TSG RAN WG 2#6 **TSGR2#6(99)801**
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Agenda item: **10**
Source: **Golden Bridge Technology**
Title: **CPCH Delay Measurements for TS25.321, MAC Protocol**

Document for: **Discussion and approval**

INTRODUCTION

Previous contributions [5] have shown how to use traffic volume measurements to support transport channel switching and network optimization. This contribution describes how the traffic delay should be measured in the UE uplink in order to improve transport channel switching and network optimization. Since the uplink has a common RACH channel, a common CPCH channel, and a dedicated type of transport channels it is essential for the system capacity that the network has full control of when and why a UE should use one or the other of these types of channels. Though traffic volume measurements may provide be sufficient input to RNC for control of circuit style services, packet services also require the measurement of delay characteristics to assess network performance. Finally this contribution describes how the delay measurements could be implemented and what quantity to use for delay measurements.

DISCUSSION

<u>The Need for Traffic Delay Measurements:</u>

Traffic volume measurements alone are not sufficient to assess the performance of UE uplink transmissions for packet services. Traffic volume measurements report the size of the RLC buffer payload in units of octets. While traffic volume may be related to traffic delay, the are independent measures of performance. Traffic volume may be very high while traffic delay may be very low when upper layer applications provide uplink data in large segments (e.g. file transfers) under very low network loading conditions. Similarly traffic volume may be very low while traffic delay may be high when upper layer uplink data is limited (URL requests) and sporadic under very high network loading conditions. In addition, throughput delay has traditionally been a useful parameter to study and optimize network performance for multi-access networks. Uplink traffic delay measurements would be beneficial for UTRAN.

Uplink traffic delay is a useful parameter to consider when assessing network performance and allocating network resources. For a UE which is assigned CPCH resources, a high uplink traffic delay may indicate the need for a network adjustment. The UE may be switched to a dedicated channel. The network may allocate additional CPCH channels to the CPCH set in use by the

UE. The UE may be reassigned to a different CPCH set in which the traffic loading is much lower.

Uplink traffic delay measurements are similar in many ways to uplink traffic volume measurements. Both use identical measurement objects: data in RLC buffers. Both may use similar measurement reporting criteria: periodic or threshold. Additional measurement reporting quantities apply equally well to delay measurements as to volume measurements. For these reasons, and to minimize the impact on the UTRAN specifications, it is proposed to consider traffic delay measurements as new additional measurement quantities to be reported using the Traffic Volume Measurement Type already defined in the specifications.

An initial consideration of the sources of uplink traffic delay in the UE suggests that two different delay measures may be sufficient to characterize performance. **Buffer delay** is defined to be the uplink traffic delay while data is in Layer 2 buffers waiting for an opportunity to access the radio network. **Radio access delay** is defined to be the uplink traffic delay in Layer 1 while the UE contends for access on a common uplink channel. Buffer delay will normally be much larger than radio access delay. Radio access delay provides additional performance insight, which is not apparent in buffer delay alone. For instance a UE may experience high buffer delay with low radio access delay when the UE is permitted quick and easy access CPCH channels, but only to CPCH channels with low capacity (low data rate and/or very short max packet length).

Finally note that although this contribution was drafted primarily to address network optimization for uplink CPCH services, the traffic delay measurement approach described here is general and will apply equally to RACH and DCH uplink channels.

<u>Measurement of Traffic Delay:</u>

Buffer delay is operationally defined to be the time between the arrival of a block of data in the RLC data buffer and the first output of that transport block to PHY for uplink transmission. The time is rounded up to the next frame and quantified in number of frames (10 msec resolution). Buffer delay is equivalent to the time the data spends in Layer 2.

Radio access delay is operationally defined to be the time between the first output of that transport block to PHY for uplink transmission until the transport block is transmitted on the CPCH channel air interface. This period may include multiple unsuccessful access attempts to busy CPCH channels, collision backoff s, etc. The time is rounded up to the next frame and quantified in number of frames (10 msec resolution). Each channel access is measured. Radio access delay is equivalent to the time the data spends in Layer 1.

Buffer delay may be a useful measure for all uplink channels. Radio access delay is a useful measure for contention based uplink channels (RACH or CPCH), but may provide little information about uplink operation with DCH channels.

Uplink traffic throughout delay, the traditional concept, is the simple sum of Buffer delay plus Radio access delay for any given measurement period.

TRAFFIC DELAY MEASUREMENT APPROACH

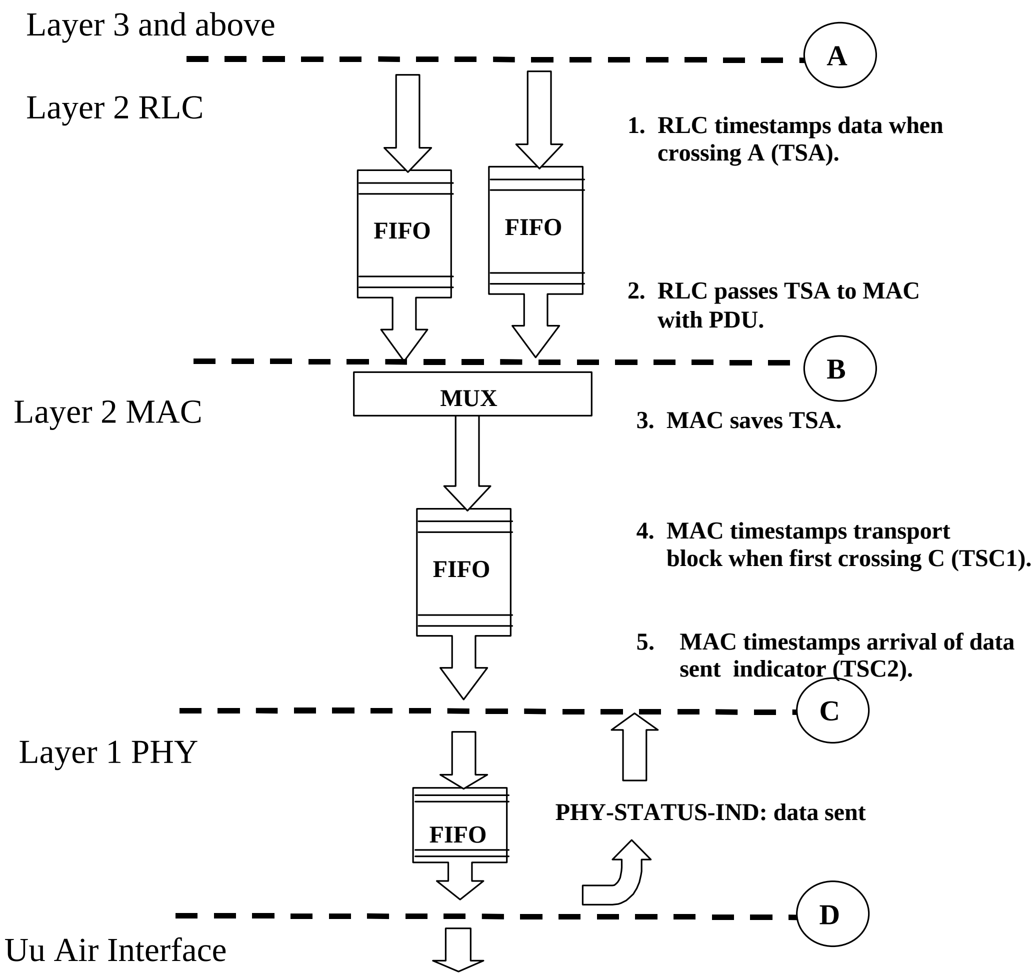

Figure 2. Concept for UplinkTraffic Delay Measurements

Traffic delay distribution statistics have been used in many systems to tune network performance. In order to address the distribution of traffic delays while limiting the complexity of the measurement for the UE, only two measures are proposed here for each traffic delay: an average measurement and the maximum measurement.

Average traffic delay measurements require a specified averaging period to be meaningful. If the measurement criterion is periodic, the assumed averaging period will be the measurement period. If the measurement criterion is immediate (periodic without period specified), an averaging period must be specified in the measurement control message. If the measurement is to be a threshold measurement, an averaging period must be specified in the measurement control message so that a sliding window average measurement may be performed.

Figure 2 shows the use of timestamps to permit the measurement of the traffic delays for CPCH. In this concept the MAC layer implements the uplink traffic delay measurements. When traffic delay measurements are requested by RNC, RLC timestamps (TSA, in the figure) the arrival of upper layer data blocks into the specified RLC buffer. MAC receives this timestamp with each uplink transport block from RLC. MAC then timestamps (TSC1) the first transmission of the transport block to PHY for uplink transmission. If the access to the uplink is granted, PHY transmits the transport block and returns a status indicator signifying that the data has been successfully transmitted. MAC then timestamps (TSC2) the arrival of the data sent status indicator. If PHY is unable to transmit the transport block, it returns a status indicator with an event code explaining the cause. MAC would then take an appropriate response, e.g. retransmit the transport block later, or retransmit the transport block on a different CPCH channel. Assuming the timestamp values are integers equivalent to current frame number, the required traffic delay measures are simply the difference between the timestamps.

Buffer delay = TSC1 – TSA

Radio access delay = TSC2 - TSC1

The above concept is not the only way to implement these traffic delay measurements. Other implementations are possible and the specifications should remain neutral on implementation techniques. This contribution proposes only that the operational definition of the new required measurements be accepted and that the measurements are to be performed in the MAC layer. In this way the interlayer primitives may be correctly defined in the specifications.

<u>Means to Limit Amount of Delay Reporting:</u>

In contribution [5], Ericsson explains the issue of limiting measurement reports when triggered by a threshold-crossing event for uplink traffic volume measurements. The same analysis and conclusions apply equally well to traffic delay measurements. Traffic delay threshold measurement reports may be limited by specifying time to trigger and pending time after trigger. These items are already defined in the specifications for measurements of type “Traffic Volume Measurement”. Since traffic delay measurements may be added as a new measurement quantity to measurements of type “Traffic Volume Measurement”, the same report limiting capability will apply to traffic delay measurements

PROPOSAL

The following changes should be incorporated into the latest version of TS25.321, MAC Protocol Specification. The baseline text listed here for these changes is from R2-99712 [4] which is the latest version of the spec.

8.2 Primitives between MAC and RLC

8.2.1 Primitives

The primitives between MAC layer and RLC layer are shown in Table 8.2.1.1

Generic Name	Type				Parameters
	Request	Indication	Response	Confirm	
MAC-DATA	X	X			MU, TS
MAC-ERROR		X			[FFS]
MAC-STATUS		X	X		[FFS]

Table 8.2.1 Primitives between MAC layer and RLC layer

MAC-DATA Request/Indication

- MAC-DATA Request primitive is used to request that an upper layer PDU be sent using the procedures for the information transfer service.
- MAC-DATA Indication primitive indicates the arrival of an upper layer PDU received by means of the information transfer service.

MAC-ERROR Indication

- MAC-ERROR Indication primitive indicates to RLC that an error condition has occurred.

MAC-STATUS Indication/Response

- MAC-STATUS Indication primitive indicates to RLC about changes in the rules under which it may transfer data to MAC. Parameters of the primitive can indicate a transmission timer value, whether the RLC can transfer data and whether that data is restricted to supervisory frames only.
- MAC-STATUS Response enables RLC to acknowledge a MAC-STATUS Indication. It is possible that RLC would use this primitive to indicate that it has nothing to send or that it is in a suspended state.

8.2.2 Parameters

a) Message Unit (MU)
It contains the RLC layer message (RLC-PDU) to be transmitted or received by the MAC sub-layer.

b) Time Stamp (TS)
This is a timestamp (e.g. frame number) of the time of arrival of this MU into the RLC buffer. This is an optional parameter to be included only for uplink traffic delay measurements.

[Note (from Tdoc WG2 009/99): This description are based on L2-LAC specification drafted TTC/ARIB Joint meeting. Because SAP between LAC and MAC is defined in our structure of MAC, the name of Signal is changed to Primitive. And format of explanation of primitives are changed to avoid verbose description. Request and Indication are combined to explain. Primitives for Activation/Deactivation or Establish/Release or Connect/Disconnect for MAC connection are FFS.]

[Note (from Tdoc WG2 009/99): The parameters for RLCMAC-ERROR and RLCMAC-STATUS are FFS.]

REFERENCES

[1] TSGR2#5(99)596, “CPCH parameter additions to 25.331, RRC Protocol Specification”
[2] TSGR2#5(99)516, “MAC Protocol Specification”, TS25.321 V3.0.0
[3] TSGR2#4(99)568, “MAC Primitives”
[4] TSGR2#6(99) 712 “MAC Protocol Specification,” TS25.321 V3.0.0
[5] TSGR2#5(99)594, “Traffic Volume Measurements”