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

Digital terminal equipments – Operations, administration and maintenance features of transmission equipment

SPNE mechanisms/auxiliary functions

Recommendation ITU-T G.776.2

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Recommendation ITU-T G.776.2

SPNE mechanisms/auxiliary functions

Summary

Signal processing functions (SPFs) designed for speech quality, when located in the network, may interact with in-band signalling (e.g., tandem free operation) and non-voice services (e.g., high speed circuit switched data). The platform that carries these SPFs is called signal processing network equipment (SPNE) and may therefore need to provide mechanisms/auxiliary functions to support in-band signalling and non-voice services depending on where in the network the SPNE is going to be deployed and what services and/or in-band signalling are present. This Recommendation defines these mechanisms/auxiliary functions of a signal processing network equipment (SPNE) designed for the use in the circuit switched part of a network (mobile, fixed and hybrid).

Source

Recommendation ITU-T G.776.2 was approved on 13 June 2008 by ITU-T Study Group 16 (2005-2008) under Recommendation ITU-T A.8 procedure.

Keywords

Codec, echo cancellation, HSCSD, SPF, SPNE, TFO, VAD/CNG, VED, V.21.

FOREWORD

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CONTENTS

Introduction

Signal processing functions designed for speech quality are normally provided on a platform called signal processing network equipment. Since these signal processing functions may either not be required on all calls or not be applied to digital media, additional mechanisms/auxiliary functions are required which are not necessarily part of the specific signal processing functions as such. Therefore, these auxiliary functions/mechanisms are considered to be provided by a signal processing network equipment.

Recommendation ITU-T G.776.2

SPNE mechanisms/auxiliary functions

1 Scope

This Recommendation defines mechanisms/auxiliary functions for a signal processing network equipment (SPNE) designed for the use in the circuit switched part of a network (mobile, fixed and hybrid). The SPNE addressed in this Recommendation is a physical entity that contains one or more of the following signal processing functions (SPFs) optimized for speech quality, acoustic echo control, electric echo cancellation, noise reduction and automatic level control. The SPNE can be designed as stand-alone equipment or can be integrated in some other network equipment. The SPNE provides the SPFs permanent associated to the circuits or arranged in a pool. Depending on where in the network the SPNE is going to be provided, the mechanisms/auxiliary functions identified in this Recommendation include appropriate interfaces to allow external control of the SPFs and the support of in-band signalling such as tandem free operation (TFO) and of services such as high speed circuit switched data (HSCSD).

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.

[ITU-T G.703] Recommendation ITU-T G.703 (2001), *Physical/electrical characteristics of hierarchical digital interfaces*.
<http://www.itu.int/rec/T-REC-G.703>

[ITU-T G.704] Recommendation ITU-T G.704 (1998), *Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels*.
<http://www.itu.int/rec/T-REC-G.704>

[ITU-T G.711] Recommendation ITU-T G.711 (1988), *Pulse code modulation (PCM) of voice frequencies*.
<http://www.itu.int/rec/T-REC-G.711>

[ITU-T Q.115.0] Recommendation ITU-T Q.115.0 (2002), *Protocols for the control of signal processing network elements and functions*.
<http://www.itu.int/rec/T-REC-Q.115.0>

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 in path equipment (IPE) [b-3GPP TS 28.062]: The term "in path equipment" is used for any telecommunication equipment within the (64 kbit/s) transmission path for the speech signal between two entities, which want to communicate via IS messages, i.e., the IS partners.

3.2 Term defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 hybrid network: A combined circuit switched and packet switched network, e.g., IP trunking.

3.2.2 signal processing function (SPF): An SPF designed/optimized for speech quality is a function (realized in hardware, silicon or software) that performs voice processing such as electric and acoustic echo control, noise reduction or automatic level control.

3.2.3 signal processing network equipment (SPNE): A type of network equipment or element that contains one or more signal processing functions or devices.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BSC	Base Station Controller
CNG	Comfort Noise Generation
EC	Echo Cancellation
ECD	Echo Control Device
FFS	For further study
HSCSD	High Speed Circuit Switched Data
If	Interface
IP	Internet Protocol
IPE	In-Path Equipment
IS	In-band Signalling
ISC	International Switching Centre
ISDN	Integrated Services Digital Network
L	Linear conversion (combination of coder and decoder)
LE	Local Exchange
MG	Media Gateway
MGC	Media Gateway Controller
MS	Mobile Station
MSC	Mobile Switching Centre
PSTN	Public Switched Telephone Network
RNC	Radio Network Controller
SPF	Signal Processing Function
SPNE	Signal Processing Network Equipment
SPNE:ECD	Signal Processing Network Equipment containing an Echo Control Device
SPNE:MG	Signal Processing Network Equipment providing signal processing functions of a Media Gateway
SPNE:VED	Signal Processing Network Equipment containing a Voice Enhancement Device/function

TCH	Traffic CHannel
TDM	Time-Division Multiplexing
TE	Transit Exchange
TFO	Tandem Free Operation
VAD	Voice Activity Detection
VED	Voice Enhancement Device/Function (acoustic echo control and noise reduction)

5 Conventions

None.

6 SPNEs in typical network scenarios

The following clauses describe some exemplary network scenarios with SPNEs.

6.1 ISDN/PSTN

A typical example in an ISDN/PSTN network would be a SPNE:ECD associated with an international switching centre (ISC). The SPNE:ECD provides echo control devices for a number of E1/T1 circuits. The SPNE:ECD can be deployed either as stand-alone equipment or integrated in an exchange/switch; see Figure 1.

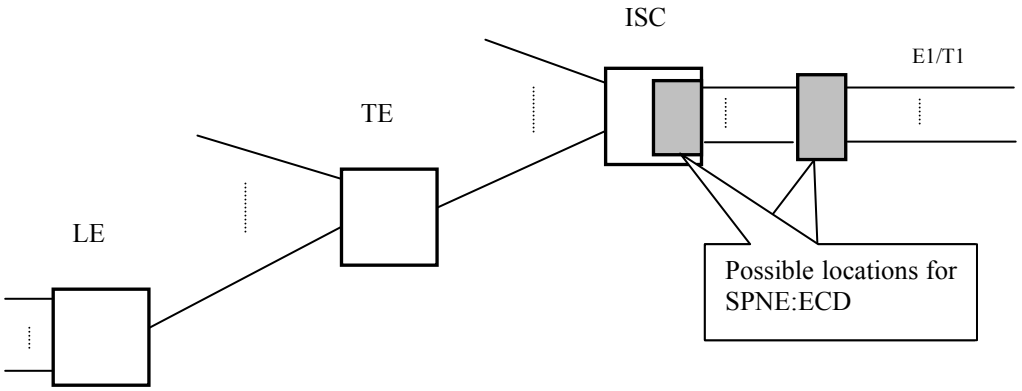


Figure 1 – SPNE:ECD associated with an ISC

6.2 Mobile network

In the mobile network, the so called SPNE:VED provides acoustic echo control and noise reduction to reduce the speech quality degradation due to acoustic echo and noise injected into the network by the mobile station (MS). Some possible locations of the SPNE:VED (either as stand-alone equipment or as integrated version) in a mobile network are shown in Figure 2.

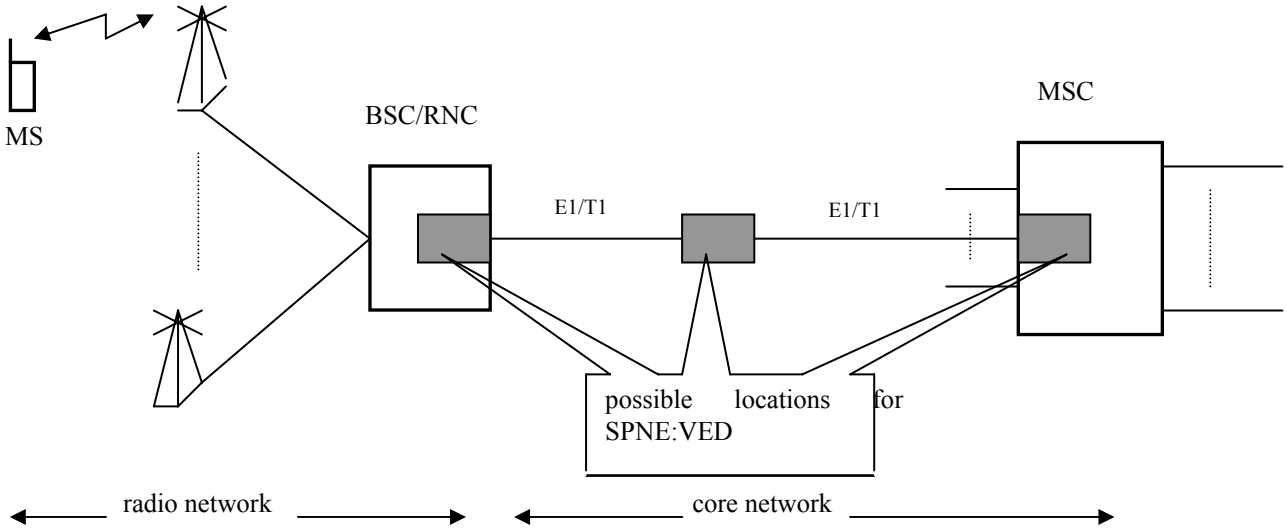


Figure 2 – Possible locations of a SPNE:VED in a mobile network

6.3 Hybrid (TDM/IP) network

The media gateway includes an SPNE:MG providing signal processing functions such as echo cancellation, transcoding and VAD/CNG. The SPNE:MG is normally integrated in a media gateway; see Figure 3.

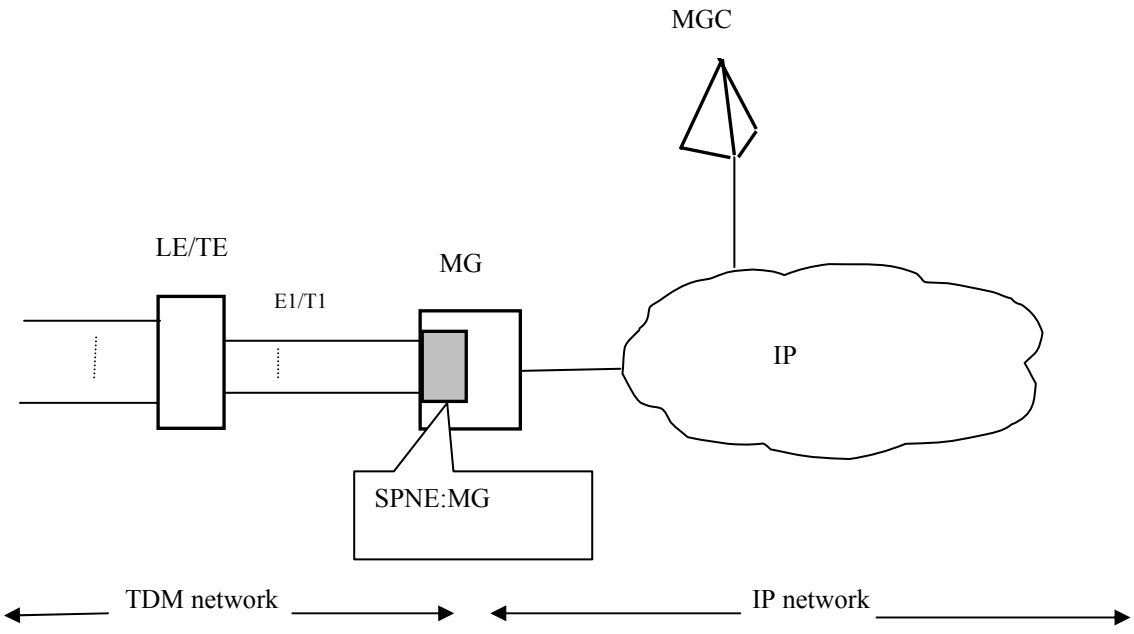


Figure 3 – SPNE:MG

7 Types and functional entities of the SPNE

SPNE as described in this Recommendation is a physical equipment that can be located in several places in a circuit switched network. The SPFs contained in the SPNE process the voice/voiceband signals carried on the bearer to improve their quality. In addition to these SPFs, the SPNE needs to have mechanisms/auxiliary functional entities, depending on where in the network the SPNE is going to be deployed and what services the network supports.

7.1 Types A and B

SPNE types A and B can be designed as either stand-alone equipment or as an integrated device.

7.1.1 Type A: SPNE with a control plane interface for SPNE

The SPFs of this type of SPNE are controlled (enabled/disabled) on a per-call basis. A specific control plane interface is required, whereby the control plane is either embedded in the bearer carrying the media or has its own bearer. For a stand-alone SPNE, the protocols used at the control plane interface are described in [ITU-T Q.115.0], whereas for an integrated SPNE this is an implementation matter.

7.1.2 Type B: SPNE without a control plane interface for SPNE

This type of SPNE can adopt the IS_Passive behaviour of an in-path equipment (IPE) for its SPFs, if required. An IS_Passive IPE shall never actively initiate the exchange of IS messages. The active initiation is only done by terminals or their "representatives". They need not and do not understand the IS protocol, but let it pass unaltered. This type of SPNE requires detection mechanisms for in-band signalling, any kind of non-voice information and a protocol entity to communicate with other SPNEs in order to optimize the provisioning of the SPFs. This applies for the stand-alone version as well as for the integrated version.

The following auxiliary functional entities are identified:

– A control plane interface that allows the SPFs to be controlled by the corresponding call control/bearer control entity (network logic/resource control) on a per-call basis.

– A TFO functional entity that allows the disabling/bypass of the SPFs.

– An HSCSD functional entity that allows the disabling/bypass of the SPFs.

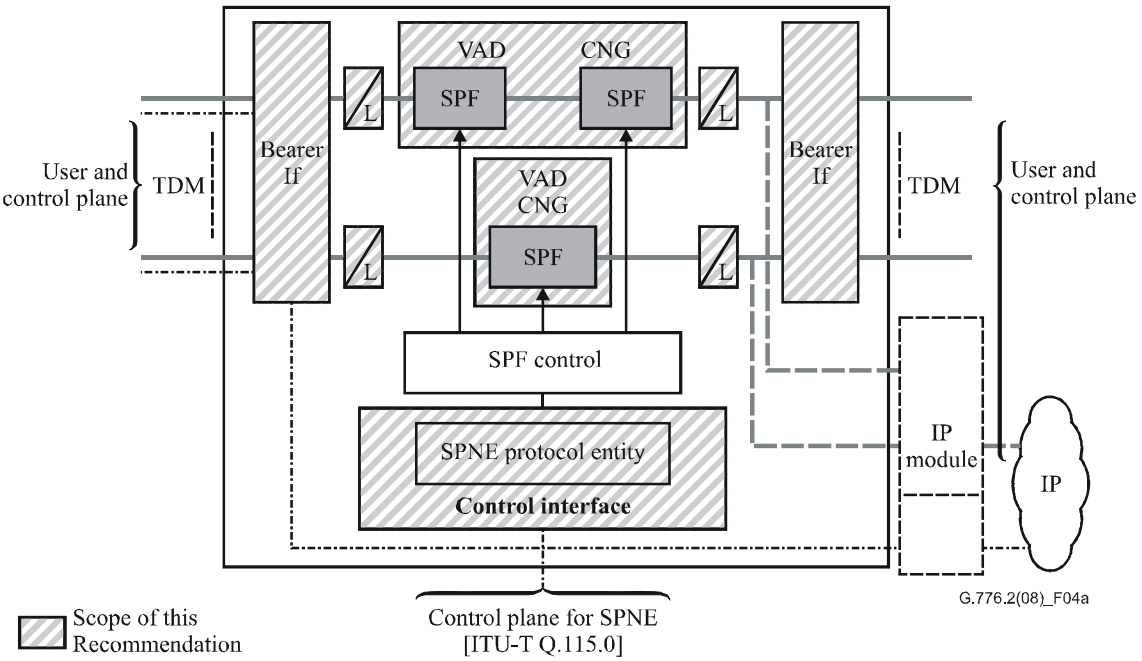
– A protocol entity for the in-band communication with other SPNEs (FFS).

– A linear conversion function (e.g., rx ITU-T G.711 codec → linear,
tx: linear → ITU-T G.711 codec).

– A VAD/CNG function.

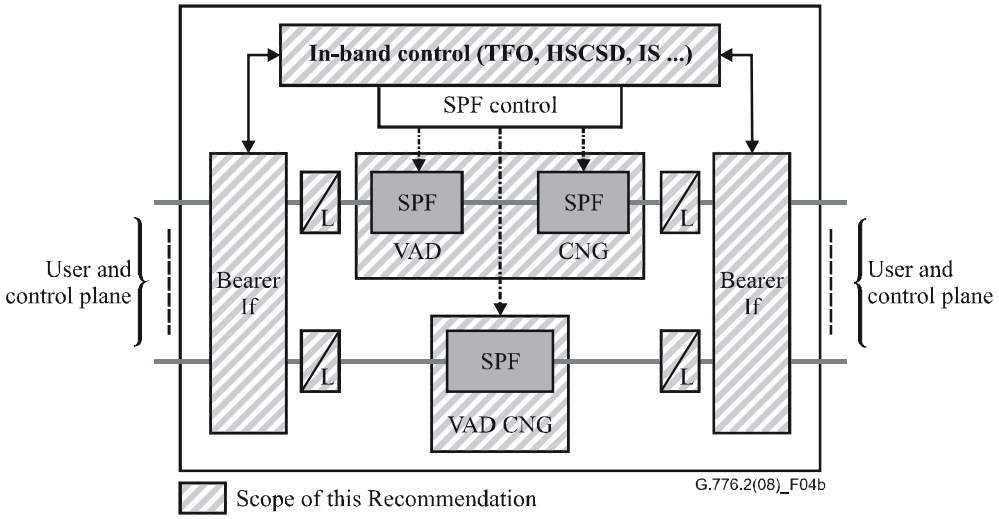
NOTE – Tone disabling (defined in [b-ITU-T G.164], [b-ITU-T G.165] and [b-ITU-T G.168]) is considered to be an inherent function of an echo control device and therefore not a matter of the SPNE.

Figures 4a and 4b shows the basic block diagrams of SPNE types A and B.



NOTE – If signal processing is done on the coded representation of the signal, then L is not needed.

Figure 4a – SPNE (type A) and its auxiliary functional entities



NOTE – If signal processing is done on the coded representation of the signal, then L is not needed.

Figure 4b – SPNE (type B) and its auxiliary functional entities

7.2 The signal processing functions

The specific SPFs are not in the scope of this Recommendation. Examples of SPF Recommendations can be found in, e.g., [b-ITU-T G.168], [b-ITU-T G.169] and [b-ITU-T G.160].

7.3 SPNE mechanisms/auxiliary functions

7.3.1 SPNE type A

The SPFs are provided on a per-call basis only for voice (voiceband data) calls and depending on the specific order of precedence in case of the presence of, e.g., TFO, i.e., controlled by a network

logic for these SPF(s). Therefore, there is no interaction between SPF(s) and, e.g., TFO and/or HSCSD.

7.3.1.1 Control plane interface for SPNE

The protocols used on this interface are described in [ITU-T Q.115.0] and the network logic that decides where and when a certain SPF is needed for a specific call is defined in [b-ITU-T Q.115.1] for network echo control devices/functions and in [b-ITU-T Q.115.2] for voice enhancement devices/functions. The default state of the SPFs is "disabled", this avoids any interference with non-voice calls (note that the network logics for SPFs are not invoked for non-voice calls considering that SPFs are designed for voice).

7.3.1.2 Bearer interface

Any standardized interface. If the user plane and the control plane are on the same bearer, i.e., control signalling is embedded (e.g., channel-associated signalling in time slot 16 of an E1), then the bearer interface must be able to extract/insert the control signalling on behalf of the control interface.

7.3.1.3 Linear conversion (coder/decoder) (optional)

This function is needed if internal processing is based on the linear representation of the signal. As a minimum, the G.711 codec shall be supported. Support of any other standardized codec is optional.

7.3.1.4 VAD/CNG

VAD/CNG is placed in parallel to SPFs designed for speech quality. In case of silence detected by the VAD function, the media stream (comfort noise) is generated by the CNG function. VAD/CNG enhances listening comfort. The generated comfort noise should imitate the actual noise by the overall power level and the power levels in the sub-bands 500 Hz, 1000 Hz and 2000 Hz. Certain services, such as the voiceband data service and the digital media service do not require the generation of comfort noise.

The VAD/CNG is enabled on a per-call basis, dependent on information available in the call controller.

7.3.1.5 V.21 preamble detection function (optional)

In the scenario "V.34 fax calls G.3 fax, fallback to G.3 mode" the re-enabling of an echo canceller is not guaranteed; [b-ITU-T T.30] specifies a short silence period for the fallback to G.3 mode, so that an echo cancellation function compliant to [b-ITU-T G.168] cannot "re-enable" if "tone disabled". The V.21 detection function re-enables a "tone disabled" echo cancellation function in the presence of V.21 preamble (flags). The control interface between the V.21 detection function and the echo cancellation function is implementation dependent. Figure 5 shows the collocation of the V.21 detection function in an SPNE providing the echo cancellation function.

The detection of the V.21 preamble can be notified, e.g., to a media gateway controller.

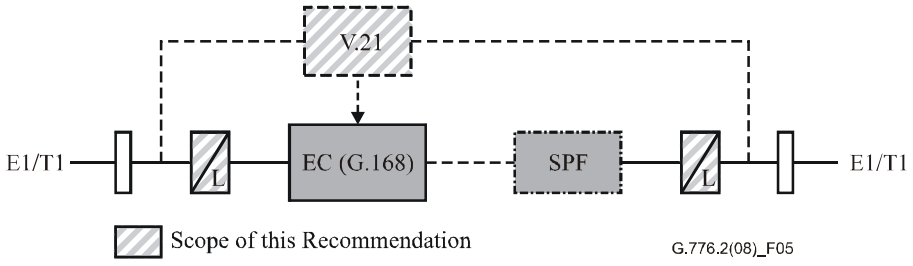


Figure 5 – Collocation of the V.21 detection function with its echo canceller in the SPNE

7.3.2 SPNE type B

Functional entities to detect in-band signalling (e.g., TFO) and non-voice services (e.g., HSCSD) are required. In addition, an in-band signalling entity may be required to communicate with other SPNEs in order to avoid multiple provisioning of the same SPFs for a specific call (FFS). This type of SPNE cannot be used in media gateways as a media gateway controller does explicitly request the SPFs, therefore a control interface is needed.

7.3.2.1 User plane and control plane

In addition to the media, in-band signalling may be embedded in the bearer carrying the media and/or, dependent on the call scenario, non-voice services may be present on the bearer. Specific functional entities should support these appropriately.

7.3.2.1.1 TFO detector (control plane)

The TFO functional entity is required in case the SPNE is designed to be used in network locations where it becomes an in-path equipment. It should support tandem free operation according to the standards [b-3GPP TS 28.062] and [b-TIA/EIA-895]. On recognition of TFO, the SPFs for that bearer channel have to be disabled or bypassed.

7.3.2.1.2 HSCSD detector (control plane)

HSCSD is a feature that introduces general bearer services and a multi-slot mechanism is used for user rates that can be achieved with one or more TCH/F. The HSCSD functional entity is required in case the SPNE is designed to be used in network locations where the bearer may carry HSCSD. On recognition of HSCSD, the SPFs for that bearer channel have to be disabled or bypassed.

7.3.2.1.3 IS (in-band protocol for SPF) between SPNEs (control plane)

NOTE – There is currently no signalling (protocol) defined.

7.3.2.2 Bearer interface

Any standardized interface may be supported.

7.3.2.3 Linear conversion (coder/decoder) (optional)

This function is needed if internal processing is based on the linear representation of the signal. As a minimum, the G.711 codec shall be supported. Support of any other standardized codec is optional.

7.3.2.4 VAD/CNG

VAD/CNG is placed in parallel to SPFs designed for speech quality. In case of silence detected by the VAD function, the media stream (comfort noise) is generated by the CNG function. VAD/CNG enhances listening comfort. The generated comfort noise should imitate the actual noise by the overall power level and the power levels in the sub-bands 500 Hz, 1000 Hz and 2000 Hz. Certain services, such as the voiceband data service and the digital media service do not require the generation of comfort noise.

7.3.2.5 V.21 preamble detection function; optional

In the scenario "V.34 fax calls G.3 fax, fallback to G.3 mode" the re-enabling of an echo canceller is not guaranteed; [b-ITU-T T.30] specifies a short silence period for the fallback to G.3 mode, so that an echo cancellation function compliant to [b-ITU-T G.168] cannot "re-enable" if "tone disabled". The V.21 detection function re-enables a "tone disabled" echo cancellation function in the presence of V.21 preamble (flags). The control interface between the V.21 detection function and the echo cancellation function is implementation dependent. Figure 5 shows the collocation of the V.21 detection function in an SPNE providing the echo cancellation function.

Appendix I

Example of an SPNE serving one E1/T1

(This appendix does not form an integral part of this Recommendation)

I.1 SPNE:VED

Figure I.1 shows the individual signal processing functions designed/optimized for speech quality that may be included in an SPNE:VED. This diagram is for illustration purposes and different SPNEs may not have the same signal processing functions designed/optimized for speech quality and may serve more than one E1/T1.

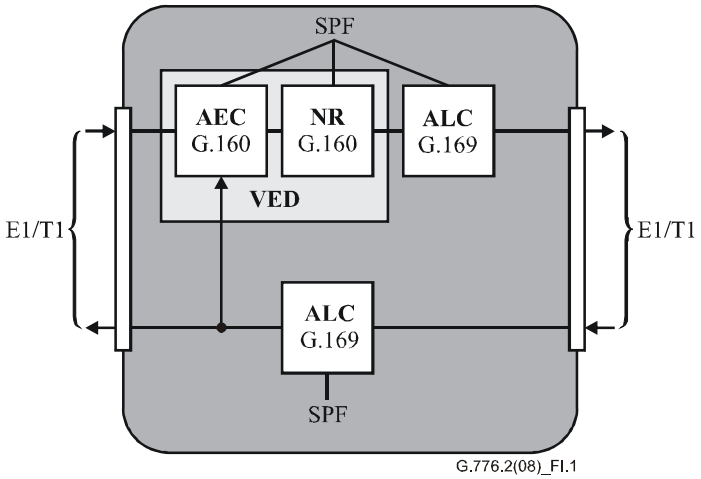


Figure I.1 – Example block diagram showing the SPFs designed/optimized for speech quality of an SPNE:VED

Bibliography

[b-ITU-T G.160] Recommendation ITU-T G.160 (2008), *Voice enhancement devices.* <http://www.itu.int/rec/T-REC-G.160>

[b-ITU-T G.164] Recommendation ITU-T G.164 (1988), *Echo suppressors*. <http://www.itu.int/rec/T-REC-G.164>

[b-ITU-T G.165] Recommendation ITU-T G.165 (1993), *Echo cancellers*. <http://www.itu.int/rec/T-REC-G.165>

[b-ITU-T G.168] Recommendation ITU-T G.168 (2007), *Digital network echo cancellers*. <http://www.itu.int/rec/T-REC-G.168>

[b-ITU-T G.169] Recommendation ITU-T G.169 (1999), *Automatic level control devices*. <http://www.itu.int/rec/T-REC-G.169>

[b-ITU-T Q.115.1] Recommendation ITU-T Q.115.1 (2002), *Logic for the control of echo control devices and functions*. <http://www.itu.int/rec/T-REC-Q.115.1>

[b-ITU-T Q.115.2] Recommendation ITU-T Q.115.2 (2007), *Logic for the control of voice enhancement devices and functions.* <http://www.itu.int/rec/T-REC-Q.115.2>

[b-ITU-T T.30] Recommendation ITU-T T.30 (2005), *Procedures for document facsimile transmission in the general switched telephone network.* <http://www.itu.int/rec/T-REC-T.30>

[b-3GPP TS 22.034] 3GPP TS 22.034 V6.0.0 (2004), *High Speed Circuit Switched Data (HSCSD); Stage 1*. <http://www.3gpp.org/ftp/Specs/html-info/22034.htm>

[b-3GPP TS 28.062] 3GPP TS 28.062 V4.0.0 (2001), *Inband Tandem Free Operation (TFO) of speech codecs; Service description; Stage 3*. <http://www.3gpp.org/ftp/Specs/html-info/28062.htm>

[b-TIA/EIA-895] TIA/EIA-895 (2002), *CDMA Tandem Free Operation*. <http://www.tiaonline.org/standards/technology/cdma2000/documents/TIA-EIA-895.pdf>

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