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Timing of the Uplink Shared Channel.

Abstract

At the Layer 2/3 and Layer 1 experts group meeting held in December 1998 a proposal for a new transport channel called Uplink Shared Channel (USCH) was introduced by Motorola [1][2]. The USCH concept refers to an uplink power resource that is shared by the packet users. Since the assignment and re-assignment of the power resource to various packet data users are made on a frame by frame basis (i.e. with a granularity of 10 msec) the transmissions from separate UE's in subsequent frames may overlap in time resulting in excessive noise rise at the BTS. In this contribution, protocols for USCH timing are discussed which prevents the overlap of subsequent packet data frames in time.

1.0 Introduction

In the USCH concept, the assignment and re-assignment of the power resource to various packet data users are made on a frame by frame basis. As such, two different UE's may be assigned a low SF for high rate packet data transfer (e.g. 384 kbps) in consecutive frames. Considering the largest cell has a maximum radius of 16 kilometers, the round trip line-of-sight (LOS) propagation delay is around 100μs. As an example, if the two UE's are located approximately 16 kilometers apart, the last part of transmission from the first UE will overlap the transmission from the first part of the second UE for approximately 1/6 of a slot `due to the propagation delay. This may result in excessive noise rise at the BTS for a brief period resulting in frame erasures on packets transmitted from the UE's connected to that cell. To prevent the above scenario there needs to be a mechanism for timing advance, guard periods etc, so that the transmissions from separate UE's in subsequent frames do not overlap in time.

Figure 1, shows the propagation delay from UE's A, B and C to BTS without any timing offset correction. Since $\alpha<\beta<\gamma$, the transmission from UE's A and B or B and C may overlap due to propagation delay if assignments are made to UE's A, B and C in consecutive frames respectively. As such, the UE's need to retard their timing by an amount Δt to prevent collisions. Figure 2, illustrates the signaling method for timing events with three UE's A, B and C being assigned the USCH on a frame by frame basis. It may be noted that the timing offset $\Delta t_1, \Delta t_2, \ldots, \Delta t_n$ is computed once in every frame and communicated to the UE's using the ACCH. The Δt's are assigned one frame prior to the start of packet data transmission using a 10 bit field in the ACCH. As an example, Δt_2 is communicated to UE#B in Frame#1, Δt_3 is communicated to UE#C in Frame#2, Δt_6 is communicated to UE#A and UE#B in Frame#5 and so on. Figure 3 shows the message sequence diagram illustrating the order of signaling events from BTS to UE's for communicating the timing information using the ACCH. The protocol for USCH timing enables three methods for setting Δt's to avoid uplink collisions. In this contribution, these three methods are described.

2.0 Method – 1

In this method, the timing offset is computed based on the relative distance between the two UE's with respect to the BTS. In this technique, initially an estimate of the Time of Arrival (TOA) of the UE#A(denoted by λ) from the BTS is obtained from the RACH. In the subsequent frame, the resource is assigned to near-end UE#B. An estimate of the TOA from the BTS to the near-end UE is obtained from the RACH channel which is denoted by μ. The timing adjustment of $\Delta t_2=(\lambda-\mu)$ is then broadcast on the Access Control Channel (ACCH). The UE#B then retards its frame timing by Δt_2 before the start of its packet data transmission.

3.0 Method – 2

With respect to Figure-2, at Frame#1 a time offset Δt_2 is broadcast using the ACCH. UE#B transmits its data packets using the time offset Δt_2 from its frame boundary. While the UE#B is transmitting its data packets, BTS computes the TOA from UE#B which is denoted by ρ. The BTS broadcasts the timing offset $\Delta t_3 = (\Delta t_2+\rho)$ using the ACCH channel during Frame#2. In the subsequent frame(Frame#3), the resource is assigned to UE#C. The UE#C transmits its data packets using an offset Δt_3 from the frame boundary. In the meantime, BTS again computes the TOA from UE#C which is denoted by σ. Consequently, the BTS broadcasts the timing offset $\Delta t_4 = (\Delta t_3+\sigma)$ which will be used by UE#A accessing the USCH at Frame#4. In general the timing offset which is broadcast at Frame#(N+1) follows the general rule given by $\Delta T_{N+1}>\Delta T_N$. It may be noted that the timing offset which is broadcast using the ACCH is reset to zero after it reaches a certain threshold e.g. 10000 μs. If multiple UE's are transmitting packets in a given frame (Frame#6 in Figure 2) they all read the timing offset information from the ACCH (Δt_6) and adjust their transmit time accordingly.

4.0 Method – 3

In this method, the UE's instead of computing Δt's based on range, uses a fix guard period. If the guard period is set to ν μsec, $\Delta t_3 = (\Delta t_2+\nu)$, $\Delta t_4 = (\Delta t_3+\nu)$ and so on and so forth. For a cell of size 16 kilometers, ν is set to 100 μs while for a 1600 meters cell ν is set to 10 μs.

5.0 Conclusion

It is recommended that USCH timing protocol described in Section-1 for timing retardation be adopted in the 3GPP standard for the USCH.

3.0 References

[1] Motorola, "Shared Channel Options for Downlink Packet Data Transmission," SMG 2 UMTS L1 681/98.
[2] Motorola, "Mechanisms for Managing Uplink Interference and Bandwidth," SMG 2 UMTS L1 683/98.
[3] Motorola, "Methods for Operating the Uplink Shared Channel," SMG2 UMTS-L1 046/99.

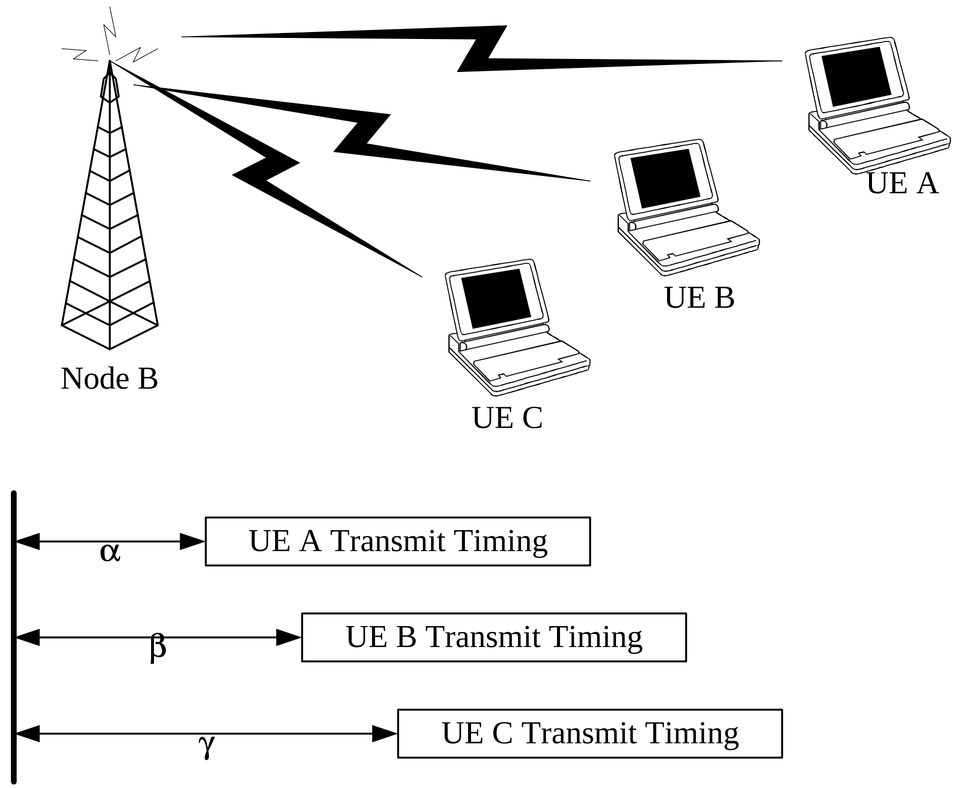

Figure 1 UE propagation delays.

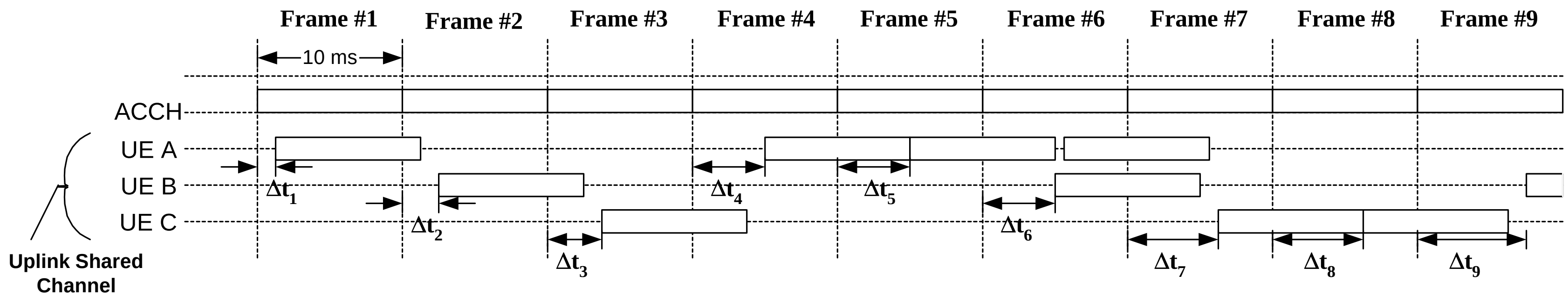

Figure 2 Timing diagram of USCH relative ACCH.

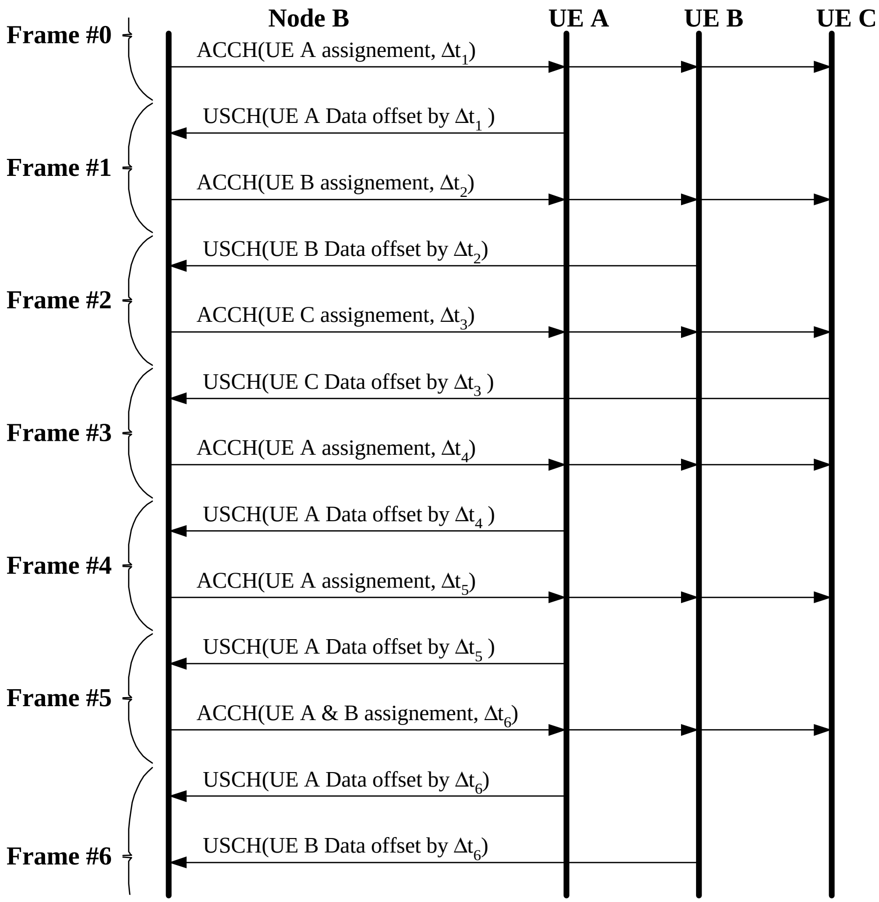

Figure 3 Message Sequence Diagram for USCH timing adjustments.