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Agenda Item:11

Source: Motorola

Title: Operation of the Uplink Shared Channel Document for : Other Business

Operation 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. 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 benefits of USCH were summarized in [3]. In [4] the physical layer issues identified in [3] were addressed and tentative solutions were provided to all of them. In this contribution the solutions provided in [4] are further refined with respect to the operation of USCH.

1.0 Introduction

Convergence of fast power control loop and the availability of good channel estimates at the base station are critical in case of uplink packet data transmission where packets arrives in a bursty manner [5]. A simple solution is to essentially use a low rate bi-directional link maintenance channel between the packet bursts. The link maintenance consists of power-control commands and pilot symbols needed to preserve power control and synchronization of the dedicated physical channel. However, there is a cost associated with the use of link maintenance channel since code and power resource are consumed even though no data is being transmitted. The cost increases linearly with the number of users engaged in a packet call. In this follow-up contribution to [4] we propose a preamble using DPCCH be transmitted before the beginning of a packet transfer.

2.0 Operation of the USCH

Figure 1 illustrates the conventional approach of packet data transmission on a dedicated channel with a bi-directional link maintenance channel. In this method an initial Random-Access request is used to set up a dedicated channel. A low rate link maintenance channel (DPCCH) is maintained between the packet burst to preserve power control and synchronization of the uplink dedicated physical channel. It may be noted that a common downlink control channel (termed as Access Control Channel (ACCH)) is broadcast continuously to carry the uplink power control bits [1]. There are a couple of disadvantages with this method:

a. Unnecessary power resource is consumed when no data is being transmitted. Further, if the number of packet data users are high it will contribute to a significant portion of noise rise in the system. Figure 2, shows the CDF of simultaneous packet calls for a typical web browsing session for various channel utilization factors. It may be noted that for channel utilization of 0.95 (which will be the case during peak commuting hours), 45% of the time there will be 15 or more simultaneous packet calls. Note that the details related to Figure 2 can be found in [6].

b. Maintaining a dedicated downlink channel for each uplink channel will worsen the code shortage problem in the downlink when the number of packet data users are high.

The advantages of using USCH have been covered in [7]. In this contribution, we propose that a preamble using DPCCH only be transmitted before the start of packet data transmission so that power control, channel estimation and search parameters are current at the start of packet transmission. Although, the same idea was conveyed in our earlier contribution [4], it was not clear how this will work using the existing physical layer specification. In this contribution, we further clarify the issues which were addressed in [4].

Figure 3 illustrates the modified approach for discontinuous packet data transmission. Three cases are considered, a) packets are transmitted only in the downlink using DSCH, b) packets are transmitted only in the uplink using USCH and c) packets are transmitted in both the uplink and downlink direction. In all the cases an uplink channel has to be maintained so as to convey the power control bits for forward link, piggybacking information and/or to carry the data using the USCH. To prime the fast reverse link power control loop, searcher and channel estimator, the transmission of preamble using DPCCH starts one frame (16 slots) prior to the scheduled uplink or downlink packet data transmission. This is shown in Figure 4, where the DPCCH is mapped into Q channel and subsequently complex scrambled by a UE specific complex scrambling code. It may be noted that the length of the preamble is settable. The UE then decides on the initial power with which to transmit the preamble. Ideally, the preamble transmit power should be chosen so that it is received at the BTS with exactly the power needed to detect the preamble. However, there is a large variance on the initial estimate of the transmit power due to changing radio environment, errors in uplink path-loss estimation due to non-reciprocity with downlink path loss etc. This may cause excess uplink noise rise resulting in decreased capacity in the system if a large number of packet data users are accessing the system simultaneously. To prevent this scenario, the preamble is transmitted with an additional negative power offset from the computed open loop estimate. Further, the initial power control step size for transmitting the preamble is set at a higher value (e.g. 2dB) so that power control loop converges faster if the UE is in a deep fade. On the receipt of the first down power control command at the UE during the preamble transmission phase the step size reverts back to normal power control (PC) step size (e.g. 1dB). It may be noted that the step size always goes back to its normal setting in the beginning of actual packet data transmission.

Figure 5 shows the CDF of consecutive idle frames within a packet call for various values of utilization. The mean packet size is assumed to be 480 bytes and a code rate of eight blocks per frame is used which translates into 384 Kbps UDD service. The following conclusions can be drawn from the figure:

1. For low values of system utilization, 10% of the time the number of consecutive idle frames within a packet call will exceed 5.
2. For high values of system utilization, 35% of the time the number of consecutive idle frames within a packet call will exceed 5.
3. In view of the above, it can be concluded that use of a dedicated link maintenance channel will be wasteful when data traffic is discontinuous. Preamble based packet data transmission allows link maintenance only when necessary. Furthermore, when data traffic is continuous the preamble based packet transmission will look like a link maintenance channel.

Conclusion

In this contribution, it was shown that preamble based packet transmission is required for USCH operation since it allows link maintenance only when necessary. As such, it is recommended to include provision of both link maintenance channel and preamble based method in the 3GPP specification.

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, “Benefits of the ACCH for Signaling Fast Assignments,” SMG 2 UMTS L1 047/99.
[4] Motorola, “Methods for Operating the Uplink Shared Channel,” SMG 2 UMTS L1 046/99.
[5] SMG2 UMTS L2/3 Experts Group, “Liason from SMG2 L2/3 Expert Group to L1 Expert Group with regards to proposed USCH,” SMG 2 UMTS L23 581/98.
[6] Motorola, “State Occupancy Estimations for Shared Channel Concept,” Submitted to 3GPP-RAN-WG1
[7] Motorola, “Benefits of the Uplink Shared Channel (USCH),” SMG 2 UMTS L1 048/99.

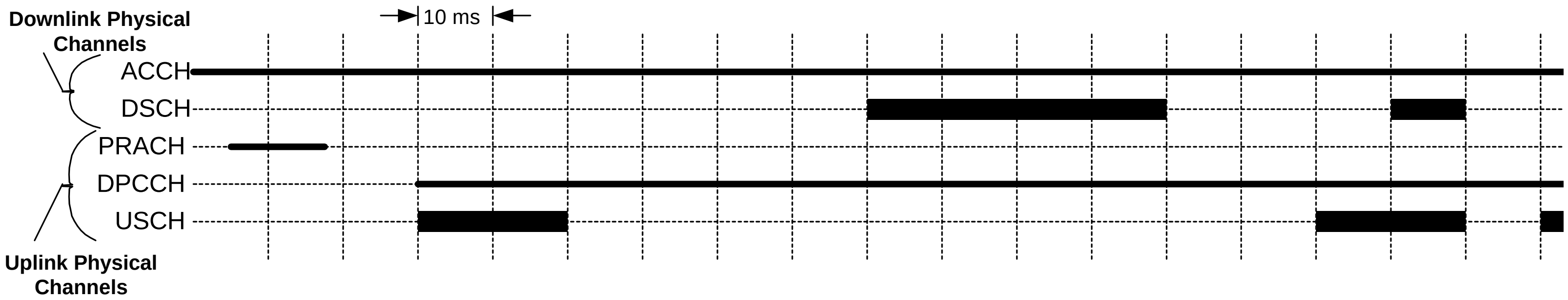

Figure 1 Shared Channel with continuous uplink link maintenance channel (DPCCH)

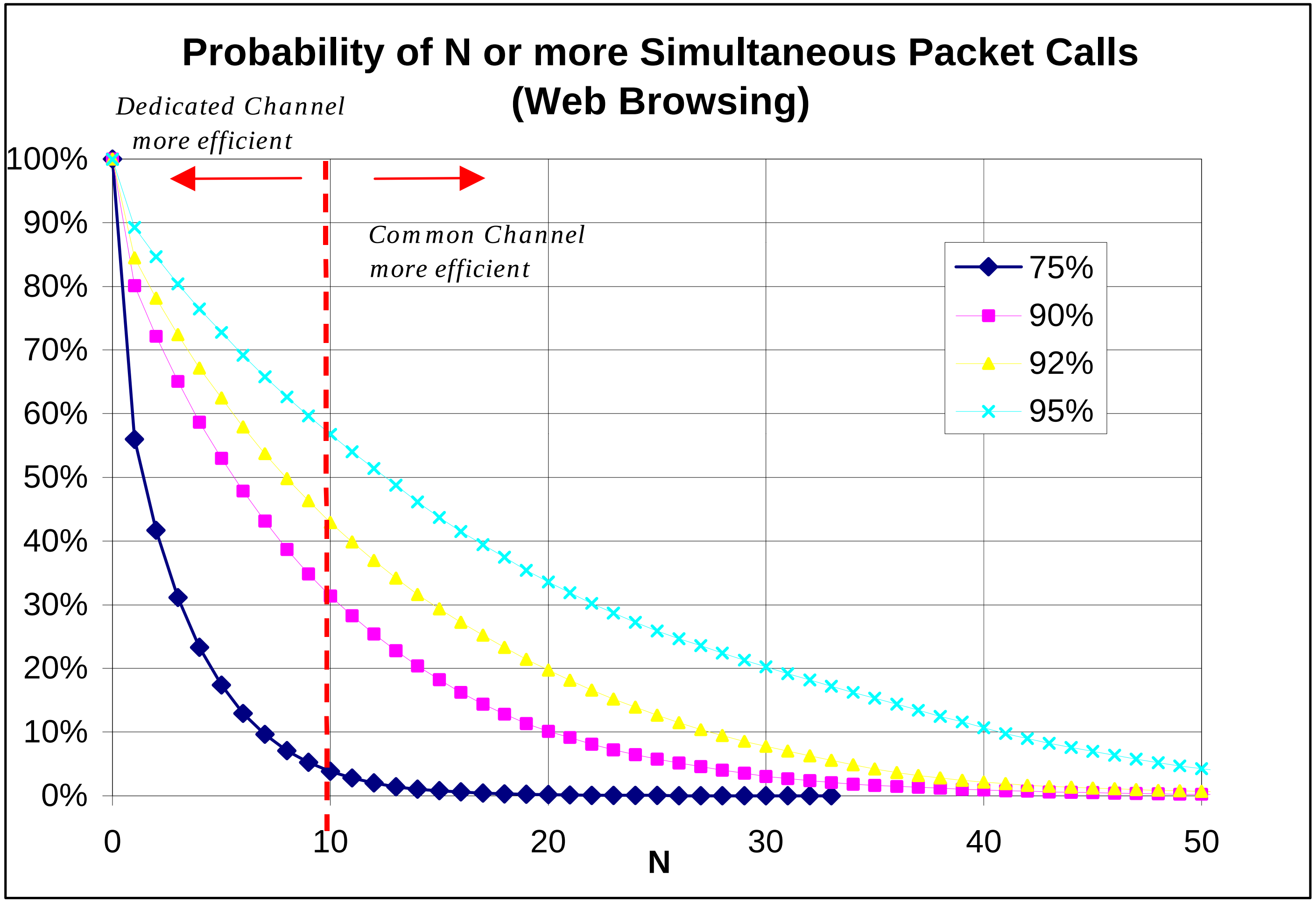

Figure 2. CDF of Number of Simultaneous Packet Calls for different Utilization Factors

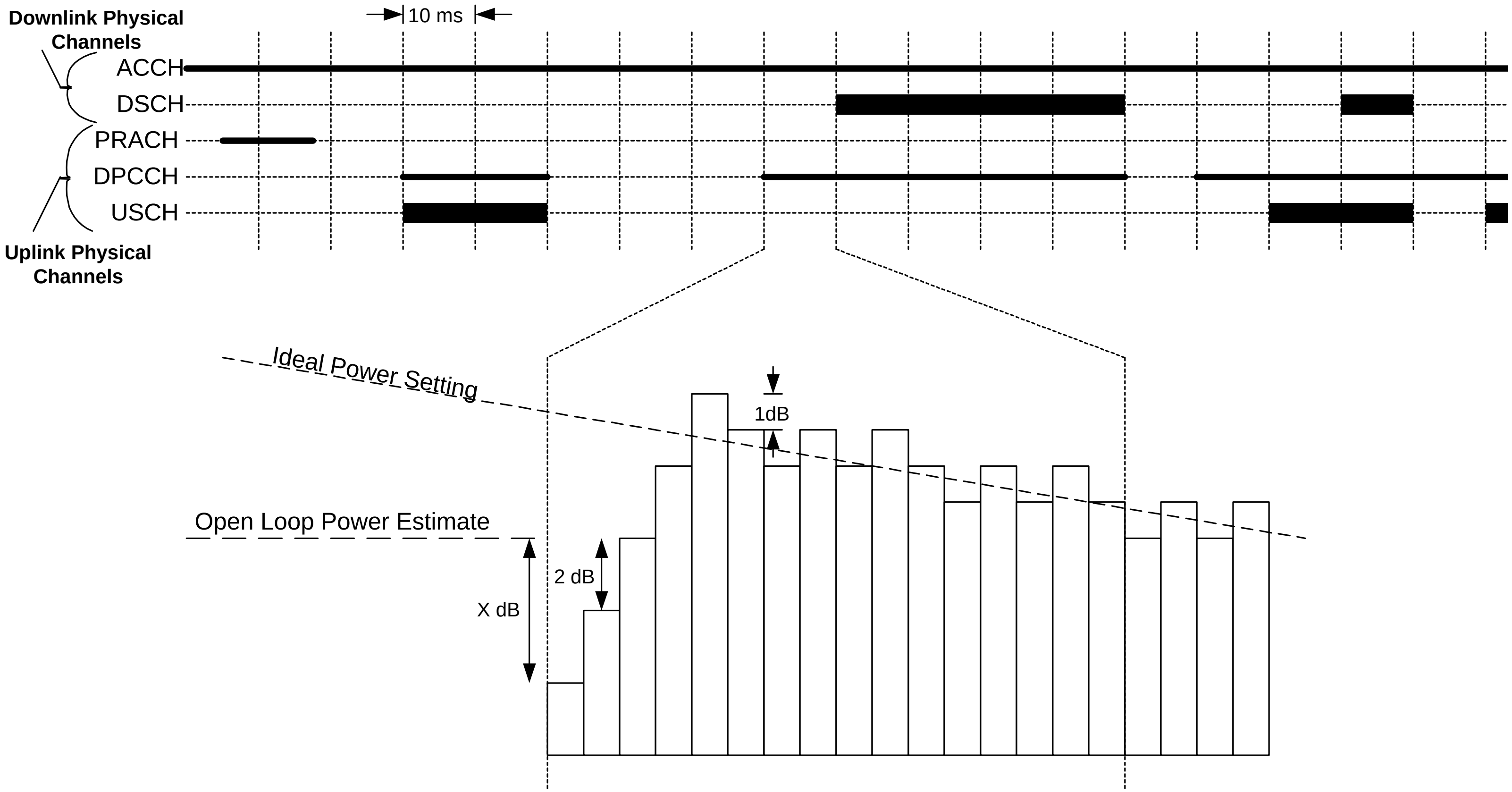

Figure 3 Uplink Shared Channel with discontinuous DPCCH.

Figure 4. Preamble Transmission using DPCCH before the start of Packet Data Transmission

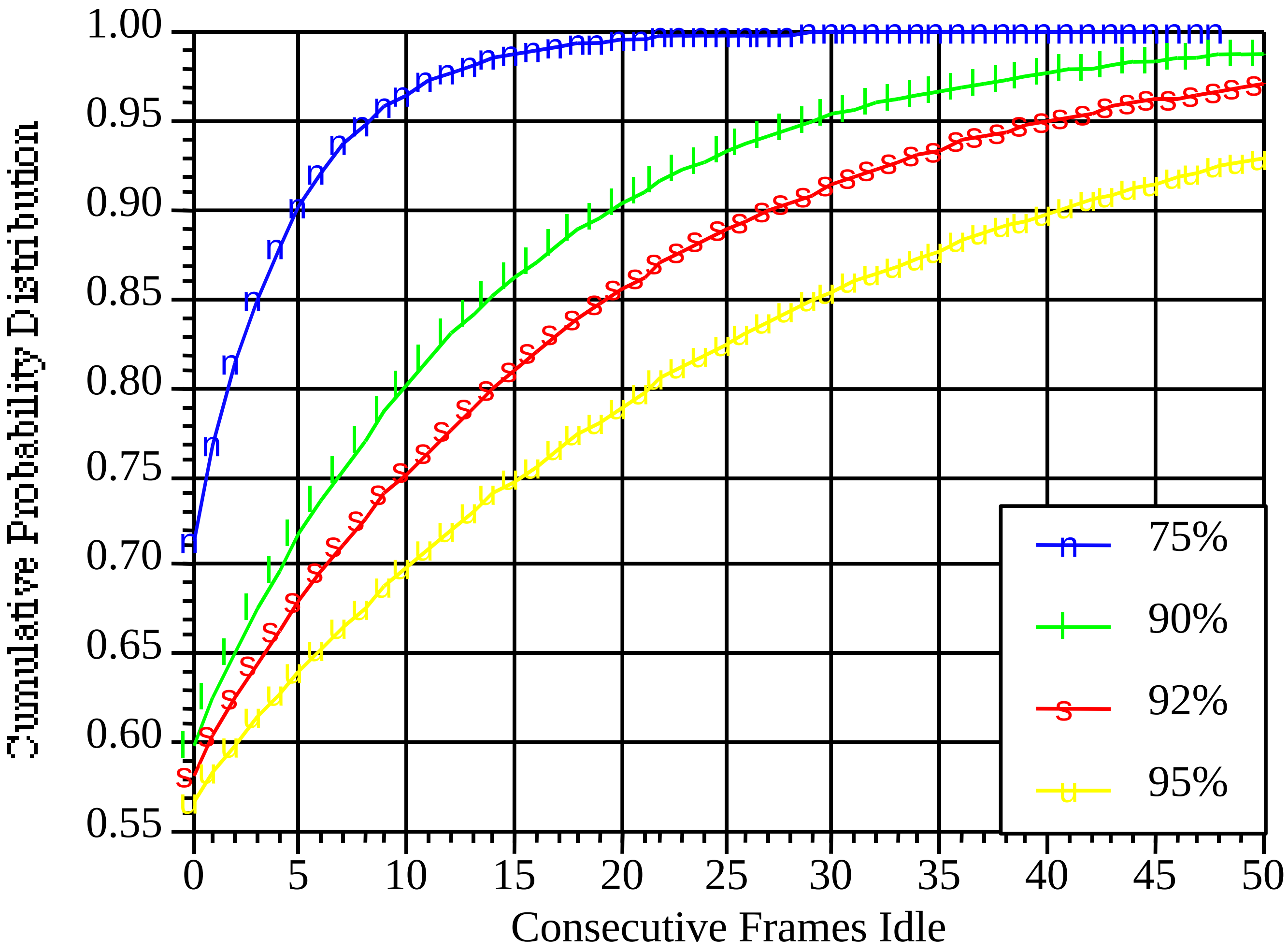

Figure 4. Consecutive idle frames within a packet call for various values of system utilization. Mean packet size is 480 bytes, and a code rate of eight blocks per frame is represented