TSG-RAN Working Group 2 (Radio layer 2 and Radio layer 3) ***TSGR2#2(99)133***
Stockholm 8th to 11th March 1999

Agenda Item: 7.2.1

Source: SONY International (Europe)

Title: RACH Prioritisation Scheme for Multi-service Provision

Document for: Decision

Summary

Access to the RACH in UMTS is contention based. In areas of heavy usage predictable access via the RACH may not be possible. A collision of RACH bursts occurs only if two UEs attempt to send a burst in the same time frame using the same time offset and preamble signature. Each UE must then retry its initial attempt. The number of retries and subsequent retransmissions can increase the number of collisions further reducing efficiency. A discussion of RACH access capabilities was presented to this group in [2].

In GSM, RACH access is controlled by the random assignment of users to an access class. A bit map is transmitted upon the BCCH to inform users which access classes may and may not attempt RACH access at a particular time (see [3]).

UMTS, however, is expected to provide a much wider range of services than GSM, including different forms of data transmitted via the RACH (packet data transmitted via RACH, for instance). It may be the case that the delay requirements for the different services in terms of access are not the same. For instance, a user may be prepared to accept a longer wait when web browsing than when making a voice call, due to his perception gained from other access points to these services. Upon this basis of customer perception an operator may wish to tailor RACH access capabilities to the different services provided.

Introduction

In the current UMTS standard, the RACH is based upon an initial preamble spreading code, which differentiates between one cell and another cell. Following this, within the preamble part of each RACH burst, is the preamble signature, one of 16 separate preamble signatures available for use within that cell. In addition, within one time frame (10ms), are a number of time offsets, each of 1.25 ms, allowing a further eight variations. A collision, where two RACH bursts collide and are lost, only occurs when both the same random signature and random time offset are chosen for the same time frame. This allows a theoretical limit of 128 accesses per 10ms. The work done in [2] however suggests a much lower throughput in times of high load. In situations where numerous packet data users are present in a cell, this could overload the RACH, causing degradation in access quality.

The proposed scheme divides the RACH resources (in this case, preamble signatures) between different Access Service Classes.

Access Service Classes relate to different priorities of RACH use, for instance, a request for a circuit switched connection may have one priority, a request for packet data on a dedicated channel may have another priority, or packet data transmitted via the RACH a third priority. The division of RACH resources between different Access Service Classes gives a means of controlling the quality of access for different types of use.

RACH Partitioning Scheme

The RACH access slots

The preamble signature and time offset combination is shown in Figure 1, as an array of possible combinations taken over a time of 10ms.

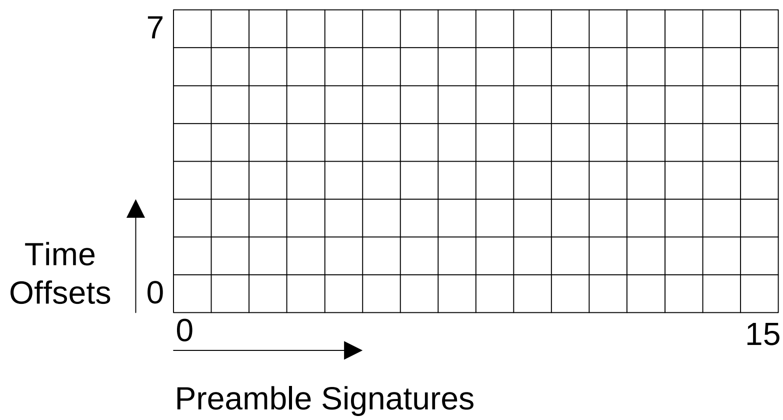


Figure 1

Partitioning of the RACH access slots

The proposal involves partitioning the possible access slots into a number of sections, using the preamble signatures. Each Access Service Class maps to a group of preamble signatures at layer 1, and also relates to a priority level, for instance three levels, 1, 2 and 3. The different possible types of RACH use can then be given a priority value corresponding to one of these classes.

An example is given in Figure 2. One group of slots may be reserved for transfer of Access Service Class 1(for instance CCCH, high priority) traffic, utilising preamble signatures 0-6. Access Service Class 2 could be reserved for DCCH data (allocated preamble signatures 7-10, medium priority), and a third priority level for DTCH data transfer in the case of channel switching (allocated preamble signatures 11-15, low priority).

The number Access Service Classes, and mappings are given purely as examples, as are the number of preamble signatures allocated to each.

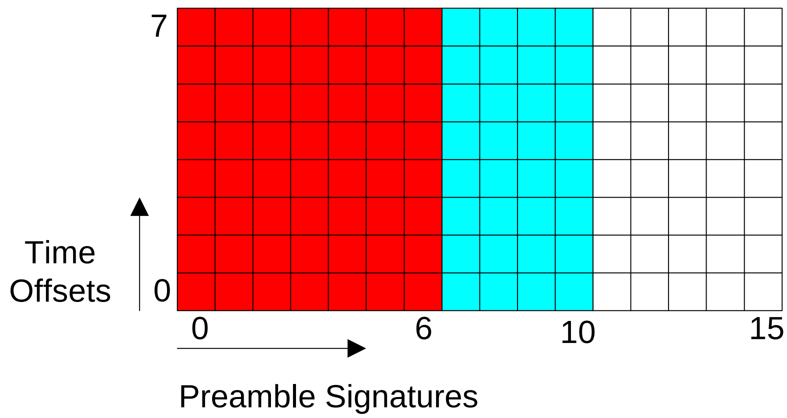


Figure 2

The network (with respect to current traffic levels) may dynamically control the actual size of each group depending upon the traffic from a particular Access Service Class. This would also be in line with the assigned priority level of the Access Service Class.

Transmission of the Access Service Class information

The details of the Access Service Class division will be periodically broadcast upon the BCCH. It is suggested to divide up the RACH resources via the preamble signatures. The transmission of one four-bit value would allow division into two Access Service Classes, or two four-bit values would allow three, and so on. The periodicity at which the Access Service Classes information is broadcast may depend upon traffic levels and rate of traffic level change at a particular time.

The figure of 8 bits to create three different Access Service Classes compares favourably with other proposals [1] where a number of bits in the region of 30 must be transmitted to give three possible service style groups. It is also important to note that a UE is not necessarily prevented from transmitting upon the RACH for a particular Access Service Class at any particular time, only that the size of the RACH resource available may be different depending upon the service required. This could, of course, mean prevention of transmission if an Access Service Class is allocated no RACH resources at a particular time.

As the MAC layer is to control mapping between logical channels and transport channels, it is proposed that the mapping of data for RACH transmission to Access Service Class be done at the MAC layer.

Proposed Additions to Permanent Documents

Additions to S2.01

Abbreviation to add to section 5.2:

ASC Access Service Class

Bullet point to add to section 7.3.1.2 MAC Functions

- Selection of Access Service Class for RACH transmission, based upon type of data to be transmitted, where Access Service Class maps to a part of the overall PRACH resource.

Additions to S2.21

Abbreviation to add to section 3:

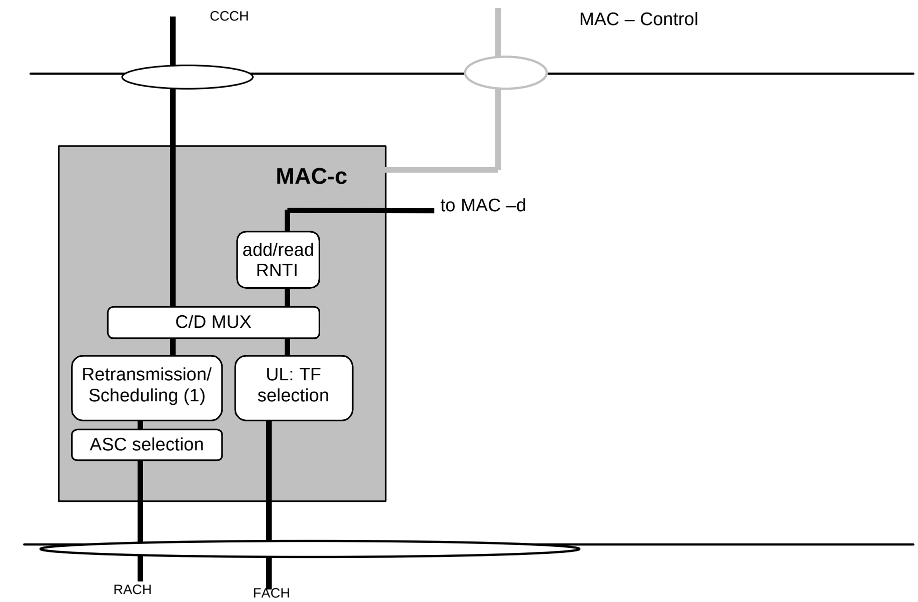
ASC Access Service Class

Bullet point to add to section 6.1 Description of the MAC functions:

- Selection of Access Service Class for RACH transmission, based upon type of data to be transmitted, where Access Service Class maps to a part of the overall PRACH resource.

Modification to diagram in section 4.2.3

Figure 4.2.3.2



DL	Downlink	RNTI	Radio Network Temporary Identity
TF	Transport Format	UE	User Equipment
TFC	Transport Format Combination	UL	Uplink
(1)	Applies only for Case C termination	ASC	Access Service Class

Conclusion

We have presented a scheme, which aims to allow more service specific tailoring of RACH resources, to ensure that certain types of access upon the RACH can be maintained especially in areas where the load is high. We believe that this scheme offers high flexibility, and low overhead, compared to other options, and that it should be considered for use within the UMTS system.

References

[1] Tdoc SMG2 L23 207 /98 “Proposal for RACH Access Control in UTRAN”, Source: Bosch Telecom

[2] Tdoc SMG2 L23 104/98 “Performance Results for the RACH”, Source: Philips

[3] GSM 02.11 version 5.0.1, “Digital cellular telecommunications system; Service accessibility”