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Contents

Foreword

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

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Version x.y.z

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1 Scope

The present document specifies the stage 1 description for the Tandem Free Operation (TFO) feature which provides the capability to avoid tandeming speech codecs in mobile to mobile speech calls. The primary aim is to realise improvements in speech quality. The TFO mode of operation could also be used to reduce inter-Mobile services Switching Center (MSC) transmission bandwidth requirements.

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.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[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: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

3 Definitions and abbreviations

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

3.1 Definitions

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

Tandem Free Operation (TFO): avoidance of tandeming speech codecs in mobile to mobile speech calls

TFO call: mobile to mobile call where TFO has been applied

Normal call or operation: call where TFO has not been applied

Negotiation phase: phase during which the applicability of TFO is assessed through the exchange of information such as the capabilities of the respective transcoders and the types of speech codecs being used

A party: user originating the call

B party: user receiving the call (unless the call is forwarded)

For simplicity the term MS is also used when UE is meant for 3G systems. The same is valid for TRAU and TC analogously.

3.2 Abbreviations

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

ASCI	Avanced Speech Call Items
MSC	Mobile services Switching Centre
PLMN	Public Land Mobile Network

4 Description

The TFO feature avoids the tandeming of speech codecs that occurs in mobile to mobile speech calls.

4.1 Applicability of TFO to Basic Services

TFO shall be applicable to all mobile to mobile speech calls where both parties use the same GSM speech coding standard. TFO shall be supported for all of the GSM speech coding standards (i.e. Full Rate, Half Rate and Enhanced Full Rate). It would also be desirable to extend the TFO approach to realise quality enhancements when different speech codec standards are in use, e.g. by handing over one of the links to provide common codec types and then applying TFO.

4.2 Support in Mobile Stations (MS)

TFO shall not require any modifications to existing or future mobile stations. There shall be no additional user intervention required to enable or invoke the feature. Correspondingly, it shall not be possible for a user to disable the feature.

4.3 Parameters to be indicated and negotiated

The speech codec standards used on each party shall be indicated and negotiated, if applicable.

4.4 Provision of Service

4.4.1 Location Independence

TFO shall be capable of being applied for mobile to mobile calls regardless of the serving networks of the A or B parties. Thus, the A and B parties may be registered on different PLMNs or on the same network.

4.4.2 Provision of service within and between networks

Provision of the TFO feature shall be determined by the network operator on a network (or sub-network) wide basis, where equipment to support the feature has been deployed. It shall not be necessary for the service capability to be rolled out throughout an entire network before being made operational.

TFO between networks shall be applied if appropriate between supporting (sub) networks.

In the case where a TFO call is handed over between two parts of a network, but the new part is not provisioned with TFO, the call shall revert to normal operation.

In the case where a normal call is handed over between two parts of a network, and the new part is provisioned with TFO, the call will switch to TFO if appropriate.

NOTE: TFO operation will normally require that the coded speech is transmitted transparently (i.e. without errors) between the relevant transcoders (e.g. by bit-stealing).

4.4.3 Subscription and Billing Information

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

4.5 Quality of Service (QoS)

4.5.1 Impact on Speech Quality

The speech quality and timing requirements depend on the phase of the call and are defined in table 1. In all cases the duration and degradation should be minimised.

The timing requirements for the application and removal of TFO are derived from the typical user's perception of the feature in the context of typical call set-up times together with handover operation. There is a much stricter requirement on the time taken to revert to normal operation than to apply TFO because when TFO is enabled only on one side of a call, the speech will be unintelligible. Likewise, failures in the transmission of the coded speech without (significant) errors (e.g. due to routing via an ADPCM link) should be detected rapidly as the speech quality may also be seriously degraded.

Table 1: TFO speech quality and timing requirements

Call phase	Reference condition (note 1)	Maximum degradation	Speed of operation
TFO negotiation following call set-up	normal transcoding stages	"no perceptible degradation"	2 sec (note 2) 7 sec (note 3)
TFO negotiation following TFO interruption or handover	normal transcoding stages	"no perceptible degradation"	7 sec (notes 4 and 5)
transition from normal operation to TFO	normal transcoding stages	"no annoying artefacts"	
return from TFO to normal operation	TFO transcoding stages	"no annoying artefacts"	160 ms
continuous TFO	TFO transcoding stages	"no degradation"	
continuous normal operation	normal transcoding stages	"no degradation"	

NOTE 1: All reference conditions are defined as error free with no bit-stealing and with no transmission delay between the TRAUs "normal transcoding stages" refers to the speech codec(s) selected prior to TFO.
NOTE 2: Objective for time taken to establish TFO after call set-up.
NOTE 3: Maximum time allowed for TFO negotiation after call set-up.
NOTE 4: Objective for time taken to establish TFO after re-establishment of transparent PCM link.
NOTE 5: Once TFO has been successfully established during a call, an unlimitted number of negotiation attempts may be made after any subsequent interruptions of TFO.

NOTE: The timing limits and the quality degradations specified in table 1 are to some extent inter-dependent.

5 Interaction with supplementary services

5.1 General

This clause defines the interactions between supplementary services and TFO.

Neither TFO nor attempted TFO establishment shall interfere with the provision or invocation of any supplementary services.

5.2 Explicit Call Transfer (ECT)

Following call transfer, the new call route is evaluated and TFO applied if possible, otherwise normal operation applies.

5.3 Call wait/Call hold

Following the establishment of another call, the new call route shall be evaluated and TFO applied if possible, otherwise normal operation applies.

5.4 Multiparty

Where more than two parties are involved in a call, TFO may not be applicable. As a result, when a two-party TFO call is extended to multi-party, all the links shall revert to normal operation.

5.5 Service Announcements

TFO shall not disrupt the provision of call progress or similar speech announcements to the user which originate in any of the networks routing a call.

6 Interaction with Alternate and Followed by services

There shall be no impact on data transmission due to TFO or attempted TFO establishment.

7 Interaction with other speech services

There is no requirement for TFO in ASCI services.

8 Interaction with DTMF

DTMF transmission performance during TFO shall be no worse than during normal operation.

9 Interaction with Lawful Intercept

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

Annex A (informative): Limitations of initial in-band TFO implementations

This annex highlights the limitations of the applicability of the in-band TFO solutions, some of these limitations could be overcome, however they imply modifications of equipments that are not in the scope of the specifications.

When analogue lines are used TFO either in-band or out-if-band can not apply.

The main limitation of TFO in-band is the digital transparency of the PCM lonks behind the MSCs that cannot be guaranteed in all the configurations of Mobile-to-Mobile calls.

When digital lines are used the non-transparency is mainly due to the use of In Path Equipments (IPE). These IPEs consist mainly in Echo Cancellers and DCMEs.

The Network Echo Cancellers intend to remove the echo due to the unbalanced hybrids present in the PSTN when going from four wires to two wires in the subscriber local loops. These IPEs are useful in the mobile-to-PSTN calls. These Echo Cancellers should not be used in mobile-to-mobile calls since both terminals are digital. The enabling and disabling of these equipments are properly managed in some countries and not in other countries. Therefore TFO can apply to inter-PLMN calls in the countries where the network echo cancellers are properly configured. The main issue is that there's no easy internationally recognised way to identify mobile-to-mobile calls. They are usually correctly configured for Mobile-to-Mobile calls within a PLMN.

Another limitation that should apply to a very small number of mobile-to_mobile calls is the use of A/μ Laws converters in some international calls.

In some networks Acoustical Echo Cancellers are used. It would be preferable to keep them enabled in Tandem Free calls. This implies that this be taken into account by the Acoustical Echo Cancellers.

The DCMEs they are mainly used in the long distance calls although some operators use them in their PLMN. The only known way to disable the DCMEs is to ask for a transparent 64 kbit/s UDI connection. This option is not reasonable since such connections are more expensive than the speech calls and would imply modifications in the MSCs. Therefore when a DCME is used in-band TFO cannot be established.

In order to get TFO working for the vast majority of the Mobile-to-Mobile calls it is desirable that the IPEs be modified in order to allow the in-band TFO cross them without modification.

TFO implies that compatible speech codec configurations are being used in both MSs. In-band TFO can be established only after the call set-up has been made and thus there can be different speech codecs used in the MSs. The TFO standard shall include ways to solving the codec mismatch otherwise in-band TFO won't apply to these Mobile-to-Mobile calls.

Annex B (informative): Change history

SMG#	SPEC	CR	VERS	NEW_VERS	PHASE	SUBJECT
s23	02.53	new	2.0.0	5.0.0	R97	Tandem Free Operation Stage 1
s24	02.53	A001	5.0.0	5.1.0	R97	CR to GSM 02.53 Modifications to Annex A (informative): Limitations of initial in-band TFO implementations
s25	02.53	new	5.1.0	7.0.0	R98	Version change as part of Release 1998
s29	02.53		7.0.0	7.0.1	R98	Publication of version 7.0.1
	02.53		7.0.1		R99	Version 8.0.0

Change history

Date	TSG SA#	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2001-03	11	SP-010098	002		Extension of TFO to AMR	8.0.0	4.0.0
2001-09					Clean-up	4.0.0	4.0.1
2002-06	16				Version for Release 5	4.0.1	5.0.0
2004-12					Version for Release 6	5.0.0	6.0.0
2007-06	36				Version for Release 7	6.0.0	7.0.0
2008-12	42				Version for Release 8	7.0.0	8.0.0
2009-12	46				Version for Release 9	8.0.0	9.0.0
2011-03	51				Version for Release 10	9.0.0	10.0.0
2012-09	57				Version for Release 11	10.0.0	11.0.0
2014-09	65				Version for Release 12	11.0.0	12.0.0
2015-12	70				Version for Release 13	12.0.0	13.0.0

History

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