# GSM Logical Channels

## Control Channels

### Broadcast Control Channel (BCCH)

The Broadcast Control Channel is transmitted by the BTS at all times. The RF carrier used to transmit the BCCH is referred to as the BCCH carrier. The information carried on the BCCH is monitored by the MS periodically (at least every 30 secs), when it is switched on and not in a call.

Broadcast Control Channel (BCCH) – Carries the following information (this is only a partial list):

- Location Area Identity (LAI).
- List of neighbouring cells which should be monitored by the MS.
- List of frequencies used in the cell.
- Cell identity.
- Power control indicator.
- DTX permitted.
- Access control (for example, emergency calls, call barring).
- CBCH description.

The BCCH is transmitted at constant power at all times, and its signal strength is measured by all MS which may seek to use it. “Dummy” bursts are transmitted to ensure continuity when there is no BCCH carrier traffic.

- **Frequency Correction Channel (FCCH)**

  This is transmitted frequently on the BCCH timeslot and allows the mobile to synchronize its own frequency to that of the transmitting base site. The FCCH may only be sent during timeslot 0 on the BCCH carrier frequency and therefore it acts as a flag to the mobile to identify Timeslot 0.

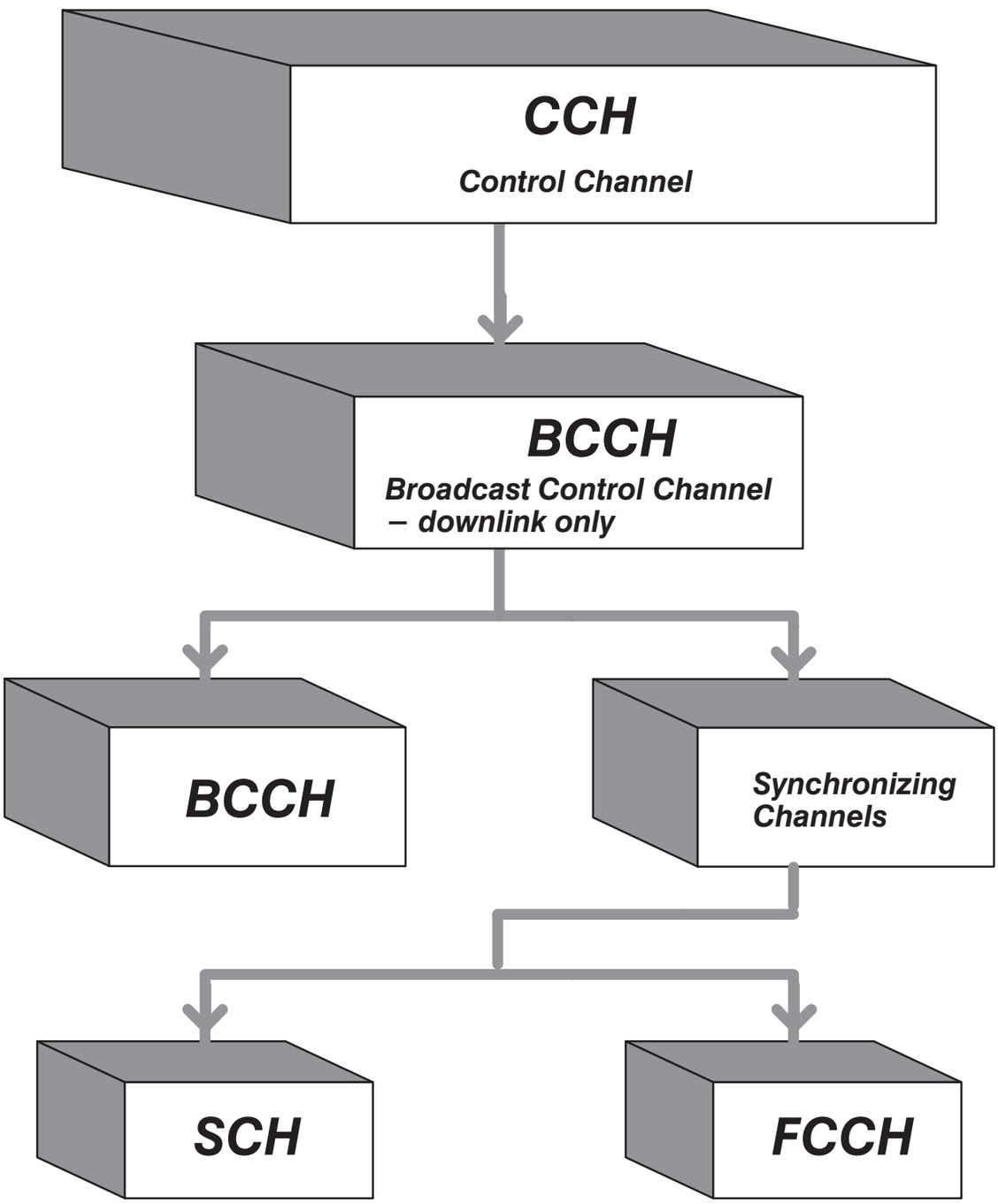
- **Synchronization Channel (SCH)**

  The SCH carries the information to enable the MS to synchronize to the TDMA frame structure and know the timing of the individual timeslots. The following parameters are sent:

  – Frame number.
  – Base Site Identity Code (BSIC).

The MS will monitor BCCH information from surrounding cells and store the information from the best six cells. The SCH information on these cells is also stored so that the MS may quickly resynchronize when it enters a new cell.

# Broadcast Control Channel (BCCH)



## Control Channels

### Common Control Channels (CCCH)

The Common Control Channel (CCCH) is responsible for transferring control information between all mobiles and the BTS. This is necessary for the implementation of “call origination” and “call paging” functions.

It consists of the following:

- **Random Access Channel (RACH)**

  Used by the mobile when it requires to gain access to the system. This occurs when the mobile initiates a call or responds to a page.

- **Paging Channel (PCH)**

  Used by the BTS to page MS, (paging can be performed by an IMSI, TMSI or IMEI).

- **Access Grant Control Channel (AGCH)**

  Used by the BTS to assign a dedicated control channel to a MS in response to an access message received on the Random Access Channel. The MS will move to the dedicated channel in order to proceed with either a call setup, response to a paging message, Location Area Update or Short Message Service.

- **Cell Broadcast Channel (CBCH)**

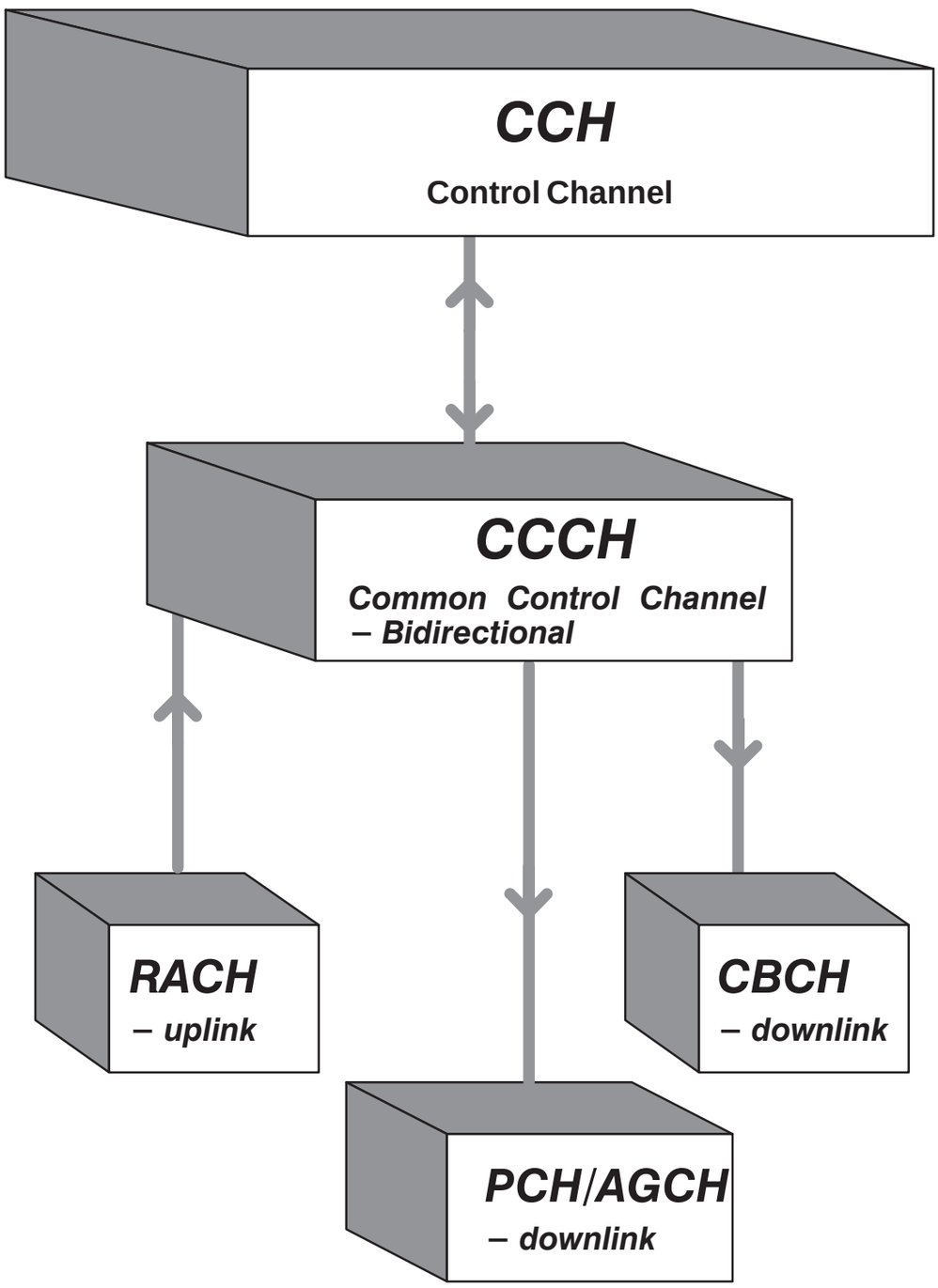
  This channel is used to transmit messages to be broadcast to all MSs within a cell. The CBCH uses a dedicated control channel to send its messages, however it is considered a common channel because the messages can be received by all mobiles in the cell.

Active MSs must frequently monitor both BCCH and CCCH. The CCCH will be transmitted on the RF carrier with the BCCH.

***Acronyms:***

| | |
|---|---|
| CCCH | Common Control Channel |
| RACH | Random Access Channel |
| PCH | Paging Channel |
| AGCH | Access Grant Channel |
| CBCH | Cell Broadcast Channel |

# Common Control Channel (CCCH)



## Control Channels

### Dedicated Control Channels (DCCH)

The DCCH is a single timeslot on an RF carrier which is used to convey eight Stand-alone Dedicated Control Channels (SDCCH). A SDCCH is used by a single MS for call setup, authentication, location updating and SMS point to point.

As we will see later, SDCCH can also be found on a BCCH/CCCH timeslot, this configuration only allows four SDCCHs.

### Associated Control Channels (ACCH)

These channels can be associated with either an SDCCH or a TCH. They are used for carrying information associated with the process being carried out on either the SDCCH or the TCH.

- **Slow Associated Control Channel (SACCH)**

  Conveys power control and timing information in the downlink direction (towards the MS) and Receive Signal Strength Indicator (RSSI), and link quality reports in the uplink direction.

- **Fast Associated Control Channel (FACCH)**

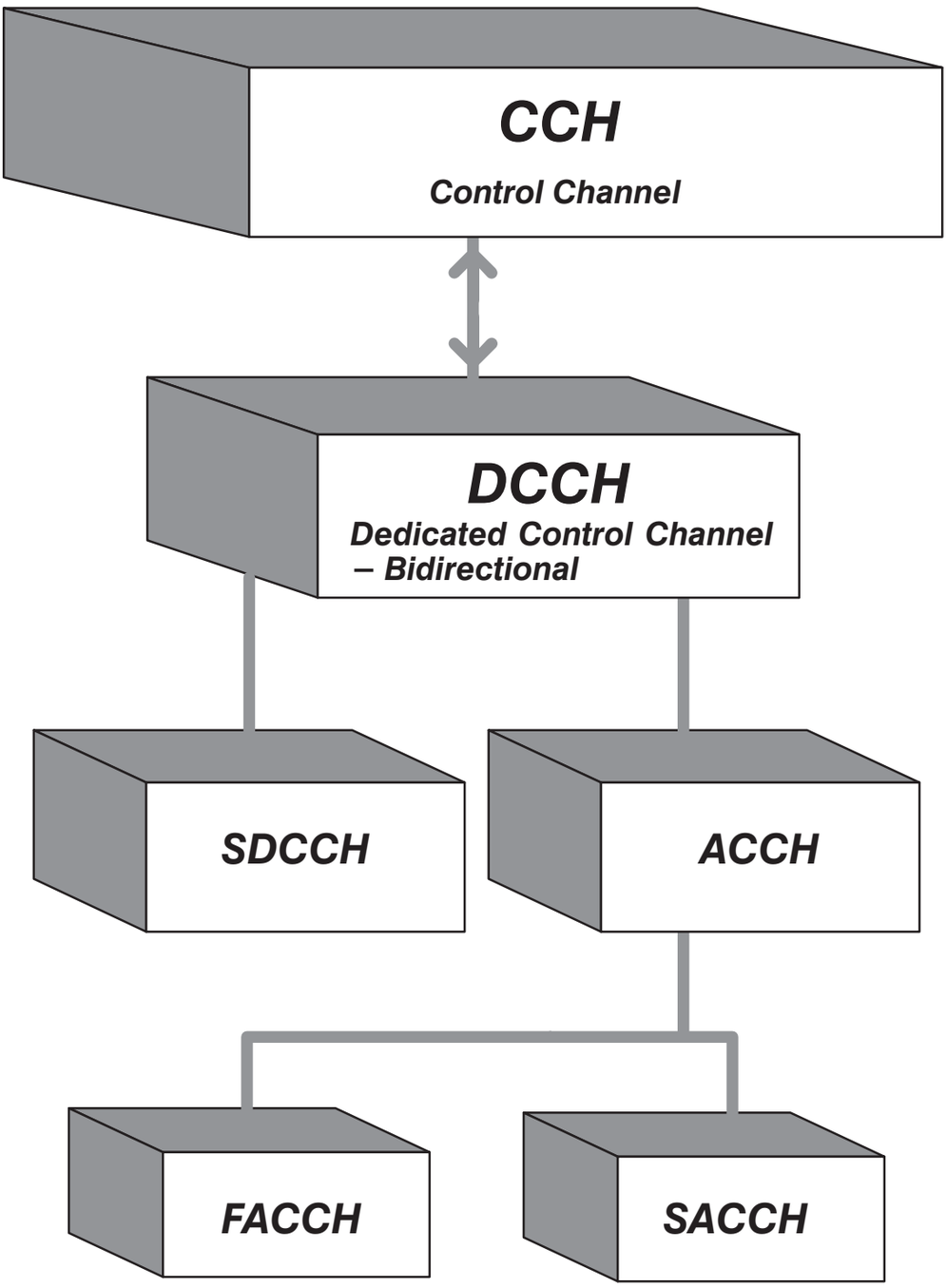
  The FACCH is transmitted instead of a TCH. The FACCH "steals" the TCH burst and inserts its own information. The FACCH is used to carry out user authentication, handovers and immediate assignment.

All of the control channels are required for system operation, however, in the same way that we allow different users to share the radio channel by using different timeslots to carry the conversation data, the control channels share timeslots on the radio channel at different times. This allows efficient passing of control information without wasting capacity which could be used for call traffic. To do this we must organise the timeslots between those which will be used for traffic and those which will carry control signalling.

***Acronyms:***

| | |
|---|---|
| SDCCH | Stand-alone Dedicated Control Channel |
| SACCH | Slow Associated Control Channel |
| FACCH | Fast Associated Control Channel |

# Dedicated Control Channel (DCCH)



## Channel Combinations

The different logical channel types mentioned are grouped into what are called channel combinations. The four most common channel combinations are listed below:

- Full Rate Traffic Channel Combination – TCH8/FACCH + SACCH
- Broadcast Channel Combination – BCCH + CCCH
- Dedicated Channel Combination – SDCCH8 + SACCH8
- Combined Channel Combination – BCCH+CCCH+SDCCH4+SACCH4

The Half Rate Channel Combination (when introduced) will be very similar to the Full Rate Traffic Combination.

- Half Rate Traffic Channel Combination – TCH16/FACCH + SACCH

## Channel Combinations and Timeslots

The channel combinations we have identified are sent over the air interface in a selected timeslot.

Some channel combinations may be sent on any timeslot, but others must be sent on specific timeslots. Below is a table mapping the channels combinations to their respective timeslots:

| Channel Combination | Timeslots |
|---|---|
| Traffic | Any timeslot |
| Broadcast | 0,2,4,6 (0 must be used first) * |
| Dedicated | Any timeslot |
| Combined | 0 only |

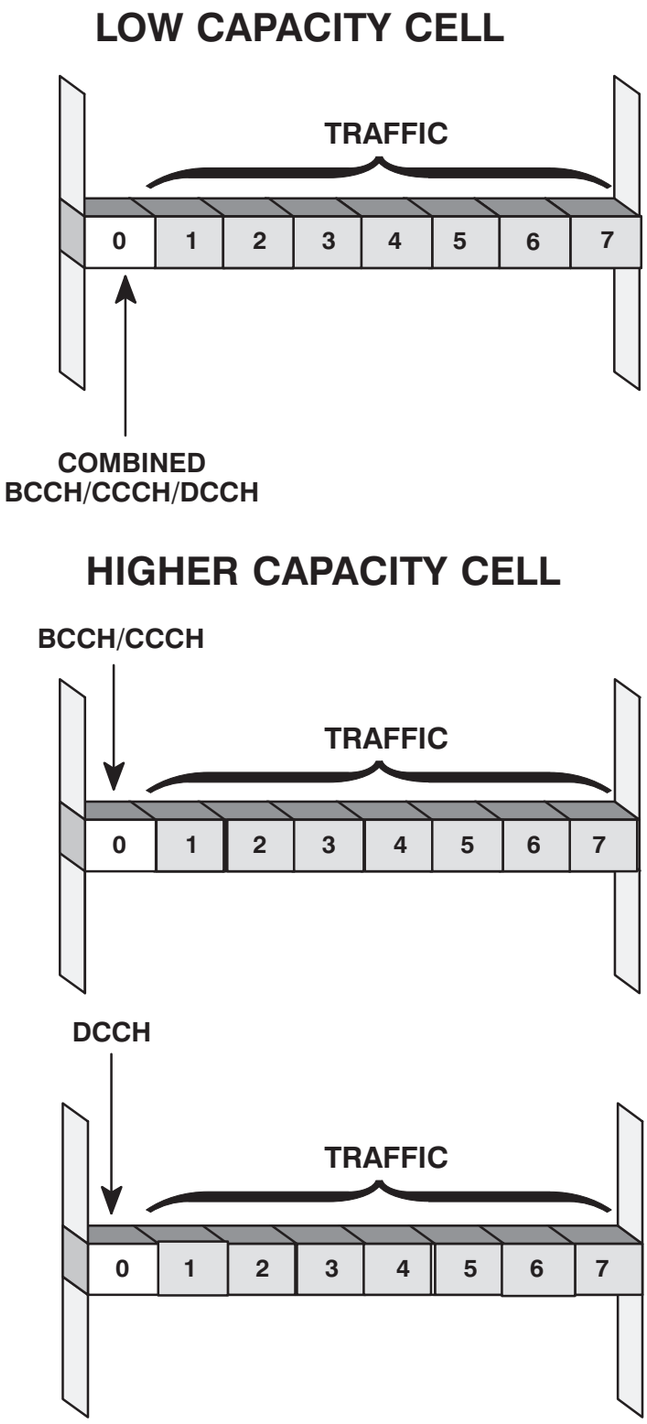
The diagram opposite illustrates how these different channel combinations may be mapped onto the TDMA frame structure.

***** If broadcast is assigned to timeslots 2, 4 or 6 then FCCH and SCH will be replaced with dummy bursts since these control channels may only occur on timeslot 0.

***Note:***

Only one BCCH/CCCH timeslot is required per cell (not RF carrier).

# Timeslots and TDMA Frames



# Multiframes and Timing

There are eight timeslots within each TDMA frame, enabling eight physical channels to share a single physical resource – the RF carrier. In turn, each physical channel may be shared by a number of logical channels.

In order to understand how a single physical channel is shared by various logical channels, it is necessary to introduce the GSM *multiframe* structures that make it possible.

## The 26-frame Traffic Channel Multiframe

The illustration opposite shows the time relationship between time-slot, TDMA frame, and the 26-frame multiframe. Some of the times shown are approximate numbers as the GSM recommendations actually state the exact values as fractions rather than in decimal form (for example, the exact duration of a time-slot is 15/26 ms).

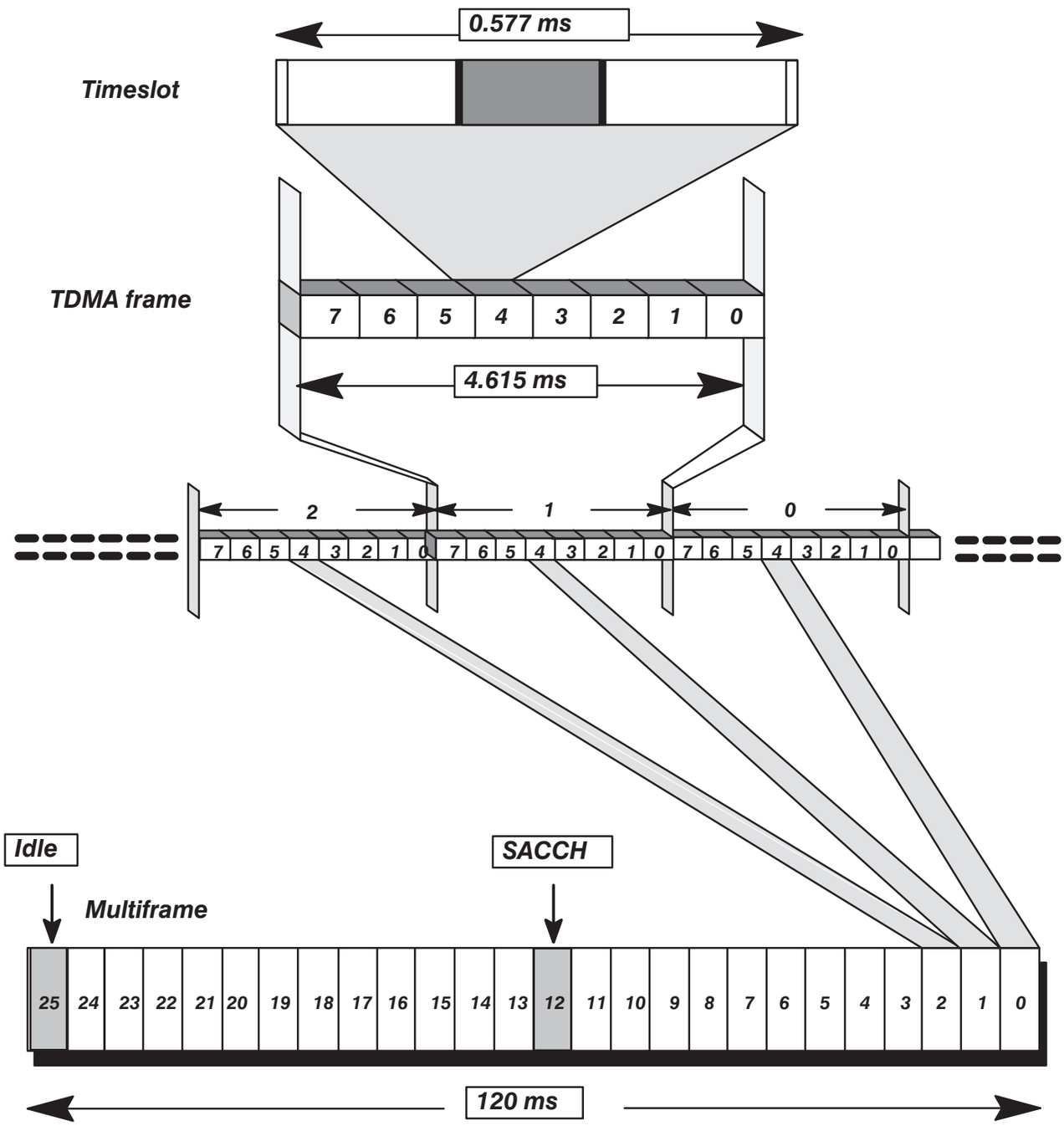
***Note:***

The 12th frame (no. 13) in the 26-frame traffic channel multiframe is used by the Slow Associated Control Channel (SACCH) which carries link control information to and from the MS–BTS. Each timeslot in a cell allocated to traffic channel usage will follow this format, that is, 12 bursts of traffic, 1 burst of SACCH, 12 bursts of traffic and 1 idle.

The duration of a 26-frame traffic channel multiframe is 120 ms (26 TDMA frames).

When half rate is used, each frame of the 26-frame traffic channel multiframe allocated for traffic will now carry two MS subscriber calls (the data rate for each MS is halved over the air interface). Although the data rate for traffic is halved, each MS still requires the same amount of SACCH information to be transmitted, therefore frame 12 WILL BE USED as SACCH for one half of the MSs and the others will use it as their IDLE frame, and the same applies for frame 25, this will be used by the MSs for SACCH (those who used frame 12 as IDLE) and the other half will use it as their IDLE frame.

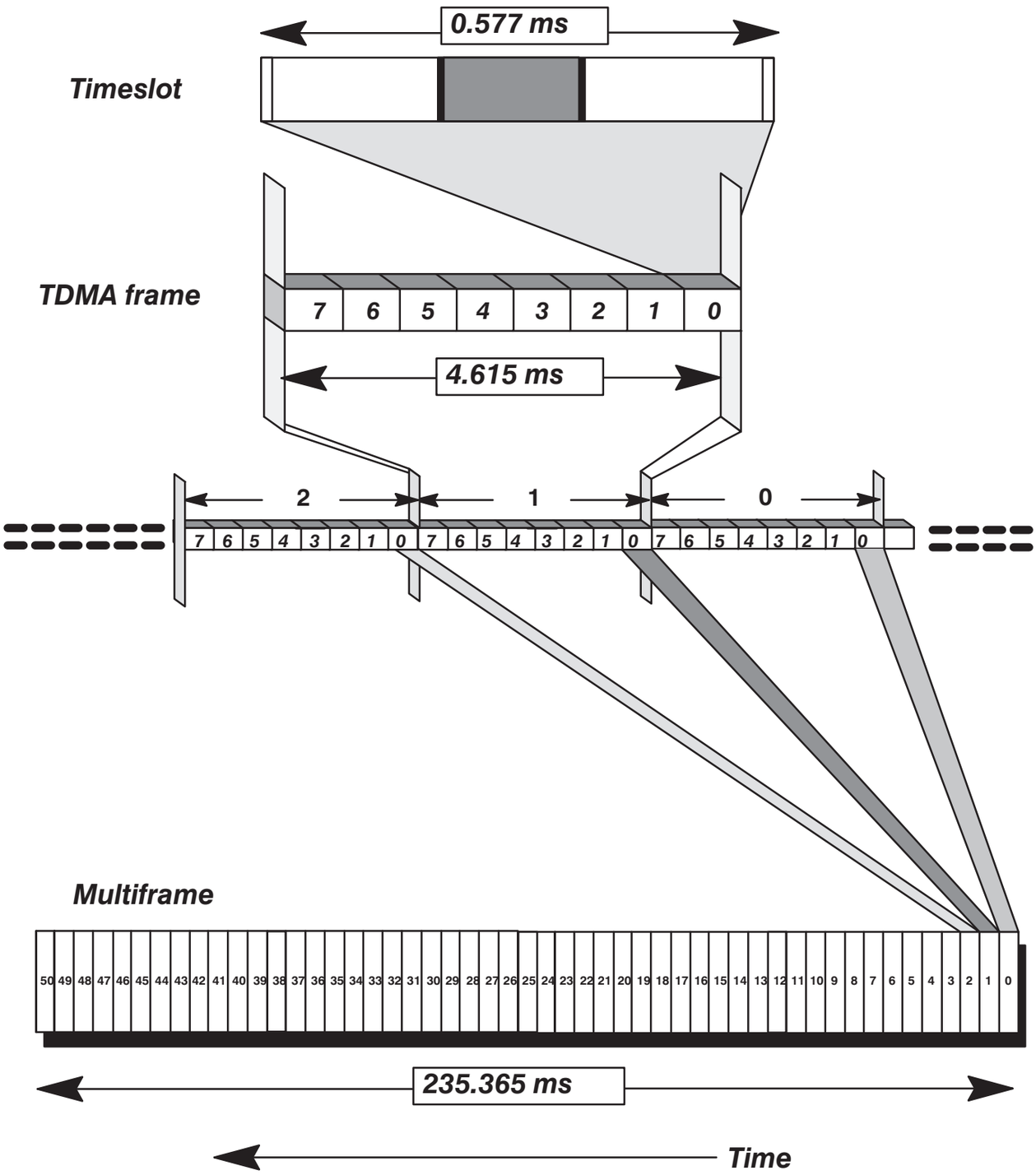
# 26-Frame Traffic Channel Multiframe



## The 51-frame Control Channel Multiframe

The 51-frame structure used for control channels is considerably more complex than the 26-frame structure used for the traffic channels. The 51-frame structure occurs in several forms, depending on the type of control channel and the network provider's requirements.

# 51-Frame Control Channel Multiframes

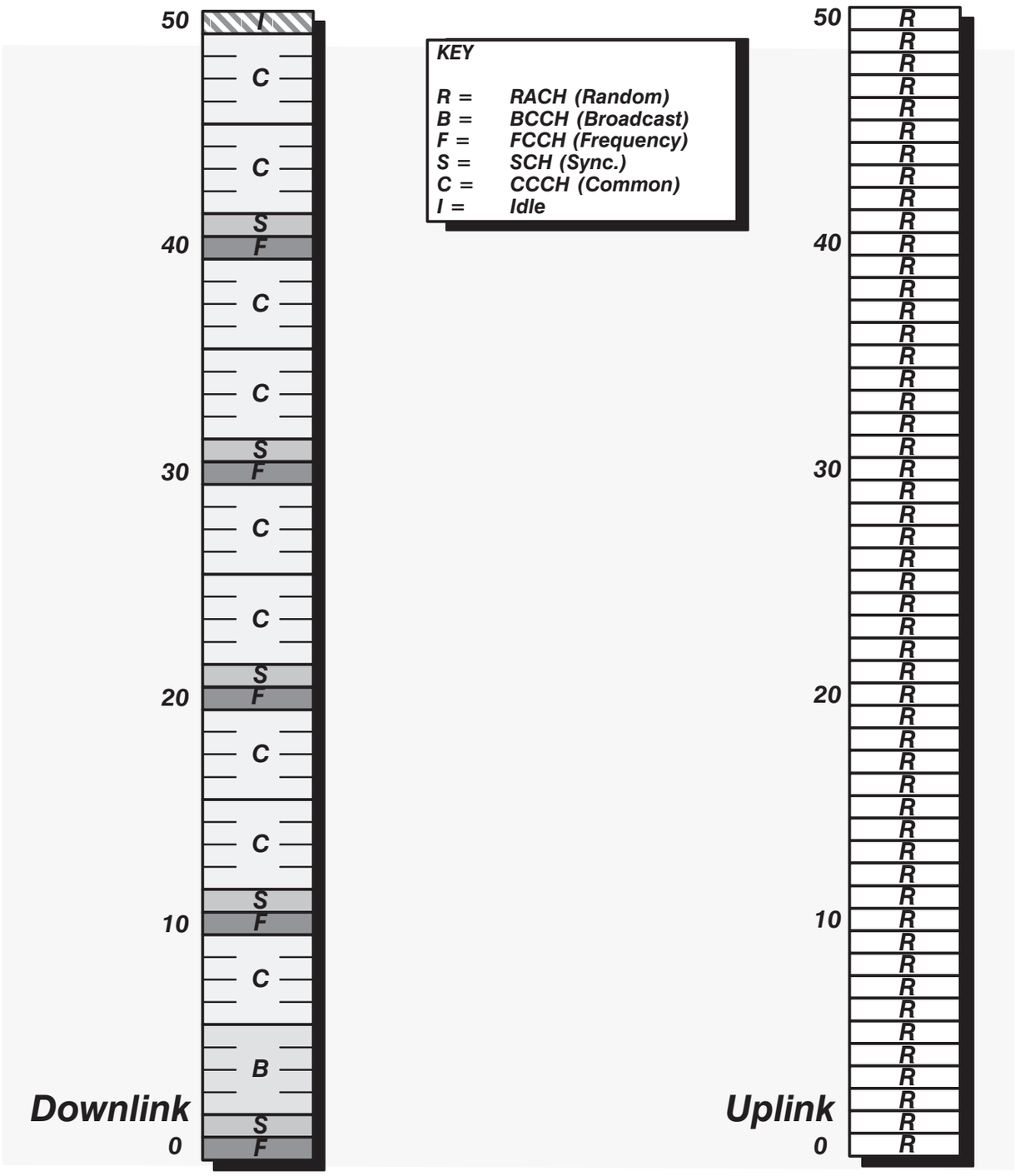


## The 51-frame Control Channel Multiframe (BCCH/CCCH)

The BCCH/CCCH 51-frame structure illustrated on the opposite page will apply to timeslot 0 of each TDMA frame on the 'BCCH carrier' (the RF carrier frequency to which BCCH is assigned on a per cell basis). In the diagram, each vertical step represents one repetition of the timeslot (= one TDMA frame), with the first repetition (numbered 0) at the bottom.

Looking at the uplink (MS–BSS) direction, all timeslot 0s are allocated to RACH. This is fairly obvious because RACH is the only control channel in the BCCH/CCCH group which works in the uplink direction. In the downlink direction (BSS–MS), the arrangement is more interesting. Starting at frame 0 of the 51-frame structure, the first timeslot 0 is occupied by a frequency burst ('F' in the diagram), the second by a synchronizing burst ('S') and then the following four repetitions of timeslot 0 by BCCH data (B) in frames 2–5. The following four repetitions of timeslot 0 in frames 6–9 are allocated to CCCH traffic (C), that is, to either PCH (mobile paging channel) or AGCH (access grant channel). Then follows, in timeslot 0 of frames 10 and 11, a repeat of the frequency and synchronising bursts (F and S), four further CCCH bursts (C) and so on. Note that the last timeslot 0 in the sequence (the fifty-first frame – frame 50) is idle.

# BCCH/CCCH Multiframe



## The 51-frame Control Channel Multiframe – DCCH/8 (SDCCH and SACCH)

The diagram opposite shows the 51-frame structure used to accommodate eight SDCCHs, although, as it takes two repetitions of the multiframe to complete the entire sequence, it may be more logical to think of it as a 102-frame structure. This structure may be transmitted on any timeslot.

Note that the SACCHs (shaded) are associated with the SDCCHs. It is important to remember that each SDCCH has an SACCH just like a traffic channel.

i.e. D0 associated with A0

D1 associated with A1

. .

. .

. .

. .

. .

D7 associated with A7

Note: The downlink and uplink channels are staggered in order to give the mobile time to process the received message and formulate a response.