TSG-RAN Working Group 2 (Radio layer 2 and Radio layer 3) ***TSGR2#2(99)152***

Stockholm 8th to 11th March 1999

Agenda Item: 7.5

Source: Ericsson

Title: **Proposal on refinement of MAC Data PDU Formats**

Document for: Decision

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1 INTRODUCTION

This contribution addresses some open issues on MAC Data PDU formats and proposes some refinements of present specification in S2.21.

It is assumed that the proposed formats are applicable to both modes FDD and TDD.

2 DISCUSSION OF ISSUES RELATED TO MAC PDU'S

2.1 Size of MAC PDU

One issue to be decided is whether there should be any constraints on the size of MAC PDUs, e.g. whether MAC PDUs (i.e. MAC header and/or MAC SDUs) should be defined as an integer number of octets or whether any bit strings shall be permitted..

Octet-based PDU structure is a desired (although not very important) feature of ARQ protocols since, e.g., it allows to dimension length indicators with less information element code space. Thus, in the non-transparent transmission mode, it is likely that RLC PDUs will always be octet-based. However for the nontransparent transmission mode, no such constraint should be defined. For instance, for support of the AMR source coding rates non-octet based bit numbers need to be handled. It is therefore recommended that generally arbitrary bit numbers ≥ 0 should be permitted as MAC SDU size. In practice, of course, this shall mean that only a certain number of selected sizes will need to be defined to cover the service needs appropriately.

Considering the MAC header, we also do not see a significant implementation gain in restricting it to an integer number of octets. Generally, the MAC header can be kept very small. In the presumably most frequently applied service scenarios it can be kept smaller than one octet.

Although of course it would always be possible to include fill bits or over-dimension some fields for achieving an octet based MAC PDU size, this should be avoided, since the implied overhead could for low-rate services become rather significant.

The actual size of the MAC PDUs within a transport block set is indicated between MAC and L1 as part of the transport format. Information on PDU size must not be included in the MAC header.

2.2 C/D field

Presently we do not see a need to distinguish between different types of RACH/FACH allowing different MAC header formats.

RACH/FACH should always be allowed to carry dedicated channel data. Therefore, the C/D field should be defined as mandatory part of the MAC header and have a length 1 bit. Case b) in Sec. 9.2.1.2 of S2.21 should be removed. If

needed case b) could be included in a future release.

2.3 UE identification on CCCH

Regarding UE identification, the same assumptions as used in 3GPP RAN WG3 should be applied here [1]. For CCCH messages (and also UTRAN originated PCCH messages) an "s-RNTI" (SRNC-RNTI) and a RNC-ID shall be included into the message.

In case that ciphering of all CCCH messages is not required, the UE-ID could be included as part of the L3-RRC protocol and routing to SRNC performed within RRC.

Whether the UE-ID should be included on MAC or on RRC should be left open until it is decided if ciphering of any CCCH message is required.

2.4 UE identification for dedicated data carried on FACH/RACH

Each MAC PDU carrying dedicated data (DCCH or DTCH) shall include a UE-ID. This case is only applicable when a RRC connection exists and a UE-ID has already been allocated by CRNC. In accordance with assumptions made by 3GPP RAN WG3, the c-RNTI should be used as UE-ID. There is no reason to consider any other type of UE-ID to be used by MAC on RACH/FACH.

2.5 MAC multiplexing of dedicated channels, C/T field

2.5.1 Different MAC multiplexing cases

The different cases of MAC multiplexing of dedicated channels can be classified in two dimensions, firstly according to which channels are multiplexed, i.e. DCCH and a single DTCH, DCCH and several DTCH's, or several DTCH's only. Secondly, according to the employed transport channel, i.e. whether dedicated (DCH), common (RACH/FACH) or shared (DSCH) transport channel is used.

The MAC header should be designed such that unnecessary overhead is avoided, if not for all cases then at least for the most frequently applied ones. For simplification of implementation, however, not too many different MAC header cases should be defined. For rather rarely occurring cases, some overhead should be acceptable.

From an implementation point of view, the most simple solution would be, to define just one field of fixed length for logical channel identification, and include it into the MAC header whenever MAC multiplexing is applied. This approach was applied in the ARIB MAC specification Ver. 1.0 (Tdoc RAN WG2 009/99).

The present MAC specification S2.21 V.0.0.1 allows a more efficient representation of channel ID. In the following we propose some refinements, aiming to make a reasonable compromise between implementation complexity and protocol overhead.

2.5.2 Representation of channel identification

Ericsson's initial proposal for representation of channel identification was aimed to represent it with two fields: a 1-bit C/T field used for separation of DCCH and DTCH, and a n-bit T field providing identification of DTCH instance (where $n = \lceil \log_2 N) \rceil$ for N multiplexed channels).

The T field would need to be included only for DTCH, not for DCCH. However, considering that multiplexed MAC PDU's should have the same size, the saving of the T field in the DCCH MAC header should be compensated with an accordingly larger payload, i.e. MAC SDU size. A change of the payload size however would only be possible in steps of octets due to the desired octet-structure of RLC PDUs. Thus the T field would need to be dimensioned with at least 1 octet, which seems to be far too much.

We therefore propose the following:

Presumably most frequently applied will be the case where a DCCH and a single DTCH will be multiplexed before mapped to a common or shared transport channel. In this case a single bit C/T field would be sufficient to indicate which logical channel is employed.

When multiplexing of DTCH is permitted, then the C/T field size should be changed to n bits (where selecting n = 4

or 5 bits should be sufficient to cover all practical cases of MAC multiplexing). The C/T field would be included for both DCCH and DTCH, i.e. for each DCCH MAC PDU a few bits would be wasted. However, we regard this as a marginal inefficiency while implementation complexity is kept reasonably low.

3 PROPOSAL

In this contribution, in summary, we propose the following:

- In general the size of MAC PDUs should not be constrained to octet numbers. The size (in terms of numbers of bits) of both, MAC header and MAC SDU, shall be selected such that service needs are matched appropriately.
- Mandatory C/D field of 1 bit length on RACH and FACH.
- UE-ID for CCCH messages shall be defined as s-RNTI and RNC-ID. Leave it open whether it is included on MAC or RRC until the necessity of ciphering is decided.
- UE-ID for DCCH/DTCH data on RACH/FACH (i.e. C/D = D) shall be defined as the c-RNTI.
- Separation between 3 C/T field cases: not present when no MAC multiplexing of dedicated channels is applied, 1-bit field when multiplexing only two logical channels (e.g. DTCH and DCCH, i.e. to cover the presumably most frequently occuring case efficiently), n-bit field when multiple DTCH and DCCH are multiplexed (e.g. n=4, ffs., i.e. to cover all remaining cases).

References:

[1] TSGR2#2(99)067, “Definition and usage of RNTI, LS from TSG-RAN WG3”, Source: TSG-RAN WG3

[2] TSGR2#2(99)xxx, “Ciphering model”, Source: Ericsson

[3] 3GPP RAN S2.01, “Radio Interface Protocol Architecture”.

[4] 3GPP RAN S2.21, “MAC Protocol specification”.

[5]

ANNEX: Proposed changes in S2.21

The proposed changes are included below into S2.21 V0.0.2 with revision markers.

4 ELEMENTS FOR PEER-TO-PEER COMMUNICATION

4.1 Protocol data units

4.1.1 MAC Data PDU

MAC PDU consists of an optional MAC header and a MAC Service Data Unit (MAC SDU), see figure 9.1.1. Both the MAC header and the MAC SDU are of variable size. The size of MAC header and SDU can take selected numbers of bits, not constrained to integer numbers of octets.

The content and the size of the MAC header depends on the type of the logical channel, and in some cases none of the parameters in the MAC header are needed.

The size of the MAC-SDU depends on the size of the RLC-PDU, which is defined during the setup procedure.

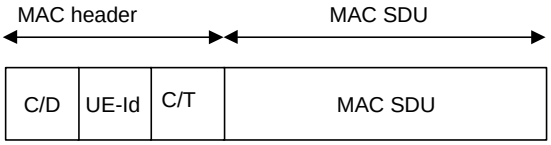

Figure 9.1.1.1 MAC data PDU

4.2 Formats and parameters

4.2.1 MAC Data PDU: Parameters of the MAC header

The following fields are defined for the MAC header:

- C/D field
  The C/D field is a single-bit flag that provides identification of the logical channel class on FACH and RACH transport channels, i.e. whether it carries CCCH or dedicated logical channel information.

C/D field	Designation
1	CCCH
0	DCCH or DTCH

Table 9.2.1.1: Coding of the C/D Field

- C/T field
  The C/T field provides identification of the logical channel instance when multiple logical channels are carried on the same transport channel. ~~The C/T field~~It is used also to provide identification of the logical channel type on dedicated transport channels and on FACH and RACH when used for user data transmission. The C/T field is included into the MAC header only when multiplexing of logical channels is performed on MAC. Its size and

designation shall depend on the type and number of multiplexed logical channels. In order to limit the overall number of MAC header options, the C/T field shall be restricted to a size of either 1 or 4 (ffs.) bits:

C/T field (1 bit)	Designation
0	logical channel 1 (e.g. DCCH)
1	logical channel 2 (e.g. DTCH)

C/T field (4bits)	Designation
0000	logical channel 1
0001	logical channel 2
…	…
ffs 1111	Ffs logical channel 16

Table 9.2.1.2: Structures of the C/T field

Editors note: In table 9.2.1.2 the general structure of the C/T field should contain information elements, which describes indicators for DCCH/DTCH and the number of logical channels. One possible solution is a separation into two parts, details are ffs.

- UE-Id
  The UE-Id field provides an identifier of the UE . The following types of UE-Id are currently defined:

  c-RNTI included into MAC header for DCCH and DTCH when mapped to common channels

  s-RNTI + RNC-ID used on CCCH (included on MAC or RRC, ffs.)

Editors note: Whether or not other UE-Id types are needed is ffs. It may includes a ID type field to distinguish between different types of UE Id's but has to include in any case the appropriated UE Identification. The type and the length of the UE Id field may be different depending on the C/D field value. If available the Id type indicates the type of UE identifier that is actually in use. The RNTI is one of the possible UE Id's, further UE id formats are ffs.

4.2.1.1 MAC header for DTCH and DCCH

a) DTCH or DCCH mapped to DCH, no multiplexing of dedicated channels on MAC:
No MAC header is required.

b) DTCH or DCCH mapped to DCH, with multiplexing of dedicated channels on MAC:
C/T field is included in MAC header.

c) DTCH or DCCH mapped to RACH/FACH:
C/D field and as UE-Id the c-RNTI are included in the MAC header. C/T field is included if multiplexing on MAC is applied.

d) DTCH or DCCH mapped to RACH/FACH, where DTCH or DCCH are the only channels (ffs).
As UE-Id the c-RNTI field is included in MAC header. C/T field is included if multiplexing on MAC is applied.

e) DTCH or DCCH mapped to DSCH:

The MAC-PDU format for DSCH is left for further study.

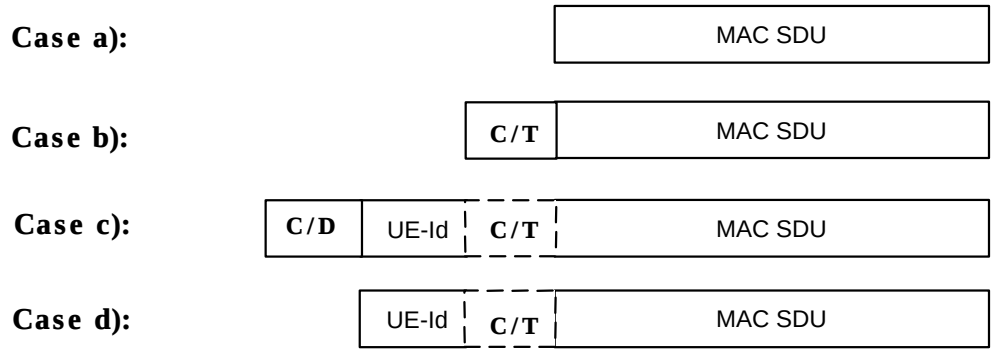

Figure 9.2.2.1: MAC Data PDU formats for DTCH and DCCH

4.2.1.2 MAC header for CCCH

a) CCCH mapped to RACH/FACH:
C/D field ~~has to be~~is included ~~and UE-id field may be included~~ in MAC header. ~~Details of usage the UE-id field is ffs.~~ Possibly s-RNTI and RNC-ID may be included as UE-Id.

Editors note: It is for further study whether UE identification on CCCH is performed by MAC or RRC. This will depend on whether ciphering of CCCH messages is required or not.

~~b) CCCH mapped to RACH/FACH, where CCCH is the only channel (ffs):~~
~~UE-id field may be included in the MAC header.~~

Editors note: The usage of the MAC header for BCCH and PCCH is ffs.

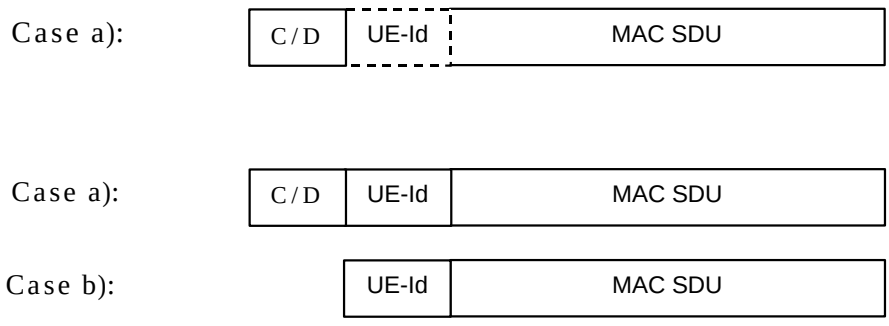

Figure 9.2.1.2.1 : MAC Data PDU formats for CCCH