3GPP TSG RAN WG2 #1 **Tdoc RAN WG2 035/99**
Helsinki, Finland
20-22 January 1998

Source: Nokia

Flexible RLC-PDU building in Variable Rate WCDMA

1. Introduction

In earlier contributions to ETSI SMG2 UMTS-L23 EG /1,2,3/ the concept of semi-static size payload units as the basic segmentation unit of the RLC re-transmission protocol and the possibility to include a variable number of payload units to an RLC-PDU have been introduced in order to utilize the variable-rate WCDMA physical layer more efficiently.

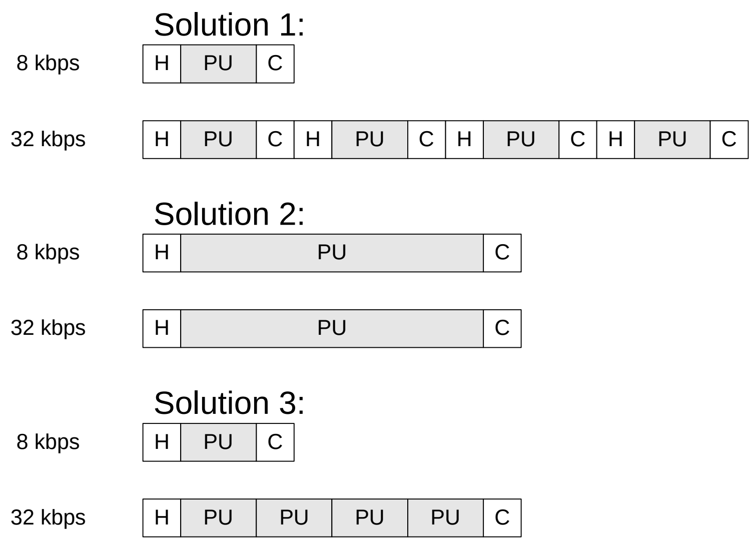

Figure 1: Solutions for producing RLC-PDU:s for variable bitrates

Example cases of three possible solutions are shown in Figure 1, where H refers to Header, PU to payload unit and C to error detection coding (e.g. CRC).

In solution 1 the RLC-PDU size is detemined according to the lowest applicable transmission rate. Delay performance for retransmissions is good, but a lot of overhead is produced in the 32 kbps case.

Solution 2 solves the problem by introducing four times longer interleaving; in this example the interleaving period could be 40 ms. The overhead is optimised very well, but the delay performance deteriorates by a factor of four. This causes difficulties in providing a given quality level on RLC, because the longer delay forces a need to adjust the maximum number of retransmissions and consequently the radio transmission quality in order not to exceed upper (e.g. application) layer retransmission timers. Rescheduling packet traffic to give space to circuit-switched traffic is also slower.

Solution 3 describes a method, which offers constant good delay performance for retransmissions and is well optimised for higher transmission rates also. In short, the solution is to determine the payload unit size according to the lowest data rate and the maximum RLC-PDU size according to what is considered optimal for the radio resource usage.

This contribution further describes a few scenarios where allowing multiple payload units (solution 3) offers a more optimized solution compared to the technique of using only fixed-size RLC-PDU:s.

2. Switching between Dedicated and Common Transport Channels

It is expected that RLC shall operate continuously across different transport channel types and that retransmission across different channel types is possible. This means that the same segmentation unit should be used when changing from a Dedicated to Common transport channel and vice-versa, otherwise RLC has to be reset each time when carrying out channel type switching, which contradicts the requirement. In addition, the segmentation shall be carried out by RLC, and MAC shall not provide further segmentation of the MAC SDUs.

The Common physical channels in ARIB at the moment are defined to carry the following amount of data units :

FACH-L :	66 oct,	FACH-S :	12 oct
RACH-L:	74 oct,	RACH-S:	14 oct

Although the final size of data units which can be carried by the common physical channels may be different, this does indicate the fact that data units on common physical channels will be optimized for a different purpose (e.g. commonly used control plane message size, spreading code of Common physical channel, and collision control of RACH, etc).

The more optimized PDU size for RLC on a dedicated channel has been assumed to be in the order of 40-80 oct. Clearly these PDU:s are too big for RACH/FACH – S channel transportation. Fixing the RLC-PDU size to those of RACH/FACH – S, on the other hand, means high overhead when moving to DCH operation.

Allowing several payload units offers a clear advantage over the fixed-size RLC-PDU solution, since the former is targeted for optimized operation over variable-rate WCDMA physical layer. The payload unit can be made quite small (e.g. 10 oct), so that it fits into both dedicated and Common channels easily. When moving to dedicated channels, several payload units can be accommodated into one RLC-PDU in order to share the header overhead, and thus improve the user throughput.

E.g. for FACH-S the transport format set could allow only one PU in an RLC-PDU, for FACH-L perhaps 4 PU's in a PDU and for a dedicated channel one or four PU's for each PDU and variable amount of PDUs per transmission time interval would be allowed.

3. Variable-rate operation within Dedicated channels

Even for dedicated channel operation, it is not clear that an RLC-PDU can always be set to be at least 40 oct during the entire radio access bearer connection, since it requires the minimum data rate of 32kbps. Although WCDMA has large capacity due to wideband operation, the operator may choose to deploy the radio network with light load in order to reduce the number of sites needed (e.g. system is more coverage limited). 32 kbps means several simultaneous voice calls in the cell and the system may not be able to sustain this for all the data connections. Consequently some data connections may operate below 32kbps sometimes during the connection, and RLC must be able to support that efficiently.

Furthermore, when carrying out an inter-RNC handover, the target (drift) RNC may suffer from code shortage and thus cannot sustain the original minimum data rate of 32kbps. Resetting RLC at this point causes unnecessary interruption of the service.

4. Handling of variable-size higher layer SDUs

In packet data transmission higher layer SDUs are variable-sized by nature. This requires RLC to have efficient segmentation and concatenation solutions. Segmentation and concatenation can be well supported with both one and several payload units. However, allowing several payload units has the additional advantage of reducing zero padding for the last SDU in the case that the last SDU does not fill the whole PDU.

Depending on the characteristics of the user traffic, the gain offered by reducing zero padding may or may not be significant. In the case of a single large session application (e.g. a file transfer from the UE) zero padding at the end causes no significant overhead. In a multi-session of smaller SDUs (e.g. some interactive type of traffic) where the gap between sessions is sufficient for the physical layer to go into discontinous transmission (i.e. sending nothing on DPDCH) zero padding may become a more significant part of system overhead, if not controlled appropriately. This type of user traffic exhibits similar characteristics to real-time variable-rate traffic, but can tolerate more delay and delay variation and can thus be handled as non real-time traffic by UTRAN.

5. Optimising air interface transmission dynamically

Depending on the encountered characteristics of the user data stream during the connection, the air interface transmission can be dynamically optimised only by changing the transport formats in the transport format set, without any problems of resetting RLC, loosing data or resegmentation of retransmissions.

E.g. if the transport format set is first selected as follows:

TF	PUs in PDU	Am of PDU
1	-	0
2	4	1
3	4	2
4	4	4

I.e. Transport Formats having always 4 PU's per RLC-PDU are allowed and the amount of RLC-PDUs is allowed to be 0,1,2 or 4. If it is then realised that very often small SDUs are received and unnecessary padding is utilised (in TF 2) and the transport format 3 (having 2 RLC-PDUs) is not utilised at all, then the transport formats could be changed to the following:

TF	PUs in PDU	Am of PDU
1	-	0
2	1	1
3	4	1
4	4	4

The change could also be done in reverse order and basically from any transport format set to another during the communication according to the encountered user data characteristics. The granularity of the allowed changes is determined by the selected size of the PU.

6. Conclusion

A number of cases have been presented, where allowing an RLC-PDU to consist of a variable number of fixed-size payload units adds flexibility to the system without significant increase in the overhead. This scheme can also be described as compression of redundant header data.

The proposed solution should be a basic ability of the segmentation and concatenation unit in RLC. It should also be addressed in the formats of RLC-PDU:s.

7. References

/1/ Tdoc SMG2 UMTS-L23 107, 189/98, “RLC-U PDU format for variable-rate transmission”, source: Nokia

/2/ Tdoc SMG2 UMTS-L23 317, 414, 518/98, “Design Criteria on RLC”, source: Nokia

/3/ Tdoc SMG2 UMTS-L23 302, 415, 519/98, “Elements for RLC peer-to-peer communication”, source: Nokia

/4/ Tdoc SMG2 UMTS-L23 44/99, “Acknowledged-mode data (AMD) PDU format allowing several payload units”, source: Nokia