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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Foreword

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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

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1 Scope

The present document specifies the stage 1 description for the Noise Suppression feature for the AMR codec which enhances the input speech signal corrupted by acoustic noise. In analogy with ITU-T Recommendations I.130 [1], Stage 1 is an overall service description, from the service subscriber's and user's standpoints, that views the network as a single entity which provides services to the user.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
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[1] ITU-T Recommendations I.130 (1988): "Method for the characterization of telecommunication services supported by an ISDN and network capabilities of an ISDN".

[2] GSM 01.04 (ETR 350): "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[3] GSM 03.50: "Digital cellular telecommunications system (Phase 2+); Transmission planning aspects of the speech service in the GSM Public Land Mobile Network (PLMN) system".

3 Definitions and abbreviations

GSM 01.04 [2] (ETR 350) provides a list of abbreviations and acronyms used in GSM specifications.

4 Description

Noise Suppression for the AMR codec is an optional feature designed to enhance speech quality in a range of environments where there is significant (acoustic) background noise. The noise suppression function is a preprocessing module that is used to improve the signal to noise ratio of a speech signal prior to voice coding. In so doing it may use functions and/or data from the AMR speech encoding function. It shall be possible to implement AMR Noise Suppression in the mobile station (operating on the uplink speech signal). The possibility to implement AMR Noise Suppression in the network (operating on the downlink speech signal) is for further study. The noise suppression specification shall be comprised of bit exact fixed point C code. Test vectors shall be defined to verify operation.

The AMR Speech decoder C-code should not be altered by the Noise Suppression.

It shall be possible for the network to disable the operation of the example noise suppression algorithm defined by this feature, whether that operation is operational in the network, the mobile station, or both locations.

4.1 Applicability of Noise Suppression to Basic Services.

This feature shall be applicable (as an option) to all speech calls where the narrowband AMR codec is utilised. Operation of noise suppression for wideband AMR is for further study.

4.2 Support in Mobile Stations (MS)

Support of the Noise Suppression feature shall require modifications to future mobile stations. Provision of the feature in AMR-capable mobile stations is a manufacturer dependent option.

Use of the feature in the network during a call should not place any requirements on its use within the MS. Similarly, use of the feature by the MS during a call shall not place any requirements on its use in the network.

The network shall be able to enable or disable this example optional noise suppression function both at call set-up and in call [Signalling between network and mobile to allow this control is under study in SMG2 WPA].

4.3 Support in the Network

Provision of the feature in the network should be an option.

Use of the feature in the network during a call should not place any requirements on its use within the MS. Similarly, use of the feature by the MS during a call should not place any requirements on its use in the network.

The network should be able to enable or disable this example optional noise suppression function both at call set-up and in call.

4.4 Parameters to be indicated and negotiated

[TBD]

4.5 Provision of Service

4.5.1 Location Independence

The Noise suppression feature shall be location independent.

4.5.2 Provision of service within and between networks

Provision of the feature is the same whether or not the call is wholly contained within a network or between networks.

4.5.3 Subscription and Billing Information

This feature shall not be provisioned on a per-subscriber basis and no record of the application of Noise Suppression is necessary for billing purposes.

4.6 Quality of Service (QoS)

4.6.1 Impact on Speech Quality

The following performance requirements are stated under the assumption that the noise suppressor is tested as an integral part of the AMR speech codec with the speech codec operating at the following rates [TBD]. The performance requirements must be met for all these stated speech codec rates.

4.6.1.1 Initial Convergence Time

The initial convergence time shall be a maximum of T seconds with T equal to 2s. The definition of this time interval shall be understood strictly in accordance with its means of use in subjective listening experiments. Its use shall be defined by a process whereby the first T seconds of each sample processed through the AMR speech codec with and without noise suppression active, is deleted before presentation to listeners. It is assumed that this process does not reduce intelligibility, or introduce clipping or similar effects into the resultant speech plus noise material.

To test the subjective effect of initial convergence, there will be a subset of subjective testing defined where this initial period of T seconds is not removed from the processed samples. These tests should be representative of the full range of noise conditions.

4.6.1.2 No Degradation in Clean Speech

The noise suppression function must not have a statistically significant distorting effect on clean speech, in comparison with the performance of the AMR codec without noise suppression applied. This requirement also applies to the case where tandeming of the standardised example noise suppression function occurs for mobile to mobile calls, in which case the reference condition is the tandem condition without noise suppression activated.

This requirement also applies when VAD/DTX is active.

4.6.1.3 No Artefacts in Residual Noise

The noise suppression function must not introduce any subjectively objectionable artefacts in the residual noise. This requirement also applies to the case where tandeming of the standardised example noise suppression function occurs for mobile to mobile calls, in which case the reference condition is the tandem condition without noise suppression activated.

This requirement also applies when VAD/DTX is active.

4.6.1.4 No Speech Clipping and no Reduction in Intelligibility

The noise suppression function should introduce no subjectively objectionable degradation such as clipping or distortion in the speech, and no reduction in intelligibility. This requirement also applies to the case where tandeming of the standardised example noise suppression function occurs for mobile to mobile calls, in which case the reference condition is the tandem condition without noise suppression activated.

This requirement also applies when VAD/DTX is active.

4.6.1.5 Quality Impact compared to AMR

The AMR speech codec with noise suppression activated must produce an output in noisy speech which is preferred amongst test listeners with statistical significance, compared to the case where noise suppression is not used. This requirement also applies to the case where tandeming of the standardised example noise suppression function occurs for mobile to mobile calls, in which case the reference condition is the tandem condition without noise suppression activated.

This requirement also applies when VAD/DTX is active.

4.6.2 Impact on Speech Path Delay

The one way algorithmic delay due to the activation of AMR noise suppression shall be no more than 7 ms in excess of the delay inserted by the AMR speech codec.

In handsfree case, this delay is part of the 39ms delay specified in GSM 03.50 [3].

4.7 Impact on Complexity

Table 4.1 defines complexity limits for AMR noise suppression.

Table 4.1 Complexity Requirements for AMR Noise Suppression

Quantity	Complexity Limit (Upper Bound)
Number of weighted operations per second	5 WMOPS
Scratch pad RAM	Re-use AMR speech encoder scratch pad RAM (or in the case of implementation which does not reside in the same device as the speech encoder, the available scratch pad RAM should be the same as that defined for the AMR speech encoder)
Static RAM	1,5 kwords
Data ROM	1 kword
Program ROM	2000 basic ETSI operations

4.8 Impact on Channel Activity

The AMR speech codec with noise suppression activated should not significantly increase channel activity when used in conjunction with DTX.

Channel activity increase will be measured thanks to the Voice Activity factor (VAF), defined as follows.

Let x be the VAF measured by the AMR VAD as an averaged value on all clean speech signals.

Let y be the VAF measured by the AMR VAD without AMR NS active as an averaged value on all clean speech + noise signals (where the applicable clean speech signal is the speech signal used in the measure of x).

Let w be the VAF measured by the AMR VAD with AMR NS active as an averaged value on all clean speech +noise signals (where the applicable clean speech signal is the speech signal used in the measure of x). w is required to be less than the maximum of y and x. Any case where w is greater than y should be further investigated.

For real word signals, w is required not to be significantly greater than y. Any case where w is greater than y should be further investigated.

These requirements shall apply to all standardized AMR VADs. (w,x,y) are determined using all VADs, and the requirements are checked relatively to each AMR VAD independently.

5 Interaction with supplementary services

5.1 General

This clause defines the interactions between GSM supplementary services and the Noise Suppression Feature.

The application of Noise Suppression shall not interfere with the provision or invocation of any supplementary services.

5.2 Explicit Call Transfer (ECT)

No adverse interaction. If the new party is a mobile station with support for the Noise Suppression feature, the noise suppression feature shall be invoked.

5.3 Call wait/Call hold.

No interaction.

5.4 Multiparty

No interaction.

5.5 Service Announcements

No interaction.

6 Interaction with Alternate and Followed by services

There shall be no impact on data transmission due the Noise Suppression Feature.

7 Interaction with other speech services

There is no requirement for Noise Suppression in ASCI services.

8 Interaction with DTMF and other signalling tones

DTMF and other signalling tones transmission performance during the application of Noise Suppression shall be no worse than the case where Noise Suppression is turned off.

9 Interaction with Lawful Intercept

In the case where lawful intercept is required in a call where Noise Suppression is activated, the Noise Suppression shall not cause any degradation in the speech quality received by the A and B parties.

10 Interaction with TFO

No interaction.

Annex A (informative): Change Request History

SMG#	Tdoc SMG	Spec	CR	Cat	PH	Vers	New Vers	Subject
29	P-99-425	02.76			2+		8.0.0	New version 8.0.0 for R99

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2001-03	11				New version 4.0.0 for Release 4	8.0.0	4.0.0
2001-08					Clean-up	4.0.0	4.0.1
2002-06	16				Version 5.0.0 for Release 5	4.0.1	5.0.0
2004-12	26				Version 6.0.0 for Release 6	5.0.0	6.0.0
2007-06	36				Version 7.0.0 for Release 7	6.0.0	7.0.0
2008-12	42				Version 8.0.0 for Release 8	7.0.0	8.0.0
2009-12	46				Version 9.0.0 for Release 9	8.0.0	9.0.0
2011-03	51				Version 10.0.0 for Release 10	9.0.0	10.0.0
2012-09	57				Version 11.0.0 for Release 11	10.0.0	11.0.0

History

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V11.0.0	October 2012	Publication