The GSM Air Interface

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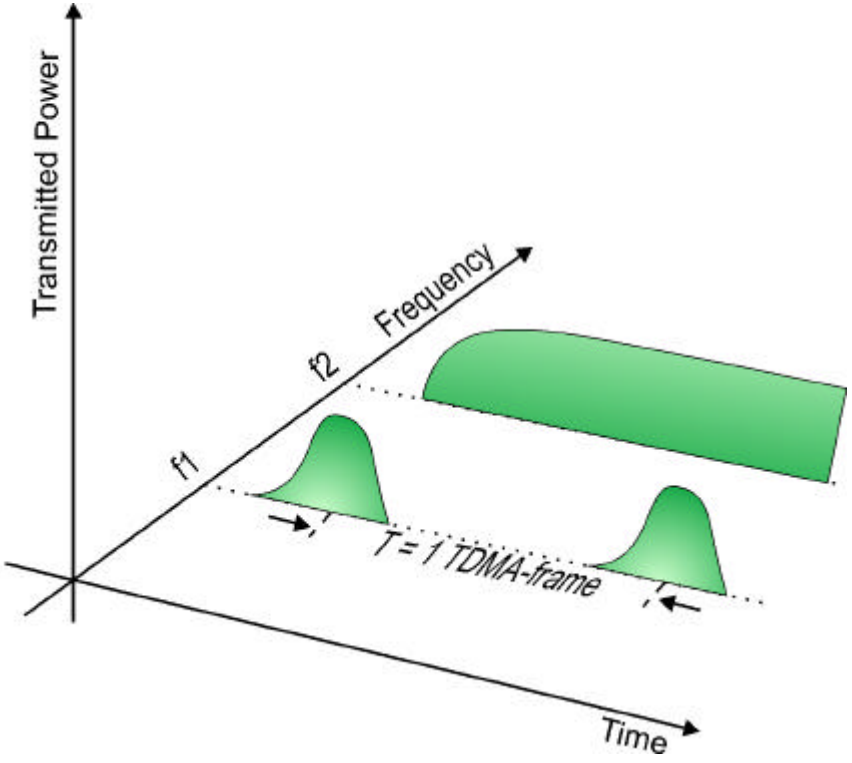
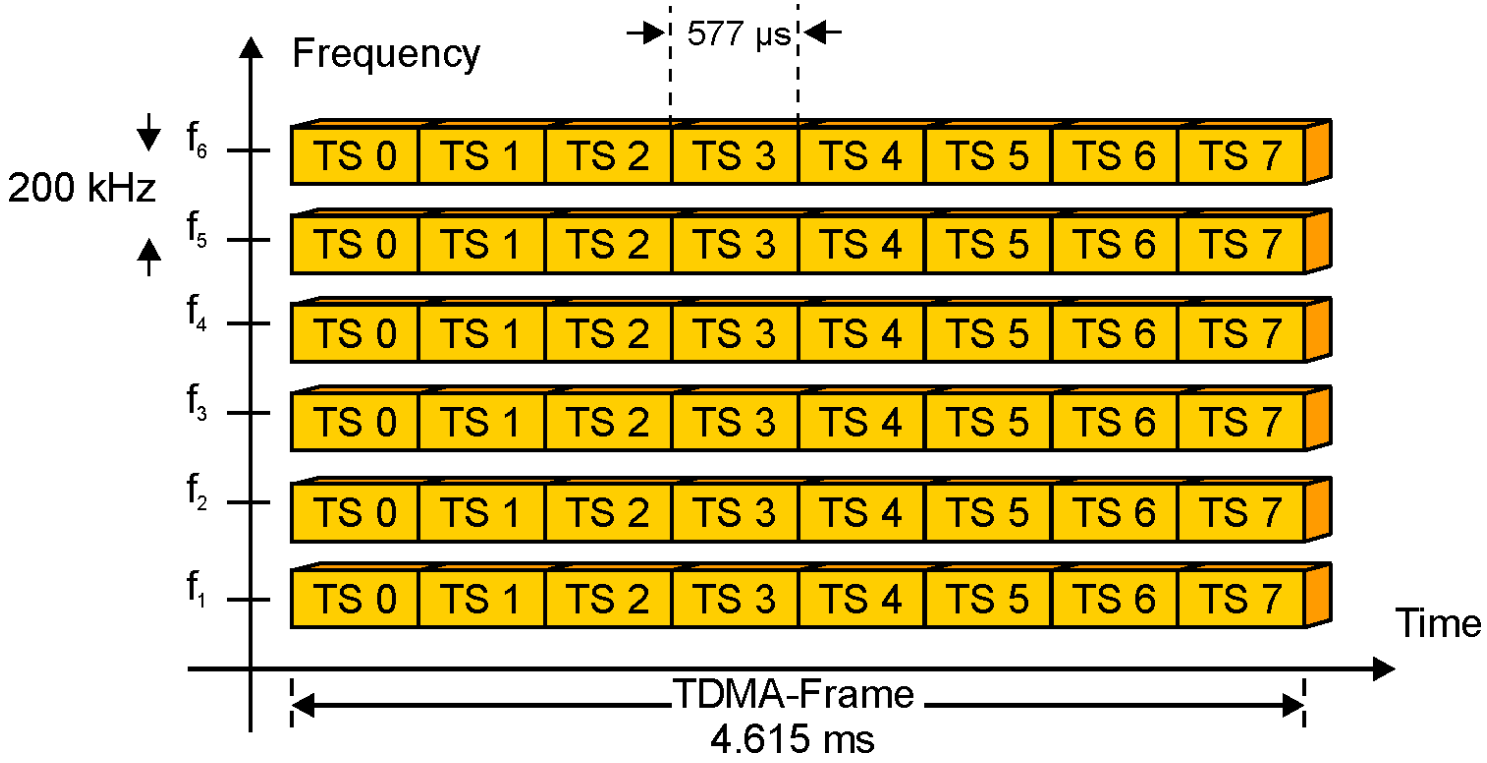
(1) Time Division Multiple Access (TDMA):

- ➔ Basically, three different access schemes need to be distinguished: FDMA, TDMA and CDMA. For GSM, a combined TDMA and FDMA scheme has been selected.
- ➔ In a TDMA system, each user is permitted to transmit so called bursts only during “his” timeslot.
- ➔ This way, multiple users may use a given frequency at the same time.
- ➔ In a plain FDMA system, each user is assigned one frequency. This frequency cannot be used by any-body else while this transaction is ongoing.



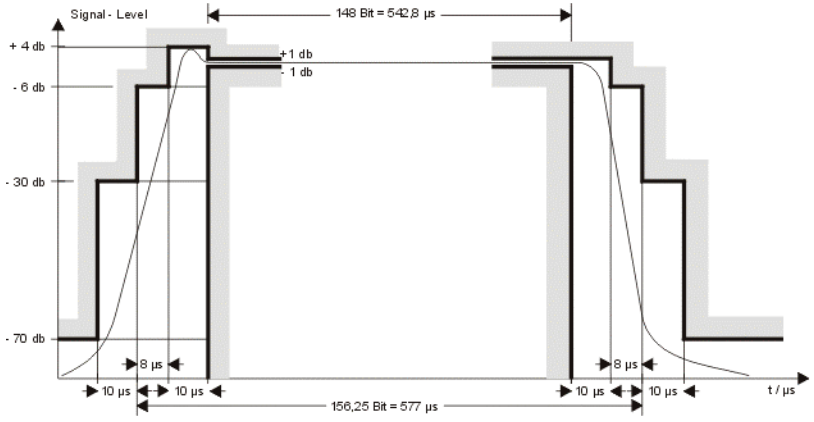
(2) Time Division Multiple Access (TDMA):

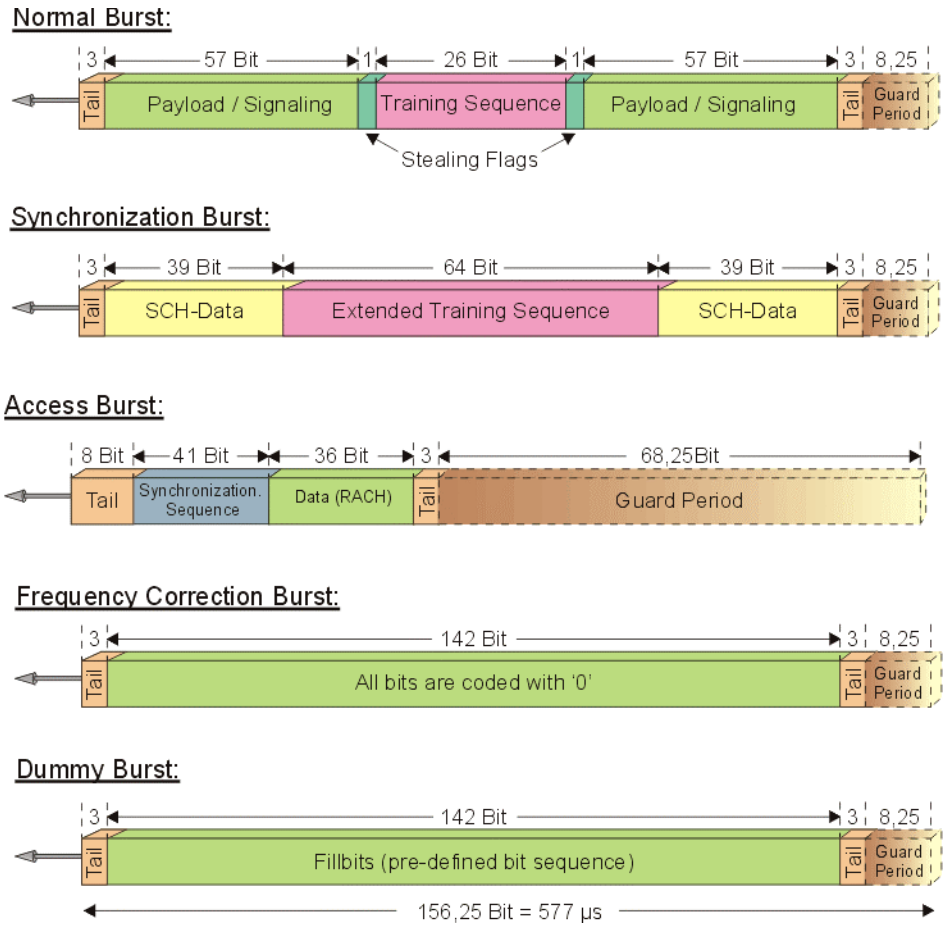


(3) Time Division Multiple Access (TDMA):

- ➔ In GSM, 1 Timeslot lasts 577 µs and 8 Timeslots are combined to 1 TDMA frame that lasts 4.615 ms.
- ➔ Two adjacent frequencies in GSM have a spacing of 200 kHz.
- ➔ In GSM, each frequency is divided into eight timeslots. Please note that you need one timeslot for uplink transmission and one timeslot for downlink transmission.

(1) The GSM Bursts:





(2) The GSM Bursts:

Each TDMA system achieves information transfer by means of so called bursts. In GSM, five different burst types have been defined:

- The **Frequency Correction Burst (FB)** is the simplest burst of all. It consists of 142 bits, all coded with '0' as well as a head and a tail. The FB is used on the not yet introduced FCCH (Frequency Correction Channel) that serves as the beacon of the BTS. A particular function of the FB is to allow the camping mobile stations a readjustment of their frequency generator.
- The **Synchronization Burst (SB)** is used on the Synchronization Channel (SCH) that has neither been introduced yet. The SCH conveys frame number and some initial identification of the cell to the surrounding mobile stations.

"Both types of bursts, FB and SB, as well as the respective channels are only applicable on timeslot 0 of the carrier that also transmits the BCCH."

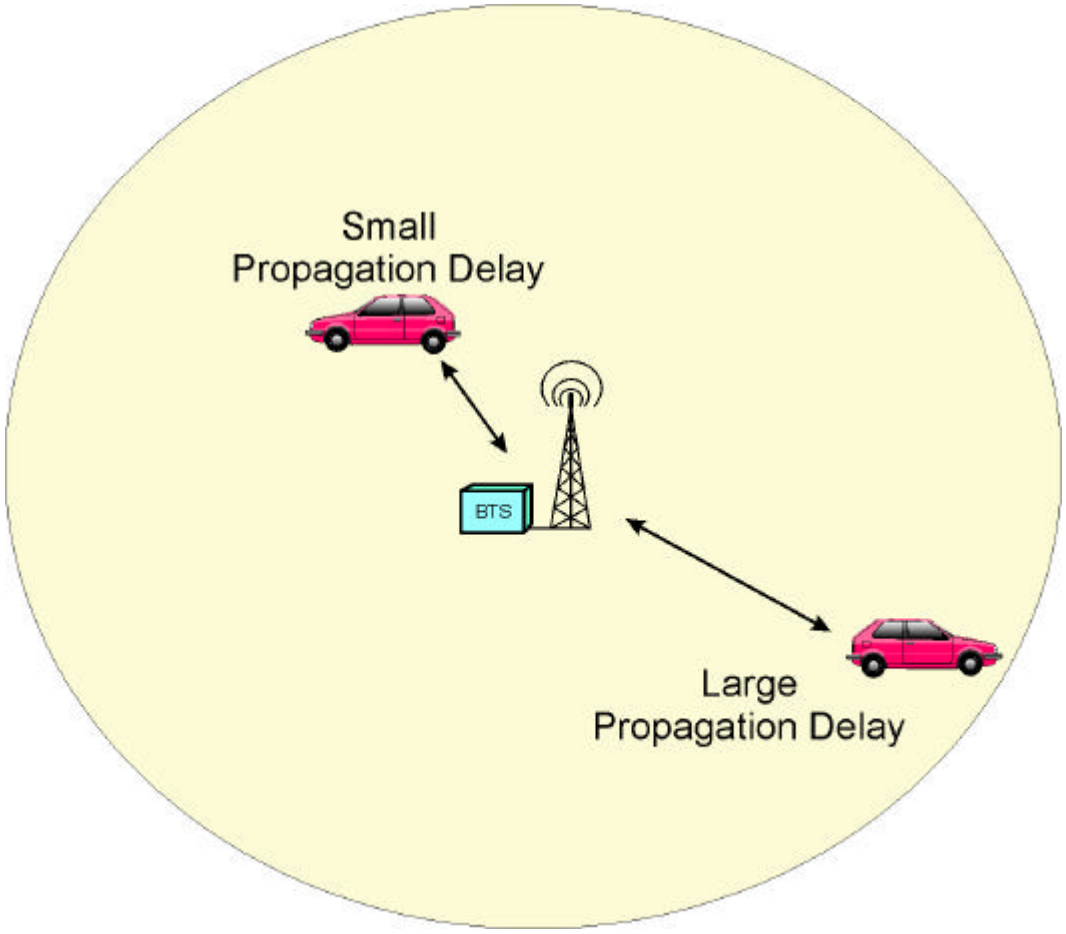
(3) The GSM Bursts:

- The **Access Burst (AB)** is used in uplink direction only in case the mobile station doesn't possess valid information about the current propagation delay of that cell. Therefore, the AB is shortened to ensure that it will definitely fit into the respective receive window of the BTS. This method allows for a maximum distance of 35 km between mobile station and BTS.

- The **Normal Burst (NB)** is the bearer for almost every kind of information, signaling and payload, in uplink and downlink direction.

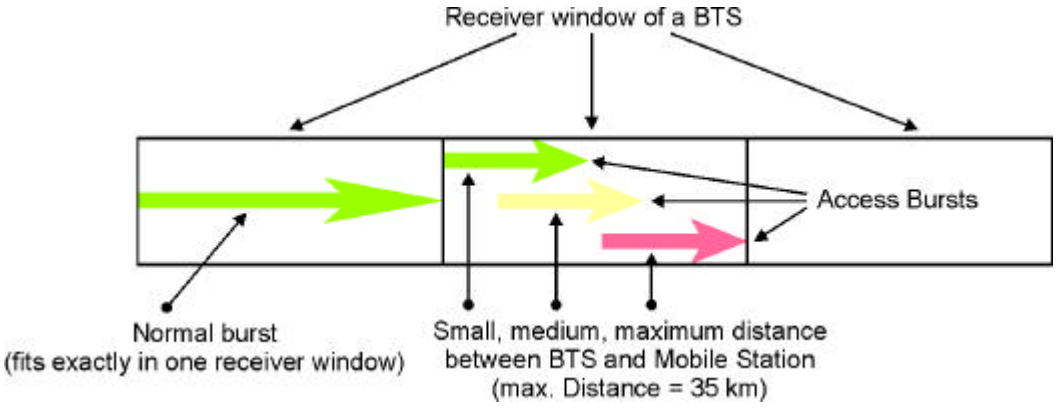
- The **Dummy Burst (DB)** serves a special function on the BCCH carrier where all timeslots need to transmit permanently, even without being in use. All not-used timeslots of the BCCH therefore transmit dummy bursts whereas a dummy burst consists of a pre-defined and fixed bit sequence. Permanent transmission on all timeslots of the BCCH carrier is required because the BCCH carrier serves as reference for handover and cell selection decisions.

(1) The Trouble with the Propagation Delay:



(2) The Trouble with the Propagation Delay:

- Each TDMA system inherently suffers from the propagation delay problem because the incoming uplink bursts must not collide at the BTS. Suitable measures need to be taken to resolve this problem.
- Obviously, the propagation delay varies with the distance between BTS and mobile station. In a mobile communication network like GSM, subscribers shall be able to roam. Thus, the propagation delay may also change during a transaction.
- Accordingly, the propagation delay needs to be determined not only initially, that is when a connection between mobile station and network is established, but also periodically during a transaction.
- The figure on the side illustrates three 'receiver windows' of a BTS. Please focus on the window in the middle as it illustrates the function of the access burst.



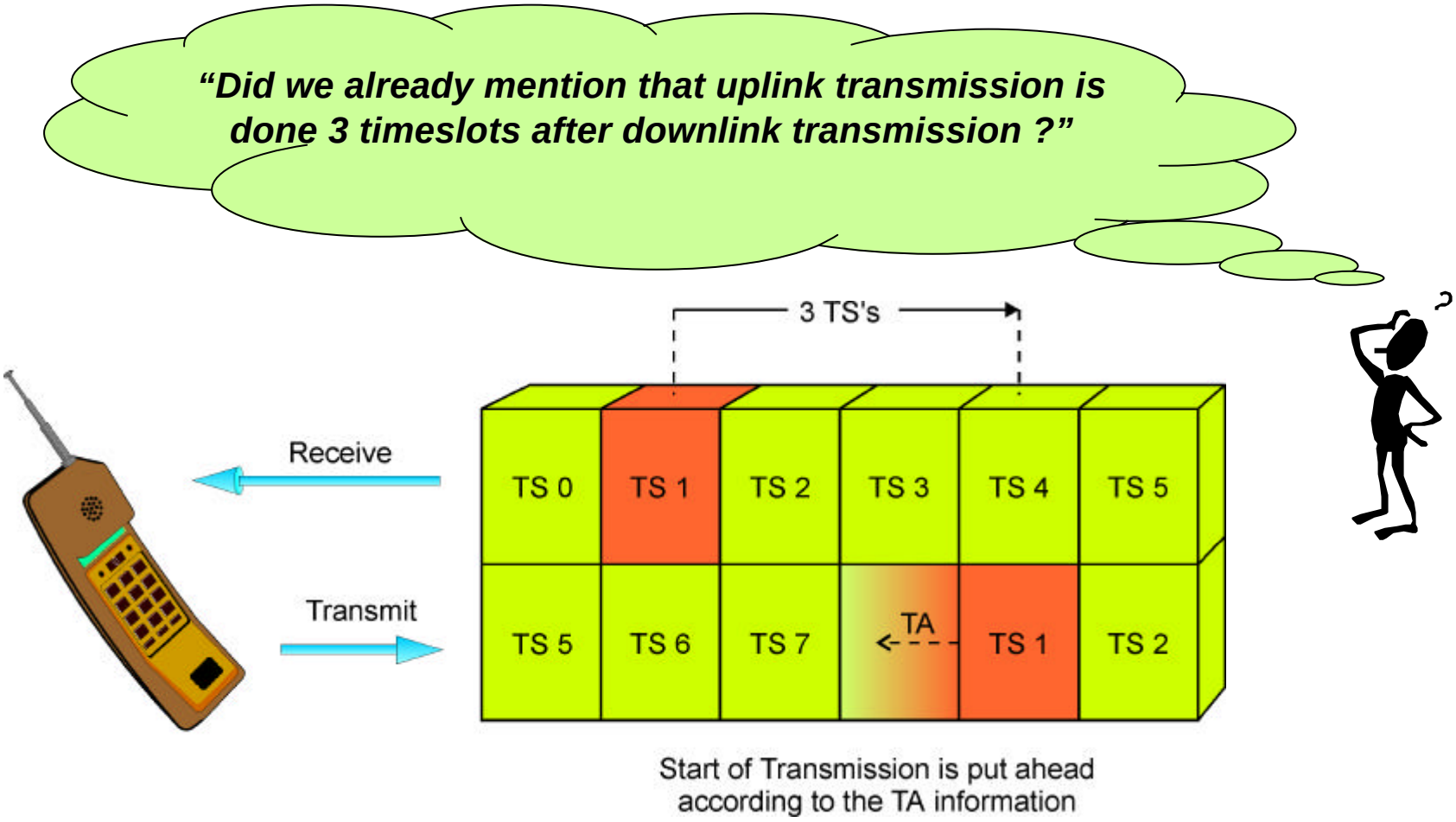
(1) Resolution of the the Propagation Delay Problem:

In GSM, the resolution of the propagation delay problem is achieved in two different ways:

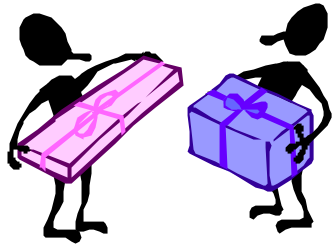
➔ Initial System Access:
When first accessing a BTS, a mobile station will use an access burst with limited information content. This access burst will always fit into the receiver window of the BTS (provided that the distance is not larger than 35 km). The BTS will measure the exact time when this access burst is received. Based on this measurement, the system will tell the mobile station how much its start of transmission needs to be put ahead. Now the mobile station may use normal bursts that will be received by the BTS exactly in “their” receiver windows.

➔ While Involved in a Transaction:
During a transaction, the mobile station will transmit normal bursts towards the BTS. With the distance changing rather slowly, the BTS will constantly recalculate and readjust the timing advance information.

(2) Resolution of the Propagation Delay Problem:



Logical and Physical Channels:



The discrimination of logical and physical channels is rather simple:

- ➔ The physical channel in GSM is one timeslot, offering a throughput rate of 22.8 kbit/s.
- ➔ The logical channels are the application specific bearer channels that GSM defines to suit the various requirements of a mobile network environment.
- ➔ Many restrictions apply for the allocation of logical channels (⇔ GSM 05.02).

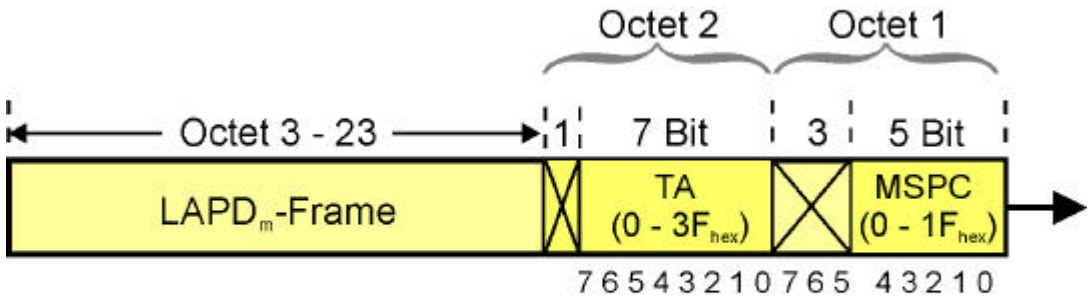
(1) Logical Channel Types:

- **Traffic Channels (TCH):**
  The most important logical channel type is the traffic channel. TCH's are bidirectional PTP channels to transmit speech or data between BTS and mobile station. Different types of TCHs exist. Important examples are the TCH/FS or the TCH/FD.
- **Dedicated Control Channels (SDCCH)**:
  The SDCCH is a bidirectional PTP channel reserved for the transmission of signaling information. SDCCH's are mainly used during connection establishment.
- **Associated Control Channels (ACCH):**
  ACCH's are used to transmit signaling and layer 1 information (Timing Advance, power control information, ...) for their master channels which are either TCH's or SDCCH's. Two types of ACCH exist, the SACCH and the FACCH.

(2) Logical Channel Types:

SACCH: The Slow Associated Control Channel is periodically using the resources of its master channel to transmit layer 1 information, measurement reports and signaling information between BTS and mobile station.

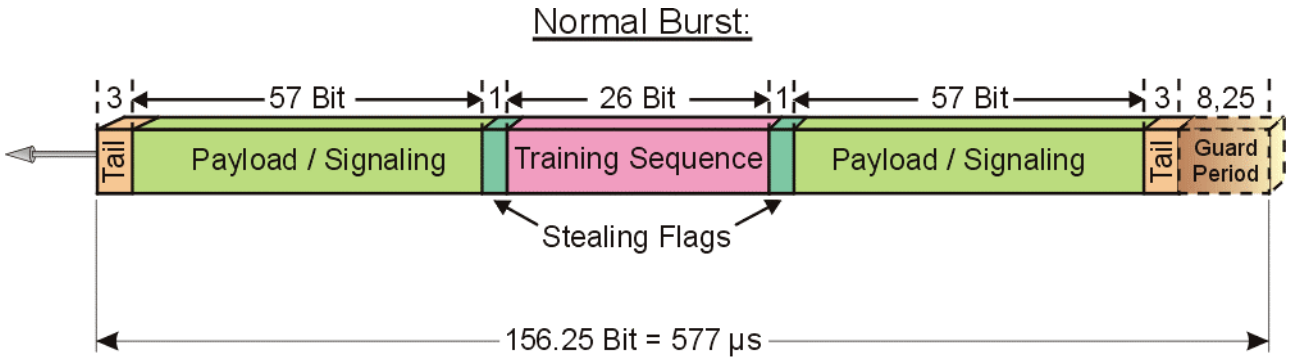
Format of SACCH:



TA = Timing Advance Control
MSPC = MS Power Control
LAPDm-Frame = SYS_INFO 5 or 6 or Signaling

(3) Logical Channel Types:

FACCH: The FACCH is also using the resources of its master channel to transmit signaling information between BTS and mobile station. Note that the FACCH is "stealing" those resources from its master channel (Stealing Flag) !
The FACCH is only used when the information that needs to be transmitted cannot wait for the next SACCH cycle.



"Dependent on the setting of the stealing flags, no, only the even numbered or only the odd numbered bits of a normal burst have been stolen for FACCH."