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Technical Specification

**Digital cellular telecommunications system (Phase 2+);
Tandem Free Operation (TFO);
Service description;
Stage 1
(GSM 02.53 version 5.0.0)**

GSM®

GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS



European Telecommunications Standards Institute

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Foreword

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

This specification specifies the stage 1 description for the Tandem Free Operation (TFO) within the digital cellular telecommunications system.

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

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

This specification specifies the stage 1 description for the Tandem Free Operation (TFO) feature which provides the capability to avoid using 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 Normative references

References may be made to:

- a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or
- b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or
- c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or
- d) publications without mention of a specific version, in which case 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.

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| [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 this specification the following definitions and abbreviations also apply:

3.1 Definitions

Tandem Free Operation (TFO): the avoidance of using two 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).

3.2 Abbreviations

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

4 Description

The TFO feature avoids the use 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 TRAU's. '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 unlimited number of negotiation attempts may be made after any subsequent interruptions of TFO.

Note that 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.

The limitations of the applicability of the initial in-band TFO solution currently being defined are outlined as follows.

The main limitation is the transparency that cannot be ensured in all mobile-to-mobile calls configuration. The non-transparency is mainly due to the use of In Path Equipments and of analogue lines. When analogue lines are used the TFO in-band or out-band if defined one day can be forgotten for obvious reasons.

The IPEs consist mainly of Echo Cancellers and DCMEs. The Echo Cancellers intend to cancel the echo due to the unbalanced hybrids present in the PSTN when going from four wires to two wires. 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. The main issue is that there's no easy internationally recognised way to identify mobile-to-mobile calls. Regarding 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.

Due to these limitations it was decided to include in the in-band TFO the proper means for preserving the transparency at least for the bits that must reach the distant transcoder. The main manufacturers of IPEs are active in the design of this part of the TFO. Nevertheless it is expected that the first deployments of the in-band TFO may precede the up-grading of the IPEs or may have to coexist with IPEs that will never be up-graded.

In such a configuration it can be stated that:

- In-band TFO will work within a PLMN most of the time.
- In-band TFO will work between PLMNs in countries where the ECs are properly configured at the call set-up when there's no DCME.
- In-band TFO is unlikely to work for international inter-PLMNs calls.
- In-band TFO cannot work when DCMEs are used.

Three speech codecs can currently be used by GSM systems. TFO implies that the same speech codec is being used in both MSs. Since the in-band TFO is attempted after the call set-up has been made it is possible to have different speech codecs used in the MSs. The TFO standard include the option to report to the BSC the distant configuration of the BSS and MS in term of speech codec in use and in term of possible other speech codec. The BSC can then initiate a intra-cell handover with a CHANNEL_MODE_MODIFY in order to realign the speech codecs. A symmetric rules has been designed in order to limit the number of messages to exchange and to avoid Ping-Pong effects.

Nevertheless a limitation is:

- TFO will not be possible if the codec mismatch solution is not implemented.

Other limitations have been found:

- TFO is interrupted when DTMF is sent by a mobile.
- TFO is interrupted when bridges are used.
- TFO is interrupted if a call is forwarded to a PSTN terminal.

It must be noted that after TFO has been interrupted periodical attempts to re-establish it are made. Therefore TFO should re-establish when it is possible.

History

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