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| **Agenda Item** | **:** | |
| **Source** | **:** | Samsung Electronics Co., Ltd. and SK Telecom |
| **Title** | **:** | An adaptive tracking scheme for USTS |
| **Document for** | **:** | Information and discussion |

## 1. Introduction

In USTS, the uplink synchronisation procedure of UE is divided into two steps. The First step is an initial synchronisation of the uplink channel and the second step is a tracking procedure to acquire and maintain the exact uplink synchronisation. In the first step, UE uses Round Trip Propagation Delay (RTPD) for the uplink synchronisation and the resolution of RTPD is 3 chips. In the second step, a UE adjusts the coarse synchronisation set up in the first stage to the exact synchronisation for USTS by using of a Time Alignment Bit (TAB) command and a timing control step. The 20ms TAB command period and timing control step size of 1/4 chip are used for the current tracking scheme. In the current tracking scheme, the maximum required time can be up to 230 ms (23 radio frames) for synchronisation because the maximum error between the USTS synchronisation and the initial synchronisation is 3 chips. The mean of the error is 1.5 chips, which requires 12 radio frames for synchronisation in average. In this paper, we suggest the new tracking methods, which reduce the synchronisation time for the USTS.

## 2. Proposal

The proposed schemes change the TAB command period or timing control step size to reduce the synchronisation time for USTS. In other words, when a UE enters USTS mode it can adjusts its uplink transmission time with the timing control step bigger in size than that of the current scheme and the TAB command period shorter than that of the current scheme during first P frames.

(1) Scheme 1: The timing control step size is 3/4 for the first TAB period and the timing control step size is 1/4 for the other TAB periods.

Table 1 shows the difference of the required number of frames for uplink synchronisation of USTS between the current scheme and the scheme 1. In table 1, we assume that the error between the USTS synchronisation and the initial synchronisation is uniformly distributed between –1.5 chips and +1.5 chips, and that the TAB command period is 20ms and the resolution of timing control step size is 1/4 chip. In Table 1, we assume that a UE chooses a smaller value.

| Initial synchronisation error(chips) | 0 | 1/4 | 2/4 | 3/4 | 4/4 | 5/4 | 6/4 |
|---|---|---|---|---|---|---|---|
| Probability | 1/12 | 1/6 | 1/6 | 1/6 | 1/6 | 1/6 | 1/12 |
| Required frames for current scheme | 0 | 2 | 4 | 6 | 8 | 10 | 12 |
| Required frames for proposed scheme | 8 | 6 | 4 | 2 | 4 | 6 | 8 |

Table 1. The performance difference between current scheme and proposed scheme

(The first timing control step size 3/4 chip is used for proposed scheme.)

As shown in table 1, the average number of required frames for current USTS tracking scheme is 6 and the average number of required frames for proposed scheme is 5.

(2) Scheme 2: A TAB command is transmitted to the UE once every frame during the first three frames and is transmitted once every 2 frames after three frames are transmitted .

Table 2 shows the result of scheme 2. The timing control step size 1/4 is used for the current scheme and scheme 2. The TAB command period of current scheme is the same as that of table1 20ms.

| Initial synchronisation error | 0 | 1/4 | 2/4 | 3/4 | 4/4 | 5/4 | 6/4 |
|---|---|---|---|---|---|---|---|
| Probability | 1/12 | 1/6 | 1/6 | 1/6 | 1/6 | 1/6 | 1/12 |
| Required frames for current scheme | 0 | 2 | 4 | 6 | 8 | 10 | 12 |
| Required frames for proposed scheme | 0 | 1 | 2 | 3 | 5 | 7 | 9 |

Table 2. The performance difference between current scheme and proposed scheme

(The TAB command period 10ms is used for proposed scheme during the first 3 frames.)

The average number of frames for proposed scheme is 45/12, i.e. 4 and the average number of frames for current scheme is 6.

(3) Scheme 3: The timing control step size is 3/4 for the first TAB period and the timing control step size is 1/4 for the other TAB periods and a TAB command is transmitted to UE once every frame during the first three frames and is transmitted once every 2 frames after three frames are transmitted.

Table 3 shows the result of proposed scheme 3 which uses the timing control step size 3/4 for

the first TAB period and the TAB command period 10ms during the first 3 frames.

| Initial synchronisation error | 0 | 1/4 | 2/4 | 3/4 | 4/4 | 5/4 | 6/4 |
|---|---|---|---|---|---|---|---|
| Probability | 1/12 | 1/6 | 1/6 | 1/6 | 1/6 | 1/6 | 1/12 |
| Required frames for current scheme | 0 | 2 | 4 | 6 | 8 | 10 | 12 |
| Required frames for proposed scheme | 5 | 3 | 2 | 1 | 2 | 3 | 5 |

Table 3. The performance difference between current scheme and proposed scheme

(The first timing control step size 3/4 and the TAB command period 10ms during the first 3 frames are used)

The results of the proposed scheme in table 3 is 32/12, i.e.3. The method which uses the combination of the timing control step size 3/4 and the TAB command period 10ms during the first 3 frames has the best performance among the current and 3 proposed methods.

## 3. Conclusion

We propose the adaptive tracking schemes for USTS for fast initial synchronisation and shows three performance results of proposed schemes. The first scheme is that a UE uses the timing control step size 3/4 for the first TAB period, the second scheme is that the UTRAN sends a TAB command once every frame during the first 3 frames, and the third scheme is a combination of the first and the second schemes. The result of any of the above three methods is better that that of the current method and reduces the time for the USTS synchronisation. This is beneficial to the performance of USTS because a UE can enter USTS mode more quickly than the current scheme.

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