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**Speech and multimedia Transmission Quality (STQ);
Guidance on objectives for Quality related Parameters
at VoIP Segment-Connection Points;
A support to NGN transmission planners**

Reference
RTR/STQ-00181

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Speech and multimedia Transmission Quality (STQ).

Introduction

The present document is intended to fill a gap in a field where the industry has expressed an urgent need for standardized objectives. Based on the assumption that voice over IP services with the goal of users being satisfied or even very satisfied with the overall voice communication quality, the present document provides initial guidance on voice quality related parameters and respective objectives for interconnected networks.

The present document forms part of STQ's roadmap with respect to quality aspects of NGN.

1 Scope

The present document provides guidance on the quality parameters that need to be considered at the Segment-connection of Voice over IP (VoIP) services and provides guidance on objectives for these parameters.

Inside the TISPAN NGN overall architecture (see figure 1), the present document considers only the transport layer.

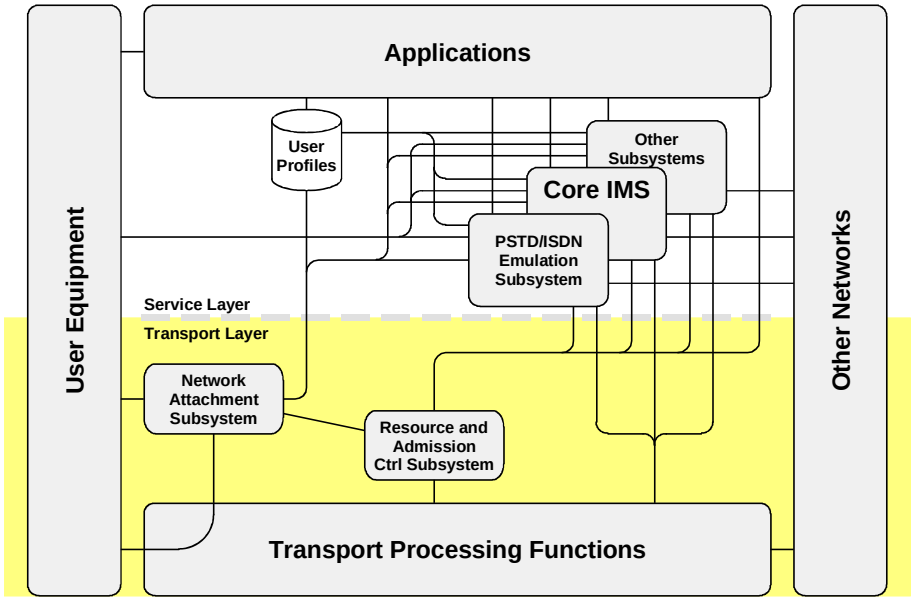

Figure 1: TISPAN NGN overall architecture (adapted from [i.14])

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ITU-T Recommendation Y.1540 (2002): "Internet protocol data communication service - IP packet transfer and availability performance parameters".

[i.2] ITU-T Recommendation Y.1541 (2006): "Network performance objectives for IP-based services".

[i.3] ITU-T Recommendation Y.1542 (2006): "Framework for achieving end-to-end IP performance objectives".

[i.4] ITU-T Recommendation G.107 (2008): "The E-model: a computational model for use in transmission planning".

[i.5] ITU-T Recommendation G.108 (1999): "Application of the E-model: A planning guide".

[i.6] ITU-T Recommendation G.109 (1999): "Definition of categories of speech transmission quality".

[i.7] ITU-T Recommendation G.113 (2007): "Transmission impairments due to speech processing".

[i.8] Void.

[i.9] ITU-T Recommendation G.1020 (2006): "Performance parameter definitions for quality of speech and other voiceband applications utilizing IP networks".

[i.10] ETSI ES 202 737: "Speech and multimedia Transmission Quality (STQ); Transmission requirements for narrowband VoIP terminals (handset and headset) from a QoS perspective as perceived by the user".

[i.11] ETSI ES 202 738: "Speech and multimedia Transmission Quality (STQ); Transmission requirements for narrowband VoIP loudspeaking and handsfree terminals from a QoS perspective as perceived by the user".

[i.12] ETSI ES 202 739: "Speech and multimedia Transmission Quality (STQ); Transmission requirements for wideband VoIP terminals (handset and headset) from a QoS perspective as perceived by the user".

[i.13] ETSI ES 202 740: "Speech and multimedia Transmission Quality (STQ); Transmission requirements for wideband VoIP loudspeaking and handsfree terminals from a QoS perspective as perceived by the user".

[i.14] ETSI ES 282 001: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Functional Architecture".

[i.15] GSMA Document IR.3445: "Inter-Service Provider IP Backbone Guidelines".

[i.16] ITU-T Recommendation G.8261 (2008): "Timing and synchronization aspects in packet networks".

[i.17] ITU-T Recommendation G.8262 (2007): "Timing characteristics of synchronous ethernet equipment slave clock (EEC)".

[i.18] ITU-T Recommendation G.8264 (2008): "Timing distribution through packet networks".

[i.19] IEEE 1588: "Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control System".

[i.20] ITU-T Recommendations of the P.862-series: "Perceptual evaluation of speech quality (PESQ): An objective method for end-to-end speech quality assessment of narrow-band telephone networks and speech codecs".

[i.21] ITU-T Recommendation P.834: "Methodology for the derivation of equipment impairment factors from instrumental models".

[i.22] ITU-T Recommendation G.711: "Pulse code modulation (PCM) of voice frequencies".

[i.23] ITU-T Recommendation G.726: "40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM)".

[i.24] ITU-T Recommendation G.727: "5-, 4-, 3- and 2-bit/sample embedded adaptive differential pulse code modulation (ADPCM)".

[i.25] ITU-T Recommendation G.728: "Coding of speech at 16 kbit/s using low-delay code excited linear prediction".

[i.26] ITU-T Recommendation G.729: "Coding of speech at 8 kbit/s using conjugate-structure algebraic-code-excited linear prediction (CS-ACELP)".

[i.27] ITU-T Recommendation I.231.1: "Circuit-mode bearer service categories: Circuit-mode 64 kbit/s unrestricted, 8 kHz structured bearer service".

[i.28] ITU-T Recommendation G.826: "End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections".

[i.29] ITU-T Recommendation Q.115.1: "Logic for the control of echo control devices and functions".

[i.30] ETSI EN 300 726: "Digital cellular telecommunications system (Phase 2+) (GSM); Enhanced Full Rate (EFR) speech transcoding (GSM 06.60 version 8.0.1 Release 1999)".

[i.31] IETF RFC 1483: "Multiprotocol Encapsulation over ATM Adaptation Layer".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

access segment: network segment from the customer interface (UNI) to the interface on the customer side of the first Gateway Router

segment-connection point: point between two segments

NOTE: The terms "interconnection" or "interconnection point" have been used in the NGN standards, e.g. in [i.14], the same terms are generally used for NNIs, not for the connection between access segment and transit segment, they might be misinterpreted. Therefore, throughout the present document, the terms "Segment-connection" or "Segment-connection point" are used.

total transit segment: segment between Gateway routers, including the gateway routers themselves

NOTE: The network segment may include interior routers with various roles.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACELP	Algebraic Code-Excited Linear Prediction
ADM	Add-Drop-Multiplexer
ADPCM	Adaptive Differential Pulse Code Modulation
ADSL	Asymmetric Digital Subscriber Line
AGW	Access GateWay
ATM	Asynchronous Transfer Mode
BNG	Broadband Network Gateway
BRAS	Broadband Remote Access Server
BS	Base Station

BSC	Base Station Controller
BTS	Base Transceiver Station
CL	router Core Layer
CPN	Customer Premises Network
CS-ACELP	Conjugate Structure Algebraic Code- Excited Linear Prediction
DECT	Digital European Cordless Telephone
DL	router Distribution Layer
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
EC	Echo Canceller
ESR	Errored Seconds Ratio
ETH	Ethernet
FoIP	Fax over IP
GoB	Good or Better
GSM	Global System for Mobile communications
GSMA	Global System for Mobile communications Association
GW	GateWay
HIS	High Speed Internet
IAD	Integrated Access Device
IBCF	Interconnection Border Control Function
Ie	Equipment Impairment Factor
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPDV	IP packet Delay Variation
IPER	IP packet Error Ratio
IPLR	IP packet Loss Ratio
IPTD	IP packet Transfer Delay
ISDN	Integrated Services Digital Network
ITU	International Telecommunication Union
ITU-T	ITU Telecommunication Standardization Sector
JB	De-jitter Buffer
LAN	Local Area Network
MGW	Media Gateway
MoIP	Modem over IP
MOS	Mean Opinion Score
MP-ACELP	Multipulse Algebraic Code Excited Linear Prediction
MP-MLQ	Multipulse Maximum Likelihood Quantization
MSAN	Multi Service Access Node
MTU	Maximum Transmission Unit
NC	Network Controller
NGN	Next Generation Network
NI	Network Interface
NNI	Network to Network Interface
NTP	Network Termination Point
PDH	Plesiochronous Digital Hierarchy
POTS	Plain old telephone service
PoW	Poor or Worse PLC
PSTN	Public Switched Telephone Network
PTP	Point to Point
QoS	Quality of Service
RACS	Resource Admission Control Subsystem
RGW	Residential Gateway
RNC	Radio Network Controller
SBC	Session Border Controller
SoIx	Service-oriented Interconnection
STM 1	Synchronous Transport Module 1
SyncE	Synchronous Ethernet
TE	Terminal Equipment
TELR	Talker Echo Loudness Rating
TRAU	Transcoder and Rate Adaption Unit
UMSC	UMTS Mobile Switching Centre
UMTS	Universal Mobile Telecommunications System

UNI	User Network Interface
VBD	Voice Band Data
VDSL	Very High Speed Digital Subscriber Line
VGW	Voice Gateway
VoIP	Voice over Internet Protocol
VoNGN	Voice over NGN
WiMAX	Worldwide Interoperability for Microwave Access
xDSL	x Digital Subscriber Line

4 Reference Configuration

Compared to networks and systems that are circuit-based, those based on IP pose distinctly different challenges for planning and achieving the end-to-end performance levels necessary to adequately support the wide array of user applications (voice, data, fax, video, etc.). The fundamental quality objectives for these applications are well understood and have not changed as perceived by the user; what has changed is the technology (and associated impairments) in the layers below these applications. The very nature of IP-based routers and terminals, with their queuing methods and de-jitter buffers, respectively, makes realizing good end-to-end performance across multiple network operators a very major challenge for applications with stringent performance objectives. Fortunately ITU-T Recommendations Y.1540 [i.1] and Y.1541 [i.2] together provide the parameters needed to capture the performance of IP networks, and specify a set of "network QoS" classes with end-to-end objectives specified. It is widely accepted (i.e. beyond the ITU-T) that the network QoS classes of ITU-T Recommendation Y.1541 [i.2] should be supported by Next Generation Networks, and thus by networks evolving into NGNs. ITU-T Recommendation Y.1542 [i.3] considers various approaches toward achieving end-to-end (UNI-UNI) IP network performance objectives.

The general reference configuration for the present document follows the principles shown in figure 2; the number of concatenated transit providers may vary.

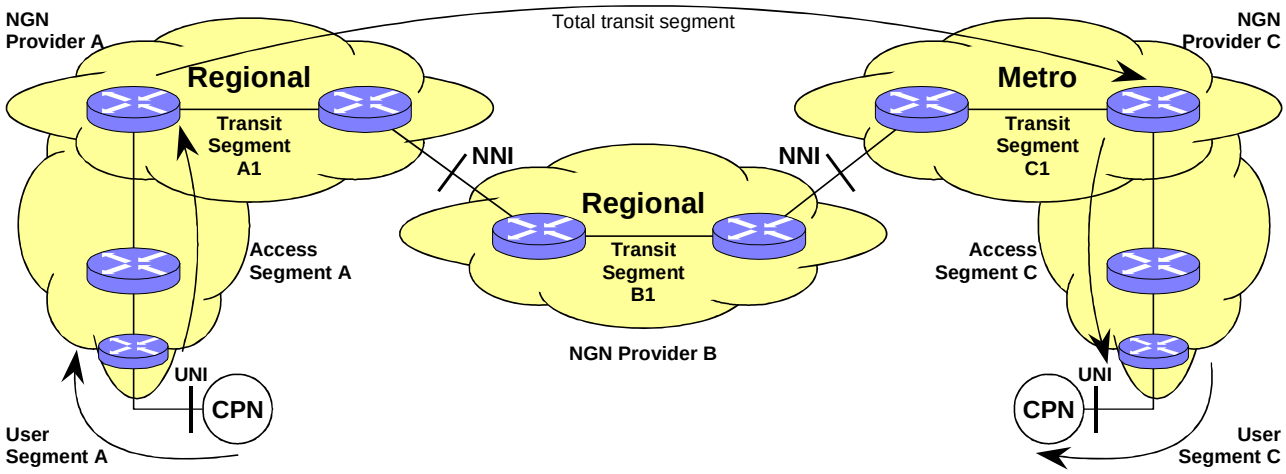

Figure 2: General Reference Configuration

- Thus the end-to-end connection can be decomposed into the User segment A.
- UNIA (sending side).
- Access segment A.
- Segment-connection Point Ain.
- Total transit segment.
- Segment-connection Point Cout.
- Access segment C.
- UNIC (receiving side).

- User segment C.

The total transit segment can be further decomposed into:

- Transit segment A1.
- Segment-connection point Aout.
- Transit segment A2 (NNI).
- Segment-connection point Bin.
- Transit segment B1.
- Segment-connection point Bout.
- Transmit segment B2 (NNI).
- Segment-connection point Cin.
- Transit segment C1.

4.1 Generic Segment-connection Points

Due to real-world constraints the simplified **static divisor** approach according to ITU-T Recommendation Y.1542 [i.3] has been chosen for the impairment apportionment between access and transit networks.

This approach "divides" the UNI-to-UNI path into three segments and budgets the impairments such that the total objective is met in principle.

As outlined in [i.15] the delay values for the total transit segment are in a fixed relation to the distances between different geographical regions (see table 2). Thus, for the near future dynamic allocation of delay budgets is not expected to be implemented between user segments, access segments and transit segments.

In figure 3, the upper part displays the division of the connection as seen from a QoS point of view whereas the lower part shows this division in terms of the NGN Functional Architecture [i.14].

NOTE: The reference points Ic, Iw, and Iz are defined in [i.14] in clause 7.2.2.

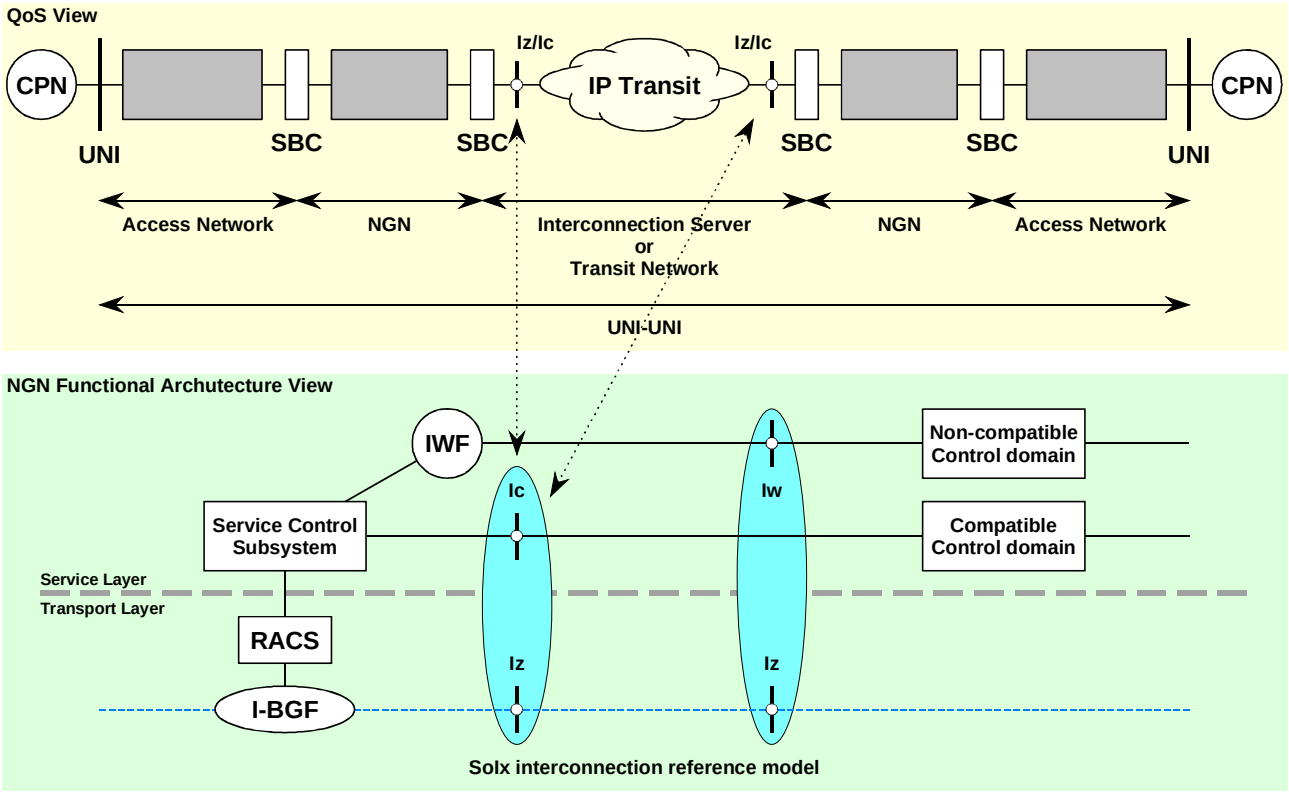

Figure 3: Division of the connection

Hence, there should be objectives for the following portions of the connection:

- UNI (send side) ←→ Segment-connection Point A.
- Segment-connection Point A ←→ Segment-connection Point C.
- Segment-connection Point C ←→ UNI (receive side).

The guidance on respective objectives is given in clause 5.

As illustrated in figure 3, SoIx interconnection is typically characterized by the presence of two types of information exchanged between the two interconnected domains:

- Service-related signalling information, that allows to identify the end-to-end service that has been requested. For example, in case of IMS-to-IMS SoIx interconnection, this is mapped to SIP signalling on the Ic reference point.
- Transport information that carries the bearer traffic.

The presence of the service-related signalling in SoIx interconnection enables the end-to-end service awareness.

An NGN interconnection could be a SoIx even if the transport information is not exchanged between the interconnected domains, as long as service-related signalling is exchanged.

An NGN transport layer interconnection is considered being part of an NGN SoIx interconnection if the transport layer is controlled from the service layer in both of the interconnected domains.

- **SoIx Interconnection interface** includes at least Ic and Iz reference points between two interconnected domains that have same or compatible service control sub systems/domains.
- **SoIx Interconnection interface with Interworking** includes at least the Iw and Iz reference points between two interconnected domains that have non- compatible service control sub systems/domains.

4.2 Transport Reference Parameters and Configurations

At the Segment-connection Points (figure 3) different access networks can be connected. Following access networks can be considered:

- PSTN/ISDN classic access Configuration.
- NGN PSTN/ISDN access Configuration.
- Access DSL Configuration.
- WiMAX.
- GSM.
- UMTS.

In the following clauses are defined the end-to-end delay, and the Talker Echo Loudness Rating. The detailed values of jitter and delay for the access are described in clause A.6.

4.2.1 Reference Configurations

The following clauses describe the Backbone and access reference configuration. In the calculation is at the Segment-connection point taken into account only one SBC.

4.2.1.1 Backbone Configuration

Figure 4 shows the backbone configuration. The number of elements used in the configuration and the delay values are described in clause A.6.

Figure 4: Backbone

4.2.1.2 PSTN/ISDN classic access Configuration

Figure 5 shows the PSTN/ISDN classic access configuration. The number of elements used in the configuration and the delay values are described in clause A.6.

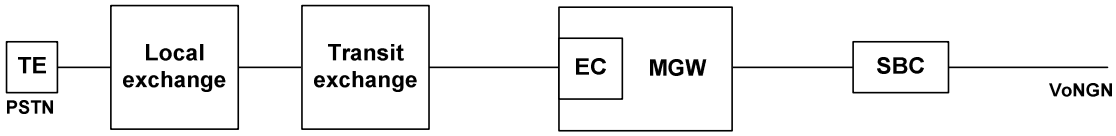

Figure 5: Reference configuration for PSTN/ISDN with classical access

4.2.1.3 NGN PSTN/ISDN access Configuration

Figure 6 shows the NGN PSTN/ISDN classic access configuration. The number of elements used in the configuration and the delay values are described in clause A.6.

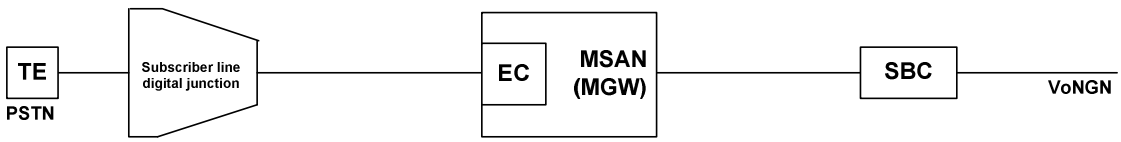

Figure 6: Reference configuration for NGN with PSTN/ISDN access

4.2.1.4 Access DSL Configuration

Figure 7 shows the xDSL access configuration. The number of elements used in the configuration and the delay values are described in clause A.6.

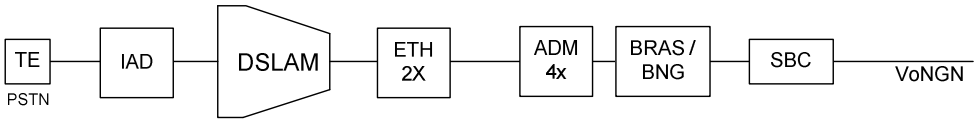

Figure 7: Reference configuration for DSL access

4.2.1.5 WiMax Access Configuration

Figure 8 shows the WiMax access configuration. The number of elements used in the configuration and the delay values are described in clause A.6.

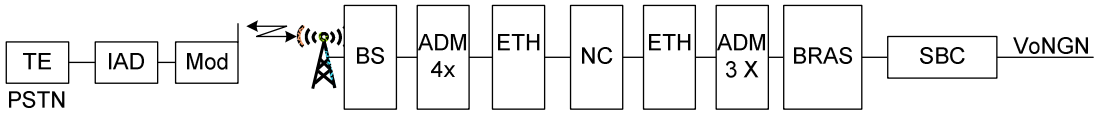

Figure 8: Reference configuration for WiMax Configuration

4.2.1.6 GSM Access configuration

Figure 9 shows the GSM access configuration. The number of elements used in the configuration and the delay values are described in clause A.6.

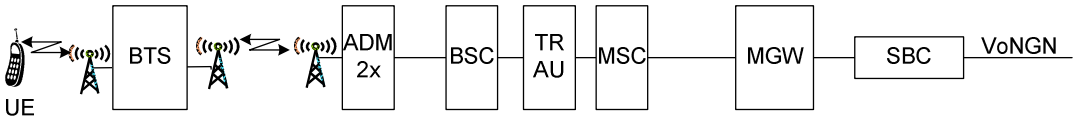

Figure 9: Reference configuration for GSM Access

4.2.1.7 Access configuration from UMTS Release 3

Figure 10 shows the UMTS Release 3 access configuration. The number of elements used in the configuration and the delay values are described in clause A.6.

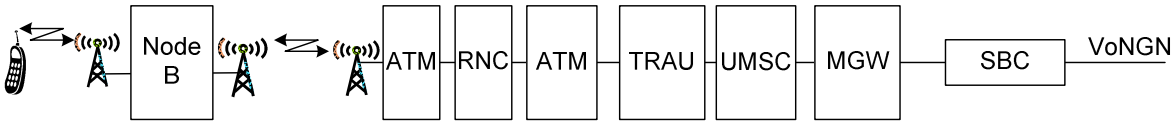

Figure 10: Reference configuration from UMTS Release 3

4.2.1.8 Access configuration from UMTS Release 4

Figure 11 shows the UMTS Release 4 access configuration. The number of elements used in the configuration and the delay values are described in clause A.6.

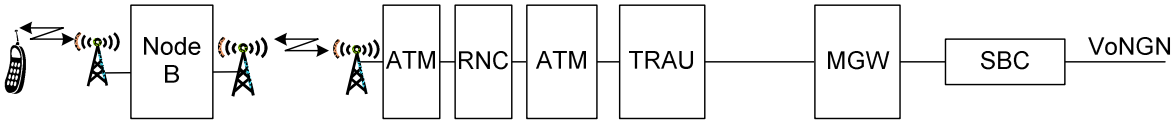

Figure 11: Reference configuration from UMTS Release 4

4.2.1.9 CPE reference configuration

The Jitter and Delay calculation is based on the fact that different terminals are connected at same time on the CPE.

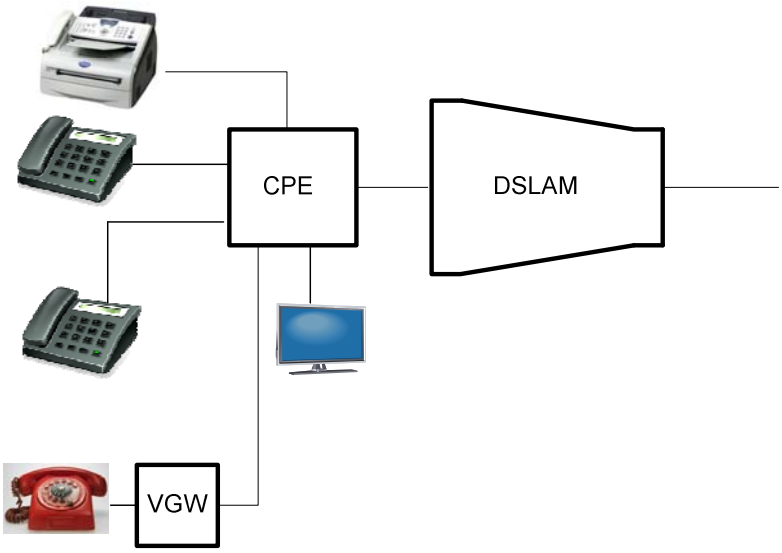

Figure 12: Terminal reference configuration for DSL access

4.3 Delay Values

4.3.1 Backbone Delay

Table 1 shows the long distance delay values for typical reference distances.

Table 1: Long Distance Delay

Distance	Delay (propagation and equipment delay)
1 400 km	11 ms
5 000 km (Intra Regional)	30 ms
10 000 km (Inter Regional)	55 ms
19 000 km (Inter Regional)	100 ms
27 500 km (Inter Regional)	145 ms
NOTE: Delay values see also table 2. Due to involvement of multiple service providers the equipment delay can be up to 21 ms.	

Table 2 shows delay values between originating and terminating Service Provider premises. The End-to-End delay values are based on values contained in the GSMA document IR.3445 [i.15].

Table 2: End-to-End delay values between originating and terminating Service Provider premises

EF& AF-4	Middle Europe	North Europe	East Europe	South Europe	East Asia	South East Asia	Oceania	N. America East Cost	N. America West Cost	Central America	South America	Africa
Middle Europe	28	23	40	36	170	180	190	60	100	113	165	121
North Europe	23	20	18	38	175	180	200	65	108	125	168	135
East Europe	40	18	20	51	180	185	220	83	108	141	175	131
South Europe	36	37	51	36	173	178	190	73	110	124	168	109
East Asia	170	175	180	173	75	83	138	170	143	177	230	192
South East Asia	180	180	185	178	83	63	128	180	155	245	240	126
Oceania	190	200	210	190	138	128	45	180	155	185	235	144
N. America E. Cost	60	65	83	73	170	180	180	20	45	46	140	163
N. America W. Cost	100	108	108	110	143	155	155	45	20	63	150	209
Central America	113	125	141	124	178	245	185	46	123	20	67	147
South America	165	168	175	168	230	240	235	240	150	67	60	140
Africa	121	135	131	109	192	125	144	163	209	147	90	90

NOTE: See [i.15].

4.4 Network parameters: End-to-End Delay, Talker Echo Loudness Rating, R Value

In this clause, end to end delay values (mouth to ear) for different access lines and the respective R-values (depending on the calculated delay) are shown.

The following clause describes the Network parameters: End-to-End Delay, Talker Echo Loudness Rating for a national network. The detailed values of End-to-End Delay, and Jitter values and the time values for the jitter buffers are described in clause A.6.

4.4.1 Delay with regional propagation delay (1 400 km/11 ms)

The regional reference configuration is based on a distance of 1 400 km which is the average value for intra-European regional calls. The detailed time distribution is described in clause A.6.1.

For the calculation of the Voice Quality parameters used network parameters are contained in clause A.6. For the calculation is used the Packet size of 10 ms and 20 ms, the access of DSL line 128 kbit/s uplink; 128 kbit/s downlink, DSL line 256 kbit/s uplink; 256 kbit/s downlink, DSL line 384 kbit/s uplink; DSL line 512 kbit/s uplink, DSL line 768 kbit/s uplink, 1 024 kbit/s downlink. The codecs are G.726, G.729A and G.711.

In case VBD it's the goal to keep the audio end-to-end delay constant during the entire call. The jitter buffer has to be implemented in such a way that any jitter occurring during the entire call will not change the end to end delay.

In case of voice the strategy of jitter buffer implementation is to keep the end to end audio delay as low as possible under all jitter conditions. Any jitter buffer implementation should mostly not impair the listening speech quality as perceived by the user.

For voice calls between MSAN, IAD, MGW adaptive jitter buffers are required. The minimum jitter buffer size should be smaller or equal to one packet size.

For adaptive jitter buffers the maximum aberration from the real jitter in the network should be one packetization time interval. It is recommended that the jitter measurement period for Jitter should be 2-3 packet intervals, not only on one packet interval. The adaptation interval towards higher values should be done immediately after the jitter measurement period. The adaptation towards lower values should be after at least several seconds or during silence periods.

In the case of DSL to DSL connections are calculated systems with the same upstream and downstream (e.g. 128/128 to 128/128; 256/256 to 256/256; 384/384 to 384/384, 384/1 024 to 384/1 024; 512/1 024 to 512/1 024, 768/1 024 to 768/1 024, 1 024/1 024 to 1 024/1 024).

The delay values of the used components are state of the art. The R values are based on wired terminals with the Talker Echo Loudness Rating TELR = 65. For DECT terminals the Talker Echo Loudness Rating TELR = 65 is used under the condition that the echo cancellation is deployed in the gateway according ITU-T Recommendation Q.115.1 [i.29].

For other national networks which have different propagation delay, the Access parameters from clause A.6 can be used and the propagation delay from tables 1 and 2 can be added.

To enable an easy comparison of the user satisfaction the tables are coloured in the same colours as table 23: Relation between R-value and user satisfaction.

Table 3 shows End-to-End delay in ms and R value between DSL line 128 kbit/s uplink; 128 kbit/s downlink and PSTN/ISDN G.729. The R values are based on wired terminals with the Talker Echo Loudness Rating TELR = 65.

Table 4 shows End-to-End delay in ms and R value between DSL line 128 kbit/s uplink; 128 kbit/s downlink and PSTN/ISDN G.711. The R values are based on wired terminals with the Talker Echo Loudness Rating TELR = 65.

Table 5 shows End-to-End delay in ms and R value between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.711;. The R values are based on wired terminals with the Talker Echo Loudness Rating TELR = 65.

Table 6 shows End-to-End delay in ms and R value between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.729A. The R values are based on wired terminals with the Talker Echo Loudness Rating TELR = 65.

Table 7 shows End-to-End delay in ms and R value between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.726/32/20. The R values are based on wired terminals with the Talker Echo Loudness Rating TELR = 65.

Table 8 shows End-to-End delay in ms and R value between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.726/40/20. The R values are based on wired terminals with the Talker Echo Loudness Rating TELR = 65.

Table 9 shows End-to-End delay ms Delay between DSL line 384 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN for G.711. The R values are based on wired terminals with the Talker Echo Loudness Rating TELR = 65.

Table 10 shows End-to-End delay in ms and R value between DSL line 384 kbit/s uplink; 384 kbit/s downlink and PSTN/ISDN for G.726/32/20. The R values are based on wired terminals with the Talker Echo Loudness Rating TELR = 65.

Table 11 shows End-to-End delay in ms and R value between DSL line 384 kbit/s uplink; 384 kbit/s downlink and PSTN/ISDN for G.726/40/20. The R values are based on wired terminals with the Talker Echo Loudness Rating TELR = 65.

Table 12 shows End-to-End delay in ms and R value between DSL line 512 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN for G.711. The R values are based on wired terminals with the Talker Echo Loudness Rating TELR = 65.

Table 13 shows End-to-End delay in ms and R value between DSL line 768 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS 40 ms; DSL 50 ms) worst case and best case scenario
(JB POTS/DSL 40 ms, DSL-DSL 40 ms) packet size 20 ms.

Table 14 shows End-to-End delay in ms and R value between DSL line 768 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS 40 ms; DSL 50 ms) worst case and best case scenario
(JB POTS/DSL 20 ms, DSL-DSL 30 ms) packet size 10 ms.

Table 15 shows End-to-End delay in ms and R value between DSL line 1 024 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS 40 ms; DSL - DSL 40 ms) worst case and best case scenario
(JB POTS/DSL 40 ms, DSL-DSL 40 ms) packet size 20 ms.

Table 16 shows End-to-End delay in ms and R value between DSL line 1 024 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS/DSL 40 ms; DSL-DSL 30 ms) worst case and best case scenario
(JB POTS/DSL 20 ms, DSL-DSL 30 ms) packet size 10 ms.

Table 17 shows End-to-End delay in ms and R value between different access types, with wired terminals packet size 20 ms. The R values are based on wired terminals with the Talker Echo Loudness Rating TELR = 65.

Table 18 shows End-to-End delay in ms and R value between DSL line 128 kbit/s uplink; 128 kbit/s downlink and PSTN/ISDN G.729. The R values are based on DECT Terminals.

Table 19 shows End-to-End delay in ms and R value between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.711; G.726/40/20. The R values are based on DECT Terminals. (Q.115.1 [i.29]).

Table 20 shows End-to-End delay in ms and R value between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.729A. The R values are based on DECT Terminals.

Table 21 shows End-to-End delay ms Delay between DSL line 384 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN for G.711. The R values are based on DECT Terminals.

Table 22 shows End-to-End delay ms Delay between DSL line 512 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN for G.711. The R values are based on DECT Terminals.

Table 3: End-to-End delay in ms and R value between DSL line 128 kbit/s uplink; 128 kbit/s downlink PSTN/ISDN to PSTN/ISDN are provided with G.711, DSL Access with G.729A with wired terminals

	PSTN/ISDN Delay (ms) / R	**DSL Delay (ms) / R**
PSTN/ISDN	63 ms / R = 92 (20 ms Packet size) 43 ms / R = 92 (10 ms Packet size)	102 ms - 144 ms / R = 79 (20 ms Packet size) (Ie = 11)
DSL	108 ms - 153 ms / R = 79 (20 ms Packet size) (Ie = 11)	160 ms - 207 ms / R = 74 (20 ms Packet size) (Ie = 11)

Table 4: End-to-End delay for DSL line 128 kbit/s uplink; 128 kbit/s downlink G.711 packet size 20 ms with wired terminals

	PSTN/ISDN Delay (ms) / R	**DSL Delay (ms) / R**
PSTN/ISDN	63 ms / R = 92 (20 ms Packet size) 43 ms / R = 92 (10 ms Packet size)	102 ms - 122 ms / R = 90
DSL	103 ms - 148 ms / R = 90	147 ms - 207 ms / R = 85

Table 5: End-to-End delay in ms and R value between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.711 with wired terminals

	PSTN/ISDN Delay (ms) / R	**DSL Delay (ms) / R**
PSTN/ISDN	63 ms / R = 92 (20 ms Packet size) 43 ms / R = 92 (10 ms Packet size)	66 ms - 96 ms / R = 90 (20 ms Packet size) 62 ms - 93 ms / R = 91 (10 ms Packet size)
DSL	79 ms - 109 ms / R = 91 (20 ms Packet size) 68 ms - 98 ms / R = 91 (10 ms Packet size)	112 ms - 132 ms / R = 90 (20 ms Packet size) 97 ms - 118 ms / R = 90 (10 ms Packet size)

Table 6: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink packet size 20 ms for G.729A with wired terminals

	PSTN/ISDN Delay (ms) / R	**DSL Delay (ms) / R**
PSTN/ISDN	63 ms / R = 92 (20 ms Packet size) 43 ms / R = 92 (10 ms Packet size)	66 ms - 96 ms / R = 80 (20 ms Packet size)
DSL	89 ms - 119 ms / R = 79 (20 ms Packet size)	112 ms - 132 ms / R = 79 (20 ms Packet size)

Table 7: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.726/32/20 (JB POTS/DSL 90 ms, DSL - DSL 120 ms) worst case and best case scenario (JB POTS- DSL 40 ms, DSL-DSL 70 ms)

	PSTN/ISDN Delay (ms) / R	DSL Delay (ms) / R
PSTN/ISDN	63 ms / R = 92 (20 ms Packet size)	69 ms - 94 ms / R = 84
DSL	75 ms - 100 ms / R = 84	96 ms - 117 ms / R = 83

Table 8: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.726/40/20 (JB POTS/DSL 90 ms, DSL - DSL 120 ms) worst case and best case scenario (JB POTS- DSL 40 ms, DSL-DSL 70 ms)

	PSTN/ISDN Delay (ms) / R	**DSL Delay (ms) / R**
PSTN/ISDN	63 ms / R = 92 (20 ms Packet size)	68 ms - 93 ms / R = 88
DSL	78 ms - 103 ms / R = 88	98 ms - 118 ms / R = 88

Table 9: End-to-End delay ms Delay between DSL line 384 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN for G.711 with wired terminals

	PSTN/ISDN Delay (ms) / R	**DSL Delay (ms) / R**
PSTN/ISDN	63 ms / R = 92 (20 ms Packet size) 43 ms / R = 92 (10 ms Packet size)	62 ms - 82 ms / R = 91 (20 ms Packet size) 52 ms - 67 ms / R = 91 (10 ms Packet size)
DSL	72 ms - 91 ms / R = 91 (20 ms Packet size) 60 ms - 74 ms / R = 91 (10 ms Packet size)	85 ms - 101 ms / R = 91 (20 ms Packet size) 64 ms - 84 ms / R = 91 (10 ms Packet size)

Table 10: End-to-End delay between DSL line 384 bit/s uplink; 384 kbit/s downlink and PSTN/ISDN for G.726/32/20 (JB POTS/DSL 60 ms, DSL - DSL 90 ms) worst case and best case scenario (JB POTS- DSL 40 ms, DSL-DSL 70 ms)

	PSTN/ISDN Delay (ms)	**DSL Delay (ms)**
PSTN/ISDN	63 ms / R = 92 (20 ms Packet size)	68 ms - 78 ms / R = 84
DSL	67 ms - 77 ms / R = 84	88 ms - 103 ms / R = 84

Table 11: End-to-End delay between DSL line 384 kbit/s uplink; 384 kbit/s downlink and PSTN/ISDN for G.726 /40/20 (JB POTS/DSL 60 ms, DSL - DSL 90 ms) worst case and best case scenario (JB POTS- DSL 40 ms, DSL-DSL 70 ms)

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN	63 ms / R = 92 (20 ms Packet size)	68 ms - 78 ms / R = 89
DSL	68 ms - 78 ms / R = 89	89 ms - 103 ms / R = 87

Table 12: End-to-End delay ms Delay between DSL line 512 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN for G.711 with wired terminals

	PSTN/ISDN Delay (ms) / R	DSL Delay (ms) / R
PSTN/ISDN	63 ms / R = 92 (20 ms Packet size) 43 ms / R = 92 (10 ms Packet size)	62 ms - 72 ms / R = 91 (20 ms Packet size) 52 ms - 62 ms / R = 91 (10 ms Packet size)
DSL	70 ms - 80 ms / R = 91 (20 ms Packet size) 59 ms - 69 ms / R = 91 (10 ms Packet size)	74 ms - 89 ms / R = 91 (20 ms Packet size) 63 ms - 78 ms / R = 91 (10 ms Packet size)

Table 13: End-to-End delay between DSL line 768 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS 40 ms; DSL 50 ms) worst case and best case scenario (JB POTS/DSL 40 ms, DSL-DSL 40 ms) packet size 20 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		67 ms / R = 91
DSL	68 ms / R = 91	77 ms - 82 ms / R = 91

Table 14: End-to-End delay between DSL line 768 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS 40 ms; DSL 50 ms) worst case and best case scenario (JB POTS/DSL 20 ms, DSL-DSL 30 ms) packet size 10 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		47 ms - 57 ms / R = 92
DSL	52 ms - 57 ms / R = 92	61 ms - 71 ms / R = 92

Table 15: End-to-End delay between DSL line 1 024 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS 40 ms; DSL - DSL 40 ms) worst case and best case scenario (JB POTS/DSL 40 ms, DSL-DSL 40 ms) packet size 20 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		67 ms / R = 92
DSL	68 ms / R = 91	77 ms / R = 91

Table 16: End-to-End delay between DSL line 1 024 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS/DSL 40 ms; DSL-DSL 30 ms) worst case and best case scenario (JB POTS/DSL 20 ms, DSL-DSL 30 ms) packet size 10 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		47 ms - 57 ms / R = 92
DSL	57 ms / R = 92	66 ms / R = 92

Table 17: End-to-End delay between different access types, with wired terminals packet size 20 ms

	NGN PSTN/ISDN-NGN Delay (ms) / R	WiMAX Delay (ms) / R	GSM Delay (ms) / R	UMTS Release 3 Delay (ms) / R Ie = 5	UMTS Release 4 Delay (ms) / R Ie = 5
NGN PSTN/ISDN	63 ms / R = 92	102 ms / R = 91	158 ms /84	162 ms /84	157 ms /84
WiMax	109 ms / R = 91	148 ms / R = 90	204/80	208/80	203/80
GSM **Ie = 5**	152 ms / R = 85	191 ms / R = 82	247 ms / R = 69 **(without TFO Ie = 10)** 188/77 (see note)	251 ms / R = 69 **(without TFO** Ie = 10)	246 ms / R = 69 **(without TFO** Ie = 10)
UMTS Release 3 **Ie = 5**	174 ms / R = 83	214 ms / R = 79	270 ms / R = 67 **(without TFO** Ie = 10)	274 ms / R = 66 **(without TFO** Ie = 10)	269 ms / R = 67 **(without TFO** Ie = 10)
UMTS Release 4 Ie = 5	169 ms / R = 84	209 ms / R = 80	265 ms / R = 67 **(without TFO** Ie = 10)	269 ms / R = 67 **(without TFO** Ie = 10)	264 ms / R = 67 **(without TFO** Ie = 10)
NOTE: UTRAN Delay without TFO and propagation delay.					

Table 18: End-to-End delay in ms and R value between DSL line 128 kbit/s uplink; 128 kbit/s downlink packet size 20 ms and PSTN/ISDN G.729 with DECT Terminals TELR = 65 with the condition that the echo cancellation is deployed in the gateway according ITU-T Recommendation Q.115.1 [i.29], additional delay due to DECT 15 ms per user equipment

	PSTN/ISDN Ie = 7 Delay (ms) / R	DSL Ie = 11 Delay (ms) / R
PSTN/ISDN	78 ms / R = 84	117 ms -159 ms / R = 71
DSL	123 ms - 168 ms / R = 71 Note (Ie= 11 +7)	175 ms - 222 ms / R = 65 Note (Ie= 11 +7)

Table 19: End-to-End delay in ms and R value between DSL line 256 kbit/s uplink; 256 kbit/s downlink packet size 20 ms and PSTN/ISDN for G.711 with DECT Terminals TELR = 65 with the condition that the echo cancellation is deployed in the gateway according ITU-T Recommendation Q.115.1 [i.29] additional delay due to DECT 15 ms per user equipment

	PSTN/ISDN Ie = 7 Delay (ms) / R	DSL Ie = 7 Delay (ms) / R
PSTN/ISDN	78 ms / R = 84	81 ms - 111 ms / R = 83
DSL	94 ms - 124 ms / R = 83	127 ms - 147 ms / R = 83

Table 20: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink packet size 20 ms for G.729A with DECT Terminals TELR = 65 with the condition that the echo cancellation is deployed in the gateway according ITU-T Recommendation Q.115.1 [i.29] additional delay due to DECT 15 ms per user equipment

	PSTN/ISDN Ie = 7 Delay (ms) / R	DSL Ie = 7 Delay (ms) / R
PSTN/ISDN	78 ms / R = 84	81 ms - 111 ms / R = 72
DSL	104 ms -134 ms / R = 72 Note (Ie= 11 +7)	127 ms - 147 ms / R = 72 Note (Ie= 11 +7)

Table 21: End-to-End delay ms Delay between DSL line 384 kbit/s uplink; 1 024 kbit/s downlink packet size 20 ms and PSTN/ISDN for G.711 with DECT Terminals TELR = 65 with the condition that the echo cancellation is deployed in the gateway according ITU-T Recommendation Q.115.1 [i.29] additional delay due to DECT 15 ms per user equipment

	PSTN/ISDN Ie = 7 Delay (ms) / R	DSL Ie = 7 Delay (ms) / R
PSTN/ISDN	78 ms / R = 84	77 ms - 97 ms / R = 84
DSL	87 ms - 107 ms / R = 84	100 ms - 116 ms / R = 84

Table 22: End-to-End delay ms Delay between DSL line 512 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN for G.711 with wired terminals packet size 20 ms and PSTN/ISDN for G.711 with DECT Terminals TELR = 65 with the condition that the echo cancellation is deployed in the gateway according ITU-T Recommendation Q.115.1 [i.29] additional delay due to DECT 15 ms per user equipment

	PSTN/ISDN Ie = 7 Delay (ms) / R	DSL Ie = 7 Delay (ms) / R
PSTN/ISDN	78 ms / R = 84	77 ms - 87 ms / R = 84
DSL	85 ms - 95 ms / R = 84	89 ms - 104 ms / R = 84

4.4.2 Categories of User Satisfaction

The following information is an excerpt from ITU-T Recommendation G.109 [i.6].

While the single parameters describe the individual factors affecting speech transmission quality, it is the combined effect of all parameters together which leads to the overall level of speech transmission quality as perceived by the user. For transmission planning purposes, the E-model (G.107 [i.4]) is a useful tool for assessing the combined effect of all parameters and hence differentiating between categories of speech transmission quality.

The primary output of the E-model is the Transmission Rating Factor R. Table 23 gives the definitions of the categories of speech transmission quality in terms of ranges of Transmission Rating Factor R provided by ITU-T Recommendation G.107 [i.4]. Also provided are descriptions of "User satisfaction" for each category.

Table 23 shows Relation between *R*-value and user satisfaction.

Table 23: Relation between *R*-value and user satisfaction

R Value	MOS CQEN Value	Categories of User Satisfaction
94	4,42	Very satisfied (Best)
93	4,40	
92	4,38	
91	4,36	
90	4,34	
87	4,195	Satisfied (High)
85	4,18	
82	4,09	
81	4,06	
80	4,03	Some users dissatisfied (Medium)
77	3,85	
73	3,74	
70	3,60	
68	3,50	Many users dissatisfied (Low)
60	3,10	
50	2,58	Nearly all users dissatisfied (Poor)
MOS = 1 + (0,035) × R + (000 007) × R (R - 60) (100 - R)		
NOTE 1: Connections with R-values below 50 are not recommended. NOTE 2: Although the trend in transmission planning is to use R-values, equations to convert R-values into other metrics e.g. MOS, % GoB, % PoW, can be found in ITU-T Recommendation G.107 [i.4], annex B.		

5 Guidance on Segment-connection Voice Quality Objectives

The objectives proposed in the present document are based on transmission planning aspects as outlined in ITU-T Recommendation G.107 [i.4] (The E-model) and its companion documents ITU-T Recommendations G.108 [i.5] and G.109 [i.6]. For the purposes of verification of these objectives, ITU-T Recommendations of the P.862- series [i.20] and eventually ITU-T Recommendation P.834 [i.21] should be consulted. For the calculation according to G.107 all input parameters excluding the delay and Ie related values are set to default values according to ITU-T Recommendation G.107 [i.4]. This means, that the R-Values reached with different delay and Ie values are under optimal conditions, any deviation from default values for the other parameters will most probably decrease the quality.

The overall aim of the Segment-connection voice quality objectives is to enable network operators, service providers and indirectly also equipment manufacturers to provide end-to-end voice quality with which users are satisfied or even very satisfied. In order to achieve this goal the simplified approach here is, to limit end-to-end delay to 150 ms, except for cases where this is not feasible due to geographical constraints; Also the accumulated sum across the entire connection should not exceed Ie = 12. With routers and gateways currently deployed the 150 ms margin can be reached with an inter regional distance of 10 000 km (propagation delay of 55 ms) for xDSL Access. For PSTN Access an inter regional distance of 19 000 km can be reached, which is the reference connection in ITU-T Recommendation Y.1541 [i.2] (propagation delay of 100 ms).

Annex A provides detailed information on parameters used in the present document which can be useful in the context of the present document.

5.1 Guidance on Access Segment Objectives

The following objectives can be applied between the following points, it should be noted that these parameters may vary between both directions of transmission:

- UNI_A (sending side) → Segment-connection point A (receiving side);
- Segment-connection point A (sending side) → UNI_C (receiving side);
- UNI_A (sending side) → Segment-connection point C (receiving side); and
- Segment-connection point C (sending side) → UNI_C (receiving side).

See figure 2 for details. The categories in table 24 refer to ITU-T Recommendation G.109 [i.6] with the following notations.

Table 24: Guidance on objectives for either Access Segment for R > 90

Parameter	Value
IPDV [ms] sending	55 ms
IPDV [ms] receiving	10 ms
IPLR	3×10^{-4}
IPER	3×10^{-5}

NOTE: The total Jitter should not be higher than 75 ms. The calculation is based on Intra-continent Jitter Value -**5 ms** per Provider (maximum of two involved in the service delivery chain)

5.2 Guidance on Total Transit Segment Objectives

The following objectives can be applied between:

- Segment-connection point A ←→ Segment-connection point C.

See figure 1 for details. The objectives are based on the application of Class 0 of ITU-T Recommendation Y.1541 [i.2]. The determination of cases where Class 1 of ITU-T Recommendation Y.1541 [i.2] should be applied and the associated objectives are for further study.

Table 25: Guidance on Objectives for Total Transit Segments

Parameter	Value
IPDV Intra-continent Jitter Value -**5 ms** per Provider (maximum of 2 involved in the service delivery chain) (see note)	10 ms
IPDV Inter-continent Jitter Value -**10 ms** per Provider (maximum of 2 involved in the service delivery chain) (see note)	20 ms
IPLR	$3{,}0 \times 10^{-4}$
IPER	3×10^{-5}
Ie	0
NOTE: The Jitter Values are based on values contained in the GSMA document IR.3445 [i.15].	

The proposed transit delay value applies to total transit segments which are intra-continental, only. For total transit segments which are intercontinental 140 ms may be appropriate, see table I.2 of ITU-T Recommendation Y.1542 [i.3], the proposed objectives for the present document is for further study.

It is assumed that transcoding in the total transit segment can be avoided at all.

Transit delay includes the core and distribution delay as well as the propagation delay defined in ITU-T Recommendation Y.1541 [i.2].

5.2.1 Availability

Values for availability are following:

- Availability of the IP Backbone Service Provider Core: 99,995 %.
- Service Providers connection to IP Backbone Service Provider core with single connection: 99,7 %.
- Service Providers connection to IP Backbone Service Provider core with dual connection: 99,9 %.

5.3 Voice Terminals

In order to be able to achieve the goal of users being satisfied or even very satisfied with the overall voice communication quality it is assumed that the VoIP terminals used in this context comply with one or more of the following ETSI standards:

- ES 202 737 [i.10].
- ES 202 738 [i.11].
- ES 202 739 [i.12].
- ES 202 740 [i.13].

5.4 End-to-End Aspects

Figures 8 and 9 depict a summary of the proposed delay objectives and the end-to-end delay targets that can be achieved between two xDSL or Ethernet lines. The figure presents the delay distribution between the calling and the called user. The delay of the calling user contains the packetization delay, the compression delay, the serialization time and the play out buffer size. The delay of the called user contains the decompression, the serialization time, the dejitter buffer delay and the PLC. The reference connection is based on an inter regional distance of 10 000 km (propagation delay and core equipment delay -55 ms).

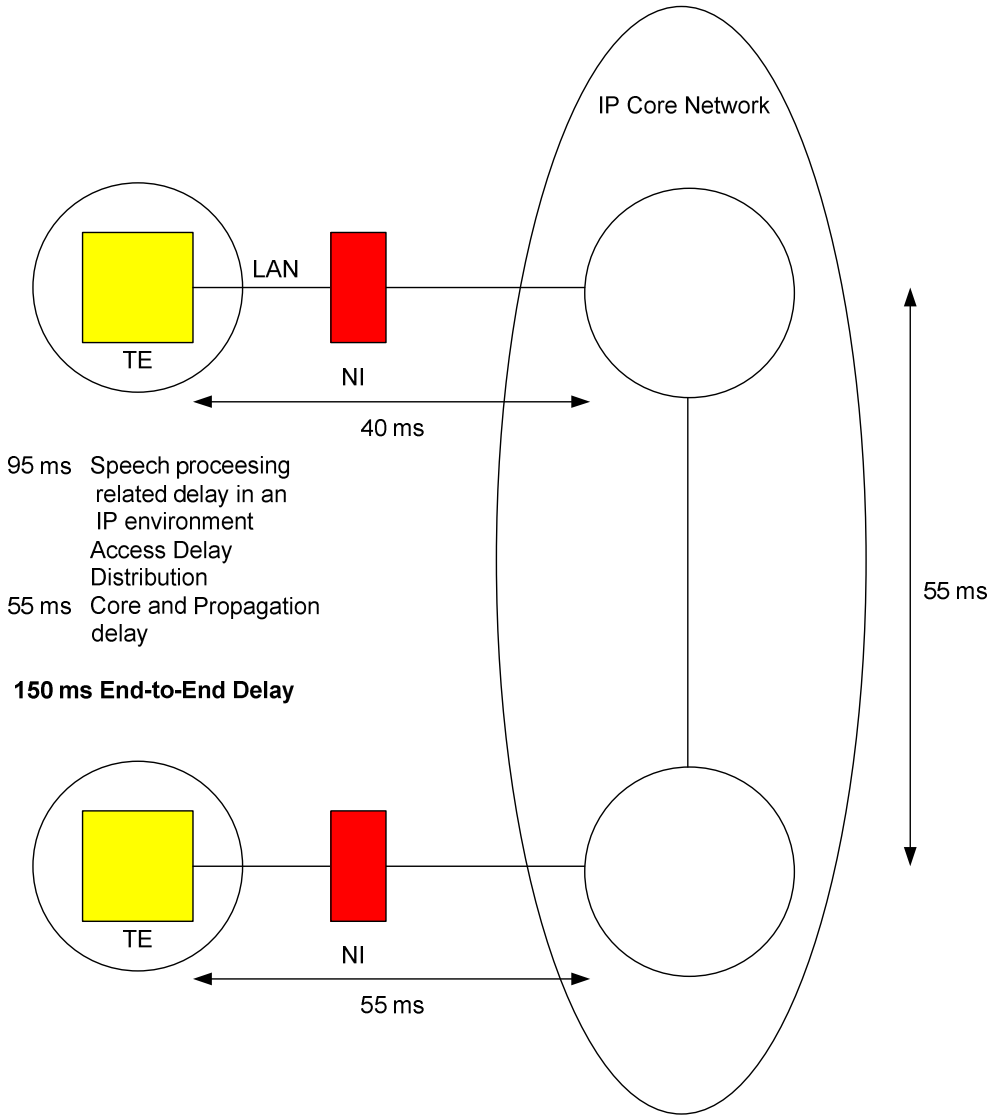

Figure 8: Delay Objectives for BEST (G.109) voice communication quality (R > 90)

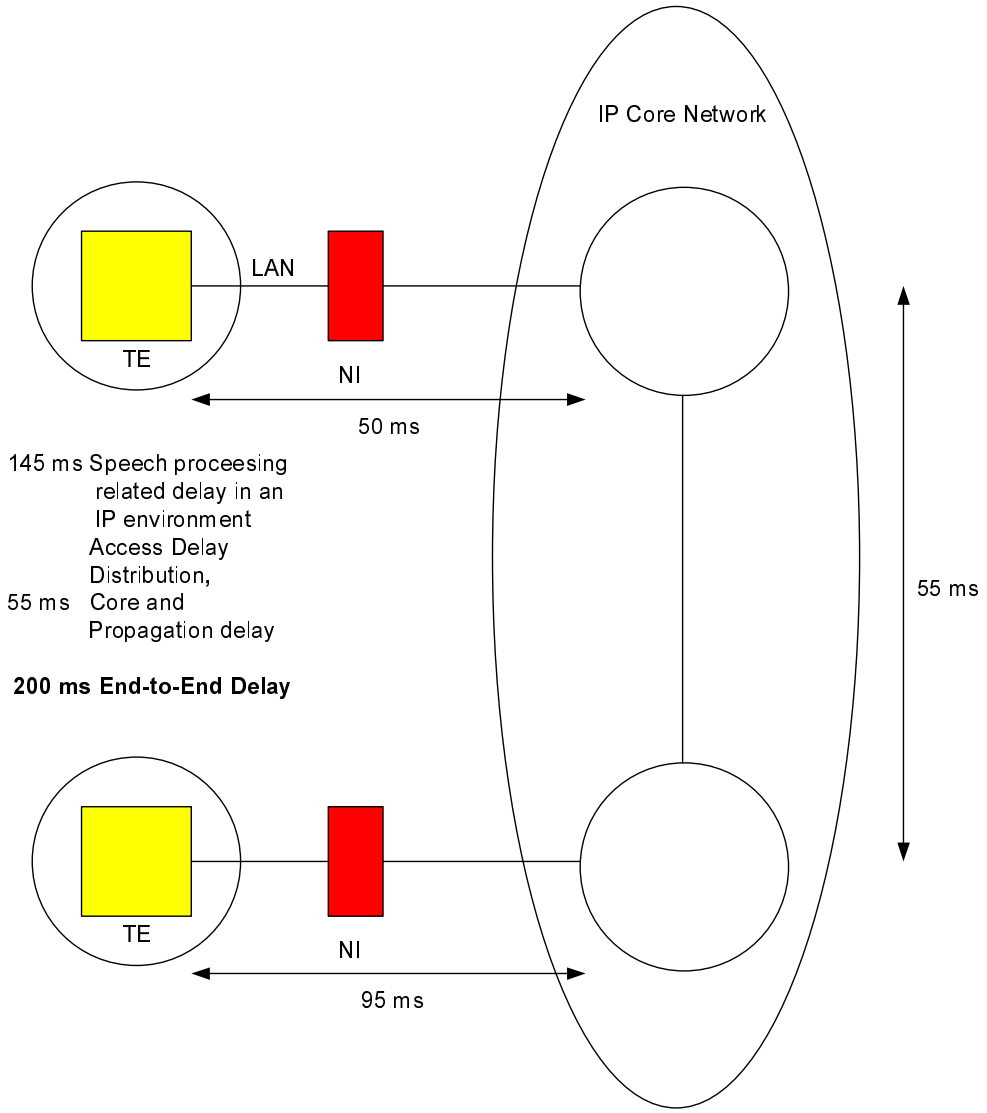

Figure 9: Delay Objectives for HIGH (G.109) voice communication quality (R > 80)

6 Possible Implications due to other services

Even though the present document is focussed on VoIP, it may be worthwhile to consider - at the time of deployment - implications that may arise due to other services which are likely to be carried over the same infrastructure. The following may serve as one example, with its provisional objectives being derived from past and current implementations in traditional networks.

EXAMPLE: The IP-based network should also be capable to carry the 64 kbit/s transparent data service described in ITU-T Recommendation I.231.1 [i.27], also known as "64 k clear-mode". The basis of the objective here is use of ITU-T Recommendation G.826 [i.28], a standard for synchronous digital networks. While the IP core is a packet network and not a synchronous network, it is being used to emulate a service currently transported over a synchronous network. Hence the performance of the emulation should be no worse than the performance of the synchronous network as specified by ITU-T Recommendation G.826 [i.28]. The standard requires an Errored Second Ratio (ESR) of < 0,16 for an STM-1 link which can carry about 1 200 "clear-mode" channels. From this, the end-to-end probability of loss per packet can be shown to be about $1,5 \times 10^{-6}$. In ITU-T Recommendation G.826 [i.28], budgets of 18,5 % of $1,5 \times 10^{-6}$ were allocated to each national network, so the packet loss for a national connection should be no more than $2,75 \times 10^{-7}$. Allocation of this ratio to individual operators' networks within the national network is yet to be agreed, but it is fairly unlikely that there will be more than three operators' switched networks between any customer and the international gateway, so an initial allocation could be $9,0 \times 10^{-8}$ to each operator's network.

Table 26: Summary of provisional objectives

Parameter	Provisional Objective
IP packet loss ratio for national connections	$2,75 \times 10^{-7}$
IP packet loss ratio for each operator's network	$9,0 \times 10^{-8}$
End-to-end probability IP packet loss ratio	$1,5 \times 10^{-6}$
IP packet error ratio for each operator's network	$1,0 \times 10^{-8}$

7 Synchronization of endpoints

To ensure the synchronization of the endpoints (e.g. MSAN, GW; AGW) the endpoints should be synchronized with Synchronous Ethernet (SyncE) based on the ITU-T Recommendations G.8261 [i.16], G.8262 [i.17] and G.8264 [i.18]. Additionally, PTP (IEEE 1588 v2 [i.19]) and NTPv4 may be used as mean for synchronization of endpoints. A distinction needs to be made between time and timing synchronisation. Legacy networks tend only to be interested in timing synch whereas in IP based NGN, both time and timing can be important. Synchronous Ethernet provides timing synch whereas PTP and NTP provide both if correctly implemented.

8 Transmission of fax and modem

The present document describes the network parameters: End-to-End Delay, Talker Echo Loudness Rating, and R Value using adaptive jitter buffers. The disadvantage adaptive jitter buffer is that a part of the jitter budget is transferred to the user. While the human audio capacity is not very sensible to audio delay variation, modem and fax applications are extremely sensible to audio delay variation. For this reason adaptive jitter buffer are not appropriate for use with fax and modem transmission.

For fax and modem transmission are needed a **fixed jitter** buffers which maintains a constant size which constant end-to-end audio delay. The minimum size of jitter buffer for well developed networks is 100 ms.

Annex A:
Summary of Relevant Transmission Planning Data

This annex provides condensed information on transmission planning data that may be considered useful in the context of the present document.

A.1 Delay in VoIP Terminals

The following information is an excerpt from ES 202 737 [i.10], ES 202 738 [i.11], ES 202 739 [i.12] and ES 202 740 [i.13].

A.1.1 Send Delay

For a VoIP terminal, send delay is defined as the one-way delay from the acoustical input (mouthpiece) of this VoIP terminal to its interface to the packet based network. The total send delay is the upper bound on the mean delay and takes into account the delay contributions of all of the elements shown in figures 2 and A.1 in ITU-T Recommendation G.1020 [i.9], respectively.

The sending delay T(s) is defined as follows:

$$T(s) = T(ps) + T(la) + T(aif) + T(asp).$$

Where:

T(ps) = packet size = N × T(fs).

N = number of frames (samples) per packet.

T(fs) = frame size of encoder.

T(la) = look-ahead of encoder.

T(aif) = air interface framing.

T(asp) = allowance for signal processing.

The additional delay required for IP packet assembly and presentation to the underlying link layer will depend on the link layer. When the link layer is a LAN (e.g. Ethernet), this additional time usually will be very small. For the purposes of the present document it is assumed that in the test setup this delay can be neglected.

NOTE: With the knowledge of the codec specific values for T(fs) and T(la) the requirements for send delay for any type of coder and any packet size T(ps) can easily be calculated. Table A.1 provides examples for delay values calculated accordingly.

Table A.1

Codec	N Bytes in the Packet	T(fs) in ms	T(ps) in ms	T(la) in ms	T(aif) in ms	T(asp) in ms	T(s) Requirement in ms
G.711 [i.22]	80	0,125	10	0	0	10	< 20
G.711 [i.22]	160	0,125	20	0	0	10	< 30

A.1.2 Receive delay

For a VoIP terminal, receive delay is defined as the one-way delay from the interface to the packet based network of this VoIP terminal to its acoustical output (earpiece). The total receive delay is the upper bound on the mean delay and takes into account the delay contributions of all of the elements shown in figures 3 and A.2 of ITU-T Recommendation G.1020 [i.9], respectively.

The receiving delay T(r) is defined as follows:

T(r) = T(fs) + T(aif) +T(jb) + T(plc) + T(asp).

Where:

T(fs) = frame size of encoder.

T(aif) = air interface framing.

T(jb) = de-jitter buffer size.

T(plc) = PLC buffer size.

T(asp) = allowance for signal processing.

The additional delay required for IP packet disassembly and presentation from the underlying link layer will depend on the link layer. When the link layer is a LAN (e.g. Ethernet), this additional time usually will be very small. For the purposes of the present document it is assumed that in the test setup this delay can be neglected.

NOTE: With the knowledge of the codec specific values for T(fs) and T(la) the requirements for receive delay for any type of coder and any packet size T(ps) can easily be calculated. Table A.2 provides examples calculated accordingly.

Table A.2

Codec	N	T(fs) in ms	T(aif) in ms	T(jb) in ms	T(plc) in ms	T(asp) in ms	T(r) Requirement in ms
G.711 [i.22]	80	0,125	0	10	10	10	< 30,125
G.711 [i.22]	80	0,125	0	10	0	10	< 20,125
G.711 [i.22]	160	0,125	0	10	10	10	< 30,125
NOTE 1: T(ps) = packet size = N × T(fs). NOTE 2: N = number of frames per packet.							

A.2 Impairment Factors of Codecs

The following data is an excerpt from annex I to ITU-T Recommendation G.113 [i.7].

Table A.3 provides provisional planning values for the equipment impairment factor Ie of some codecs which are relevant in the context of the present document. These Ie values refer to non-error conditions without propagation errors, frame-erasures or packet loss.

Table A.3: Provisional planning values for the equipment impairment factor Ie

Codec type	Reference	Operating rate (kbit/s)	Ie value
PCM	G.711 [i.22]	64	0
ADPCM	G.726 [i.23], G.727 [i.24]	40	2
	G.721 (1988), G.726 [i.23], G.727 [i.24]	32	7
LD-CELP	G.728 [i.25]	16	7
CS-ACELP	G.729 [i.26]	8	10
	G.729-A + VAD	8	11
ACELP	GSM 06.60 (EN 300 726 [i.30]), Enhanced Full Rate	12,2	5

A.3 Network QoS Classes for Voice Applications

The following information is an excerpt from ITU-T Recommendation Y.1541 [i.2].

Table A.4: Provisional IP network QoS class definitions and network performance objectives

		QoS Classes					
Network Performance Parameter	**Nature of Network Performance Objective**	**Class 0**	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5 Un-specified**
IPTD	Upper bound on the mean IPTD	100 ms	400 ms	**Not relevant for voice communication!**			
IPDV	Upper bound on the $1 - 10^{-3}$ quantile of IPTD minus the minimum IPTD	50 ms	50 ms				
IPLR	Upper bound on the packet loss probability	1×10^{-3}	1×10^{-3}				
IPER	Upper bound	1×10^{-4}					

A.4 Comparison of Codecs, Link Speed and Capacity examples

Table A.5: Comparison of Codecs, Link Speed and Capacity examples - (ADSL RFC 1483 [i.31] Bridging)

	G.711			G.726				G.729A	
Codec Bit Rate (kb/s)	64	64	64	32	32	40	40	8	8
Ie	0			7		2		11	
Packet Frame Duration (ms)	10	20	30	20	30	20	10	20	30
Bytes	80	160	240	160	240	160	80		
Frames per Packet								2	3
IP Payload (Bytes)	120	200	280	120	160	140	90	60	70
IP Bitrate needed (kbit/s)	96	80	74	48	42	56	72	24	18
ATM Cells Needed IP Packet Size	4	5	7	4	4	4	3	2	2
ATM Bytes Needed	212	265	371	212	212	212	159	106	106
Serialization time (ms) 128 kbit/s (ATM Bytes Needed x 8)/128	13	17	23	13	13	13	10	7	7
Serialization time 256 kbit/s	7	8	12	7	7	7	5	3	3
Serialization time 384 kbit/s	4	6	8	4	4	4	3	2	2
Serialization time 1 024 kbit/s	2	2	3	2	2	2	1	1	1
ATM Bitrate Needed (kb/s)/channel (ATM Bytes x 8/duration)	170	106	98	84,84	56	84.8	127	42	28
Delay in IP environment (ms) (2N + 1)x frame size + Look ahead Where: N = number of frames per packet; frame size is in ms	30 (2x120+1) x 0,125	40 (2x160+1) x 0,125	60	40	60	40	30	55	75

Table A.6: Link Speed and Capacity examples for signalization traffic (ADSL RFC 1483 [i.31] Bridging)

IP Payload (Bytes)	1 500	800	600
IP Bitrate needed (kbit/s)			
ATM Cells Needed IP Packet Size	33	19	14
ATM Bytes Needed	1 749	1 007	742
Serialization time (ms) 128 kbit/s (ATM Bytes Needed x 8)/128	109	63	46
Serialization time 256 kbit/s	54	31	23
Serialization time 384 kbit/s	36	20	15
Serialization time 1 024 kbit/s	13	8	6

A.5 Serialization Delay

Table A.7: Serialization Delay in Milliseconds for Different Frame Sizes

Frame Size (bytes)	Line Speed (Kbps)										
	19,2	56	64	128	256	384	512	768	1 024	1 544	2 048
38	15,83	5,43	4,75	2,38	1,19	0,79	0,59	0,40	0,30	0,20	0,15
48	20,00	6,86	6,00	3,00	1,50	1,00	0,75	0,50	0,38	0,25	0,19
64	26,67	9,14	8,00	4,00	2,00	1,33	1,00	0,67	0,50	0,33	0,25
128	53,33	18,29	16,00	8,00	4,00	2,67	2,00	1,33	1,00	0,66	0,50
256	106,67	36,57	32,00	16,00	8,00	5,33	4,00	2,67	2,00	1,33	1,00
512	213,33	73,14	64,00	32,00	16,00	10,67	8,00	5,33	4,00	2,65	2,00
1 024	426,67	149,29	128,00	64,00	32,00	21,33	16,00	10,67	8,00	5,31	4,00
1 500	625,00	214,29	187,50	93,75	46,88	31,25	23,44	15,63	11,72	7,77	5,86
2 048	853,33	292,57	256,00	128,00	64,00	42,67	32,00	21,33	16,00	10,61	8,00

Table A.8: Best and Worst Case Processing Delay

Coder	Rate	Required Sample Block	Best Case Coder Delay	Worst Case Coder Delay
ADPCM, G.726	32 kbit/s	10 ms	2,5 ms	10 ms
CS-ACELP, G.729A	8,0 kbit/s	10 ms	2,5 ms	10 ms
MP-MLQ, G.723.1	6,3 kbit/s	30 ms	5 ms	20 ms
MP-ACELP, G.723.1	5,3 kbit/s	30 ms	5 ms	20 ms

A.6 Transport Reference Parameters

A.6.1 Backbone Parameters

Table A.9 shows the number of elements used in the configuration and the delay values.

Table A.9: Transport Network parameters

SBC	ADM 4x	DL 2x	CL 4x	SBC 1	SBC 1	CL 4x	DL 2x	ADM 4x	SBC
0,1	0,4	1	0,4	0,1	0,1	0,4	1	0,4	0,1

Table A.10 shows the long distance delay values for typical reference distances.

Table A.10: Delay values for typical reference distances

Delay Equipment	Propagation delay (5 µs/km)	Sum
4 ms	7 ms for 1 400 km	11 ms
5 ms	25 ms for 5 000 km (Intra Regional)	30 ms
5 ms	50 ms for 10 000 km (Inter Regional)	55 ms
7 ms	138 ms for 27 500 km (Inter Regional)	145 ms

A.6.2 Network and Access Parameters

Table A.11 shows the voice sample size for the transport network at the various instances in ms and bytes respectively.

Table A.11: Transport Network parameters

Voice Packet Size						
Codec	**Packet size in ms**	**In Byte**	**RTP**	**UDP**	**IP**	**IP Packet size IPV4**
G.711	10	80	12	8	20	120
G.711	20	160	12	8	20	200
G.729	10	10	12	8	20	50
G.729	20	20	12	8	20	60

Table A.12 shows access network parameters for different technologies.

NOTE: These values are examples, they can differ due to different settings of the DSL connections.

Table A.12: Access Network parameters for G.711 Packet size 20 ms

Technology	Transport in Byte (Payload)	Number of Packets	Voice without overhead	Data rate in kbit/s
Ethernet 802.3	218	N/A	160 Byte	87,2
ATM RFC 1483 [i.31] Bridging	265	5		106

Table A.13: Access Network parameters for G.726/32 Packet size 20 ms

Technology	Transport in Byte (Payload)	Number of Packets	Voice without overhead	Data rate in kbit/s
Ethernet 802.3	138	N/A	160 Byte	55,2
ATM RFC 1483 [i.31] Bridging	212	4		84.8

Table A.14: Access Network parameters for G.726/40 Packet size 20 ms

Technology	Transport in Byte (Payload)	Number of Packets	Voice without overhead	Data rate in kbit/s
Ethernet 802.3	158	N/A	160 Byte	63,2
ATM RFC 1483 [i.31] Bridging	212	4		84.8

Table A.15: Access Network parameters for G.711 Packet size 10 ms

Technology	Transport in Byte (Payload)	Number of Packets	Voice without overhead	Data rate in kbit/s
Ethernet 802.3	138	N/A	80 Byte	110,4
ATM RFC 1483 [i.31] Bridging	212	4		169,6

Table A.16: Access Network parameters for G.729 Packet size 20 ms

Technology	Transport in Byte (Payload)	Number of Packets	Voice without overhead	Data rate in kbit/s
Ethernet 802.3	78	N/A	20 Byte	35,2
ATM RFC 1483 [i.31] Bridging	106	2	20 Byte	42,2

Table A.17 shows ADSL serialization times for access and codecs.

Table A.17: DSL serialization times for 20 ms Packet size

ADSL access line (kbit/s)	Serialization time for G.711 20 ms (ATM based)	Serialization time for G.711 20 ms (ETH based)	Serialization time for G.729A (ATM based)	Serialization time for G.729A (ETH based)
128	17	14	7	5
256	8	7	3	3
384	6	5	2	2
512	4	3		1
768	3	2		1
1 024	2	2	1	1

Table A.18: DSL serialization times for 20 ms Packet size

ADSL access line (kbit/s)	Serialization time for G.726/32/20 (ATM based)	Serialization time for G.726/32/20 (ETH based)	Serialization time for G.726/40/20 (ATM based)	Serialization time for G.726/40/20 (ETH based)
128	13	8	13	9
256	7	4	7	4
384	4	3	4	3
512	3	2	3	2
768	2	1	2	1
1 024	2	1	2	1

Table A.19: DSL serialization times for 10 ms Packet size

ADSL access line (kbit/s)	Serialization time for G.711 (ATM based)	Serialization time for G.711 (ETH based)
128	13 (see note)	9
256	7	4
384	4	3
512	3	2
768	2	1
1 024	2	1
NOTE: 10 ms Packet size is not applicable for 128 kbit/s access line.		

Table A.20 shows backbone parameters.

Table A.20: Backbone parameters

Parameter	Value
IPDV Intra-continent jitter value -5 ms per provider (maximum of 2 involved in the service delivery chain)	10
IPDV Inter-continent jitter value -10 ms per provider (maximum of 2 involved in the service delivery chain)	20
IPLR	$3{,}0 \times 10^{-4}$
IPER	3×10^{-5}
Ie	0

Table A.21 shows various coder parameters.

Table A.21: Coder parameters packet size 20 ms

Coder Processing Delay	Algorithmic Delay G.729	Decompression Delay
Default values: AGW: 5 ms IAD: 10 ms	15 ms	G.711: 1 ms G.729: 2 ms

Table A.22 shows coder delay values.

Table A.22: Coder delay

Packetization Delay	20 ms
Processing time	AGW = 5 ms; IAD = 10 ms
Algorithmic delay G.729	5 ms look ahead + 10 ms frame size
Play out buffer Size Min (Note)	1/2 t_{dmax} + voice serialization
Play out buffer Size Max (Note)	1,5 x Serial. time data packet
Serialization	Depends on the access
Packetization Delay	10 ms
Processing time	AGW = 5 IAD = 10 ms
Play out buffer Size Min (Note)	1/2 t_{dmax} + voice serialization
Play out buffer Size Max (Note)	1,5 x Serial. time data packet
Serialization	Depends on the access
NOTE: The delay caused due to the play out buffer is handled in clause "Queuing and buffering delay".	

Table A.23 shows decoder delay values.

Table A.23: Decoder delay

Decompression time per block	1 ms G.711, 2 ms G.729
Serialization time	Depends on the access
De-jitter Buffer Size	De-jitter Buffer caused due Queuing at the access and transit segments
De-jitter buffer delay	0,5 time de-jitter buffer size
PLC	3,25 ms

A.6.3 Delay and Jitter Values

A.6.3.1 Delay and Serialization time

Table A.24 shows delay values or respective ranges for various network elements and signalization frames.

The serialization times of signalling packets produce delay variation for media packets, even if no other traffic (e.g. data traffic is present).

Table A.24: Network element delay and Serialization time for signalization

Network element	Delay	Serialization time for signalization frame	Comments
Legacy network switch	0,45 s	0	
MGW Sending Packet size 20 ms	25 ms	0	G.711; 20 ms packetization; STM 1
MGW Sending Packet size 10 ms	15 ms	0	G.711; 10 ms packetization + processing time
MGW Receiving Packet size 10 ms Jitter Buffer 20 ms	26 ms	0	½ De-jitter Buffer 20 ms + Depacketization + PLC; STM 1

Network element	Delay	Serialization time for signalization frame	Comments
MGW Receiving Packet size 10 ms jitter Buffer 30 ms	16 ms	0	½ De-jitter Buffer 30 ms + Depacketization + PLC; STM 1
MGW Receiving with adaptive Jitter buffer 40 ms Packet size 20 ms	26 ms	0	½ De-jitter Buffer 40 ms + Depacketization + PLC; STM 1
MGW Receiving Jitter buffer 50 ms	31 ms	0	½ De-jitter Buffer 50 ms + Depacketization + PLC; STM 1
ADM	0,1 ms	0	
Transmission fibre optic	5 µs/km	0	
IAD Sending ATM line 128 kbit/s Packet size 20 ms	47 ms	63 ms - 109 ms Caused by Signalization	G.711; 20 ms packetization, + compression time per block serialization time 128 kbit/s ATM Line (reInvite 1 749 Byte x 8/128 10^3 = 109 ms; Registration 1 007 Byte x 8/128 10^3 = 63 ms)
IAD Sending Ethernet 128 kbit/s Packet size 20 ms	44 ms	50 ms - 94 ms Caused by Signalization	G.711; 20 ms packetization, + compression time per block serialization time 128 kbit/s Ethernet Line (reInvite 1 500 Byte x 8/128 10^3 = 94 ms; Registration 800 Byte x 8/128 10^3 = 50 ms)
IAD Sending ATM line 256 kbit/s Packet size 20 ms	38 ms	31 ms - 55 ms Caused by Signalization	G.711; 20 ms packetization, compression time per block serialization time 256 kbit/s ATM Line (reInvite 1 749 Byte x 8/256 10^3 = 55 ms; Registration 1 007 Byte x 8/256 10^3 = 31 ms)
IAD Sending Ethernet 256 kbit/s Packet size 20 ms	37 ms	25 ms - 46 ms Caused by Signalization	G.711; 20 ms packetization, compression time per block serialization time 256 kbit/s Ethernet Line (reInvite 1 500 Byte x 8/256 10^3 = 46 ms; Registration 800 Byte x 8/256 10^3 = 25 ms)
IAD Sending ATM line 256 kbit/s G.726/32/20	34 ms	31 ms - 55 ms Caused by Signalization	G.711; 20 ms packetization, compression time per block serialization time 256 kbit/s ATM Line (reInvite 1 749 Byte x 8/256 10^3 = 55 ms; Registration 1 007 Byte x 8/256 10^3 = 31 ms)
IAD Sending ATM line 256 kbit/s G.726/40/20	37 ms	31 ms - 55 ms Caused by Signalization	G.711; 20 ms packetization, compression time per block serialization time 256 kbit/s ATM Line (reInvite 1 749 Byte x 8/256 10^3 = 55 ms; Registration 1 007 Byte x 8/256 10^3 = 31 ms)

Network element	Delay	Serialization time for signalization frame	Comments
IAD Sending ATM line 384 kbit/s Packet size 20 ms	36 ms	21 ms - 36 ms Caused by Signalization	G.711; 20 ms packetization, compression time per block serialization time 384 kbit/s ATM Line (reInvite, 1 749 Byte x 8/384 10^3 = 36 ms; Registration 1 007 Byte x 8/384 10^3 = 21)
IAD Sending Ethernet line 384 kbit/s Packet size 20 ms	35 ms	17 ms - 31 ms Caused by Signalization	G.711; 20 ms packetization, compression time per block serialization time 384 kbit/s Ethernet Line (reInvite, 1 500 Byte x 8/384 10^3 = 31 ms; Registration 800 Byte x 8/384 10^3 = 17)
IAD Sending ATM line 384 kbit/s Packet size 10 ms	24 ms	21 ms - 36 ms Caused by Signalization	G.711; 10 ms packetization, compression time per block serialization time 384 kbit/s ATM Line (reInvite, 1 749 Byte x 8/384 10^3 = 36 ms; Registration 1 007 Byte x 8/384 10^3 = 21)
IAD Sending Ethernet line 384 kbit/s Packet size 10 ms	23 ms	17 ms - 31 ms Caused by Signalization	G.711; 10 ms packetization, compression time per block serialization time 384 kbit/s Ethernet Line (reInvite, 1 500 Byte x 8/384 10^3 = 31 ms; Registration 800 Byte x 8/384 10^3 = 17)
IAD Sending ATM line 384 kbit/s Packet size 20 ms G.726/32/20	33 ms	21 ms - 36 ms Caused by Signalization	G.726/32/20; compression time per block serialization time 384 kbit/s ATM Line (reInvite, 1 749 Byte x 8/384 10^3 = 36 ms; Registration 1 007 Byte x 8/384 10^3 = 21)
IAD Sending ATM line 384 kbit/s Packet size 20 ms G.726/40/20	34 ms	21 ms - 36 ms Caused by Signalization	G.726/32/20; compression time per block serialization time 384 kbit/s ATM Line (reInvite, 1 749 Byte x 8/384 10^3 = 36 ms; Registration 1 007 Byte x 8/384 10^3 = 21)
IAD Sending ATM line 512 kbit/s Packet size 20 ms	34 ms	16 ms - 27 ms Caused by Signalization	G.711; 20 ms packetization, compression time per block serialization time 512 Kbit/s ATM Line (reInvite 1 749 Byte x 8/512 10^3 = 27 ms; Registration 1 007 Byte x 8/512 10^3 = 16 ms)
IAD Sending ATM line 512 kbit/s Packet size 20 ms	33 ms	13 ms - 23 ms Caused by Signalization	G.711; 20 ms packetization, compression time per block serialization time 512 Kbit/s ATM Line (reInvite 1 500 Byte x 8/512 10^3 = 23 ms; Registration 800 Byte x 8/512 10^3 = 13 ms)

Network element	Delay	Serialization time for signalization frame	Comments
IAD Sending ATM line 512 kbit/s Packet size 10 ms	23 ms	16 ms - 27 ms Caused by Signalization	G.711; 10 ms packetization, compression time per block serialization time 512 Kbit/s ATM Line (reInvite 1 749 Byte x 8/512 10^3 = 27 ms; Registration 1 007 Byte x 8/512 10^3 = 16 ms)
IAD Sending ETH line 512 kbit/s Packet size 10 ms	22 ms	13 ms - 23 ms Caused by Signalization	G.711; 10 ms packetization, compression time per block serialization time 512 Kbit/s ATM Line (reInvite 1 500 Byte x 8/512 10^3 = 23 ms; Registration 800 Byte x 8/512 10^3 = 13 ms)
IAD Sending ATM line 768 kbit/s Packet size 20 ms	33 ms	10 ms - 18 ms Caused by Signalization	G.711; 20 ms packetization, compression time per block serialization time 768 Kbit/s ATM Line (reInvite 1 749 Byte x 8/768 10^3 = 18 ms; Registration 1 007 Byte x 8/768 10^3 = 10 ms)
IAD Sending Ethernet line 768 kbit/s Packet size 20 ms	32 ms	8 ms - 15 ms Caused by Signalization	G.711; 20 ms packetization, compression time per block serialization time 768 Kbit/s ATM Line (reInvite 1 500 Byte x 8/768 10^3 = 15 ms; Registration 800 Byte x 8/768 10^3 = 8 ms)
IAD Sending ATM line 768 kbit/s Packet size 10 ms	22 ms	10 ms - 18 ms Caused by Signalization	G.711; 10 ms packetization, compression time per block serialization time 768 Kbit/s ATM Line (reInvite 1 749 Byte x 8/768 10^3 = 18 ms; Registration 1 007 Byte x 8/768 10^3 = 10 ms)
IAD Sending Ethernet line 768 kbit/s Packet size 10 ms	21 ms	8 ms - 15 ms Caused by Signalization	G.711; 10 ms packetization, compression time per block serialization time 768 Kbit/s ATM Line (reInvite 1 500 Byte x 8/768 10^3 = 15 ms; Registration 800 Byte x 8/768 10^3 = 8 ms)
IAD Sending ATM line 1 024 kbit/s Packet size 20 ms	32 ms	8 ms - 13 ms Caused by Signalization	G.711; 20 ms packetization, compression time per block serialization time 1 024 Kbit/s ATM Line (reInvite 1 749 Byte x 8/1 024 10^3 = 13 ms; Registration 1 007 Byte x 8/1 024 10^3 = 8 ms)
IAD Sending Ethernet line 1 024 kbit/s Packet size 20 ms	32 ms	6 ms - 12 ms Caused by Signalization	G.711; 20 ms packetization, compression time per block serialization time 1 024 Kbit/s ATM Line (reInvite 1 500 Byte x 8/1 024 10^3 = 12 ms; Registration 800 Byte x 8/1 024 10^3 = 6 ms)

Network element	Delay	Serialization time for signalization frame	Comments
IAD Sending ATM line 1 024 kbit/s Packet size 10 ms	22 ms	8 ms - 14 ms Caused by Signalization	G.711; 10 ms packetization, compression time per block serialization time 1 024 Kbit/s ATM Line (reInvite 1 749 Byte x 8/1 024 10^3 = 14 ms; Registration 1 007 Byte x 8/1 024 10^3 = 8 ms)
IAD Sending Ethernet line 1 024 kbit/s Packet size 10 ms	22 ms	6 ms - 12 ms Caused by Signalization	G.711; 10 ms packetization, compression time per block serialization time 1 024 Kbit/s ATM Line (reInvite 1 500 Byte x 8/1 024 10^3 = 12 ms; Registration 800 Byte x 8/1 024 10^3 = 6 ms)
IAD receiving ATM line 128 Kbit/s Adaptive Jitter Buffer = 80 ms Packet size 20 ms	61 ms	46 ms - 109 ms Caused by Signalization	G.711; 20 ms packetization, ½ De-jitter Buffer 80 ms + depacketization + PLC serialization time 128 kbit/s ATM Line (200 OK, 401 742 Byte x 8/128 10^3= 46 ms reInvite 1 749 Byte x 8/128 10^3 = 109 ms)
IAD receiving ETH line 128 Kbit/s Adaptive Jitter Buffer = 80 ms Packet size 20 ms	58 ms	37 ms - 93 ms Caused by Signalization	G.711; 20 ms packetization, ½ De-jitter Buffer 80 ms + depacketization + PLC serialization time 128 kbit/s ATM Line (200 OK, 401 600 Byte x 8/128 10^3 = 37 ms reInvite 1 500 Byte x 8/128 10^3 = 93 ms)
IAD receiving ATM line 128 Kbit/s Jitter Buffer = 100 ms Packet size 20 ms	71 ms	109 ms Caused by Signalization	G.711; 20 ms packetization, ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 128 kbit/s ATM Line (200 OK, 401 742 Byte x 8/128 10^3= 46 ms reInvite 1 749 Byte x 8/128 10^3 = 109 ms)
IAD receiving ATM line 128 Kbit/s Jitter Buffer = 150 ms Packet size 20 ms	96 ms	46 ms - 109 ms Caused by Signalization	G.711; 20 ms packetization, ½ De-jitter Buffer 150 ms + depacketization + PLC serialization time 128 kbit/s ATM Line (200 OK, 401 742 Byte x 8/128 10^3= 46 ms reInvite 1 749 Byte x 8/128 10^3 = 109 ms)
IAD receiving Ethernet line 128 Kbit/s Jitter Buffer = 150 ms Packet size 20 ms	92 ms	37 ms - 93 ms Caused by Signalization	G.711; 20 ms packetization, ½ De-jitter Buffer 150 ms + depacketization + PLC serialization time 128 kbit/s ATM Line (200 OK, 401 600 Byte x 8/128 10^3 = 37 ms reInvite 1 500 Byte x 8/128 10^3 = 93 ms)
IAD receiving ATM line 128 Kbit/s Jitter Buffer = 200 ms Packet size 20 ms	121 ms	46 ms - 109 ms Caused by Signalization	G.711; 20 ms packetization, ½ De-jitter Buffer 200 ms + depacketization + PLC serialization time 128 kbit/s ATM Line (200 OK, 401 742 Byte x 8/128 10^3 = 46 ms) reInvite 1 779 Byte x 8/128 10^3 = 109 ms)

Network element	Delay	Serialization time for signalization frame	Comments
IAD receiving Ethernet line 128 Kbit/s Jitter Buffer = 200 ms Packet size 20 ms	118 ms	37 ms - 111 ms Caused by Signalization	G.711; 20 ms packetization, ½ De-jitter Buffer 200 ms + depacketization + PLC serialization time 128 kbit/s ATM Line (200 OK, 401 600 Byte x 8/128 10^3 = 37 ms) (reInvite 1 779 Byte x 8/128 10^3 = 111 ms
IAD receiving ATM line 256 kbit/s Jitter Buffer = 40 ms Packet size 10 ms	31 ms	23 ms - 55 ms Caused by Signalization	G.711; 10 ms packetization ½ De-jitter Buffer 40 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3 = 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)
IAD receiving ETH line 256 kbit/s Jitter Buffer = 40 ms Packet size 10 ms	28 ms	19 ms - 47 ms Caused by Signalization	G.711; 10 ms packetization ½ De-jitter Buffer 40 ms + depacketization + PLC serialization time 256 kbit/s ETH Line (200 OK, 401 600 Byte x 8/256 10^3 = 19 ms reInvite 1 500 Byte x 8/256 10^3 = 47 ms)
IAD receiving ATM line 256 kbit/s Jitter Buffer = 50 ms Packet size 10 ms	37 ms	23 ms - 55 ms Caused by Signalization	G.711; 10 ms packetization ½ De-jitter Buffer 50 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3 = 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)
IAD receiving ETH line 256 kbit/s Jitter Buffer = 50 ms Packet size 10 ms	33 ms	19 ms - 47 ms Caused by Signalization	G.711; 20 ms packetization ½ De-jitter Buffer 50 ms + depacketization + PLC serialization time 256 kbit/s ETH Line (200 OK, 401 600 Byte x 8/256 10^3 = 19 ms reInvite 1 500 Byte x 8/256 10^3 = 47 ms)
IAD receiving ATM line 256 kbit/s Jitter Buffer = 50 ms Packet size 20 ms	37 ms	23 ms - 55 ms Caused by Signalization	G.711; 20 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3 = 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)
IAD receiving ETH line 256 kbit/s Jitter Buffer = 50 ms Packet size 20 ms	36 ms	19 ms - 47 ms Caused by Signalization	G.711; 20 ms packetization ½ De-jitter Buffer 50 ms + depacketization + PLC serialization time 256 kbit/s ETH Line (200 OK, 401 600 Byte x 8/256 10^3 = 19 ms) reInvite 1 500 Byte x 8/128 10^3 = 47 ms)
IAD receiving ATM line 256 kbit/s Jitter Buffer = 100 ms Packet size 20 ms	62 ms	23 ms - 55 ms Caused by Signalization	G.711; 20 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3 = 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)

Network element	Delay	Serialization time for signalization frame	Comments
IAD receiving Ethernet line 256 kbit/s Jitter Buffer = 100 ms Packet size 20 ms	61 ms	19 ms - 47 ms Caused by Signalization	G.711; 20 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 256 kbit/s ETH Line (200 OK, 401 600 Byte x 8/256 10^3 = 19 ms) reInvite 1 500 Byte x 8/128 10^3 = 47 ms)
IAD receiving ATM line 256 kbit/s Jitter Buffer = 100 ms Packet size 10 ms	67 ms	23 ms - 55 ms Caused by Signalization	G.711; 10 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3 = 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)
IAD receiving ETH line 256 kbit/s Jitter Buffer = 100 ms Packet size 10 ms	58 ms	23 ms - 47 ms Caused by Signalization	G.711; 10 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 256 kbit/s ETH Line (200 OK, 401 742 Byte x 8/256 10^3 = 23 ms reInvite 1 500 Byte x 8/256 10^3 = 47 ms)
IAD receiving ATM line 256 kbit/s Jitter Buffer = 150 ms Packet size 20 ms	87 ms	23 ms - 55 ms Caused by Signalization	G.711 20 ms packetization ½ De-jitter Buffer 150 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3= 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)
IAD receiving Ethernet line 256 kbit/s Jitter Buffer = 150 ms Packet size 20 ms	86 ms	19 ms - 47 ms Caused by Signalization	G.711; 20 ms packetization ½ De-jitter Buffer 150 ms + depacketization + PLC serialization time 256 kbit/s ETH Line (200 OK, 401 600 Byte x 8/256 10^3 = 19 ms) reInvite 1 500 Byte x 8/256 10^3 = 47 ms
IAD receiving Ethernet line 256 kbit/s Jitter Buffer = 150 ms Packet size 10 ms	85 ms	19 ms - 47 ms Caused by Signalization	G.711; 10 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 600 Byte x 8/256 10^3 = 19 ms reInvite 1 500 Byte x 8/256 10^3 = 47 ms)
IAD receiving ATM line 256 kbit/s Jitter Buffer = 40 ms G.726/32/20	28 ms	23 ms - 55 ms Caused by Signalization	G.726/32/20 ½ De-jitter Buffer 40 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3= 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)

Network element	Delay	Serialization time for signalization frame	Comments
IAD receiving ATM line 256 kbit/s Jitter Buffer = 70 ms G.726/32/20	43 ms	23 ms - 55 ms Caused by Signalization	G.726/32/20 ½ De-jitter Buffer 70 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3= 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)
IAD receiving ATM line 256 kbit/s Jitter Buffer = 90 ms G.726/32/20	53 ms	23 ms - 55 ms Caused by Signalization	G.726/32/20 ½ De-jitter Buffer 90 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3= 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)
IAD receiving ATM line 256 kbit/s Jitter Buffer = 120 ms G.726/32/20	73 ms	23 ms - 55 ms Caused by Signalization	G.726/32/20 ½ De-jitter Buffer 130 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3= 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)
IAD receiving ATM line 256 kbit/s Jitter Buffer = 40 ms G.726/40/20	30 ms	23 ms - 55 ms Caused by Signalization	G.726/40/20 ½ De-jitter Buffer 40 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3= 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)
IAD receiving ATM line 256 kbit/s Jitter Buffer = 70 ms G.726/40/20	45 ms	23 ms - 55 ms Caused by Signalization	G.726/40/20 ½ De-jitter Buffer 70 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3= 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)
IAD receiving ATM line 256 kbit/s Jitter Buffer = 90 ms G.726/40/20	55 ms	23 ms - 55 ms Caused by Signalization	G.726/40/20 ½ De-jitter Buffer 90 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3= 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)
IAD receiving ATM line 256 kbit/s Jitter Buffer = 120 ms G.726/32/20	65 ms	23 ms - 55 ms Caused by Signalization	G.726/40/20 ½ De-jitter Buffer 130 ms + depacketization + PLC serialization time 256 kbit/s ATM Line (200 OK, 401 742 Byte x 8/256 10^3= 23 ms reInvite 1 779 Byte x 8/256 10^3 = 55 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 40 ms Packet size 10 ms	28 ms	15 ms - 37 ms Caused by Signalization	G.711; 10 ms packetization ½ De-jitter Buffer 40 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)

Network element	Delay	Serialization time for signalization frame	Comments
IAD receiving ETH line 384 kbit/s Jitter Buffer = 40 ms Packet size 10 ms	27 ms	13 ms - 31 ms Caused by Signalization	G.711; 10 ms packetization ½ De-jitter Buffer 40 ms + depacketization + PLC serialization time 384 kbit/s ETH Line (200 OK, 401 600 Byte x 8/384 10^3 = 13 ms reInvite 1 500 Byte x 8/384 10^3 = 31 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 50 ms Packet size 10 ms	33 ms	15 ms - 37 ms Caused by Signalization	G.711; 10 ms packetization ½ De-jitter Buffer 50 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)
IAD receiving ETH line 384 kbit/s Jitter Buffer = 50 ms Packet size 10 ms	32 ms	13 ms - 31 ms Caused by Signalization	G.711; 20 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 384 kbit/s ETH Line (200 OK, 401 600 Byte x 8/384 10^3 = 13 ms reInvite 1 500 Byte x 8/384 10^3 = 31 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 50 ms Packet size 20 ms	35 ms	15 ms - 37 ms Caused by Signalization	G.711; 10 ms packetization ½ De-jitter Buffer 50 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)
IAD receiving ETH line 384 kbit/s Jitter Buffer = 50 ms Packet size 20 ms	34 ms	19 ms Caused by Signalization	G.711; 20 ms packetization ½ De-jitter Buffer 50 ms + depacketization + PLC serialization time 384 kbit/s ETH Line (200 OK, 401 600 Byte x 8/384 10^3 = 19 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 100 ms Packet size 20 ms	60 ms	15 ms - 37 ms Caused by Signalization	G.711; 20 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)
IAD receiving Ethernet line 384 kbit/s Jitter Buffer = 100 ms Packet size 20 ms	59 ms	13 ms - 31 ms Caused by Signalization	G.711; 20 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 384 kbit/s ETH Line (200 OK, 401 serialization time 384 kbit/s ETH Line (200 OK, 401 600 Byte x 8/384 10^3 = 13 ms reInvite 1 500 Byte x 8/384 10^3 = 31 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 100 ms Packet size 10 ms	58 ms	15 ms - 37 ms Caused by Signalization	G.711; 10 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)

Network element	Delay	Serialization time for signalization frame	Comments
IAD receiving ETH line 384 kbit/s Jitter Buffer = 100 ms Packet size 10 ms	57 ms	13 ms - 31 ms Caused by Signalization	G.711; 10 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 384 kbit/s ETH Line (200 OK, 401 600 Byte x 8/384 10^3 = 13 ms reInvite 1 500 Byte x 8/384 10^3 = 31 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 150 ms Packet size 20 ms	85 ms	15 ms - 37 ms Caused by Signalization	G.711 20 ms packetization ½ De-jitter Buffer 150 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)
IAD receiving Ethernet line 384 kbit/s Jitter Buffer = 150 ms Packet size 20 ms	84 ms	13 ms - 31 ms Caused by Signalization	G.711; 20 ms packetization ½ De-jitter Buffer 150 ms + depacketization + PLC serialization time 384 kbit/s ETH Line (200 OK, 401 600 Byte x 8/384 10^3 = 13 ms reInvite 1 500 Byte x 8/384 10^3 = 31 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 40 ms G.726/32/20	26 ms	15 ms - 37 ms Caused by Signalization	G.726/32/20 ½ De-jitter Buffer 40 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 60 ms G.726/32/20	36 ms	15 ms - 37 ms Caused by Signalization	G.726/32/20 ½ De-jitter Buffer 70 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 70 ms G.726/32/20	41 ms	15 ms - 37 ms Caused by Signalization	G.726/32/20 ½ De-jitter Buffer 90 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 90 ms G.726/32/20	51 ms	15 ms - 37 ms Caused by Signalization	G.726/32/20 ½ De-jitter Buffer 130 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 40 ms G.726/40/20	27 ms	15 ms - 37 ms Caused by Signalization	G.726/40/20 ½ De-jitter Buffer 40 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)

Network element	Delay	Serialization time for signalization frame	Comments
IAD receiving ATM line 384 kbit/s Jitter Buffer = 60 ms G.726/40/20	37 ms	15 ms - 37 ms Caused by Signalization	G.726/40/20 ½ De-jitter Buffer 60 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 70 ms G.726/40/20	42 ms	15 ms - 37 ms Caused by Signalization	G.726/40/20 ½ De-jitter Buffer 70 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)
IAD receiving ATM line 384 kbit/s Jitter Buffer = 90 ms G.726/40/20	52 ms	15 ms - 37 ms Caused by Signalization	G.726/40/20 ½ De-jitter Buffer 90 ms + depacketization + PLC serialization time 384 kbit/s ATM Line (200 OK, 401 742 Byte x 8/384 10^3 = 15 ms reInvite 1 779 Byte x 8/384 10^3 = 37 ms)
IAD receiving ATM 1 024 kbit/s Jitter Buffer = 20 ms Packet size 10 ms	16 ms	6 ms - 13 ms Caused by Signalization	10 ms packetization ½ De-jitter Buffer 20 ms + depacketization + PLC serialization time 1 024 kbit/s ATM Line (200 OK, 401 742 Byte x 8/1 024 103= 6 ms reInvite 1 779 Byte x 8/1 024 103 = 13 ms)
IAD receiving ATM 1 024 kbit/s Jitter Buffer = 30 ms Packet size 10 ms	21 ms	6 ms - 13 ms Caused by Signalization	10 ms packetization ½ De-jitter Buffer 30 ms + depacketization + PLC serialization time 1 024 kbit/s ATM Line (200 OK, 401 742 Byte x 8/1 024 103= 6 ms reInvite 1 779 Byte x 8/1 024 103 = 13 ms)
IAD receiving ETH 1 024 kbit/s Jitter Buffer = 30 ms Packet size 10 ms	20 ms	5ms - 12 ms Caused by Signalization	20 ms packetization ½ De-jitter Buffer 30 ms + depacketization + PLC serialization time 1 024 kbit/s ETH Line (200 OK, 401 600 Byte x 8/1 024 103= 5 ms) reInvite 1 500 Byte x 8/1 024 10^3 = 12 ms
IAD receiving ATM 1 024 kbit/s Jitter Buffer = 50 ms Packet size 10 ms	31 ms	6 ms - 13 ms Caused by Signalization	20 ms packetization ½ De-jitter Buffer 50 ms + depacketization + PLC serialization time 1 024 kbit/s ATM Line (200 OK, 401 742 Byte x 8/1 024 10^3= 6 ms reInvite 1 779 Byte x 8/1 024 103 = 13 ms)
IAD receiving Ethernet 1 024 kbit/s Jitter Buffer = 50 ms Packet size 20 ms	30 ms	5ms - 12 ms Caused by Signalization	20 ms packetization ½ De-jitter Buffer 50 ms + depacketization + PLC serialization time 1 024 kbit/s ATM Line (200 OK, 401 600 Byte x 8/1 024 10^3= 5 ms) reInvite 1 500 Byte x 8/1 024 10^3 = 12 ms

Network element	Delay	Serialization time for signalization frame	Comments
IAD receiving ATM 1 024 kbit/s Jitter Buffer = 100 ms Packet size 20 ms	56 ms	6 ms - 13 ms Caused by Signalization	½ De-jitter Buffer 100 ms + depacketization + PLC 1 024 kbit/s ATM Line(200 OK, 401 742 Byte x 8/1 024 10^3 = 6 ms reInvite 1 779 Byte x 8/1 024 10^3 = 13 ms)
IAD receiving Ethernet 1 024 kbit/s Jitter Buffer = 100 ms Packet size 20 ms	55 ms	5 ms - 12 ms Caused by Signalization	20 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 1 024 kbit/s ATM Line (200 OK, 401 600 Byte x 8/1 024 10^3= 5 ms) reInvite 1 500 Byte x 8/1 024 10^3 = 12 ms
IAD receiving ATM 1 024 kbit/s Jitter Buffer = 100 ms Packet size 10 ms	56 ms	6 ms- 14 ms Caused by Signalization	½ De-jitter Buffer 100 ms + depacketization + PLC 1 024 kbit/s ATM Line(200 OK, 401 742 Byte x 8/1 024 10^3 = 6 ms reInvite 1 779 Byte x 8/1 024 10^3 = 14 ms)
IAD receiving Ethernet 1 024 kbit/s Jitter Buffer = 100 ms Packet size 10 ms	55 ms	5 ms - 12 ms Caused by Signalization	10 ms packetization ½ De-jitter Buffer 100 ms + depacketization + PLC serialization time 1 024 kbit/s ATM Line (200 OK, 401 600 Byte x 8/1 024 10^3= 5 ms reInvite 1 500 Byte x 8/1 024 10^3 = 12 ms)
DSLAM sending	0,1 ms - 0,3 ms		(Packet size 500 Byte - 1 500 Byte)
DSLAM Receiving	0,1 ms - 0,3 ms		(Packet size 500 Byte - 1 500 Byte)
Ethernet switch	0,1 ms - 0,3 ms		(Packet size 500 Byte - 1 500 Byte)
ATM switch STM 1	0,1 ms - 0,3 ms		(Packet size 500 Byte - 1 500 Byte)
ATM Access switch STM 1 (APEX)	0,3 ms - 1 ms		(Packet size 500 Byte - 1 500 Byte)
BRAS / BNG	1 ms - 3 ms		
WiMAX	25 ms		
Mobile Station GSM Uplink	72,1 ms		
Mobile Station GSM Downlink	14,3 ms		
BTS Uplink	15,8 ms		
BTS Downlink	40,8 ms		
PtP Microwave link	15,8 ms		
PDH Microwave link	1,4 ms		
BSC	1 ms		
TRAU Uplink	1,5 ms		
TRAU Downlink	39 ms		
MSC Uplink	0,5 ms		
MSC Downlink	1,5 ms		
UE, R.99	37 ms		
Node B, Uplink R.99	22 ms		
Node B, Downlink R.99	9 ms		
RNC Uplink R.99	12 ms		
RNC Downlink	12 ms		
TRAU R.99	11 ms		
UMSC	5 ms		
SBC	0,1 ms		
Router Distribution Layer	0,5 ms		
Router Core Layer	0,1 ms		

Network element	Delay	Serialization time for signalization frame	Comments
Digital transit exchange			
Digital-digital	0,45 ms		
Digital local exchange			
analogue-analogue	1,5 ms		
Digital local exchange, analogue subscriber line-digital junction	0,975 ms		
Digital local exchange, digital subscriber line-digital junction	0,825 ms		
Echo cancellers	0,5 ms		
PLC	3,25 ms		
Processing Time AGW	5 ms	Sending 1,5 ms - 2 ms Receiving 1,5 ms - 2 ms Internal 1 ms	
Processing Time RGW	10 ms		

A.6.3.2 Queuing and Buffering Delay

After the compressed voice payload is built, a header is added and the frame is queued for transmission on the network connection. Voice needs to have strict priority in the router/gateway. Therefore, a voice frame should only wait for either one or several data frames that already play out (depending on the implementation of the prioritization algorithm, or for other voice frames ahead of it). Essentially the voice frame waits for the serialization delay of any preceding frames in the output queue. Queuing delay ($ß_n$) is a variable delay and is dependent on the trunk speed and the state of the queue. There are random elements associated with the queuing delay.

$$t_{D\text{-}max} = (\text{Maximum \# Data MTU bytes})/(\text{link speed kbps}/8).$$

Total core network maximum data MTU queuing time is: $= t_{Q\text{-}wo} \times (\text{number of hops} - 1)$.

Table A.25 shows queuing and buffering delay values caused by different configurations based on the "worst case" assumption that either several voice terminals are connected or that voice and video services are operated at the same time.

Table A.25: Queuing and Buffering Delay

Network element	Max Queuing/Buffering Delay $t_{D\ max}$	Queuing/Buffering delay caused due to interaction with data traffic (see note 1)	Statistical delay 1/2 t_{dmax} + voice serialization time
IAD sending G.711; 128 Kbit/s	109 ms (ATM) 94 ms (ETH)	164 ms	72 ms - 20 ms frame size G.711 (ATM) 68 ms - 10 ms frame size G.711 (ATM)
IAD sending G.729; 128 Kbit/s Line	109 ms (ATM) 94 ms (ETH)	164 ms	60 ms - 20 ms frame size G.729 (ATM)
IAD sending G.711; 256 Kbit/s Line	54 ms (ATM) 47 ms (ETH)	81 ms	35 ms - 20 ms frame size G.711 (ATM) 34 ms - 10 ms frame size G.711 (ATM)
IAD sending G.729A; 256 Kbit/s Line	54 ms (ATM) 48 ms (ETH)	81 ms	30 ms - 20 ms frame size G.711 (ATM)
IAD sending G.726 32/20; 256 Kbit/s Line	54 ms (ATM) 48 ms (ETH	81 ms	31 ms - 20 ms frame size G726/32(ATM)
IAD sending G.726 40/20; 256 Kbit/s Line	54 ms (ATM) 48 ms (ETH	81 ms	34 ms - 20 ms frame size G726/32(ATM)
IAD sending G.711; 384 Kbit/s Line	36 ms (ATM) 31 ms (ETH)	54 ms	24 ms - 20 ms frame size G.711 (ATM) 23 ms - 10 ms frame size G.711 (ATM)
IAD sending G.726 32/20; 384 Kbit/s Line	36 ms (ATM) 31 ms (ETH)	54 ms	21 ms - 20 ms frame size G726/32(ATM)
IAD sending G.726 40/20; 384 Kbit/s Line	36 ms (ATM) 31 ms (ETH)	54 ms	22 ms - 20 ms frame size G726/32(ATM)

Network element	Max Queuing/Buffering Delay $t_{D\ max}$	Queuing/Buffering delay caused due to interaction with data traffic (see note 1)	Statistical delay 1/2 t_{dmax} + voice serialization time
IAD sending G.711; 512 Kbit/s Line	27 ms (ATM) 23 ms (ETH)	41 ms	16 ms - 20 ms frame size G.711 (ATM) 16 ms - 10 ms frame size G.711 (ATM)
IAD Sending ATM line 768 kbit/s	18 ms (ATM) 16 ms (ETH)	27 ms	12 ms - 20 ms frame size G.711 (ATM) 11 ms - 10 ms frame size G.711 (ATM)
IAD sending G.711; 1 024 Kbit/s Line	14 ms (ATM) 12 ms (ETH)	21 ms	9 ms - 20 ms frame size G.711 (ATM) 8 ms - 10 ms frame size G.711 (ATM)
IAD receiving G.711; 128 Kbit/s Line	109 ms (ATM) 94 ms (ETH)		72 ms - 20 ms frame size G.711 (ATM) 68 ms - 10 ms frame size G.711 (ETH)
IAD receiving G.711; 256 Kbit/s Line	54 ms (ATM) 47 ms (ETH)		35 ms - 20 ms frame size G.711 (ATM) 34 ms - 10 ms frame size G.711 (ATM)
IAD receiving G.726 32/20; 256 Kbit/s Line	54 ms (ATM) 48 ms (ETH		31 ms - 20 ms frame size G726/32(ATM)
IAD receiving G.726 40/20; 256 Kbit/s Line	54 ms (ATM) 48 ms (ETH		34 ms - 20 ms frame size G726/32(ATM)
IAD receiving G.711; 384 Kbit/s Line	36 ms (ATM) 31 ms (ETH)		24 ms - 20 ms frame size G.711 (ATM) 23 ms - 10 ms frame size G.711 (ATM)
IAD receiving G.726 32/20; 384 Kbit/s Line	36 ms (ATM) 31 ms (ETH)		21 ms - 20 ms frame size G726/32(ATM)
IAD receiving G.726 40/20; 384 Kbit/s Line	36 ms (ATM) 31 ms (ETH)		22 ms - 20 ms frame size G726/32(ATM)
IAD receiving G.711; 512 Kbit/s Line	31 ms (ATM) 27 ms (ETH)		20 ms - 20 ms frame size G.711 (ATM) 20 ms - 10 ms frame size G.711 (ATM)
IAD receiving G.711; 1 024 Kbit/s Line	14 ms (ATM) 12 ms (ETH)		9 ms - 20 ms frame size G.711 (ATM) 8 ms - 10 ms frame size G.711 (ATM)

NOTE 1: 1,5 x Serial. time data packet (1 749 Bytes) for ATM.
1,5 x Serial. time data packet (1 500 Bytes) for Ethernet.
NOTE 2: Serialization time for data frame caused by Signalization in regularly time distance (e.g. every 60 s).
NOTE 3: 1 500 Bytes at the IP layer needs 1 779 ATM Bytes.
800 Bytes at the IP layer needs 1 007 ATM Bytes.
600 Bytes at the IP layer needs 742 ATM Bytes.

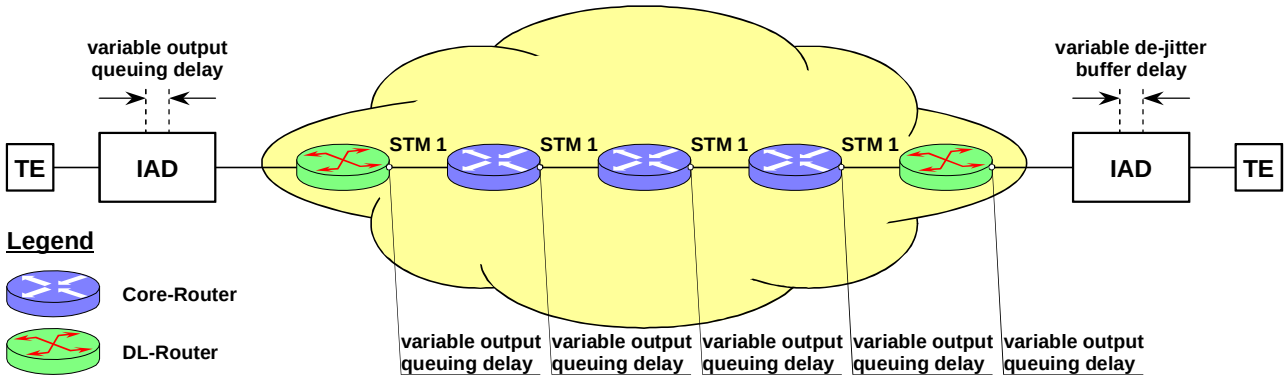

Figure A.1: Variable Delay and the De-Jitter Buffer Reference Diagram

From a de-jitter buffer point of view, it has to adapt to the maximum end-to-end delay variation (green curve in figure A.2 shows possible end-to-end audio delay variation, the steps are due to de-jitter buffer adoption to delay variation).

a) Playout buffer:

In the playout buffer are usually 1, 2 or more packets. In the playout buffer, no prioritisation exists. A packet in the playout buffer has to be sent first, even if it is a low priority packet and a strict priority packet is waiting.

NOTE: The de-jitter buffer should compensate the time which is needed that the packets lives the playout buffer.

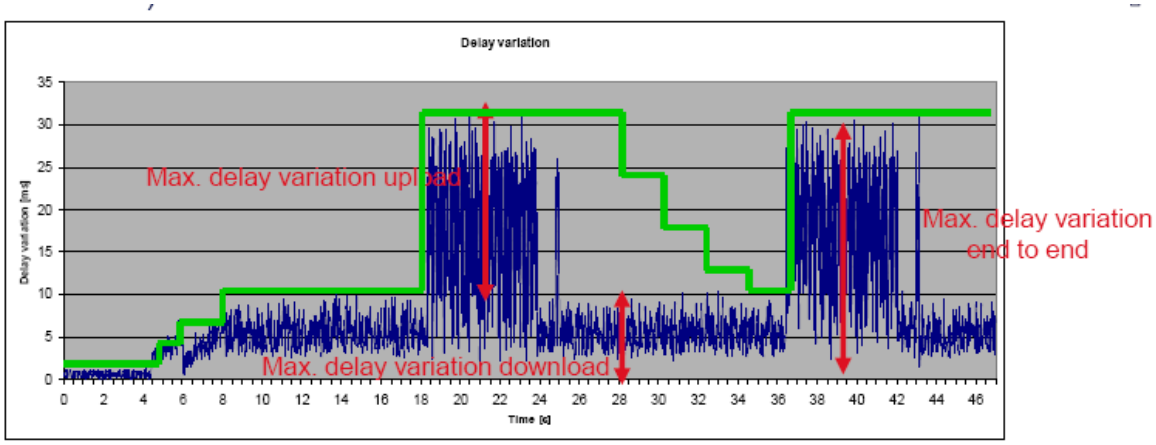

Figure A.2: Maximum Delay Variation

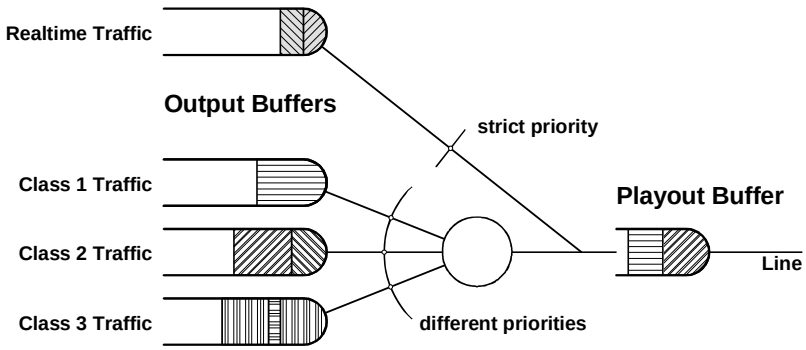

Figure A.3: Playout Buffer

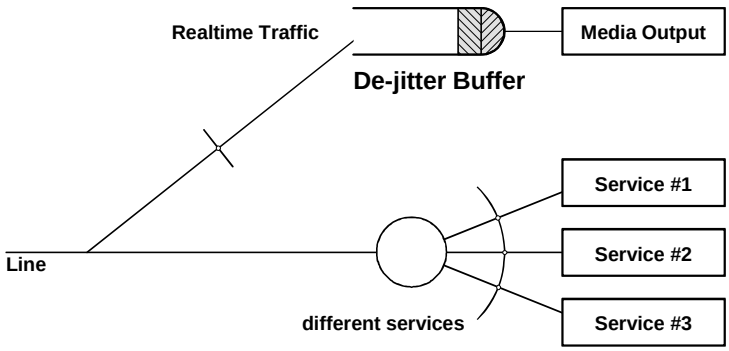

Figure A.4: De-jitter Buffer

b) De-jitter buffer:

The initial playout delay of the de-jitter buffer is configurable in most implementations. The maximum depth of the buffer before it overflows is normally set to 1,5 or 2,0 times this value.

A.6.3.3 Delay and Jitter Values for PSTN/ISDN classic access

Table A.26 shows end-to-end delay values between service provider premises.

Table A.26: One way delay values between originating and terminating Service Provider premises

	Digital local exchange, analogue subscriber line-digital junction	Transit Exchange	MGW	Echo cancellers	Sum
Sending 20 ms Packetization	0,975 ms	0,45 ms	25 ms		26 ms (40 ms G.729)
Sending 10 ms Packetization	0,975 ms	0,45 ms	15 ms		16 ms
Receiving adaptive De-jitter Buffer 20 ms for packet size 10 ms	0,975 ms	0,45 ms	14,25 ms	0,5 ms	16 ms
Receiving adaptive De-jitter Buffer 30 ms for packet size 10 ms	0,975 ms	0,45 ms	19,256 ms	0,5 ms	21 ms
Receiving adaptive De-jitter Buffer 40 ms	0,975 ms	0,45 ms	24,25 ms	0,5 ms	26 ms
Receiving 50 ms De-jitter Buffer 10/20 ms packet size	0,975 ms	0,45 ms	29,25 ms	0,5 ms	31 ms
Receiving 60 ms De-jitter Buffer 10/20 ms packet size	0,975 ms	0,45 ms	34,25 ms	0,5 ms	36 ms
Receiving 80 ms adaptive De-Jitter Buffer	0,975 ms	0,45 ms	39,25 ms	0,5 ms	41 ms
Receiving 90 ms De-Jitter Buffer	0,975 ms	0,45 ms	49,251 ms	0,5 ms	51 ms
Receiving 100 ms De-Jitter Buffer	0,975 ms	0,45 ms	54,251 ms	0,5 ms	56 ms

	Digital local exchange, analogue subscriber line-digital junction	Transit Exchange	MGW	Echo cancellers	Sum
Receiving 120 ms De-Jitter Buffer	0,975 ms	0,45 ms	64,251 ms	0,5 ms	66 ms
Receiving 150 ms De-Jitter Buffer	0,975 ms	0,45 ms	79,2576 ms	0,5 ms	81 ms
Receiving 180 ms De-Jitter Buffer	0,975 ms	0,45 ms	94,251 ms	0,5 ms	96 ms

A.6.3.4 Delay and Jitter Values for NGN PSTN/ISDN access

Table A.27 shows end-to-end delay values between service provider premises with NGN PSTN/ISDN access.

Table A.28 shows the End-to-End delay values between PSTN/ISDN users for different De-jitter Buffer values.

Table A.27: One way delay values between originating and terminating Service Provider premises with NGN PSTN/ISDN access

	Digital local exchange, analogue subscriber line-digital junction	MGW	Echo cancellers	Sum
Sending 20 ms Packetization	0,975 ms	25 ms		26 ms (40 ms G.729)
Sending 10 ms Packetization	0,975 ms	15 ms		16 ms
Receiving adaptive De-jitter Buffer 20 ms	0,975 ms	14,25 ms	0,5 ms	16 ms
Receiving adaptive De-jitter Buffer 30 ms	0,975 ms	19,25 ms	0,5 ms	21 ms
Receiving adaptive De-jitter Buffer 40 ms	0,975 ms	24,25 ms	0,5 ms	21 ms
Receiving 50 ms De-Jitter Buffer	0,975 ms	29,25 ms	0,5 ms	31 ms
Receiving 60 ms De-Jitter Buffer	0,975 ms	34,25 ms	0,5 ms	35 ms
Receiving 70 ms De-Jitter Buffer	0,975 ms	39,25 ms	0,5 ms	41 ms
Receiving 80 ms De-Jitter Buffer	0,975 ms	44,25 ms	0,5 ms	45 ms
Receiving 100 ms De-Jitter Buffer	0,975 ms	54,25 ms	0,5 ms	56 ms
Receiving 110 ms De-Jitter Buffer	0,975 ms	59,25 ms	0,5 ms	61 ms
Receiving 120 ms De-Jitter Buffer	0,975 ms	64,25 ms	0,5 ms	66 ms
Receiving 130 ms De-Jitter Buffer	0,975 ms	69,25 ms	0,5 ms	71 ms
Receiving 140 ms De-Jitter Buffer	0,975 ms	74,25 ms	0,5 ms	76 ms
Receiving 150 ms De-Jitter Buffer	0,975 ms	79,25 ms	0,5 ms	81 ms
Receiving 160 ms De-Jitter Buffer	0,975 ms	84,25 ms	0,5 ms	86 ms

Table A.28: End-to-End delay values between PSTN/ISDN users for different De-jitter Buffer values

PSTN/ISDN	PSTN/ISDN
Adaptive De-jitter Buffer 20 ms	32 (10 ms Packet.) 29 ms without PLC
De-jitter Buffer 30 ms	37 (10 ms Packet.)
De-jitter Buffer 40 ms	52 (20 ms Packet.) 42 (10 ms Packet.)
De-jitter Buffer 50 ms	57 (20 ms Packet.) 47 (10 ms Packet.)
De-jitter Buffer 60 ms	61 (20 ms Packet.) 51 (10 ms Packet.)
De-jitter Buffer 80 ms	67 (20 ms Packet.) 57 (10 ms Packet.)
De-jitter Buffer 90 ms	57 (20 ms Packet.) 67 (10 ms Packet.)
De-jitter Buffer 100 ms	82 (20 ms Packet.) 72 (10 ms Packet.)

A.6.3.5 Delay and Jitter Values for Symmetric Access DSL (128 kbit/s)

Table A.29 shows the one way delay between originating and terminating Service Provider premises for ADSL/VDSL line 128 kbit/s uplink; 128 kbit/s downlink G.729A.

Table A.30 shows the one way delay between originating and terminating Service Provider premises for ADSL/VDSL line 128 kbit/s uplink; 128 kbit/s downlink G.711.

Table A.31 shows the De-jitter buffer values for DSL line 128 kbit/s uplink; 128 kbit/s downlink, for more registered terminals without additional data traffic.

Table A.32 shows the End-to-End Delay between DSL line 128 kbit/s uplink; 128 kbit/s downlink and POTS/ISDN for G.729A without regional propagation delay.

Table A.29: Delay for DSL line 128 kbit/s uplink; 128 kbit/s downlink G.711 for more registered terminals

	IAD	DSLAM (see note)	ETH	ADM	BRAS / BNG	Sum
Sending 20 ms Packetization ATM line	47 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	51 ms
Receiving 20 ms Packetization ATM line	61 ms (Adaptive JB 80 ms) POTS - DSL	0,3 ms	0,6 ms	0,4 ms	3 ms	65 ms
Receiving 20 ms Packetization ATM line	71 ms (100 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	75 ms
Receiving 20 ms Packetization ATM line	96 ms (150 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	100 ms
Receiving 20 ms Packetization ATM line	81 ms (160 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	85 ms
Receiving 20 ms Packetization ATM line	111 ms (180 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	115 ms
Receiving 20 ms Packetization ATM line	121 ms (200 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	125 ms
Receiving 20 ms Packetization ATM line	141 ms (240 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	145 ms
NOTE: In case of interleaving, the additional delay should be added.						

Table A.30: Delay for DSL line 128 kbit/s uplink; 128 kbit/s downlink G.729A for more registered terminals

	IAD	DSLAM (see note)	ETH	ADM	BRAS	Sum
Sending ATM line	52 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	56 ms
Receiving ATM line	49 ms (80 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	53 ms
Receiving ATM line	59 ms (100 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	63 ms
Receiving ATM line	69 ms (120 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	73 ms
Receiving ATM line	84 ms (150 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	88 ms
Receiving ATM line	89 ms (160 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	93 ms
Receiving ATM line	99 ms (180 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	103 ms
Receiving ATM line	109 ms (200 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	113 ms
Receiving ATM line	129 ms (240 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	133 ms
Receiving ATM line	189 ms (360 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	193 ms
NOTE: In case of interleaving, the additional delay should be added.						

Table A.31: De-jitter buffer values for DSL line 128 kbit/s uplink; 128 kbit/s downlink, for more registered terminals without additional data traffic

	Access
Sending	72 ms - 164 ms
Receiving	72 ms
De-jitter buffer Min: POTS- DSL: 72 ms DSL-> DSL: 142 ms De-jitter buffer Max: POTS- DSL: 164 ms DSL-> DSL: 236 ms	

Table A.32: End-to-End delay for DSL line 128 kbit/s uplink;128 kbit/s downlink G.729A - worst case scenario (JB POTS/DSL 160 ms, DSL-DSL 240 ms) and best case scenario (JB POTS/DSL 80 ms, DSL-DSL 160 ms) packet size 20 ms

	PSTN/ISDN Delay (ms)	**DSL Delay (ms**
PSTN/ISDN		91 ms - 133 ms
DSL	97 ms - 142 ms	149 ms - 196 ms

Table A.33: End-to-End delay for DSL line 128 kbit/s uplink; 128 kbit/s downlink G.711 - worst case scenario (JB POTS/DSL 160 ms, DSL-DSL 240 ms) and best case scenario (JB POTS/DSL 80 ms, DSL-DSL 160 ms) packet size 20 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms
PSTN/ISDN		91 ms - 111 ms
DSL	92 ms - 137 ms	136 ms - 196 ms

A.6.3.6 Delay and Jitter Values for Symmetric Access DSL (256 kbit/s)

Table A.34 shows the one way delay between originating and terminating Service Provider premises for ADSL/VDSL line 256 kbit/s uplink; 256 kbit/s downlink G.711.

Table A.35 shows the one way delay between originating and terminating Service Provider premises for ADSL/VDSL line 256 kbit/s uplink; 256 kbit/s downlink G.726/32/20.

Table A.36 shows the one way delay between originating and terminating Service Provider premises for ADSL/VDSL line 256 kbit/s uplink; 256 kbit/s downlink G.726/40/20.

Table A.37 shows the one way delay between originating and terminating Service Provider premises for ADSL/VDSL line 256 kbit/s uplink; 256 kbit/s downlink G.729A.

Table A.38 shows the De-jitter buffer values for DSL line 256 kbit/s uplink; 256 kbit/s downlink.

Table A.39 shows the De-jitter buffer values for DSL line 256 kbit/s uplink; 256 kbit/s downlink for G.726/32/20.

Table A.40 shows the De-jitter buffer values for DSL line 256 kbit/s uplink; 256 kbit/s downlink for G.726/40/20.

Table A.41 shows the End-to-End delay ms Delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.711, packet size 20 ms without regional propagation delay.

Table A.42 shows the End-to-End delay ms Delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.711, packet size 10 ms without regional propagation delay.

Table A.43 shows the End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.729A packet size 20 ms (Adaptive JB POTS/DSL 100 ms) without regional propagation delay.

Table A.44 shows the End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.726/32/20 (Adaptive JB POTS/DSL 100 ms) without regional propagation delay.

Table A.45 shows the End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.726/40/20 (Adaptive JB POTS/DSL 100 ms) without regional propagation delay.

Table A.34: One way delay for DSL line 256 kbit/s uplink; 256 kbit/s downlink G.711

	IAD	DSLAM (see note 2)	ETH	ADM	BRAS / BNG	Sum
Sending 20 ms packet size ATM Line	38 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	42 ms
Sending 10 ms packet size ATM line	27 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	31 ms
Receiving 10 ms packet size ATM Line	31 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	35 ms
Receiving 10 ms packet size ATM Line	32 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	36 ms
Receiving 20 ms packet size ATM Line	37 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	41 ms
Receiving 10 ms packet size ATM Line	36 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	40 ms
Receiving 20 ms packet size ATM Line	52 ms (80 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	56 ms
Receiving 10 ms packet size ATM Line	51 ms (80 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	55 ms
Receiving 20 ms packet size ATM line	62 ms (100 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	66 ms
Receiving 20 ms packet size ATM line	72 ms (120 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	76 ms
Receiving 20 ms packet size ATM line	89 ms (160 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	93 ms
Receiving 20 ms packet size ATM line	88 ms (160 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	92 ms

NOTE 1: In the playout buffer 1, 2 or more packets. In the playout buffer, no prioritisation exists. A packet in the playout buffer has to be sent first, even if it is a low priority packet and a strict priority packet is waiting.
NOTE 2: In case of interleaving, the additional delay should be added.

Table A.35: One way delay for DSL line 256 kbit/s uplink; 256 downlink; G.726/32/20

	IAD	DSLAM	ETH	ADM	BRAS / BNG	Sum
Sending	34 ms	0,3 ms (see note 2)	0,6 ms	0,4 ms	3 ms	38 ms
Receiving 20 ms packet size ATM line	28 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	32 ms
Receiving 20 ms packet size ATM line	43 ms (70ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	47 ms
Receiving 20 ms packet size ATM line	53 ms (90 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	57 ms
Receiving 20 ms packet size ATM line	83 ms (120 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	68 ms
NOTE 1: In the playout buffer 1, 2 or more packets. In the playout buffer, no prioritisation exists. A packet in the playout buffer has to be sent first, even if it is a low priority packet and a strict priority packet is waiting. NOTE 2: In case of interleaving, the additional delay should be added.						

Table A.36: One way delay for DSL line 256 kbit/s uplink; 256 downlink; G.726/40/20

	IAD	DSLAM	ETH	ADM	BRAS / BNG	Sum
Sending	37 ms	0,3 ms (see note 2)	0,6 ms	0,4 ms	3 ms	41 ms
Receiving 20 ms packet size ATM line	27 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	31 ms
Receiving 20 ms packet size ATM line	42 ms (70 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	46 ms
Receiving 20 ms packet size ATM line	52 ms (90 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	56 ms
Receiving 20 ms packet size ATM line	62 ms (120 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	66 ms
NOTE 1: In the playout buffer 1, 2 or more packets. In the playout buffer, no prioritisation exists. A packet in the playout buffer has to be sent first, even if it is a low priority packet and a strict priority packet is waiting. NOTE 2: In case of interleaving, the additional delay should be added.						

Table A.37: One way delay for DSL line 256 kbit/s uplink; 256 downlink; G.729A

	IAD	DSLAM	ETH	ADM	BRAS	Sum
Sending	48 ms	0,3 ms (see note 2)	0,6 ms	0,4 ms	3 ms	52 ms
Receiving	25 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	29 ms
Receiving	30 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	34 ms
Receiving	45 ms (80 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	49 ms
Receiving	55 ms (100 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	59 ms
Receiving	65 ms (120 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	69 ms
Receiving	85 ms (150 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	89 ms

NOTE 1: In the playout buffer 1, 2 or more packets. In the playout buffer, no prioritisation exists. A packet in the playout buffer has to be sent first, even if it is a low priority packet and a strict priority packet is waiting.
NOTE 2: In case of interleaving, the additional delay should be added.

Table A.38: De-jitter buffer values for DSL line 256 kbit/s uplink; 256 kbit/s downlink for G.711

	Access
Sending	35 ms - 81 ms
Receiving	35 ms
De-jitter buffer DSL->POTS: 35 ms DSL->DSL: 70 ms De-jitter buffer Max: DSL->POTS: 81 ms DSL->DSL: 116 ms	

Table A.39: De-jitter buffer values for DSL line 256 kbit/s uplink; 256 kbit/s downlink for G.726/32/20

	Access
Sending	31 ms - 81 ms
Receiving	31 ms
De-jitter buffer DSL->POTS: 31 ms DSL->DSL: 62 ms De-jitter buffer Max: DSL->POTS: 81 ms DSL->DSL: 112 ms	

Table A.40: De-jitter buffer values for DSL line 256 kbit/s uplink; 256 kbit/s downlink for G.726/40/20

	Access
Sending	34 ms - 81 ms
Receiving	34 ms
De-jitter buffer DSL->POTS: 34 ms DSL->DSL: 68 ms De-jitter buffer Max: DSL->POTS: 81 ms DSL->DSL: 115 ms	

Table A.41: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.711 (JB POTS/DSL 100 ms, DSL - DSL 120 ms) worst case and best case scenario (JB POTS/DSL 40 ms, DSL-DSL 80 ms) packet size 20 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		61 ms - 92 ms
DSL	68 ms - 98 ms	98 ms - 118 ms

Table A.42: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/SDN for G.711 (JB POTS/DSL 100 ms, DSL - DSL 120 ms) worst case and best case scenario (JB POTS - DSL 40 ms, DSL-DSL 80 ms) packet size 10 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		51 ms - 82 ms
DSL	57 ms - 87 ms	86 ms - 107 ms

Table A.43: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.729A (JB POTS/DSL 100 ms, DSL - DSL 120 ms) worst case and best case scenario (JB POTS- DSL 40 ms, DSL-DSL 80 ms) packet size 20 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		55 ms - 85 ms
DSL	78 ms - 108 ms	101 ms - 121 ms

Table A.44: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.726/32/20 (JB POTS/DSL 90 ms, DSL - DSL 120 ms) worst case and best case scenario (JB POTS- DSL 40 ms, DSL-DSL 70 ms)

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		58 ms - 83 ms
DSL	64 ms - 89 ms	85 ms - 106 ms

Table A.45: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.726/40/20 (JB POTS/DSL 90 ms, DSL - DSL 120 ms) worst case and best case scenario (JB POTS- DSL 40 ms, DSL-DSL 70 ms)

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		57 ms - 82 ms
DSL	67 ms - 92 ms	87 ms - 107 ms

A.6.3.7 Asymmetric Access DSL (384 kbit/s uplink; 1 024 kbit/s downlink) and symmetric Access DSL (384 kbit/s uplink; 384 kbit/s downlink)

Table A.46 shows the one way delay between originating and terminating Service Provider premises for ADSL/VDSL line 384 kbit/s uplink; 1 024 kbit/s downlink G.711.

Table A.47 shows the one way delay between originating and terminating Service Provider premises for ADSL/VDSL line 384 kbit/s uplink; 384 kbit/s downlink G.711.

Table A.48 shows the one way delay between originating and terminating Service Provider premises for ADSL/VDSL line 384 kbit/s uplink; 384 kbit/s downlink G.726/32/20 and G.726/40/20.

Table A.49 shows the De-jitter buffer values for DSL line 384 kbit/s uplink; 1 024 kbit/s downlink.

Table A.50 shows the De-jitter buffer values for DSL line 384 kbit/s uplink; 384 kbit/s downlink.

Table A.51 shows the De-jitter buffer values for DSL line 384 kbit/s uplink; 384 kbit/s downlink for G.726/32/20.

Table A.52 shows the De-jitter buffer values for DSL line 384 kbit/s uplink; 384 kbit/s downlink for G.726/40/20.

Table A.53 shows the End-to-End delay between DSL line 384 kbit/s uplink; 384 kbit/s downlink and PSTN/ISDN for G.726/32/20 (JB POTS/DSL 60 ms, DSL - DSL 90 ms) worst case and best case scenario
(JB POTS- DSL 40 ms, DSL-DSL 70 ms).

Table A.54 shows the End-to-End delay between DSL line 384 kbit/s uplink; 384 kbit/s downlink and PSTN/ISDN for G.726 /40/20 (JB POTS/DSL 60 ms, DSL - DSL 90 ms) worst case and best case scenario
(JB POTS- DSL 40 ms, DSL-DSL 70 ms).

Table A.55 shows the End-to-End delay between DSL line 384 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS/DSL 70 ms; DSL- DSL 80 ms) worst case and best case scenario (JB POTS/DSL 30 ms, DSL-DSL 40 ms) packet size 20 ms.

Table A.56 shows End-to-End delay between DSL line 384 kbit/s uplink; 384 kbit/s downlink and PSTN/ISDN packet size 20 ms.

Table A.57 shows End-to-End delay between DSL line 384 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN packet size 10 ms.

Table A.58 shows End-to-End delay between DSL line 384 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN packet size 20 ms.

Table A.46: One way delay for DSL line 384 kbit/s uplink, 1 024 kbit/s downlink

	IAD	DSLAM (see note)	ETH	ADM	BRAS / BNG	Sum
Sending Packet size 20 ms	36 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	40 ms
Sending Packet size 10 ms	24 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	28 ms
Receiving Packet size 10 ms	21 ms (30 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	25 ms
Receiving Packet size 10 ms	26 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	30 ms
Receiving Packet size 20 ms	26ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	30 ms
Receiving Packet size 10 ms	31 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	35 ms
Receiving Packet size 20 ms	31 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	35 ms
Receiving Packet size 10 ms	36 ms (60 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	40 ms
Receiving Packet size 20 ms	36 ms (60 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	40 ms
Receiving Packet size 10 ms	41 ms (70 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	45 ms
Receiving Packet size 20 ms	41 ms (70 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	45 ms
Receiving Packet size 10 ms	46 ms (80 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	50 ms
Receiving Packet size 20 ms	46 ms (80 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	50 ms
Receiving Packet size 10 ms	56 ms (100 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	60 ms
Receiving Packet size 20 ms	56 ms (100 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	60 ms
Receiving Packet size 10 ms	61 ms (110 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	65 ms
Receiving Packet size 20 ms	61 ms (110 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	65 ms

NOTE: In case of interleaving, the additional delay should be added.

Table A.47: One way delay for DSL line 384 kbit/s uplink, 384 kbit/s downlink

	IAD	DSLAM (see note)	ETH	ADM	BRAS / BNG	Sum
Sending Packet size 20 ms	36 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	40 ms
Sending Packet size 10 ms	24 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	28 ms
Receiving Packet size 10 ms	23 ms (30 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	27 ms
Receiving Packet size 10 ms	28 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	32 ms
Receiving Packet size 20 ms	30 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	34 ms
Receiving Packet size 10 ms	33 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	37 ms
Receiving Packet size 20 ms	35 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	39 ms
Receiving Packet size 10 ms	38 ms (60 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	42 ms
Receiving Packet size 20 ms	40 ms (60 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	44 ms
Receiving Packet size 10 ms	43 ms (70 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	47 ms
Receiving Packet size 20 ms	45 ms (70 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	49 ms
Receiving Packet size 10 ms	48 ms (80 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	52 ms
Receiving Packet size 20 ms	52 ms (80 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	56 ms
Receiving Packet size 10 ms	58 ms (100 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	62 ms
Receiving Packet size 20 ms	62 ms (100 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	66 ms
Receiving Packet size 10 ms	63 ms (110 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	67 ms
Receiving Packet size 20 ms	62 ms (110 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	69 ms
Receiving Packet size 10 ms	68 ms (120 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	72 ms
Receiving Packet size 20 ms	72 ms (120 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	76 ms
NOTE: In case of interleaving, the additional delay should be added.						

Table A.48: One way delay for DSL line 384 kbit/s uplink, 384 kbit/s downlink G.726/32/20 and G.726/40/20

	IAD	DSLAM (see note)	ETH	ADM	BRAS / BNG	Sum
IAD Sending ATM line 384 kbit/s Packet size 20 ms G.726/32/20	33 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	37 ms
IAD Sending ATM line 384 kbit/s Packet size 20 ms G.726/32/20	34 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	38 ms
IAD receiving ATM line 384 kbit/s Jitter Buffer = 40 ms G.726/32/20	26 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	30 ms

	IAD	DSLAM (see note)	ETH	ADM	BRAS / BNG	Sum
IAD receiving ATM line 384 kbit/s Jitter Buffer = 60 ms G.726/32/20	36 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	40 ms
IAD receiving ATM line 384 kbit/s Jitter Buffer = 70 ms G.726/32/20	41 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	45 ms
IAD receiving ATM line 384 kbit/s Jitter Buffer = 90 ms G.726/32/20	51 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	55 ms
IAD receiving ATM line 384 kbit/s Jitter Buffer = 40 ms G.726/40/20	27 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	31 ms
IAD receiving ATM line 384 kbit/s Jitter Buffer = 60 ms G.726/40/20	37 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	41 ms
IAD receiving ATM line 384 kbit/s Jitter Buffer = 70 ms G.726/40/20	42 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	46 ms
IAD receiving ATM line 384 kbit/s Jitter Buffer = 90 ms G.726/40/20	52 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	56 ms

Table A.49: De-jitter buffer value for DSL line 384 kbit/s uplink, 1 024 kbit/s downlink

	Access
Sending	24 ms - 54 ms
Receiving	9 ms
De-jitter Min.: DSL - > POTS: 24 ms DSL-> DSL: 33 ms De-jitter Max.: DSL - > POTS: 54 ms DSL-> DSL: 63 ms	

Table A.50: De-jitter buffer value for DSL line 384 kbit/s uplink, 384 kbit/s downlink

	Access
Sending	24 ms - 54 ms
Receiving	24 ms
De-jitter Min.: DSL - > POTS: 24 ms DSL-> DSL: 48 ms De-jitter Max.: DSL - > POTS: 54 ms DSL-> DSL: 78 ms	

Table A.51: De-jitter buffer values for DSL line 384 kbit/s uplink; 384 kbit/s downlink for G.726/32/20

	Access
Sending	31 ms - 54 ms
Receiving	31 ms
De-jitter buffer DSL->POTS: 31 ms DSL->DSL: 62 ms De-jitter buffer Max: DSL->POTS: 54 ms DSL->DSL: 85 ms	

Table A.52: De-jitter buffer values for DSL line 384 kbit/s uplink; 384 kbit/s downlink for G.726/40/20

	Access
Sending	34 ms - 54 ms
Receiving	34 ms
De-jitter buffer DSL->POTS: 34 ms DSL->DSL: 68 ms De-jitter buffer Max: DSL->POTS: 54 ms DSL->DSL: 88 ms	

Table A.53: End-to-End delay between DSL line 384 kbit/s uplink; 384 kbit/s downlink and PSTN/ISDN for G.726/32/20 (JB POTS/DSL 60 ms, DSL - DSL 90 ms) worst case and best case scenario (JB POTS- DSL 40 ms, DSL-DSL 70 ms)

	PSTN/ISDN Delay (ms)	**DSL Delay (ms)**
PSTN/ISDN		56 ms - 66 ms
DSL	56 ms - 66 ms	77 ms - 92 ms

Table A.54: End-to-End delay between DSL line 384 kbit/s uplink; 384 kbit/s downlink and PSTN/ISDN for G.726 /40/20 (JB POTS/DSL 60 ms, DSL - DSL 90 ms) worst case and best case scenario (JB POTS- DSL 40 ms, DSL-DSL 70 ms)

	PSTN/ISDN Delay (ms)	**DSL Delay (ms)**
PSTN/ISDN		57 ms - 67 ms
DSL	57 ms - 67 ms	78 ms - 94 ms

Table A.55: End-to-End delay between DSL line 384 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS/DSL 70 ms; DSL- DSL 80 ms) worst case and best case scenario (JB POTS/DSL 30 ms, DSL-DSL 40 ms) packet size 20 ms

	PSTN/ISDN Delay (ms)	**DSL Delay (ms)**
PSTN/ISDN		51 ms - 71 ms
DSL	61 ms - 81 ms	74 ms - 90 ms

Table A.56: End-to-End delay between DSL line 384 kbit/s uplink; 384 kbit/s downlink and PSTN/ISDN (JB POTS/DSL 60 ms; DSL- DSL 80 ms) worst case and best case scenario (JB POTS/DSL 30 ms, DSL-DSL 50 ms) packet size 20 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		53 ms - 68 ms
DSL	61 ms - 75 ms	79 ms - 96 ms

Table A.57: End-to-End delay between DSL line 384 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS/DSL 60 ms; DSL 70 ms) worst case and best case scenario (JB POTS/DSL 30 ms, DSL-DSL 40 ms) packet size 10 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		41 ms - 56 ms
DSL	49 ms - 63 ms	53 ms - 73 ms

Table A.58: End-to-End delay between DSL line 384 kbit/s uplink; 384 kbit/s downlink and PSTN/ISDN (JB POTS/DSL 60 ms; DSL- DSL 80 ms) worst case and best case scenario (JB POTS/DSL 30 ms, DSL-DSL 50 ms) packet size 10 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		43 ms - 58 ms
DSL	49 ms - 63 ms	55 ms - 80 ms

A.6.3.8 Asymmetric Access DSL (512 kbit/s uplink; 1 024 kbit/s downlink)

Table A.59 shows the one way delay between originating and terminating Service Provider premises for ADSL/VDSL line 512 kbit/s uplink; 1 024 kbit/s downlink G.711.

Table A.60 shows the De-jitter buffer values for DSL line 512 kbit/s uplink; 1 024 kbit/s downlink.

Table A.61 shows End-to-End delay between DSL line 512 kbit/s uplink; 1 024 kbit/s downlink for packet size 20 ms.

Table A.62 shows End-to-End delay between DSL line 512 kbit/s uplink; 1 024 kbit/s downlink for packet size 10 ms.

Table A.59: One way delay for DSL line 512 kbit/s uplink, 1 024 kbit/s downlink

	IAD	DSLAM (see note)	ETH	ADM	BRAS / BNG	Sum
Sending Packet size 20 ms	34 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	38 ms
Sending Packet size 10 ms	23 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	27 ms
Receiving Packet size 10 ms	21 ms (30 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	25 ms
Receiving Packet size 10 ms	26 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	30ms
Receiving Packet size 20 ms	26 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	30 ms
Receiving Packet size 10 ms	31 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	35 ms
Receiving Packet size 20 ms	31 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	35 ms
Receiving Packet size 10 ms	36 ms (60 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	40 ms
Receiving Packet size 20 ms	36 ms (60 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	40 ms

	IAD	DSLAM (see note)	ETH	ADM	BRAS / BNG	Sum
Receiving Packet size 10 ms	41 ms (70 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	45 ms
Receiving Packet size 20 ms	41 ms (70 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	45 ms
Receiving Packet size 10 ms	46 ms (80 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	50 ms
Receiving Packet size 20 ms	46 ms (80 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	50 ms
Receiving Packet size 10 ms	56 ms (100 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	60 ms
Receiving Packet size 20 ms	56 ms (100 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	60 ms
Receiving Packet size 10 ms	61 ms (110 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	65 ms
Receiving Packet size 20 ms	61 ms (110 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	65 ms
NOTE: In case of interleaving, the additional delay should be added.						

Table A.60: De-jitter buffer value for DSL line 512 kbit/s uplink, 1 024 kbit/s downlink

	Access
Sending	16 ms - 41 ms
Receiving	9 ms
De-jitter Min.: DSL - > POTS: 16 ms DSL-> DSL: 24 ms De-jitter Max.: DSL - > POTS: 41 ms DSL-> DSL: 50 ms	

Table A.61: End-to-End delay between DSL line 512 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS 50 ms; DSL 60 ms) worst case and best case scenario (JB POTS/DSL 30 ms, DSL-DSL 30 ms) packet size 20 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		5 1 ms - 61 ms
DSL	59 ms - 69 ms	63 ms - 78 ms

Table A.62: End-to-End delay between DSL line 512 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS 50 ms; DSL 60 ms) worst case and best case scenario (JB POTS/DSL 30 ms, DSL-DSL 30 ms) packet size 10 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		41 ms - 51 ms
DSL	48 ms - 58 ms	52 ms - 67 ms

A.6.3.9 Asymmetric Access DSL (768 kbit/s uplink, 1 024 kbit/s downlink)

Table A.63 shows the one way delay between originating and terminating Service Provider premises for ADSL/VDSL line 768 kbit/s uplink; 1 024 kbit/s downlink G.711.

Table A.64 shows the De-jitter buffer values for DSL line 768 kbit/s uplink; 1 024 kbit/s downlink.

Table A.65 shows End-to-End delay between DSL line 768 kbit/s uplink; 1 024 kbit/s downlink packet size 20 ms.

Table A.63 shows End-to-End delay between DSL line 768 kbit/s uplink; 1 024 kbit/s downlink packet size 10 ms.

Table A.63: One way delay for DSL line 768 kbit/s uplink, 1 024 kbit/s downlink

	IAD	DSLAM (see note)	ETH	ADM	BRAS / BNG	Sum
Sending Packet size 20 ms	32 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	36 ms
Sending Packet size 10 ms	21 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	25 ms
Receiving Packet size 10 ms	16 ms (20 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	20 ms
Receiving Packet size 10 ms	21 ms (30 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	25 ms
Receiving Packet size 10 ms	26 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	30 ms
Receiving Packet size 20 ms	26 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	30 ms
Receiving Packet size 10 ms	31 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	35 ms
Receiving Packet size 20 ms	31 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	35 ms
Receiving Packet size 10 ms	36 ms (60 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	40 ms

Table A.64: De-jitter buffer value for DSL line 786 kbit/s uplink, 1 024 kbit/s downlink

	Access
Sending	12 ms - 27 ms
Receiving	9 ms
De-jitter Min.: DSL - > POTS: 12 ms DSL-> DSL: 21 ms De-jitter Max.: DSL - > POTS: 27 ms DSL-> DSL: 36 ms	

Table A.65: End-to-End delay between DSL line 768 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS 40 ms; DSL 50 ms) worst case and best case scenario (JB POTS/DSL 40 ms, DSL-DSL 40 ms) packet size 20 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		56 ms
DSL	57 ms	66 ms - 71 ms

Table A.66: End-to-End delay between DSL line 768 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS 40 ms; DSL 50 ms) worst case and best case scenario (JB POTS/DSL 20 ms, DSL-DSL 30 ms) packet size 10 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		36 ms - 46 ms
DSL	41 ms - 46 ms	50 ms - 60 ms

A.6.3.10 Symmetric Access DSL (1 024 kbit/s)

Table A.67 shows the one way delay between originating and terminating Service Provider premises for ADSL/VDSL line 1 024 kbit/s uplink; 1 024 kbit/s downlink G.711.

Table A.68 shows the De-jitter buffer values for DSL line 1 024 kbit/s uplink; 1 024 kbit/s downlink.

Table A.69 shows End-to-End delay between DSL line 1 024 kbit/s uplink; 1 024 kbit/s downlink for the packet size 20 ms.

Table A.70 shows End-to-End delay between DSL line 1 024 kbit/s uplink; 1 024 kbit/s downlink for the packet size 10 ms.

Table A.67: One way delay for DSL line 1 024 kbit/s uplink, 1 024 kbit/s downlink

	IAD	DSLAM (see note)	ETH	ADM	BRAS / BNG	Sum
Sending Packet size 20 ms	32 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	36 ms
Sending Packet size 10 ms	22 ms	0,3 ms	0,6 ms	0,4 ms	3 ms	25 ms
Receiving Packet size 10 ms	16 ms (20 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	20 ms
Receiving Packet size 10 ms	21 ms (30 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	25 ms
Receiving Packet size 10 ms	26 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	30 ms
Receiving Packet size 20 ms	26 ms (40 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	30 ms
Receiving Packet size 10 ms	31 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	35 ms
Receiving Packet size 20 ms	31 ms (50 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	35 ms
Receiving Packet size 10 ms	36 ms (60 ms JB)	0,3 ms	0,6 ms	0,4 ms	3 ms	40 ms

Table A.68: De-jitter buffer value for DSL line 1 024 kbit/s

	Access
Sending	9 ms - 21 ms
Receiving	9 ms
De-jitter Min.: DSL - > POTS: 9 ms DSL-> DSL: 18 ms De-jitter Max.: DSL - > POTS: 21 ms DSL-> DSL: 30 ms	

Table A.69: End-to-End delay between DSL line 1 024 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS 40 ms; DSL - DSL 40 ms) worst case and best case scenario (JB POTS/DSL 40 ms, DSL-DSL 40 ms) packet size 20 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		56 ms
DSL	57 ms	66 ms

Table A.70: End-to-End delay between DSL line 1 024 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN (JB POTS/DSL 40 ms; DSL-DSL 30 ms) worst case and best case scenario (JB POTS/DSL 20 ms, DSL-DSL 30 ms) packet size 10 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		36 ms - 46 ms
DSL	46 ms	55 ms

A.6.3.11 GSM Access

Table A.71 shows the number of elements and the delay values used for a GSM connection.

Table A.71: One way delay for GSM

	MS	BTS	ADM 2X	BSC	TRAU	MSC	MGW	SUM
Sending Packet size 20 ms	72,1	15,8	0,2	1	1,5	0,5	22 ms	113
Sending Packet size 10 ms	72,1	15,8	0,2	1	1,5	0,5	15 ms	106
Receiving 50 ms De-jitter Buffer Packet size 20 ms	14,3	40,8	0,2	1	39	1,5	26 ms	123
Receiving 80 ms De-Jitter Buffer Packet size 50 ms	14,3	40,8	0,2	1	39	1,5	36 ms	132
Receiving 100 ms De-Jitter Buffer Packet size 20 ms	14,3	40,8	0,2	1	39	1,5	51 ms	138
Receiving 150 ms De-Jitter Buffer Packet size 20 ms	14,3	40,8	0,2	1	39	1,5	76 ms	163

A.6.3.12 UMTS Release 3 Access

Table A.72 shows the number of elements and the delay values used for an UMTS Release 3 connection.

Table A.72: One way delay for UMTS Release 3

UMTS Release 3	UE	Node B	RiFu	RNC	ATM	TRAU	UMSC	MGW	SUM
Number of segments	1	1	1	1	2	1	1	1	
Sending Packet size 20 ms	57	22	1,4	12	6	11	5	22	136
Receiving 50 ms De-jitter Buffer Packet size 20 ms	37	29	1,4	12	6	11	5	26	127

A.6.3.13 UMTS Release 4 Access

Table A.73 shows the number of elements and the delay values used for an UMTS Release 4 connection.

Table A.73: One way delay for UMTS Release 4

UMTS Release 4	UE	NodeB	RiFu	RNC	ATM	TRAU	MGW	SUM
Number of segments	1	1	1	1	2	1	1	
Sending Packet size 20 ms	57	22	1,4	12	6	11	22	131
Receiving 50 ms De-jitter Buffer Packet size 20 ms	37	29	1,4	12	6	11	26	122

A.6.3.14 WiMax

Table A.74 shows the number of elements and the delay values used for a WiMax connection.

Table A.74: One way delay for WiMax

WiMax	IAD	Radio	NC	Ethernet	ADM	BRAS / BNG	SUM
Number of segments	1	1	1	2	6	1	
Sending Packet size 20 ms	29	25	1	4	0,6	10	70
Receiving 50 ms De-jitter Buffer Packet size 20 ms	26	25	1	4	0,6	10	67

A.7 Delay with inter-regional propagation delay (10 000 km/55 ms)

A.7.1 Delay and Jitter Values for Symmetric Access DSL (256 kbit/s)

Table A.75 shows End-to-End delay between DSL line 256 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN for a distance of 10 000 km.

Table A.75: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.711 packet size 20 ms

	PSTN/ISDN Delay (ms) / R	DSL Delay (ms) / R
PSTN/ISDN		115 ms - 146 ms / R = 88
DSL	122 ms - 154 ms / R = 89	152 ms - 172 ms / R = 88

A.7.2 Asymmetric Access DSL (384 kbit/s uplink; 1 024 kbit/s downlink)

Table A.76 shows End-to-End delay between DSL line 384 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN for a distance of 10 000 km.

Table A.76: End-to-End delay between DSL line 384 kbit/s uplink; 1 024 kbit/s downlink and PSTN/ISDN packet size 20 ms

	PSTN/ISDN Delay (ms) / R	DSL Delay (ms) / R
PSTN/ISDN		105 ms - 130 ms / R = 90
DSL	115 ms - 135 ms / R = 90	119 ms - 144 ms / R = 90

A.7.3 MSAN - PSTN Access

Table A.77 shows End-to-End delay between PSTN/ISDN lines for a distance of 10 000 km.

Table A.77: End-to-End delay for PSTN lines for a distance of 10 000 km

PSTN/ISDN- PSTN/ISDN Delay (ms)
101 (10 ms Packet.)
111 (20 ms Packet.)

A.8 Delay with inter-regional propagation delay (19 000 km/100 ms)

A.8.1 MSAN - PSTN Access

Table A.78 shows End-to-End delay between PSTN/ISDN lines for a distance of 19 000 km.

Table A.78: End-to-End delay for PSTN for a distance of 19 000 km

PSTN/ISDN- PSTN/ISDN Delay (ms)
137 (10 ms Packet.)
157 (20 ms Packet.)

Annex B:
Measured values at Telekom Austria premises

This annex contains delay values measured under labour conditions with different access lines and codecs.

B.1 Delay Values for Symmetric Access DSL (128 kbit/s)

Table B.1: End-to-End delay for DSL line 128 kbit/s uplink; 128 kbit/s downlink G.729A

	PSTN/ISDN Delay (ms) / R	DSL Delay (ms) / R
PSTN/ISDN		122 ± 6
DSL	120 ± 22	173 ± 23

B.2 Delay and Jitter Values for Symmetric Access DSL (256 kbit/s)

Table B.2: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.711 packet size 20 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		85 ± 5
DSL	83 ± 10	

Table B.3: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/SDN for G.711 packet size 10 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		87
DSL	90	76 ± 1

Table B.4: End-to-End delay between DSL line 256 kbit/s uplink; 256 kbit/s downlink and PSTN/ISDN for G.729A packet size 20 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		75 ± 9
DSL	100 ± 1	

B.3 Asymmetric Access DSL (384 kbit/s uplink; 8 Mbit/s downlink)

Table B.5: End-to-End delay between DSL line 384 kbit/s uplink; 8 Mbit/s kbit/s downlink and PSTN/ISDN packet size 20 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		66 ± 10
DSL	66 ± 10	78 ± 10

Table B.6: End-to-End delay between DSL line 384 kbit/s uplink; 8 Mbit/s downlink and PSTN/ISDN packet size 10 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		46 ± 4
DSL	44 ± 4	63 ± 5 (2x TV without HSI, one VoIP-Connection) 74 ± 4 (2x TV with HSI, one VoIP-Connection)

B.4 Symmetric Access DSL (384 kbit/s uplink; 384 kbit/s downlink)

Table B.7: End-to-End delay between DSL line 384 kbit/s uplink; 384 kbit/s downlink and PSTN/ISDN packet size 10 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		42 ± 2
DSL	66 ± 13	66 ± 10

B.5 Symmetric Access ADSL 2+ (512 kbit/s uplink; 5 Mbit/s downlink with HSI and FTP traffic and without TV)

Table B.8: End-to-End delay between DSL line 512 kbit/s uplink; 5 Mb/s downlink and packet size 10 ms

	PSTN/ISDN Delay (ms)	DSL Delay (ms)
PSTN/ISDN		
DSL		63 ± 4

B.6 PSTN/ISDN

Table B.9: End-to-End delay between PSTN/ISDN packet size 20 ms

	PSTN/ISDN Delay (ms) / R
PSTN/ISDN	46 ± 4

Table B.10: End-to-End delay between PSTN/ISDN packet size 10 ms

	PSTN/ISDN Delay (ms) / R
PSTN/ISDN	28 ± 2

Annex C:
Test templates for Voice applications based on the present document

This annex contains test templates to test the quality parameters that need to be considered at the Segment-connections points of Voice over IP (VoIP) Modem over IP (MoIP) and Fax over IP (FoIP) services.

C.1 Configuration: MSAN POTS - MSAN POTS

C.1.1 Configuration: MSAN POTS - MSAN POTS; Application: Voice

Test num.	Testing time	Config / Test numbers	Codec	Packetization time	P.862.1	R Value	Delay Upstream	Delay Downstream	Active Level
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
6					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.1.2 Configuration: MSAN POTS - MSAN POTS; Application: Fax, bit rate ≤ 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.1.3 Configuration: MSAN POTS - MSAN POTS; Application: Fax, bit rate > 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.1.4 Configuration: MSAN POTS - MSAN POTS; Application: Modem V.32/V.32 bis - start procedure; handshake according V.25 without phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.1.5 Configuration: MSAN POTS - MSAN POTS; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.8 with phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.2 Configuration: MSAN POTS - POTS

C.2.1 Configuration: MSAN POTS - POTS; Application: Voice

Test Num.	Testing time	Config / Test numbers	Codec	Packet. time	P.862.1	R Value	Delay Upstream	Delay Downstream	Active Level
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.2.2 Configuration: MSAN POTS - POTS; Application: Fax, bit rate ≤ 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.2.3 Configuration: MSAN POTS - POTS; Application: Fax, bit rate > 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.2.4 Configuration: MSAN POTS - POTS; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.25 without phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.2.5 Configuration: MSAN POTS - POTS; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.8 with phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.3 Configuration: POTS - MSAN POTS

C.3.1 Configuration: POTS - MSAN POTS; Application: Voice

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	P.862.1	R Value	Delay Upstream	Delay Downstream	Active Level
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.3.2 Configuration: POTS - MSAN POTS; Application: Fax, bit rate ≤ 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.3.3 Configuration: POTS - MSAN POTS; Application: Fax, bit rate > 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.3.4 Configuration: POTS - MSAN POTS; Application: Modem V.32/V.32 bis - start procedure; handshake according V.25 without phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.3.5 Configuration: POTS - MSAN POTS; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.8 with phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.4 Configuration: DSL - DSL

C.4.1 Configuration: DSL - DSL; Application: POTS - POTS/Voice

Test num.	Testing time	Config / Test numbers	Bandwidth Upstream/ Downstream		Codec	Packet. time	Numb. of concurrent calls	P.862.1	R Value	Delay Upstream	Delay Downstream	Active Level
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.4.2 Configuration: DSL - DSL; Application: POTS - POTS/Fax, bit rate ≤ 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Bandwidth Upstream/ Downstream		Packet. time	Numb. of concurrent calls	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.4.3 Configuration: DSL - DSL; Application: POTS - POTS/Fax, bit rate > 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Bandwidth Upstream /Downstream		Packet. time	Numb. of concurrent calls	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.4.4 Configuration: DSL - DSL; Application: POTS - POTS/Modem, V.32/V.32 bis - start procedure; handshake according V.25 without phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Bandwidth Upstream/ Downstream		Packet. time	Numb. of concurrent calls	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.4.5 Configuration: DSL - DSL; Application: POTS - POTS/Modem, V.32/V.32 bis - start procedure; handshake according V.8 with phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Bandwidth Upstream/ Downstream		Packet. time	Numb. of concurrent calls	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.5 Configuration: MSAN - DSL

C.5.1 Configuration: MSAN - DSL; Application: POTS - POTS/Voice

Test num.	Testing time	Config / Test numbers	Bandwidth Upstream/ Downstream		Codec	Packet. time	Numb. of concurrent calls	P.862.1	R Value	Delay Upstream	Delay Downstream	Active Level
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.5.2 Configuration: MSAN - DSL; Application: POTS - POTS/Fax, bit rate ≤ 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Bandwidth Upstream/ Downstream		Packet. time	Numb. of concurrent calls	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.5.3 Configuration: MSAN - DSL; Application: POTS - POTS/Fax, bit rate > 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Bandwidth Upstream/ Downstream		Packet. time	Numb. of concurrent calls	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.5.4 Configuration: MSAN - DSL; Application: POTS - POTS/Modem, V.32/V.32 bis - start procedure; handshake according V.25 without phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Bandwidth Upstream/ Downstream		Packet. time	Numb. of concurrent calls	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.5.5 Configuration: MSAN - DSL; Application: POTS - POTS/Modem, V.32/V.32 bis - start procedure; handshake according V.8 with phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Bandwidth Upstream/ Downstream		Packet. time	Numb. of concurrent calls	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.6 Configuration: DSL - MSAN

C.6.1 Configuration: MSAN - DSL; Application: POTS - POTS/Voice

Test num.	Testing time	Config / Test numbers	Bandwidth Upstream/ Downstream		Codec	Packet. time	Numb. of concurrent calls	P.862.1	R Value	Delay Upstream	Delay Downstream	Active Level
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.6.2 Configuration: DSL - MSAN; Application: POTS - POTS/Fax, bit rate ≤ 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Bandwidth Upstream/ Downstream		Packet. time	Numb. of concurrent calls	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.6.3 Configuration: DSL - MSAN; Application: POTS - POTS/Fax, bit rate > 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Bandwidth Upstream /Downstream		Packet. time	Numb. of concurrent calls	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.6.4 Configuration: DSL - MSAN; Application: POTS - POTS/Modem, V.32/V.32 bis - start procedure; handshake according V.25 without phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Bandwidth Upstream/ Downstream		Packet. time	Numb. of concurrent calls	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.6.5 Configuration: DSL - MSAN; Application: POTS - POTS/Modem, V.32/V.32 bis - start procedure; handshake according V.8 with phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Bandwidth Upstream/ Downstream		Packet. time	Numb. of concurrent calls	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5								Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.7 Configuration: POTS - DSL

C.7.1 Configuration: POTS - DSL; Application: Voice

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	P.862.1	R Value	Delay Upstream	Delay Downstream	Active Level
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.7.2 Configuration: POTS - DSL; Application: Fax, bit rate ≤ 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.7.3 Configuration: POTS - DSL; Application: Fax, bit rate > 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.7.4 Configuration: POTS - DSL; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.25 without phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.7.5 Configuration: POTS - DSL; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.8 with phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.8 Configuration: DSL - POTS

C.8.1 Configuration: DSL - POTS; Application: Voice

Test: num.	Testing time	Config / Test numbers	Codec	Packet. time	P.862.1	R Value	Delay Upstream	Delay Downstream	Active Level
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.8.2 Configuration: DSL - POTS; Application: Fax, bit rate ≤ 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.8.3 Configuration: DSL - POTS; Application: Fax, bit rate > 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.8.4 Configuration: DSL - POTS; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.25 without phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.8.5 Configuration: DSL - POTS; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.8 with phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.9 Configuration: MSAN ISDN - MSAN ISDN

C.9.1 Configuration: MSAN ISDN - MSAN ISDN; Application: Voice

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	P.862.1	R Value	Delay Upstream	Delay Downstream	Active Level
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.9.2 Configuration: MSAN ISDN - MSAN ISDN; Application: Fax, bit rate ≤ 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.9.3 Configuration: MSAN ISDN - MSAN ISDN; Application: Fax, bit rate > 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.9.4 Configuration: MSAN ISDN - MSAN ISDN; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.25 without phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.9.5 Configuration: MSAN ISDN - MSAN ISDN; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.8 with phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.10 Configuration: ISDN - MSAN ISDN

C.10.1 Configuration: ISDN - MSAN ISDN; Application: Voice

Test num.	Testing time	Codec	Packet. time	P.862.1	R Value	Delay Upstream	Delay Downstream	Active Level
1				Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2				Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3				Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4				Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5				Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.10.2 Configuration: ISDN - MSAN ISDN; Application: Fax, bit rate ≤ 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.10.3 Configuration: ISDN - MSAN ISDN; Application: Fax, bit rate > 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.10.4 Configuration: ISDN - MSAN ISDN; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.25 without phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.10.5 Configuration: ISDN - MSAN ISDN; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.8 with phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.11 Configuration: MSAN ISDN - ISDN

C.11.1 Configuration: MSAN ISDN - ISDN; Application: Voice

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	P.862.1	R Value	Delay Upstream	Delay Downstream	Active Level
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.11.2 Configuration: MSAN ISDN - ISDN; Application: Fax, bit rate ≤ 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.11.3 Configuration: MSAN ISDN - ISDN; Application: Fax, bit rate > 14,4 kbit/s

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.11.4 Configuration: MSAN ISDN - ISDN; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.25 without phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

C.11.5 Configuration: MSAN ISDN - ISDN; Application: Modem, V.32/V.32 bis - start procedure; handshake according V.8 with phase reversals

Test num.	Testing time	Config / Test numbers	Codec	Packet. time	Delay Upstream	Delay Downstream	Active Level	Noise	Signal to Interval Noise
1					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
2					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
3					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
4					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:
5					Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:	Mean: Std-Dev: Range:

Annex D: Bibliography

ITU-T Recommendation G.114 (2003): "One-way transmission time".

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V1.1.1	February 2009	Publication
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