



**Speech and multimedia Transmission Quality (STQ);
Procedures for the identification and selection of
common modes of de-jitter buffers and echo cancellers**

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Foreword

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

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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Introduction

The present document describes the characteristics of a de-jitter buffer, including the requirement for in-band tone activating and other control mechanisms.

1 Scope

De-jitter buffers and echo cancellers have a major effect on voice and data transmission quality in telecommunication networks. They affect the three service categories of PSTN/ISDN voice, voiceband data (due to PSTN modem and fax calls), and ISDN circuit mode data. Since the requirements for the settings of de-jitter buffers differ for different services, the present document describes the activation and mode switching procedures of de-jitter buffers and echo cancellers, including the requirement for in-band tone activating and other control mechanisms.

It is assumed that the clock accuracy of all elements involved is sufficiently high for application of the present document.

The scope of the present document is considering de-jitter buffer usage in circuit-to-IP media gateways, such as residential, access or trunking gateways in context of NGN/IMS.

The notion of circuit relates to a PSTN analog line or an ISDN 1x64 bearer channel.

The current version of the present document contains additional de-Jitter Buffer requirements for the transmission of V.152, Echo Canceller Tests and de-Jitter Buffer Tests.

The requirements for Echo Cancellers and de-Jitter Buffers in for speech transmission are out of scope in the present document. These requirements are covered in ETSI ES 202 718 [i.27].

The present document is:

- a) applicable:
 - a1) to circuit-to-IP media gateways and communication services with a gateway interworking function operating at the level of a synchronous byte-stream, such as:
 - service "voice-over-IP" (VoIP) without or with silence suppression;
 - service "voiceband data-over-IP" (VBDoIP); and
 - service "circuit-mode data-over-IP" (CMDoIP);
 - a2) to IP-to-IP media gateways for dedicated interworking services between two IP domains, such as:
 - service "IPDV reduction between two IP domains" with different Grade of Service (GoS) as e.g. described in Recommendation ITU-T G.799.3 [i.22];
 - service "RTP IPDV reduction between two RTP domains", which may be subject of an "RTP transport translator" topology (see IETF RFC 5117 [i.23] and Recommendation ITU-T H.248.88 [i.24]);

but IP-to-IP media gateways are basically out of scope of the present document due to its focus on circuit-to-IP gateway types;

and is:

- b) not applicable, because de-jitter buffers are not required:
 - b1) to circuit-to-IP media gateways and communication services with a gateway interworking function operating at the level of individual packets as atomic units (i.e. an asynchronous packet-stream), such as:
 - service "facsimile-over-IP" (FoIP) according to [i.7];
 - service "text-over-IP" (ToIP) according to [i.25]; and
 - service "data-over-IP" (MoIP) according to [i.26];
 - b2) to IP-to-IP media gateways in general.

Additionally the present document contains Transmission Requirements for Media Gateways (MGWs) with respect to voiceband data (VBD) and 64 kbit/s transparent data service.

2 References

2.1 Normative 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 referenced document (including any amendments) applies.

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

- [1] Recommendation ITU-T V.8 (11/2000): "Procedures for starting sessions of data transmission over the public switched telephone network".
- [2] Recommendation ITU-T V.8bis (11/2000): "Procedures for the identification and selection of common modes of operation between data circuit-terminating equipments (DCEs) and between data terminal equipments (DTEs) over the public switched telephone network and on leased point-to-point telephone-type circuits".
- [3] Recommendation ITU-T G.168: "Digital network echo cancellers".
- [4] Recommendation ITU-T V.21 (1988): "300 bits per second duplex modem standardized for use in the general switched telephone network".
- [5] Recommendation ITU-T V.22 (1988): "1200 bits per second duplex modem standardized for use in the general switched telephone network and on point-to-point 2-wire leased telephone-type circuits".
- [6] Recommendation ITU-T V.25 (1996): "Automatic answering equipment and general procedures for automatic calling equipment on the general switched telephone network including procedures for disabling of echo control devices for both manually and automatically established calls".
- [7] Recommendation ITU-T V.32 (1993): "A family of 2-wire, duplex modems operating at data signalling rates of up to 9600 bit/s for use on the general switched telephone network and on leased telephone-type circuits".
- [8] Recommendation ITU-T V.32bis (1991): "A duplex modem operating at data signalling rates of up to 14 400 bit/s for use on the general switched telephone network and on leased point-to-point 2-wire telephone-type circuits".
- [9] Recommendation ITU-T V.152 (2010): "Procedures for supporting voiceband data over IP Networks".

2.2 Informative references

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

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] Recommendation ITU-T G.164: "Echo Suppressors".

- [i.2] Recommendation ITU-T G.165: "Echo Cancellers".
- [i.3] Recommendation ITU-T V.2 (1988): "Power levels for data transmission over telephone lines".
- [i.4] Void.
- [i.5] Recommendation ITU-T G.131 (1996): "Control of talker echo".
- [i.6] Recommendation ITU-T Q.115.1 (1999): "Logic for the control of echo control devices/functions".
- [i.7] Recommendation ITU-T T.38 (2010): "Procedures for real-time Group 3 facsimile communication over IP networks".
- [i.8] Introduction to V.34 High-Speed Fax.

NOTE: Available at: <http://www.gaoresearch.com/V34Fax/V34Fax.php>.

- [i.9] Recommendation ITU-T V.34 (1998): "A modem operating at data signalling rates of up to 33 600 bit/s for use on the general switched telephone network and on leased point-to-point 2-wire telephone-type circuits".
- [i.10] Recommendation ITU-T T.30: "Procedures for document facsimile transmission in the general switched telephone network".
- [i.11] Recommendation ITU-T V.150.1: "Modem-over-IP networks: Procedures for the end-to-end connection of V-series DCEs".
- [i.12] Recommendation ITU-T V.18: "Procedures for starting sessions of data transmission over the public switched telephone network".
- [i.13] Recommendation ITU-T G.711: "Pulse code modulation (PCM) of voice frequencies".
- [i.14] Recommendation ITU-T G.1020 (11/2003): "Performance parameter definitions for quality of speech and other voiceband applications utilizing IP networks".
- [i.15] Recommendation ITU-T T.4: "Standardization of Group 3 facsimile terminals for document transmission".
- [i.16] Recommendation ITU-T T.6: "Facsimile coding schemes and coding control functions for Group 4 facsimile apparatus".
- [i.17] ETSI TR 183 072 (V3.1.1): "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Emulation Services for PSTN Modem Calls".
- [i.18] Recommendation G.161.1: "Do-no-harm testing".
- [i.19] Recommendation ITU-T I.231.1: "Circuit-mode bearer service categories : Circuit-mode 64 kbit/s unrestricted, 8 kHz structured bearer service".
- [i.20] IETF RFC 4040: "RTP Payload Format for a 64 kbit/s Transparent Call".
- [i.21] Recommendation ITU-T Q.931: "ISDN user-network interface layer 3 specification for basic call control".
- [i.22] Recommendation ITU-T G.799.3: "Signal processing functionality and performance of an IP-to-IP voice gateway optimised for the transport of voice and voiceband data".
- [i.23] IETF RFC 5117: "RTP Topologies".
- [i.24] Recommendation ITU-T H.248.88: "Gateway control protocol: RTP topology dependent RTCP handling by ITU-T H.248 media gateways with IP terminations".
- [i.25] Recommendation ITU-T V.151: "Procedures for the end-to-end connection of analogue PSTN text telephones over an IP network utilizing text relay".

- [i.26] Recommendation ITU-T V.150.1: "Modem-over-IP networks: Procedures for the end-to-end connection of V-series DCEs".
- [i.27] ETSI ES 202 718: "Speech and multimedia Transmission Quality (STQ); Transmission Requirements for IP-based Narrowband and Wideband Home Gateways and Other Media Gateways from a QoS Perspective as Perceived by the User".
- [i.28] Recommendation ITU-T P.501: "Test signals for use in telephony".
- [i.29] Recommendation ITU-T G.826: "End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections".
- [i.30] Recommendation ITU-T V.17 (02/1991): "A 2-wire modem for facsimile applications with rates up to 14 400 bit/s".
- [i.31] Recommendation ITU-T V.27 (11/1988): "4800 bits per second modem with manual equalizer standardized for use on leased telephone-type circuits".
- [i.32] Recommendation ITU-T V.29 (11/1988): "9600 bits per second modem standardized for use on point-to-point 4-wire leased telephone-type circuits".

3 Definitions and abbreviations

3.1 Definitions

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

acoustic echo: acoustic echoes consist of reflected signals caused by acoustic environments

NOTE: In these acoustic environments, an echo path is introduced by the acoustic path from the loudspeaker or earpiece to the microphone, e.g. echo created from hands-free speakerphones [3].

de-jitter buffer [i.14]: buffer designed to remove the delay variation (i.e. jitter) in packet arrival times

NOTE: Data is put into the de-jitter buffer at a variable rate (i.e. whenever they are received from the network), and taken out at a constant rate.

Echo Canceller (EC): voice-operated device placed in the 4-wire portion of a circuit and used for reducing the cancelled end echo present on the send path by subtracting an estimation of that echo from the cancelled end echo [3]

G3 facsimile equipment (G3FE) [i.7]: G3FE refers to any entity which presents a communications interface conforming to Recommendation ITU-T T.30 [i.10], Recommendation ITU-T T.4 [i.15] and optionally Recommendation ITU-T T.6 [i.16]

NOTE: A G3FE may be a traditional G3 facsimile machine, an application with a Recommendation ITU-T T.30 [i.10] protocol engine, or any of the other possibilities mentioned in the network model for IP facsimile.

Non-Linear Processor (NLP): device having a defined suppression threshold level and in which:

- a) signals having a level detected as being below the threshold are suppressed; and
- b) signals having a level detected as being above the threshold are passed although the signal may be distorted.

NOTE: The present document assumes an echo canceller is equipped with an NLP function that can be enabled or disabled when performing the tests defined in the present document. An NLP function can be enabled or disabled by the user (for the purpose of performing a particular test), or may also be disabled upon detection of an appropriate disabling tone (e.g. 2 100 Hz) [3].

pseudo-VBDoIP emulation service: XoIP emulation service, trying to support voiceband data in *audio mode* (see clause 3.2.1 of Recommendation ITU-T V.152 [9]), also known as non-V.152 VBDoIP service

PSTN modem call [i.17]: voiceband data call originating/terminating in a PSTN domain

NOTE: The term voiceband data (VBD) is an umbrella term for all kind of teleservices which using a "data-oriented transport" in the frequency band of the narrowband voice spectrum (which is a 3,1-kHz-band). The data-oriented transport is realized by modem protocols (definition as in clause 3.13 of Recommendation ITU-T V.152 [9]), as defined e.g. within the Recommendations ITU-T V.x-series. Teleservices may be categorized into three major applications areas: facsimile, text-based communication and general data services.

T.38/G3 [i.7]: Recommendation ITU-T T.38/G3 refers to an ITU-T T.38 endpoint that supports G3FE, but excludes the Recommendation ITU-T T.30/V.34 procedures.

T.38/V.34G3 [i.7]: Recommendation ITU-T T.38/G3 refers to an ITU-T T.38 endpoint that supports G3FE and includes the Recommendation ITU-T T.30/V.34 half-duplex procedures.

VBD gateway [9]: media gateway that is compliant with Recommendation ITU-T V.152 [9]

VBDtoIP emulation service: XoIP emulation service compliant to Recommendation ITU-T V.152 [9]

voiceband data mode [9]: transport of voiceband data over a voice channel of a packet network with the encoding appropriate for modem signals as defined in section 6 of Recommendation ITU-T V.152 [9]

XoIP emulation service (for PSTN modem calls) [i.17]: emulation service in IP networks, based on appropriated gateway technologies for interworking voiceband data information between the PSTN and IP networks

NOTE: Example emulation services for the three main VBD application areas, which may be summarized as (by using notation "application/transport"):

- Facsimile/modem: Gateway technologies for PSTN-to-IP interworking see e.g. Recommendation ITU-T V.152 [9] for pass-through mode and Recommendation ITU-T T.38 [i.7] as packet-relay mode;
- Text/modem: Gateway technologies for PSTN-to-IP interworking see e.g. Recommendation ITU-T V.152 [9] for pass-through mode and Recommendation ITU-T V.151 [i.25] as packet-relay mode; and
- Data/modem: Gateway technologies for PSTN-to-IP interworking see e.g. Recommendation ITU-T V.152 [9] for pass-through mode and Recommendation ITU-T V.150.1 [i.11] as packet-relay mode.

3.2 Abbreviations

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

ANM	Answer Message
ANS	Answer Tone
ATA	Analog Terminal Adapter
CED	Called station identification tone
CM	Call Menu signal
CM/JM	Call Menu signal/Joint Menu signal
CMD	Circuit-Mode Data
CNG	Calling Tone
CSS	Composite Source Signal
CT	Calling Tone
DCE	Data Communication Equipment
DJB	De Jitter Buffer
DTMF	Dual-Tone Multi-Frequency signalling
EC	Echo Canceller
ECM	Error Correction Mode
ERL	Echo Return Loss
ERLE	Echo Return Loss Enhancement
GSTN	General Switched Telephone Network
IAD	Integrated Access Device
IP	Internet Protocol

IPDV	IP Delay Variation
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
ITU-T	International Telecommunication Union - Telecommunication Standardization Sector
JB	de-Jitter Buffer
JBD	de-Jitter Buffer Delay
JBS	de-Jitter Buffer Size
JM	Joint Menu signal
MGC	Media Gateway Controller
MGW	Media Gateway
MSAN	Multi Service Access Nodes
NGN	New Generation Network
NLP	Non-Linear Processor
NNI	Network Network Interface
PCM	Pulse Code Modulation
PLC	Packet Loss Concealment
PSTN	Public Switched Telephone Network
QAM	Quadrature Amplitude Modulation
RCV	Received
RTP	Real Time Protocol
SDP	Session Description Protocol
SIP	Session Initiation Protocol
SSND	Signal - Send
TDM	Time Division Multiplexing
UDI	Unrestricted Digital Information
UNI	User Network Interface
VBD	VoiceBand Data

4 Characteristics of de-jitter buffers

4.1 De-Jitter buffers

The present document describes the activation procedures of a de-jitter buffer, including the requirement for in-band tone activating and other control mechanisms. The de-jitter buffers are assumed to be dynamic de-jitter buffers and fixed de-jitter buffers. Fixed de-jitter buffers shall be provided for fax and voiceband data and 64 kbit/s bit sequence (UDI).

A de-jitter buffer is designed to remove the effects of jitter from the decoded voice stream, buffering each arriving packet for a short interval before playing it out synchronously. A **fixed de-jitter buffer** maintains a constant size whereas an **adaptive de-jitter buffer** has the capability of adjusting its size dynamically in order to optimize the delay/discard trade-off. The disadvantage of **adaptive de-jitter buffer** is that a part of the jitter budget is transferred to the user. While the human perception of audio delay variation is low, modem and fax applications are extremely sensitive to delay variation in the audio path. For this reason adaptive de-jitter buffer are not applicable for fax and modem transmission. Fixed de-jitter buffers try to maintain a constant End-to-End audio delay.

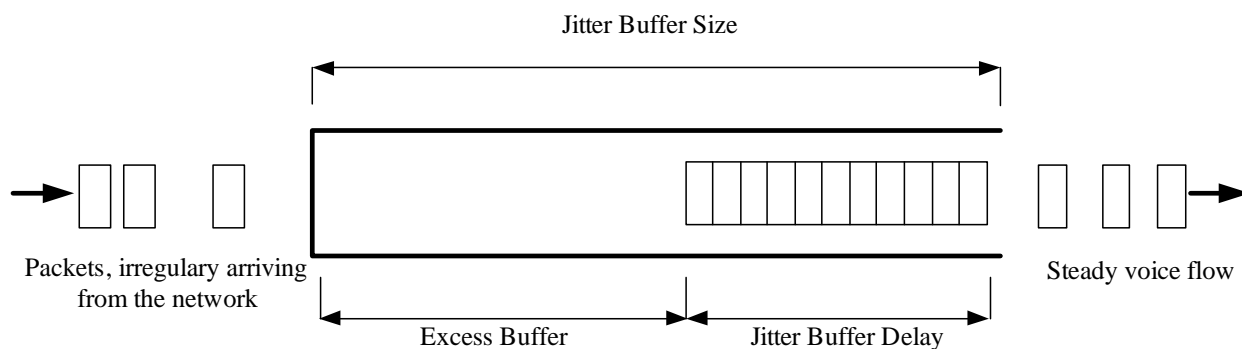


Figure 1: De-jitter buffer Size and Delay

De-jitter buffer Size (JBS): The maximum amount of time packets can stay in the buffer.

De-jitter buffer Delay (JBD): The de-jitter buffer delay is also called de-jitter delay, holding time or play-out delay. It corresponds to the time packets stay in the buffer, which is less than the de-jitter buffer size. The time of departure of each packet is determined by reading out the timestamp information provided by RTP.

4.2 Purpose, operation and environment

For proper operation for VBD-services, De-jitter buffers have the following fundamental requirements:

- 1) fast and correct switching between dynamic and fix de-jitter buffer mode;
- 2) proper operation during facsimile and data transmissions.

For proper operation of speech services in good quality, false detection of tones (e.g. from answering machines, call centres or speech) has to be minimized.

NOTE: It may be necessary to make a balancing between quality requirements of VBD and speech services.

4.3 External enabling of fixed de-jitter buffers

The fixed de-jitter buffer for 64 kbit/s bit sequence (UDI) and V.152 VBD shall be activated directly by signalization.

5 Characteristics of VBD-mode switching of de-jitter buffers

5.1 General

The de-jitter buffer covered by the present document should be equipped with a tone detector that conforms to this clause.

- The change of the de-jitter buffer to VBD-mode should be based on the following signals (mostly taken out of Recommendation ITU-T V.152 [9]). For Facsimile applications:
 - CED as per Recommendation ITU-T T.30 [i.10]
 - ANSam as per Recommendation ITU-T V.8 [1]
 - Preamble as per Recommendation ITU-T T.30 [i.10], section 5.3.1
 - CNG as per Recommendation ITU-T T.30 [i.10]
- For Modem applications:
 - ANS as per Recommendation ITU-T V.8 [1]
 - ANSam as per Recommendation ITU-T V.8 [1]
 - /ANS as per Recommendation ITU-T V.25 [6]
 - 2 225 Hz answer tone as per Recommendation ITU-T V.150.1 [i.11], appendix VI
 - Unscrambled binary ones signal as per Recommendation ITU-T V.22 [5]
 - CI signals that precede ANSam, as per Recommendations ITU-T V.8 [1] and V.21 [4]
 - Dual-frequency tones (1 375 Hz + 2 002 Hz and 1 529 Hz + 2 225 Hz) as per Recommendation ITU-T V.8bis [2]

- For Text Telephony applications:
 - ANS as per Recommendation ITU-T V.8 [1]
 - ANSam as per Recommendation ITU-T V.8 [1]
 - Text telephone signals as defined by Recommendation ITU-T V.18 [i.12], section 5.1.1
 - CI signals that precede ANSam, as per Recommendation ITU-T V.8 [1]
 - CT (Calling Tone) signals that precede ANS, as per Recommendation ITU-T V.25 [6]
 - Initiating Segment 1 dual tones (1 375 Hz & 2 002 Hz) as per Recommendation ITU-T V.8bis [2]

5.2 Detector characteristics

5.2.1 Detector characteristics for frequency range of $2\ 100\ \text{Hz} \pm 21\ \text{Hz}$

The tone detector shall detect a tone in the frequency range of $2\ 100\ \text{Hz} \pm 21\ \text{Hz}$ (see Recommendation ITU-T V.21 [4]). The detection channel bandwidth should be chosen wide enough to encompass this tone (and possibly other tones used within national networks). At the same time, the detection channel bandwidth should be such that, in conjunction with guard action and timing, adequate protection is provided against false operation of the detector by speech signals. The detector channel sensitivity (threshold level) should be such that the detector will operate on the lowest expected power of the tone. The band characteristics shown in figure 2 will permit changing the de-jitter buffer behaviour by the $2\ 100\ \text{Hz}$ tone as well as others used in North America. The figure indicates that in the frequency band $2\ 079\ \text{Hz}$ to $2\ 121\ \text{Hz}$ detection **shall** be possible whilst in the band $1\ 900\ \text{Hz}$ to $2\ 350\ \text{Hz}$ detection **may** be possible. Providing that only the recommended $2\ 100\ \text{Hz}$ tone is used internationally, interference with signalling equipment will be avoided. The dynamic range of the detector should be consistent with the input levels as specified in Recommendation ITU-T V.2 [i.3] with allowances for variation introduced by the public switched telephone network.

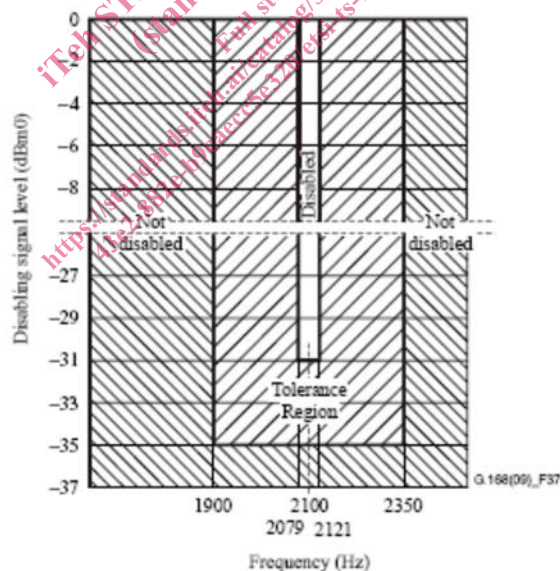


Figure 2: Required band characteristics