TSG-RAN Working Group 2 (Radio layer 2 and Radio layer 3) *TSGR2#2(99)134*
Stockholm 8th to 11th March 1999

Agenda Item: 6.2, 7.3

Source: Siemens AG

Title: Outline of a Proposed Resource Allocation Methodology for UMTS-TDD

Document for: Decision

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1. Introduction

This paper outlines a system for resource allocation for the TDD implementation of UMTS. It identifies how TDD resources could be utilised for dedicated and shared channels and how this relates to the MAC architecture model. The case of ODMA is not addressed in this paper. The paper assumes that the concept of the USCH is adopted to the standards.

3. Discussion

It is proposed that, in the TDD implementation of UMTS, capacity is allocated to a channel through the assignment of resource units (the combination of one code in one slot within a frame). Dependent upon its channel type, a channel may be allocated one or more resource units in every frame or every 'nth' frame until released or for a limited number of frames, regularly or irregular distributed within the multi-frame. The number of resource units that are assigned to a transport channel does not, on its own, define the capacity of the channel, spreading factor and coding rate are also factors.

For resource allocation purposes, it is convenient to separate the transport channels into the groups control channels, dedicated transport channels and shared transport channels.

3.1 Control Channels

For some of the common control channels (FACH, RACH and, possibly, PCH) one or more resource units would be allocated in every frame to each of the channels, for the remaining common control channels (BCH and SCH) resource units would be allocated to the channel for only a fraction of the frames in the multi-frame. It is proposed that the numbers of resource units assigned (controlling bearer capacity) and the location of the resource units that are assigned, would be controlled by the RRC that is located in the RNC.

The location of the resource units assigned to the common control channels would be identified to a UE partly through the synchronisation process (the c_p sequence points to the location of the BCH, possibly indirectly) and partly through the BCCH message contents. Allocations made to common channels need not be fixed, their location can be changed to match capacity, interference and frame re-segmentation (division between up-link and downlink slots) needs.

Within the MAC architecture model [1], the interface to the physical layer resource units allocated to the common control channels is controlled by the MAC-b, MAC-p and MAC-c objects, the MAC-sy object interfaces with the synchronisation process. The allocation of MAC architecture model objects for ODMA control channel management is ffs.

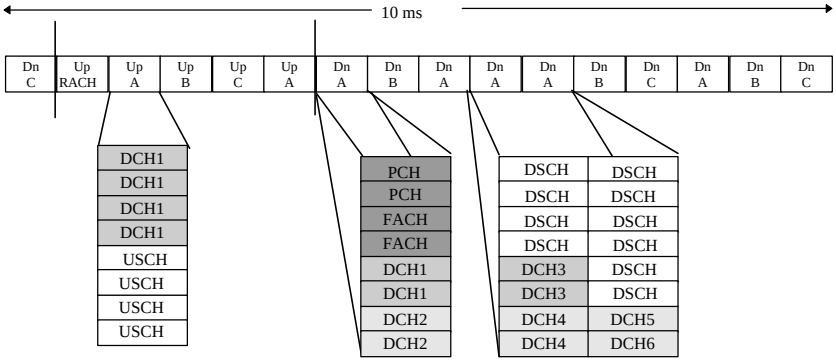

Figure1: Illustration of TDD Resource Allocation

3.2 Dedicated Transport Channels

Resource units that are assigned to dedicated channels are allocated for the exclusive use of a single UE until all logical channels that are using the traffic channel are released. The channel will be assigned one or more resource units in each frame or every n^{th} frame, the number of resource units allocated in each direction can be unequal to reflect the channels asymmetry. It is proposed that the selection of the resource units that are to be assigned to the DCH will be made by the RRC located in the RNC.

A DCH may be associated with a single DTCH or the UE DCCH, or with several DTCH and/ or the DCCH. A UE may be assigned several DCH and each may support a single or multiple logical channels. Where there are several logical channels associated with a DCH then the MAC will be responsible for selecting what is to be transmitted in each transmission time interval and signalling this through a use of TFCI bits.

In the MAC architecture model, the mapping between the logical DTCH/DCCH channels and the physical DCH traffic channels is assigned to the single MAC-d object that is created in the UE and the single MAC-d object that is created for the UE in the UTRAN. The MAC-d objects will map between each DCH and its associated DTCH/DCCH channels, multiplexing where necessary. The MAC-d will also determine when signalling and data traffic should be transmitted on the common channels (RACH and FACH) and forward such traffic to the MAC-c.

The sets of resource units that are assigned to a DCH are not expected to change frequently, however, some changes may be required to ensure efficient use of resources, for example by packing DCH channels into as few slots as possible. It is proposed that changes to the number or location of resource units allocated to a DCH would be controlled by the RNC RRC.

Initial allocations of resource units to the DCH would be signalled with the channel set up signalling . Once the bearer has been established any changes to the allocated resources would be signalled to the UE using either the DCCH or the FACH. The UE should transmit an acknowledgement either on the DCCH, the RACH or a resource unit specifically allocated to it for acknowledgement purposes by the RRC.

3.3 Shared Transport Channels

Much of the traffic that the TDD implementation of UMTS will carry is expected to be packet traffic with bursty characteristics e.g. web browsing. It is proposed that this traffic should, in the main, be transported using the uplink and downlink shared channels (USCH, DSCH). It is possible for a UE to operate one or more DCH whilst using the DSCH and USCH. One or more DTCH may be mapped onto both the DCH and the DSCH/USCH or, alternatively, the DTCH mapped to the DCH may be different from those that are mapped to the DSCH and USCH.

It is anticipated that the USCH/ DSCH would be allocated the majority of the capacity that is not currently in use for DCH or common channel use, consequently, the capacity assigned to the DSCH/ USCH and the resource units that it is assigned can be expected to vary with time. It is proposed that resource units are assigned for DSCH/USCH use by the RNC RRC and this function would revise the allocation made whenever resource units are required or released by other channels. There could be one DSCH/USCH pair per cell or a cell could, in principle, operate several such channels at the same time.

For efficient use of DSCH/USCH resources it is proposed that control of access to the shared channels is the responsibility of the UTRAN MAC and in the MAC architecture model the scheduling function is contained in the UTRAN MAC-sh object that is responsible for a DSCH/ USCH pair. There is one MAC-sh for each DSCH/ USCH pair.

Access to the shared channels is achieved through a UE being assigned one or more resource units, from the set available to the shared channel, for one or more frames. The scheduling function will determine how many resource units are to be assigned, for how many frames and which resources units are to be used. It will determine what resources are to be assigned based on the traffic state and the quality of service target for the particular UE and the other UEs that it services. A data transfer session could contain a sequence of capacity allocations to the UE, some may be consecutive whilst others may be spaced in time dependent upon the traffic situation that is being administered by the scheduler.

The allocation process may have two elements, allocation for data transfer and allocation for acknowledgement (RLC Status). Typically, the allocation for data transfer will provide a capacity that would be matched to the number of PDUs to be transferred and the coding rate. The acknowledgement allocation, for the return direction, could be matched to the relatively small capacities required for status messages. Acknowledgement capacity need not always be assigned, and for uplink data transfer the option exists for acknowledgements to be transmitted on the FACH.

It is expected that, in TDD implementations of UMTS, the FACH would be the best channel, in terms of minimising the total resources that are used for signalling, for signalling access allocations for the USCH and DSCH.

In the MAC architecture model, it is proposed that there would be one MAC-sh entity in the UTRAN for each DSCH/USCH pair. This would be responsible for scheduling access to the shared bearers for the logical channels that are using them. Because these logical channels interface to the UE MAC-d instances there is a transfer of data between the MAC-d and the MAC-sh. The UTRAN MAC-sh instances also interface with the FACH for shared channel access signalling. In each UE

that makes use of a shared channel there will also be a MAC-sh instance. This will act as a gateway between the logical channels connected to the MAC-d and the shared physical channels. The MAC-sh will act upon shared channel allocations signalled to it on the FACH by transferring data from the MAC-d to the USCH or from the DSCH to the MAC-d.

References

1. 3GPP Technical Specification 3GPP S2.21 V0.0.2 MAC protocol specification
2. 3GPP Technical Document 3GPP RAN WG2 032/99 ‘Benefits of the Uplink Shared Channel (USCH).