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SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

International telephone connections and circuits –
Apparatus associated with long-distance telephone circuits

Interaction aspects of signal processing network equipment

Recommendation ITU-T G.161



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Recommendation ITU-T G.161

Interaction aspects of signal processing network equipment

Summary

The evolution towards interactive multimedia applications and implementation of new signal processing devices, both in terminals and communication networks, means that a number of sophisticated signal processing algorithms will be deployed for echo control, noise reduction, level control, voice activity detection, speech coding, speech recognition and voiceband traffic technologies. These technologies may interact with one another and with the imperfections of transmission systems, such as delay and error bursts, to adversely affect the quality of speech and voiceband signals.

The purpose of Recommendation ITU-T G.161 is to clarify interaction aspects and to provide guidance to minimize the undesirable interactions of signal processing network equipment (SPNE), between different SPNE, between SPNE and terminals and between SPNE and transmission systems in telecommunication networks.

History

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1.0	ITU-T G.161	2002-06-13	15
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3.0	ITU-T G.161	2012-06-29	16

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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Recommendation ITU-T G.161

Interaction aspects of signal processing network equipment

1 Scope

The evolution towards interactive multimedia applications and implementation of new signal processing devices, both in terminals and communication networks, means that a number of sophisticated signal processing algorithms will be deployed for echo control, noise reduction, level control, voice activity detection, speech coding, speech recognition and voiceband traffic technologies. These technologies may interact with one another and with the imperfections of transmission systems, such as delay and error bursts, to adversely affect the quality of speech and voiceband signals.

The purpose of this Recommendation is to clarify interaction aspects and to provide guidance to minimize the undesirable interactions of signal processing network equipment (SPNE), between different SPNE, between SPNE and terminals and between SPNE and transmission systems in telecommunication networks.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

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3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 acoustic echo: An acoustic echo is the reflected signal resulting from the acoustic path between the earphone/loudspeaker and microphone of a terminal, hand-held or hands-free mobile station.

3.2.2 automatic level control device: An automatic level control (ALC) device is a signal processing function located in the digital transmission path which automatically adjusts the level of a signal towards a predetermined value. Devices which modify the frequency response or spectral content of the signal in such a way as to affect the overall level of the signal are also defined as ALC devices for the purpose of this Recommendation. An ALC device is designed to process signals in one direction of transmission (see Figure 1).

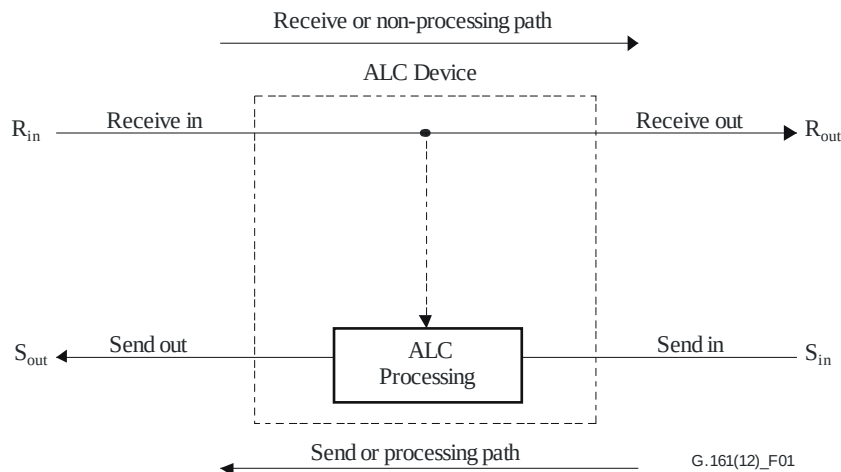


Figure 1 – Block diagram of an automatic level control device [ITU-T G.169]

3.2.3 cancelled end: The side of an echo canceller which contains the echo path on which this echo canceller is intended to operate. This includes all transmission facilities and equipment (including the hybrid and terminating telephone set) which is included in the echo path.

3.2.4 circuit multiplication equipment (CME): Circuit multiplication equipment is a general class of equipment which permits concentration of a number of 64 kbit/s PCM encoded input trunk channels on a reduced number of transmission channels (see Figure 2).

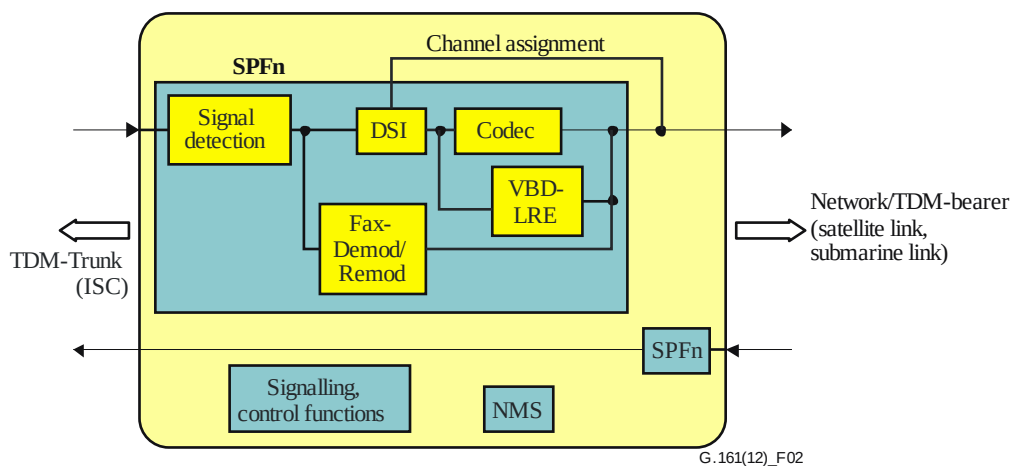


Figure 2 – Block diagram of digital circuit multiplication equipment (DCME) ([ITU-T G.763] and [ITU-T G.768])

3.2.5 IP-based circuit multiplication equipment (CME) (IP-CME): IP-CME constitutes a general class of equipment that permits concentration of a number of IP ports on a reduced number of transmission channels over IP-based networks (see Figure 3).

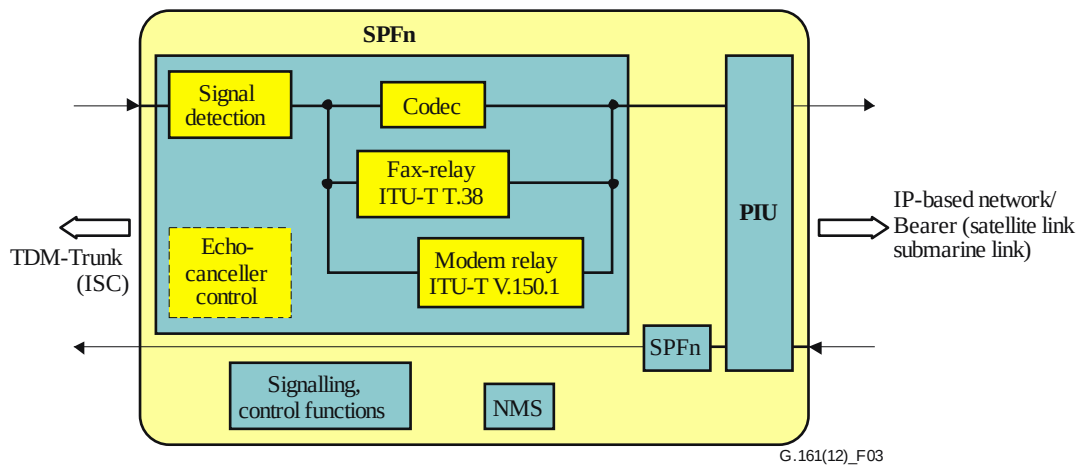


Figure 3 – Block diagram of IP-CME [ITU-T G.769]

3.2.6 network acoustic echo controller: Network acoustic echo controllers are devices placed in the 4-wire portion of a circuit and used for reducing cancelled-end acoustic echo.

3.2.7 network echo canceller: A network echo canceller is a 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 (see Figure 4).

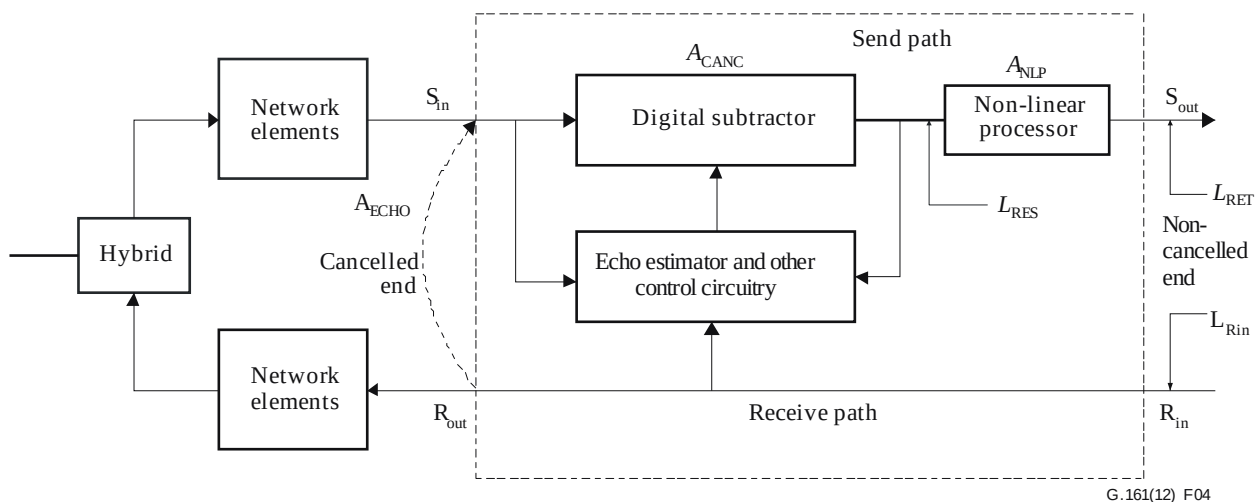


Figure 4 – Block diagram of an echo canceller [ITU-T G.168]

3.2.8 network echo suppressors: A network echo suppressor is a voice-operated device placed in the 4-wire portion of a circuit and used for inserting loss in the transmission path to suppress echo. The path in which the device operates may be an individual circuit path or a path carrying a multiplexed signal.

3.2.9 signal processing network device (SPND): A physical entity (e.g., chipset) that contains one or more signal processing network functions (SPNFs).

3.2.10 signal processing network element/equipment (SPNE): A stand-alone physical entity that supports one or more signal processing network functions (SPNFs). It may also be controlled internally and/or externally and managed through a network management system which contains managed objects, a management communications function and a management application function. SPNEs include, e.g., echo cancellers, voice enhancement devices, circuit multiplication equipment, and voice gateways.

NOTE 1 – Examples of managed objects are: receive/transmit port, power supply, plug-in cards, SPNFs. The communications function provides facilities for the transport of telecommunications management network (TMN) messages to and from the management application function, as well as facilities for the transit of messages. The message communications function does not originate or terminate messages. A management application function is the origin and termination for all TMN messages.

NOTE 2 – An SPNE in this context is a combination of hardware and software that performs SPNFs.

3.2.11 signal processing network function (SPNF): A function within a physical entity (e.g., SPNE, SPND) that performs signal processing to provide support or services to the transport network and/or to the users. Examples include electric or acoustic echo control, noise reduction, automatic level control, digital speech interpolation, low-rate encoding, transcoding.

3.2.12 terminal acoustic echo controller: Terminal acoustic echo controllers are voice operated devices installed in audio terminals on the customer premises, used for the purpose of eliminating acoustic echoes and protecting the communication from howling due to acoustic feedback from loudspeaker to microphone.

3.2.13 voice enhancement device (VED): A VED is defined as certain signal processing network functions such as noise reduction and acoustic echo control (see [ITU-T G.160], [ITU-T G.168] and [ITU-T G.169]) in the digital transmission path that perform voice enhancement functions on voiceband signals.

Voice enhancement functions in a mobile network environment (see Figure 5) include the control of acoustic echo generated by wireless handsets, noise reduction, and the recognition and accommodation of tandem-free operation (TFO) and interworking function (IWF) signals.

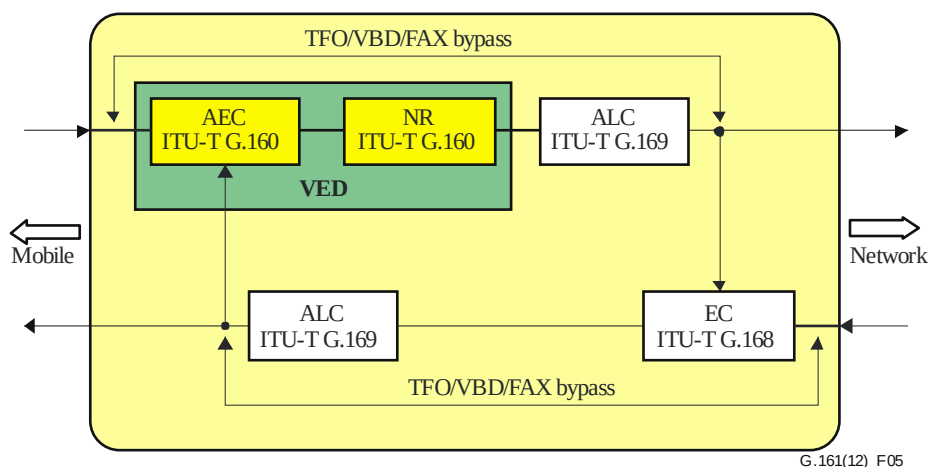


Figure 5 – Block diagram of a voice enhancement device [ITU-T G.160]

3.2.14 voice gateways: A voice gateway is a subset of a gateway that deals with voice and voiceband traffic only, and not data or video traffic (see Figure 6).

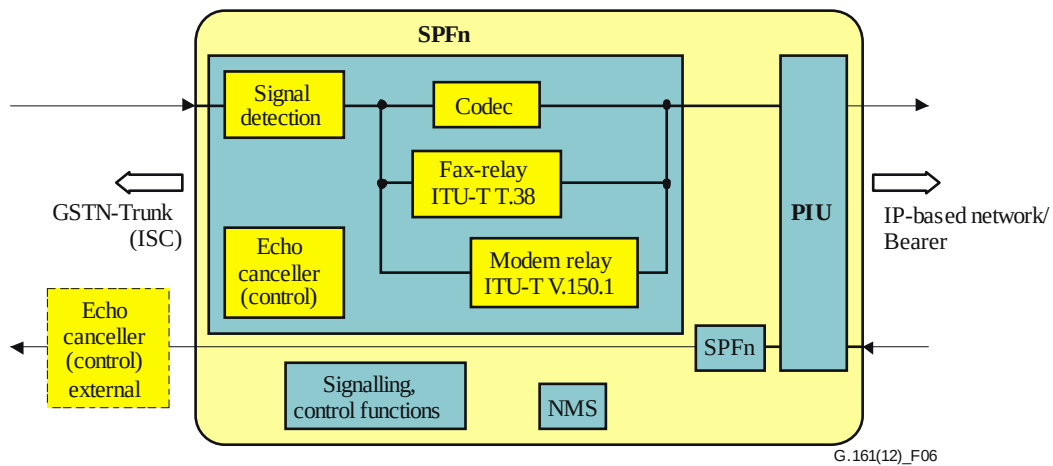


Figure 6 – Block diagram of a voice gateway (TIGIN) [ITU-T G.799.1]

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

A/D	Analogue-to-Digital converter
ADPCM	Adaptive Differential Pulse Code Modulation
AEC	Acoustic Echo Controller
ALC	Automatic Level Control
BSC	Base Station Controller
BTS	Base Transmitter Station
CED	Called station identification
CEST	Cancelled-End Speech Threshold
CME	Circuit Multiplication Equipment
CN	Comfort Noise
CNG	Comfort Noise Generation
CPE	Customer Premises Equipment
D/A	Digital-to-Analogue converter
DCME	Digital Circuit Multiplication Equipment
DSI	Digital Speech Interpolation
DTDT	Double Talk Detection Threshold
EC	Echo Canceller
ERL	Echo Return Loss
ERLE	Echo Return Loss Enhancement
GSM	Global System for Mobile Communications
GSTN	General Switched Telephone Network
HDLC	High-level Data Link Control
HRDP	Hypothetical Reference Digital Path
IP	Internet Protocol

IWF	InterWorking Function
LRET	Returned Echo Level
LSB	Least Significant Bit
MS	Mobile Station
MSB	Most Significant Bit
MSC	Mobile Switching Centre
NLP	Non-Linear Processor
NR	Noise Reduction
PBX	Private Branch exchange
PCM	Pulse Code Modulation
PIU	Packet Interface Unit
PLC	Packet Loss Concealment
PSTN	Public Switched Telephone Network
SPNE	Signal Processing Network Equipment
SPNF	Signal Processing Network Function
TASI	Time Assignment Speech Interpolation
TCE	Transcoder Equipment
TDM	Time Division Multiplex(ing)
TDMA	Time Division Multiple Access
TFO	Tandem-Free Operation
TIGIN	Transport Network Equipment for Interconnecting GSTN and IP Networks
UMTS	Universal Mobile Telecommunications System
VBD-LRE	VoiceBand Data-Low Rate Encoding/decoding
VED	Voice Enhancement Device
VoIP	Voice over IP

5 Interaction aspects of signal processing network equipment

5.1 Interaction aspects of echo suppressors

The principle of echo suppressors is summarized as follows: When speech is detected on the receive path, a very high attenuation is inserted in the send path. When double talk is detected, the send path is closed and a receive loss is inserted in the receive path. Thus, during double talk, there is no echo suppression in the send path, but the echo is much more attenuated than the direct speech. Other refinements are possible, as indicated in [ITU-T G.164]. The following text relates to ITU-T G.164 echo suppressors.

Many problems can occur in the operation of echo suppressors; this is because the decision as to which end is talking and which is listening is based essentially on the transmission levels. If the level of the echo is high and the level of direct speech is low, speech could be mutilated and/or it could be difficult to distinguish between single talk and double talk. This could also be the case at the beginning or at the end of a speech burst.