Technical Specification Group Services and System Aspects
Meeting #11, Palm Springs, USA, 19-22 March 2001

TSGS#11(01)0098

Source: **TSG-SA WG4**

Title: **CR to TS 02.53 and TS 03.53**

Document for: **Approval**

Agenda Item: **7.4.3**

The following CRs were agreed at the TSG-SA WG4 meetings #16 and are presented to TSG SA #11 for approval.

Spec	CR	Rev	Phase	Subject	Cat	Ver	WG	Meeting	S4 doc
02.53	A002		Rel-4	Extension of TFO to AMR	C	8.0.0	S4	TSG-SA WG4#16	S4-010256
03.53	A001	1	Rel-4	Extension of TFO to AMR	C	8.0.0	S4	TSG-SA WG4#16	S4-010290

3GPP TSG-S4#16 meeting ***Tdoc S4 (01)0256***
February 26 - March 2, 2001 Sophia Antipolis, France

CR-Form-v3

CHANGE REQUEST

⌘ **02.53** **CR** **002** ⌘ rev **-** ⌘ Current version: **8.0.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘ (U)SIM ☐ ME/UE ☐ Radio Access Network ☐ Core Network ☒

Title:	⌘	Extension of Stage 1 description of TFO to AMR-NB codec types
Source:	⌘	3GPP TSG-SA4
Work item code:	⌘	TFO-AMR
Date:	⌘	28.2.2001
Category:	⌘	**C**
Release:	⌘	REL-4

Use one of the following categories:
F *(essential correction)*
A *(corresponds to a correction in an earlier release)*
B *(Addition of feature),*
C *(Functional modification of feature)*
D *(Editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:
2 (GSM Phase 2)
R96 (Release 1996)
R97 (Release 1997)
R98 (Release 1998)
R99 (Release 1999)
REL-4 (Release 4)
REL-5 (Release 5)

Reason for change:	⌘	AMR and 3G systemsTFO wideband codec were not covered
Summary of change:	⌘	Extensions and adoptions to latest TFO agreements
Consequences if not approved:	⌘	TFO feature would be inconsistent

Clauses affected:	⌘	1, 2, 3, 4, 5, Annex A
Other specs Affected:	⌘	☐ Other core specifications ⌘ ☐ Test specifications ☐ O&M Specifications
Other comments:	⌘	

~~GSM~~3G TS ~~0~~22.053 V3~~8~~.0.0 (200~~1~~0-~~1~~02)

Technical Specification

GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

Digital cellular telecommunications system (Phase 2+);
Tandem Free Operation (TFO);
Service Description;
Stage 1
(3G TS~~GSM~~ ~~0~~22.053 version 3~~8~~.0.0 Release ~~1999~~4)

Keywords

Global System for Mobile communications
(GSM), speech, tandem free operation (TFO)

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Contents

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Foreword

This Technical Specification (TS) has been produced by the Special Mobile Group (SMG).

The present document specifies the stage 1 description for the Tandem Free Operation (TFO) within the digital cellular telecommunications system.

The contents of the present document is subject to continuing work within SMG and may change following formal SMG approval. Should SMG modify the contents of the present document, it will be rereleased by SMG with an identifying change of release date and an increase in version number as follows:

Version 8.x.y

where:

8 Indicates GSM Phase 2+ Release 1999;

y the third digit is incremented when editorial only changes have been incorporated in the specification;

x the second digit is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.

1 Scope

The present document specifies the stage 1 description for the Tandem Free Operation (TFO) feature which provides the capability to avoid using tandeming two GSM 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 CCITT 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.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.
- 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*.

For this Release 1997/1998 document, references to GSM documents are for Release 1998 versions (version 7.x.y).

[1] CCITT Recommendations I.130 (1988): "General modelling methods - Method for the characterisation of telecommunications 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 Definitions and abbreviations

GSM 01.04 (ETR 350) [2] provides a list of abbreviations and acronyms used in GSM specifications. For the purposes of the present document the following definitions and abbreviations also apply:

3.1 Definitions

Tandem Free Operation (TFO): the avoidance of using tandemingtwo GSM speech codecs in mobile to mobile speech calls

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

Normal call or operation: a 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

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

4 Description

The TFO feature avoids the ~~use~~ tandeming of ~~two GSM~~ 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 ~~GSM~~ 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 ~~GSM~~ 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 ~~GSM~~ 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 GSM 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 GSM 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.

Three speech codecs can currently be used by GSM systems. TFO implies that the same compatible speech codec configurations areis 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): Document change history

SMG	SPEC	CR	VERS	NEW_VE	PHA	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
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

History

Document history		
V7.0.1	July 1999	ETSI TS 101 108 Publication
V8.0.0	December 2000	

3GPP TSG-S4#16 meeting **Tdoc S4 (01)0290**
February 26 - March 2, 2001 Sophia Antipolis, France

CR-Form-v3

CHANGE REQUEST

⌘ **03.53** **CR** **001Rev1** ⌘ rev **-** ⌘ Current version: **8.0.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘ (U)SIM ☐ ME/UE ☐ Radio Access Network ☐ Core Network ☒

Title:	⌘	Extension of Stage 2 description of TFO to AMR-NB codec types
Source:	⌘	3GPP TSG-SA 4
Work item code:	⌘	TFO-AMR
Date:	⌘	28.2.2001
Category:	⌘	**C**
Release:	⌘	REL-4

Use one of the following categories:
F *(essential correction)*
A *(corresponds to a correction in an earlier release)*
B *(Addition of feature),*
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D *(Editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:

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R96	*(Release 1996)*
R97	*(Release 1997)*
R98	*(Release 1998)*
R99	*(Release 1999)*
REL-4	*(Release 4)*
REL-5	*(Release 5)*

Reason for change:	⌘	AMR and 3G systemsTFO wideband codec were not covered
Summary of change:	⌘	Extensions and adoptions to latest TFO agreements
Consequences if not approved:	⌘	TFO feature would be inconsistent

Clauses affected:	⌘	1, 2, 3, 5, 6, 7, 8
Other specs Affected:	⌘	☐ Other core specifications ⌘ ☐ Test specifications ☐ O&M Specifications
Other comments:	⌘	

ETSI TS 101 732 V38.0.0 (20010-024)

Technical Specification

Digital cellular telecommunications system (Phase 2+);
Tandem Free Operation (TFO);
Service description;
Stage 2
(3G TSGSM 023.053 version 38.0.0 Release 19994)

GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

Reference
RTS/SMG-110353Q8

Keywords
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Foreword

This Technical Specification (TS) has been produced by the Special Mobile Group (SMG).

The present document defines the stage 2 service description for Tandem Free Operation (TFO) in and between GSM and UMTS. Tandem Free Operation applies only to speech calls.

The contents of the present document is subject to continuing work within SMG and may change following formal SMG approval. Should SMG modify the contents of the present document, it will be re-released by SMG with an identifying change of release date and an increase in version number as follows:

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8 Indicates GSM Phase 2+ Release 1999;

y the third digit is incremented when editorial only changes have been incorporated in the specification;

x the second digit is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.

1 Scope

The present document defines the stage 2 service description for Tandem Free Operation (TFO) in and between GSM and UMTS. Tandem Free Operation applies only to speech calls.

NOTE: The TFO principles are built so that they could be used as well by other systems other than GSM and UMTS.

In analogy with CCITT Recommendations I.130 [2] and with reference to CCITT Recommendations VI.1 Q.65 (Stage 2 of the method for the characterisation of services supported by an ISDN), the second stage of the following three-level structure is derived from a stage 1 service description.

- 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.

- Stage 2 identifies the functional capabilities and information flows needed to support the service described in stage 1. Furthermore, it identifies various possible physical locations for the functional capabilities. The output of Stage 2, which is signalling system independent, is used as an input to Stage 3, the design of signalling system and switching Recommendations.

- Stage 3 defines the signalling system protocols and switching functions needed to implement the service described in stage 2.

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.
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[1~~1~~] GSM 01.04 (ETR 350): "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] CCITT Recommendations I.130 (1988): "General modelling methods - Method for the characterisation of telecommunication services supported by an ISDN and network capabilities of an ISDN".

[3] ~~GSM~~ 3G TS 0~~4~~2.053: "Digital cellular telecommunications system (Phase 2+); Tandem Free Operation (TFO); Service description; Stage 1".

[4] 3G TS ~~GSM 04~~8.060 (ETS 300 737): "Digital cellular telecommunications system (Phase 2+); Inband control of remote transcoders and rate adaptors for Enhanced Full Rate (EFR) and full rate traffic channels".

[5] 3G TS ~~GSM 4~~08.061 (ETS 300 979): "Digital cellular telecommunications system (Phase 2+); In-band control of remote transcoders and rate adaptors for half rate traffic channels".

3 Definitions and abbreviations

3.1 Definitions

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

Tandem Free Operation: corresponds to the Mobile-to-Mobile calls for which the speech is not transcoded two times but only one by the Mobile Stations.

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:

TFO: Tandem Free Operation
IPE: In Path Equipment

Further abbreviations used may be found in GSM 01.04.

4 Main Concepts

In-band TFO aims to remove the speech coding and decoding done in the BSS in MS-to-MS calls in order to improve the perceived speech quality. In-band TFO is established after call set-up using in-band signalling. This signalling is therefore controlled by the TRAU.

Using in-band signalling implies that the link between the TRAUs is transparent in the sense that the digital content of what is emitted by a TRAU is not modified. The so-called In Path Equipments must therefore be disabled or configured in such a way that the information (signalling and coded speech) required for Tandem Free is not altered.

5 TFO Architecture and Transmission Mechanism

5.1 TFO Access Interfaces and Reference Points

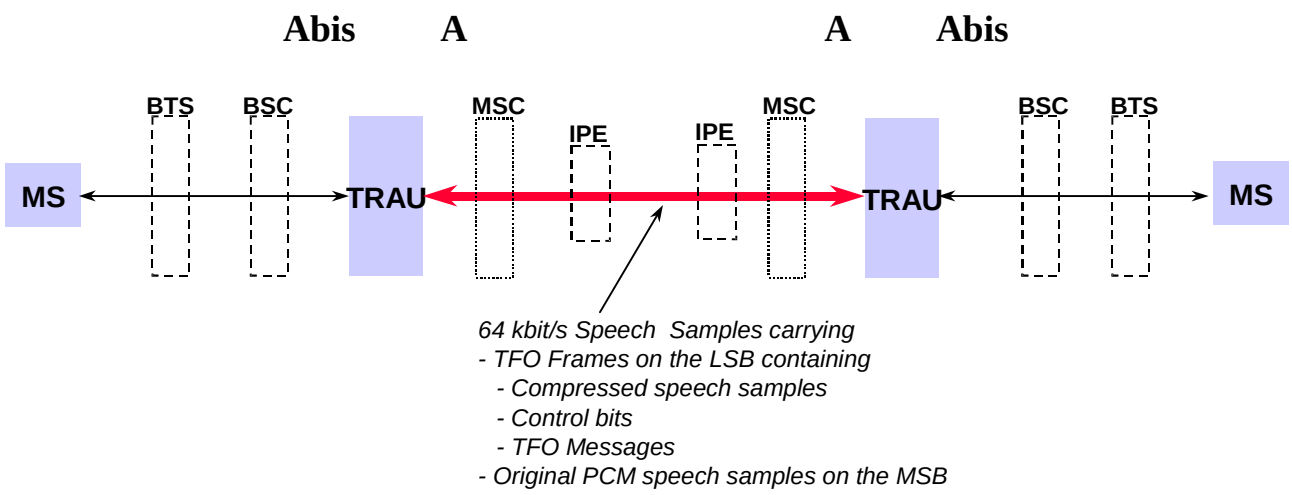
The GSM BSS reference points for TFO are described in Figure 1. GSM A interface reference point applies here with the exception ~~(as compared with 08.02)~~ that speech is not in the standard 64 kbit/s PCM format and between TFO TRAUs in-band signalling is used. For speech and in-band signalling the MSC is transparent.

The UMTS core network reference points for TFO are described in Figure 2. The UMTS Nb interface reference point applies here with the exception that speech is not in the standard 64 kbit/s PCM format and between TFO TRAUs in-band signalling is used. For speech and in-band signalling the Core Network is transparent.

Additional transmission equipments are taken into account. These equipments are all those which can process the PCM signal between the two peer BSS, e.g. echo cancellers, DCME. The BSS to BSS transmission is then considered transparent provided no transmission equipment along the circuit do not modify the 1~~2~~ or more LSB or these transmission equipments implement a TFO "transparency mode". A specific signalling allows to remotely control in-band these equipments.

BSS-MSC out-of-band signalling consists in this version of TFO of the normal BSSMAP signalling which carries the list of acceptable speech codec that may be used for the TFO negotiation mechanism.

Use of TFO specific out-of-band mechanism is not foreseen in that version of the specification.



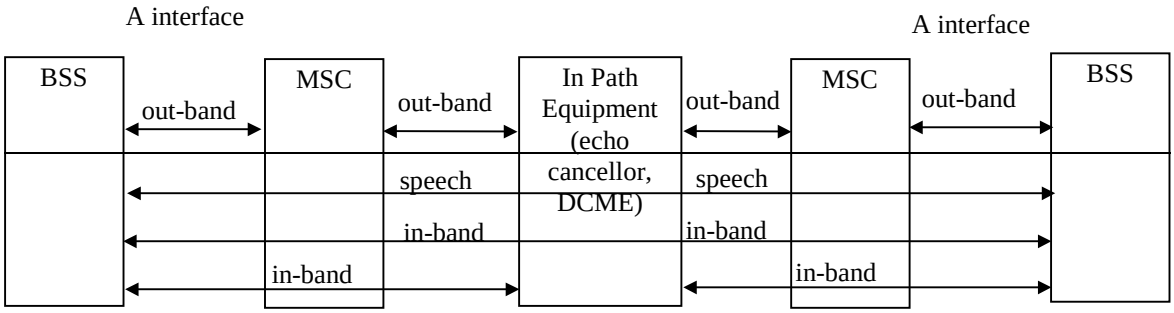


Figure 1

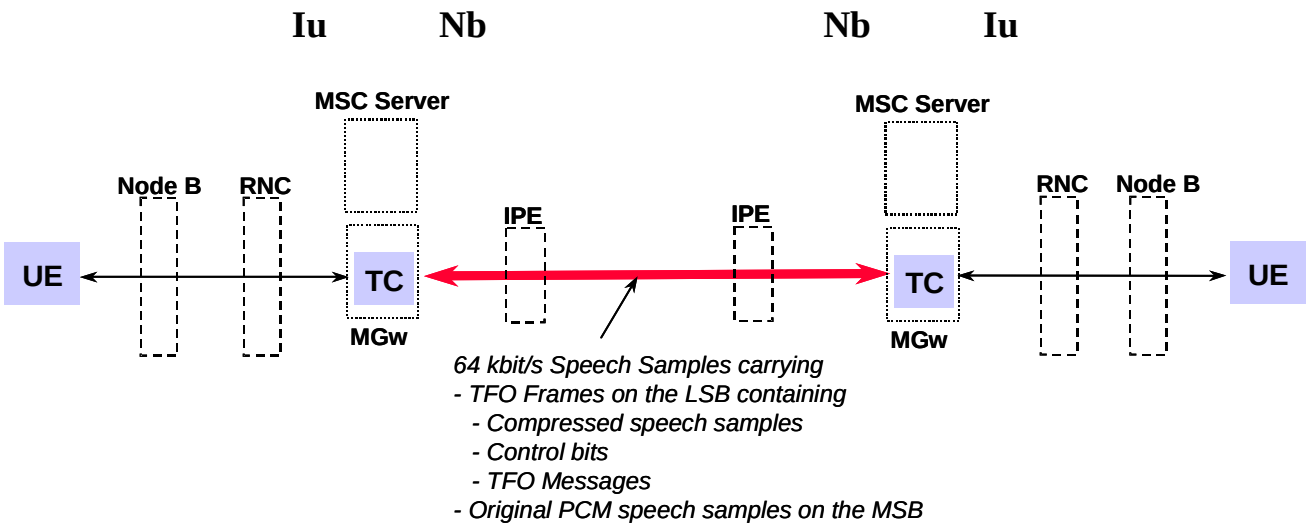


Figure 2

5.2 General In-band Transmission Mechanism for TFO

In TFO establishment mode, one bit out of 16 LSB bits is regularly stolen of the 64 kbits/s circuit. This provides for a 0.5kbits/s channel and has been selected so that the degradation on the speech quality is inaudible.

~~In TFO established mode and when the FR of EFR codec is used, bit stealing takes place on the 2 LSB bits (bits 7-8) on each PCM sample. This provides for a 16 kbits/s channel that allows to carry vocoded speech in TFO speech frames which are similar to the frames in 08.60. The contents of the 6 MSB (bits 1-6) is normal A/μ law information.~~

~~In TFO established mode and when the HR codec is used, bit stealing takes place on the LSB bit (bit 8) on each PCM sample. This provides for a 8 kbits/s channel that allows to carry vocoded speech in TFO frames which are similar to the 8 kbit/s frames in 08.61. The contents of bit 1-7 is normal A/μ law information.~~

In TFO established mode bit stealing takes place on the LSB bit/s (bit 8, 7.. 9-N; N>=1: number of stolen LSB bits) on each PCM sample. The number N of stolen LSB bit/s depends on the codec type. This provides for a N*8 kbits/s channel that allows to carry vocoded speech in TFO frames. The contents of the "unstolen" bits 1- (8-N) is normal A/μ-law information.

5.3 High-Level Functions Required for TFO

The high level functions which apply to TFO are described hereafter. Not all these functions need necessarily to be covered by the first description of TFO since some issues may be too complex to solve in an initial stage or at all.

The list of functions which are applicable to the BSS follows:

- signalling a request message (TFO_REQ) on the A interface that the TRAU supports TFO;
- signalling an acknowledgement message (TFO_ACK) that the request message has been received from the peer entity;
- monitoring request and acknowledgement messages on the A interface that the peer entity supports TFO;
- remote control of echo cancellors, DCME, ...;
- signalling of current speech codec with acknowledgement message;
- signalling of speech codec capability with acknowledgement message;
- change of current speech codec within the BSS (optional);
- sending of TFO speech frames to the A interface;
- reception of TFO speech frames from the A interface;
- conversion of a flow of TRAU frames into TFO speech frames;
- conversion of a flow of TFO speech frames into TRAU frames.

The following function applies to IPEs that may be along the 64 kbits/s circuit, such as DCME or echo cancellers equipments:

- monitoring of TFO negotiation messages- repetition of LSB bit 8 one time out of 16 (TFO establishment mode, i.e reproduce at the output of the IPE the detected message);
- capability to go full or sub-64 kbit/s transparent mode and to resume normal operation based on TFO negotiation messages
- capability to monitor and alter TFO speech frame control information (optional);
- capability to insert TFO negotiation messages (optional).

No assumption is made currently on the interactions between call set-up as seen by the MSC and TFO. This means that the initial working assumption is that TFO works independently of the Call Control in the MSC, using only a mechanisms internal to the BSS to activate and de-activate TFO operation.

6 Model of operation

6.1 Overview

The TRAU must first identify each other as TRAU that are TFO capable. Next the TRAUs must check that they a~~'~~re using ~~the same~~ compatible speech codec types. If they don't use ~~the same~~ compatible speech codec types they can inform the BSC in order to modify the speech codec used in the MS. If they a~~'~~re using ~~the same~~ a compatible speech codec type the TRAU starts to insert TFO speech frames in the LSB(s) of the PCM octet present on the A / Nb interface. These frames contain the speech parameters as obtained from the uplink TRAU frames.

6.2 TFO establishment phase

6.2.1 Sending of TFO_REQ message by a BSS

The TFO_REQ message is sent using bit stealing on bit 8, by stealing one bit out of 16. This allows to have the least possible degradation of the PCM, since the TFO_REQ message is sent even in cases where TFO will not be possible e.g. MS to PSTN call.

6.2.2 Monitoring of TFO_REQ by a BSS

The monitoring of the TFO_REQ message can be performed by a BSS which is capable of TFO.

Upon reception of a TFO_REQ message, the BSS replies with an TFO_ACK message which can contain the following information:

- - system identification (GSM, UMTS...);
- - the current speech codec;
- - the list of supported speech codecs;
- - a random value that allows the detection of loop backs of a given BSS.

6.3 Transparency of transmission equipments

6.3.1 Local disabling

Not used.

6.3.2 Transparency to TFO negotiation messages

IPE which support TFO protocol need t~~-~~o first synchronise on "transparency patterns" contained in the in-band transmitted TFO messages (negotiation messages TFO_REQ, TFO_ACK) as discussed in subclause 6.2 and in addition track some specific TFO message (Go transparent command, Go to normal) needed to set the transparency mode required in TFO established mode or return to normal operation. ~~-~~Having synchronised to a transparency pattern, the IPE should reproduce at its output the TFO message in order to ensure transparency of the in-band signalling path. Some additional delay with respect to normal operation of the IPE may be introduced by the IPE as far as the in-band signalling information is concerned but such delay should be a multiple of 20ms. No delay should be introduced on other bits.

6.3.3 Transparency to TFO speech frames

As part of the TFO establishment, if TFO can be successufully established (same codec type) then each TRAU sends TFO negotiation messages (Go transparent commands) which indicate to the In Path Equipment (IPE) along the BSS to BSS circuit the type of IPE transparency mode. The TFO speech frame then contains a "keep open" pattern that

maintains the operation of the IPE as commanded. That "keep open" pattern is part of the synchronisation pattern of each TRAU frame and does not require hence complete tracking of the TFO speech frames by the IPE (nevertheless the commands within the TFO negotiation messages should be checked continuously). IPE revert to normal operation in case the keep open pattern is absent for [1s] or a new command "Go to normal" is received.

IPE which support TFO protocol set the transparency mode as indicated in the received Go transparent command after having reproduced the received Go transparent command at its output. The IPE should simultaneously start to track the keep open pattern. -Then the bits corresponding to the "transparent" path are copied in the 64 kbit/s output stream of the equipment. The delay introduced by the IPE on the TFO contained in the transparent part of the 64kbit/s should be less than or equal to the delay in normal operation.

These principles should be GSM/UMTS independent, allowing other systems to use the same transparency principle.

The behaviour of the IPE regarding the remaining part of the circuit can be either of the following:

- the IPE is speech transparent, meaning that the upper bits in the 64 kbits/s output stream should contain PCM speech, that speech being obtained by running the IPE in its normal way, possibly reproducing the PCM at the input. IPE should keep the same alignment as present at the input between transparent LSB~~:~~s and upper bits containing the PCM speech;

- the IPE is non speech transparent, meaning that the IPE may strip the upper bits, if the IPE is the compressor part of an DCME. In such a case the peer IPE (the decompression part of the ~~a~~ DCME) should reproduce the speech from the received TFO frame). This implies that the DCME implements the decoding part of some ~~GSM~~ vocoders;

~~- half-duplex TFO capable IPE.~~

6.4 Modification of speech codec

6.4.1 Introduction

In the speech codec modification procedure BSS informs the peer BSS the ~~GSM~~ speech codec ~~versions~~ types supported by the sending BSS (within the ongoing call) and tries to align the codecs using implicit rule and BSS internal means to make appropriate handover

The support of the informing and BSS internal modification procedures are optional for a BSS since it depends on the BSS internal capabilities. This means that TFO should be applicable even if the informing and modification are not supported by one of the two peer entities. In this case, TFO will be available if both BSS happen to use ~~the same~~ a compatible speech codec ~~version~~type.

6.4.2 Exchanged parameters

6.4.3 The exchanged parameters are the speech codec currently in use and the other possible codecs that can be used within the call Modification procedure

In the TFO request message (TFO_REQ), the BSS informs the fact that it supports TFO.

The possible modification procedure is started when the TFO request message from the peer BSS has been detected. It is not synchronised explicitly on Call Set-up states.

If both BSS receive a TFO_REQ indicating that ~~the~~ a ~~same~~ compatible speech codec type is used, the modification is not necessary and the BSS can move to the TFO established mode.

If the speech codec configurations used on both sides are ~~different~~not compatible, each BSS looks at the list of the acceptable speech codec configutations from the other BSS.

There is an implicit rule as to the speech codec configuration that every BSS will try to use based on the current speech codec configuration, the list of locally acceptable speech codec configurations, and the list of remotely acceptable

speech codec configuration~~s~~. Each BSS then tries if it supports it to perform a change of codec configuration via a intra-BSS (normally intra-cell) handover.

When a handover has been performed, each BSS will reply to TFO_REQ by a new TFO_ACK message indicating the newly used speech codec configuration. The process goes on until either ~~the~~ a ~~same~~ compatible codec configuration is used, or no more change of the codec configuration is possible according to the fixed rule.

There is a timer that protects the TFO establishment phase. The BSS, after the timer has elapsed, stops sending TFO request messages, but continues the monitoring of the peer entity. This is in order not to degrade the communication if TFO cannot be established. To resume the TFO establishment phase, it will be up to the peer entity to send a new TFO_REQ message to initiate a new attempt of establishment/modification of TFO e.g. when a handover has occurred.

6.4.4 Change of speech codec configuration in the BSS

This procedure is internal to the BSS. It can be based on the use of O&M frames on the Abis interface or on the use of a specific TRAU to BSC interface or on some other method.

6.5 TFO operation

6.5.1 End to end delay

The end to end delay is similar to normal MS-MS call in TFO operation within a 20 ms range.(

6.5.2 Synchronisation between TRAUs

The synchronisation depends on the kind of bit stealing used:

- 0,5 kbits/s. There is a specific pattern one bit out of 16 on the LSB;
- 8 kbits/s. The synchronisation contained in the TFO frames ~~of GSM 08.61~~ is used;
- 16 kbits/s. The synchronisation contained in the TFO frames ~~of GSM 08.60~~ is used.

Some sub-part of the synchronisation patterns can be understood by transmission equipments as well.

There is no time alignment between TRAUs.

6.5.3 Monitoring in TFO operation

A TRAU in TFO established mode monitors permanently the synchronisation with the peer TRAU entity

In case of loss of synchronisation, a timer is started. When the timer elapses, the TRAU sends normal PCM speech, reverts to non-TFO mode and starts re-establishment procedures.

6.5.4 DTX aspects

Each direction is independent from the DTX point of view. This leads to the following scenarios for the transfer of speech in one direction:

Table 1

Uplink User A	Downlink User B
DTX	DTX
DTX	no DTX
no DTX	DTX
no DTX	no DTX

The sending BSS, when DTX is applied on the uplink direction, generates normal speech frames when no SID frame is received

When a SID frame is received in the uplink, the BSS sends ~~a normal speech~~ this SID frame to the peer BSS. ~~The fact that TRAU frame was a SID frame is indicated to the peer BSS.~~

When uplink DTX is applied and nothing is received from the MS by the BTS, i.e during comfort noise generation, ~~normal speech~~ NO_DATA frames are sent to the peer BSS. ~~The fact that comfort noise generation was applied is indicated to the peer BSS.~~

Based on th~~ese~~ information, the receiving BSS can perform the best action depending on its mode ~~DTX/ no DTX. If DTX is applied, it is felt that the best is to re-use the SID frame that was received by the peer BSS, even if it means shifting in time the sending of the frame (because both radio physical layers are not synchronised)~~.

6.5.5 Error concealment

The BSS which has received a bad frame in the uplink ~~direction builds a normal speech frame which is~~ send~~s~~t it unmodified to the peer BSS. ~~the fact that it was a bad frame that has been rebuilt is indicated as well to the peer BSS (BFI indication).~~The peer BSS either performs error concealment or forwards the frame to the MS.

6.5.6 Management of UFE bit

The UFE bit is managed as described in the 3G~~SM~~ TS ~~0~~48.0~~6~~0 ~~for the GSM EFR~~ and 3G~~SM~~ TS ~~0~~48.0~~6~~1 ~~for the GSM HR~~.

6.5.7 Handover management

Different cases of handovers from the TRAU point of view will be encountered :

1) handover with modification of the TRAU on one side or, which is equivalent, no modification of TRAU but change of transcoder DSP;

2) intra-cell handover without modification of transcoder DSP;

3) inter-cell handover without modification of transcoder DSP.

In case 1, TFO will be interrupted and re-established if the newly allocated TRAU (TRAU B) is TFO capable. Indeed the newly allocated TRAU will start in normal mode and, if it is TFO capable, will immediately attempt to establish TFO. This will interrupt the reception of TFO frames at the TRAU in TFO mode (TRAU A). As defined in subclause 6.5.3, the synchronisation loss timer ~~will~~ may elapse and TRAU A will revert to normal mode. TFO will then be re-established given TFO establishment attempts are~~performed~~ by the new TRAU.

The management of handover for cases 2 and 3 will depend on the time put to actually switch the communication from one traffic channel to another ~~-~~one in the intra-cell handover case or between base stations in the inter-cell handover case. If the handover is fast enough, i.e. the timers to detect the loss of synchronisation do not elapse, then the TFO will be maintained. In the opposite case there will be a fallback to regular tandem. Attempts to re-establish TFO shall be performed if both TRAUs are still TFO-capable.

6.5.8 Other issues

The bridging of the communication in the MSC can potentially interfere TFO. The conference bridge will prevent TFO operation as long as it is present. The TFO synchronisation pattern should be lost and both TRAUs should revert to non-TFO operation if the bridge is present. TFO operation will start again from the start when the bridge is removed (handover is performed).

7 Compatibility Issues

Since the radio interface is not modified, there is no compatibility issue with the MS. It is up to the second TRAU to make sure that what it sends to the BTS is compatible with the existing.

The compatibility issue is with end systems not supporting TFO.

The TFO negotiation message synchronisation patterns should be chosen such that no other system uses such a pattern for another purpose, and that this pattern cannot be generated by a peer entity which is not supporting TFO. This does not preclude other systems than GSM or UMTSto use TFO since the type of system is part of the negotiation mechanism.

8 Interactions with Other Services

8.1 General

The identified interactions are with the supplementary and basic services that modify the configuration of a communication.

One example of Supplementary Service is Explicit Call Transfer, where a MS to MS communication can result in a MS to non-MS communication. Similarly, in a communication where user A is a Mobile user and User B is not a Mobile user become a communication between user A and user C where both are Mobile users.

One example of Basic Service is Alternate speech and data, where TFO should not degrade the transitions between speech and data.

More generally, the identified interactions are all related to the transitions between a configuration where TFO is possible (and potentially used) and a configuration where TFO is not possible.

The consequence of a Multiparty Call is that TFO operation is not possible.

The interactions between TFO and Lawful Intercept ~~are~~ will depend on the capability of the devices used in such a case to not alter the in-band information (signalling and coded speech) required by the in-band TFO system. These devices can either use the 6- or 7- bit PCM available on the A-interface..

The SS that modifies the digital content of what is emitted by a TRAU will interrupt TFO. Nevertheless as soon as the transparency is re-established the TRAUs will attempt re-establishing TFO.

8.2 Support of DTMF

The existing DTMF could be applied independently of TFO. It should be noted that DTMF in TFO operation means Mobile Terminated DTMF which is currently excluded from the standard.

The DTMF when inserted by the MSC will interrupt the TFO since the TFO speech frames are modified when crossing the MSC.

The TFO must be restablished as soon as possible when the DTMF insertion stops.

9 Operational Aspects

TFO feature shall be defined so that a TFO capable TRAU should be able interact with a TFO non capable TRAU without noticeable degradation of quality. It shall be possible to roll-out TFO on part of the network.

The TFO establishment protocol shall define timers to set e.g. the negotiation message transmission time or the time needed to declare the loss of synchronisation (see subclause 6.5.3). When setting the values of these timers it should be made sure that two sets of timers at both TRAUs are consistent in order to allow TFO establishment. Given that both TRAUs may be located in different PLMN and be manufactured by different companies, most of the timers will have to be initialised at pre-defined values.

Annex A (Informative): Change history

SMG#	SPEC	CR	PHASE	VERS	NEW_VERS	SUBJECT
	03.53	30 Sept 1996			0.0.0	Draft proposal
	03.53	25 Nov 1996			0.0.0	Draft proposal after comments
	03.53	27 Jan 1997			0.0.1	Version 0.0.0 has been presented to SMG3/WPA and joint SMG3/SMG11 in dec. 96. No comments were made. Only change is editorial on official TS GSM reference
	03.53	29 June 1997			0.0.2	Changes reflecting the last decisions in SMG11.
	03.53	18 Aug 1997			0.1.0	Changes reflecting the decisions in SMG11 TFO #6 - format of the messages - applicable to different systems - transparency principle for transmission equipments.
	03.53	01 Aug 1997			0.1.1	Changes reflecting the review in SMG11 TFO #8 in Bois D'Arcy - transparency of IPEs can be for 1 up to 8 bits - no fixed pattern is used for the 6 MSB - informative annex on IPE is added
	03.53	08 Oct 1997			0.2.0	Clarifications reflecting SMG11/TFO in Bois D'Arcy and SMG11 in Le Mans Incorporation of comments received by e-mail. Version for presentation to SMG3/SA
	03.53	08 Nov 1997			0.3.0	Addition of some text regarding the main concept, handover management, UFE bit management, interaction with Supplementary services.
	03.53	08 Dec 1997			1.0.0	Presented to SMG. The presented version was approved in SMG3/SA, but since it was not seen by SMG3, it was requested that it is presented again to SMG3, and was then only presented to SMG for information.
SMG#	**SPEC**	**CR**	**PHASE**	**VERS**	**NEW_VERS**	**SUBJECT**
S29	03.53		R98		7.0.0	Release 1998 version (new)
S31	03.53		R99		8.0.0	Release 1999 version (new)

History

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