TSG-RAN Working Group 2 (Radio layer 2 and Radio layer 3)
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# 1. Recap on the concept of the uplink shared channel (USCH)

On the December UMTS meeting, Motorola came up with the proposal of introducing a shared uplink channel to the UMTS system specification Motorola, “Mechanisms for managing uplink interference and bandwidth”, Tdoc SMG2 UMTS-L23 535/98.. Though on the uplink there is no code blocking problem (all channelization codes are available for the same UE sending its specific scrambling sequence), the limitation of uplink channels results from the fact that the more channels are used by different UEs the stronger their mutual interference at the receiving base station will be. Adding a new uplink connection will result in a noise rise at the base station with the limitation - to be observed by the base station – that a special maximum noise amount at the base station must not be exceeded.

According to Motorola, “Mechanisms for managing uplink interference and bandwidth”, Tdoc SMG2 UMTS-L23 535/98., the shared uplink channel is a channel usable by a number of *predefined* UEs for transmitting data in the uplink. In order to coordinate the access to the shared channel (using as a criterion the noise budget at the receiving base station), a scheduler in the base station is in charge of messaging whether a particular predefined UE is allowed to send and which spreading factor to use for that transmission. For messaging this control data that has to be received by all predefined UEs, a new downlink control channel, the Access Control Channel (ACCH) is introduced in Motorola, “Mechanisms for managing uplink interference and bandwidth”, Tdoc SMG2 UMTS-L23 535/98..

Motorola, “Mechanisms for managing uplink interference and bandwidth”, Tdoc SMG2 UMTS-L23 535/98. does not go too far into physical layer details. However, it has to be assumed that the uplink shared channel is not expressed in terms of one uplink scrambling code and a number of channelization codes, which the predefined UEs use. Instead, the UEs use the same scrambling code for transmission on the uplink shared channel as used for normal dedicated channels. Now, what is the significant difference between an uplink shared channel and using a number of dedicated uplink channels? According to Motorola, the difference lies in the *fast* scheduling in the base station in case of the uplink shared channel. In particular, in the current system concept (without USCH), the dedicated channel changes the spreading factor autonomously (and adjusts its transmission power accordingly), and there is no means for the base station to control, for an existing dedicated channel, the spreading factor to be used in a given frame, which is possible with the uplink shared channel concept.

Since the normal dedicated channels cannot be controlled by the base station with respect to their spreading factors, transmission via a number of dedicated channels whose bit rate is assumed to sum up to the same value as that of an uplink shared channel, will not allow as much data transmission as would be possible via the uplink shared channel due to statistical multiplexing effects.

The proposed procedure to use the USCH in Motorola, “Mechanisms for managing uplink interference and bandwidth”, Tdoc SMG2 UMTS-L23 535/98. is as follows. UEs with data to send perform the following procedure Motorola, “Mechanisms for managing uplink interference and bandwidth”, Tdoc SMG2 UMTS-L23 535/98.:

1. At the beginning of a packet transmission session, the UE sends an initial request on the RACH carrying a reservation request containing the length of the local queue available in the UE. (The longer the queue, the longer a UE can buffer its data before transmitting. UE with longer queues are more easily able to accept phases with lower data rates.
2. A temporary User-ID is assigned by the base station and messaged via a downlink control channel.
3. The UEs monitor the ACCH for assignment of spreading factors
4. Upon receiving a spreading factor assignment, UEs use the measured information on the path loss and spreading factor assignment to calculate the initial transmit power.
5. UEs transfer their data on the USCH while performing fst power control using a common power control channel as indicated on the Power Control Position Assignment.
6. The UE continues to monitor the ACCH for subsequent spreading factor assignments until the queues are empty.

It seems that it is not sufficient to just send the queue depth via the RACH as expressed under 1. Instead it would be necessary also to include some information about the capacity needed on the uplink for the coming packet transmission.

## 2. FAUSCH for signalling access to the uplink shared channel

According to Y. Du, and C. Herrmann, "Fast uplink Signalling by matched Sequence Detection", PVE 03-1690, June, 1998., Philips, "Fast Uplink Signalling Mechanism for FDD and TDD Systems", Tdoc SMG2 UMTS-L23 162/98, the fast Uplink Signalling Channel FAUSCH provides a means for each UE registered in a given radio cell, to message to the base station a request for "something" in that it sends during its particular time-offset during the 10 ms frame an Uplink Signalling Code (USC). Current understanding in L23 and L1 expert groups is that a UE can message the request for a dedicated channel especially for packet data transmission.

With respect to the shared channel, further applications for the FAUSCH are possible, given that a cell-specific USC is assigned in addition to the USC, that is used for conveying the request for a dedicated channel, or that in a given cell the USC is defined only to be applicable for these further applications. In all cases the procedure is similar to that described in Y. Du, and C. Herrmann, "Fast uplink Signalling by matched Sequence Detection", PVE 03-1690, June, 1998., Philips, "Fast Uplink Signalling Mechanism for FDD and TDD Systems", Tdoc SMG2 UMTS-L23 162/98: When a UE registers with the UMTS Terrestrial Radio Access Network (UTRAN) and is then known to the network on cell-level, the UE is assigned USCs (e.g. for conveying the request for a dedicated channel and for the further purposes as described below), and a unique time-offset during the 10 ms frame when to send the USC.

1. The concept in Motorola, "Mechanisms for managing uplink interference and bandwidth", Tdoc SMG2 UMTS-L23 535/98. stipulates a number of 8 predefined UEs that can use the shared channel and will send their capacity requests via the RACH. Here, instead of the RACH, the FAUSCH could be used to indicate for a predefined UE (i.e. the UE has been assigned a temporary User ID for using the USCH in the procedure cited in section 1) the need for capacity on the uplink shared channel.

   Sending an USC would then mean that the UE needs some predefined capacity (i.e. low rate transmission, e.g. 16 kbps) on the USCH to send the reservation request, which would – without the FAUSCH –be included in the RACH transmission. On receiving the USC of this particular UE, the base station grants or rejects the capacity for sending the (low rate) reservation request via the ACCH including starting time and spreading code for transmissions by this UE on the USCH. On receiving the reservation request, the base station grants or rejects this capacity via the ACCH. If capacity is granted, the UE starts transmitting its packet, based on the spreading factor assignments conveyed by the base station via the ACCH.
2. The 8 predefined users in Motorola, "Mechanisms for managing uplink interference and bandwidth", Tdoc SMG2 UMTS-L23 535/98. seem to be fixed Private communication with Motorola, 1998.. The exchange of one user by another user would need some signalling via the RACH, in order to assign the temporary User ID to another UE. Here, again the FAUSCH can be used to improve the performance, in that now any UE of the radio cell can take part in the shared channel directly without a RACH access to change the set of predefined users:
   A UE that is not yet involved in transmissions via the USCH sends its USC to indicate that it wants to use the USCH. If the activities of the 8 UEs already using the USCH allow removing one of the 8 UEs from the set of users of the USCH, the base station would notify (via the ACCH) the UE, that is to be removed, that its temporary User ID is no longer valid. Furthermore, the base station would also notify the new UE about its temporary User ID via the ACCH.

Advantages of using the FAUSCH instead of the RACH:

- RACH suffers from collisions, therefore additional delay and interference arise, which make the calculation of additional noise more difficult, since collisions are not easily predictable. RACH cannot be used with closed-loop power control, and with RACH, i.e. the more data is sent via the RACH, the worse the negative interference influences due to the weak power control mechanism. On the other hand, if the USCH is used also to convey capacity requests, this data is sent via a channel that can perform closed-loop power control.
- FAUSCH interference contribution is at least by a factor of 10 lower Tdoc SMG2 UMTS L1 623/98, "Comparison of Eb/N0 for packet transmission using RACH and FAUSCH", Philips.. Since the number of FAUSCH channels is known in advance, the calculation of interference to be expected is much easier.

## 3. References


[1] Motorola, "Mechanisms for managing uplink interference and bandwidth", Tdoc SMG2 UMTS-L23 535/98.

[2] Y. Du, and C. Herrmann, "Fast uplink Signalling by matched Sequence Detection", PVE 03-1690, June, 1998.

[3] Philips, "Fast Uplink Signalling Mechanism for FDD and TDD Systems", Tdoc SMG2 UMTS-L23 162/98

[4] Private communication with Motorola, 1998.

[5] Tdoc SMG2 UMTS L1 623/98, "Comparison of Eb/N0 for packet transmission using RACH and FAUSCH", Philips.