Mobile Communications
Problem Set 10

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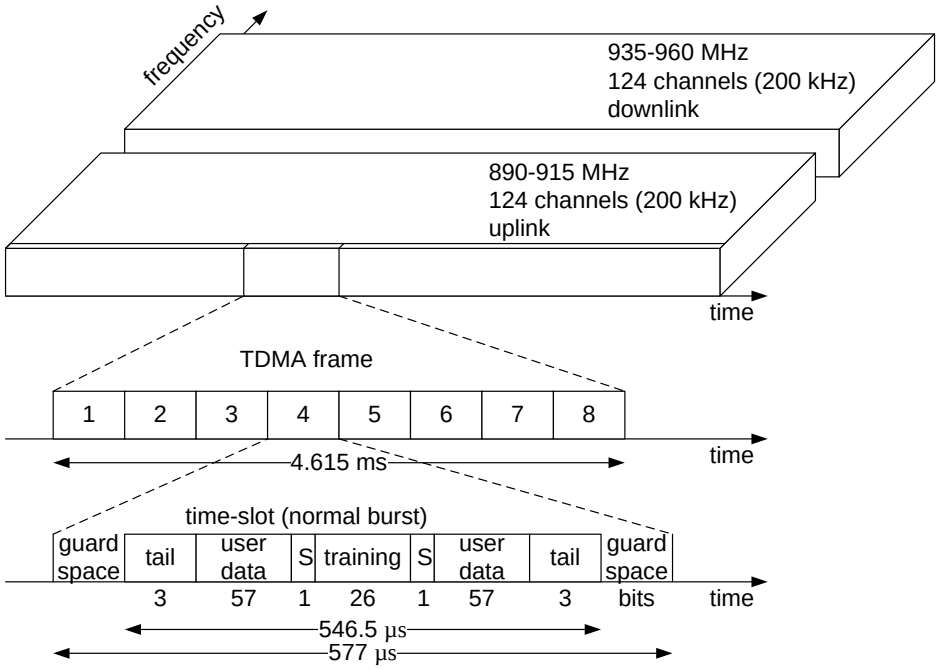
1. Explain the use of training sequences in GSM.

   Solution:

   GSM uses TDMA with the following frame structure



   Training sequences are bit sequences that are known for sender and receiver. They are used to

   - to estimate the channel conditions and hence adapt the parameters of the receiver
   - select the strongest signal in case of multi-path propagation

2. What types of bursts exist within a TDMA frame in GSM?

   Solution:

   - normal burst: for data transmission (indicated by the field S in the figure above)
   - frequency correction burst: to correct the mobile stations local oscillator
   - synchronization burst: with an extended training sequence
   - access burst: for initial connection setup

- dummy burst: used if no data is available for a slot

3. Do collisions occur when mobile stations try to generate calls in GSM?

   Solution:

   Mobile stations (MS) originate calls on the random access channel (RACH) using slotted ALOHA multiple access. Hence, it is possible that call attempts from different MS collide.

4. Calculate the timing advance for cells with the following radius (a) 2 km, (b) 10 km. Given that the guard space of GSM is 30.5 μs is a timing advance (theoretically) needed in cases (a) and (b)? Is the timing advance more critical in city centers or in rural areas? Given that timing advance is coded in 63 bits times 3.69 μs, in which distance steps does the timing advance information change?

   Solution:

   A distance d of 2 km (10 km) causes a round trip time RTT of 13 μs (66 μs) as

   $$RTT = \frac{2 \cdot d \quad [m]}{3 \times 10^8 \quad [m/s]}$$

   Since the guard space of GSM is 30.5 μs it covers the timing advance of cells with 2 km radius making it unnecessary in this case. However, since GSM is standardized for cells up to 35 km with RTT of 233 μs the guard space would be insufficient making the timing advance mechanism crucial.

   Mobile radio cells have a much smaller coverage area in city centers than in rural areas. The idea behind that is to use a frequency reuse pattern in city centers to incorporate as many subscribers as possible. In rural areas a mobile radio cell can be as large as 35 km (theoretically!). The timing advance is more critical for larger distances, i.e., in rural areas.

   Since the timing advance steps are given by 3.69 μs each it changes for each 554m change in the distance between the mobile station and the base station (BTS). This is given by

   $$\frac{3.69\mu s \cdot 3 \times 10^8 m/s}{2} = 554m$$