TSG-RAN Working Group 2 (Radio layer 2 and Radio layer 3)
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Agenda Item: 9.1

Source: Ericsson

Title: **Piggybacking of Status Information in RLC**

Document for: Decision

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1 Introduction

This contribution proposes to include the possibility to use piggybacking of control information in AMD PDUs for RLC acknowledged mode.

2 Discussion

A good way of decreasing the amount of PDUs transmitted between two peer AM mode RLC entities is to include the possibility to piggyback control information in AMD PDUs. The piggyback information is included by replacing the padding and may thus only be utilised when an AMD PDU cannot be completely filled with RLC SDUs. The piggybacked information shall be added when building a PDU to be transmitted in a transmission time interval and is not saved in any retransmission buffer.

Consider the following example where the piggybacking functionality would be very good to have:

Example 1. Suppose that an AM RLC connection is used for downloading data to a UE using TCP/IP (e.g. downloading an email or using ftp). The traffic between the peer RLC entities will then be highly asymmetric. The downlink user data traffic will consist of large TCP-packets and therefore large RLC SDUs. The traffic on the uplink would almost only consist of TCP acknowledgements (TCP-ACK). The size of the TCP-ACK is in the order of 5-6 octets when Van Jacobson header compression [2] is used. An uplink RLC SDU would then be in the same order since it is assumed that higher layers are not adding any overhead to the TCP-ACK. Further, TCP-ACKs are not generated in such a frequency that concatenation of several RLC SDUs can be utilised. The size of the PU used by the UE is 10 octets (80 bits). As a result, 4-5 octets of padding will in most cases be added in every AMD PDU sent by the UE. If piggybacking is used the UE can include acknowledgements and retransmission requests in all AMD PDUs. Consequently, less STATUS PDUs need to be transmitted by the UE and the total system load is decreased resulting in higher capacity.

The main benefits of having this piggybacking scheme are:

- Less unnecessary information (i.e. padding) is transmitted on the radio interface, which leads to higher system capacity and less power consumption in the UE.
- The complexity increase in introducing piggybacking is very small.
- A faster ARQ response can be achieved and less poll/status messages needs to be exchanged.

It is proposed that a STATUS PDU type may be optionally piggybacked on an AMD PDU. The piggybacked STATUS PDUs will be of variable size when piggybacked depending on the amount of free space in the AMD PDU.

The additions/changes needed in [1] are limited and presented in the next section.

3 Changes to TS 25.322

3.1 Acknowledged mode entity (Section 4.2.1.3)

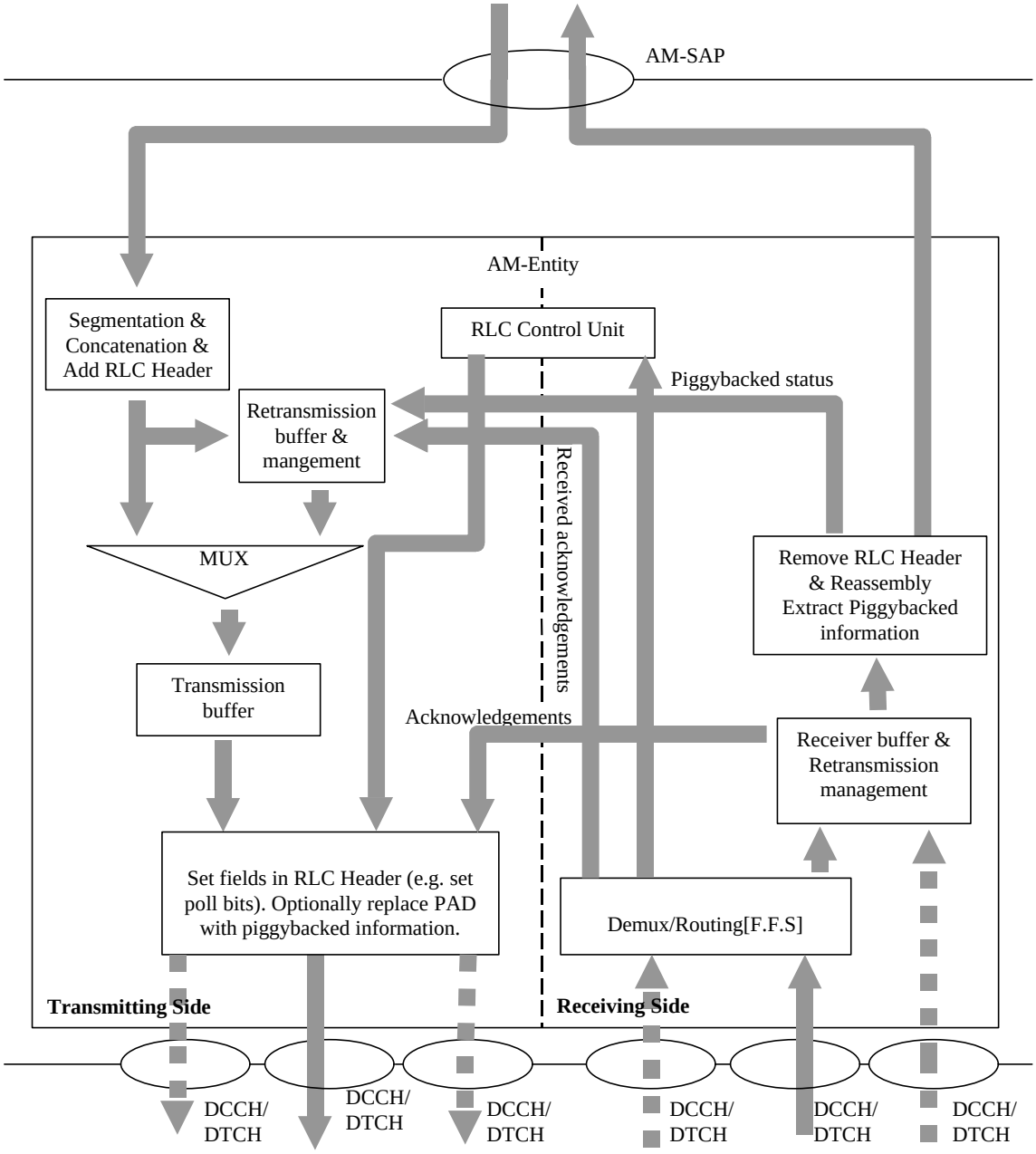


Figure Error! No text of specified style in document.**-1 Model of a acknowledged mode entity.**

~~*[The possibility to send higher layer information during set up of acknowledged mode is [F.F.S]]*~~

The transmitting side of the AM-entity receives SDUs from the higher layers. The SDUs are segmented and/or concatenated to PUs of fixed length. PU length is a semi-static value that is decided in bearer setup and can only be changed through bearer reconfiguration by RRC.

For purposes of RLC buffering and retransmission handling, the operation is the same as if there would be one PU per PDU. For concatenation or padding purposes, bits of information on the length and extension are inserted into the beginning of the last PU where data from an SDU is included. If several SDUs fit into one PU, they are concatenated and the appropriate length indicators are inserted into the beginning of the PU. After that the PUs are placed in the retransmission buffer and the transmission buffer. RLC PDU is constructed from PU buffers.

The MUX then decides which PDUs and when the PDUs are delivered to MAC, e.g. it could be useful to send RLC control PDUs on one logical channel and data PDUs on another logical channel. The PDUs are delivered via a function that completes the RLC-PDU header and potentially replaces padding with piggybacked status information. This includes setting the poll bit, *[The setting of other bits in the Header is [F.F.S]. and will be specified when the AMD PDU Structure will be defined]*, compressing subsequent PUs into one RLC-PDU or setting up the extended RLC-PDU header (PUs not in sequence) where applicable. The dashed lines illustrate the case where AMD PDUs and control PDUs are transmitted on separate logical channels. The retransmission buffer also receives acknowledgements from the receiving side, which are used to indicate retransmissions of PUs and when to delete a PU from the retransmission buffer.

The Receiving Side of the AM-entity receives PDUs through one of the logical channels from the MAC sublayer. The RLC-PDU~~:~~s are expanded into separate PUs and potential piggybacked status information are extracted.~~and~~ The PUs are ~~-~~placed in the receiver buffer until a complete SDU has been received. The receiver buffer requests retransmissions of PUs by sending negative acknowledgements to the peer entity. After that the headers are removed from the PDUs and the PDUs are reassembled into a SDU. Finally the SDU is delivered to the higher layer.
The receiving side also receives acknowledgements from the peer entity. The acknowledgements are passed to the retransmission buffer on the transmitting side.

3.2 Protocol data units (Section 9.1)

Table 3: RLC PDU names and descriptions

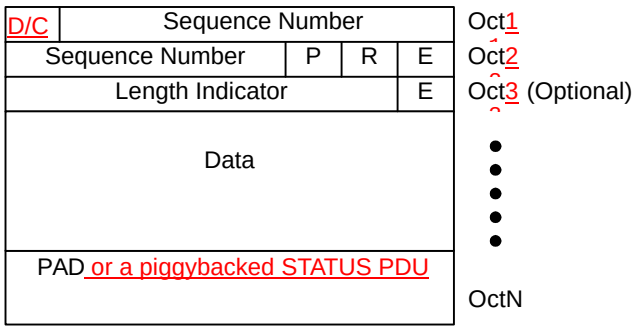
Functionality	PDU name	Description
Management of the connection	BGN	Request Initialization
	BGAK	Request Acknowledgement
	BGREJ	Connection Reject
	END	Disconnect Command
	ENDAK	Disconnect Acknowledgement
Acknowledged Data Transfer	AMD	Sequenced acknowledged mode data
	STATUS [FFS]	Solicited or Unsolicited Status Report
	Piggybacked STATUS	Piggybacked Solicited or Unsolicited Status Report
Unacknowledged Data Transfer	UMD	Sequenced unacknowledged mode data

3.3 Formats and Parameters (Section 9.2)

AMD PDU

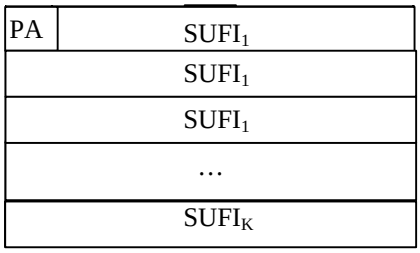
Note: R bit may be H bit. It is FFS.

Transfers user data and piggybacked status information ~~-~~and requests status report by setting a Poll bit.



Piggybacked STATUS PDU

The format of the piggybacked STATUS PDU is the same as the ordinary STATUS PDU except that the D/C field and the PDU type field is omitted.



- Length Indicator (LI): 7bit
  This field is optional and is used if concatenation, ~~or~~ padding or piggybacking takes place in RLC. It indicates the end of the last segment of a SDU. Some values are reserved for special purposes:
  ~~Especially~~ "0000000" indicates that the previous RLC PDU is exactly filled with the last segment of a RLC SDU~~, and~~
  "1111110" indicates that the rest part of the RLC PDU includes a piggybacked STATUS PDU
  "1111111" indicates that the rest part of the RLC PDU is padding~~.~~

4 Proposal

We propose that

- the possibility to piggyback control information in AMD PDUs as described in section 2 is introduced for acknowledged mode RLC.
- the changes proposed in section 3 are included in [1].

5 References

[1] 3GPP, TS 25.322 V1.0.0 "Description of the RLC protocol".
[2] RFC1144, Van Jacobson - "Compressing TCP/IP Headers for Low-Speed Serial Links"