3GPP TSG-RAN Working Group 3 ***TSGW3#4(99)498***
June 1st-4th, 1999
Warwick, England

Agenda Item: **6.2**

Source: **Siemens, Italtel**

Title: **Study Item (ARC/3) "Overall Delay Budget within the Access Stratum"**

Document for: **Status report**

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1 Introduction

This contribution reports the status of the e-mail discussion on Study Item ARC/3 "Overall Delay Budget within the Access Stratum".

2 Report of the reflector activity

Some first rough estimations appeared on the reflector, no comment has been received back.

In Appendix A the report has been updated with the comment from last RAN3 meeting about satellite components.

In the Delay Estimation Template reported in Appendix B a reference model with branch definition has been added.

The components described in Tdoc. TSGR3#3(99)313 have been included, as well as the figures proposed via reflector.

3 Results and Conclusion

It is suggested to leave the Study Item open in order to allow a further refinement of the figures proposed until now.

Appendix A

1 Scope, Abbreviations, etc.

2 References

[1]: Selection procedures for the choice of radio transmission technologies of the UMTS (UMTS 30.03 version 3.2.0) - TR 101 112 V3.2.0 (1998-04)

[2]: Requirements for the UMTS Terrestrial Radio Access system (UTRA) (UMTS 21.01 version 3.0.1)- TR 101 111 V3.0.1 (1997-10)

[3]: Quality of Service and Network Performance (UMTS 22.25 version 3.1.0) - TR 22.25 V3.1.0 (1998-03)

[4]: ITU-T Recommendation G.174: Transmission Performance Objectives for Terrestrial Digital Wireless Systems using Portable Terminals to access the PSTN (6/94)

[5] ITU-T Recommendation G.114: Transmission Systems and Media General Characteristics of International Telephone Connections and International Telephone Circuits - One-Way Transmission Time (02/96)

[6]: Technical characteristics, capabilities and limitations of mobile satellite systems applicable to the UMTS (UMTS 30.20 version 3.1.0) - TR 30.20 V3.1.0 (1998-01)

3 External requirements on UTRAN

Reference [1] gives a minimum set of services to be supported in UMTS. The list characterises services by the following set of parameters:

- Range of supported data rates;
- BER requirements;
- One way delay requirements;
- Activity factor.

Table 1reports the list of services, as provided in [1].

Table 1: List of test data rates for evaluation purposes

<table>
<tr><td></td><td colspan="4">bit rates (kbps)</td><td rowspan="2">BER</td><td rowspan="2">One way delay</td><td rowspan="2">Channel activity</td></tr>
<tr><td>Test environments</td><td>Indoor Office</td><td>Out- to Indoor and Pedestrian</td><td>Vehicular 120 km/h</td><td>Vehicular 500 km/h</td></tr>
<tr><td>Representative low delay data bearer for speech*[1]</td><td colspan="4">8</td><td>$\leq 10^{-3}$</td><td>20 ms</td><td>50%</td></tr>
<tr><td>LDD Data (circuit-switched, low delay)*[1]</td><td rowspan="2">144-384-2048</td><td rowspan="2">64 - 144 - 384</td><td rowspan="2">32 - 144 - 384</td><td rowspan="2">32 -- 144</td><td rowspan="2">$\leq 10^{-6}$</td><td>50 ms</td><td rowspan="2">100%</td></tr>
<tr><td>LCD Data (circuit-switched, long delay constrained)*[1]</td><td>300 ms</td></tr>
</table>

*1 One-way delay (excluding propagation delay, delay due to speech framing and processing delay of voice channel coding) for all the test services.

NOTE: For LDD services, a BER threshold of 10^{-4} will be considered for the initial comparison phase of the different concepts in order to reduce simulation times. The BER threshold of 10^{-6} will be considered in the optimisation phase.

UDD Data (packet) - Connection-less information types not reported.

According to references [3] and [4], the total one-way end-to-end delay for voice services should be kept within 40 ms.

In the following figure it is reported from [2] the reference model for the computation of the transmission delay.
It should be considered that:

- The error protection contains any FEC, CRC, interleaving coding and macro-diversity processing.
- UTRAN inter-node delays are not taken into account.
- Implementation overheads, such as processing time, are not included in the definition.
- Speech encoding is not included in the radio transmission chain since it is assumed there will be bearer definitions applicable for speech transmission, as well as for video compression etc.

The one-way delay figures are only applicable for defining the radio technology bearers and not for defining the complete access delay for the radio access network. This means that the total delay will be larger. Thus the figures Tt and Ti must be lower than the requirement for total delay in the access network.

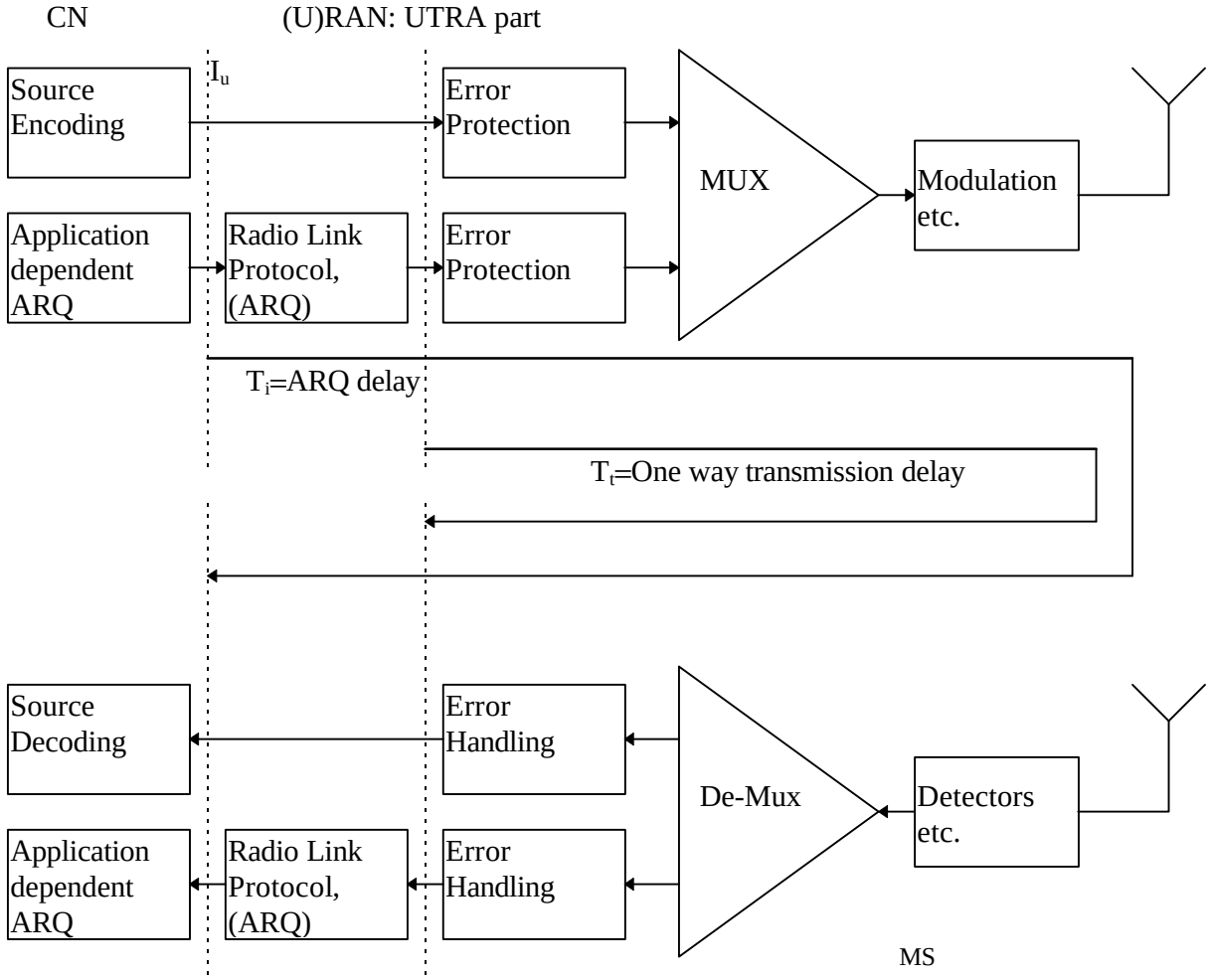


Figure 1: Reference Model for Transmission Delay

4 UTRAN Delay Components: Definitions

In this chapter the transmission delay components across the UTRAN are identified and described.
A short description of each component is given, along with affected services and impacting parameters.
The paper is mainly based on 3GPP RAN WG3 Tdoc. TSGW3#2(99)169 – UTRAN Delay Estimation

4.1 Symbols used

↑ = Direct proportionality
↓ = Inverse proportionality
RT = Real Time
NRT = Non Real Time
CBR = Constant Bit Rate

4.2 UTRAN Network Components

4.2.1 Packetisation, De-packetisation and End-System Play-Out Delay

RT **NRT** The originating terminal adds a packetisation delay. Factor influencing this delay is the ↓ instantaneous source data rate.
CBR When a real time CBR data stream terminates at an application end-point, play-out buffering is required to remove the CDV caused by the statistical sharing effects of the packet network. Once this variation is removed and de-packetisation applied, the resulting traffic stream from the protocol stack can be fed to higher layers as a constant stream of data. This delay is dependent on the bit-rate of the connection, the ↑ buffer depth (dimensioned on the maximum CDV allowed) and the packet size.

[Evaluation part ffs.]

4.2.2 Macro-diversity Combining Delay

RT **NRT** The Macro Diversity Combination function may require additional switching and processing in the RNC. Even though the delay introduced is heavily implementation-dependent, it has to be considered as a component of the overall delay evaluation.
As a remark, this component has a step-like behaviour as a UE enters or leave a soft-HO state or, more in general, when branches are added/removed.

[Evaluation part ffs.]

4.2.3 Interleaving and Turbo Coding

RT **NRT** Interleaving is a physical layer function that segments transport blocks over several radio frames. These blocks can be interleaved over 1, 2, 4, and 8 transport blocks. Thus, the interleaving will add a large transmission delay to the data stream over the air interface ↑ proportional to the interleaving factor.
RT Turbo coding has it own internal interleaving mechanism, for data services this is an additional delay depending on the ↑ block dimension and on the ↓ service data rate.

[Evaluation part ffs.]

4.2.4 MAC Scheduling Delay

RT For real-time services a single code or resource unit will be allocated on a deterministic basis. This implies that a delay no bigger that one transport block is foreseen.
NRT Non-real-time services using shared channels require statistical scheduling, the delay introduced may become important: even though delay guarantees will not be applicable, the delay introduced has an impact on acknowledgement delay and on the resulting QoS. The component depends on ↑ the load factor of the used resource.

[Evaluation part ffs.]

4.2.5 Re-transmission Delay

NRT The retransmission of data streams will not take place over real time bearers. When retransmission is used in non-real time services, guaranteed delivery over the radio interface is performed by the RLC. The amount of retransmissions needed for a single transport block is a multiplication factor for delay, i.e. if it take two re-transmission to transfer a transport block successfully then twice the physical layer delay would be added: interface ↑ the maximum number of allowed re-transmissions defines the weight introduced by this component.

[Evaluation part ffs.]

4.3 Transport Network

4.3.1 AAL Packetisation, Multiplexing and De-packetisation Delay

RT **NRT** This component, considered on a point-to-point link, is due to the ATM SAR sub-layer action and to the multiplexing of cells and sub-cells (for AAL2) on the ATM link. This delay depends on↑ the number of connections on a single link, on ↓ the data-rate of the link, on the adaptation layer and type of virtual connections (VC/VP) selected.

[Evaluation part ffs.]

4.3.2 Media Delay

RT **NRT** The propagation delay over cabled networks can assumed to be fixed and proportional to the ↑ connection length.
The same can be assumed for microwave and satellite connections, but to the medium delay a further component must be added, which considers the technology used for the link, e.g. point-to-multipoint, point-to-point, radio ATM.
For satellite links, the delay can be time-dependent, in accordance with the orbit eccentricity .

The following delay can be assumed, according to [5]:

Coax cable: 4 μs/km;
Optical fibre: 5μs/km.

In case μwave links are used, the following indicative values can be considered (ffs):

PDH microwave link: 1.5 ms
SDH microwave link: 1 ms
Point-to-multipoint microwave link: 5 ms

According to [5] and [6] the delay introduced by a satellite link can range between 60ms (max. value for LEOs) and 310 ms (max. value for HEOs).
It is therefore suggested to allow a single satellite hop along a link over the UTRAN between a UE and the Core Network.

4.3.3 Switch Delay

RT **NRT** This is the component due to switching nodes (Cross-Connects and Switches) along UTRAN terrestrial interfaces, only. Its value is proportional to ↑ the number of intervening nodes and has a heavy dependence on ↑ the traffic load of each node.

[Evaluation part ffs.]

5 UTRAN Delay Estimation

6 UTRAN Overall Delay Budget (conclusion to be included in Ch. 13.1 of S3.01)

Appendix B

1 Delay Budget Template

1.1 Delay Components

1.1.1 UTRAN Nodes

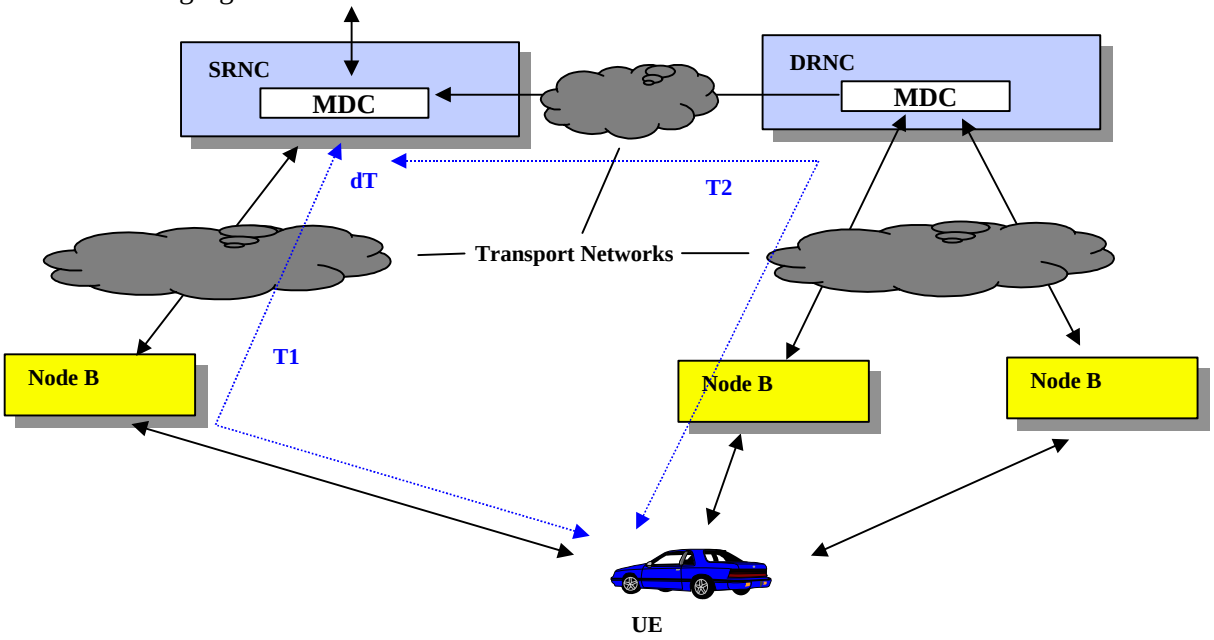
U1): Packetisation, De-packetisation and End-System Play-Out Delay
U2): Macro-diversity Combining Delay
U3): Interleaving and Turbo Coding
U4): MAC Scheduling Delay
U5): Re-transmission Delay
U6): Uu delay

1.1.2 Transport Network

TN1): AAL Packetisation, Multiplexing and De-packetisation Delay
TN2): Media Delay
TN3): Switch Delay

1.2 UTRAN Reference Configuration

In the following figure the reference model and branch definitions used in the document are shown.



1.3 Delay Budget Template

Service (kbit/s)	**8 (RT)**	**32**	**64**	**144**	**384**	**2048**	**Source/Reference**
Delay Component	Delay (ms)						
T1 Branch							
U3	40	100	100	100	100	100	
U6	0.05						
TN1 – I_{ub}	1	1	1	1	1	1	

Service (kbit/s)	**8 (RT)**	**32**	**64**	**144**	**384**	**2048**	**Source/Reference**
Delay Component	Delay (ms)						
TN2 – I_{ub}	14						TSGR3#3(99)313, Nokia
TN3 – I_{ub}	0						
U1	22	1	1	1	1	1	
U2	1	1	1	1	1	1	
U4	0	10	10	10	10	10	
U5							
T1 Branch Delay							
T2 Branch							
U3	40	100	100	100	100	100	
U6	0.5						
TN1 – I_{ub}	1	1	1	1	1	1	
TN2 – I_{ub}	14						TSGR3#3(99)313, Nokia
TN3 – I_{ub}	-						
U1 – DRNC	22	2	2	2	2	2	
U2 – DRNC	1	1	1	1	1	1	
TN1 – I_{ur}	1	1	1	1	1	1	
TN2 – I_{ur}	3						
TN3 – I_{ur}	2.7						
U1 – SRNC	22	2	2	2	2	2	
U2 – SRNC	1	1	1	1	1	1	
U4	0	10	10	10	10	10	
U5							
T2 Branch Delay							
I_u Interface							
U1 (packetisation only)	1	1	1	1	1	1	
TN1 – I_u	0.5	0.5	0.5	0.5	0.5	0.5	
TN2 – I_u	1						
TN3 – I_u	2.5						
Iu Delay							