GSM Channel Concept

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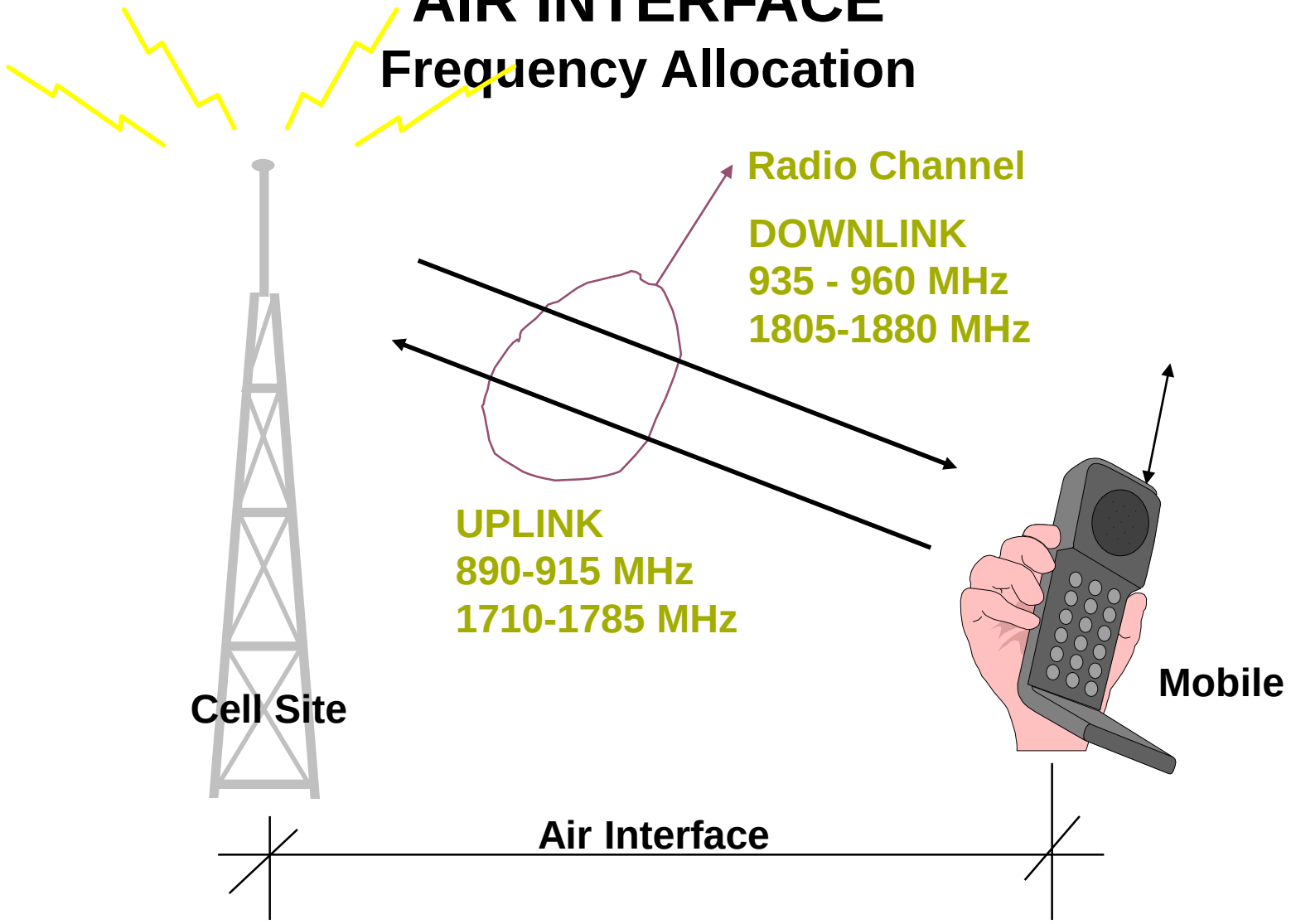
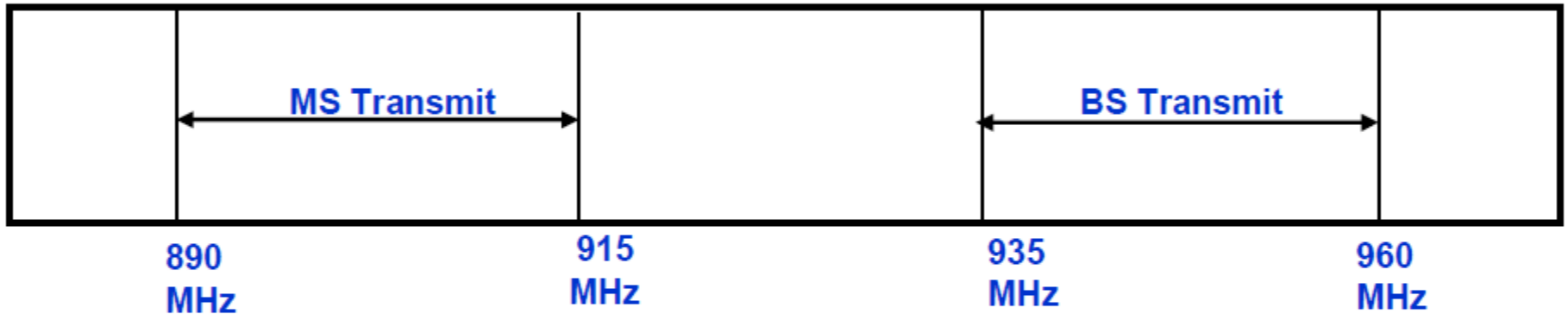
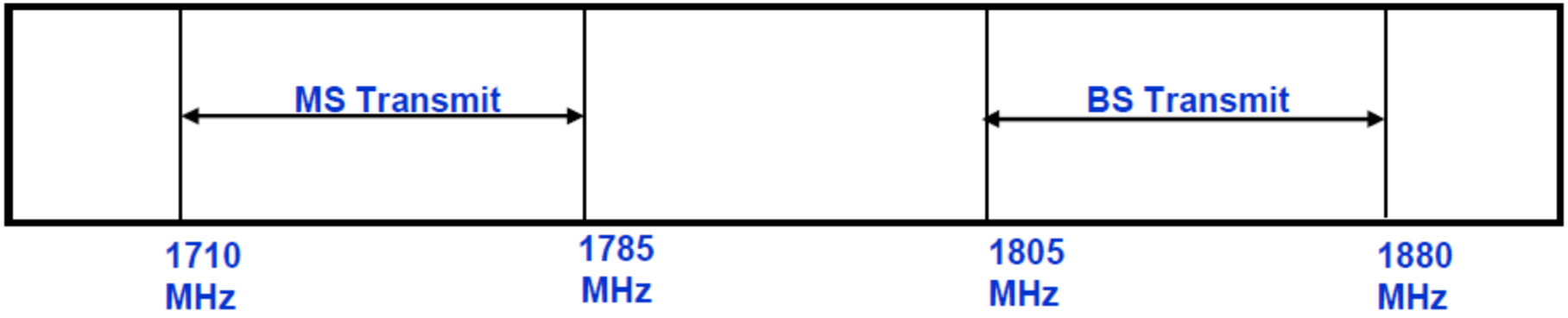
AIR INTERFACE
Frequency Allocation



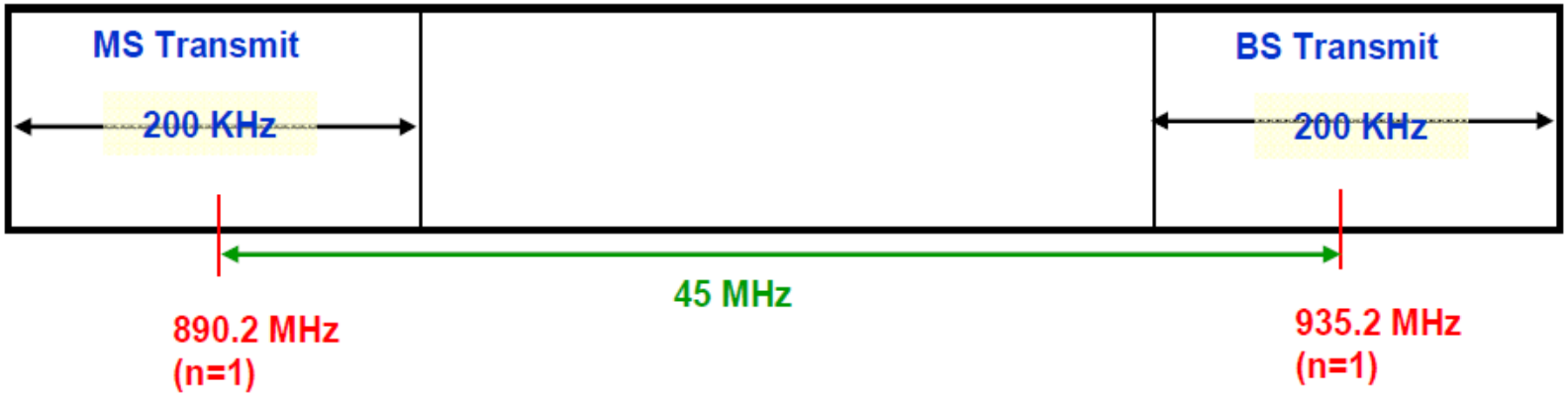
- **Spectrum Allocation**
  - **900 MHz band**



  - **1800 MHz band**

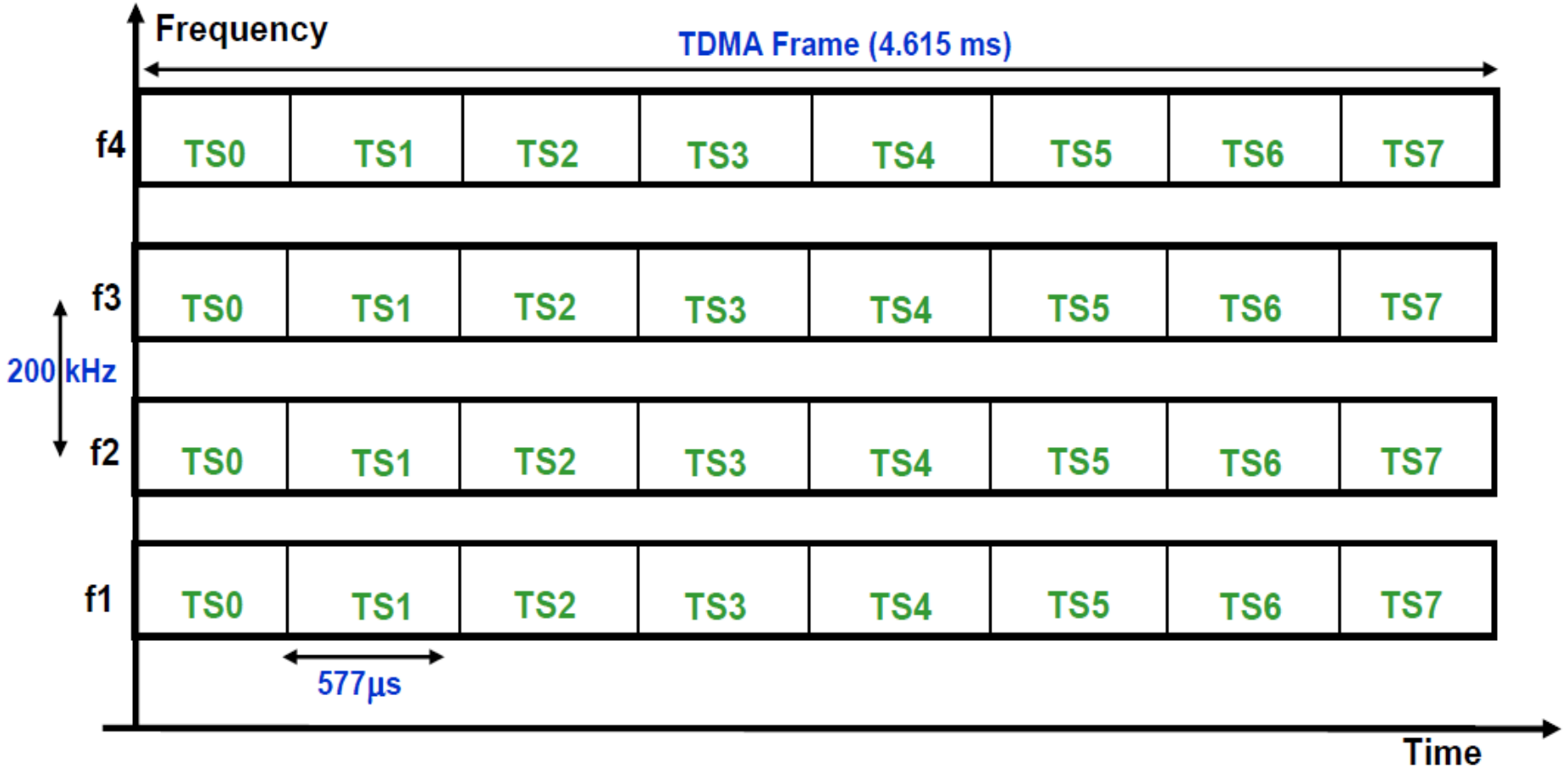


- **The ARFCN**
  - **Channel bandwidth is 200kHz**

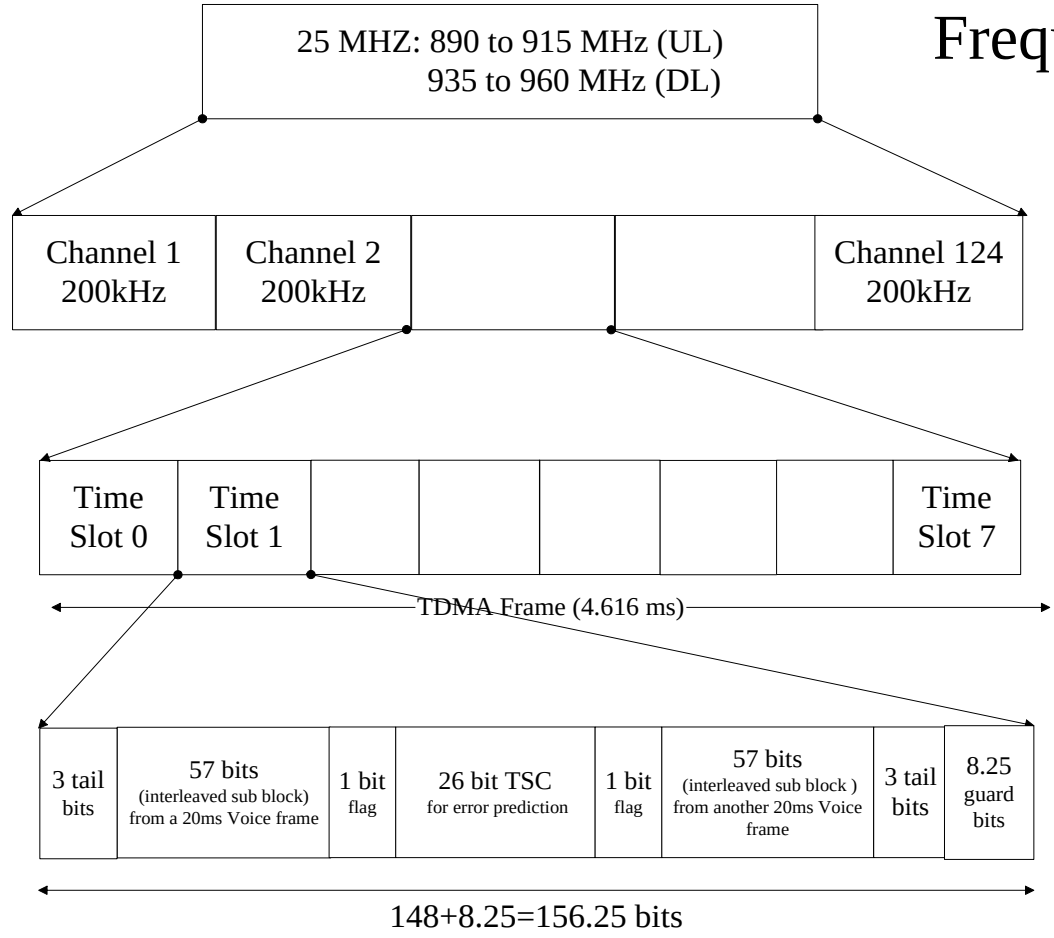


GSM 900	F-DL(n) = 890 + 0.2*n	$1 \leq n \leq 124$	F-UL(n) = F-DL(n) + 45
E-GSM 900	F-DL(n) = 890 + 0.2*n	$0 \leq n \leq 124$	F-UL(n) = F-DL(n) + 45
	F-DL(n) = 890 + 0.2*(n - 1024)	$975 \leq n \leq 1023$	
GSM 1800	F-DL(n) = 1710.2 + 0.2*(n - 512)	$512 \leq n \leq 885$	F-UL(n) = F-DL(n) + 95

- **Access scheme**
  - **TDMA with FDMA**



GSM: TRX/TDMA Frame



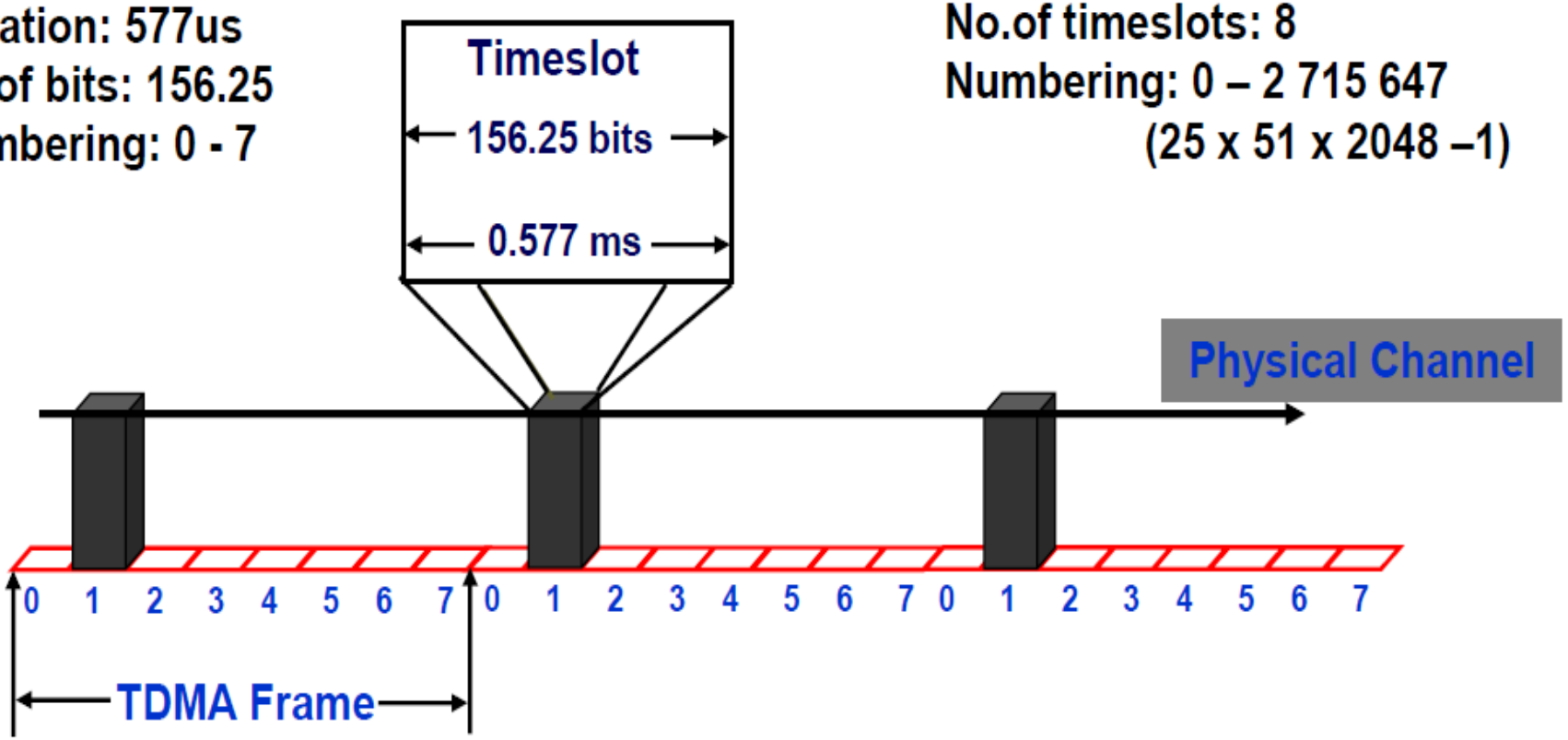
1TS=0.577ms
1bit=3.69μs

1800MHz Band : 1710-1785MHz(UL)
1805-1880MHz(DL)
Total no. of Channel is 374.

– Time Division Multiple Access (TDMA)

Timeslot
Duration: 577us
No.of bits: 156.25
Numbering: 0 - 7

TDMA Frame
Duration: 4.615ms
No.of timeslots: 8
Numbering: 0 – 2 715 647
(25 x 51 x 2048 –1)



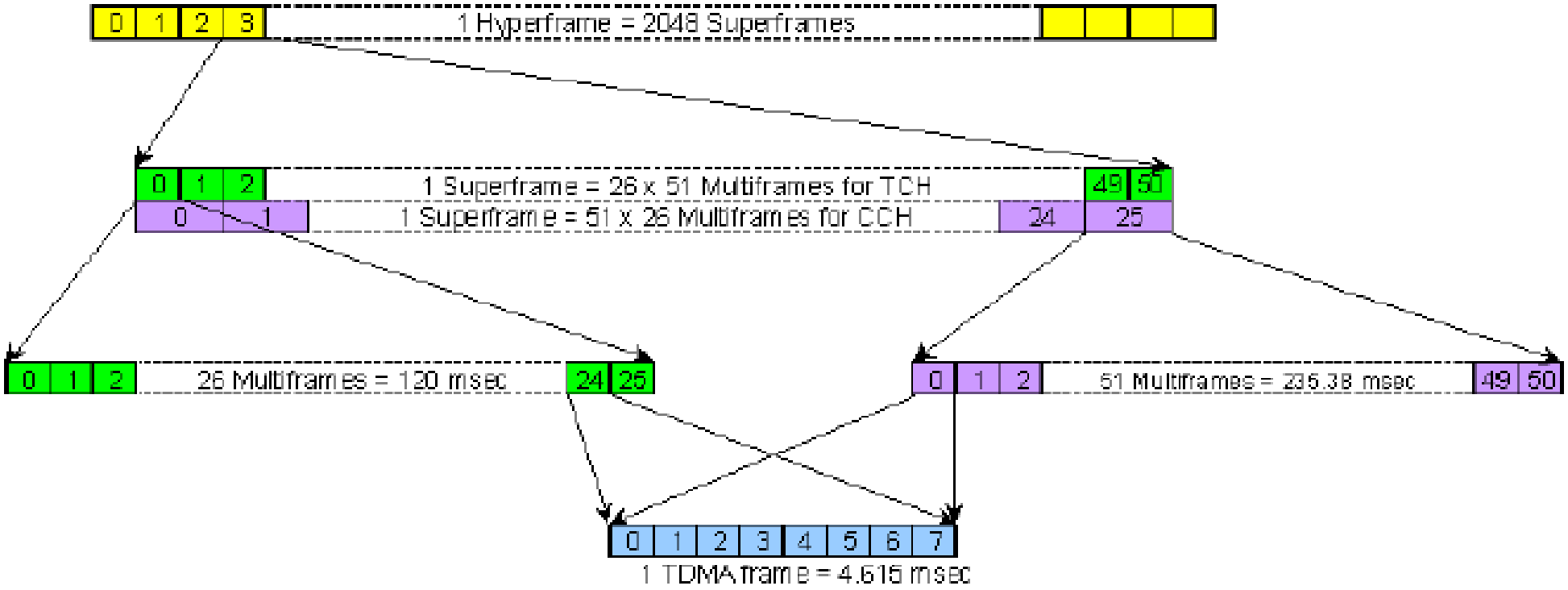
- **TDMA frame structures**
  - **Timeslot (15/26 ms)**
  - **Frame:**
    - **8 timeslots (TS0 - TS7)**
  - **Multiframe**
    - **26 frames (FN0 - FN25)**
    - **51 frames (FN0 - FN50)**
  - **Superframe**
    - **51 * 26-frame multiframes**
    - **26 * 51-frame multiframes**
  - **Hyperframe**
    - **2048 superframes**

The 200 KHz spectrum or frame is divided in time into 8 slots. Each of the 8 slots is called a **Timeslot**, and its duration is (15/26ms) 0.577ms. The duration of the frame is 8*0.577=4.615ms.

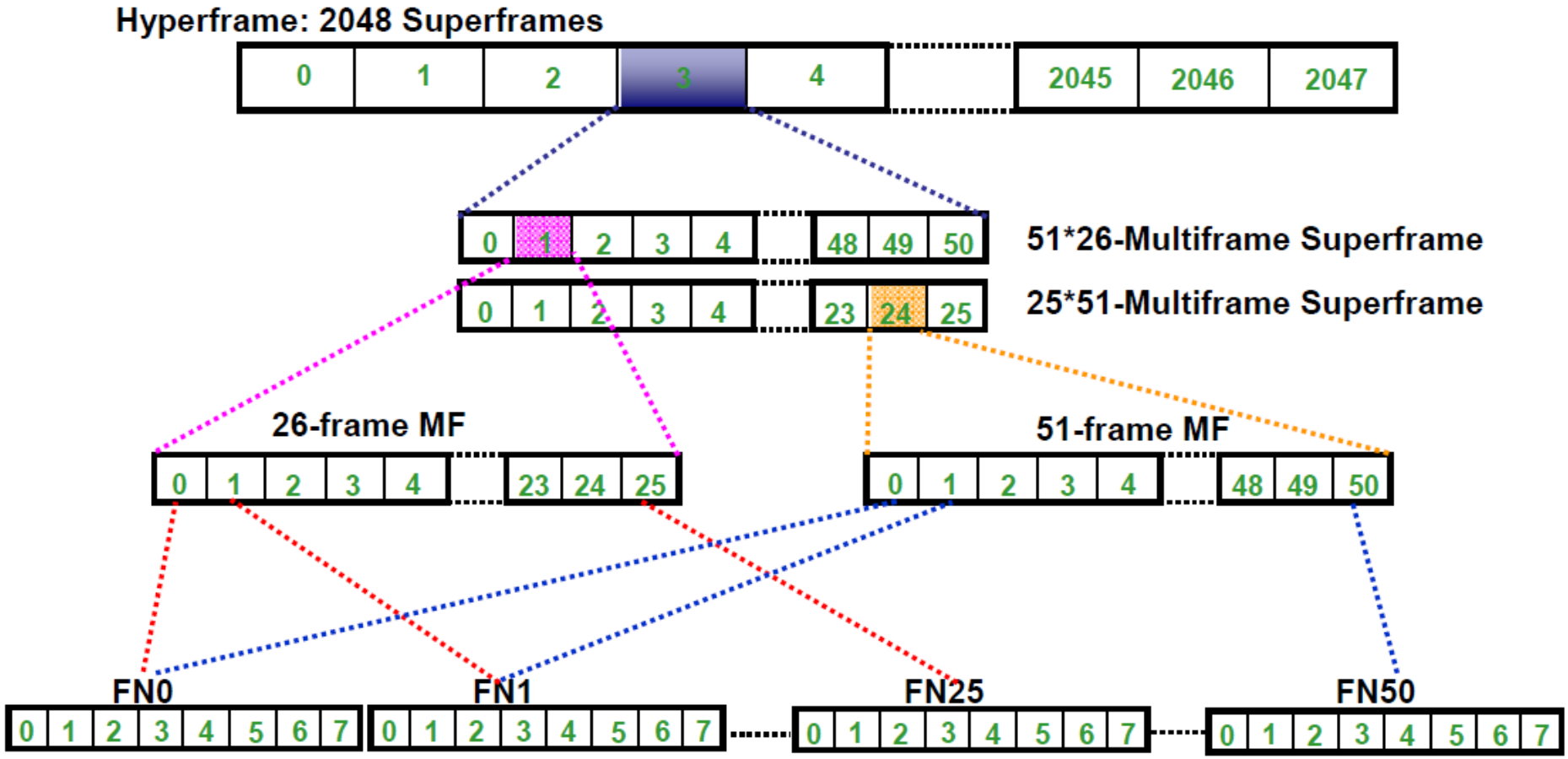
Each frame has a unique number called the Frame Number (FN), starting from 0. A frame structure/hierarchy is important in order to give the BTS an internal clock system. This clocking system is used for other functions such as network access, logical channel configuration etc.

A 26-frame multiframe is used to carry Traffic channels (TCH) and associated control channels (SACCH). The 51-frame multiframe is used for control channels exclusively.

Superframe and Hyperframe



- **TDMA frame structures**



LOGICAL CHANNELS

TCH

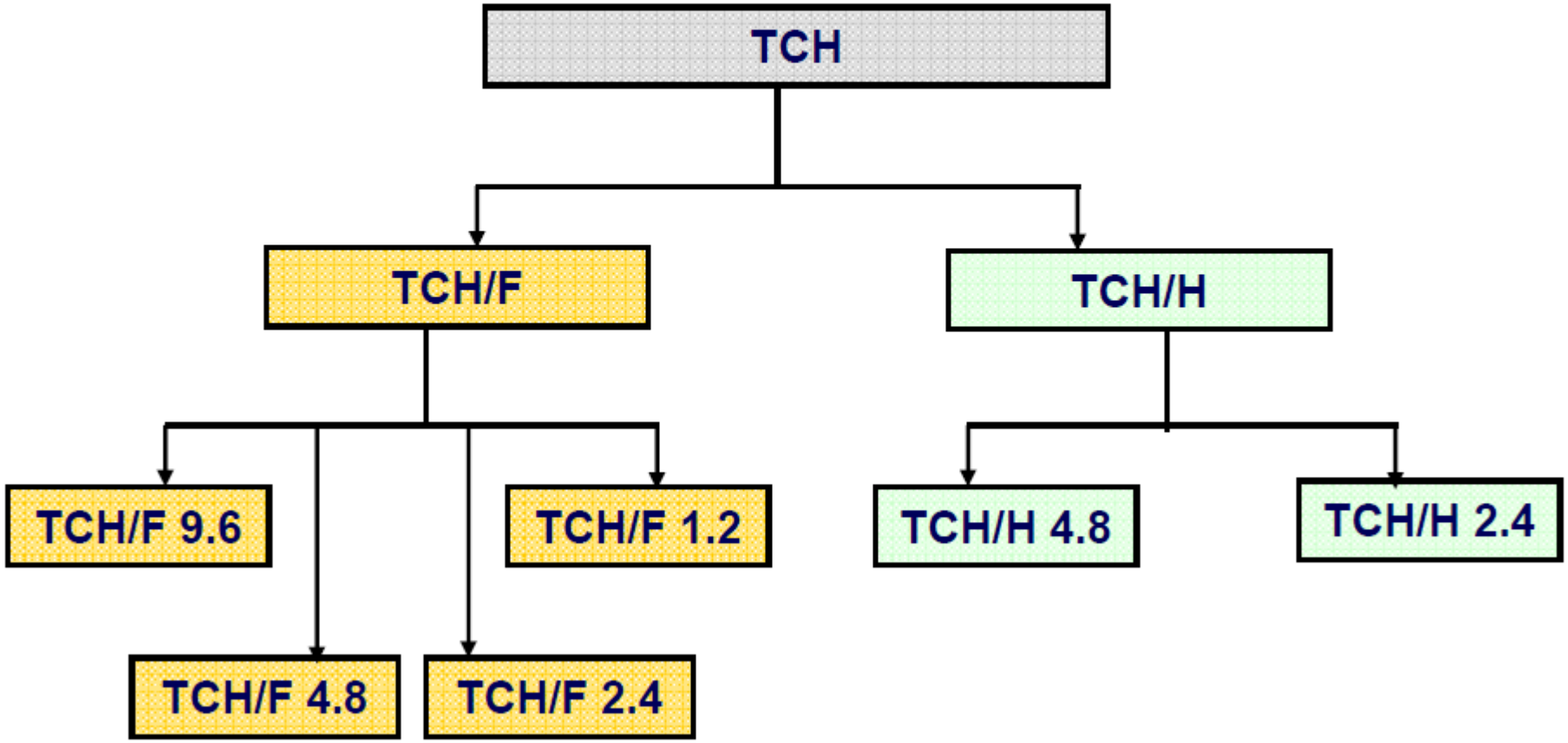
CBCH

3 Broadcast Channels
1) FCCH
2) SCH
3) BCCH

3 Common Control Channels
1) PCH
2) RACH
3) AGCH

3 Dedicated Control Channels
1) SDCCH
2) SACCH
3) FACCH

- **Logical Channels**
  - **Traffic CHannels (TCH)**



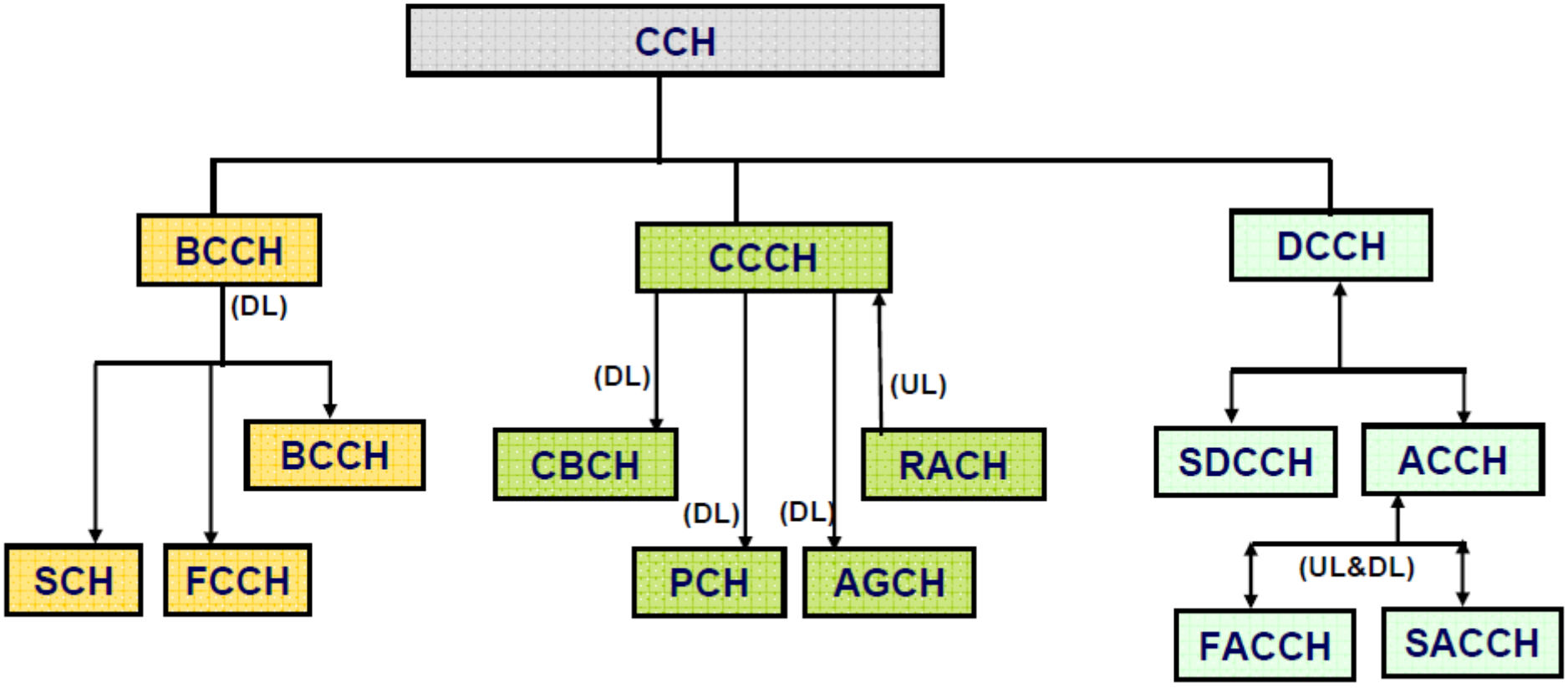
TCH = TRAFFIC CHANNEL

Full rate => Used for speech at 13 Kbits/s
or sending data at 9.6 Kbits/s

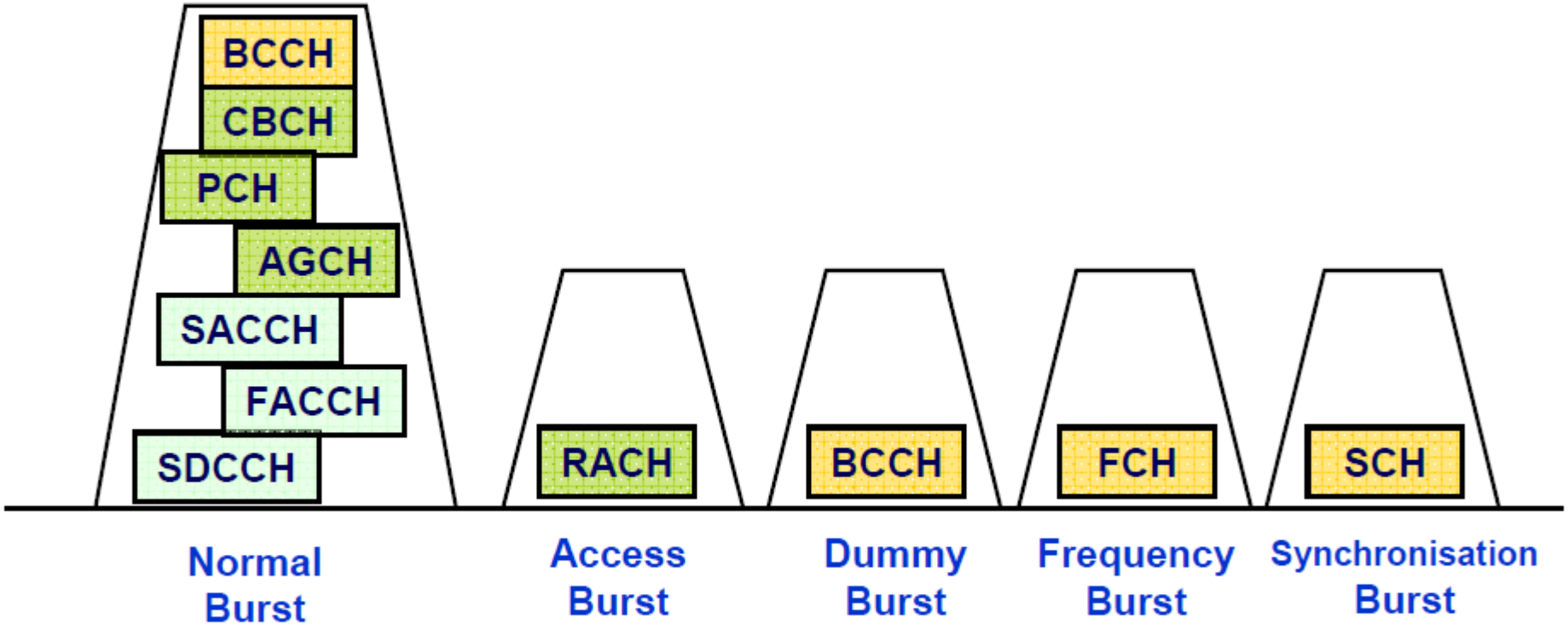
Half rate => Used for speech at 6.5 Kbits/s
or sending data at 4.8 Kbits/s

Enhanced Full rate => Used for speech at 13 Kbits/s
or sending data at 9.6 Kbits/s but
with almost Land line quality

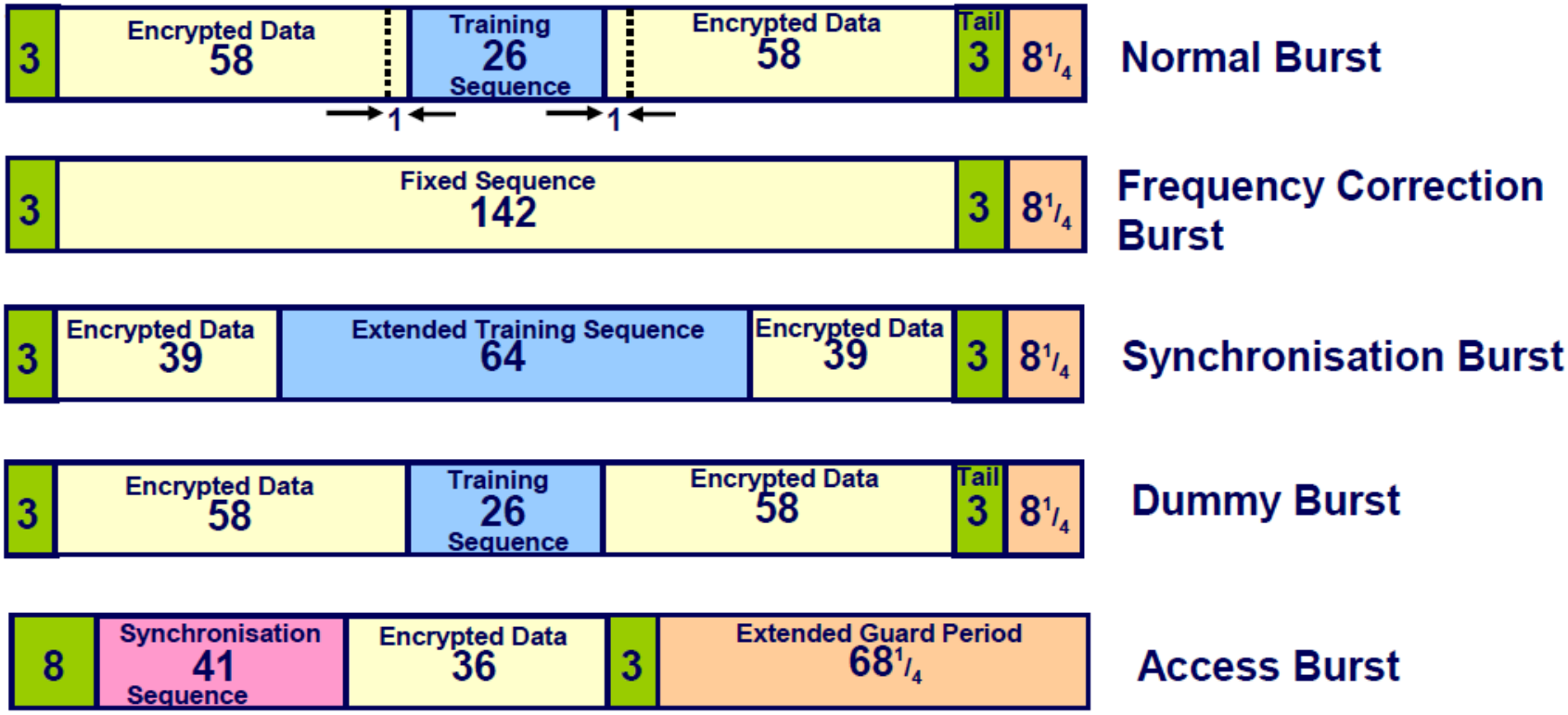
- **Logical Channels**
  - Control CHannels (CCH)



- **Logical Channels**



- **Physical channel - bursts**



BROADCAST CHANNELS

FCCH = FREQUENCY CORRECTION CHANNEL (Downlink only)

- To tell the Mobile that this is the BCCH carrier
- To able the Mobile to synchronize to the frequency
- bursts only containing zeroes are transmitted.

SCH = SYNCHRONISATION CHANNEL (Downlink only)

- Used for sending BSIC (Base station Identity Code)
- Give TDMA frame number to the Mobile

BCCH = BROADCAST CONTROL CHANNEL (Downlink only)

- Used for sending information to the mobile like-
- CGI (Cell Global identity)
- LAI (Location Area Identity)
- BCCH carriers of the neighboring cells
- maximum output power allowed in the cell
- Other broadcast messages like barred cell

COMMON CONTROL CHANNELS

PCH = PAGING CHANNEL

=> Used for paging the Mobile. (Downlink only)
Reason could be an incoming call or an incoming Short Message.

RACH = RANDOM ACCESS CHANNEL

=> Used for responding to the paging (terminating), Location updating or to make call access (originating) by asking for a signaling channel. (Uplink only)

AGCH = ACCESS GRANT CHANNEL

=> Used to allocate SDCCH to the mobile.
(Downlink only)

DEDICATED CONTROL CHANNELS

SDCCH = STAND ALONE DEDICATED CONTROL CHANNEL

=> Used for allocating voice channel (TCH) to the mobile (call setup) and Location updating.

=> Send Short Text message to Idle Mobile (Uplink & Downlink)

SACCH = SLOW ASSOCIATED CONTROL CHANNEL

=> Used for sending information to the mobile like CGI (Cell Global identity), LAI (Location Area Identity), BCCH of all the neighbors and TA (Timing Advance)

=> Send Short Text message to Busy Mobile (Downlink

=> Used for sending signal strength & bit error rate measurement of the serving cell and signal strength of the BCCHs of the neighboring cells. (Uplink)

FACCH = FAST ASSOCIATED CONTROL CHANNEL

=> Used for handover. (Uplink & Downlink)

CBCH = CELL BROADCAST CHANNEL

=> Used for sending **short messages to all the mobiles within a geographic area**. Typical example is Traffic congestion in a major road or a major accident in an area. **Up to 93 characters can be sent**.

=> If the mobile is in the Idle mode then the short message will be send through the CBCH. **If the mobile is Busy, it will not be sent**.

NOT TO BE CONFUSED WITH SMS !!!!!!!

(SHORT MESSAGE SERVICE)

=> SMS messages are **short TEXT messages up to 160 characters** in length that you can send or receive. The messages are not sent straight to the other mobile but is **sent to message centre** operated by the Network provider.

=> If the mobile was switched off or is at outside of the coverage area, the message is stored in the Message Service Center. The message will be offered to the subscriber when the mobile is switched on again or has reentered the coverage area again.

=> **If the mobile is in the Idle mode the short message will be send through the SDCCH. If the mobile is Busy the short message will send through the SACCH.**

Channel combinations

The following combinations of logical channel types are allowed for the radio timeslots and specified by GSM (Rec. 05.02):

a) TCH/F + FACCH/F + SACCH/TF

b) TCH/H + FACCH/H + SACCH/TH

c) SDCCH/8 + SACCH/C8

d) FCCH + SCH + BCCH + CCCH (TS 0)-**Uncombined**

e) FCCH + SCH + BCCH + CCCH + SDCCH/4 + SACCH/C4 (TS 0)-**combined**

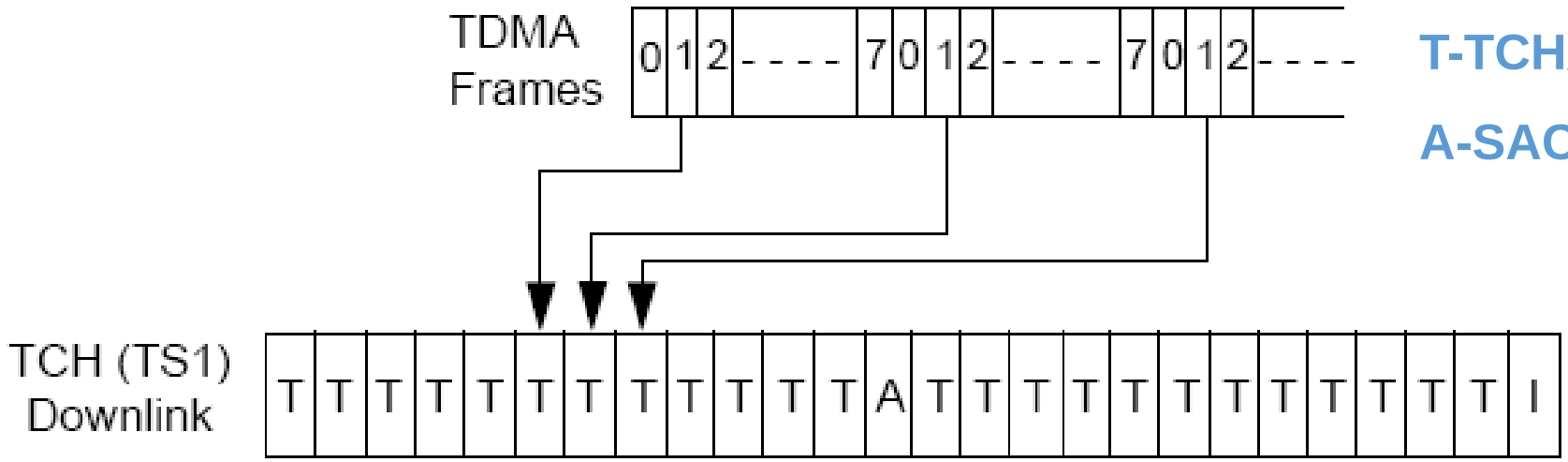
f) BCCH + CCCH

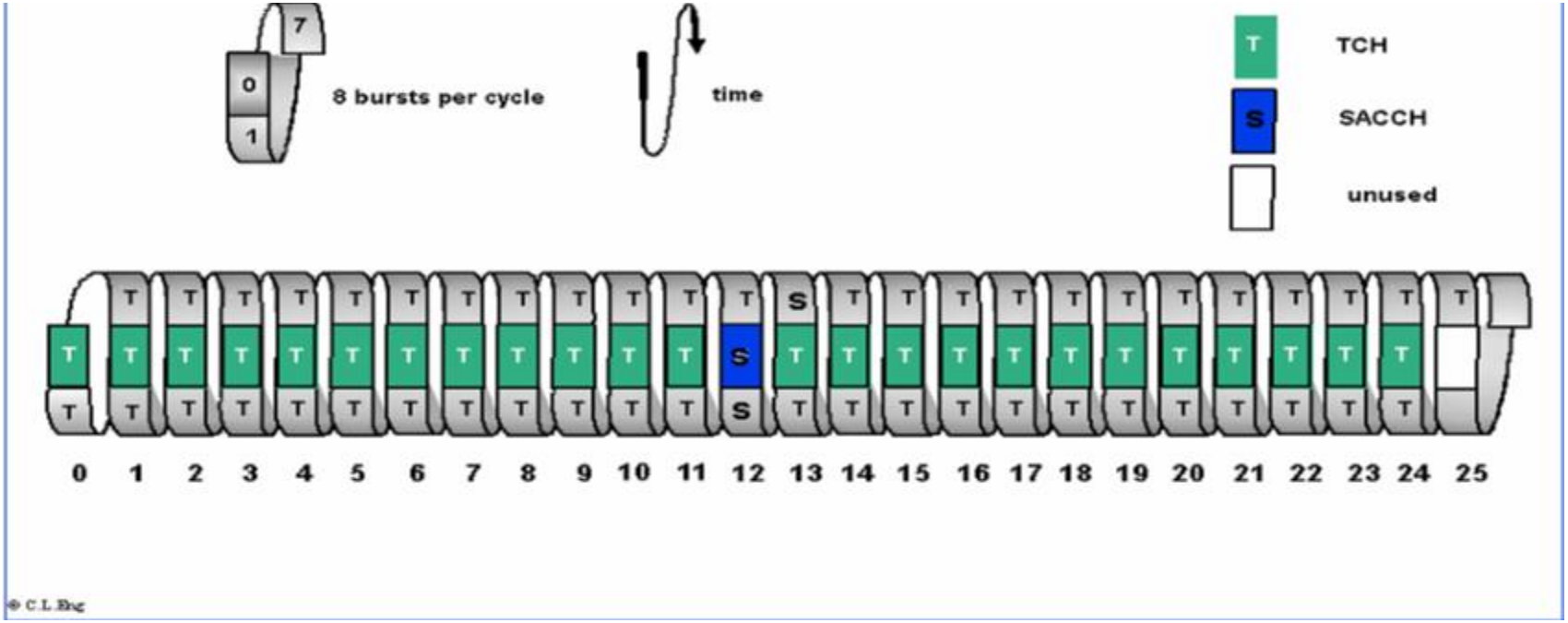
g) SDCCH/8 + SACCH/8 + CBCH

h) FCCH + SCH + BCCH + CCCH + SDCCH/4 + SACCH/C4 + CBCH (TS 0)

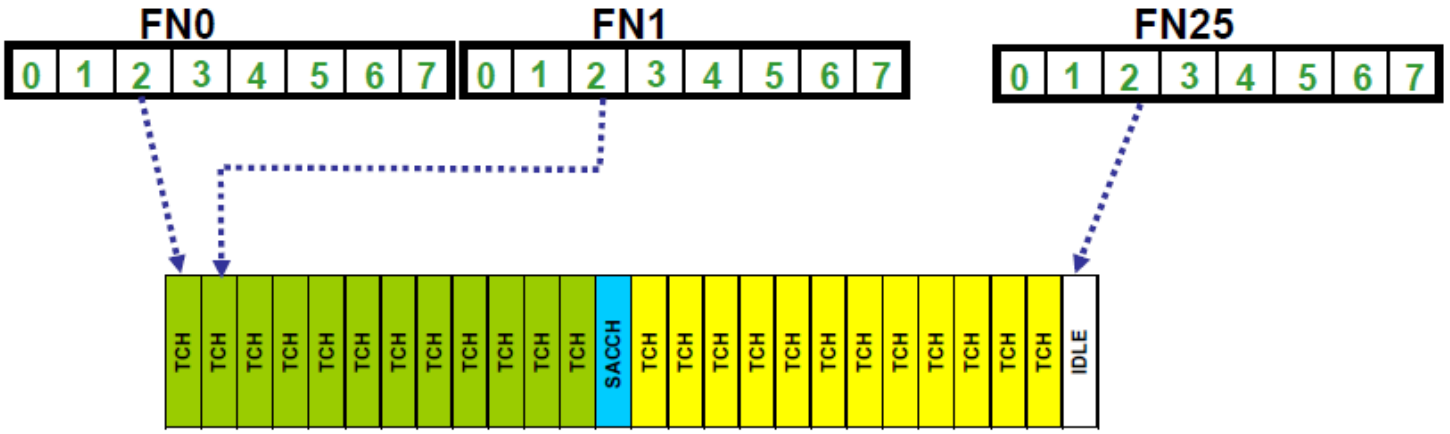
***A "**+**" indicates that the channels are used simultaneously.

a) TCH/F + FACCH/F + SACCH/TF



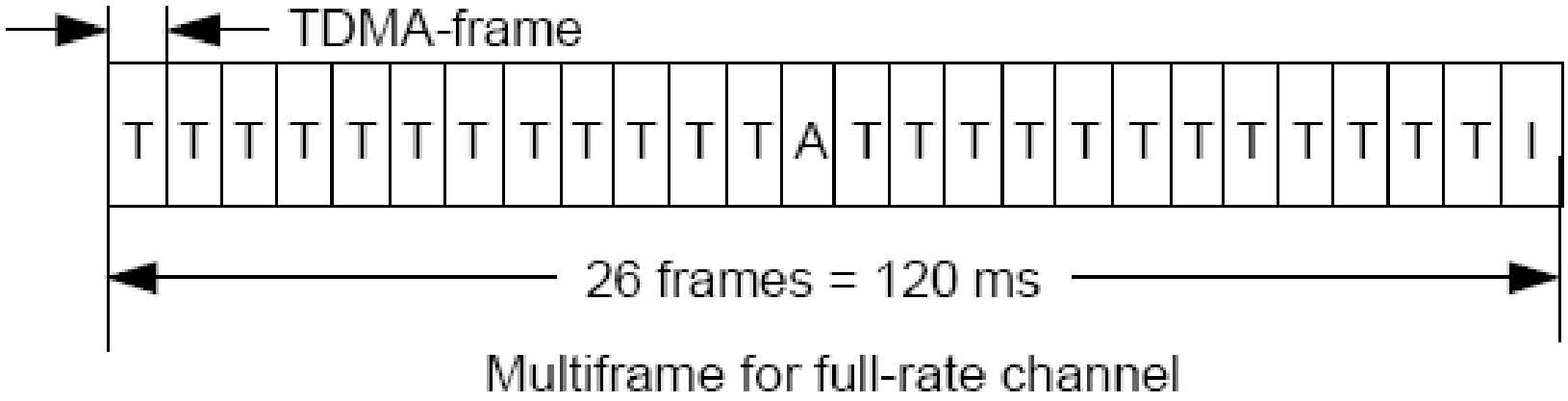


- **Channel Mapping: Logical to Physical**
  - **TCH carrier**
    - **TCH/F + SACCH/TF + FACCH/F**

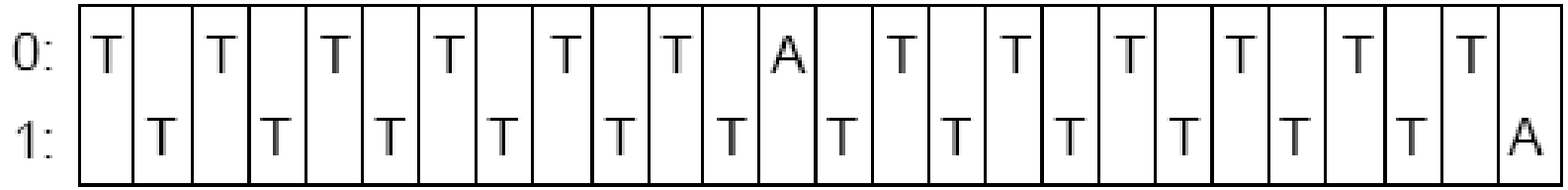


- **24 slots for TCH/F**
- **1 slot for SACCH**
- **1 idle slot**

b) TCH/H + FACCH/H + SACCH/TH



Multiframe for full-rate channel



Multiframe for half-rate channels (0.1)

c) SDCCH/8 + SACCH/C8

SDCCH/8 Multiframe TS1: SDCCH/8

downlink

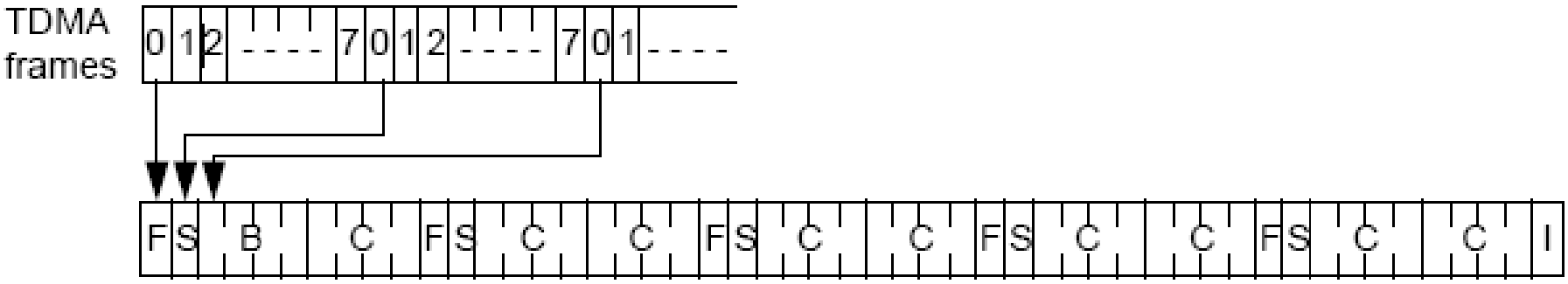
SDCCH				SDCCH				SDCCH				SDCCH				SDCCH				SDCCH				SDCCH				SDCCH				SACCH				SACCH				SACCH				SACCH				
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50

uplink

SACCH				SACCH				SACCH								SDCCH				SDCCH				SDCCH				SDCCH				SDCCH				SDCCH				SDCCH				SDCCH				SACCH			
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50

Note that the uplink and downlink patterns are time shifted, so that SDCCH subchannel 0 is sent in frames 0-3 on downlink and in frames 15-18 on uplink. The reason for this is to achieve more efficient communication, by giving the MS time to calculate its answers to the requests received on downlink SDCCH.

d) **FCCH + SCH + BCCH + CCCH (TS 0)-Uncombined**



BCCH + CCCH
(downlink)

F (FCCH) Frequency Correction Channel, **S** (SCH) Synchronization Channel,
B (BCCH - Norm) Broadcast Control Channel, **C** (CCCH) Common Control CHannel: Paging CHannel(PCH) or Access Grant CHannel (AGCH), **I** Idle

BCCH/CCCH Multiframe TS0: BCCH + CCCH/9

downlink

F	S	BCCH				CCCH				F	S	CCCH				CCCH				F	S	CCCH				CCCH				F	S	CCCH				CCCH				
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50

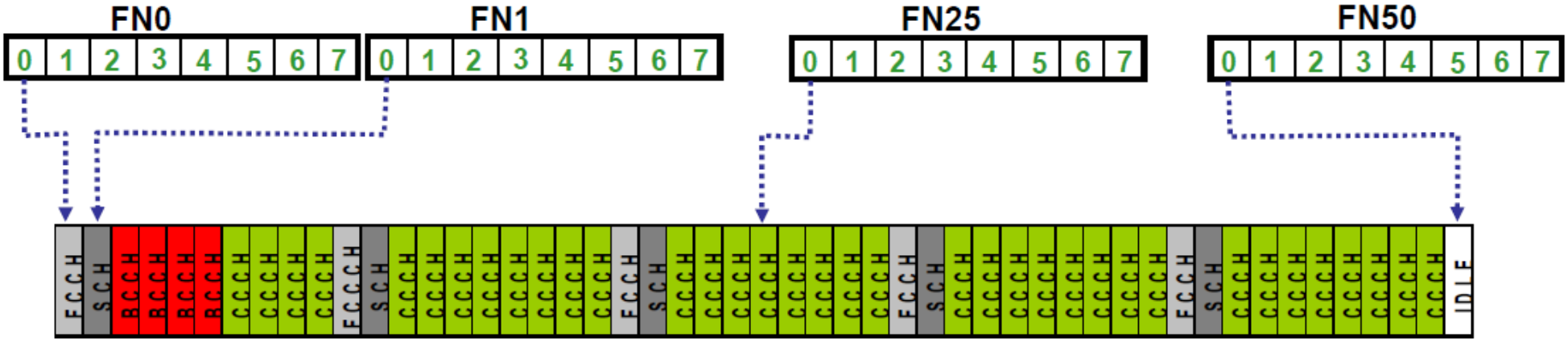
F = FCCH, S = SCH

uplink

R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50

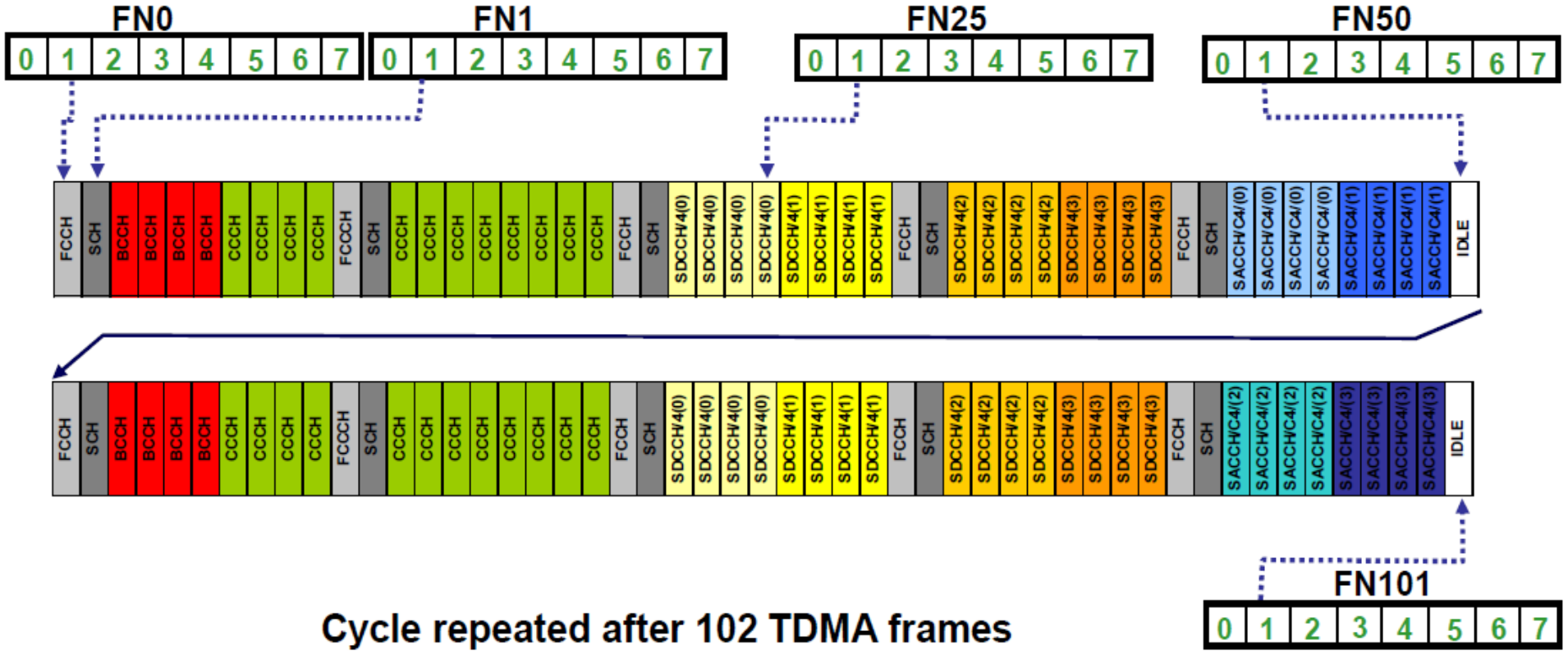
R = RACH

- **Channel Mapping: Logical to Physical**
  - **BCCH carrier (non combined)**
    - **FCH + SCH + BCCH + CCCH**



- **5 TS for FCH**
- **5 TS for SCH**
- **4 TS for BCCH**
- **36 TS for CCCH**
- **1 TS is idle**

- **Channel Mapping: Logical to Physical**
  - **BCCH carrier (combined)**
    - **FCCH + SCH + BCCH + CCCH + SDCCH/4 + SACCH/C4**



F = FCCH
S = SCH
B = BCCH
C = PCH or AGCH
D = SDCCH
A = SACCH
T = TCH

4.615 ms

TS0	TS1	TS2	TS3	TS4	TS5	TS6	TS7	
F	D	T	T	T	T	T	T	
S	D	T	T	T	T	T	T	
B	D	T	T	T	T	T	T	
B	D	T	T	T	T	T	T	
B	D	T	T	T	T	T	T	
B	D	T	T	T	T	T	T	
C	D	T	T	T	T	T	T	
C	D	T	T	T	T	T	T	
C	D	T	T	T	T	T	T	
C	D	T	T	T	T	T	T	
F	D	T	T	T	T	T	T	
S	D	T	T	T	T	T	T	
C	D	A	T	A	T	A	T	
C	D	T	T	T	T	T	T	
C	D	T	T	T	T	T	T	
C	D	T	T	T	T	T	T	

1 Frame

(Downlink - BTS transmit)

1 carrier = 200 kHz

R = RACH
A = SACCH
T = TCH

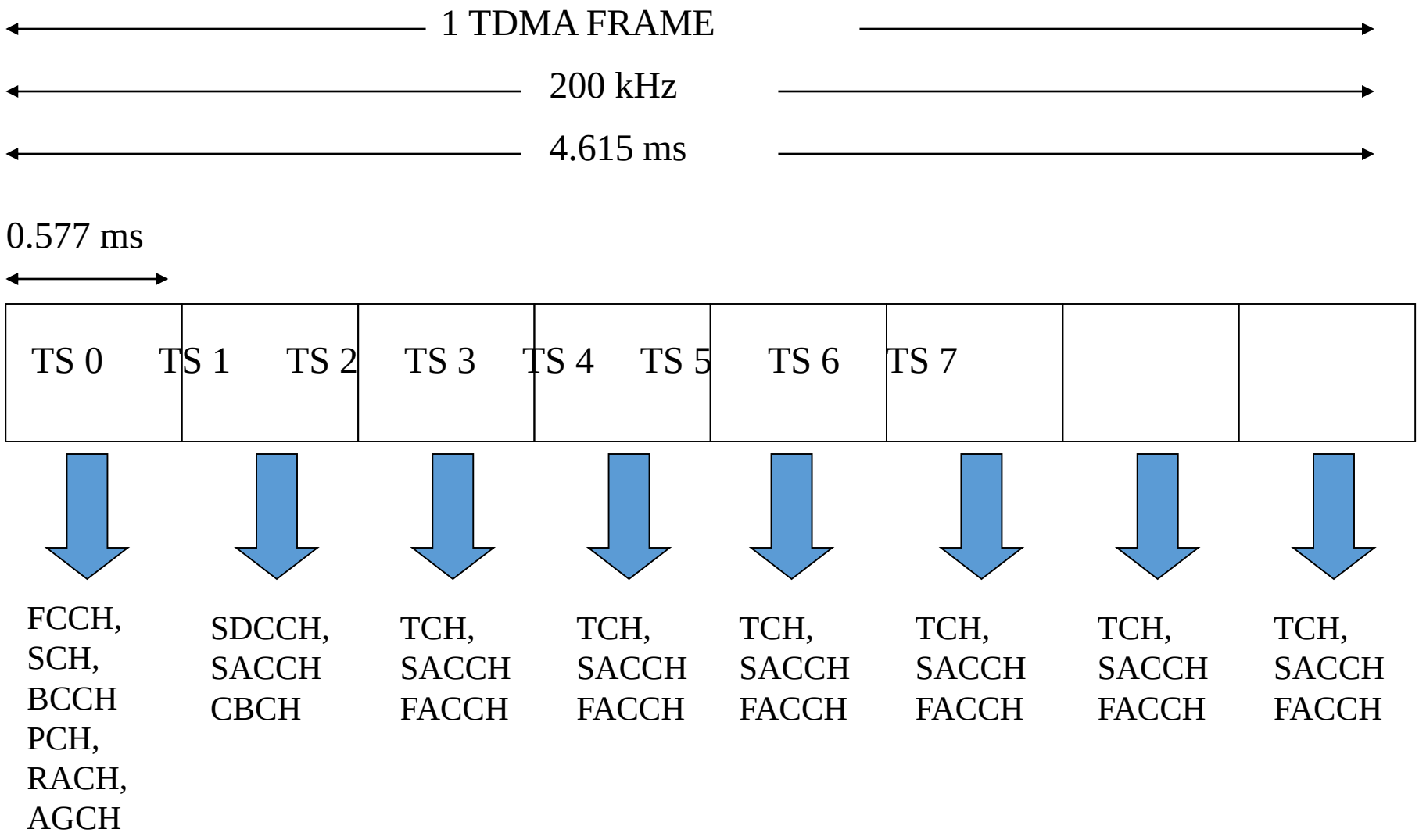
4.615 ms

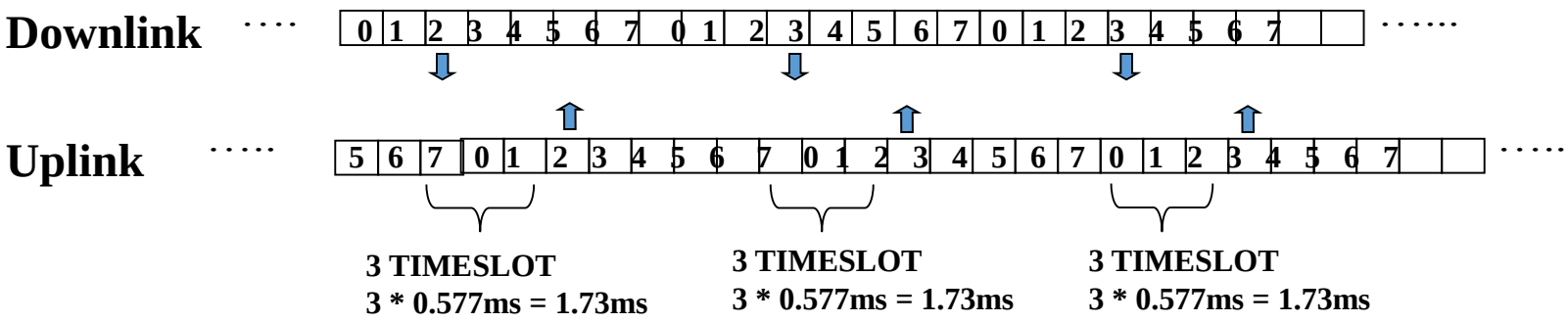
TS0	TS1	TS2	TS3	TS4	TS5	TS6	TS7	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	
R	D	A	I	A	I	A	I	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	
R	D	T	T	T	T	T	T	

1 Frame

(Uplink - Mobile transmit)

1 carrier = 200 kHz


1 TDMA FRAME
200 kHz
4.615 ms
0.577 ms
TS 0
TS 1
TS 2
TS 3
TS 4
TS 5
TS 6
TS 7
FCCH, SCH, BCCH PCH, RACH, AGCH
SDCCH, SACCH CBCH
TCH, SACCH FACCH
TCH, SACCH FACCH
TCH, SACCH FACCH
TCH, SACCH FACCH
TCH, SACCH FACCH
TCH, SACCH FACCH



TCH UP-DOWNLINK OFFSET

This means that the mobile does not transmit and receive at the same time.

Also note that :

in TS 0 : All the Logical Channels will repeat itself after 51 frames
in TS 1 : All the Logical Channels will repeat itself after 102 frames
in TS 2 to 7 : All the Logical Channels will repeat itself after 26 frames

MOBILE STATIONS ISDN NUMBER (MSISDN)

=> Is the mobile number used in a GSM PLMN (Public Land Mobile Network)
MSISDN = Country Code + National Destination Code + Subscriber number
e.x. 63 + 0918 + 8889999
Maximum length is 15 digits.

INTERNATIONAL MOBILE SUBSCRIBER IDENTITY (IMSI)

=> Is the subscriber number used over radio path for all signaling in the GSM PLMN.
This number is stored in SIM (Subscriber Identity Module), HLR (Home Location Register, and VLR (Visitor Location Register).
IMSI = MCC + MNC + MSIN
= Mobile Country Code + Mobile Network Code + Mobile Identification Number
[3 digit] [2 digit] [11 digit]
e.x. 502 + 19 + 2345451

TEMPORARY MOBILE SUBSCRIBER IDENTITY (TMSI)

=> Is used for the subscriber's confidentiality. Since the TMSI has only local significance (within MSC/VLR) the structure of the TMSI can be chosen by the Vendor.
But the size must be 1/2 of the size of IMSI. Each time a mobile request for location updating or call setup, MSC/VLR allocates to the IMSI a new TMSI, so the TMSI is used on the signaling path, protecting the IMSI identity. Plus since the TMSI is half the size of IMSI, we can page twice the amount compared to IMSI.

LOCATION AREA IDENTITY (LAI)

=> Is used to uniquely identify each location area in the GSM PLMN. When the system receives an incoming call it knows in which location area it should page the mobile and does not page the entire network.

LAI = MCC + MNC + LAC

Mobile Country Code + Mobile Network Code + Location Area Code

[3 digit] [2 digit] [1 to 65 536]

e.x. = 502 + 20 + 60001

CELL GLOBAL IDENTITY (CGI)

=> Is used for cell identification within the GSM network.

LAI = MCC + MNC + LAC + CI

Mobile Country Code + Mobile Network Code + Location Area Code + Cell Identity

[3 digit] [2 digit] [1 to 65 536] [1 to 65 536]

e.x. = 502 + 20 + 60001 + 50001

BASE STATION IDENTITY CODE (BSIC)

=> Is used to distinguish co channel Frequency used in the neighboring cell.

BSIC = NCC + BCC

Network Color Code + Base Station Color Code

[1 to 7] [1 to 7]

SUBSCRIBER IDENTITY MODULE (SIM)

SIM is used to provide storage on subscriber related information as following :
• IMSI (International Mobile Subscriber Identity).
• Temporary network data like TMSI, LAI, Location update status.
• Subscriber Authentication Key (Ki) and Ciphering Key (Kc) which are used for security purposes.
• BCCH information : List of carrier frequencies to be used for cell selection.
• Forbidden PLMN.
• Language preference.
• PIN number (Personal Identification Number) and PIN error counter.
• PUK number (Personal Unlock Key) and PUK error counter.

PIN management

The PIN number consist of 4 to 8 digit and it is loaded by the service activator an subscription time. Afterwards the PIN number can be changed as many times an user wishes including the length of the PIN number.
The user can disable the PIN function but again can be inhibited at subscription time by a authorized person. If an incorrect PIN is entered, an indication is given to the user. After 3 consecutive entries the SIM is blocked, even if if the SIM is removed or the mobile is switch off and on.
If the SIM card is blocked the user cannot access the network. The unblocking of the SIM card can only be done by keying in the PUK (Personal Unlock Key). PUK is 8 digit and is given to the user at subscription time. If an incorrect PUK is entered more than 10 times then the PUK will not work anymore and the SIM card will continue to be blocked until taken to the mobile vendor service center.


Thank
you