Royal Institute of Technology
Department of Microelectronics and Information Technology

High latency links in GSM base station subsystem

Investigation of the impact of a high latency link between a base transceiver station and a base station controller in a GSM/GPRS system

Master of Science Thesis in Telecommunication

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Examiner: **Prof. Björn Pehrson**

Abstract

In May 2003 Ericsson AB provided KTH IMIT with a GSM/GPRS container containing a core GSM/GPRS network. The aim is to provide other Swedish universities and technical institutes connection to the core network. For being able to connect to the core network, each university or institute must enable their own connection between a local owned base station and the base station controller situated in the GSM/GPRS container at KTH IMIT. Normally the physically connection from one base station to the base station controller is realised via a leased E1 link, but to lease links is expensive and the proposal was made to connect a remote base station via the Swedish university network and thereby run E1 on top of IP. The technology to run an E1 link on top of an IP network is commercial available, by implementing two Multiservice IP concentrators, provided by Axerra Ltd.

After having configured the GSM/GPRS container with sufficient functionality the question arise, how far away a base station can be placed from the core network. European sites have normally a latency of 20 to 100 ms in the IP network and if crossing the Atlantic latency will increase up to 200 ms. Will we be able to place base stations at European or US sites, and what services could we provide in that case?

This master thesis examines the GSM and GPRS protocols that traverse the link between the base station and the base station controller and answers the question how these protocols will behave if the latency is increased to 20 ms, 100 ms or 200 ms.

Acknowledgements

I would like to thank my supervisor, Johan Montelius, for his support and all good advices. I also want to thank my examiner, Björn Pehrson, who gave me the opportunity to accomplish the master thesis at KTH IMIT.

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1 Introduction

In this chapter the topic of the master thesis is introduced and a general introduction given. A problem statement is done, the goals to fulfil are stated and the limitations described. The outline of the report is given.

1.1 Background

In the year 2002, the Swedish Agency for Innovation Systems (Vinnova) partly funded a project called Mobile Stockholm Open Service Platform (MSOSP), carried out by department of Microelectronics and Information Technology (IMIT) at the Royal Institute of Technology (KTH) in Stockholm together with the companies Axerra Ltd., Ericsson AB, Movious Ltd. and Swefour AB. The purpose of this project was to establish a test bed providing a service platform integrating private mobile telephone and Wireless Local Area Networks (WLAN). The test bed should later on be available as a national resource for academic research and education.

In May 2003 Ericsson AB provided KTH IMIT with a GSM/GPRS container containing a core GSM/GPRS network and two micro base stations. The implementation of the test bed could start. The next task was to get the GSM/GPRS container up and running and to provide other Swedish universities and technical institutes connection to the core network. The question aroused how this connection could be done in the most proper way. For being able to connect to the core network, each university or institute must enable their own connection between a local owned base station (BTS) and the base station controller (BSC) situated in the GSM/GPRS container at KTH IMIT. Normally the physically connection from one BTS to the BSC is realised via a leased E1[1] link, but to lease links is expensive and the proposal was made to connect a remote BTS via the Swedish university network (SUNET) and thereby run E1 on top of IP. The technology to run an E1 link on top of an IP network is commercial available. Axerra Ltd provides the needed hardware, a Multiservice IP concentrator. This master thesis will investigate the impact of the high latency link (the IP network SUNET) between a BTS and the BSC in the GSM/GPRS system.

1.2 Problem Description

This master thesis will investigate the latency problem that arises when having an E1 link running on top of an IP network. How far could a BTS be placed away from the core network before connection to the BSC is broken? Is it possible to connect a BTS situated wherever in Sweden, or even in Europe or America? What services could be provided? As known, European sites have normally a latency of 20 to 100 ms in the IP network and if crossing the Atlantic the latency will increase up to 200 ms.

In this thesis, the GSM and GPRS protocols that traverse the link between the BTS and the BSC are examined and the question how these protocols will behave if the latency is increased to 20 ms, 100 ms or 200 ms will be investigated. The report will also propose solutions to identified problems, as if services could be provided, but need specific configurations of the available hardware.

[1] This thesis will refer to E1 interchangeably to E1/T1 for the whole document.

Why were the requirements given to evaluate the latency of 20, 100 and 200 ms? Were does those values come from? Are those values relevant?

In the year 2002, Ian March and Fengyi Li performed large scale measurements on Voice over IP (VoIP). The paper "A VoIP Measurement Infrastructure" [VoIP Measure Infra] presents the result of more than 25000 samples of VoIP sessions in order the measure the quality of VoIP. The approach of the simulation was to periodically send a pre-recorded phone call between two hosts (belonging to academic networks) over the Internet and to measure how the packets arrive at the receiver. Among other parameters, the delay was measured by deriving Internet Control Message Protocol (ICMP) times from ping measurements and using Real-time Transfer Control Protocol (RTCP) sender and receiver reports implemented in the phone equipment. The ICMP and RTCP delays are presented in Table 4 at page 7 [VoIP Measure Infra], showing that the earlier made assumption for the latency values of 20, 100 and 200 ms was accurate.

1.3 Limitation

This thesis will handle the latency problem for GSM and GPRS protocols only. The research will be done theoretically by studying the standardised GSM specification [3GPP TS] and the latencies to be considered are 20 ms, 100 ms and 200 ms. This thesis will not deal with the configuration of either the GSM/GPRS network or the IP network. A test bed could be used for demo the latency, but will not be used for measuring or testing reasons.

1.4 Outline

The thesis is divided into seven chapters and eight appendixes. Chapter 1 gives an introduction to the work that will be performed. It defines the requirements, describes the problem and states the limitations. In Chapter 2 a brief overview of the concepts of GSM and GPRS is given. Only parts needed to understand the later analysis are presented. The main focus is put on the protocols traversing the latency link. Readers with experience in this field are recommended to overlook this chapter. Readers who want to learn more about the technology are referred to specialist literature.

In Chapter 3 the latency analysis is presented. The affected protocols are identified and the services dependent of the latency are stated. The test performed in the GSM/GPRS container is presented in chapter 4. Chapter 5 and 6 are presenting the conclusions made and what could be done in the future, and Chapter 7 is stating a final discussion about what could have been done better.

Chapter 8 is stating the references.

Appendixes A to C contain a list of timers and counters specified for GSM and GPRS that are affecting the latency link.

Appendix D shows the evaluation outcome and Appendix E the BSC log showing the resources of the base transceiver station.

In Appendix F the used glossary is presented.

2 GSM/GPRS Overview

GSM is the acronym for Global System for Mobile Communication, a technology providing wireless voice and circuit switched data services. GPRS stands for General Packet Radio Services, an extension of the GSM system in order to provide packet data services. This chapter gives an overview of the GSM/GPRS network nodes, the traffic types, the protocols and interfaces, relevant for the reader in order to understand the problem discussed in this thesis. To fully understand the GSM and GPRS technology, the reader is referred to specialist literature.

2.1 Network Architecture

A basic GSM network system supporting GPRS is shown in Figure 2-1. The network is divided into three major systems; the core network containing the Switching System (SS), the Operation and Support System (OSS), and the access network containing the Base Station System (BSS). The network architecture is specified in [3GPP TS 03.02].

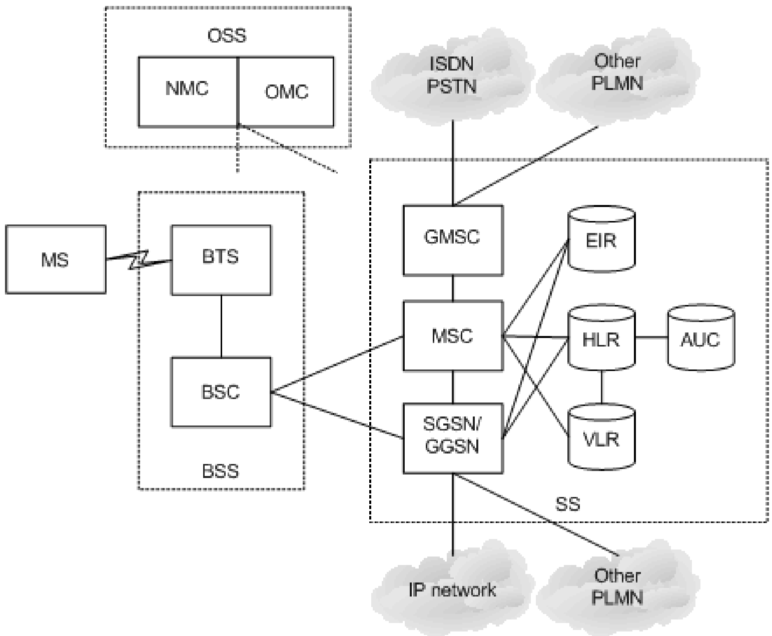

Figure 2-1. GSM/GPRS network architecture

A Mobile Station (MS) is transmitting voice or data traffic via the air to a BTS, which is connected to the switching system via a BSC. The switching system is sending voice and circuit switched data traffic to the Mobile Switching Centre (MSC) and packet switched data traffic to the Serving GPRS Support Node (SGSN) and the Gateway GPRS Support Node (GGSN). Voice and circuit data traffic are routed to external networks as the Integrated Services Digital Network (ISDN), the Public Switched Telephone Network (PSTN), or other Public Land Mobile Networks (PLMN) via the Gateway Mobile Services Switching Centre (GMSC), while the packet switched data traffic is routed to external IP networks and other PLMN via the GGSN. Databases as the Equipment Identity Register (EIR), the Home

Location Register (HLR), the Authentication Centre (AUC) and the Visitor Location Register (VLR) are used to control and maintain subscribers and security issues. The Network Management Centre (NMC) and Operation and Management Centre (OMC) are used to support and manage the network nodes.

MS, Mobile Station
The mobile station is the device that is used by a subscriber in order to send and receive traffic. The MS contains of the Mobile Equipment (ME), which can be a cellular phone or a laptop equipped with a GSM card, and a Subscriber Identity Module (SIM) containing among other things subscriber information.

BTS, Base Transceiver Station
The base transceiver station is the network node sending and receiving messages via the air and contains therefore only functions that are related to radio and which must be located closest to the radio interface, as channel coding and decryption for circuit switched traffic.

BSC, Base Station Controller
The base station controller is controlling one or more base transceiver stations. It also handles functions related to the radio equipment, as channel allocation and administration to the mobile station, handover procedures, paging, and sometimes also voice transcoding. (Some vendors implement the transcoder in the base transceiver station instead.)

MSC, Mobile-services Switching Centre
The mobile-switching centre is the exchange for circuit switched data, which is performing switching and signalling functions as well as supervising and registering billing information.

GMSC, Gateway MSC
The gateway MSC is the connection point to external networks. It performs routing function and register billing information towards external operators.

SGSN, Serving GPRS Node
The serving GPRS node is the counterpart to MSC for packet switched data. It stores subscriber data needed to handle originating and terminating packet data transfer.

GGSN, Gateway GPRS Support Node
The gateway GPRS support node is the counterpart to the GMSC, a connection point to Internet Service Providers (ISP) or corporate Local Area Networks (LAN). The GGSN is connected to the SGSN via an internal IP network.

EIR, Equipment Identity Register
The equipment identity register is a database containing lists of permitted and not permitted (i.e. stolen) mobile equipment.

HLR, Home Location Register
The home location register is a database containing and managing all subscriber information for one operator.

VLR, Visitor Location Register
The visitor location register is a database holding a copy of the subscriber information of subscribers currently situated in its location. It manages information needed for the call-setup and supplementary services attached to a mobile subscriber.

AUC, Authentication Centre
The authentication centre is a database storing the encryption key for each subscriber and managing the authentication and ciphering procedures.

NMC, Network Management Centre
The network management centre is controlling the GSM network and reporting transmission problems.

OMC, Operation and Maintenance Centre
One operation and maintenance centre can control hundreds of network nodes within the GSM network. It is sending alarming reports for different kinds of faults, as incorrect input voltage, corrupt data signals etc.

2.2 Traffic Types

A GSM/GPRS PLMN can exchange traffic with different types of networks, e.g. analogue and digital circuit switched as well as packet switched networks. Three types of traffic are specified: voice, circuit switched data and packet switched data. Circuit switched data supports two types of transmission: transparent and non-transparent. Non-transparent data traffic is handling error detection and frame retransmission and makes is thereby reliable, while transparent data traffic has no error handling included and is therefore non-reliable. The advantage of the later one is to gain higher data rates. The traffic types are specified in [3GPP TS 03.10].

2.3 Interfaces and Protocols

The nodes within the GSM/GPRS network are communicating with each other over different interfaces as shown in Figure 2-3.

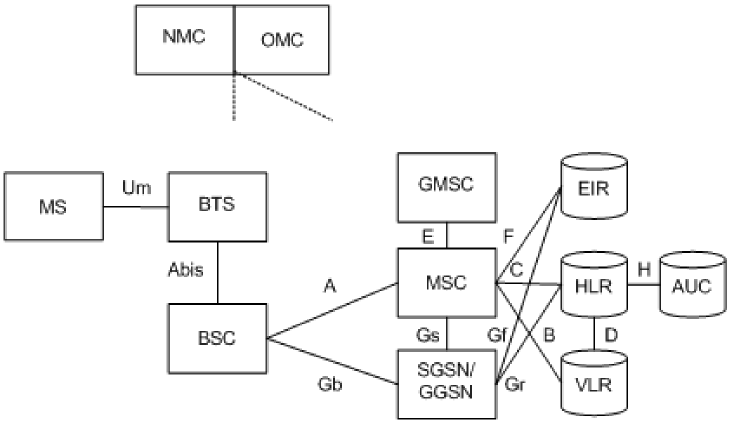

Figure 2-3. GSM/GPRS interfaces

Each interface is using several protocols for transferring messages between the nodes. The protocols are divided into two planes: the user plane, responsible for the transmission of the user traffic and additional information as transfer control procedures, and the signalling plane, handling the subscriber access to the network as well as controlling and supporting the functions within the user plane. Figure 2-4 shows how the protocol model could look like.

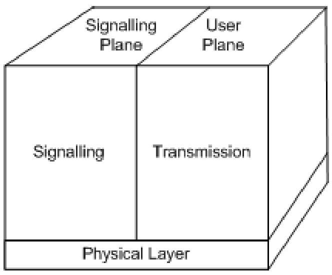

Figure 2-4. GSM/GPRS Protocol model

Circuit switched traffic

The signalling protocols for circuit switched traffic are represented in Figure 2-5.

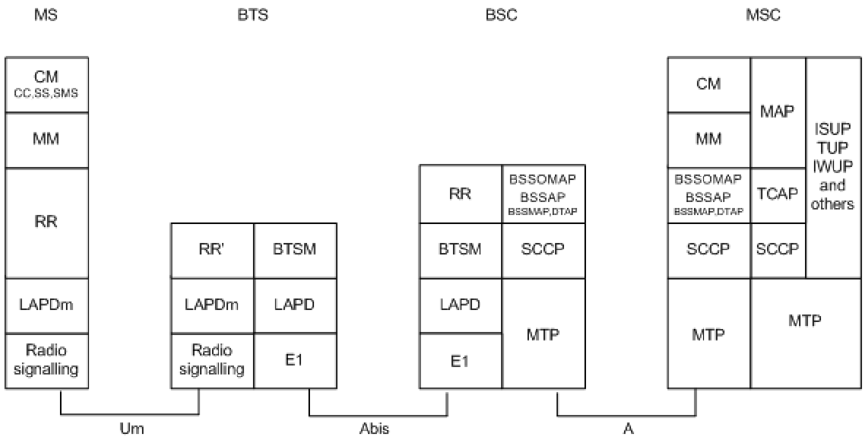

Figure 2-5. GSM signalling protocols

The interface between the MS and the BTS is called Um. Layer 1, the physical layer, represents functions as the assignment of channels and the handling of system information e.g. measurement results, required to transmit data over the radio interface. Layer 2, the data link layer, is based on the slightly modified ISDN protocol Link Access Protocol on the D channel (LAPD), called Link Access Protocol on the Dm channel (LAPDm). This link is used to convey signalling information between layer 1 and layer 3. Layer 3, the network layer, provides services for the user applications and is divided into three sub layer protocols: the Connection Management (CM), the Mobility Management (MM) and the Radio Resource Management (RR). The Connection Management layer is further subdivided into three protocols: Call Control (CC), Supplementary Services (SS), and Short Message Service (SMS).

The interface between the BTS and the BSC is called Abis. Layer 1 for GSM 900 and GSM 1800 is a 2 Mbps digital transmission link based on the standard CCITT[2] G.703 interface E1, while GSM 1900 is based on a 1.5 Mbps digital transmission link standardised by ANSI T1.403 interface T1. Layer 2 is using the LAPD protocol for transmissions between Layer 1 and Layer 3. Layer 3 MM, CM and most RR messages on the Um interface are not interpreted by either the BTS or BSC and are transferred transparently over Abis. Some RR messages however must be interpreted by the BSC, e.g. paging and start ciphering. The BTS Management (BTSM) is managing the BTS and the RR messages.

The BSC is connected to the MSC via the A interface. The exchanges use a separate network system; the CCITT Signalling System No. 7 (SS#7) including the Message Transfer Part (MTP) and the Signalling Connection Control Part (SCCP) providing additional functions to MTP. MTP can handle different user applications, as telephony or ISDN and is divided into three functional levels; level 1 for the physical layer, level 2 for the data link layer and level 3 for the network layer. Layer 1 is realised either by a 2 or 1.5 Mbps digital transmission link E1 or T1 provided by MTP level 1 or analogue by the use of modems. Layer 2 is handled by MTP level 2, while Layer 3 uses the protocols Base Station System Application Part (BSSAP) and Base Station System Operation and Maintenance Application Part (BSSOMAP) (CM and MM). For being able to transfer BSSAP and BSSOMAP messages, the SCCP protocol is used on top of MTP level 3. BSSAP is divided into two sub protocols, the Base Station System

[2] The International Telecommunication Union (ITU) now handles the CCITT standards.

Management Application Part (BSSMAP) and the Direct Transfer Application Part (DTAP). BSSMAP is used for the radio resource handling at BSS, while DTAP is used for the layer 3 Um messages passed transparently through the BTS and analysed by the BSC.

The Transaction Capabilities Application Part (TCAP) protocol is part of SS#7 and used for database queries, while the Mobile Application Part (MAP) protocol is a specific extension of SS#7 for communication with other GSM components. The ISDN User Part (ISUP), the Telephony User Part (TUP), the Internetworking Function User Part (IWUP), and others are used for the signalling between different PLMNs.

Despites the signalling protocols for transmitting signalling messages there are also transmission protocols defined for handling user messages. As described in chapter 2.2 Traffic Types, there are three different message types for circuit switched traffic: speech, transparent data and non-transparent data. The transmission protocols of those are described in Figure 2-6 to 2-8.

The speech transmission is performed transparently between the mobile station and a Transcoding and Rate Adaption Unit (TRAU). The task of the TRAU is to transform GSM speech coded signals to the ISDN standard form. The TRAU can be physically situated in the BTS, the BSC (as shown in Figure 2-6), the MSC or standalone.

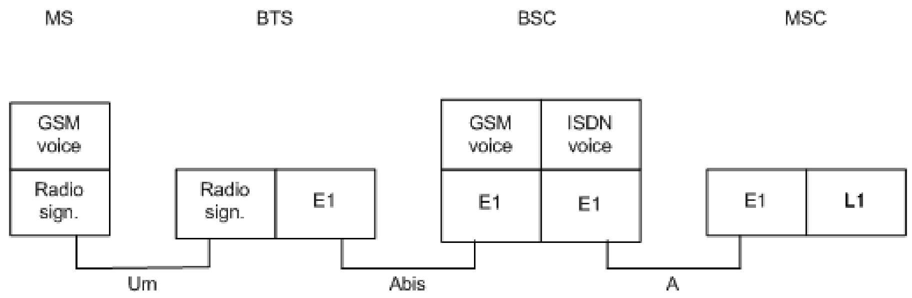

Figure 2-6. GSM speech transmission protocols

Transparent data traffic is sent transparently from the mobile station through the BSS, therefore no extra protocols are needed for the transmission of user messages.

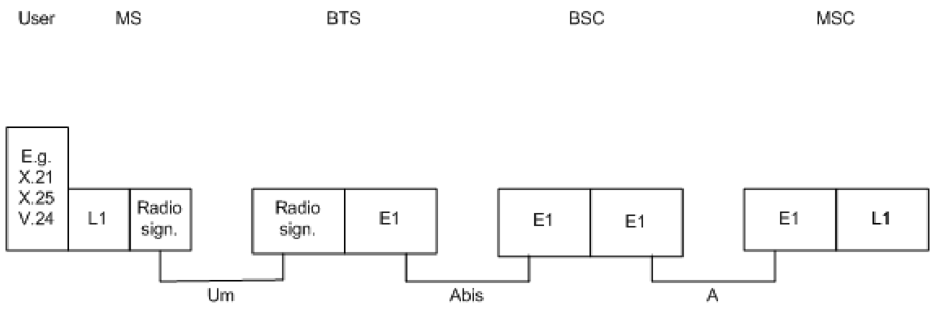

Figure 2-7. GSM transparent data transmission protocols

Non-transparent data traffic in the other hand is not sent transparently, and the reason for that is to provide protection against transmission errors. The Radio Link Protocol (RLP) is a Layer 2 protocol, providing an error detection scheme with automatic retransmission of faulty blocks. A Non-transparent Protocol (NTP) and an Interface Protocol (IFP) are defined at the MS interface to provide transmission of different kinds of data, e.g. V.24 or X.25.

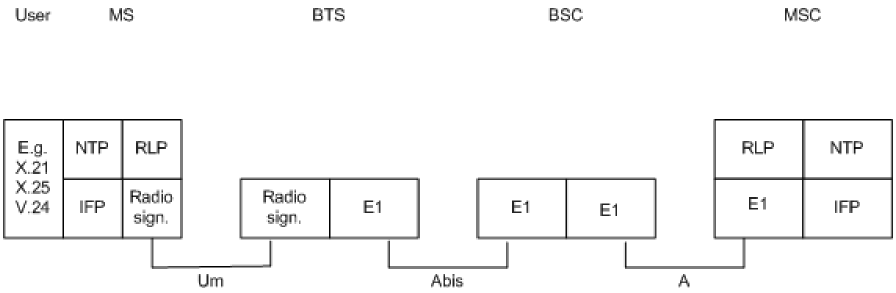

Figure 2-8. GSM non-transparent data transmission protocols

<u>Packet switched traffic</u>
The transmission protocols for packet switched traffic are represented in Figure 2-9 and the signalling protocols in Figure 2-10.

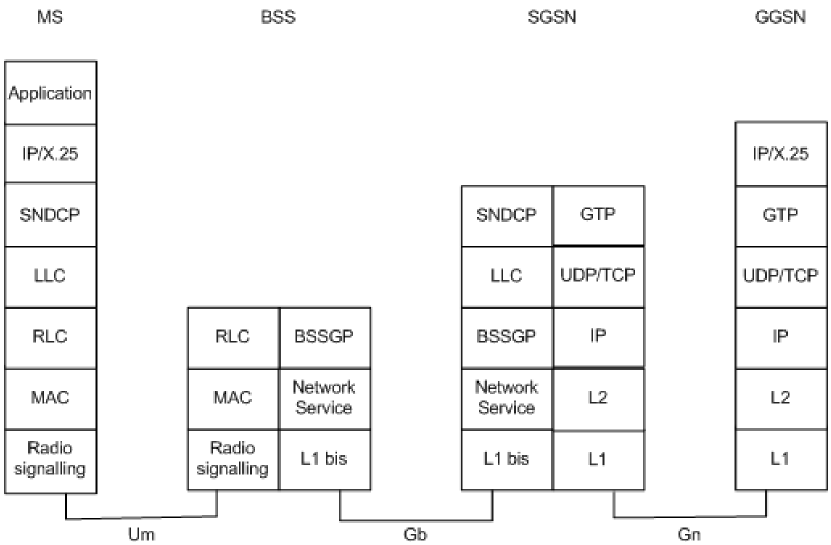

Figure 2-9. GPRS transmission protocols

GPRS is logical build on top of GSM adding two new nodes to the network, the SGSN and the GGSN sometimes combined to the Combined GSN (CGSN). The GPRS network looks like an IP network for stations connected from both inside and outside the network. The same interfaces are used as for GSM, except for a further interface called G, connecting to the GPRS nodes; Gb between the BSC and the SGSN and Gn between the SGSN and the GGSN. The Abis interface is not specified within the GSM recommendation.

The GPRS MS is communicating to the SGSN using the Sub Network Dependent Convergence Protocol (SNDCP) and the Logical Link Control (LLC). SNDCP is a protocol mapping network layer characteristics to underlying networks as well as adapting the data to be sent over the radio link. LLC is providing a reliable logical link. Applications can run on top of IP or X.25.

The Radio Link Control (RLC) is providing a reliable radio link and the Medium Access Control (MAC) is controlling the access signalling to the radio link as well as mapping LLC frames to the GSM physical channel. The handling of RLC and MAC is performed by the Packet Control Unit (PCU), which can be physically situated in the BTS, the BSC or standalone.

The Base Station GPRS Protocol (BSSGP) transmits routing and quality of service related information between the BSC and the SGSN via the network service layer.

The GPRS Tunnelling Protocol (GTP) is a protocol used internal between the SGSN and the GGSN, providing transmission of TCP/IP or X.25 packets without the need of controlling function. The GTP packets are sent either over an UDP or a TCP protocol, depending of the need of reliability. IP is the backbone network protocol for GPRS providing routing of user data and controlling the signalling.

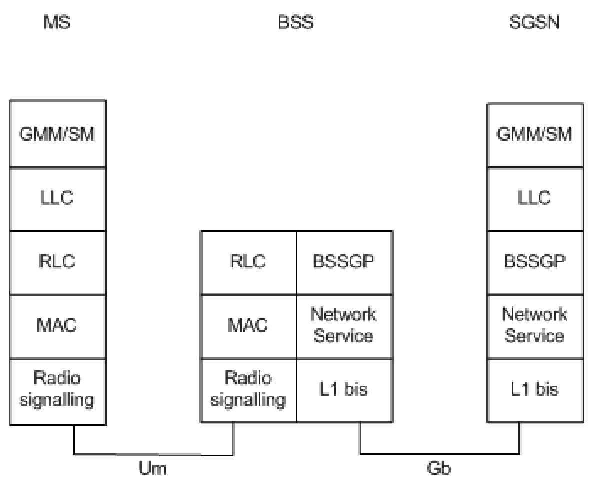

Figure 2-10. GPRS signalling protocols

The GPRS Mobility Management and Session Management (GMM/SM) is a protocol handling the functions for MM and SM.

The other interfaces are of less importance for this thesis and are therefore not explained in more detail. The aspects above are described in [3GPP TS 03.50], [3GPP TS 03.60], [3GPP TS 04.22], [3GPP TS 08.01], [3GPP TS 08.04], [3GPP TS 08.06] and [3GPP TS 08.52].

3 Latency Analysis

In this chapter the actual investigation of the latency analysis is performed. For being able to investigate the latency problem, all timers and retransmission counters used in the protocols passing the Abis interface have to be checked. Also relevant timer's comprehensive for the whole system has to be considered.

3.1 Affected Specifications

The timers are found in the GSM specifications and the mapping for the actually specifications to the different layers is represented in Figure 3-1 for the GSM signalling protocols, Figure 3-2 for non-transparent data transmission protocols, Figure 3-3 for the GPRS transmission protocols and Figure 3-4 for the GPRS signalling protocols. The actually protocols to be investigated are marked with grey colour.

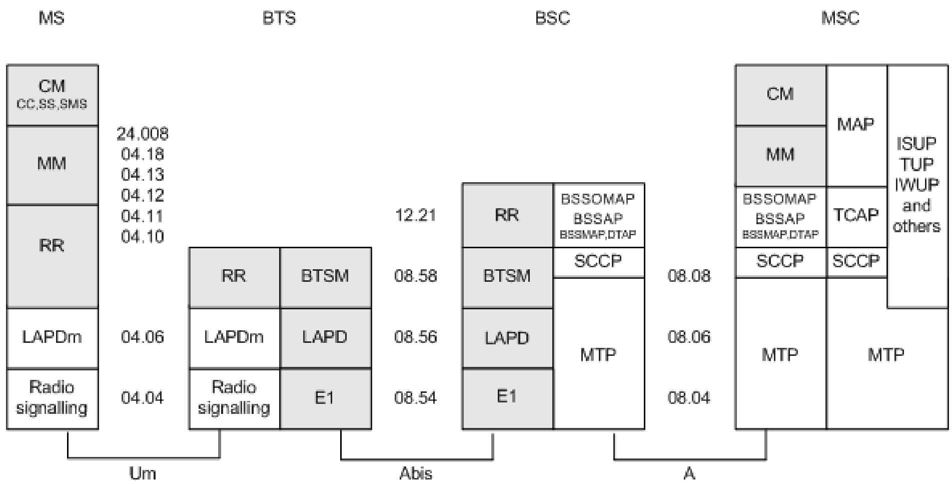

Figure 3-1. Specification mapping GSM signalling protocols

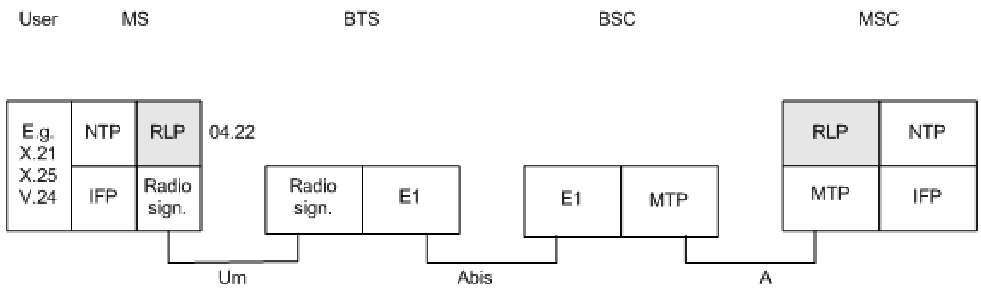

Figure 3-2. Specification mapping GSM non-transparent data transmission protocols

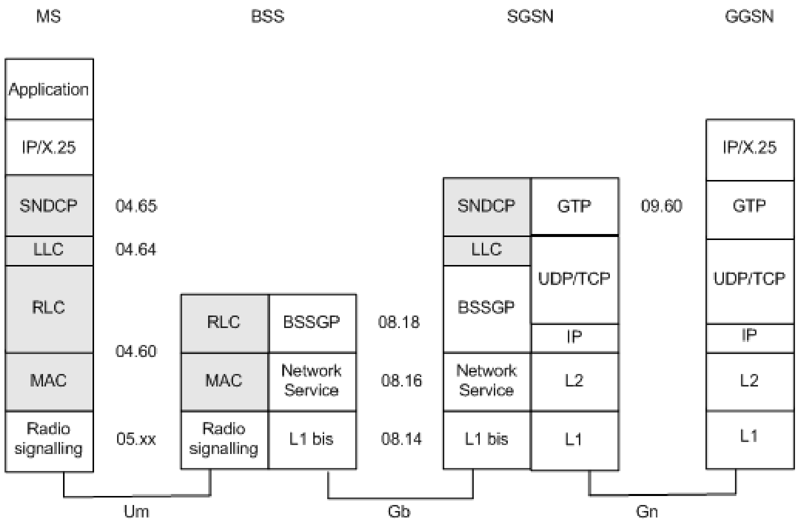

Figure 3-3. Specification mapping GPRS transmission protocols

IP and X.25 are protocols not part of GSM and therefore not specified within the GSM recommendations. IP is standardised in RFC 791 and X.25 is standardised by CCITT. The Abis interface for GPRS is not standardised within the GSM recommendations. As mentioned earlier RLC and MAC are handled by the PCU, which is physically stored in the BSC in the GSM/GPRS container and therefore those protocols are also traversing Abis and have to be investigated.

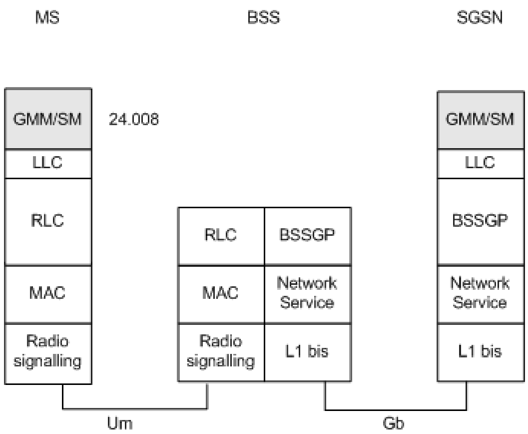

Figure 3-4. Specification mapping GPRS signalling protocols

3.2 Affected Protocols

In this thesis the requirement is to focus on timers which have an impact to the latency problem, e.g. timer expiring within 20, 100 or 200 ms. Table 3-1 is showing the affected protocols and whether they include sensitive timers or not. I am also presenting timers for less than 250 ms and less than 500 ms, because 250 ms is a critical limit for layer 2 handling and timers above 500 ms are assumed to not affect the latency problem. Except for timers there can also be counters for the number of retransmission defined. The retransmission of messages can be optional; therefore the values in Table 3-1 are represented independent of the counter values, i.e. the retransmission counter is set to 0. A list including all timers and counters affecting the Abis interface is represented in Appendix A to C.

Protocol	Timers defined with expiring time:						
	≤20 ms	≤100 ms	≤200 ms	≤250 ms	≤500 ms	Network depended	Other information
E1							No timer handling
LAPD				**X**			Default retransmission procedure with default maximum value N200=3. Max delay: 240msx3=720ms
BTSM							Defined in RR
RR					**X**	**X**	Set in other message.
MM							Set in other message or not specified
CM:CC						**X**	
CM:SS							No timers specified
CM:SMS							No values specified
RLP		**X**[1]	**X**[2]		**X**[3]		[1]applicable for multi-link version frames [2]4 retransmissions possible [3]6 retransmissions possible dependent on data rate
MAC/RLC		**X**[1]	**X**		**X**		Set in other message Several retransmission counters with values defined in cell configuration or set to specific values. [1]packet cell change notification
LLC							Smallest timer 5 s with retransmission value of 5.
SNDCP							No timers and counters are specified.
GMM						**X**	
SM							Smallest timer 8 s. No counters specified.
Round trip delay speech			**X**				Recommendations only
Round trip delay circuit switched data					**X**		value < T1 – T2, (T1,T2 are RLP timers) example full rate data: T1–T2=520–80= 440 ms Recommendations only
Round trip delay packet switched data							No information found in 3GPP specifications

Table 3-1. Affected protocols

As it is shown in Table 3-1, the layer 2 protocols LAPD, RLP and MAC/RLC as well as the round-trip delay include timers that will be affected by the latency. Layer 2 timers should be greater than the maximum time between the transmission of a command frame and the reception of the corresponding response or acknowledgement frame and shorter than the shortest layer 3 timer used for supervising this message flow [3GPP TS 08.56]. Therefore the layer 2 protocols are the ones of importance when the delay of the link is increased. Several layer 3 protocol timers are network depended or have their timers specified by the network operator. By comparing the specified values, you can assume that even the smallest values will be greater than 1 second, and therefore not be affected by the latency. The round-trip delay values are recommendations only, and therefore you can overlook these values. But you should be aware of that increasing the delay within speech conversations could lead to difficulties in handling the echo functionality and simultaneous speech in both directions.

3.3 Affected Timers and Counters

As described in the previous section several timers and counters are defined for each protocol. Generally a timer can be restarted a certain number of times (set by the counter defining the number of retransmissions) and the expiring time will be timer times counter. What will happen if a timer expires and cannot be restarted due to the number of allowed restarts is reached?

Different timers will lead to different actions taken when expiring. To abort the recently performed procedure is a generally taken action, but this will not always lead to an abort of the link. The Appendixes A to C include, if defined in the specifications, the reason for when a timer expires and what will happen in that case.

As discussed in the previous section the relevant timers are found in layer 2 protocols which handle the responses or acknowledgements of a command frame. In case those timers are expiring, the link will be released.

4 Evaluation

This chapter described the test performed in the GSM/GPRS container. The test coverage is simplified and the test has been performed within one day only. The main reason for that is because the performance of running exhaustive tests is not within the scope of this thesis.

The GSM/GPRS core network located at KTH IMIT is described in Figure 4-1. Other universities and institutes will connect their base stations to the GSM/GPRS container via the IP network SUNET. The GSM/GPRS container could be connected to external networks, but this is not the case today. Compared to the architecture described in Figure 2-1, the GSM/GPRS container is connected to SUNET through Multiservice IP concentrators (AXN) in order to be able to run GSM/GPRS traffic over IP.

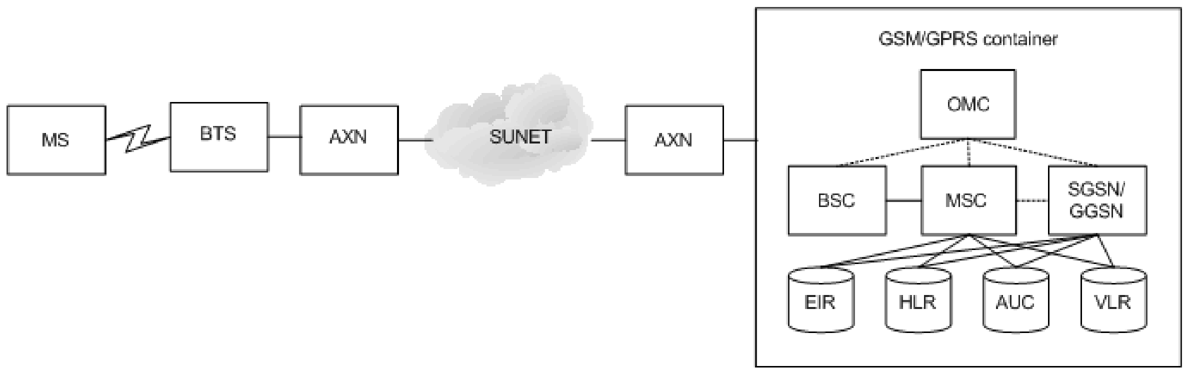

Figure 4-1. GSM/GPRS core network

The influence of the latency was evaluated with a test bed based on the core network, as shown in Figure 4-2. SUNET was simulated by an emulation package called NIST Net, running on a Linux computer. The Linux computer acts as a router and can emulate a wide range of network conditions as packet delay distributions, congestion and background loss, bandwidth limitation, and packet reordering / duplication. The handling of the AXN is described in [AXN UG] and of NIST Net in [NIST Net UG].

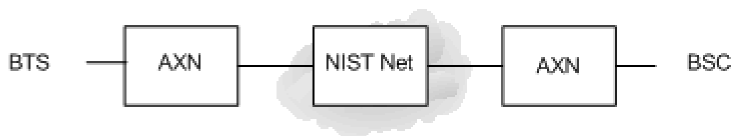

Figure 4-2. GSM/GPRS test bed

Along with latency also jitter will occur in an IP network. Jitter is the variation of latency over time occurring in the network. The AXNs can be configured for handling the latency and jitter through defining proper values for the packet delay configuration and the size of the jitter buffer. The jitter buffer at the AXN closest to the GSM/GPRS container has to be defined in order to match the jitter that occurs within the network; e.g. if jitter occurs in the range of ± 10 ms, the jitter buffer has to handle a size of 20 ms. The aim of the test that has been performed was to try the behaviour of the Abis link and not the capacity of the AXN to AXN connection, therefore the values of the packet delay (set to 2 ms) and the jitter buffer (set to 20 ms) within the AXN was set to statically values. With NIST Net the delay of the IP network was simulated. The delay value was changed increasingly (between 20 and 550 ms) while the jitter was set statically (set to 0). The delay over the Abis link will be the NIST Net delay + AXN packet delay + AXN jitter buffer/2 (which is around 20 to 30 ms in addition to the delay set in NIST Net).

Due to limited functionality in the GSM/GPRS container, only speech traffic was sent during the test. Only one BTS was connected to the BSC and therefore the handover function was not performed either. The test was performed by setting up a speech call and increasing the delay in the NIST Net until a link break occurred. A detailed table of the tested delay values and the outcome is found in Appendix D. The approximately time before the link was broken was obtained to around 500 ms. This value is higher than the expected 240 ms for LAPD. There are several aspects to be considered for why the link was breaking at different times and later than expected:

- The loss of the signalling link was shifting dependent of the delay value set in NIST Net. The behaviour could be stressed by changing the delay rapidly and starting with high values. The most stable performance was achieved when changing the delay values in smaller steps starting from zero and with more time in between the changes.
- The jitter buffer at the AXNs has not been adjusted to the NIST Net delay during the test.
- The configuration of the retransmission counter for LAPD is not known, but it is probably set to the maximum default of 3 times, which increase the possible delay to 720 ms.
- Are there other configurations set in the BSC resulting in the acceptance of a longer delay?

The state of the signalling and speech link has been monitored in the BSC and is shown in Appendix E. The signalling link broke before the speech link, but without signalling the speech link will always break shortly after.

I want to point out once again that the test performance was simplified, because running exhausted tests are not within the scope of this thesis.

5 Conclusion

The question to be answered within this thesis was how the GSM/GPRS system will be affected if the latency in the IP network will be 20 ms, 100 ms or 200 ms. By studying the GSM recommendations the following assumptions can be made: The latency of 20 ms will have no affects at all. Depending on the configuration of the retransmission counters, different results can be achieved. The worst case occurs if the counter is set to zero: RLP, which is the protocol for non-transparent data will be affected if the latency reaches 100 ms. MAC/RLC, used for GPRS will be affected by the latency of 200 ms. Important to notice is that both speech and transparent data traffic will be affected when the latency is greater then 240 ms, due to the limitation within LAPD. The affect will occur in loosing the signalling link, which results in the interruption of the traffic. The best case is if the retransmission counter is set to the highest possible value. In that case I assume that the latency of 200 ms has no affect for any traffic.

6 Future Work

I want to finalise this report by suggesting subjects that could be investigated in further studies. Those issues were outside the scope of this thesis, yet important for the latency problem of the Abis connection.

6.1 Impact of the Multiservice IP Concentrators

To technically realise to run an E1 link on top of an IP network you need to implement new hardware devices to the core network, the Multiservice IP concentrators. The AXN can be configured for packet delay and jitter buffer size. The jitter buffer should be used to eliminate the jitter occurring in the IP network. How well does the AXN actually handle the jitter and could the AXN itself have any impact to the latency?

6.2 GSM Satellite Function

Today, several providers offer the possibility of sending GSM/GPRS traffic via a satellite. Ericsson provides a satellite delay function in the BSC, in which the LAPD delay can be set to 250 ms (according to the BSC specification given in the GSM/GPRS container). The default value of the LAPD timer is 240 ms according to the GSM recommendations, so if being able to configure the GSM/GPRS container to run over satellite does it mean that you could have another 10 ms (250 ms – 240 ms) or even 490 ms (250 ms + 240 ms) of possible delay over the Abis link? The questions is, if it is possible to set this value, and if yes, if there are other limitations that occurs? To get an answer to these questions, Ericsson has been contacted, but as of today no answer has been received.

The delay when transmitting GSM traffic over a satellite assumes to be much higher then when transmitting over IP. Is the functionality of running GSM/GPRS over a satellite implemented in the GSM/GPRS container and could this feature be used for increasing the delay without affecting the services provided?

7 Final Discussion

If I had the chance to start with this thesis again, would I have done anything differently? No, I suppose I would not. To first identify the protocols and after that identifying the specified values for the timers is the only way to attack the problem. In the beginning a searched the Internet for Abis latency issues, without any result. I contacted one university, suggested by my supervisor. I may have put more time and effort in finding any latency studies, or I also could have contacted more universities. What I regret is for not pushing harder to get a contact at Ericsson, the provider of the GSM/GPRS container. I am aware of that Ericsson most probably has performed latency investigations, and that they have a lot internal specifications that would have been of great help. But I am also aware of the existing company rules, of how to handle internal company information towards the outside world.

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Appendix A – GSM Timer

A1. E1

The signalling layer on Abis is described in [3GPP TS 08.54].

The used protocol is unreliable, with the consequence that the sent packages arrival is not controlled. Each package is transmitted at a certain bit rate, and the layer above, LAPD, handles flow control. Therefore **no timers** are handled within this protocol.

A2. LAPD

The link layer on Abis is described in [3GPP TS 08.56]. The values are directly derived from this specification.

Timer	Time-out value	Decription
T200	default **240 ms** (Note) Default maximum number of retransmission (N200) is **3**.	waiting for ACK
T201	1 s The default and maximum value of (N201) is 260 octets for all SAPI values.	time before the retransmission of TEI Identity request
T202	15 s The maximum value of (N202) is not used (i.e. equivalent to infinity).	minimum time between the transmission of TEI Identity request messages
T203	10 s No retransmission defined.	idle mode timer, max time allowed without frames being exchanged for each TEI

Note: **This timer depends on the timer values used for supervising the message flow between the mobile station and the network. The proper operation of the procedure requires timer T200 to be greater than the maximum time between transmission of command frames and the reception of their corresponding response or acknowledgement frames and shorter than the shortest layer 3 timer used for supervising this message flow.**

Table A2-1. Timer LAPD

A3. BTSM

The Abis layer 3 protocol BTSM is described in [3GPP TS 08.58]. The figure and statements are directly derived from this specification.

The TRX management includes a procedure for controlling the traffic flow as represented in Figure A3-1. When the first OVERLOAD message has been received, the BSC will reduce the traffic by one step and will start the timers T1 and T2. For the period of T1 all OVERLOAD messages will be ignored. When receiving an OVERLOAD message after the expiring of timer T1, but still within the period of timer T2, the traffic will be decreased by one more step and the timers T1 and T2 are restarted. This step-by-step reduction of the traffic will be continued until the maximum reduction is obtained. In case timer T2 expires without receiving an OVERLOAD message, the traffic will be increased by one-step and timer T2 will be restarted. This step-by-step increase of traffic will be continued until full load has been resumed. The number of steps and the method of reducing the load are implementation dependent.

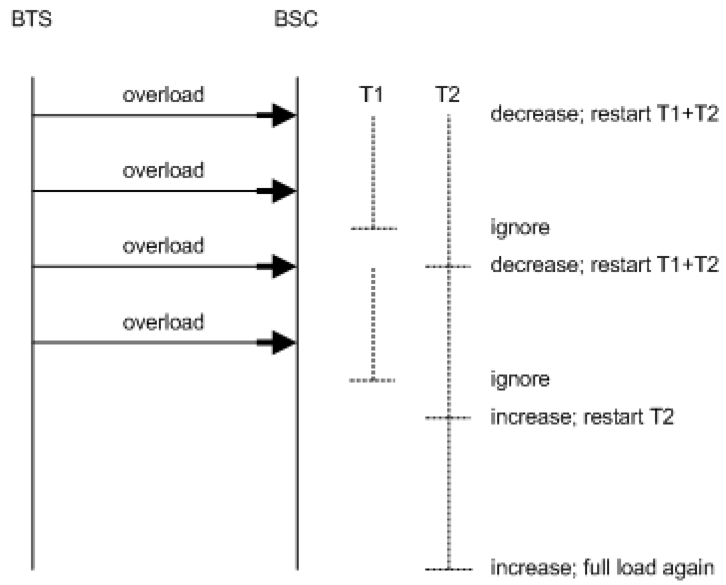

Figure A3-1. Traffic flow procedure BTSM

The timers T1 and T2 are defined in the Radio Resource Control protocol [3GPP TS 04.18].

A4. RR

The Radio Resource Management is described in [3GPP TS 04.18]. The values are directly derived from this specification. Timers on the mobile station side are represented in Table A4-1 and for the network side in A4-2.

Timers on the mobile station side

Timer	Time-out value	Cause for start	Normal stop	At expiry
T3122 (Note1)	**set in IMMEDIATE ASSIGN REJ**	on reception of IMMEDIATE ASSIGN REJ		
T3124	**675 ms if allocated channel type in HANDOVER CMD is SDCCH (+ SACCH), otherwise 320 ms**	used in seizure procedure during hand-over, when two cells are not synchronized		
T3126	minimum value equal to time taken by T+2S slots of mobile station's RACH. (S is parameter depending on CCCH configuration and on value of Tx-integer and T is value of parameter Tx-integer broadcast on BCCH), maximum value 5 s	-after sending maximum allowed number of CHANNEL REQ during immediate assignment procedure or -on reception of IMMEDIATE ASSIGN REJ whichever occurs first	on receipt of: -IMMEDIATE ASSIGN or -IMMEDIATE ASSIGN EXT	abort of immediate assignment procedure
T3128	1 s	-when mobile station starts uplink investigation procedure and -uplink is busy	on receipt of first UPLINK FREE	abort of uplink investigation procedure
T3130	5 s	after sending first UPLINK ACCESS during VGCS uplink access procedure	on receipt of VGCS ACCESS GRANT	abort of uplink access procedure
T3110 (Note2)	**value is set to such that DISC frame is sent twice in case of no answer from network (should be chosen to obtain a good probability of normal termination (i.e. no time out of T3109) of the channel release procedure)**	-used to delay channel deactivation after reception of (full) CHANNEL REL -purpose is to let some time for disconnection of main signalling link		
T3134	5 s	-used in seizure procedure during RR network controlled cell change order procedure -purpose is to detect lack of answer from network or lack of availability of target cell		
T3142	**set in: - IMMEDIATE ASSIGN REJ or -DTM REJ**	-used during packet access on CCCH and during packet access while in dedicated mode - started on reception of IMMEDIATE ASSIGN REJ or DTM REJ		
T3148	4 s	-used during DTM establishment in dedicated	on receipt of either: -DTM ASSIGN CMD	abort of packet access procedure

		mode -started after sending DTM REQUEST during packet access procedure while in dedicated mode	-PACKET ASSIGN -DTM REJ -ASSIGN CMD or - HANDOVER CMD	
T3146	-minimum value equal to time taken by T+2S slots of mobile station's RACH (S is parameter depending on CCCH configuration and on value of Tx-integer and T is value of parameter Tx-integer broadcast on BCCH) --maximum value is 5 s	either after: -sending maximum allowed number of CHANNEL REQ or EGPRS PACKET CHANNEL REQ messages during a packet access procedure or -on reception of IMMEDIATE ASSIGN REJ during packet access procedure whichever occurs first	on receipt of either: -IMMEDIATE ASSIGN or -IMMEDIATE ASSIGN EXT	abort of packet access procedure
T3164	5 s	-used during packet access using CCCH -started at reception of IMMEDIATE ASSIGN	at transmission of RLC/MAC block on assigned temporary block flow	mobile station returns to packet idle mode
T3190	5 s	-used during packet downlink assignment on CCCH -started at reception of: -IMMEDIATE ASSIGN or -PDCH ASSIGN CMD when in dedicated mode	at reception of RLC/MAC block on the assigned temporary block flow	mobile station returns to packet idle mode
T3204	1 s	-used by mobile station with non-GSM capabilities -started after sending first CHANNEL REQ during packet access procedure (CHANNEL REQ was sent requesting a single block packet access and purpose of packet access procedure is to send PACKET PAUSE)	at the receipt of IMMEDIATE ASSIGN granting single block period on assigned packet uplink resource	abort of packet access procedure

Note: Applicable for GSM only (before Rel-4)

Note1: If the last timeslot of the message block containing an IMMEDIATE ASSIGNMENT REJECT message is sent at time T and contains a Wait Indication of W seconds then the MS shall at least respond to PAGING REQUEST messages sent later than T + (W + 1) seconds [3GPP TS 04.13].

Note2: If the last timeslot of the message block carrying the CHANNEL RELEASE message occurs at time T, then the MS shall cease transmissions on all channels before T + 500 ms [3GPP TS 04.13].

Table A4-1. Timer RR mobile station side

Timers on the network side

Timer	Time-out value	Cause for start	Normal stop	At expiry
T3101 (Note1)	**network dependent** could be higher than maximum time for L2 establishment attempt	when channel is allocated with IMMEDIATE ASSIGN	when mobile station has correctly seized channels	
T3103	**network dependent** could be higher than maximum transmission time of HANDOVER CMD, plus value of T3124, plus maximum duration of attempt to	-started by sending of HANDOVER -purpose is to keep old channels sufficiently long for mobile station to be able to return to old channels, and to release channels if mobile station is lost	when mobile station has correctly seized new channel	

	establish data link in multi frame mode			
T3105	**network dependent** may be set to such low value that message is in fact continuously transmitted T3105 shall be coded as a binary presentation of 10 ms in the range of <0-FF> [3GPP TS 12.21]	-used for repetition of PHYSICAL INFO during hand-over procedure		
T3107	**network dependent** could be higher than maximum transmission time of ASSIGN CMD plus twice maximum duration of attempt to establish data link multi frame mode	-started by sending of : -ASSIGN CMD or -DTM ASSIGN CMD -purpose is to keep old channel sufficiently long for mobile station to be able to return to old channels, and to release channels if mobile station is lost	when mobile station has correctly seized new RR channels	
T3109	**network dependent** should be large enough to ensure that mobile station detects radio link failure	-started when lower layer failure is detected by the network, when it is not engaged in RF procedure -used in channel release procedure -purpose is to release channels in case of loss of communication		
T3111	**equal to T3110**	-used to delay channel deactivation after disconnection of main signalling link -purpose is to let some time for possible repetition of disconnection		
T3113	**network dependent** could allow for repetitions of CHANNEL REQ and requirements associated with T3101	when network has sent PAGING REQ	when network has received PAGING RESP	
T3115	**network dependent** may be set to such low value that message is in fact continuously transmitted	used for repetition of VGCS UPLINK GRANT during uplink access procedure		
T3117 (Note)	**network dependent** could be higher than maximum transmission time of PDCH ASSIGN CMD, plus T3132, plus maximum duration of attempt to establish data link in multi frame mode	-started by sending of PDCH ASSIGN CMD -purpose is to keep old channel sufficiently long for mobile station to be able to return to old channels, and to release channels if mobile station is lost	when mobile station has correctly accessed target TBF	
T3119 (Note)	**network dependent** could be higher than maximum transmission time of RR_CELL	-started by sending of RR-CELL CHANGE ORDER -purpose is to keep old channels sufficiently long for mobile station to be able to	when mobile station has correctly accessed new cell	

	CHANGE ORDER, plus T3134, plus maximum duration of attempt to establish data link in multi frame mode	return to old channels, and to release channels if mobile station is lost		
T3121	**network dependent**	-started by sending of INTER SYSTEM TO UTRAN HANDOVER -purpose is to keep old channels sufficiently long for mobile station to be able to return to old channels, and to release channels if mobile station is lost	when mobile station has correctly seized UTRAN channel(s)	
T3123	**network dependent**	-started by sending of INTER SYSTEM TO CDMA2000 HANDOVER -purpose is to keep old channels sufficiently long for mobile station to be able to return to old channels, and to release channels if mobile station is lost	when mobile station has correctly seized CDMA2000 channel(s)	
T3141	**network dependent**	when a temporary block flow is allocated with IMMEDIATE ASSIGN during packet access procedure	when mobile station has correctly seized temporary block flow	

Note: Applicable for GSM only (before Rel-4)
Mote1: If the last timeslot of the message block containing an IMMEDIATE ASSIGNMENT (or IMMEDIATE ASSIGNMENT EXTENDED) message is transmitted at time T then, the MS shall be ready to transmit the SABM frame with its information field before T + 25 ms. This requirement shall apply for assignment to TCH/F, TCH/H and SDCCH [3GPP 04.13]

Table A4-2. Timer RR network side

Counters

Ny1: The maximum number of repetitions for the PHYSICAL INFORMATION message during a handover. The value is **network dependent**.

Ny2: The maximum number of repetitions for the VGCS UPLINK GRANT message during an uplink access procedure. The value is **network dependent**.

A5. MM

The Mobility Management is described in [3GPP TS 24.008]. The values are directly derived from this specification. Timers on the mobile station side are represented in Table A5-1 and for the network side in A5-2.

Timers on the mobile station side

Timer (st at)	Time-out value	Cause for start	Normal stop	At expiry
T3210 (3)	20 s	LOC_UPD_REQ sent	-LOC_UPD_ACC -LOC_UPD_REJ -AUTH_REJ -Lower layer failure	start T3211
T3211 (1,2)	15 s	-LOC_UPD_REJ with cause#17 netw. failure -lower layer failure or RR conn. released after RR conn. abort during loc. updating	-time-out -cell change -request for MM connection establishment -change of LA	Restart Location update procedure
T3212 (1,2) (Note1)	**is broadcasted in SYSTEM INFO**	termination of MM service or MM signalling	-initiation of MM service or MM signalling	initiate periodic updating
T3213 (1,2,11)	4 s	location updating failure	-expiry -change of BCCH param	new random attempt
T3214 (3,5,7)	20 s	AUTHENT FAILURE Cause = 'MAC failure' or 'GSM authentication unacceptable' sent	AUTHENT REQ received	consider network as 'false'
T3216 (3,5,7)	15 s	AUTHENT FAILURE Cause = Synch failure sent	AUTHENT REQ received	consider network as 'false'
T3218 (3,5,7)	20 s	RAND and RES stored as a result of of a UMTS authentication challenge	-Cipher mode setting (A/Gb mode only) Security mode setting (Iu mode only) CM_SERV_ACCEPT received CM SERVICE REJECT received -LOCATION UPDATING ACCEPT received -AUTHENT REJ received -AUTHENT FAIL sent -enter MM IDLE or NULL	delete stored RAND and RES
T3220 (7)	5 s	IMSI DETACH	release from RM-sublayer	enter Null or Idle, ATTEMPTING TO UPDATE
T3230 (5)	15 s	-CM SERV REQ -CM REEST REQ	-Cipher mode setting -CM SERV REJ -CM SERV ACC	provide release ind
T3240 (9,10)	10s	Note	Note	abort RR connection
T3241 (25)	300 s	Note	Note	abort RR connection

Note: Timer T3240 is started in the mobile station when:

-the mobile station receives a LOCATION UPDATING ACCEPT message completing a location updating procedure

-the mobile station receives a LOCATION UPDATING REJECT
-the mobile station has sent a CM SERVICE ABORT
-the mobile station has released or aborted all MM connections

Timer T3240 is stopped, reset, and started again at receipt of an MM message.

Timer T3240 is stopped and reset (but not started) at receipt of a CM message that initiates establishment of an CM connection (an appropriate SETUP, REGISTER, or CP-DATA) message.

Timer T3241 is started in the mobile station when entering MM state RR CONNECTION RELEASE NOT ALLOWED.
Timer T3241 is stopped and reset (but not started) when the MM state RR CONNECTION RELEASE NOT ALLOWED is left.
If timer T3241 expires, the MS shall abort the RR connection and enter the MM state MM IDLE.

Note1: When the T3212 time-out value is set to the non-zero value P and the last timeslot of the message block containing a CHANNEL RELEASE message is transmitted at time T then, assuming the next event shall be the periodic location update, the next CHANNEL REQUEST message shall be transmitted between time T + P decihours - 15 seconds and time T + P decihours + 15 seconds [3GPP TS 04.13].

Table A5-1. Timer MM mobile station side

Timers on the network side

Timer (st at)	Time-out value	Cause for start	Normal stop	At expiry
T3250 (6)	12 s	TMSI-REAL-CMD or LOC UPD ACC with new TMSI sent	TMSI-REALL-COM received	optionally release RR connection
T3255	**not specified**	LOC UPD ACC sent with"Follow on Proceed"	CM SERVICE REQUEST	release RR connection or use for mobile station terminating call
T3260 (5)	12 s	AUTHENT REQ sent	-AUTHENT RESP received -AUTHENT FAILURE received	optionally release RR connection

Table A5-2. Timer MM network side

Counters

No counters are specified.

A6. CM:CC

The Call Control function for circuit switched traffic is described in [3GPP TS 24.008]. The values are directly derived from this specification. Timers on the mobile station side are represented in Table A6-1 and for the network side in A6-2.

Timers on the mobile side

Timer	Time-out value	State	Cause for start	Normal stop	At first expiry	At second expiry
T303	30 s	Call initiated	CM SER RQ sent	CALL PROC, or REL COMP received	Clear the call	Timer is not restarted
T305	30 s	Disconnect Request	DISC sent	REL or DISC received	REL sent.	Timer is not restarted
T308	30 s	Release request	REL sent	REL COMP or REL received	Retrans. RELEASE restart T308	Call ref. release
T310 (Note)	30 s	Outgoing call Proceeding	CALL PROC received	ALERT,CONN, DISC or PROG rec.	Send DISC	Timer is not restarted
T313	30 s	Connect Request	CONN sent	CONNect ACK received	Send DISC	Timer is not restarted
T323	30 s	Modify Request	MOD sent	MOD COMP or MOD REJ received	Clear the call	Timer is not restarted
T332	30 s	Wait for network info	START_CC sent	CC-EST. received	Clear the call	Timer is not restarted
T335	30 s	CC-Est. Confirmed	CC-EST CONF.sent	RECALL received	Clear the call	Timer is not restarted
T336	10 s		START DTMF sent	START DTMF ACK or START DTMF REJECT received	The MS considers the DTMF Procedure (for the digit) to be terminated	Timer is not restarted
T337	10 s		STOP DTMF sent	STOP DTMF ACK received	The MS considers the DTMF procedure (for the current digit) to be terminated	Timer is not restarted

Note: T310 is not started if progress indicator #1, #2, or #64 has been delivered in the CALL PROCEDING message or in a previous PROGRESS message.

Table A6-1. Timer CM:CC mobile station side

Timers on the network side

Timer	Time-out value	State	Cause for start	Normal stop	At first expiry	At second expiry
T301 (Note1)	Min 180 s	Call received	ALERT received	CONN received	Clear the call	Timer is not restarted
T303	**Network dependend**	Call present	SETUP sent	CALL CONF or REL COMP received	Clear the call	Timer is not restarted
T305	30 s	Disconnect Indication	DISC without progress indic. #8 sent or CCBS Possible	REL or DISC received	Network sends RELEASE	Timer is not restarted
T306	30 s	Disconnect Indication	DISC with progress indic. #8 sent but no CCBS possible	REL or DISC received	Stop the tone/ announc. Send REL	Timer is not restarted

T308	**Network dependend**	Release request	REL sent	REL COMP or REL received	Retrans. RELEASE restart T308	Release call reference
T310	**Network dependend**	Incoming call proceeding	CALL CONF received	ALERT, CONN or DISC received	Clear the call	Timer is not restarted
T313	**Network dependend**	Connect Indication	CON sent	CON ACK received	Clear the call	Timer is not restarted
T323	30 s	Modify request	MOD sent	MOD COMP or MOD REJ received	Clear the call	Timer is not restarted
T331	**Network dependend**	CC Connec. Pending	CM-SERV PROMPT sent	START CC received	Clear the call	Timer is not restarted
T333	**Network dependend**	CC-Est. Present	START CC received	CC-EST.CONF or REL COMP received	Clear the call	Timer is not restarted
T334 (Note2)	Min 15 s	CC-Est. Confirmed	RECALL sent	SETUP received	Clear the call	Timer is not restarted
T338	**Network dependend**	Disconnect indication	DISC with CCBS possible	REL or DISC received	stop any tone/ announc. Send REL	Timer is not restarted

Note1: The network may already have applied an internal supervision function; e.g. incorporated within call control. If such a function is known to be operating on the cell, then timer T301 is not used.

Note2: When applied to the supplementary service CCBS, the timer T334 can either represent the recall timer T4 or the notification timer T10. Thus the timer T334 can take two different values as defined in [3GPP TS 23.093].

Table A6-2. Timer CM:CC network side

Counters

No counters are specified.

A7. CM:SMS

The Point to Point Short Message Service (PtP SMS) is described in [3GPP TS 04.11] and the SMS Cell Broadcast (SMSCB) in [3GPP TS 04.12]. For SMSCB no timers are specified, while timers for PtP SMS are represented in Table A7-1. The values are directly derived from this specification.

Timer	Time-out value	Decription
TC1*	May vary with the length of the CP-DATA msg	Circuit switched GSM: MM-connection released when expired GPRS: error indication sent when expired
TR1M	35-45 s	Wait for RP-Ack
TR1N	**Not specified**	Wait for RP-Ack
TRAM	25-35 s	Wait for RETRANS Timer
TR2M	12-20 s	
TR2N	**Not specified**	Wait to send RP-Ack
TR1*	**Not specified**	Set when RP-DATA msg is sent

Table A7-1. Timer CM:SMS

No counters are defined. Retransmission for certain commands is specified, but will not be stated here due to the large time-out value of the timers. For further information about retransmission see [3GPP TS 04.11].

A8. CM:SS

The Supplementary Services are described in [3GPP TS 04.10]. **No timers** are specified for this service.

A9. RLP

The Radio Link Protocol is described in [3GPP TS 04.22]. The timers and counters for circuit-switched non-transparent data are represented in Table A9-1. The values are directly derived from this specification.

Timer	Range of values	Default values	Decription
T1 (Note)	> 420 ms (version2) > 380 ms > 440 ms > 600 ms	**520 ms (fullrate on 14.5, 29.0 or 43.5 kbit/s)** **480 ms (fullrate on 12 kbit/s)** 540 ms (fullrate on 6 kbit/s) 780 ms (halfrate)	Timer T1 be greater than the maximum time between transmission of frames and their acknowledgment. T1 = Acknowledgement Timer
N2	> 0	**6**	The value of the maximum number of retransmissions of a frame following the running out **of Timer T1** is a system parameter agreed for a period of time. N2 = Retransmission attempts
T2 (Note)		**< 80 ms (fullrate on 14.5, 29.0 or 43.5 kbit/s)** **< 80 ms (fulrate on 12 kbit/s)** **< 80 ms (fullrate on 6 kbit/s)** **< 80 ms (halfrate)**	T2 is a system parameter, which is less than T1. T2 = Reply delay
T4 (Note)	> 25 ms	**30 ms** **50 ms (fullrate on 14.5, 29.0 or 43.5 kbit/s)**	Guards the re-sequencing period when multi-link version frames may be received out of sequence due to different transmission delays. T4 = Re-sequencing timer

Note: The timer values shall fulfil the formula:

T1 > T2 + T4 + (2 * transmission delay) for multi-link operation

T1 > T2 + (2 * transmission delay) for single link operation

Table A9-1. Timer and counters RLP

Appendix B – GPRS Timer

B1. RLC/MAC

The RLC and MAC protocol for GPRS is described in [3GPP TS 04.60]. The timers on the mobile side are represented in Table B1-1 and for the network side in Table B1-2. The values are directly derived from this specification.

For each timer, it is shown whether one timer instance is needed per MS, per Temporary Block Flow (TBF) or per RLC/MAC control message.

<u>Timers on mobile station side</u>

Timer	Time-out value	Cause for start	Normal stop	At expiry
T3158 per MS	Defined by the parameter or by a random value See [3GPP TS 05.08]	Started when ordered by a NETWORK_CONTROL_ORDER and then restarted each time a Network Controlled (NC) Measurement is performed in MM Ready state and in packet idle or packet transfer mode in *A/Gb mode* and in RRC-Cell_Shared state and MAC-Idle or MAC-Shared state in *Iu mode*.	See [3GPP TS 05.08]	Restart the timer, perform the measurement and send a NC Measurement report. The timer shall be restarted with either of the parameters NC_REPORTING_PERIOD_I when in packet idle mode or MAC-Idle state or with the parameter NC_REPORTING_PERIOD_T when in packet transfer mode or MAC-Shared state
T3162 per MS	5 s	PACKET QUEUING NOTIFICATION received	PACKET UPLINK ASSIGN received	Abort Packet access procedure; indicate Packet access failure to upper layers and Return to packet idle mode or MAC-Idle state listening to its paging subchannel
T3164 per TBF	5 s	PACKET UPLINK ASSIGN Or MULTIPLE TBF UPLINK ASSIGN msg received. A separate instance of T3164 is started for each TBF for which resources were assigned. (Note2)	First RLC/MAC block send.	See [3GPP TS 04.60] sub-clause 7.1.4. (A/Gb mode) or [3GPP TS 44.160] sub-clause 7.2.5 (Iu mode)
T3166 per MS	5 s	First RLC/MAC block at one phase access send.	PACKET UPLINK ACK/NACK received.	Immediately stop transmitting on the assigned TBF; a TBF establishment failure has occurred or the contention resolution procedures has failed
T3168 per TBF	Set to 2 times the value of T3168 sent as part of system broadcast information if the total number of TBFs requested is greater than 1. Otherwise, it shall be set to the value of T3168 sent as part of system	At sending the PACKET RESOURCE REQ msg, (Extended) Channel Request Description IE in PACKET DOWNLINK ACK/NACK or the PACKET CONTROL ACKNOWLED msg requesting new TBF. A separate instance of T3168 is started for each TBF for which resources were requested. (Note2)	On receipt of a PACKET UPLINK ASSIGN message Or MULTIPLE TBF UPLINK ASSIGN, PACKET TIMESLOT RECONFIG or a MULTIPLE TBF TIMESLOT RECONFIG msg that assigns resources to an uplink TBF for which T3168 is running On receipt of a PACKET ACCESS REJ msg that rejects one or more uplink TBFs for which T3168 is running. (Note2)	Reinitiate the packet access procedure or retransmit the PACKET RESOURCE REQ or PACKET DOWNLINK ACK/NACK for the TBFs that have not been assigned resources.

	broadcast information.			
T3170 per MS	Defined by parameters TX_INT and S	After having made M + 1 attempts to send a PACKET CHANNEL REQ or EGPRS PACKET CHANNEL REQ msg, or on receipt of a PACKET ACCESS REJ msg.	On receipt of a PACKET UPLINK ASSIGN or PACKET QUEUING NOTIFICATION msg	Abort Packet access procedure; indicate a packet access failure to upper layer and return to packet idle mode or MAC-Idle state (Note2).
T3172 per TBF	assigned in message	On receipt of a PACKET ACCESS REJ msg. An instance of T3172 is started for each of the TBFs that have been rejected (Note2).	On receipt of a PACKET UPLINK ASSIGN msg or MULTIPLE TBF UPLINK ASSIGN that assigns resources to the TBF for which T3172 is running (Note2).	Packet Access in the cell no longer prohibited
T3174 per MS	15 s	On receipt of a PACKET CELL CHANGE ORDER msg	On receipt of a response to CHANNEL REQUEST or PACKET CHANNEL REQUEST in the new cell. (Note 1) On the successful completion or the occurrence of an abnormal condition in the network controlled cell reselection procedure (Note 2)	Return to old cell, and send PACKET CELL CHANGE FAILURE Perform cell update (or other GMM specific procedure) (Note2).
T3176 per MS	5 s (Note1) 15 s (Note2)	Expiry of T3174 or other abnormal condition in the network controlled cell reselection procedure. (Note2)	After sending of PACKET CELL CHANGE FAILURE msg	Stop cell change order failure procedure. (Note1) Stop handling of abnormal condition in the network controlled cell reselection procedure. (Note2)
T3178 per MS	Defined by the parameter or by a Random value See[3GPP TS 05 .08]	Started when ordered by a EXT_MEASUREMENT_O RDER and then restarted each time an extended (EXT) Measurement is performed in packet idle mode or MAC-Idle state (Note2)	See [3GPP TS 05.08]	Restart the timer, perform the measurement and send an EXT Measurement report. The timer shall be restarted with the parameter EXT_REPORTING_PERIOD
T3180 per TBF	5 s	When transmitting an RLC/MAC block to the network. An instance of T3180 is started for the TBF for which the block was intended. (Note2)	When detecting an assigned USF value on assigned PDCH	Abnormal release with access retry may be performed under certain conditions (Note2)
T3182 per TBF	5 s	After sending the last data block (with CV = 0), or Upon detecting a transmit window stall condition An instance of T3182 is started for the TBF for which the condition has occurred. (Note2)	On receipt of the PACKET UPLINK ACK/NACK msg	Abnormal release with access retry may be performed under certain conditions (Note2)

T3184 per TBF	5 s	On receipt of a PACKET UPLINK ACK/N ACK msg (in exclusive allocation) (Note2)	On receipt of PACKET UPLINK ACK/NACK msg (T3184 is also restarted)	Abnormal release with access retry may be performed under certain conditions. See [3GPP TS 44.060] sub-clause 8.1.1.3a.2 (Note2)
T3186 per MS	5 s	When packet access procedure is started	Stopped when receiving any msg from the network in response to the PACKET CHANNEL REQ msg or after M+1 attempts to send PACKET CHANNEL REQ msg on the PRACH channel	Abort Packet access procedure; indicate Packet access failure to upper layers and return to Packet Idle mode or MAC-Idle state. (Note2)
T3188	5 s (Note1) Set to the value of T3168 included as part of system broadcast information. (Note2)	If a new fixed allocation has been requested, when all data has been sent on the assigned allocation. (Note1) When a ms that supports multiple TBF procedures requests two or more uplink TBFs in a Packet Resource Request msg during a two-phase access. (Note2)	On receipt of PACKET UPLINK ASSIGNMENT, PACKET UPLINK ACK/NACK msg containing a fixed allocation, or PACKET ACCESS REJECT (Note1) When a ms that supports multiple TBF procedures receives a MULTIPLE TBF UPLINK ASSIGNMENT msg. (Note2)	Abnormal release with access retry (Note1) A ms that supports multiple TBF procedures considers its' two-phase access to have failed. (Note2)
T3190 per TBF	5 s	At reception of a downlink assignment msg. An instance of T3190 is started for each TBF that has been assigned resources. (Note2)	Restarted on receipt of data on the resources (Note1) TBF (Note2)	Abnormal release without retry may be performed under certain conditions See further [3GPP TS 44.060] sub-clauses 8.1.2.1 and 8.1.2.4 (Note2)
T3192 per TBF	assigned in system information	At sending the PACKET DOWNLINK AC K/NACK with the Final Ack Indicator=1, or at sending the PACKET CONTROL ACK as a response to final RLC data block in unacknowledged mode.	Restarted at sending the PACKET DOWNLINK ACK/NA CK with the Final Ack Indicator=1, or at sending the PACKET CONTROL ACK as a response to final RLC data block in unacknowledged mode. Stopped at the reception of a PACKET DOWNLINK ASSIG, PACKET TIMESLOT RECONFIGURE or MULTIPLE TBF DOWNLINK ASSIGN or MULTIPLE TBF TIMESLOT RECONFIG msg that assigns resources to the TBF for which T3192 was started. (Note2)	Release the resources, stop monitoring the PDCHs, and begin to monitor the paging channel If there are no other ongoing TBFs. See [3GPP TS 44.060] sub-clauses 9.3.2.6 and 9.3.3.5 (Note2)
T3194 per TBF (Note2)	200 ms	At the sending of a RLC data block on a radio block that has been stolen (i.e. intended for a different radio bearer). See 3GPP TS 44.160	On receipt of the USF for the radio bearer for which the radio block was stolen.	Restart the timer unless it has expired four times, in which case a link failure is reported to the RRC layer.
T3200 (Note1)	See [3GPP TS 04.60] sub-clause 9.1.11b	On receipt of an RLC/MAC control block containing a segment of an RLC/MAC control msg	On receipt of an RLC/MAC control block containing a segment of an RLC/MAC control msg such that the ms now has the complete control msg	Discard and ignore all segments of the partially received RLC/MAC control msg.
T3200 per RLC /MAC control msg (Note2)	See further [3GPP TS 44.060] sub-clause 9.1.11b	On receipt of an RLC/MAC control block containing a segment of an RLC/MAC control msg	On receipt of an RLC/MAC control block containing a segment of an RLC/MAC control msg such that the ms now has the complete control msg	Discard and ignore all segments of the partially received RLC/MAC control msg

T3204 (Note1)	1 s	The first attempt to send a PACKET CHANNEL REQ during a packet access procedure. The PACKET CHANNEL REQ was attempted indicating 'Single block without TBF establishment' and the purpose of the packet access procedure is to send a PACKET PAUSE msg	Upon receipt of a PACKET UPLINK ASSIGNMENT	The packet pause procedure (see [3GPP TS 04.60] sub-clause 7.6) is aborted
T3204 per MS (Note2)	1 s	The first attempt to send a PACKET CHANNEL REQ during a packet access procedure. The PACKET CHANNEL REQ was attempted indicating 'Single block without TBF establishment' and the purpose of the packet access procedure is to send a PACKET PAUSE msg.	Upon receipt of a PACKET UPLINK ASSIGN.	The packet pause procedure is aborted (A/Gb mode only).
T3206 per MS (Note2)	400 ms	When entering CCN mode	When the PACKET CELL CHANGE NOTIFICATION msg is transmitted or when CCN is no longer enabled.	Leave CCN mode and continue according to current NC mode
T3208 per MS (Note2)	0,96 s	When the PACKET CELL CHANGE NOTIFICATION msg is transmitted for the first time	Upon receipt of a PACKET CELL CHANGE CONTINUE or a PACKET CELL CHANGE ORDER msg or when CCN is no longer enabled..	Leave CCN mode and continue according to current NC mode
T3210 per MS (Note2)	0,3 s	When the PACKET CELL CHANGE NOTIFICATION msg is transmitted for the first time	Upon receipt of a PACKET NEIGHBOUR CELL DATA msg, or a PACKET CELL CHANGE CONTINUE msg or a PACKET CELL CHANGE ORDER msg or when CCN is no longer enabled.	Retransmit the PACKET CELL CHANGE NOTIFICATION msg at the first uplink opportunity.

Note1: Applicable for 3GPP TS 04.60
Note2: Applicable for 3GPP TS 44.060

Table B1-1. Timer RLC/MAC on mobile station side

T3158: Wait for sending measurement reports for network controlled cell reselection.

This timer is used on the mobile station side to define the period for performing NC-measurements and send measurement reports in either packet idle or packet transfer mode

in A/Gb mode and MAC-Idle or MAC-Shared state in Iu mode (Note2)

(see [3GPP TS 05.08]).

T3162: Wait for Packet Uplink Assignment after reception of Packet Queuing Notification

This timer is used on the mobile station side after received Packet Queuing Notification to define when to stop waiting for a Packet Uplink Assignment.

T3164: Wait for Uplink State Flag After Assignment

This timer is used on the mobile station side to define when to stop waiting for the USF determining the assigned portion of the uplink channel and repeat the procedure for random access. In multislot operation, it is enough that the assigned USF is noted on one of the uplink PDCHs.

This timer is not used when fixed allocations are assigned. (Note1)

T3166: Wait for Packet Uplink ACK/NACK after sending of first data block

This timer is used on the mobile station side to define when to stop waiting for a Packet Uplink ACK/NACK after sending of the first data block.

T3168: Wait for PACKET UPLINK ASSIGNMENT msg.

Wait for MULTIPLE TBF UPLINK ASSIGNMENT, PACKET TIMESLOT RECONFIGURE or a MULTIPLE TBF TIMESLOT RECONFIGURE msg. (Note2)

This timer is used on the mobile station side to define when to stop waiting for a PACKET UPLINK ASSIGNMENT,

MULTIPLE TBF UPLINK ASSIGNMENT, PACKET TIMESLOT RECONFIGURE or a MULTIPLE TBF TIMESLOT RECONFIGURE (Note2)

message after sending of a PACKET RESOURCE REQUEST message or a PACKET CONTROL ACKNOWLEDGEMENT message requesting new TBF.

T3170: Wait for PACKET UPLINK ASSIGNMENT message after having done (M+1) Packet Channel Requests or after reception of a PACKET ACCESS REJECT message.

This timer is used on the mobile station side when having made M + 1 attempts to send a PACKET CHANNEL REQUEST message or after reception of a PACKET ACCESS REJECT message. At expiry of timer T3170, the mobile station shall abort the packet access procedure, indicate a packet access failure to upper layer and return to packet idle mode or MAC-Idle state.

The value of this timer is equal to the time taken by T+2S TDMA frames, T and S are defined in [3GPP TS 04.60] sub-clause 7.1.2.1.1.

T3172: Prohibit packet access in the cell after PACKET ACCESS REJECT message has been received.

This timer is used on the mobile station side on receipt of a PACKET ACCESS REJECT message corresponding to one of the mobile station's 3 last PACKET CHANNEL REQUEST messages. If T3172 expires before receiving an assignment message, the mobile station returns to packet idle mode.

or MAC-Idle state. (Note2)

After T3172 expiry packet Access is no longer prohibited in the cell but no Channel Request message shall be sent as a response to a page until a PAGING REQUEST message for the mobile station is received.

T3174: Wait for response on (Note1) / successful packet access in (Note2) new cell after Packet Cell Change Order.

This timer is used on the mobile station side on receipt of a PACKET CELL CHANGE ORDER message. The timer is stopped upon successful completion of packet access in the new cell. On expiry, the mobile station returns to the old cell,

performs cell update (or other GMM specific procedure) (Note2)

and sends PACKET CELL CHANGE FAILURE message.

T3176: Stop Cell Change failure procedure. (Note1)

Sop handling of abnormal condition in the network controlled cell reselection procedure. (Note2)

This timer is started when T3174 expires.

or another abnormal condition occurs in the network controlled cell reselection procedure. (Note2)

The timer is stopped upon transmission of the PACKET CELL CHANGE FAILURE message. On expiry, the mobile station stops

attempting to send the PACKET CELL CHANGE FAILURE message. (Note1) handling of abnormal condition in the network controlled cell reselection procedure. (Note2)

T3178: Wait for sending extended measurement reports.

This timer is used on the mobile station side to define the period for performing extended measurements and send extended measurement reports in packet idle mode

or MAC-Idle state. (Note2)

(see [3GPP TS 05.08])

T3180: Wait for Uplink State Flag After Data Block

This timer is used on the mobile station side to define when to stop waiting for the USF determining the assigned portion of the uplink channel after the pervious RLC/MAC block is sent. In multislot operation, it is enough that the assigned USF is noted on one of the uplink PDCHs. If expired, the mobile station repeats the procedure for random access.

This timer does not apply to fixed allocation transfers. (Note1)

T3182: Wait for Acknowledgement

This timer is used on the mobile station side to define when to stop waiting for temporary Packet Uplink Ack/Nack after the last RLC data block has been sent for the current send window or for the entire Temporary Block Flow.

T3184: No Ack/Nack Received

At fixed allocation, this timer is used on the mobile station side to decide when to stop waiting for a Packet Uplink Ack/Nack. (This timer does not apply to mobiles performing a dynamic allocation transfer). (Note1)

At exclusive allocation, this timer is used to detect a radio link failure condition. If expired, the mobile station performs an abnormal release with access retry.

T3186: Supervision of the random access procedure

This timer is used on the mobile station side to define the maximum allowed time to repeat the sending of all PACKET CHANNEL REQUEST messages. At expiry of timer T3186, the Packet Uplink establishment procedure is aborted.

T3188: (Note1) Allocation Exhausted

This timer is used on the mobile station side to decide when to stop waiting to receive additional resources from the network. (This timer does not apply to a mobile performing a dynamic allocation transfer).

T3188: (Note2) This timer is used by a mobile station that supports multiple TBF procedures to define when to stop waiting for a MULTIPLE TBF UPLINK ASSIGNMENT message after sending a PACKET RESOURCE REQUEST message during a two-phase access that requests two or more uplink TBFs.

T3190: Wait for Valid Downlink Data Received from the Network

This timer is used on the mobile station side to stop waiting for the valid data from the network side either following the initial Packet Downlink Assignment or after some previous downlink RLC data block.

T3192: Wait for release of the TBF after reception of the final block

This timer is used on the mobile station side when the mobile station has received all of the RLC data blocks. When timer T3192 expires the mobile station shall release the resources associated with the TBF (e.g. TFI) and begin to monitor its paging channel.

T3194**:** (Note2) Minimum time between stolen radio blocks for a given radio bearer.

Following stealing a radio block for a given radio bearer, the mobile station shall expect to have this radio bearer scheduled via its USF within an interval defined by four times the duration of T3194, else link failure is reported to RRC.

T3200: RLC/MAC control message reassembly guard

T3200 is used by the mobile station to control when it will discard segments of a partially received RLC/MAC control message. The mobile station shall have one instance of timer T3200 for each segmented RLC/MAC control message that the mobile station is capable of receiving in parallel.

T3204: Wait for Packet Uplink Assignment after the first attempt to send a Packet Channel Request during a packet access procedure. The Packet Channel Request was attempted indicating 'Single block without TBF establishment' and the purpose of the packet access procedure is to send a PACKET PAUSE message.

This timer is used by a mobile station with non-GSM capabilities to stop waiting for a PACKET UPLINK ASSIGNMENT message. At expiry of timer T3204, the Packet Pause procedure ([3GPP TS 04.60] sub-clause 7.6) is aborted.

T3206: (Note2) Wait for sending of the PACKET CELL CHANGE NOTIFICATION message after entering CCN mode

This timer is used to control that the MS in CCN mode is not prevented to proceed with a cell re-selection for too long if it cannot send the PACKET CELL CHANGE NOTIFICATION message (e.g. T3192 is running and there is no uplink block granted to the MS).

T3208: (Note2) Maximum delay of the MS initiated cell re-selection after the point in time when the MS has sent the PACKET CELL CHANGE NOTIFICATION message in CCN mode.

T3208 is used by the mobile station in CCN mode to decide when to stop waiting for network assistance for the cell reselection (see [3GPP TS 44.060] sub-clause 5.5.1.1a).

T3210: (Note2) Wait for retransmitting the PACKET CELL CHANGE NOTIFICATION message after having sent the PACKET CELL CHANGE NOTIFICATION message for the first time (see [3GPP TS 44.060] sub-clause 5.5.1.1a).

This timer is used to request the mobile station to retransmit the PACKET CELL CHANGE NOTIFICATION message in the case it has not received any PACKET NEIGHBOUR CELL DATA message nor PACKET CELL CHANGE CONTINUE message nor PACKET CELL CHANGE ORDER message in response to the sending of the PACKET CELL CHANGE NOTIFICATION message sent for the first time. It can reduce the cell re-selection delay implied by entering CCN mode in case the first PACKET CELL CHANGE NOTIFICATION message was not received by the network.

Timers on network side

Timer	Time-out value	Cause for start	Normal stop	At expiry
T3169 per TBF	5 s	If counter N3101 = N3101_MAX, or if counter N3103 = N3103_MAX An instance of T3169 is started for this TBF (Note2).	None	The network releases USF and TFI resources.
T3191 per TBF	5 s	When the last RLC data block is sent with the FBI bit set to '1' An instance of T3191 is started for this TBF (Note2)	When the final PACKET DOWNLINK ACK/NACK or PACKET CONTROL ACKNOWLEDGEMENT is received Restarted at the transmission of an RLC data block with the FBI bit set to '1'.	The network releases TFI resource.
T3193 per TBF	Greater than T3192	When the final PACKET DOWNLINK ACK/NACK or PACKET CONTROL ACKNOWLEDGEMENT is received An instance of T3193 is started for this TBF (Note2)	Stopped when the network establishes a new downlink TBF using the same TFI value (Note2) Restarted at the reception of the final PACKET DOWNLINK ACK/NACK or PACKET CONTROL ACKNOWLEDGEMENT.	The network releases TFI resource
T3195 per TBF	5 s	If counter N3105 = N3105_MAX An instance of T3195 is started for this TBF (Note2)	None	The network releases TFI resources.

Note1: Applicable for 3GPP TS 04.60
Note2: Applicable for 3GPP TS 44.060

Table B1-2. Timer RLC/MAC on network side

T3169: Wait for Reuse of USF and TFI after the mobile station uplink assignment for this TBF is invalid

This timer is used on the network side to define when the current uplink assignment for this TBF is surely invalid on the mobile station side so that the assigned USF(s) and TFI can be reused on the uplink. During that period the corresponding USF(s) is not broadcast.

Its value is network dependent. The value of T3169 should be greater than T3180, T3182 and (for exclusive allocation) T3184.

T3191: Wait for reuse of TFI after sending of the last RLC Data Block on this TBF

This timer is used on the network side to define when the current assignment for this TBF is surely invalid on the mobile station side so that the TFI can be reused.

Its value is network dependent.

T3193: Wait for reuse of TFI after reception of the final PACKET DOWNLINK ACK/NACK from the mobile station for this TBF.

This timer is used on the network side to define when timer T3192 on the mobile station side has surely expired so that the TFI can be reused.

Its value is network dependent.

T3195: Wait for reuse of TFI when there is no response from the MS (radio failure or cell change) for this TBF.

This timer is used on the network side to define when the current assignment for this TBF is surely invalid on the mobile station side so that the TFI can be reused.

Its value is network dependent.

Counters on mobile side

N3102: At each cell reselection the mobile station shall set the counter N3102 to the value defined by the optional broadcast parameter PAN_MAX. Whenever the mobile station receives a Packet Ack/Nack that allows the advancement of V(S), the mobile station shall increment N3102 by the broadcast value PAN_INC, however N3102 shall never exceed the value PAN_MAX. Each time T3182 expires the mobile station shall decrement N3102 by the broadcast value PAN_DEC. When N3102 ≤ 0 is reached, the mobile station shall perform an abnormal release with cell re-selection.

N3104: When the mobile station sends the first RLC/MAC block the counter N3104 shall be initialized to 1. For each new RLC/MAC block the mobile station sends it shall increment N3104 by 1 until the first correct PACKET UPLINK ACK/NACK message is received. Then N3104 shall not be further incremented. If the N3104 counter is equal to N3104_MAX and no correct PACKET UPLINK ACK/NACK message has been received, the contention resolution fails.

N3104_MAX shall have the value:
N3104_MAX = 3 * (BS_CV_MAX + 3) * number of uplink timeslots assigned.

N3106: Applicable for [3GPP TS 44.060] only.

N3106 is used in *Iu mode* on the mobile station side to detect link failures that may occur for a given uplink RLC entity and shall be reported to the RRC layer. It is incremented each time a response to a given request is not received before a specified response time. It is reset upon reception of a response within the response time requirements. If the counter N3106 is equal to N3106max, a link failure has occurred that shall be reported to the RRC layer. There is one N3106 instance per uplink RLC entity in TCH or DCCH TBF mode.

N3106max shall have the value: 5.

Counters on network side

N3101: When the network after setting USF, receives a valid data block from the mobile station in a block assigned for this USF, it will reset counter N3101. The network will increment counter N3101 for each USF for which no data is received. N3101max shall be greater than 8.

If N3101 = N3101max, the network shall stop the scheduling of RLC/MAC blocks from the mobile station for this USF and start timer T3169 (Applicable for [3GPP TS 44.060] only).

N3103: N3103 is reset when transmitting the final PACKET UPLINK ACK/NACK message within a TBF (final ack indicator set to 1). If the network does not receive the PACKET CONTROL ACKNOWLEDGEMENT message in the scheduled block for this TBF, it shall increment counter N3103 and retransmit the PACKET UPLINK ACK/NACK message. If counter N3103 exceeds its limit, the network shall start timer T3169.

N3105: When the network after sending a RRBP field in the downlink RLC data block

or in *Iu mode* also RLC/MAC control block (Applicable for [3GPP TS 44.060] only),

receives a valid RLC/MAC control message from the mobile station, it will reset counter N3105. The network will increment counter N3105 for each allocated data block for which no RLC/MAC control message is received for this TBF. The value of N3105max is network dependent.

N3107: Applicable for [3GPP TS 44.060] only:

N3107 is used in *Iu mode* on the network side to detect link failures that may occur for a given RLC entity and that shall be reported to the RRC layer. It is incremented each time a response to a given request is not received before a specified response time. It is reset upon reception of a response within the response time requirements. If the counter N3107 is equal to N3107max, a link failure has occurred that shall be reported to the RRC layer. There is one N3107 instance per downlink RLC entity in TCH or DCCH TBF mode. The value of N3107max is network dependent.

B2. LLC

The LLC protocol for GPRS is described in [3GPP TS 04.64]. The timers and counters are represented in Table B2-1. The values are directly derived from this specification.

LLC Parameter	SAPI 1 GMM	SAPI 2 TOM 2	SAPI 3 User Data 3	SAPI 5 User Data 5	SAPI 7 SMS	SAPI 8 TOM 8	SAPI 9 User Data 9	SAPI 11 User Data 11
T200 and T201 (Note1)	5 s	5 s	5 s	10 s	20 s	20 s	20 s	40 s
N200	3	3	3	3	3	3	3	3
N201-U	400	270	500	500	270	270	500	500
N201-I	(Note2)	(Note2)	(Note2)	(Note2)	(Note2)	(Note2)	1 503	1 503

Note1: The value of timer T200 shall be used when setting timer T201.
Note2: This parameter applies to ABM procedures. ABM operation is not allowed for GMM, SMS, and TOM that use only UI frames for information transfer.

Table B2-1. Timer and counters LLC

N200: The maximum number of retransmissions of a frame.

N201: The maximum number of octets in the information field of the frame. The minimum value shall be 140 octets, and the maximum value shall be 1 520 octets. The value may be different for I frames and U and UI frames. N201-U is used for U and UI frames, and N201-I is used for I frames.

N202: The maximum number of octets in the layer-3 unitdata PDU header. The value shall be 4 for LLC version number 0.

B3. SNDCP

The SNDCP protocol for GPRS is described in [3GPP TS 04.65]. **No timers** are specified.

B4. IP/X.25

IP and X.25 are protocols not part of GSM and therefore not specified within those specifications. IP is a connectionless Internet protocol, and therefore unreliable, standardised in RFC 791. X.25 is a connection-oriented protocol, and therefore reliable, standardised by CCITT. **No timers** specified within the GSM recommendations.

B5. GMM

The GPRS Mobility Management is described in [3GPP TS 24.008]. The values are directly derived from this specification. Timers on the mobile station side are represented in Table B5-1 and B5-2, and for the network side in B5-3 and B5-4.

Timers on the mobile side

Timer	Time-out value	State	Cause for start	Normal stop	Before 5ft expiry (Note)
T3310	15 s	GMM-REG-INIT	ATTACH REQ sent	-ATTACH ACC received -ATTACH REJ received	retransmission of ATTACH REQ
T3311	15 s	GMM-DEREG ATTEMPTING TO ATTACH or GMM-REG ATTEMPTING TO UPDATE	-ATTACH REJ with other cause values -ROUTING AREA UPDATE REJ with other cause values	change of the routing area	-restart of Attach or -RAU procedure with updating of the relevant attempt counter
T3316	30 s	GMM-REG-INIT GMM-REG GMM-DEREG-INIT GMM-RA-UPDATING-INT GMM-SERV-REQ-INIT (Iu mode only)	RAND and RES stored as a result of a UMTS authentication challenge	Security mode setting (Iu mode only) SERVICE ACC received (Iu mode only) SERVICE REJ received (Iu mode only) ROUTING AREA UPDATE ACC received AUTHENTICATION AND CIPHERING REJ received AUTHENTICATION_AND_CIPHERING FAILURE sent Enter GMM-DEREG or GMM-NULL	delete stored RAND and RES
T3318	20 s	GMM-REG-INIT GMM-REG GMM-DEREG-INIT GMM-RA-UPDATING-INT GMM-SERV-REQ-INIT (UMTS only)	AUTHENTICATION & CIPHERING FAILURE (cause='MAC failure' or 'GSM authentication unacceptable') sent	AUTHENTICATION & CIPHERING REQUEST received	on first expiry, mobile station should consider network as false
T3320	15 s	GMM-REG-INIT GMM-REG GMM-DEREG-INIT GMM-RA-UPDATING-INT GMM-SERV-REQ-INIT (UMTS only)	AUTHENTICATION & CIPHERING FAILURE (cause=synch failure) sent	AUTHENTICATION & CIPHERING REQ received	on first expiry, mobile station should consider network as false
T3321	15 s	GMM-DEREG-INIT	DETACH REQ sent	DETACH ACC received	retransmission of DETACH REQ
T3330	15 s	GMM-ROUTING-UPDATING-INITIATED	ROUTING AREA UPDATE REQ sent	-ROUTING AREA UPDATE ACC received -ROUTING AREA UPDATE REJ received	retransmission of ROUTING AREA UPDATE REQ

Note: Typically, the procedures are aborted on the fifth expiry of the relevant timer.

Table B5-1. Timer GMM mobile station side

Timer	Time-out value	State	Cause for start	Normal stop	On expiry
T3302	Default 12 min (Note1)	-GMM-DEREG or -GMM-REG	-at attach failure and the attempt counter is greater than or equal to 5 -at routing area updating failure and the attempt counter is greater than or equal to 5	-at successful attach -at successful routing area updating	On every expiry, initiation of the GPRS attach procedure or RAU procedure
T3312	Default 54 min (Note1)	GMM-REG	In GSM, when READY state is left. In UMTS, when PMM-CONNECTED mode is left.	when entering state GMM-DEREG	Initiation of the Periodic RAU procedure
T3314 READY (GSM only)	Default 44 s (Note2)	all except GMM-DEREG	Transmission of a PTP PDU	forced to Standby	no cell-updates are performed
T3317 (UMTS only)	10 s	GMM-SERVICE-REQUEST-INITIATED	SERVICE REQ sent	security mode control procedure is completed, SERVICE ACCEPT received, or SERVICE REJECT received	abort the procedure

Note 1: The value of this timer is used if the network does not indicate another value in a GMM signalling procedure.
Note 2: The default value of this timer is used if neither the mobile station nor the Network sent another value, or if the Network sends this value, in a signalling procedure.

Table B5-2. Timer GMM mobile station side

Timers on the network side

Timer	Time-out value	State	Cause for start	Normal stop	Before 5ft expiry (Note)
T3322	6 s	GMM-DEREG-INIT	DETACH REQ sent	DETACH ACC received	retransmission of DETACH REQ
T3350	6 s	GMM-COMMON-PROC-INIT	-ATTACH ACCEPT sent with P-TMSI and/or TMSI -RAU ACCEPT sent with P-TMSI and/or TMSI P-TMSI REALLOC COMMAND sent	ATTACH COMPLETE received RAU COMPLETE received P-TMSI REALLOC COMPLETE received	Retransmission of the same message type, i.e. ATTACH ACCEPT, RAU ACCEPT or REALLOC COMMAND
T3360	6 s	GMM- COMMON-PROC-INIT	AUTH AND CIPH REQUEST sent	AUTH AND CIPH RESPONSE received AUTHENT-AND CIPHER-FAILURE received	Retransmission of AUTH AND CIPH REQUEST
T3370	6 s	GMM-COMMON-PROC-INIT	IDENTITY REQUEST sent	IDENTITY RESPONSE received	Retransmission of IDENTITY REQUEST

Note: Typically, the procedures are aborted on the fifth expiry of the relevant timer.

Table B5-3. Timer GMM network side

Timer	Time-out value	State	Cause for start	Normal stop	On expiry
T3313	**Network dependend**	GMM_REG	Paging procedure initiated	Paging procedure completed	Network dependent
T3314 READY (GSM only)	Default 44 s (Note)	All except GMM-DEREG	Receipt of a PTP PDU	Forced to Standby	The network shall page the MS if a PTP PDU has to be sent to the MS
Mobile Reachable	Default 4 min greater than T3312	All except GMM-DEREG	In GSM, change from READY to STANDBY state In UMTS, change from PMM-CONNECTED mode to PMM-IDLE mode.	PTP PDU received	Network dependent but typically paging is halted on 1st expiry

Note: The default value of this timer is used if neither the mobile station nor the Network sent another value, or if the Network sends this value, in a signalling procedure. The value of this timer should be slightly shorter in the network than in the mobile station.

Table B5-4. Timer GMM network side

Counters

No counters are specified.

B6. SM

The Session Management for GPRS is described in [3GPP TS 24.008]. The values are directly derived from this specification. Timers on the mobile station side are represented in Table B6-1 and for the network side in B6-2.

Timers on the mobile side

Timer	Time-out value	State	Cause for start	Normal stop	Before 5ft expiry (Note)
T3380	30 s	PDP-ACTIVE-PEND	ACTIVATE PDP CONTEXT REQUEST or ACTIVATE SECONDARY PDP CONTEXT REQUEST sent	ACTIVATE PDP CONTEXT ACCEPT or ACTIVATE SECONDARY PDP CONTEXT ACCEPT received ACTIVATE PDP CONTEXT REJECT or ACTIVATE SECONDARY PDP CONTEXT REJECT received	Retransmission of ACTIVATE PDP CONTEXT REQ or ACTIVATE SECONDARY PDP CONTEXT REQUEST
T3381	8 s	PDP-MODIFY-PENDING	MODIFY PDP CONTEXT REQUEST sent	MODIFY PDP CONTEXT ACCEPT received	Retransmission of MODIFY PDP CONTEXT REQUEST
T3390	8 s	PDP-INACT-PEND	DEACTIVATE PDP CONTEXT REQUEST sent	DEACTIVATE PDP CONTEXT ACC received	Retransmission of DEACTIVATE PDP CONTEXT REQUEST

Note: Typically, the procedures are aborted on the fifth expiry of the relevant timer.

Table B6-1. Timer SM mobile station side

Timers on the network side

Timer	Time-out value	State	Cause for start	Normal stop	Before 5ft expiry (Note)
T3385	8 s	PDP-ACT-PEND	REQUEST PDP CONTEXT ACTIVATION sent	ACTIVATE PDP CONTEXT REQ received	Retransmission of REQUEST PDP CONTEXT ACTIVATION
T3386	8 s	PDP-MOD-PEND	MODIFY PDP CONTEXT REQUEST sent	MODIFY PDP CONTEXT ACC received	Retransmission of MODIFY PDP CONTEXT REQ
T3395	8 s	PDP-INACT-PEND	DEACTIVATE PDP CONTEXT REQUEST sent	DEACTIVATE PDP CONTEXT ACC received	Retransmission of DEACTIVATE PDP CONTEXT REQ

Note: Typically, the procedures are aborted on the fifth expiry of the relevant timer.

Table B6-2. Timer SM network side

Counters

No counters are specified.

Appendix C – Round Trip Delay

C1. System delay distribution circuit-switched traffic

The transmission characteristics for a PLMN are described in [3GPP TS 03.05].
Note that the delay objectives are recommendations only in order to obtain speech and data transmission quality. All figures, delay values and statements are directly derived from this specification.

The allocated delay allowances are represented as either system dependent or implementation dependent. System dependent values cannot be changed, because the represent worst-case delays while implementation dependent means that the values are dependent on the technology used, and that the values allocated have been fixed as upper bounds. All figures for the delay budgets are for guidance only.

Speech channel round-trip delay

According to the specification, the round-trip delay for a speech channel should not overcome **180 ms** between the mobile station and the PSTN/ISDN connection point. The reason for this limit is to avoid affects of echo and simultaneous speech in both directions.

Note: All values in the following figures are in ms.

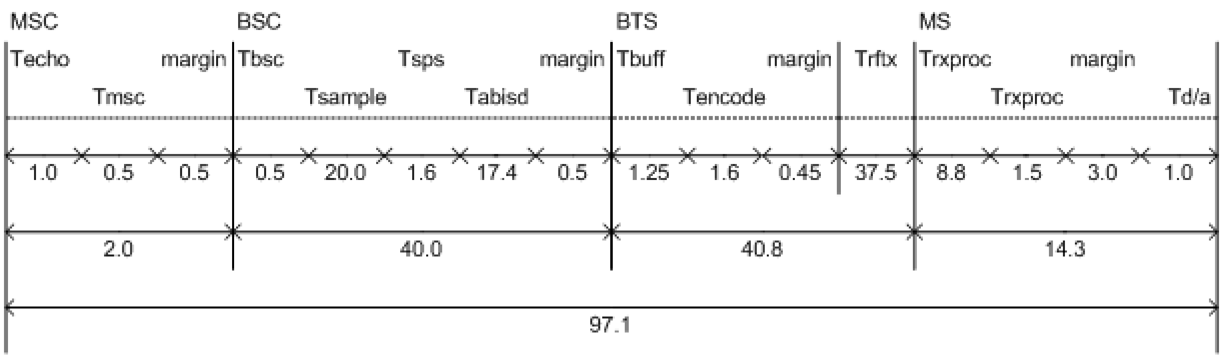

Figure C1-1. Downlink delay distribution for full rate speech (16Kbit/s Abis)

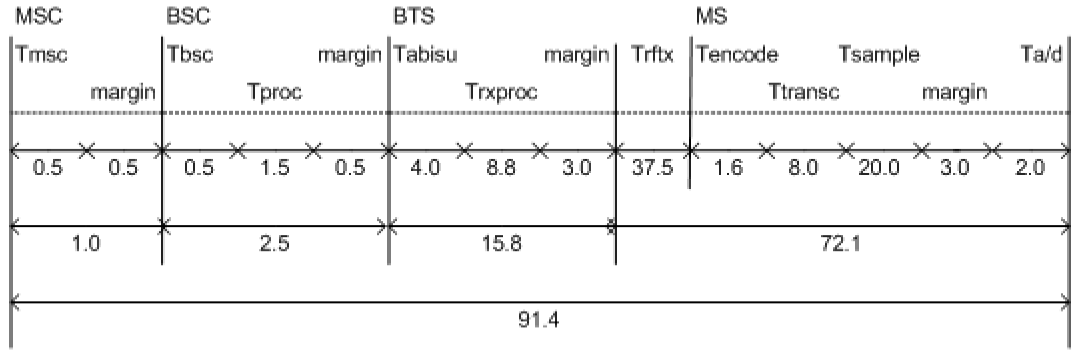

Figure C1-2. Uplink delay distribution for full rate speech (16 Kbit/s Abis)

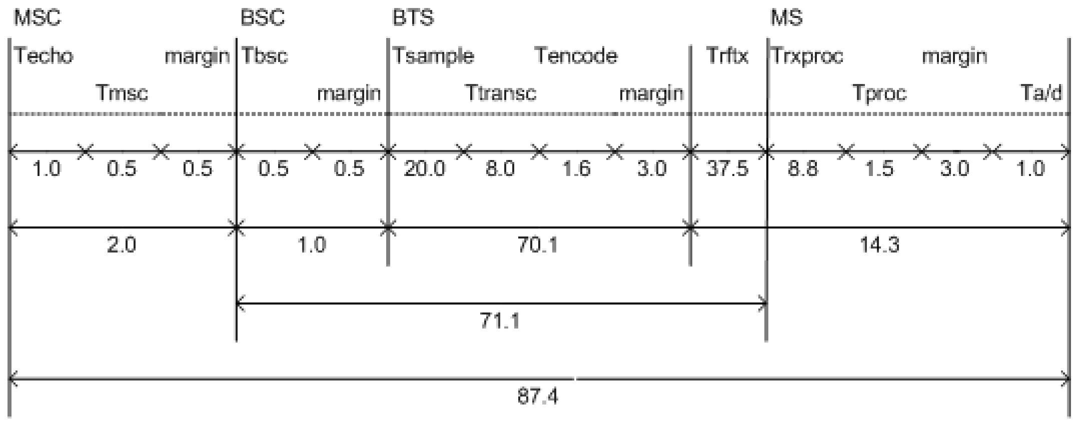

Figure C1-3. Downlink delay distribution for full rate speech (64 Kbit/s Abis)

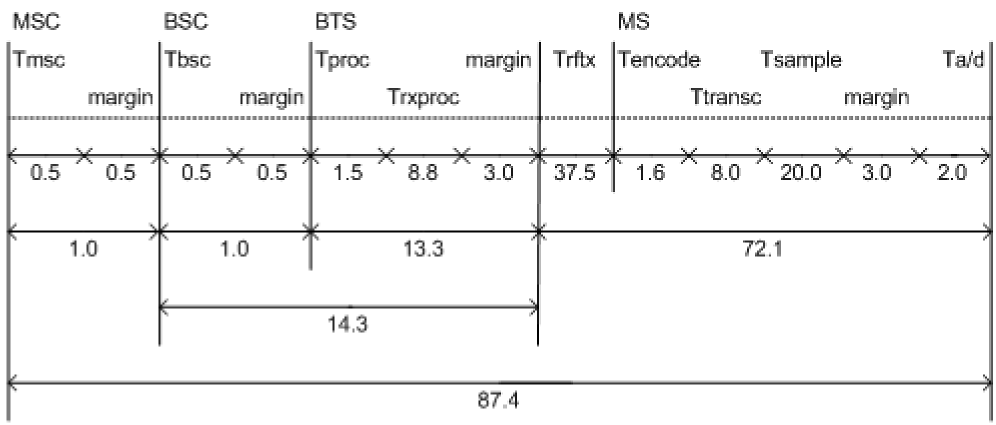

Figure C1-4. Uplink delay distribution for full rate speech (64 Kbit/s Abis)

BSS internal delay values (indicative):

Tsample: The duration of the segment of PCM speech operated on by the full-rate speech transcoder (system dependent).

Trftx: The time required for transmission of a traffic channel radio interface frame over the air interface due to the interleaving and de-interleaving (given in Table A1-2) (system dependent).

Tabisu: The time required to transmit the first 56 speech frame data bits (bits C12-C15, D1-D56 and 4 synchronization bits - 64 bits) over the 16 kbit/s Abis interface in the uplink direction (system dependent).

Tabisd: The time required to transmit the 260 speech frame data bits (bits D1-D260, C16 and 17 synchronization bits - 278 bits) over the 16 kbit/s Abis interface in the downlink direction (system dependent).

Tbuff: Due to the time alignment procedure for inbound control of the remote transcoder in case of a 16 kbit/s A-bis-interface in the downlink direction, it is required to have a buffer in the BTS of 1 ms + one 250 us regulation step (system dependent).

Tbsc: Switching delay in the BSC (implementation dependent).

Ttransc: The speech encoder processing time, from input of the last PCM sample to output of the final encoded bit (implementation dependent).

Tsps: Delay of the speech encoder after reception of the last PCM sample until availability of the first encoded bit (implementation dependent).

Tencode: The time required for the channel encoder to perform channel encoding (implementation dependent).

Trxproc: The time required after reception over the radio interface to perform equalization, channel decoding and SID-frame detection (implementation dependent).

Tproc: The time required after reception of the first RPE-sample to process the speech encoded data for the full-rate speech decoder and to produce the first PCM output sample (implementation dependent).

BSS external delay values (indicative):

Techo: Delay due to the echo canceller.

Tmsc: Switching delay in the MSC.

Data channel round-trip delay

The transmission delays for data channels apply two requirements:

1. The proper operation of the RLP protocol with the timers T1 and T2 must be ensured in order to avoid time-outs of the RLP retransmission timer T1 (**round-trip delay < T1 – T2**). This is only applicable for non-transparent data channels.
2. The roper operation of any end-to-end acknowledged protocols must be ensured. This is applicable to all data channels.

Within the delay values margins are allocated. Operations to cover the delay of processes in each entity and the amount of data proceed are not included in the budget, they are considered to be minimal and covered by the margins.

Note: All values in the following figures are in ms. The values of x, y, r, u and v depend on the user bitrate, ranging from 75 - 9600 bit/s, and the data TCH type.

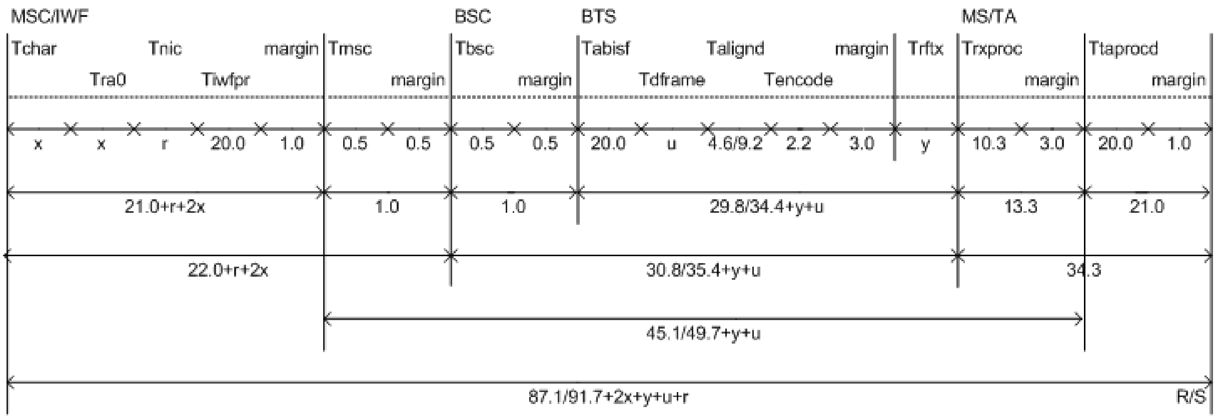

Figure C1-5. Worst-case downlink delay distribution for transparent data traffic channel

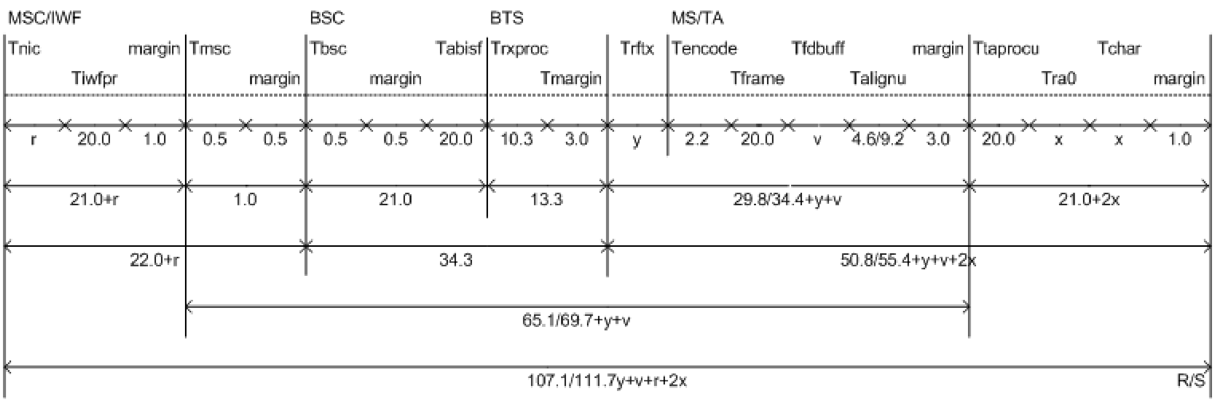

Figure C1-6. Worst-case uplink delay distribution for transparent data traffic channel

Note: All values in the following figures are in ms. The values of y, z, u, v and w depend on the data TCH type and the L2R user protocol. TRLP, diwf and TRLP, uiwf are the transmission delays seen by the RLP in the IWF in the downlink and uplink respectively. It should be noted that the corresponding transmission delays seen by the TA are given by a symmetrical assessment, but are not identical. The sum of the two, however, is the same.

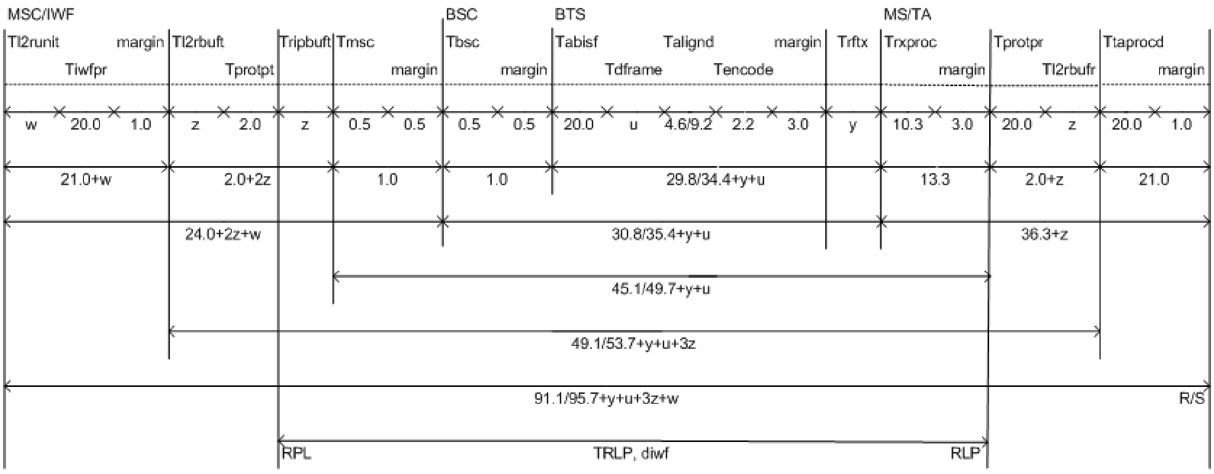

Figure C1-7. Worst-case downlink delay distribution for non-transparent data traffic channel

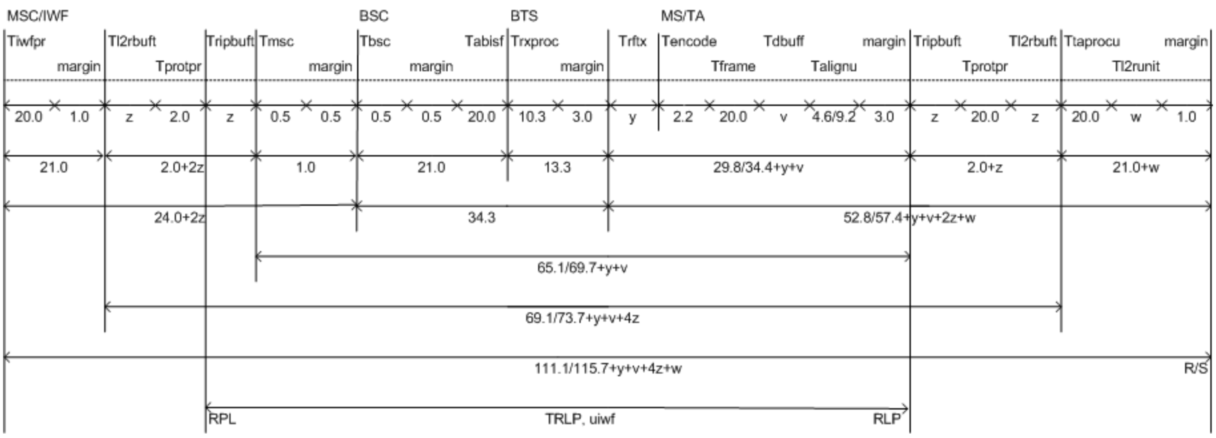

Figure C1-8. Worst-case uplink delay distribution for non-transparent data traffic channel

Transparent data only:

Tchar: The time needed in the IWF and TA to receive a character at the user bit-rate in the transmit direction for bit-to-character conversion (given in Table C1-3) (system dependent).

Tra0: The time required for buffering in the IWF and TA in the transmit direction for asynchronous-to-synchronous conversion and overspeed/underspeed detection and correction. This delay corresponds to Tchar above (given in Table C1-3) (system dependent).

Tnic: The time needed in the IWF in each direction for buffering for Network Independent Clocking. This time corresponds to one V.110 frame (system dependent).

Non-transparent data only:

Tl2runit: The necessary time in the IWF and TA in the transmit direction to convert the incoming user data bit stream into interpretable data units, e.g. characters (character oriented without framing) or data frames (e.g. bit oriented data like HDLC) (system dependent).

Tl2rbuft: Worst-case delay in the IWF and TA in the transmit direction required for buffering in the L2R in order to assemble one PDU (system dependent).

Tprotpr: Processing time used in the IWF and TA by the L2R and the RLP in the transmit or receive direction (implementation dependent).

Trlpbuft: Worst-case buffering delay in the IWF and TA required by the RLP in the transmit direction in order to synchronize one PDU towards the radio interface transmission (system dependent).

Trlpbufr: Worst-case delay in the IWF in the receive direction required for buffering in the RLP in order to assemble one PDU, before checksum calculation can be carried out (system dependent).

Tl2rbufr: Worst-case buffering delay in the IWF and TA required by the L2R in the receive direction in order to synchronize one PDU with the L2R user (system dependent).

Transparent and non-transparent data:

Tiwfpr: Processing time in the IWF in the downlink or in the uplink direction (implementation dependent).

Tabisf: Worst-case delay over the A-bis-interface due to non-synchronized A-bis-interface transmission. This delay corresponds to one TRAU frame (system dependent).

Tdframe: Additional delay to Tabisf in the downlink direction in order to receive a full radio interface data TCH frame over the A-bis-interface, so that channel encoding can start. The data TCH frame length is given in Table C1-1and Tdframe is summarized in Table C1-4 (system dependent).

Talignd: The time needed to wait in the downlink in order to align the received data over the A-bis-interface to the radio interface TDMA frame structure. This time corresponds to one TDMA-frame for full-rate channels and two for half-rate channels (system dependent).

Tframe: Delay in the uplink direction in the MS in order to receive a full radio interface data TCH frame over the user interface, so that channel encoding can start. The data TCH frame length is given in Table C1-1 (system dependent).

Tdbuff: Additional buffering needed in the TA in the uplink direction with respect to Tframe allowing a total buffering of four V.110 frames. The V.110 frame length is given in Table C1-1, and Tdbuff is summarized in Table C1-4 (system dependent).

Talignu: The time needed to wait in order to align the received uplink data over the user interface to the radio interface TDMA frame structure. This time corresponds to one TDMA-frame for full-rate channels and two for half-rate channels (system dependent).

Ttaprocd: Processing time required in the TA in the downlink direction for terminal adaptation (implementation dependent).

Ttaprocu: Processing time required in the TA in the uplink direction for terminal adaptation (implementation dependent).

Traffic channel:	Frame length (ms):	
	Radio int. (z):	V.110 (r):
TCH/FS	20	-
TCH/HS	[tbd]	-
TCH/F9.6	20	5
TCH/F4.8	20	10
TCH/H4.8	40	10
TCH/F2.4	0	10
TCH/H2.4	40	10

Table C1-1. Radio interface and V.110 frame lengths for traffic channels

Traffic channel:	Interleaving/deinterleaving (TDMA-frames/timeslots):	delay (y) (ms)
TCH/FS	7+1/1	37,5
TCH/HS	[tbd]	[tbd]
TCH/F9.6	18+3+2/1	106,8
TCH/H4.8	18+3+2/1	106,8
TCH/F4.8	36+6+4/1	212,9
TCH/F2.4	7+1/1	37,5
TCH/H2.4	36+6+4/1	212,9

NOTE: As an example, the TCH/F9.6 has an interleaving depth of 19, resulting in a delay of 18 TDMA-frames and 1 timeslot. Due to the block diagonal interleaving scheme where 4 user data blocks are channel encoded together, it may in the worst-case be necessary to wait for all the 4 subblocks spread over 3 additional TDMA-frames before channel decoding. The channel encoded block will also span a maximum of 2 SACCH frames.

Table C1-2. Interleaving/de-interleaving delay for traffic channels

Ruser	Tchar (x):
75 bit/s	146,7 ms
300 bit/s	36,7 ms
1 200 bit/s	9,2 ms
2 400 bit/s	4,6 ms
4 800 bit/s	2,3 ms
9 600 bit/s	1,2 ms

Table C1-3. Delays for bit/character conversion (11 bits)

Traffic channel:	Tdframe (u):	Tdbuff (v):
TCH/FS	-	-
TCH/HS	-	-
TCH/F9.6	0 ms	0 ms
TCH/F4.8	0 ms	20 ms
TCH/H4.8	20 ms	0 ms
TCH/F2.4	0 ms	20 ms
TCH/H2.4	20 ms	0 ms

NOTE: The various figures allocated to the various network entities given in these delay budgets are for guidance to network operators for network planning. It is up to the operator to provide other figures, if required.

Table C1-4. Tdframe and Tdbuff given for various TCH types

Appendix D – Evaluation outcome

Table F-1 states the outcome of the evaluation. The status of the signalling and speech channel is represented as BUSY meaning that traffic is ongoing, BLOC meaning that the channel is not available, and – meaning that this delay value was not tested. The delay values were chosen increasing between 0 – 550 ms and the coverage of the test is simplified and not complete. That is because the purpose of this test was to run a demo, not to perform an exhaustive test.

NIST Net Delay [ms]	Status of the signalling and speech channel [BUSY/BLOC]									
	Test1	Test2	Test3	Test4	Test5	Test6	Test7	Test8	Test9	Test10
20	BUSY	BUSY	-	-	-	-	-	-	-	-
100	BUSY	BUSY	-	-	-	-	-	-	-	-
200	BUSY	BUSY	-	-	-	-	BUSY	BUSY	BUSY	BUSY
250	BUSY	BUSY	-	-	-	-	-	-	-	-
300	BUSY	BUSY	-	-	-	-	BUSY	BUSY	BUSY	BUSY
400	BUSY	BUSY	-	-	-	-	BUSY	**BLOC**	BUSY	BUSY
440	BUSY	BUSY	-	-	-	-	-	-	BUSY	-
450	-	-	-	-	-	-	-	-	-	BUSY
460	-	-	-	-	-	-	-	-	-	BUSY
470	-	-	-	-	-	-	-	-	-	**BLOC**
498	-	-	-	-	-	**BLOC**	-	-	-	-
499	-	-	-	-	BUSY	-	-	-	-	-
500	BUSY	BUSY	BUSY	BUSY	**BLOC**	-	BUSY	-	**BLOC**	-
501	-	-	**BLOC**	**BLOC**	-	-	-	-	-	-
510	-	**BLOC**	-	-	-	-	**BLOC**	-	-	-
550	**BLOC**	-	-	-	-	-	-	-	-	-

Table F-1. Evaluation outcome

Appendix E – BSC evaluation log

The state of the channels in the BSC can be monitored. The following shows a log of this event. “rlcrp:cell=<cell name>;” is the command for printing the cell resources. TCH (Traffic Channel) is the channel that is established when user traffic is sent over the air. BCCH (Broadcast Control Channel) is a signalling channel where broadcast messages are sent continuously over the air. BCCH has to be established for being able to sent user traffic. State IDLE means that the channel is ready for transmitting traffic, while the state BUSY means that traffic is ongoing. In state BLOC no traffic can be sent and if BCCH is blocked, the Abis link has to be re-established.

The base station is running user traffic.

```
<rlcrp:cell=C1AG10;

CELL RESOURCES

CELL       BCCH  CBCH  SDCCH  NOOFTCH
C1AG10        1     1      7   14- 28

BPC    CHANNEL      CHRATE  SPV    STATE  ICMBAND  CHBAND  64K
7659   TCH-7978     FR      1,2    IDLE            P900    NONE
       TCH-24117    HR      1      IDLE            P900
       TCH-24116    HR      1      IDLE            P900
   ...
   ...
   ...

7663   TCH-7982     FR      1,2    IDLE            P900    NONE
       TCH-24125    HR      1      IDLE            P900
       TCH-24124    HR      1      IDLE            P900
7664   TCH-7983     FR      1,2    BUSY            P900    NONE
       TCH-24127    HR      1      LOCK            P900
       TCH-24126    HR      1      LOCK            P900
   ...
   ...
   ...

7672   TCH-7991     FR      1,2    IDLE            P900    NONE
       TCH-24143    HR      1      IDLE            P900
       TCH-24142    HR      1      IDLE            P900
7673   SDCCH-34602                 IDLE            P900
       SDCCH-34601                 IDLE            P900
       CBCH-34687                  BUSY            P900
       SDCCH-34600                 IDLE            P900
       SDCCH-34599                 IDLE            P900
       SDCCH-34598                 IDLE            P900
       SDCCH-34597                 IDLE            P900
       SDCCH-34596                 IDLE            P900
7674   BCCH-34693                  BUSY            P900
END
```

The base station channels are about to be disabled. The user traffic will be dropped any second, because the state of BCCH has changed to BLOC and is not able to broadcast signalling information anymore.

```
<rlcrp:cell=C1AG10;

CELL RESOURCES

CELL      BCCH  CBCH  SDCCH  NOOFTCH
C1AG10       0     0      0    1-  2

BPC    CHANNEL      CHRATE  SPV    STATE  ICMBAND  CHBAND  64K
7659   TCH-7978     FR      1,2    BLOC                    NONE
       TCH-24117    HR      1      BLOC
       TCH-24116    HR      1      BLOC
   ...
   ...
   ...
       TCH-24120    HR      1      BLOC
7662   TCH-7981     FR      1,2    BLOC                    NONE
       TCH-24123    HR      1      BLOC
       TCH-24122    HR      1      BLOC
7663   TCH-7982     FR      1,2    BLOC                    NONE
       TCH-24125    HR      1      BLOC
       TCH-24124    HR      1      BLOC
7664   TCH-7983     FR      1,2    BUSY            P900    NONE
       TCH-24127    HR      1      LOCK            P900
       TCH-24126    HR      1      LOCK            P900
   ...
   ...
   ...
7672   TCH-7991     FR      1,2    BLOC                    NONE
       TCH-24143    HR      1      BLOC
       TCH-24142    HR      1      BLOC
7673   SDCCH-34602                 BLOC
       SDCCH-34601                 BLOC
       CBCH-34687                  BLOC
       SDCCH-34600                 BLOC
       SDCCH-34599                 BLOC
       SDCCH-34598                 BLOC
       SDCCH-34597                 BLOC
       SDCCH-34596                 BLOC
7674   BCCH-34693                  BLOC
END
```

The base station has no signalling channel enabled. User traffic can not be sent.

```
<rlcrp:cell=C1AG10;

CELL RESOURCES

CELL      BCCH  CBCH  SDCCH  NOOFTCH
C1AG10       0     0      0        0
END
```

Appendix F – Abbreviations and Acronyms

A complete list of abbreviations and acronyms used within GSM is found in [3GPP TS 01.04].

A

A	interface between BSC and MSC
Abis	interface between BTS and BSC
ANSI	American National Standards Institute
ANSI T1.403	defines the electrical specification for ‘T1’ telecommunication links
AUC	Authentication Centre
AXN	Axerra Multiservice IP concentrator

B

B	interface between MSC and VLR
BSC	Base Station Controller
BSS	Base Station System
BSSAP	Base Station System Application Part
BSSGP	Base Station System GPRS Protocol
BSSMAP	Base Station System Management Application Part
BSSOMAP	Base Station System Operation and Maintenance Part
BTS	Base Transceiver Station
BTSM	Base Transceiver Station Management

C

C	interface between MSC and HLR
CC	Call Control
CCITT	Comité Consultatif International Télégraphique et Téléphonique (The International Telegraph and Telephone Consultative Committee)
CGSN	Common GPRS Support Node
CM	Connection Management

D

D	interface between HLR and VLR
DATP	Direct Transfer Application Part

E

E	interface between MSC and GMSC
E1	wide-area digital transmission scheme carrying data at a rate of 2.048 Mbps
EIR	Equipment Identity Register

F

F	interface between MSC and EIR

G

3GPP	3rd Generation Partnership Project
G.703	ITU standard for the physical and electrical characteristics of digital interfaces, including those at 64 kbps and 2.048 Mbps
Gb	interface between BSC and SGSN
Gf	interface between SGSN and EIR
Gs	interface between SGSN and MSC
Gr	interface between SGSN and HLR
Gbit	Giga bit
GGSN	Gateway GPRS Support Node
GMM	GPRS Mobility Management
GMSC	Gateway MSC
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
GTP	GPRS Tunnelling Protocol

H

H	interface between HLR and AUC
HLR	Home Location Register

I

ICMP	Internet Control Message Protocol
IFP	Interface Protocol
IMIT	department of Microelectronics and Information Technology
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
ISUP	ISDN User Part
ITU	International Telecommunication Unit
IWUP	Internetworking Function User Part

K

Kbps	Kilo bit per second
KTH	Kungliga Tekniska Högskolan (Royal Institute of Technology)

L

L1	Layer 1
L2	Layer 2
L3	Layer 3
LAN	Local Area Network
LAPD	Link Access Protocol on the D channel
LAPDm	Link Access Protocol on the Dm channel
LLC	Logical Link Control

M

MAC	Medium Access Control
Mbps	Mega bit per second
ME	Mobile Equipment

MM	Mobility Management
MMS	Multi Media Services
MS	Mobile Station
MSC	Mobile Switching Centre
MSOSP	Mobile Open Service Platform
MTP	Message Transfer Part

N

NMC	Network Management Centre
NTP	Non-transparent Protocol

O

OMC	Operation & Maintenance Centre
OSS	Operation and Support System

P

PCU	Packet Control Unit
PLMN	Public Land Mobile Network
PSPDN	Packet Switched Public Data Network
PSTN	Public Switched Telephone NETWORK

R

RFC	Requests for Comments
RLC	Radio Link Control
RLP	Radio Link Protocol
RR	Radio Resource
RTCP	Real-time Transfer Control Protocol

S

SCCP	Signalling Connection Control Part
SGSN	Serving GPRS Support Node
SIM	Subscriber Identity Module
SM	Session Management
SMS	Short Message Service
SNDCP	Subnetwork Dependent Convergence Protocol
SS	Supplementary Service
SS	Switching System
SS#7	CCITT Signalling System No. 7
SUNET	Swedish University Network

T

T1	wide-area digital transmission scheme carrying data at a rate of 1.544 Mbps
TCAP	Transaction Capabilities Application Part
TCP	Transmission Control Protocol
TRAU	Transcoding and Rate Adaption Unit
TS	Test Specification
TUP	Telephone User Part

U

UDP	User Datagram Protocol
Um	(air) interface between BTS and MS

V

V.24	ITU standard for synchronous communication
Vinnova	the Swedish Agency for Innovation Systems
VLR	Visitor Location Register
VoIP	Voice over IP

W

WAP	Wireless Application Protocol
WLAN	Wireless Local Area Network

X

X.21	ITU standard for serial communications over synchronous digital links
X.25	CCITT standard for packet switching network