

# Mobile Communication

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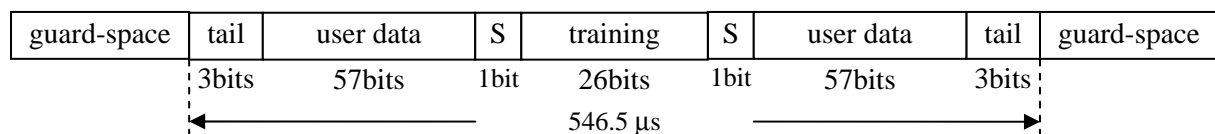
### Assignment Sheet #6

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#### Exercise 16: (GSM radio interface)

For communication on the air interface, GSM uses two bands of 25MHz each, one for the uplink and one for the downlink. Each of these bands is divided into 125 channels of 200KHz. 124 of these channels are actually available for user data. These 124 channels are referred to as **radio channels** in the following.

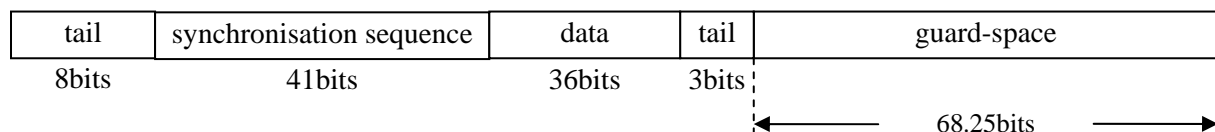
Each radio channel is further divided into eight **TDM channels**. The duration of a TDMA frame (i.e. all eight slots) is 4.615ms. A single slot is structured as follows (cf. chapter 6, slide 21):



- a) Determine the gross data rate without consideration of the guard spaces of a single TDM and a single radio channel.
- b) Determine the gross data rate with consideration of the guard spaces of a single TDM and a single radio channel.
- c) Determine the effective rate for user data of a single TDM and a single radio channel. Assume that all radio channels can be used for customer data. What is the maximum uplink and downlink bandwidth of an entire GSM cell?

TDMA requires a strict synchronization of the mobile station and the base transceiver station. If two mobile stations have a different distance to the base transceiver station, they will experience a different signal propagation delay. To compensate this difference, a parameter called **Timing Advance (TA)** is used: The BTS measures the round trip time of each MS and communicates the TA value to the MS, which is the amount of time the MS should start its transmission in advance to compensate the signal propagation time.

At the first contact of a MS to the BTS, this TA parameter is not available. Therefore, the access burst in the random access channel which is used for the first message of the MS to the BTS contains an extended guard space:



- d) How large may the distance between MS and BTS be to ensure a correct reception of the MS's message inside the random access channel? Use  $3 \cdot 10^8$  m/s as the speed of a radio wave.

- e) How far may the MS move before a new TA parameter needs to be communicated to the MS?
- f) The TA parameter is a value between 0 and 63 bits which specifies the TA in bit durations. What is the distance offset between mobile and base station corresponding to a bit duration, and what is the resulting maximum cell size?

**Exercise 17:** (GSM Data Transfer, HSCSD, GPRS, and E-GPRS)

Consider chapter 6 of the slides of the Mobile Communication lecture as PDF file. This file has a size of approx. 1620 kbytes. Assume an error free channel for the following considerations.

- a) How long does the download take, if you use a GSM 9.6, a GSM 14.4 and a DSL 2000 (2048 kbits/s downstream) connection?
- b) How long does the download take, if you use an HSCSD connection with a logical channel using eight TDM channels?
- c) Common mobile stations cannot use a logical HSCSD channel composed of eight TDM channels; often, only up to four slots can be used. What can be the reasons for this restriction? Many service providers also do not offer such logical HSCSD channels. In Germany, E-Plus offers logical channels which consist of three TDM channels for the downlink and one TDM channel for the uplink (V.120 protocol). How long does the download take, if such an HSCSD connection is used?
- d) How long does the download take, if you use a GPRS connection with CS-3 (CS-4) encoding scheme and a logical channel with three TDM channels in the downlink? What advantages can be reached, if mobile stations use GPRS instead of HSCSD for typical web applications?

Another technique to enhance the data rate in a GSM network is denoted as *Enhanced Data Rates for GSM Evolution* (EDGE). EDGE can be used with GPRS (which is denoted as E-GPRS) and HSCSD (which is denoted as ECSD, Enhanced Circuit Switched Data). Edge supports a logical channel of 473.6 kbits/s using a MCS-9 coding scheme and eight TDM channels.

T-Mobile supports EDGE with an MCS-8 coding scheme and up to seven TDM channels in the downlink, which results in a downlink bandwidth of 380.8 kbits/s. Also here, an error free channel is to be assumed.

- e) How long does the download take, if a logical channel composed of seven TDM channels and using MCS-8 coding scheme is used?
- f) Compare the maximal bandwidth of 59.2 kbits/s per TDM channel and 473.6 kbits/s per radio channel with your results for the maximal data rate for user data of exercise 15c). How can this bandwidth be reached?