Exhibit 1031

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Benefits of the Uplink Shared CHannel (USCH)

1 Introduction

Within the ETSI SMG2/Layer 2/3 experts group, the requirement for a Downlink Shared CHannel (DSCH) has been identified and an agreed description of the concept has been included in the documentation. Motorola believes that most of the reasons for using a shared channel in the downlink also apply in the uplink.

Therefore, in this paper, a brief description of the Uplink Shared CHannel (USCH) is provided. The advantages of using MAC to arbitrate access between packet data users on a shared channel compared to the alternative of using RRC controlled access to DCH's is explained. The qualitative discussion provided complements the more detailed simulation results and concept description presented in the previous meeting [1,2]. Finally, the consequences on complexity etc. of adopting the USCH concept are outlined.

2 The Uplink Shared Channel

The DSCH represents a power and code resource which is shared between users [3]. In the case of the USCH there is no short code limitation (each UE will have its own scrambling code), however, there is still a limited power resource, hence the USCH represents a shared power resource. The motivation for the USCH is essentially the same as that for the DSCH. As with the DSCH it is proposed that access to the USCH is managed by a MAC-sh entity in the CRNC [1].

3 Advantages of the shared channel concept for packet support

In this section the benefits of the shared channel approach for supporting packet connections are listed. The benefits are described in comparison with the alternative of using DCH's controlled by RRC.

3.1 Spectral efficiency and packet call delay are much less dependent on imperfect admission control

When RRC admits a new packet call on a DCH it has to assign a bit rate to the DCH on the basis of only minimal information (ie. admission is based on RRC's prediction of the connection's future requirements). If the assigned bit rate is too high then capacity will be wasted (there is a dis-continuous transmission). This problem is shown in Figure 1, see the case where the RRC chooses DCH rate #1. With the shared channel concept the resource will always be fully used in every frame (assuming of course that there are packets requiring transmission).

In order to avoid the problem of assigning a DCH which is too large, RRC will sometimes assign a DCH which has a bit rate which turns out to be too low. In this case, the DCH is more likely to be fully used (and transmission will be more continuous), however, the packet call will take longer to complete. This problem is shown in Figure 1, this time look at the case where the RRC chooses DCH rate #4. With the shared channel, packet calls will always be completed at least as quickly as is the case with RRC based control, and on the average will be completed more quickly [2].

Sometimes, the situation will occur where the assignment of a DCH would have been acceptable, see Figure 1, when DCH#3 is chosen. However, this will occur only very infrequently, being dependent on the actual packet arrival within the packet call and dependent on an imperfect RRC packet call admission procedure.

It is worth making some comments with regards to whether there might be a way of assigning a high data rate DCH in such a way that the system can still be operated efficiently (ie when DCH bit rate #1 is chosen, Figure 1). Whilst it is true that dis-continuous transmission can be exploited (and extra packet calls admitted) it is only possible to do this efficiently if there are many users active such that it is possible to rely on statistical averaging. DTX is exploited in this way in voice-only CDMA systems where the number of simultaneously active users runs to many 10's or 100's. However, the argument does not work well in a packet context. In a packet context if there are many users active then the bit rate of the assigned data pipes will have to be low, meaning that packet transfer times are increased (and essentially the transmission is not really dis-continuous anyway).

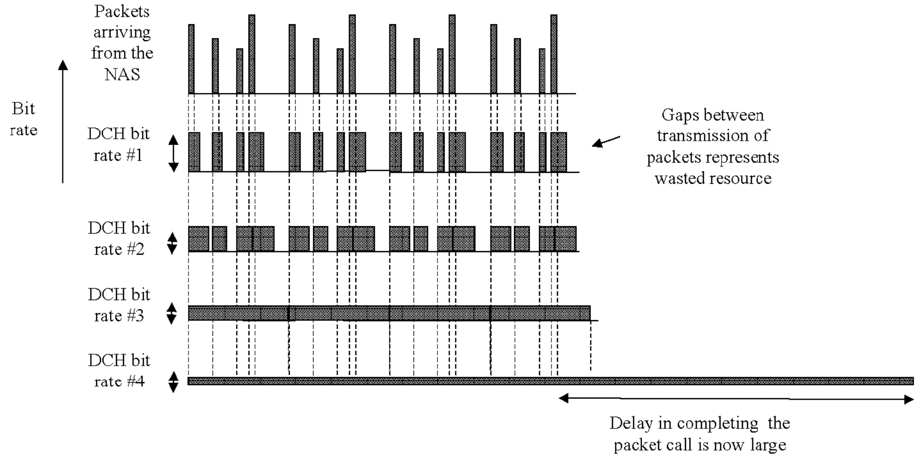

Figure 1) Figure showing the difficulty in assigning a DCH of the correct rate to carry packet data, if RRC assigns bit rate #1 or #2 then capacity is wasted, if it assigns bit rate #4 then the packet call takes much longer to complete

Note that this paper includes an Appendix which describes the terminology used in this paper along with traffic models for some of the most popular existing services including email, FTP and Web browsing. It can be seen that packets will be delivered to the Access Stratum in a very bursty manner (as indicated in Figure 1), this emphasises the importance of using fast MAC layer scheduling in order that these services (and others not yet conceived) are supported efficiently and with the best possible QoS.

3.2 Highest priority packets are always served first

When RRC based control of packet users on DCH's is used then it will often be the case that a high priority packet call will be queued, waiting for a lower priority packet call to release its DCH (see Figure 2). By using the shared channel to support packet users, highest priority packets always get served first, irrespective of which UE the packets are going to/from and this therefore improves quality of service (see Figure 3).

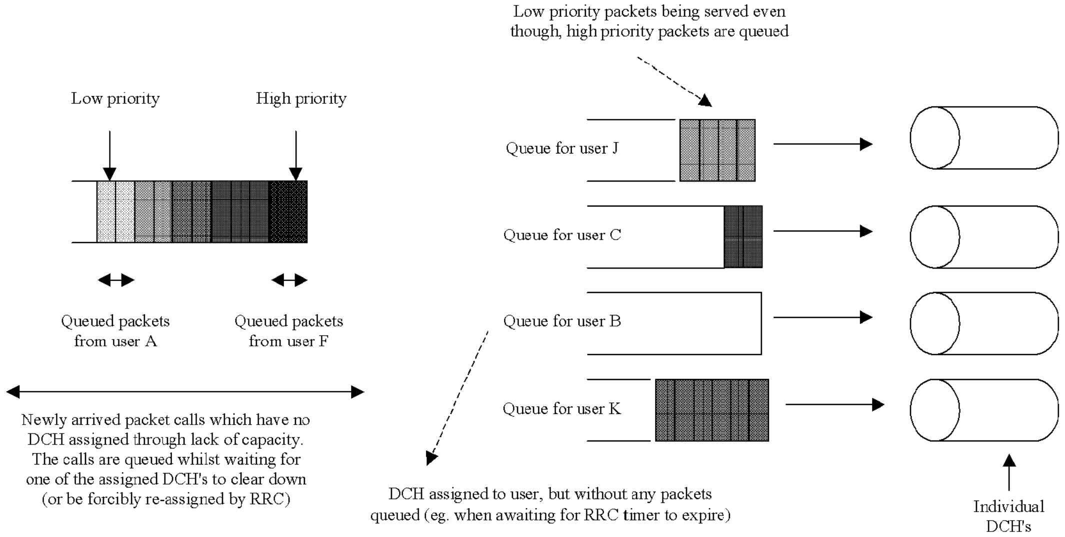

Figure 2) RRC based scheduling between users on DCH's

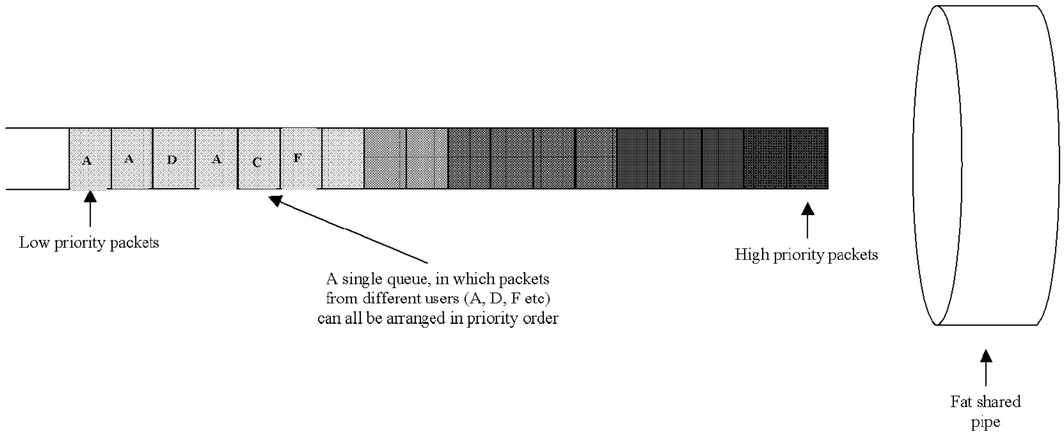

Figure 3) MAC scheduling onto a fat shared pipe (using cross-user MAC/DSCH), note highest priority packets get served first (irrespective of user)

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3.3 Capacity is not wasted whilst DCH's are being released and re-assigned

It is worth re-iterating that with RRC based control on DCH's capacity will often go wasted whilst the RRC decides whether to either change the size of the DCH or release it (this is well demonstrated in Figure 2 in which the queue for User B is empty, but the DCH is still assigned awaiting for an RRC timer to expire).

When the decision is made to release the DCH, then it will be necessary to initiate a number of RRC procedures to firstly release the DCH and then to re-assign the capacity/code etc. to another user. There will be further delay whilst the PHY, MAC and possibly RLC are re-configured for the new 'owner' of the resource. All this time, the resource is not being utilised.

It is also worth pointing out that RRC will on occasion release DCH's before the packet call is actually completed, this will also have a detrimental impact on packet call completion times.

3.4 More efficient capacity packing - Better spectrum efficiency

Downlink

To explain this benefit of the shared channel approach consider the example of carrying packet data connections in the downlink. Consider first the case where multiple DCH's are used to carry packet connections. When a new packet call arrives from the NAS, then if the packet call can be admitted the UTRAN-RRC assigns a proportion of the total downlink power to that UE. However, in making that allocation it is necessary to include a margin to account for variations in the transmit power on each of the connections which will result from changes in propagation loss and interference as the call progresses (both fast and slow changes).

With the shared channel concept it would be possible to take into account variations in mean propagation and interference conditions (with a resolution of a few 10's of ms) when performing the scheduling. It would therefore be possible to avoid having to use such a large margin. Put another way, the proportion of power assigned to the shared channel could be packed more efficiently and there would be an increase in capacity.

Uplink

In the uplink the situation is rather different, however, there are still similar opportunities to exploit. With the shared channel concept the possibility exists to dynamically vary the size of the shared channel in response to rapid changes in conditions. For example, the CRNC could temporarily increase the size of the shared channel for a period of a few frames if it knows, for example, that voice user DCH's are being re-assigned and that capacity would otherwise be wasted. Such responsiveness would not be so easy to achieve with an RRC-DCH based approach.

4 Comments on the requirement for efficiency in the uplink

Motorola believes that UMTS should be designed to make as efficient use of the uplink resource as possible. However, it is reasonable to raise the question, is there really a capacity limit in the uplink?, is there a service requirement for completing packet call transmissions quickly?

In answer to the first question, mobile radio spectrum is a very valuable (and expensive) resource, naturally operators will want to ensure that it is well used. It should also be noted that it is always difficult to envisage what future service requirements will be, however, we should ensure that UMTS can efficiently support whatever services become popular. One can certainly anticipate, that once an operator has paid a lot of money for spectrum, his pricing strategy will be such as to encourage the use of uplink services so that the spectrum is very well utilised.

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