3GPP TSG-RAN Working Group 1, Meeting #4
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Agenda Item:

Source: Siemens AG

Title: Calculation of t_{offset} for Physical Synchronisation Channel in TDD Mode

Document for: Decision

Scope

In Physical Synchronisation Channel (PSCH) of TDD mode, there are two parameters t_{offset} and t_{gap} (cf. section '7.4 The Physical Synchronisation Channel (PSCH)' in 'S1.21 - TDD, Transport channels and Physical channels description'). The exact values for these parameters shall be fixed, but no decision has been taken yet. This document proposes a scheme to calculate the exact value of t_{offset}.

Calculation of t_{offset}

The reason for adopting t_{offset} into UTRA specification was to distribute the synchronisation signals of several cells evenly over the DL transmission time. The available time window for this distribution is the active DL transmission time of the timeslot(s) carrying the PSCH, see Figure **Error! Unknown switch argument.**:

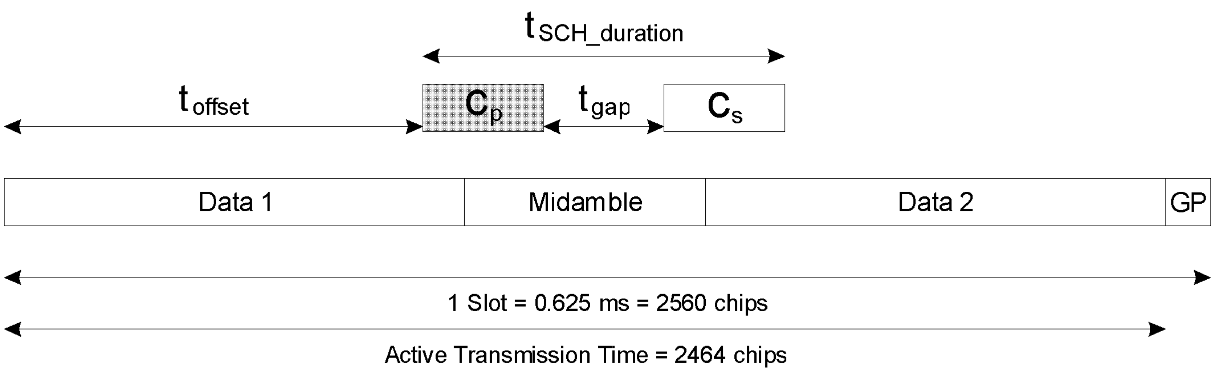


Figure Error! Unknown switch argument.**: Timing of Physical Synchronisation Channel**

The offset t_{offset} itself is to be calculated in multiples of chip duration, which is denoted as T_C. In S1.23 it is stated that we need to obtain 32 different offsets, thus $t_{offset,0}$ to $t_{offset,31}$ (cf. 'S1.23 – Spreading and modulation (TDD)', Table 9: 'Mapping scheme for Cell Parameters, Code Groups, Scrambling Codes, Midambles and t_{Offset}'). Regarding this and a guard period GP of 96 chips we obtain from the Figure **Error! Unknown switch argument.** above:

$$t_{Offset,n} = n \cdot T_C \cdot \left\lfloor \frac{2560 - 96 - \frac{t_{SCH\_duration}}{T_C}}{31} \right\rfloor \qquad ; n = 0 \ldots 31$$

Please note that $\lfloor x \rfloor$ denotes the largest integer number less or equal to x. The duration $t_{SCH\_duration}$ of the synchronisation sequences itself is depending on t_{gap}, which is not defined yet. Knowing that c_p and c_s have a duration of 256 chips each, we obtain:

$$t_{Offset,n} = n \cdot T_C \cdot \left\lfloor \frac{2560 - 96 - 512 - \frac{t_{gap}}{T_C}}{31} \right\rfloor \qquad ; n = 0 \ldots 31$$

We recommend to include this equation into S1.21 specification document, as then t_{offset} can be derived immediately when t_{gap} is given.

Revision of Text

There is an extensive descriptive text on capturing effects for PSCH in S1.21, chapter ‘7.4 The physical synchronisation channel (PSCH)’. It is recommended to remove this text and the ‘Figure 13 Sample for capturing effect whilst detecting synchronised Base Stations’. Removed text and inclusion of new text is shown in the recommended changes below.

Conclusion

It is recommended to include the changes as given below in specification document S1.21, ‘TDD, Transport channels and Physical channels description’.

7.4 The physical synchronisation channel (PSCH)

[Editors Note : The detailed scheme of CCCH pointing by SCH is FFS.]

The PSCH is similar to the FDD SCH. In order not to limit the UL/DL asymmetry the PSCH is mapped on one or two DL slots per frame only.

There are three cases of SCH and CCCH allocation as follows:

Case 1) SCH and CCCH allocated in TS#k, k=0….15

Case 2) SCH in two TS and CCCH in the same two TS: TS#k and TS#k+8, k=0…7

Case 3) SCH in two TS, TS#k and TS#k+8, k=0…7, and the primary CCCH TS#i, i=0…15, pointed by SCH

The position of SCH (value of k) in frame can change on a long term basis in any case.

Figure 12 is one example, k=0, of Case 2 or Case 3. In this case, the PSCH uses system-wide always the same two DL slots, which are slot 0 and slot 8.

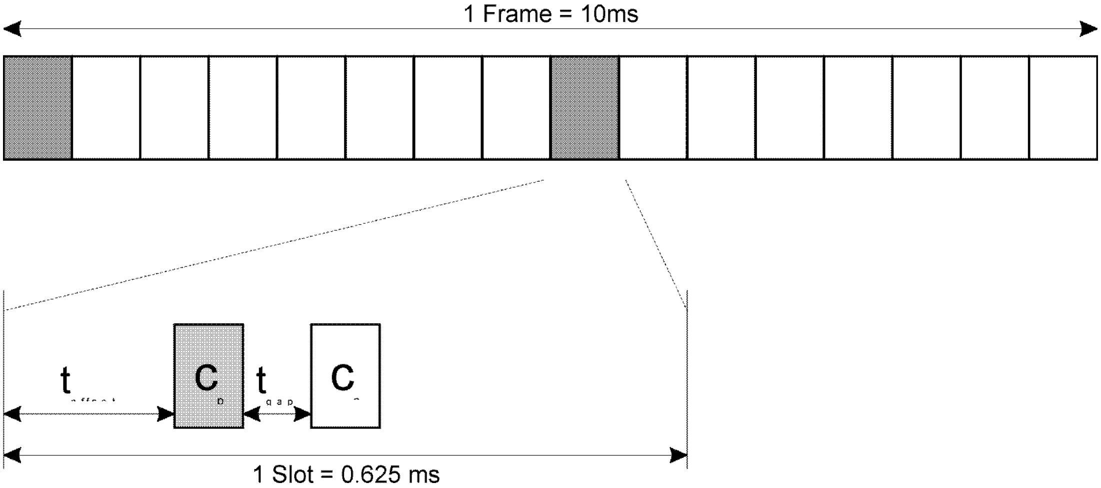


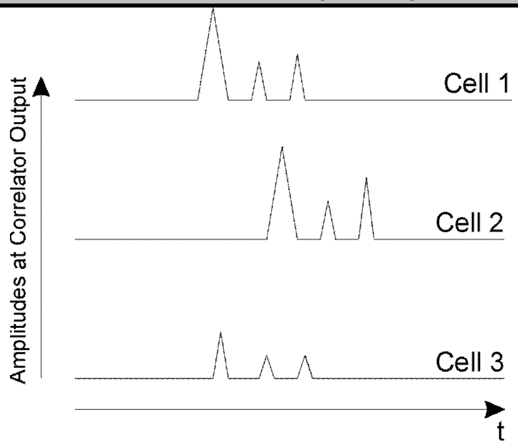
Figure 12 Scheme for Synchronisation channel SCH consisting of one primary sequence C_p and one secondary sequence C_S per slot (example of Case 2 or Case 3)

As depicted in Figure 12, the PSCH consists of a primary and secondary code sequence with 256 chips length. The used sequences C_p and C_s are the same as in FDD-Mode, see **[2]**.

The time offset t_{gap} is the time between the primary synchronisation code and the secondary synchronisation code. It provides enough time for calculations and a better interference distribution, since the codes do not superimpose. The exact value is to be determined.

Due to mobile to mobile interference, it is mandatory for public TDD systems to keep synchronisation between base stations. As a consequence of this, a capture effect concerning PSCH~~, see explanation below,~~ can arise. The time offset t_{offset} enables the system to overcome the capture effect.

~~When searching for synchronisation engaging C_p a situation as outlined in Figure 13 may occur. The correlations, which are shown separately in the figure, superimpose at the mobile's receiver. The introduction of t_{offset} will ease the detection of cell 3. Since different cells use different time offsets, the time offset t_{offset} enables the receiver to detect even cells with low correlation peaks, as there is additional separation in time-domain. The cell's specific time offset t_{offset} is obtained by decoding the SCH.~~



~~Figure 13 Sample for capturing effect whilst detecting synchronised Base Stations~~

The time offset t_{offset} is one of 32 values, depending on the cell parameter, thus on the code group of the cell, cf. 'Table 9 Mapping scheme for Cell Parameters, Code Groups, Scrambling Codes, Midambles and t_{offset}' in 'S1.23 Spreading and modulation (TDD)'. The exact value for t_{offset}, regarding column 'Associated t_{offset}' in Table 9 from S1.21, is given by:

$$t_n = t_{offset,n} = n \cdot T_C \cdot \left\lfloor \frac{2560 - 96 - 512 - \frac{t_{gap}}{T_C}}{31} \right\rfloor \qquad ; n = 0 \ldots 31$$

Please note that $\lfloor x \rfloor$ denotes the largest integer number less or equal to x and that T_C denotes the chip duration.