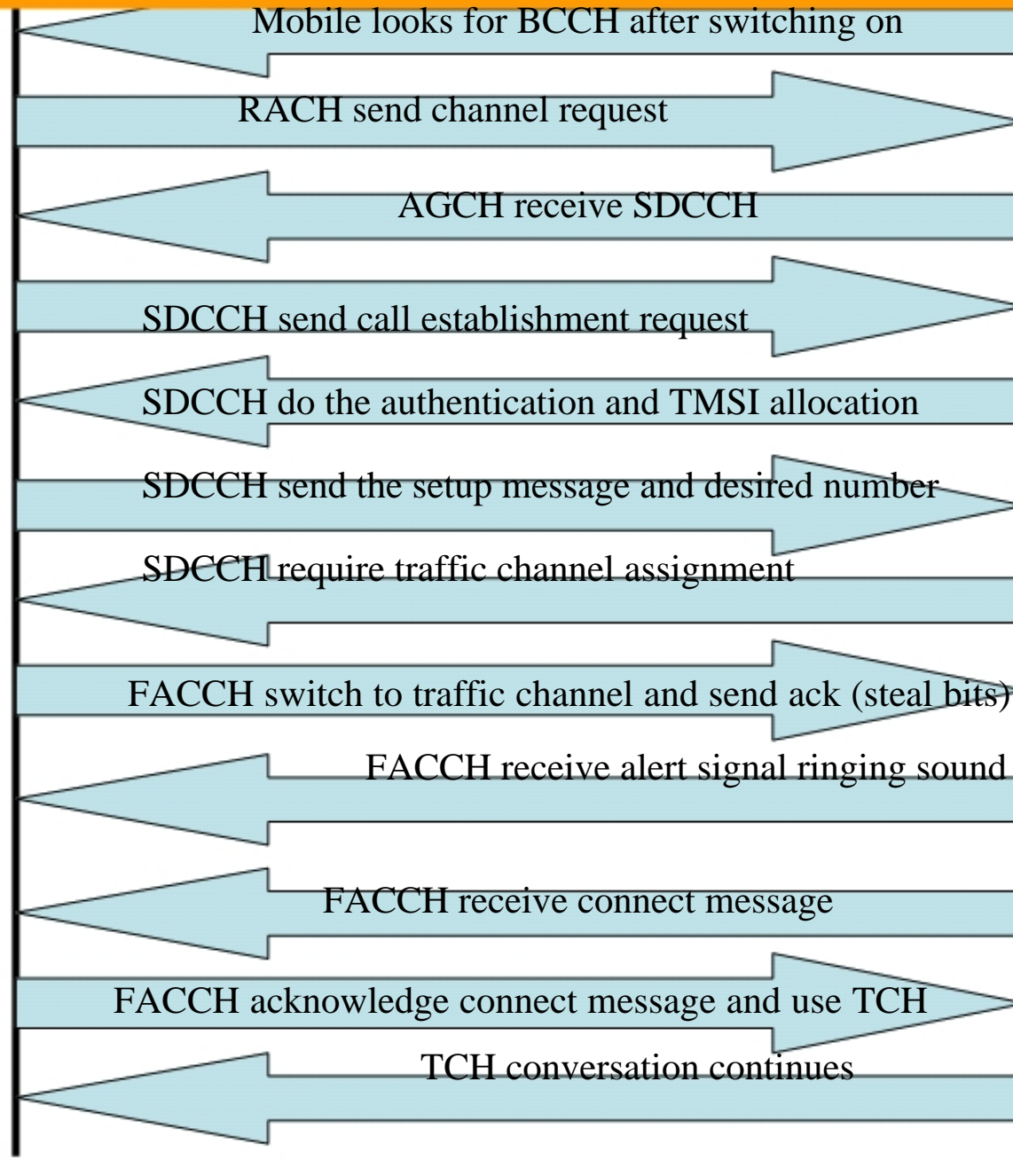


Location update from the mobile

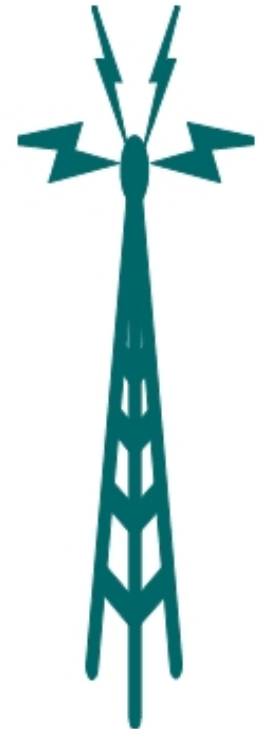
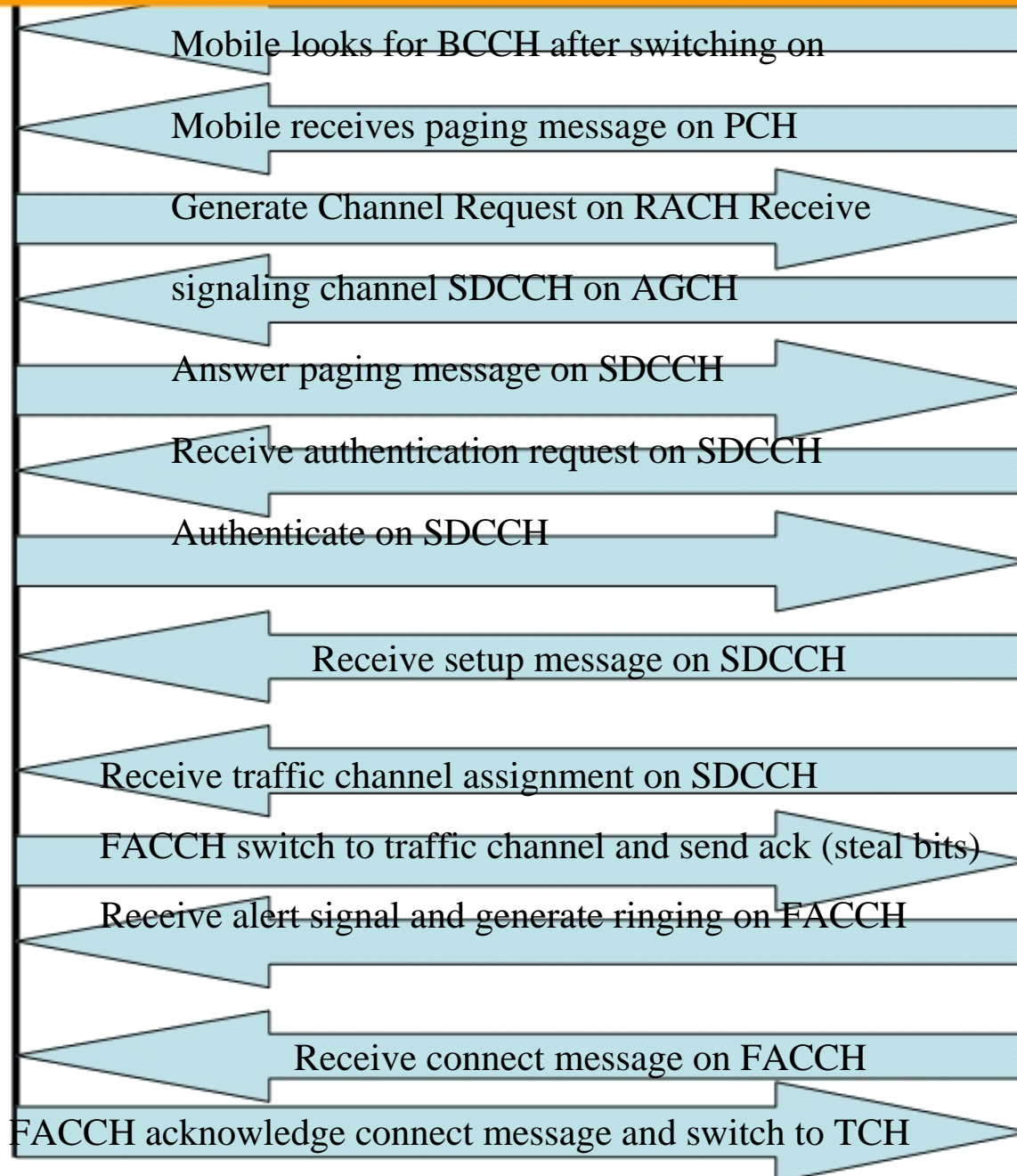


Temporary
mobile
subscriber
identity

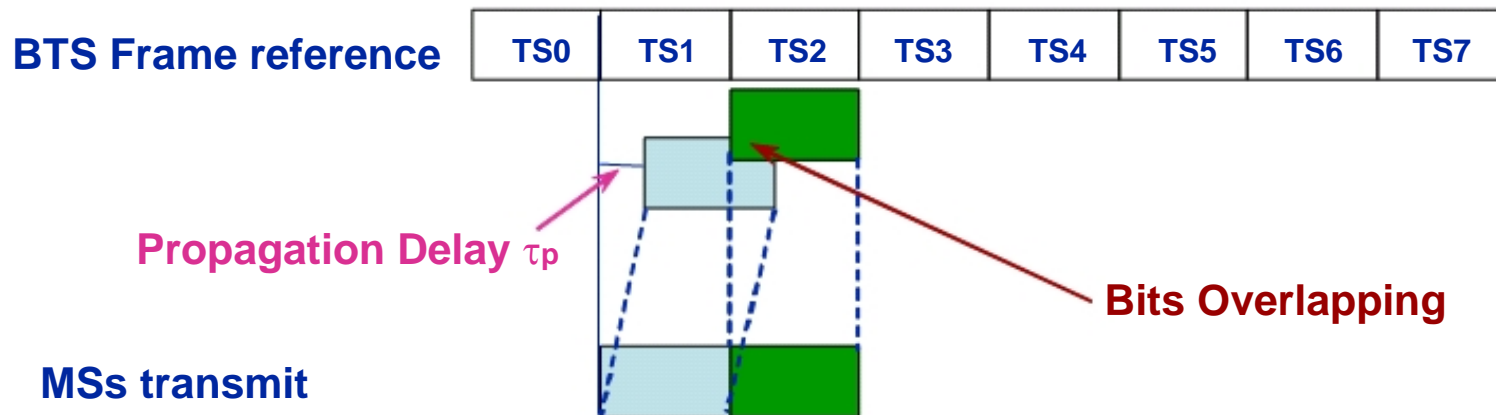
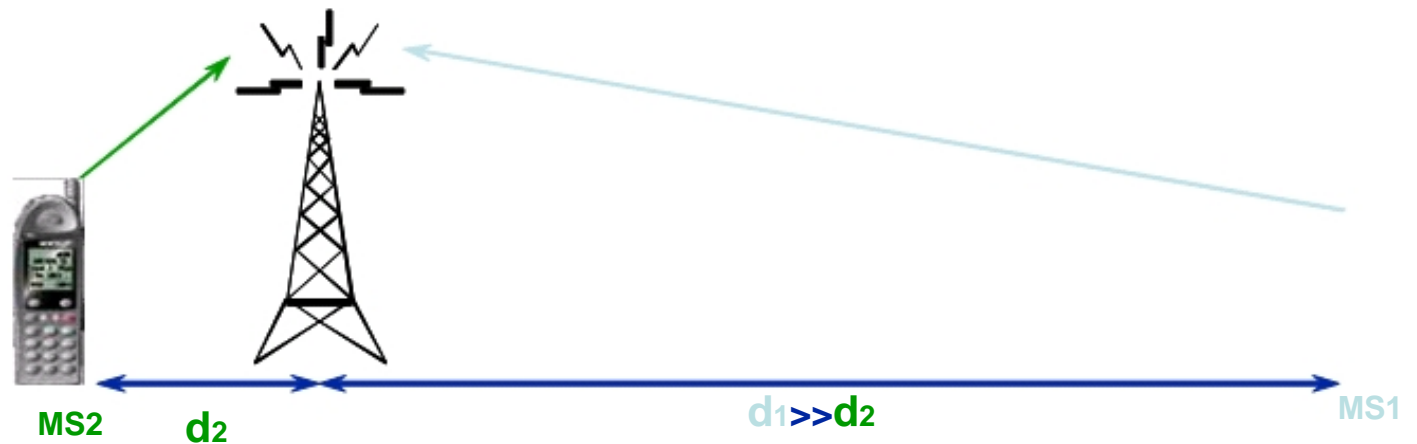
Call establishment from a mobile



Call establishment to a mobile



PROPAGATION DELAYS



Traffic Channels Combination

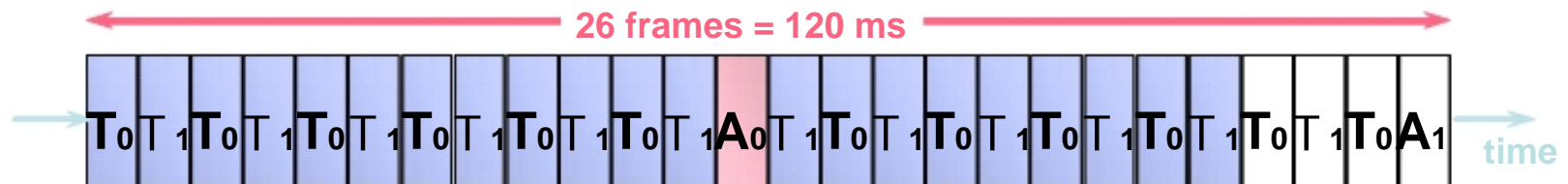
- Logical Channel Mapping (1/4) TCH/SACCH

One Full Rate Channel- Downlink & Uplink

26 frames
Multi frame

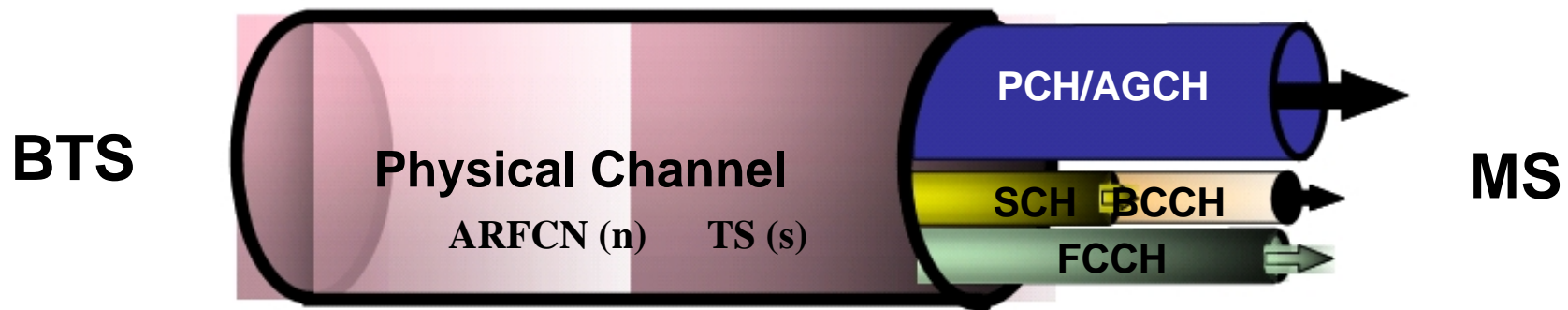
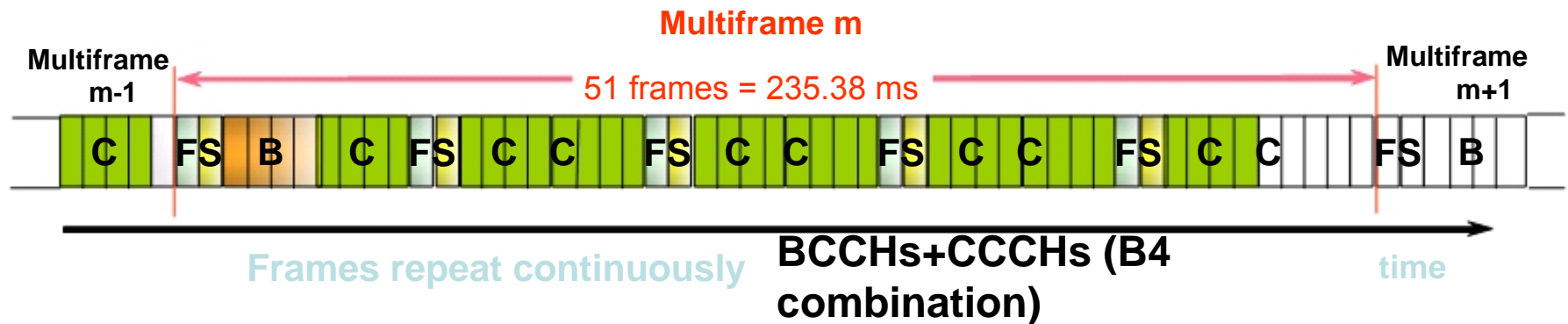


Two Half Rate Channel- Downlink & Uplink



Physical Chs and Logical Chs

- Common Channels Combination



Absolute radio frequency channel number

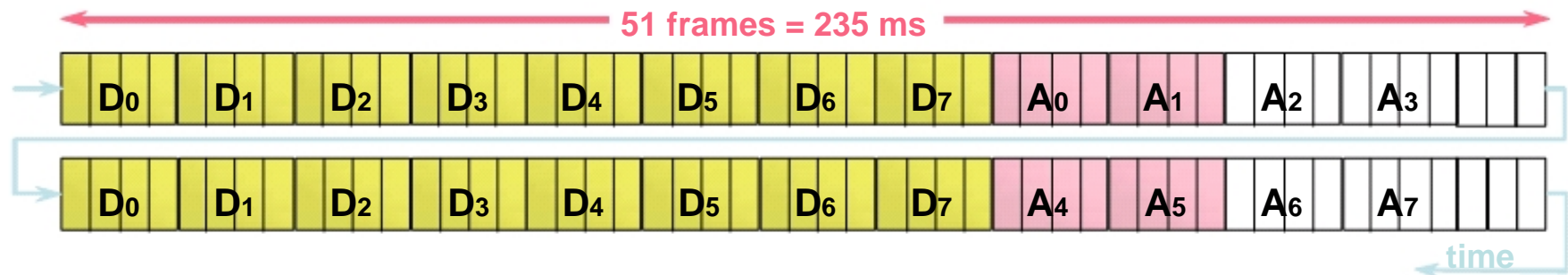
Logical Channels **F** : FCCH **S** : SCH **B** : BCCH **C** : PCH/AGCH : IDLE

Dedicated Signaling CHs Combination

- Logical Channel Mapping (2/4)

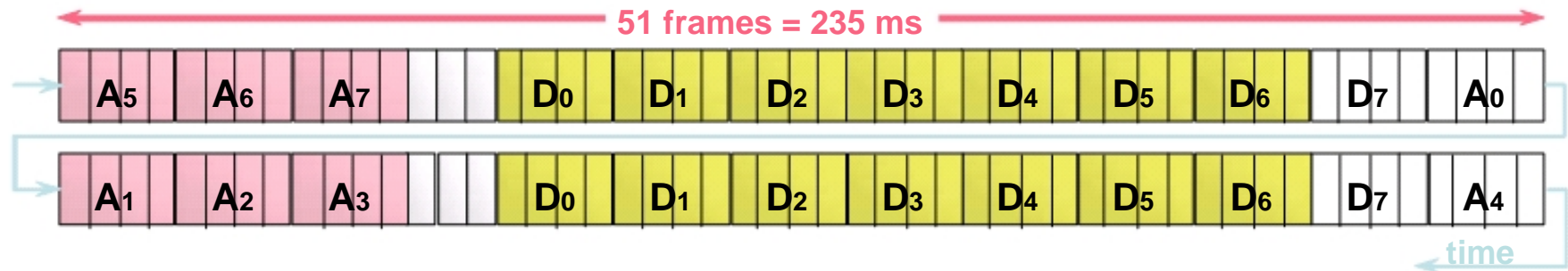
51 frames
multiframe

Downlink



SDCCH + SACCH (B7
Combination)

Uplink



A : SACCH

D : SDCCH

: IDLE

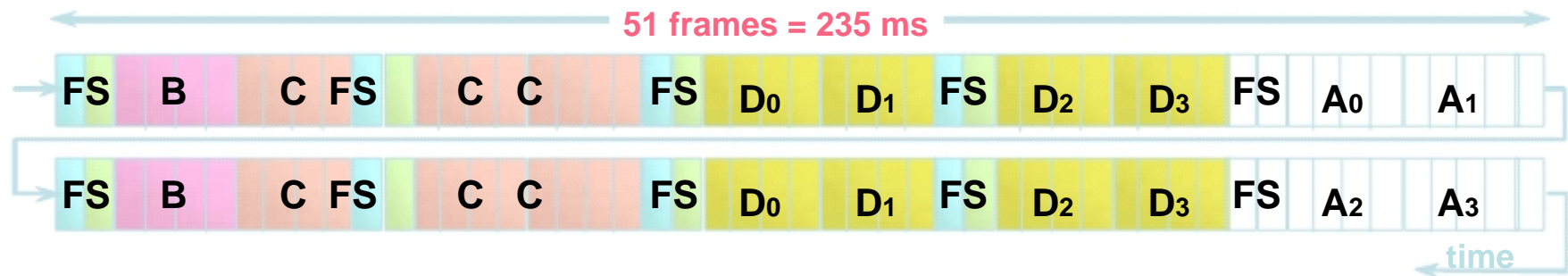
: IDLE

BCCH Combined

- Logical Channel Mapping (4/4)

BCCHs+CCCHs+SDCCH+SACCH
(B5 combination)

Downlink



Uplink



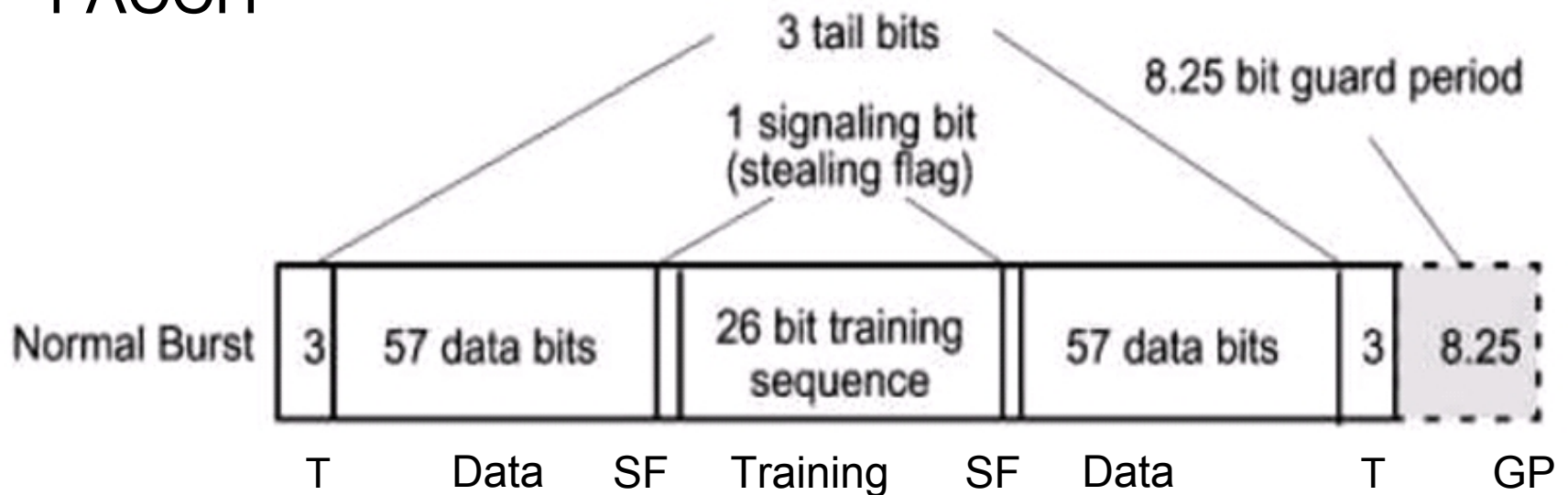
F : FCCH
 S : SCH
 B : BCCH
 C : AGCH /PCH
 R : RACH
 A : SACCH
 D : SDCCH
 : IDLE

Burst and Frames

- ▶ The information contained in one time slot on the TDMA frame is call a *burst*.
- ▶ Five types of burst
 - Normal Burst (NB)
 - Frequency Correction Burst (FB)
 - Synchronization Burst (SB)
 - Access Burst (AB)
 - Dummy Burst

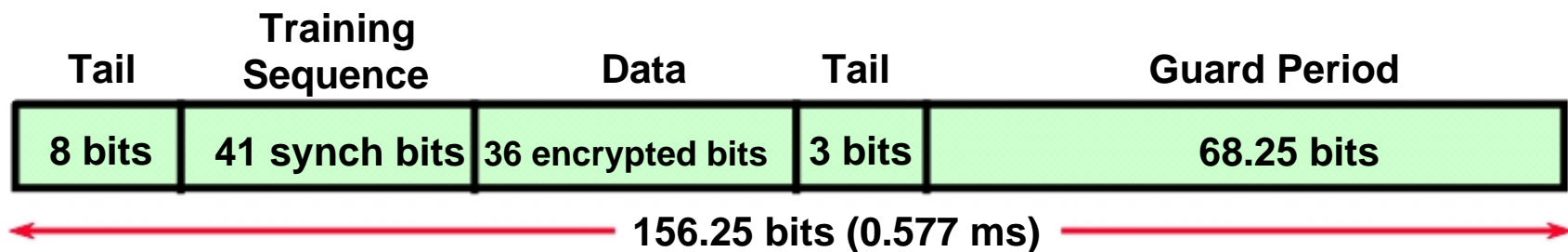
Normal Burst

- It is used to transmit both information and control bits - T trail bits are used as guard time in achieving power level.
- Training is used to estimate channel characteristics. - SF stealing flags tells whether data or signalling is being transmitted. Normally for FACCH



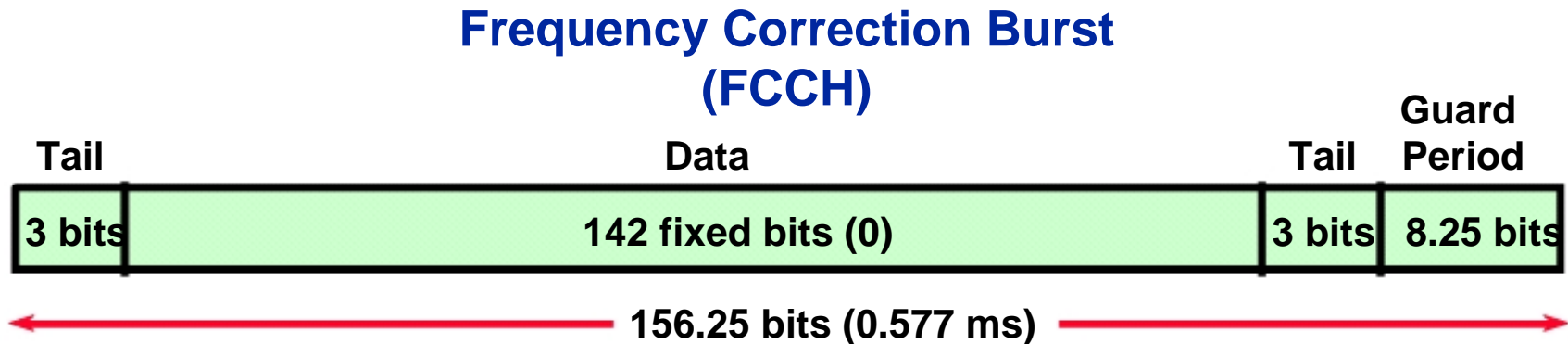
Access Burst

- used to send the Random Access Channel (RACH) information
 - RACH contains the first message from MS to BTS
 - it has a long guard period to allow BTS to calculate the MS distance from the BTS and to provide timing advance information to MS



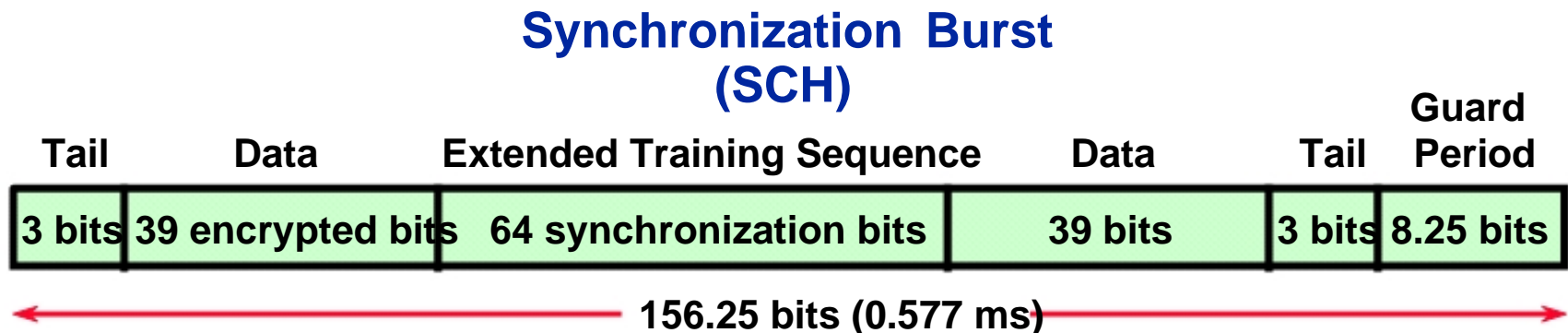
Frequency Correction Burst

- used just to transmit Frequency Correction Channel (FCCH)
- 142 bits are set to “0” in the known time slots.



Synchronization Burst

- used to transmit synchronization information
- the training sequence includes a well known sequence of bits
- Also contains the running number of TDMA frame.



Dummy Burst

- It is transmitted when no other bursts are to be transmitted
- Uses same frequency channel which is used for BCCH to ensure if BCCH transmits burst in each time slot
- Quality monitoring

