3GPP TSG RAN WG4 meeting #8 **TSG R4#8(99)654**
26 – 29 October 1999
Sophia Antipolis, France

Agenda Item: 8.6
Source: Fujitsu, NEC, NOKIA, NTT DoCoMo, Panasonic
Title: Transmit Timing Control at UE
Document for: Discussion & Decision

1.Introduction

In TSG-RAN WG4 meeting #7 in Makuhari, issues related to the transmit timing control at UE is raised in Tdoc R4-99520 and it was concluded that the condition of this issue should be defined more clearly. Further more, in TSG-RAN WG1 meeting #7 in Hanover, some related issues were also raised (R1-99a87, R1-99c38) and it was decided to send a liaison to WG4 (R1-99e13)
In this report, this issue is discussed and a proposal is made.

2. Discussion

2.1 Initial Transmission Timing

The transmission frame timing of the UE should be generated by referring to the received frame timing. In TS25.211 (3.0.0), there are descriptions as follows.

- The uplink DPCCH/DPDCH frame transmission takes place approximately T_0 chips after the reception of the first significant path of the corresponding downlink DPCCH/DPDCH frame (Section 7.6.3).
- An uplink access slot is transmitted a specified time $\tau_{p\text{-}a}$ before the corresponding downlink access slot (Section 7.3).

Also there is following description in TS25.214 (V3.0.0).

- The UE starts the transmission of the uplink DPCCH/DPDCHs at a frame timing exactly T_0 chips after the frame timing of the received downlink DPCCH/DPDCH (Section 4.3..2 c)).

Since the BS must search paths in the time range including the delay expected from the cell radius and the tolerance of the UE transmission timing, the tolerance of the UE transmission timing should be specified for when the UE starts transmission. It should be treated at WG4.

2.2 Rate of Timing Adjustment

There is a following description in TS25.214 (V3.0.0).

- During a connection, in some cases the UE is allowed to change its transmission timing. When the UE is in soft handover with cells that all are known to have the same timing reference, the UE may adjust its DPDCH/DPCCH transmission time instant. <Note: maximum rate of the adjustment should be specified in R4> Otherwise, the UE may not adjust its DPDCH/DPCCH transmission time instant. (section 4.3.3).

Furthermore, there are following description in the liaison from WG1 (R1-99e13).

" It is also believed that in some cases the UE needs to be allowed to change its transmission timing in order to cope with the previous issue. In case of soft-handover, this is restricted to the situation where all cells in the active set are known to have the same timing reference. The maximum timing adjustment of the UE DPDCH/DPCCH still needs to be determined. TSG RAN WG1 kindly asks TSG RAN WG4 for their guidance on this issue."

The maximum rate of the timing adjustment should be treated in WG4.

3.Requirement consideration

3.1 Initial Transmission Timing

Because the hardware size of the Node B is affected by the search range, the tolerance of the UE transmission timing should be reasonably small from the Node B's view point. Therefore, we propose +/-

1/2 chip for the initial transmission timing tolerance, which does not affect Node B greatly, yet which should not be so difficult from the UE manufacturing point of view. It should be noted that Node B would experience much higher errors after SHO situations.

3.2 Rate of Timing Adjustment

There are 2 cases for the UE to change the transmission timing.

Case A. The received timing changes due to the UE movement or due to the frequency difference between BS and UE and the UE manage to keep the time difference between the received timing and the transmit timing.

Case B. The received path is attenuated or vanishes due to changes in the channel condition and the UE needs to synchronize transmit timing to another received path

Both cases are illustrated in the Fig.1 and Fig.2 respectively.

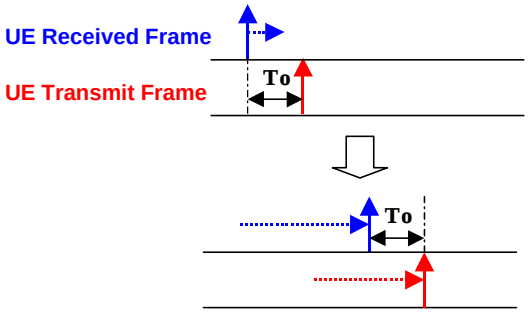

Fig.1 Case A

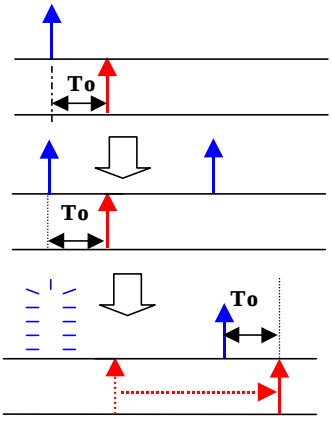

Fig.2 Case B

WG4 needs to specify the maximum rate of the timing adjustment.

For Case A, the rate of the timing adjustment does not need to be faster than the maximum timing change rate between the received clock and the transmission clock. The maximum timing change rate depends on the cause of the timing change.

1. Timing change due to the frequency difference between the transmit clock and the received clock
   Assuming that the frequency difference is 0.15ppm, the timing change is 1/4chip per 430 msec.
2. Timing change due to the UE movement
   Assuming that the maximum UE speed is 250 km/hour, the timing change is 1/4 chip per 280 msec.

For Case B, there is no reason to adjust the transmission timing so quickly. Therefore, the maximum rate of 1/4 chip per 280 msec would be sufficient for the system requirement.

From the BS point of view, the BS's capability to track the timing changes over long periods should be considered. Usually, the BS detects the path after averaging the fading profile over several frames (40~60msec), assuming operation under low C/N conditions. Therefore, the BS will not be able to track the timing change of larger then 1/4 chip per 60msec.

According to the above discussion, we feel that the maximum timing adjustment rate of 1/4 chip per 200 ms is suitable. This will mean the mobile speed of 350 km/h

Another point to be specified is the maximum adjustment step. It is difficult for the UE to adjust the transmission timing continuously. I.e., the UE change the transmission timing discontinuously. In order to track the discontinuous timing change, the BS should have the appropriate hardware to track it. The hardware size is increased according to the timing adjustment period and the step size.. Furthermore, the degradation at the timing change instance can not be avoided, and hence should be minimized. Therefore, the maximum adjustment step should be specified. We propose the adjustment step of 1/4 chip in order to minimize the increase of necessary hardware in BS's and to minimize the degradation of performance.

3.3 Conclusions

As discussed above there are a few requirements that the UE needs to comply with:

a) UE needs to lock to the first significant path received from Node B.
b) Timing tolerance for initial transmission shall be less than ±½ Chips.
c) When the significant path changes, the UE shall adjust it's transmission with step size less than or equal to 1/4 Chip.
d) The rate of adjustment shall be less or equal to 1/4 Chip per 200 ms.

4. Testing considerations

The UE should be able to comply above requirement in all channel conditions, however we should address this requirement with the propagation conditions available in our current specification. In addition we should keep in mind, that the testing conditions are possible to realize. We believe that in this case the AWGN propagation conditions are reasonable to verify that the implementation is correct in UE. In order to avoid uncertainties in uplink direction the output power should be reasonable high to ensure that this link is noise free.

Test procedure proposal:

a) Connection set-up as specified in TS 25.101 annex C.
b) Test equipment shall verify that the initial transmission is according requirement.
c) Test system introduces cell 2 into the test system at delay [5] µs from cell 1.
d) Test system verifies that that UE shall not change it's transmission timing.
e) Test system stops sending cell 1 signal.
f) Test system verifies that UE transmission timing step and rate is according requirement.

5. References

[1] TS25.211v3.0.0 Physical Channels and Mapping of Transport Channels onto Physical Channels (FDD).
[2] TS25.214v3.0.0 FDD; Physical Layer Procedures
[3] R1-99e13 LS from WG1
[4] R4-99520 Transmit timing control at UE.

--- Text Proposal ---

Text Proposal for 25.103. Section 17.2

17.2. UE Transmit Timing

17.2.1 Initial transmission timing, Timing adjustment step size and Timing adjustment rate

UE has capability to follow the frame timing change from connected Node B. UE initial transmit timing accuracy, step size and change rate are defined in following requirements.

17.2.1.1. Minimum requirement

For parameters specified in table zz UE initial transmit timing error shall be less or equal to ±1/2 Chip. UE initial transmit timing control requirement reference point shall be the first significant path of the corresponding downlink DPCCH/DPDCH frame.
UE shall be capable to change the transmission timing according the received downlink DPCCH/DPDCH frame. The maximum step size shall be less or equal to 1/4 Chip. The maximum timing adjustment rate shall be 1/4 chip per 200ms. Table zz: Test parameters for Transmit timing requirement.

Parameter	**Unit**	**Cell 1 and 2 level**
DPCH_Ec/ Ior	DB	-17
$\hat{I}_{or}$ Cell 1	dBm/3.84 MHz	-96
$\hat{I}_{or}$ Cell 2	dBm/3.84 MHz	-97
Information data rate	Kbps	12.2
TFCI	-	on
Propagation condition	AWGN	

a) Cell 2 starts transmission [5 seconds] after call has been initiated. UE shall maintain it's original timing properties.
b) Cell 1 stop transmission [5 seconds] after cell 2 has started transmission. UE shall adjust transmission timing with a maximum step size of1/4 chip, and maximum timing adjustment rate of 1/4 chip per 200ms.