Technical Specification Group Services and System Aspects **TSGS#26(04)0845**
Meeting #26, Athens, Greece
13-16 December 2004

Source: **TSG-SA WG4**

Title: CRs TS 26.103 and TS 28.062 on Tandem Free Operation / Transcoder Free Operation (Releases 4, 5 and 6)

Document for: **Approval**

Agenda Item: **7.4.3**

The following CRs, agreed at the TSG-SA WG4 meeting #33, are presented to TSG SA #26 for approval.

Spec	CR	Rev	Phase	Subject	Cat	Vers	WG	Meeting	S4 doc
26.103	030		Rel-4	TFO/TrFO Compatibility of UMTS_AMR and UMTS_AMR2	F	4.3.0	S4	TSG-SA WG4#33	S4-040616
26.103	031		Rel-5	TFO/TrFO Compatibility of UMTS_AMR and UMTS_AMR2	A	5.5.0	S4	TSG-SA WG4#33	S4-040617
26.103	032		Rel-6	TFO/TrFO Compatibility of UMTS_AMR and UMTS_AMR2	A	6.0.0	S4	TSG-SA WG4#33	S4-040618
28.062	042		Rel-4	TFO/TrFO Compatibility of UMTS_AMR and UMTS_AMR2	F	4.5.0	S4	TSG-SA WG4#33	S4-040619
28.062	043		Rel-5	TFO/TrFO Compatibility of UMTS_AMR and UMTS_AMR2	A	5.4.0	S4	TSG-SA WG4#33	S4-040620
28.062	044		Rel-6	TFO/TrFO Compatibility of UMTS_AMR and UMTS_AMR2	A	6.0.0	S4	TSG-SA WG4#33	S4-040621

3GPP TSG-SA WG4 Meeting #33 ***S4-040616***

Helsinki, Finland. 22th to 26th November 2004.

CR-Form-v7.1

CHANGE REQUEST

⌘ **26.103** **CR** **030** ⌘ **rev** **-** ⌘ Current version: **4.3.0** ⌘

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

Proposed change affects: UICC apps⌘ ☐ ME ☐ Radio Access Network ☐ Core Network ☒

Title:	⌘	TFO/TrFO Compatibility of UMTS_AMR and UMTS_AMR2
Source:	⌘	TSG SA WG4
Work item code:	⌘	TRFO-OoBTC
Date:	⌘	2004-12-14
Category:	⌘	**F**
Release:	⌘	Rel-4

Use one of the following categories:
F *(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:
Ph2 *(GSM Phase 2)*
R96 *(Release 1996)*
R97 *(Release 1997)*
R98 *(Release 1998)*
R99 *(Release 1999)*
Rel-4 *(Release 4)*
Rel-5 *(Release 5)*
Rel-6 *(Release 6)*
Rel-7 *(Release 7)*

Reason for change: ⌘ **Essential correction**

TS 26.103 (4.3.0, 5.5.0, 6.0.0) states:

ìFor the UMTS AMR2 this Codec Mode Adaptation can be performed every 20ms for the downlink traffic channel, but only every 40ms for the uplink radio channel. Ö
By this definition the UMTS AMR2 Codec Type is TFO and TrFO compatible to the FR AMR, HR AMR, UMTS AMR and UMTS AMR2 Codec Types.î

TS 28.062 (4.5.0, 5.4.0, 6.0.0) states:

Table 11-1: Compatibility of AMR Codec Types

distant → ↓ local	UMTS_AMR_2	UMTS_AMR	FR_AMR	HR_AMR	OHR_AMR
UMTS_AMR_2	compatible	compatible	compatible	compatible	compatible
UMTS_AMR	compatible	compatible	-	-	-
FR_AMR	compatible	-	compatible	compatible	compatible
HR_AMR	compatible	-	compatible	compatible	compatible
OHR_AMR	compatible	-	compatible	compatible	compatible

The UMTS_AMR_2 is the preferred Codec Type for 3G systems.

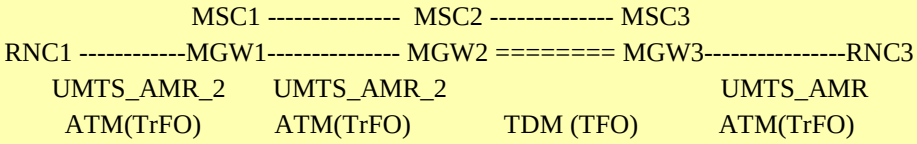
TS 23.153 (4.10.0 and 5.8.0) states:

> "The UMTS_AMR_2 is a superset of the UMTS_AMR. It behaves as a FR_AMR codec in the UL and as a UMTS_AMR codec in the DL. This allows UMTS terminals to operate in TFO with GSM terminals. The UMTS_AMR_2 is fully compatible with UMTS_AMR in TFO and TrFO and fully compatible with R99 CN nodes (TC in MGW)."

In other words: UMTS_AMR_2 is TFO/TrFO compatible to UMTS_AMR and FR_AMR; but UMTS_AMR and FR_AMR (indeed all GERAN versions) are not compatible.

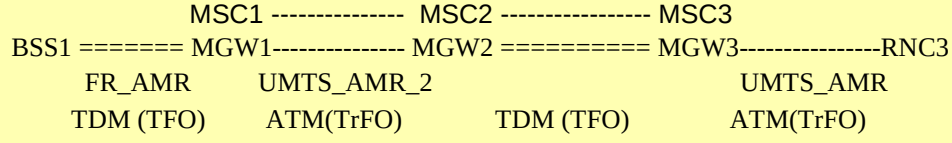
These statements are true for end-to-end TFO scenarios and end-to-end TrFO scenarios with these two Codec Types. But this may cause problems in a more complex networks supporting TFO/TrFO interworking, as explained in the following:

Let us assume that a call is set up from an UE1 served by RNC1 towards an UE3 served by RNC3. UE1 supports UMTS_AMR_2, UE3 only UMTS_AMR. For the first part of the connection, UMTS_AMR_2 is negotiated via BICC OoBTC. MSC2/MGW2 and MSC3/MGW3 are connected via a TDM link and may belong to different PLMNs. Nevertheless, all the MSCs are configured so that the same active codec mode set (ACS) is selected both for UMTS_AMR_2 and UMTS_AMR.



When the TFO peer entities in MGW2 and MGW3 exchange the locally used codec types and codec configurations via TFO in-band signalling, they will come to the conclusion that immediate TFO operation is possible, since UMTS_AMR and UMTS_AMR_2 are termed ìTFO compatibleî. The result will be an concatenation of tandem free and transcoder free links: it will be end-to-end transcoding free.
(Note that according to TS 29.232, MSC2 and MSC3 will not be informed that TFO operation was actually successfully established. Furthermore, MSC2 will not be informed that MGW3 is actually using UMTS_AMR, unless MSC2 explicitly asked MGW2 for a list of all distant codecs.).
So far so good.

But now:
Subsequently, UE1 performs an inter-system handover to GERAN. The new codec assigned by BSS1 is FR_AMR, again with the same ACS. Now, the TFO peer entities in BSS1 and MGW1 start TFO in-band signalling and go to immediate TFO operation, since FR_AMR and UMTS_AMR_2 are TFO compatible. So we end up with a **concatenation of links using FR_AMR, UMTS_AMR_2 and UMTS_AMR**. With the information locally available at MSC1/MGW1 and MSC2/MGW2, both nodes come to the conclusion that TFO/TrFO is possible, but **end-to-end, FR_AMR and UMTS_AMR are not compatible**. Since the UMTS_AMR codec does not comply with the rate control rules of the FR_AMR codec, the result will be a higher frequency of bad speech frames in downlink direction towards UE1. This can seriously **deteriorate the speech quality**.



For a solution to avoid this kind of path configuration it should be taken into account that

a) apart from R99 'UMTS only' UEs, all other UTRAN capable UEs support the UMTS_AMR_2. And it can be expected that R99 'UMTS only' UEs will soon become a small minority. Therefore, calls without involvement of an UMTS_AMR codec should be affected by the solution as little as possible.

   For this reason we do not want to require MSC1 to perform a codec modification or mid-call codec negotiation on the link between MGW1 and MGW2 after each inter-system handover of UE1, since such a requirement would apply to any call using AMR codecs. But codec changes in the core network should be avoided, if possible, since each re-initialization of the user plane will cause a short interruption of the speech transmission. Furthermore, such a requirement would create an unnecessarily high signalling load between MSC1 and MSC2 and their associated MGWs. And, most important to note: a transcoder would have to be inserted somewhere in the path.

b) Nowadays, many operating UMTS networks use the UMTS_AMR codec only in 12.2 kbit/s single mode configuration. For AMR codecs in single mode configuration, the difference in the rate control becomes meaningless.

c) Since MSC3/MGW3 can be located in a different PLMN, anywhere in the world, it cannot be excluded that in this foreign PLMN the UMTS_AMR codec is used in a multi-mode configuration with TFO.

For these reasons we propose the following solution:

i) UMTS_AMR and UMTS_AMR_2 shall only be considered as TFO- and TrFO- compatible, when used in a single mode configuration.

In the scenario above, this would mean that for an UMTS_AMR in multimode configuration immediate TFO between MGW2 and MGW3 would not be possible. MGW2 (using the new compatibility rule, for example) would terminate the TFO-negotiation. Provided that MSC2 asked MGW2 for a list of all distant codecs , MSC2 would be informed by MGW2 that UMTS_AMR was the codec used by the distant TFO partner. It would then be up to MSC2 to take appropriate measures. (Note that a codec modification from UMTS_AMR_2 to UMTS_AMR on the link between MGW1 and MGW2 would not improve this situation, because then the FR_AMR in BSS1 and the UMTS_AMR in MGW1 are not TFO-compatible. Only the point, where the transcoder is inserted, would be shifted from MGW2 to MGW1.)

ii) Since UMTS_AMR and UMTS_AMR_2 are no longer considered as TFO/TrFO-compatible in all cases, it shall be possible to discriminate clearly between the two codecs in the BICC OoBTC signalling. I.e. the UMTS_AMR_2 codec in the Supported Codecs List or Available Codecs List shall not include also the UMTS_AMR codec.

E.g. the originating MSC might want to offer in the Supported Codecs List the preferred (multimode) configuration 1 only for UMTS_AMR_2, but not for UMTS_AMR. Then the terminating MSC should not be allowed to reply with UMTS_AMR in preferred configuration 1 (which would currently be allowed according to subclause TS 23.153, 5.6).
(Note: in order to allow TrFO connections with R99 UMTS only UEs, the originating MSC can additionally include UMTS_AMR in preferred (single) mode configuration 7 to the Supported Codecs List. Or it can include UMTS_AMR in configuration 1, then the terminating MSC may select between all offers.)

Summary of change: ⌘ i) UMTS_AMR and UMTS_AMR_2 shall only be considered as TFO- and TrFO-compatible, when used in a single mode configuration with the same mode.

		ii) UMTS_AMR and UMTS_AMR_2 are treated as fully separate codec types in BICC OoBTC signalling. I.e. the UMTS_AMR_2 codec in the Supported Codecs List or Available Codecs List no longer includes also the UMTS_AMR codec.
Consequences if not approved:	⌘	Without the change (i), the network may set up a connection consisting of links using different codecs (FR_AMR, UMTS_AMR_2, and UMTS_AMR) that cannot be combined in TFO/TrFO end-to-end (FR_AMR and UMTS_AMR), although locally, at each node, the used codecs (FR_AMR and UMTS_AMR_2, or UMTS_AMR_2 and UMTS_AMR, respectively) are TFO/TrFO compatible. Since the UMTS_AMR codec does not comply with the rate control rules of the FR_AMR codec, the result will be a higher frequency of bad speech frames in downlink direction towards the UE using the FR_AMR codec. This can **seriously deteriorate the speech quality**. Without the change (ii), it is not possible for the originating MSC to restrict the use of UMTS_AMR to single mode configurations: if the originating MSC offers UMTS_AMR_2 in a multi mode configuration the terminating MSC could select the UMTS_AMR in the same multi mode configuration as Selected Codec.

Clauses affected:	⌘	5.4 in TS 26.103			
Other specs affected:	⌘	**Y** / **N** **X** / ☐ Other core specifications ☐ / **X** Test specifications ☐ / **X** O&M Specifications	⌘	TS 28.062, TS 23.153	
Other comments:	⌘				

How to create CRs using this form:

Comprehensive information and tips about how to create CRs can be found at http://www.3gpp.org/specs/CR.htm. Below is a brief summary:

1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

For Information

5.4 Four Adaptive Multi-Rate Codec Types (FR AMR, HR AMR, UMTS AMR, UMTS AMR2)

The Adaptive Multi-Rate Codec algorithm is applied in GSM and UMTS in four different Codec Types.
The Codec IDentification (CoID) codes are defined to be:
FR_AMR_CoID := 0x0000.0011.
HR_AMR_CoID := 0x0000.0100.
UMTS_AMR_CoID := 0x0000.0101.
UMTS_AMR_2_CoID := 0x0000.0110.

For Information

For information on GSM procedures (for exact details see GSM Recommendations):

The GSM AMR Codec Types comprise eight (Full Rate), respectively six (Half Rate) different Codec Modes:
12,2 Ö 4,75 kBit/s.

The active Codec Mode is selected from the Active Codec Set (ACS) by the network (Codec Mode Command) with assistance by the mobile station (Codec Mode Request). This Codec Mode Adaptation, also termed Rate Control, can be performed every 40 ms by going one Codec Mode up or down within the ACS. The Codec Modes in uplink and downlink at one radio leg may be different. In Tandem Free Operation both radio legs (A and B) are considered for the optimal selection of the active Codec Mode in each direction (uplink A and then downlink B, respectively vice versa) by the "Distributed Rate Decision" algorithm. The worst of both radio legs determines the highest allowed Codec Mode, respectively the maximally allowed rate ("Maximum Rate Control"). All rate control commands are transmitted inband: on the radio interface, the BTS-TRAU interface and the TRAU-TRAU interface.

For Information

Informative for terminals of R99 that support only UTRAN access ("UTRAN-only" terminals):
UTRAN-only terminals of R99 may either use UMTS AMR or UMTS AMR2 as default speech version in UTRAN access.

Normative for terminals that support GSM and UTRAN radio access ("dual-mode" terminals):
Dual-mode terminals of R99 and onwards shall use the UMTS AMR2 as the default speech version in UTRAN access. They need not to support the UMTS AMR, because the UMTS AMR2 in terminals is a fully compatible replacement.

Normative for all UMTS terminals of REL-4 and onwards: The UMTS AMR2 shall be the default speech version for UTRAN access in all terminals, UTRAN-only and dual-mode (GSM and UTRAN) of REL-4 and onwards.

For information on UMTS procedures (for exact details see 3GPP TS 28.062 (TFO) and 3GPP TS 23.153 (TrFO)):

FIRST CHANGE

The active Codec Mode is selected from the Active Codec Set (ACS) by the network. This Codec Mode Adaptation, also termed Rate Control, can be performed for the UMTS AMR every 20 ms by going to another Codec Mode within the ACS. For the UMTS AMR2 this Codec Mode Adaptation can be performed every 20ms for the downlink traffic channel, but only every 40ms for the uplink radio channel. The UE selects at call setup one of the two possible phases for Codec Mode Adaptation (odd or even frames). During the call changes of the Codec Mode in uplink direction are only allowed in this selected phase. Rate Control commands received in downlink direction are considered at the next possible phase.

By this definition the UMTS AMR2 Codec Type is TFO and TrFO compatible to the FR AMR, HR AMR~~, UMTS AMR~~ and UMTS AMR2 Codec Types. In any multi-mode configuration the UMTS_AMR shall be regarded as only compatible to itself, not to any other AMR codec Type, to avoid incompatibilities in TFO-TrFO-TFO interworking scenarios. In single mode configuration, UMTS_AMR and UMTS_AMR_2 are compatible, when both codec types use the same single rate ACS.

3GPP TSG-SA WG4 Meeting #33 ***S4-040617***

Helsinki, Finland. 22th to 26th November 2004.

CR-Form-v7.1

CHANGE REQUEST

⌘ **26.103** **CR** **031** ⌘ **rev** **-** ⌘ Current version: **5.5.0** ⌘

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

Proposed change affects: UICC apps⌘ ☐ ME ☐ Radio Access Network ☐ Core Network **X**

Title:	⌘	TFO/TrFO Compatibility of UMTS_AMR and UMTS_AMR2
Source:	⌘	TSG-SA WG4
Work item code:	⌘	TrFO-OoBTC
Date:	⌘	2004-12-14
Category:	⌘	**A**
Release:	⌘	Rel-5

Use one of the following categories:
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Rel-7 *(Release 7)*

Reason for change: ⌘ **Essential correction**

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TS 28.062 (4.5.0, 5.4.0, 6.0.0) states:

Table 11-1: Compatibility of AMR Codec Types

distant → ↓ local	UMTS_AMR_2	UMTS_AMR	FR_AMR	HR_AMR	OHR_AMR
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UMTS_AMR	compatible	compatible	-	-	-
FR_AMR	compatible	-	compatible	compatible	compatible
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The UMTS_AMR_2 is the preferred Codec Type for 3G systems.

TS 23.153 (4.10.0 and 5.8.0) states:

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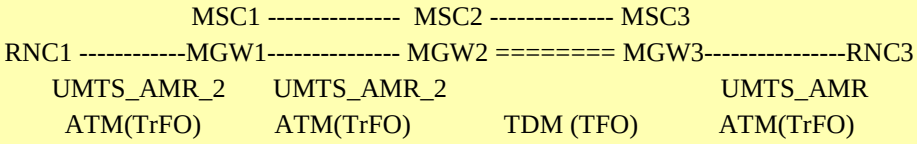
In other words: UMTS_AMR_2 is TFO/TrFO compatible to UMTS_AMR and FR_AMR; but UMTS_AMR and FR_AMR (indeed all GERAN versions) are not compatible.

These statements are true for end-to-end TFO scenarios and end-to-end TrFO scenarios with these two Codec Types. But this may cause problems in a more complex networks supporting TFO/TrFO interworking, as explained in the following:

Let us assume that a call is set up from an UE1 served by RNC1 towards an UE3 served by RNC3. UE1 supports UMTS_AMR_2, UE3 only UMTS_AMR. For the first part of the connection, UMTS_AMR_2 is negotiated via BICC OoBTC. MSC2/MGW2 and MSC3/MGW3 are connected via a TDM link and may belong to different PLMNs. Nevertheless, all the MSCs are configured so that the same active codec mode set (ACS) is selected both for UMTS_AMR_2 and UMTS_AMR.



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(Note that according to TS 29.232, MSC2 and MSC3 will not be informed that TFO operation was actually successfully established. Furthermore, MSC2 will not be informed that MGW3 is actually using UMTS_AMR, unless MSC2 explicitly asked MGW2 for a list of all distant codecs.).
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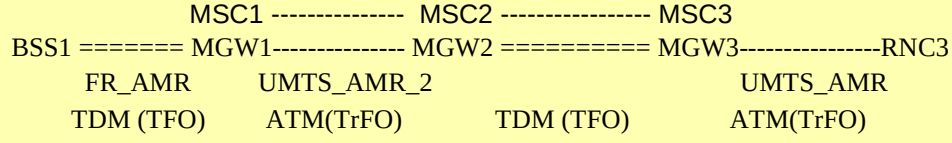
But now:
Subsequently, UE1 performs an inter-system handover to GERAN. The new codec assigned by BSS1 is FR_AMR, again with the same ACS. Now, the TFO peer entities in BSS1 and MGW1 start TFO in-band signalling and go to immediate TFO operation, since FR_AMR and UMTS_AMR_2 are TFO compatible. So we end up with a **concatenation of links using FR_AMR, UMTS_AMR_2 and UMTS_AMR**. With the information locally available at MSC1/MGW1 and MSC2/MGW2, both nodes come to the conclusion that TFO/TrFO is possible, but **end-to-end, FR_AMR and UMTS_AMR are not compatible**. Since the UMTS_AMR codec does not comply with the rate control rules of the FR_AMR codec, the result will be a higher frequency of bad speech frames in downlink direction towards UE1. This can seriously **deteriorate the speech quality**.



For a solution to avoid this kind of path configuration it should be taken into account that

a) apart from R99 'UMTS only' UEs, all other UTRAN capable UEs support the UMTS_AMR_2. And it can be expected that R99 'UMTS only' UEs will soon become a small minority. Therefore, calls without involvement of an UMTS_AMR codec should be affected by the solution as little as possible.

   For this reason we do not want to require MSC1 to perform a codec modification or mid-call codec negotiation on the link between MGW1 and MGW2 after each inter-system handover of UE1, since such a requirement would apply to any call using AMR codecs. But codec changes in the core network should be avoided, if possible, since each re-initialization of the user plane will cause a short interruption of the speech transmission. Furthermore, such a requirement would create an unnecessarily high signalling load between MSC1 and MSC2 and their associated MGWs. And, most important to note: a transcoder would have to be inserted somewhere in the path.

b) Nowadays, many operating UMTS networks use the UMTS_AMR codec only in 12.2 kbit/s single mode configuration. For AMR codecs in single mode configuration, the difference in the rate control becomes meaningless.

c) Since MSC3/MGW3 can be located in a different PLMN, anywhere in the world, it cannot be excluded that in this foreign PLMN the UMTS_AMR codec is used in a multi-mode configuration with TFO.

For these reasons we propose the following solution:

i) UMTS_AMR and UMTS_AMR_2 shall only be considered as TFO- and TrFO- compatible, when used in a single mode configuration.

In the scenario above, this would mean that for an UMTS_AMR in multimode configuration immediate TFO between MGW2 and MGW3 would not be possible. MGW2 (using the new compatibility rule, for example) would terminate the TFO-negotiation. Provided that MSC2 asked MGW2 for a list of all distant codecs , MSC2 would be informed by MGW2 that UMTS_AMR was the codec used by the distant TFO partner. It would then be up to MSC2 to take appropriate measures. (Note that a codec modification from UMTS_AMR_2 to UMTS_AMR on the link between MGW1 and MGW2 would not improve this situation, because then the FR_AMR in BSS1 and the UMTS_AMR in MGW1 are not TFO-compatible. Only the point, where the transcoder is inserted, would be shifted from MGW2 to MGW1.)

ii) Since UMTS_AMR and UMTS_AMR_2 are no longer considered as TFO/TrFO-compatible in all cases, it shall be possible to discriminate clearly between the two codecs in the BICC OoBTC signalling. I.e. the UMTS_AMR_2 codec in the Supported Codecs List or Available Codecs List shall not include also the UMTS_AMR codec.

E.g. the originating MSC might want to offer in the Supported Codecs List the preferred (multimode) configuration 1 only for UMTS_AMR_2, but not for UMTS_AMR. Then the terminating MSC should not be allowed to reply with UMTS_AMR in preferred configuration 1 (which would currently be allowed according to subclause TS 23.153, 5.6).
(Note: in order to allow TrFO connections with R99 UMTS only UEs, the originating MSC can additionally include UMTS_AMR in preferred (single) mode configuration 7 to the Supported Codecs List. Or it can include UMTS_AMR in configuration 1, then the terminating MSC may select between all offers.)

Summary of change: ⌘ i) UMTS_AMR and UMTS_AMR_2 shall only be considered as TFO- and TrFO-compatible, when used in a single mode configuration with the same mode.

		ii) UMTS_AMR and UMTS_AMR_2 are treated as fully separate codec types in BICC OoBTC signalling. I.e. the UMTS_AMR_2 codec in the Supported Codecs List or Available Codecs List no longer includes also the UMTS_AMR codec.
Consequences if not approved:	⌘	Without the change (i), the network may set up a connection consisting of links using different codecs (FR_AMR, UMTS_AMR_2, and UMTS_AMR) that cannot be combined in TFO/TrFO end-to-end (FR_AMR and UMTS_AMR), although locally, at each node, the used codecs (FR_AMR and UMTS_AMR_2, or UMTS_AMR_2 and UMTS_AMR, respectively) are TFO/TrFO compatible. Since the UMTS_AMR codec does not comply with the rate control rules of the FR_AMR codec, the result will be a higher frequency of bad speech frames in downlink direction towards the UE using the FR_AMR codec. This can **seriously deteriorate the speech quality**. Without the change (ii), it is not possible for the originating MSC to restrict the use of UMTS_AMR to single mode configurations: if the originating MSC offers UMTS_AMR_2 in a multi mode configuration the terminating MSC could select the UMTS_AMR in the same multi mode configuration as Selected Codec.

Clauses affected:	⌘	5.4 in TS 26.103			
Other specs affected:	⌘	**Y** / **N** **X** / ☐ Other core specifications ☐ / **X** Test specifications ☐ / **X** O&M Specifications	⌘	TS 28.062, TS 23.153	
Other comments:	⌘				

How to create CRs using this form:

Comprehensive information and tips about how to create CRs can be found at http://www.3gpp.org/specs/CR.htm. Below is a brief summary:

1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

For Information

5.4 Five Adaptive Multi-Rate Codec Types (FR AMR, HR AMR, UMTS AMR, UMTS AMR2, OHR AMR)

The Adaptive Multi-Rate Codec algorithm is applied in GERAN-GMSK, GERAN-8PSK and UTRAN in five different Codec Types.
The Codec IDentification (CoID) codes are defined to be:

FR_AMR_CoID := 0x0000.0011.
HR_AMR_CoID := 0x0000.0100.
UMTS_AMR_CoID := 0x0000.0101.
UMTS_AMR_2_CoID := 0x0000.0110.
OHR_AMR_CoID := 0x0000.1011.

For Information

For information on GSM procedures (for exact details see GSM Recommendations):

The GSM AMR Codec Types comprise eight (Full Rate), respectively six (Half Rate) different Codec Modes:
12,2 Ö 4,75 kBit/s.

The active Codec Mode is selected from the Active Codec Set (ACS) by the network (Codec Mode Command) with assistance by the mobile station (Codec Mode Request). This Codec Mode Adaptation, also termed Rate Control, can be performed every 40 ms by going one Codec Mode up or down within the ACS. The Codec Modes in uplink and downlink at one radio leg may be different. In Tandem Free Operation both radio legs (A and B) are considered for the optimal selection of the active Codec Mode in each direction (uplink A and then downlink B, respectively vice versa) by the "Distributed Rate Decision" algorithm. The worst of both radio legs determines the highest allowed Codec Mode, respectively the maximally allowed rate ("Maximum Rate Control"). All rate control commands are transmitted inband: on the radio interface, the BTS-TRAU interface and the TRAU-TRAU interface.

For Information

Informative for terminals of R99 that support only UTRAN access ("UTRAN-only" terminals):
UTRAN-only terminals of R99 may either use UMTS AMR or UMTS AMR2 as default speech version in UTRAN access.

Normative for terminals that support GSM and UTRAN radio access ("dual-mode" terminals):
Dual-mode terminals of R99 and onwards shall use the UMTS AMR2 as the default speech version in UTRAN access. They need not to support the UMTS AMR, because the UMTS AMR2 in terminals is a fully compatible replacement.

Normative for all UMTS terminals of REL-4 and onwards: The UMTS AMR2 shall be the default speech version for UTRAN access in all terminals, UTRAN-only and dual-mode (GSM and UTRAN) of REL-4 and onwards.

For information on UMTS procedures (for exact details see 3GPP TS 28.062 (TFO) and 3GPP TS 23.153 (TrFO)):

FIRST CHANGE

The active Codec Mode is selected from the Active Codec Set (ACS) by the network. This Codec Mode Adaptation, also termed Rate Control, can be performed for the UMTS AMR every 20 ms by going to another Codec Mode within the ACS. For the UMTS AMR 2 this Codec Mode Adaptation can be performed every 20ms for the downlink traffic channel, but only every 40ms for the uplink radio channel. The UE selects at call setup one of the two possible phases for Codec Mode Adaptation (odd or even frames). During the call changes of the Codec Mode in uplink direction are only allowed in this selected phase. Rate Control commands received in downlink direction are considered at the next possible phase.

By this definition the UMTS AMR 2 Codec Type is TFO and TrFO compatible to the FR AMR, HR AMR, OHR AMR~~, UMTS AMR~~ and UMTS AMR 2 Codec Types. In any multi-mode configuration the UMTS_AMR shall be regarded as only compatible to itself, not to any other AMR codec Type, to avoid incompatibilities in TFO-TrFO-TFO interworking scenarios. In single mode configuration, UMTS AMR and UMTS AMR 2 are compatible, when both codec types use the same single rate ACS.

3GPP TSG-SA WG4 Meeting #33 ***S4-040618***

Helsinki, Finland. 22th to 26th November 2004.

CR-Form-v7.1

CHANGE REQUEST

⌘ **26.103** **CR** **032** ⌘ **rev** **-** ⌘ Current version: **6.0.0** ⌘

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

Proposed change affects: UICC apps⌘ ☐ ME ☐ Radio Access Network ☐ Core Network ☒

Title:	⌘	TFO/TrFO Compatibility of UMTS_AMR and UMTS_AMR2
Source:	⌘	TSG-SA WG4
Work item code:	⌘	TrFO-OoBTC
Date:	⌘	2004-12-14
Category:	⌘	**A**
Release:	⌘	Rel-6

Use one of the following categories:
F *(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:
Ph2 *(GSM Phase 2)*
R96 *(Release 1996)*
R97 *(Release 1997)*
R98 *(Release 1998)*
R99 *(Release 1999)*
Rel-4 *(Release 4)*
Rel-5 *(Release 5)*
Rel-6 *(Release 6)*
Rel-7 *(Release 7)*

Reason for change: ⌘ **Essential correction**

TS 26.103 (4.3.0, 5.5.0, 6.0.0) states:

ìFor the UMTS AMR2 this Codec Mode Adaptation can be performed every 20ms for the downlink traffic channel, but only every 40ms for the uplink radio channel. Ö
By this definition the UMTS AMR2 Codec Type is TFO and TrFO compatible to the FR AMR, HR AMR, UMTS AMR and UMTS AMR2 Codec Types.î

TS 28.062 (4.5.0, 5.4.0, 6.0.0) states:

Table 11-1: Compatibility of AMR Codec Types

distant → ↓ local	UMTS_AMR_2	UMTS_AMR	FR_AMR	HR_AMR	OHR_AMR
UMTS_AMR_2	compatible	compatible	compatible	compatible	compatible
UMTS_AMR	compatible	compatible	-	-	-
FR_AMR	compatible	-	compatible	compatible	compatible
HR_AMR	compatible	-	compatible	compatible	compatible
OHR_AMR	compatible	-	compatible	compatible	compatible

The UMTS_AMR_2 is the preferred Codec Type for 3G systems.

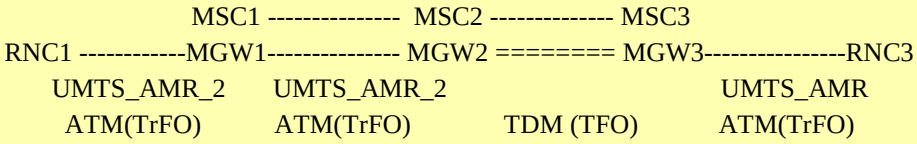
TS 23.153 (4.10.0 and 5.8.0) states:

> "The UMTS_AMR_2 is a superset of the UMTS_AMR. It behaves as a FR_AMR codec in the UL and as a UMTS_AMR codec in the DL. This allows UMTS terminals to operate in TFO with GSM terminals. The UMTS_AMR_2 is fully compatible with UMTS_AMR in TFO and TrFO and fully compatible with R99 CN nodes (TC in MGW)."

In other words: UMTS_AMR_2 is TFO/TrFO compatible to UMTS_AMR and FR_AMR; but UMTS_AMR and FR_AMR (indeed all GERAN versions) are not compatible.

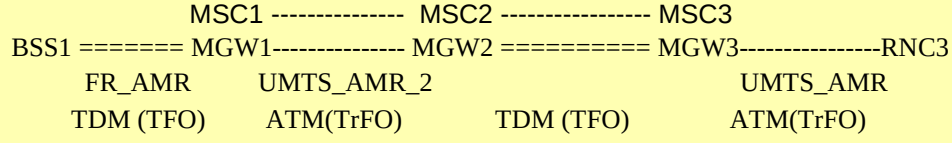
These statements are true for end-to-end TFO scenarios and end-to-end TrFO scenarios with these two Codec Types. But this may cause problems in a more complex networks supporting TFO/TrFO interworking, as explained in the following:

Let us assume that a call is set up from an UE1 served by RNC1 towards an UE3 served by RNC3. UE1 supports UMTS_AMR_2, UE3 only UMTS_AMR. For the first part of the connection, UMTS_AMR_2 is negotiated via BICC OoBTC. MSC2/MGW2 and MSC3/MGW3 are connected via a TDM link and may belong to different PLMNs. Nevertheless, all the MSCs are configured so that the same active codec mode set (ACS) is selected both for UMTS_AMR_2 and UMTS_AMR.



When the TFO peer entities in MGW2 and MGW3 exchange the locally used codec types and codec configurations via TFO in-band signalling, they will come to the conclusion that immediate TFO operation is possible, since UMTS_AMR and UMTS_AMR_2 are termed ìTFO compatibleî. The result will be an concatenation of tandem free and transcoder free links: it will be end-to-end transcoding free.
(Note that according to TS 29.232, MSC2 and MSC3 will not be informed that TFO operation was actually successfully established. Furthermore, MSC2 will not be informed that MGW3 is actually using UMTS_AMR, unless MSC2 explicitly asked MGW2 for a list of all distant codecs.).
So far so good.

But now:
Subsequently, UE1 performs an inter-system handover to GERAN. The new codec assigned by BSS1 is FR_AMR, again with the same ACS. Now, the TFO peer entities in BSS1 and MGW1 start TFO in-band signalling and go to immediate TFO operation, since FR_AMR and UMTS_AMR_2 are TFO compatible. So we end up with a **concatenation of links using FR_AMR, UMTS_AMR_2 and UMTS_AMR**. With the information locally available at MSC1/MGW1 and MSC2/MGW2, both nodes come to the conclusion that TFO/TrFO is possible, but **end-to-end, FR_AMR and UMTS_AMR are not compatible**. Since the UMTS_AMR codec does not comply with the rate control rules of the FR_AMR codec, the result will be a higher frequency of bad speech frames in downlink direction towards UE1. This can seriously **deteriorate the speech quality**.



For a solution to avoid this kind of path configuration it should be taken into account that

a) apart from R99 'UMTS only' UEs, all other UTRAN capable UEs support the UMTS_AMR_2. And it can be expected that R99 'UMTS only' UEs will soon become a small minority. Therefore, calls without involvement of an UMTS_AMR codec should be affected by the solution as little as possible.

   For this reason we do not want to require MSC1 to perform a codec modification or mid-call codec negotiation on the link between MGW1 and MGW2 after each inter-system handover of UE1, since such a requirement would apply to any call using AMR codecs. But codec changes in the core network should be avoided, if possible, since each re-initialization of the user plane will cause a short interruption of the speech transmission. Furthermore, such a requirement would create an unnecessarily high signalling load between MSC1 and MSC2 and their associated MGWs. And, most important to note: a transcoder would have to be inserted somewhere in the path.

b) Nowadays, many operating UMTS networks use the UMTS_AMR codec only in 12.2 kbit/s single mode configuration. For AMR codecs in single mode configuration, the difference in the rate control becomes meaningless.

c) Since MSC3/MGW3 can be located in a different PLMN, anywhere in the world, it cannot be excluded that in this foreign PLMN the UMTS_AMR codec is used in a multi-mode configuration with TFO.

For these reasons we propose the following solution:

i) UMTS_AMR and UMTS_AMR_2 shall only be considered as TFO- and TrFO- compatible, when used in a single mode configuration.

In the scenario above, this would mean that for an UMTS_AMR in multimode configuration immediate TFO between MGW2 and MGW3 would not be possible. MGW2 (using the new compatibility rule, for example) would terminate the TFO-negotiation. Provided that MSC2 asked MGW2 for a list of all distant codecs , MSC2 would be informed by MGW2 that UMTS_AMR was the codec used by the distant TFO partner. It would then be up to MSC2 to take appropriate measures. (Note that a codec modification from UMTS_AMR_2 to UMTS_AMR on the link between MGW1 and MGW2 would not improve this situation, because then the FR_AMR in BSS1 and the UMTS_AMR in MGW1 are not TFO-compatible. Only the point, where the transcoder is inserted, would be shifted from MGW2 to MGW1.)

ii) Since UMTS_AMR and UMTS_AMR_2 are no longer considered as TFO/TrFO-compatible in all cases, it shall be possible to discriminate clearly between the two codecs in the BICC OoBTC signalling. I.e. the UMTS_AMR_2 codec in the Supported Codecs List or Available Codecs List shall not include also the UMTS_AMR codec.

E.g. the originating MSC might want to offer in the Supported Codecs List the preferred (multimode) configuration 1 only for UMTS_AMR_2, but not for UMTS_AMR. Then the terminating MSC should not be allowed to reply with UMTS_AMR in preferred configuration 1 (which would currently be allowed according to subclause TS 23.153, 5.6).
(Note: in order to allow TrFO connections with R99 UMTS only UEs, the originating MSC can additionally include UMTS_AMR in preferred (single) mode configuration 7 to the Supported Codecs List. Or it can include UMTS_AMR in configuration 1, then the terminating MSC may select between all offers.)

Summary of change: ⌘ i) UMTS_AMR and UMTS_AMR_2 shall only be considered as TFO- and TrFO-compatible, when used in a single mode configuration with the same mode.

		ii) UMTS_AMR and UMTS_AMR_2 are treated as fully separate codec types in BICC OoBTC signalling. I.e. the UMTS_AMR_2 codec in the Supported Codecs List or Available Codecs List no longer includes also the UMTS_AMR codec.
Consequences if not approved:	⌘	Without the change (i), the network may set up a connection consisting of links using different codecs (FR_AMR, UMTS_AMR_2, and UMTS_AMR) that cannot be combined in TFO/TrFO end-to-end (FR_AMR and UMTS_AMR), although locally, at each node, the used codecs (FR_AMR and UMTS_AMR_2, or UMTS_AMR_2 and UMTS_AMR, respectively) are TFO/TrFO compatible. Since the UMTS_AMR codec does not comply with the rate control rules of the FR_AMR codec, the result will be a higher frequency of bad speech frames in downlink direction towards the UE using the FR_AMR codec. This can **seriously deteriorate the speech quality**. Without the change (ii), it is not possible for the originating MSC to restrict the use of UMTS_AMR to single mode configurations: if the originating MSC offers UMTS_AMR_2 in a multi mode configuration the terminating MSC could select the UMTS_AMR in the same multi mode configuration as Selected Codec.

Clauses affected:	⌘	5.4 in TS 26.103			
Other specs affected:	⌘	**Y** / **N** **X** / ☐ Other core specifications ☐ / **X** Test specifications ☐ / **X** O&M Specifications	⌘	TS 28.062, TS 23.153	
Other comments:	⌘				

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3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

For Information

5.4 Five Adaptive Multi-Rate Codec Types (FR AMR, HR AMR, UMTS AMR, UMTS AMR2, OHR AMR)

The Adaptive Multi-Rate Codec algorithm is applied in GERAN-GMSK, GERAN-8PSK and UTRAN in five different Codec Types.
The Codec IDentification (CoID) codes are defined to be:

FR_AMR_CoID := 0x0000.0011.
HR_AMR_CoID := 0x0000.0100.
UMTS_AMR_CoID := 0x0000.0101.
UMTS_AMR_2_CoID := 0x0000.0110.
OHR_AMR_CoID := 0x0000.1011.

For Information

For information on GSM procedures (for exact details see GSM Recommendations):

The GSM AMR Codec Types comprise eight (Full Rate), respectively six (Half Rate) different Codec Modes:
12,2 Ö 4,75 kBit/s.

The active Codec Mode is selected from the Active Codec Set (ACS) by the network (Codec Mode Command) with assistance by the mobile station (Codec Mode Request). This Codec Mode Adaptation, also termed Rate Control, can be performed every 40 ms by going one Codec Mode up or down within the ACS. The Codec Modes in uplink and downlink at one radio leg may be different. In Tandem Free Operation both radio legs (A and B) are considered for the optimal selection of the active Codec Mode in each direction (uplink A and then downlink B, respectively vice versa) by the "Distributed Rate Decision" algorithm. The worst of both radio legs determines the highest allowed Codec Mode, respectively the maximally allowed rate ("Maximum Rate Control"). All rate control commands are transmitted inband: on the radio interface, the BTS-TRAU interface and the TRAU-TRAU interface.

For Information

Informative for terminals of R99 that support only UTRAN access ("UTRAN-only" terminals):
UTRAN-only terminals of R99 may either use UMTS AMR or UMTS AMR2 as default speech version in UTRAN access.

Normative for terminals that support GSM and UTRAN radio access ("dual-mode" terminals):
Dual-mode terminals of R99 and onwards shall use the UMTS AMR2 as the default speech version in UTRAN access. They need not to support the UMTS AMR, because the UMTS AMR2 in terminals is a fully compatible replacement.

Normative for all UMTS terminals of REL-4 and onwards: The UMTS AMR2 shall be the default speech version for UTRAN access in all terminals, UTRAN-only and dual-mode (GSM and UTRAN) of REL-4 and onwards.

For information on UMTS procedures (for exact details see 3GPP TS 28.062 (TFO) and 3GPP TS 23.153 (TrFO)):

FIRST CHANGE

The active Codec Mode is selected from the Active Codec Set (ACS) by the network. This Codec Mode Adaptation, also termed Rate Control, can be performed for the UMTS AMR every 20 ms by going to another Codec Mode within the ACS. For the UMTS AMR 2 this Codec Mode Adaptation can be performed every 20ms for the downlink traffic channel, but only every 40ms for the uplink radio channel. The UE selects at call setup one of the two possible phases for Codec Mode Adaptation (odd or even frames). During the call changes of the Codec Mode in uplink direction are only allowed in this selected phase. Rate Control commands received in downlink direction are considered at the next possible phase.

By this definition the UMTS AMR 2 Codec Type is TFO and TrFO compatible to the FR AMR, HR AMR, OHR AMR~~, UMTS AMR~~ and UMTS AMR 2 Codec Types. In any multi-mode configuration the UMTS_AMR shall be regarded as only compatible to itself, not to any other AMR codec Type, to avoid incompatibilities in TFO-TrFO-TFO interworking scenarios. In single mode configuration, UMTS AMR and UMTS AMR 2 are compatible, when both codec types use the same single rate ACS.

3GPP TSG-SA WG4 Meeting #33 ***S4-040619***

Helsinki, Finland. 22th to 26th November 2004.

CR-Form-v7.1

CHANGE REQUEST

⌘ **28.062** **CR** **042** ⌘ **rev** **-** ⌘ Current version: **4.5.0** ⌘

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

Proposed change affects: UICC apps⌘ ☐ ME ☐ Radio Access Network ☒ Core Network ☒

Title:	⌘	TFO/TrFO Compatibility of UMTS_AMR and UMTS_AMR2
Source:	⌘	TSG-SA WG4
Work item code:	⌘	TrFO-OoBTC
Date:	⌘	2004-12-14
Category:	⌘	**F**
Release:	⌘	Rel-4

Use one of the following categories:
F *(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:
Ph2 (GSM Phase 2)
R96 (Release 1996)
R97 (Release 1997)
R98 (Release 1998)
R99 (Release 1999)
Rel-4 (Release 4)
Rel-5 (Release 5)
Rel-6 (Release 6)
Rel-7 (Release 7)

Reason for change: ⌘ **Essential correction**

TS 26.103 (4.3.0, 5.5.0, 6.0.0) states:

ìFor the UMTS AMR2 this Codec Mode Adaptation can be performed every 20ms for the downlink traffic channel, but only every 40ms for the uplink radio channel. Ö
By this definition the UMTS AMR2 Codec Type is TFO and TrFO compatible to the FR AMR, HR AMR, UMTS AMR and UMTS AMR2 Codec Types.î

TS 28.062 (4.5.0, 5.4.0, 6.0.0) states:

Table 11-1: Compatibility of AMR Codec Types

distant → ↓ local	UMTS_AMR_2	UMTS_AMR	FR_AMR	HR_AMR	OHR_AMR
UMTS_AMR_2	compatible	compatible	compatible	compatible	compatible
UMTS_AMR	compatible	compatible	-	-	-
FR_AMR	compatible	-	compatible	compatible	compatible
HR_AMR	compatible	-	compatible	compatible	compatible
OHR_AMR	compatible	-	compatible	compatible	compatible

The UMTS_AMR_2 is the preferred Codec Type for 3G systems.

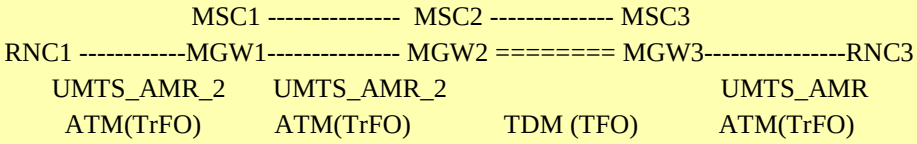
TS 23.153 (4.10.0 and 5.8.0) states:

> "The UMTS_AMR_2 is a superset of the UMTS_AMR. It behaves as a FR_AMR codec in the UL and as a UMTS_AMR codec in the DL. This allows UMTS terminals to operate in TFO with GSM terminals. The UMTS_AMR_2 is fully compatible with UMTS_AMR in TFO and TrFO and fully compatible with R99 CN nodes (TC in MGW)."

In other words: UMTS_AMR_2 is TFO/TrFO compatible to UMTS_AMR and FR_AMR; but UMTS_AMR and FR_AMR (indeed all GERAN versions) are not compatible.

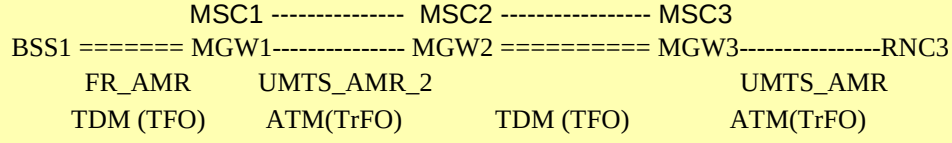
These statements are true for end-to-end TFO scenarios and end-to-end TrFO scenarios with these two Codec Types. But this may cause problems in a more complex networks supporting TFO/TrFO interworking, as explained in the following:

Let us assume that a call is set up from an UE1 served by RNC1 towards an UE3 served by RNC3. UE1 supports UMTS_AMR_2, UE3 only UMTS_AMR. For the first part of the connection, UMTS_AMR_2 is negotiated via BICC OoBTC. MSC2/MGW2 and MSC3/MGW3 are connected via a TDM link and may belong to different PLMNs. Nevertheless, all the MSCs are configured so that the same active codec mode set (ACS) is selected both for UMTS_AMR_2 and UMTS_AMR.



When the TFO peer entities in MGW2 and MGW3 exchange the locally used codec types and codec configurations via TFO in-band signalling, they will come to the conclusion that immediate TFO operation is possible, since UMTS_AMR and UMTS_AMR_2 are termed ìTFO compatibleî. The result will be an concatenation of tandem free and transcoder free links: it will be end-to-end transcoding free.
(Note that according to TS 29.232, MSC2 and MSC3 will not be informed that TFO operation was actually successfully established. Furthermore, MSC2 will not be informed that MGW3 is actually using UMTS_AMR, unless MSC2 explicitly asked MGW2 for a list of all distant codecs.).
So far so good.

But now:
Subsequently, UE1 performs an inter-system handover to GERAN. The new codec assigned by BSS1 is FR_AMR, again with the same ACS. Now, the TFO peer entities in BSS1 and MGW1 start TFO in-band signalling and go to immediate TFO operation, since FR_AMR and UMTS_AMR_2 are TFO compatible. So we end up with a **concatenation of links using FR_AMR, UMTS_AMR_2 and UMTS_AMR**. With the information locally available at MSC1/MGW1 and MSC2/MGW2, both nodes come to the conclusion that TFO/TrFO is possible, but **end-to-end, FR_AMR and UMTS_AMR are not compatible**. Since the UMTS_AMR codec does not comply with the rate control rules of the FR_AMR codec, the result will be a higher frequency of bad speech frames in downlink direction towards UE1. This can seriously **deteriorate the speech quality**.



For a solution to avoid this kind of path configuration it should be taken into account that

a) apart from R99 'UMTS only' UEs, all other UTRAN capable UEs support the UMTS_AMR_2. And it can be expected that R99 'UMTS only' UEs will soon become a small minority. Therefore, calls without involvement of an UMTS_AMR codec should be affected by the solution as little as possible.

   For this reason we do not want to require MSC1 to perform a codec modification or mid-call codec negotiation on the link between MGW1 and MGW2 after each inter-system handover of UE1, since such a requirement would apply to any call using AMR codecs. But codec changes in the core network should be avoided, if possible, since each re-initialization of the user plane will cause a short interruption of the speech transmission. Furthermore, such a requirement would create an unnecessarily high signalling load between MSC1 and MSC2 and their associated MGWs. And, most important to note: a transcoder would have to be inserted somewhere in the path.

b) Nowadays, many operating UMTS networks use the UMTS_AMR codec only in 12.2 kbit/s single mode configuration. For AMR codecs in single mode configuration, the difference in the rate control becomes meaningless.

c) Since MSC3/MGW3 can be located in a different PLMN, anywhere in the world, it cannot be excluded that in this foreign PLMN the UMTS_AMR codec is used in a multi-mode configuration with TFO.

For these reasons we propose the following solution:

i) UMTS_AMR and UMTS_AMR_2 shall only be considered as TFO- and TrFO- compatible, when used in a single mode configuration.

In the scenario above, this would mean that for an UMTS_AMR in multimode configuration immediate TFO between MGW2 and MGW3 would not be possible. MGW2 (using the new compatibility rule, for example) would terminate the TFO-negotiation. Provided that MSC2 asked MGW2 for a list of all distant codecs , MSC2 would be informed by MGW2 that UMTS_AMR was the codec used by the distant TFO partner. It would then be up to MSC2 to take appropriate measures. (Note that a codec modification from UMTS_AMR_2 to UMTS_AMR on the link between MGW1 and MGW2 would not improve this situation, because then the FR_AMR in BSS1 and the UMTS_AMR in MGW1 are not TFO-compatible. Only the point, where the transcoder is inserted, would be shifted from MGW2 to MGW1.)

ii) Since UMTS_AMR and UMTS_AMR_2 are no longer considered as TFO/TrFO-compatible in all cases, it shall be possible to discriminate clearly between the two codecs in the BICC OoBTC signalling. I.e. the UMTS_AMR_2 codec in the Supported Codecs List or Available Codecs List shall not include also the UMTS_AMR codec.

E.g. the originating MSC might want to offer in the Supported Codecs List the preferred (multimode) configuration 1 only for UMTS_AMR_2, but not for UMTS_AMR. Then the terminating MSC should not be allowed to reply with UMTS_AMR in preferred configuration 1 (which would currently be allowed according to subclause TS 23.153, 5.6).
(Note: in order to allow TrFO connections with R99 UMTS only UEs, the originating MSC can additionally include UMTS_AMR in preferred (single) mode configuration 7 to the Supported Codecs List. Or it can include UMTS_AMR in configuration 1, then the terminating MSC may select between all offers.)

Summary of change: ⌘ i) UMTS_AMR and UMTS_AMR_2 shall only be considered as TFO- and TrFO-compatible, when used in a single mode configuration with the same mode.

		ii) UMTS_AMR and UMTS_AMR_2 are treated as fully separate codec types in BICC OoBTC signalling. I.e. the UMTS_AMR_2 codec in the Supported Codecs List or Available Codecs List no longer includes also the UMTS_AMR codec.
Consequences if not approved:	⌘	Without the change (i), the network may set up a connection consisting of links using different codecs (FR_AMR, UMTS_AMR_2, and UMTS_AMR) that cannot be combined in TFO/TrFO end-to-end (FR_AMR and UMTS_AMR), although locally, at each node, the used codecs (FR_AMR and UMTS_AMR_2, or UMTS_AMR_2 and UMTS_AMR, respectively) are TFO/TrFO compatible. Since the UMTS_AMR codec does not comply with the rate control rules of the FR_AMR codec, the result will be a higher frequency of bad speech frames in downlink direction towards the UE using the FR_AMR codec. This can **seriously deteriorate the speech quality**. Without the change (ii), it is not possible for the originating MSC to restrict the use of UMTS_AMR to single mode configurations: if the originating MSC offers UMTS_AMR_2 in a multi mode configuration the terminating MSC could select the UMTS_AMR in the same multi mode configuration as Selected Codec.

Clauses affected:	⌘	11 and 11.6.2 in TS 28.062			
Other specs affected:	⌘	**Y** / **N** **X** / ( ) ( ) / **X** ( ) / **X**	Other core specifications Test specifications O&M Specifications	⌘	TS 26.103, TS 23.153
Other comments:	⌘				

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First Change

11 TFO Decision Algorithm

The TFO decision algorithm defines the processes invoked in both transcoders in order to examine the possibility for TFO establishment. Codec Types are in general only compatible to itself. All members of the AMR Codec Type family, except UMTS_AMR, are compatible, when both Codec Types use compatible multi-mode ACSs. In any multi-mode configuration the UMTS_AMR shall be regarded as only compatible to itself, not to any other AMR Codec Type, to avoid incompatibilities in TFO-TrFO-TFO interworking scenarios. In single mode configuration, UMTS_AMR and UMTS_AMR_2 are compatible, when both Codec Types use the same single rate ACS. For the AMR Codec Type family the following table 11-1 illustrates the compbatible combinations:

Table 11-1: Compatibility of AMR Codec Types

distant → ↓ local	UMTS_AMR_2	UMTS_AMR	FR_AMR	HR_AMR
UMTS_AMR_2	compatible	compatible (Note)	compatible	compatible
UMTS_AMR	compatible (Note)	compatible	-	-
FR_AMR	compatible	-	compatible	compatible
HR_AMR	compatible	-	compatible	compatible

Note: only for single mode ACSs.

The UMTS_AMR_2 is the preferred Codec Type for 3G systems.

Second Change

11.6.2 Preference List of TFO candidates

The preference list of TFO candidates orders all possible TFO configurations according to the speech quality they provide.

Table 11.6.2-1: Codec Type Preference List

Preference	TFO candidate		
#1	UMTS_AMR_2	⇔	UMTS_AMR_2
#2	UMTS_AMR_2	⇔	FR_AMR
	FR_AMR	⇔	UMTS_AMR_2
#3	FR_AMR	⇔	FR_AMR
#4	UMTS_AMR~~_2~~	⇔	UMTS_AMR
	~~UMTS_AMR~~	~~⇔~~	~~UMTS_AMR_2~~
#5 (Note)	UMTS_AMR_2	⇔	UMTS_AMR
	UMTS_AMR	⇔	UMTS_AMR_2
#6	GSM_EFR	⇔	GSM_EFR
#7	UMTS_AMR_2	⇔	HR_AMR
	HR_AMR	⇔	UMTS_AMR_2
#8	FR_AMR	⇔	HR_AMR
	HR_AMR	⇔	FR_AMR
#9	HR_AMR	⇔	HR_AMR
#10	GSM_FR	⇔	GSM_FR
#11	GSM_HR	⇔	GSM_HR

Note: only for single mode ACSs.

The codec type UMTS_AMR_2 is the most prefer~~r~~red AMR codec type, because it is compatible with all other AMR codec types. ~~Note: Whenever UMTS_AMR_2 is available, then the UMTS_AMR and FR_AMR shall not be included in the Codec_List, see Annex F (Operator¥s Guide).~~

The codec type FR_AMR is preferred to UMTS_AMR because UMTS_AMR is not compatible with FR_AMR and HR_AMR.

3GPP TSG-SA WG4 Meeting #33 ***S4-040620***

Helsinki, Finland. 22th to 26th November 2004.

CR-Form-v7.1

CHANGE REQUEST

⌘ **28.062** **CR** **043** ⌘ **rev** **-** ⌘ Current version: **5.4.0** ⌘

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

Proposed change affects: UICC apps⌘ ☐ ME ☐ Radio Access Network **X** Core Network **X**

Title:	⌘	TFO/TrFO Compatibility of UMTS_AMR and UMTS_AMR2
Source:	⌘	TSG-SA WG4
Work item code:	⌘	TrFO-OoBTC
Date:	⌘	2004-12-14
Category:	⌘	**A**
Release:	⌘	Rel-5

Use one of the following categories:
F *(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:
Ph2 (GSM Phase 2)
R96 (Release 1996)
R97 (Release 1997)
R98 (Release 1998)
R99 (Release 1999)
Rel-4 (Release 4)
Rel-5 (Release 5)
Rel-6 (Release 6)
Rel-7 (Release 7)

Reason for change: ⌘ **Essential correction**

TS 26.103 (4.3.0, 5.5.0, 6.0.0) states:

ìFor the UMTS AMR2 this Codec Mode Adaptation can be performed every 20ms for the downlink traffic channel, but only every 40ms for the uplink radio channel. Ö
By this definition the UMTS AMR2 Codec Type is TFO and TrFO compatible to the FR AMR, HR AMR, UMTS AMR and UMTS AMR2 Codec Types.î

TS 28.062 (4.5.0, 5.4.0, 6.0.0) states:

Table 11-1: Compatibility of AMR Codec Types

distant → ↓ local	UMTS_AMR_2	UMTS_AMR	FR_AMR	HR_AMR	OHR_AMR
UMTS_AMR_2	compatible	compatible	compatible	compatible	compatible
UMTS_AMR	compatible	compatible	-	-	-
FR_AMR	compatible	-	compatible	compatible	compatible
HR_AMR	compatible	-	compatible	compatible	compatible
OHR_AMR	compatible	-	compatible	compatible	compatible

The UMTS_AMR_2 is the preferred Codec Type for 3G systems.

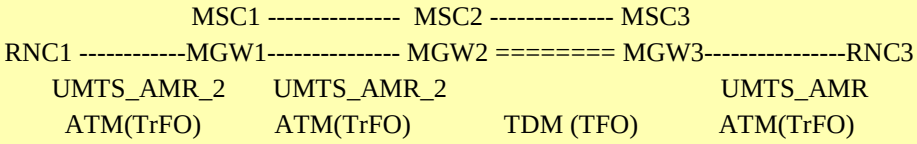
TS 23.153 (4.10.0 and 5.8.0) states:

> "The UMTS_AMR_2 is a superset of the UMTS_AMR. It behaves as a FR_AMR codec in the UL and as a UMTS_AMR codec in the DL. This allows UMTS terminals to operate in TFO with GSM terminals. The UMTS_AMR_2 is fully compatible with UMTS_AMR in TFO and TrFO and fully compatible with R99 CN nodes (TC in MGW)."

In other words: UMTS_AMR_2 is TFO/TrFO compatible to UMTS_AMR and FR_AMR; but UMTS_AMR and FR_AMR (indeed all GERAN versions) are not compatible.

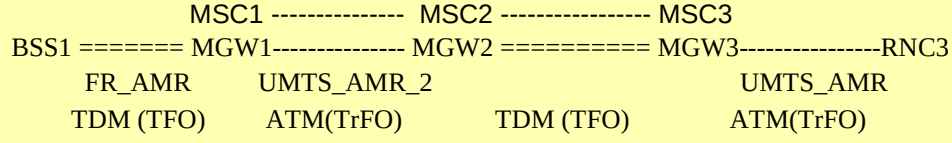
These statements are true for end-to-end TFO scenarios and end-to-end TrFO scenarios with these two Codec Types. But this may cause problems in a more complex networks supporting TFO/TrFO interworking, as explained in the following:

Let us assume that a call is set up from an UE1 served by RNC1 towards an UE3 served by RNC3. UE1 supports UMTS_AMR_2, UE3 only UMTS_AMR. For the first part of the connection, UMTS_AMR_2 is negotiated via BICC OoBTC. MSC2/MGW2 and MSC3/MGW3 are connected via a TDM link and may belong to different PLMNs. Nevertheless, all the MSCs are configured so that the same active codec mode set (ACS) is selected both for UMTS_AMR_2 and UMTS_AMR.



When the TFO peer entities in MGW2 and MGW3 exchange the locally used codec types and codec configurations via TFO in-band signalling, they will come to the conclusion that immediate TFO operation is possible, since UMTS_AMR and UMTS_AMR_2 are termed ìTFO compatibleî. The result will be an concatenation of tandem free and transcoder free links: it will be end-to-end transcoding free.
(Note that according to TS 29.232, MSC2 and MSC3 will not be informed that TFO operation was actually successfully established. Furthermore, MSC2 will not be informed that MGW3 is actually using UMTS_AMR, unless MSC2 explicitly asked MGW2 for a list of all distant codecs.).
So far so good.

But now:
Subsequently, UE1 performs an inter-system handover to GERAN. The new codec assigned by BSS1 is FR_AMR, again with the same ACS. Now, the TFO peer entities in BSS1 and MGW1 start TFO in-band signalling and go to immediate TFO operation, since FR_AMR and UMTS_AMR_2 are TFO compatible. So we end up with a **concatenation of links using FR_AMR, UMTS_AMR_2 and UMTS_AMR**. With the information locally available at MSC1/MGW1 and MSC2/MGW2, both nodes come to the conclusion that TFO/TrFO is possible, but **end-to-end, FR_AMR and UMTS_AMR are not compatible**. Since the UMTS_AMR codec does not comply with the rate control rules of the FR_AMR codec, the result will be a higher frequency of bad speech frames in downlink direction towards UE1. This can seriously **deteriorate the speech quality**.



For a solution to avoid this kind of path configuration it should be taken into account that

a) apart from R99 'UMTS only' UEs, all other UTRAN capable UEs support the UMTS_AMR_2. And it can be expected that R99 'UMTS only' UEs will soon become a small minority. Therefore, calls without involvement of an UMTS_AMR codec should be affected by the solution as little as possible.

   For this reason we do not want to require MSC1 to perform a codec modification or mid-call codec negotiation on the link between MGW1 and MGW2 after each inter-system handover of UE1, since such a requirement would apply to any call using AMR codecs. But codec changes in the core network should be avoided, if possible, since each re-initialization of the user plane will cause a short interruption of the speech transmission. Furthermore, such a requirement would create an unnecessarily high signalling load between MSC1 and MSC2 and their associated MGWs. And, most important to note: a transcoder would have to be inserted somewhere in the path.

b) Nowadays, many operating UMTS networks use the UMTS_AMR codec only in 12.2 kbit/s single mode configuration. For AMR codecs in single mode configuration, the difference in the rate control becomes meaningless.

c) Since MSC3/MGW3 can be located in a different PLMN, anywhere in the world, it cannot be excluded that in this foreign PLMN the UMTS_AMR codec is used in a multi-mode configuration with TFO.

For these reasons we propose the following solution:

i) UMTS_AMR and UMTS_AMR_2 shall only be considered as TFO- and TrFO- compatible, when used in a single mode configuration.

In the scenario above, this would mean that for an UMTS_AMR in multimode configuration immediate TFO between MGW2 and MGW3 would not be possible. MGW2 (using the new compatibility rule, for example) would terminate the TFO-negotiation. Provided that MSC2 asked MGW2 for a list of all distant codecs , MSC2 would be informed by MGW2 that UMTS_AMR was the codec used by the distant TFO partner. It would then be up to MSC2 to take appropriate measures. (Note that a codec modification from UMTS_AMR_2 to UMTS_AMR on the link between MGW1 and MGW2 would not improve this situation, because then the FR_AMR in BSS1 and the UMTS_AMR in MGW1 are not TFO-compatible. Only the point, where the transcoder is inserted, would be shifted from MGW2 to MGW1.)

ii) Since UMTS_AMR and UMTS_AMR_2 are no longer considered as TFO/TrFO-compatible in all cases, it shall be possible to discriminate clearly between the two codecs in the BICC OoBTC signalling. I.e. the UMTS_AMR_2 codec in the Supported Codecs List or Available Codecs List shall not include also the UMTS_AMR codec.

E.g. the originating MSC might want to offer in the Supported Codecs List the preferred (multimode) configuration 1 only for UMTS_AMR_2, but not for UMTS_AMR. Then the terminating MSC should not be allowed to reply with UMTS_AMR in preferred configuration 1 (which would currently be allowed according to subclause TS 23.153, 5.6).
(Note: in order to allow TrFO connections with R99 UMTS only UEs, the originating MSC can additionally include UMTS_AMR in preferred (single) mode configuration 7 to the Supported Codecs List. Or it can include UMTS_AMR in configuration 1, then the terminating MSC may select between all offers.)

Summary of change: ⌘ i) UMTS_AMR and UMTS_AMR_2 shall only be considered as TFO- and TrFO-compatible, when used in a single mode configuration with the same mode.

		ii) UMTS_AMR and UMTS_AMR_2 are treated as fully separate codec types in BICC OoBTC signalling. I.e. the UMTS_AMR_2 codec in the Supported Codecs List or Available Codecs List no longer includes also the UMTS_AMR codec.
Consequences if not approved:	⌘	Without the change (i), the network may set up a connection consisting of links using different codecs (FR_AMR, UMTS_AMR_2, and UMTS_AMR) that cannot be combined in TFO/TrFO end-to-end (FR_AMR and UMTS_AMR), although locally, at each node, the used codecs (FR_AMR and UMTS_AMR_2, or UMTS_AMR_2 and UMTS_AMR, respectively) are TFO/TrFO compatible. Since the UMTS_AMR codec does not comply with the rate control rules of the FR_AMR codec, the result will be a higher frequency of bad speech frames in downlink direction towards the UE using the FR_AMR codec. This can **seriously deteriorate the speech quality**. Without the change (ii), it is not possible for the originating MSC to restrict the use of UMTS_AMR to single mode configurations: if the originating MSC offers UMTS_AMR_2 in a multi mode configuration the terminating MSC could select the UMTS_AMR in the same multi mode configuration as Selected Codec.

Clauses affected:	⌘	11 and 11.6.2 in TS 28.062			
Other specs affected:	⌘	**Y** / **N** **X** / ( ) ( ) / **X** ( ) / **X**	Other core specifications Test specifications O&M Specifications	⌘	TS 26.103, TS 23.153
Other comments:	⌘				

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First Change

11 TFO Decision Algorithm

The TFO decision algorithm defines the processes invoked in both transcoders in order to examine the possibility for TFO establishment. Codec Types are in general only compatible to itself.

All members of the AMR-NB Codec Type family, except UMTS_AMR, are compatible, when both codec types use compatible multi-mode ACSs. In any multi-mode configuration the UMTS_AMR shall be regarded as only compatible to itself, not to any other AMR-NB Codec Type, to avoid incompatibilities in TFO-TrFO-TFO interworking scenarios. In single mode configuration, UMTS_AMR and UMTS_AMR_2 are compatible, when both Codec Types use the same single rate ACS. The UMTS_AMR_2 is the preferred AMR-NB Codec Type for 3G systems.

All members of the AMR-WB Codec Type family are compatible, when both codec types use compatible multi-mode ACSs.

For the AMR Codec Type family the following tables 11-1 and 11-2 illustrate the compatible combinations (Table 11-1 for AMR-NB codec types, table 11-2 for AMR-WB codec types):

Table 11-1: Compatibility of AMR-NB Codec Types

distant → ↓ local	UMTS_AMR_2	UMTS_AMR	FR_AMR	HR_AMR	OHR_AMR
UMTS_AMR_2	compatible	compatible (Note)	compatible	compatible	compatible
UMTS_AMR	compatible (Note)	compatible	-	-	-
FR_AMR	compatible	-	compatible	compatible	compatible
HR_AMR	compatible	-	compatible	compatible	compatible
OHR_AMR	compatible	-	compatible	compatible	compatible

Note: only for single mode ACSs.

~~The UMTS_AMR_2 is the preferred Codec Type for 3G systems.~~

Table 11-2 Compatibility of AMR-WB Codec Types

distant → ↓ local	FR_AMR-WB	UMTS_AMR-WB	OFR_AMR-WB	OHR_AMR-WB
FR_AMR-WB	compatible	compatible	compatible	compatible
UMTS_AMR-WB	compatible	compatible	compatible	compatible
OFR_AMR-WB	compatible	compatible	compatible	compatible
OHR_AMR-WB	compatible	compatible	compatible	compatible

Second Change

11.6.2 Preference List of TFO candidates

The preference list of TFO candidates orders all possible TFO combinations~~configurations~~ according to the speech quality they provide.

Table 11.6.2-1: Codec Type Combination Preference List, Part 1

distant → ↓ local	OFR_AMR-WB	UMTS_AMR-WB	FR_AMR-WB	OHR_AMR-WB
OFR_AMR-WB	**1**	**2**	**4**	**7**
UMTS_AMR-WB	symmetric	**3**	**5**	**8**

FR_AMR-WB	symmetric	symmetric	**6**	**9**
OHR_AMR-WB	symmetric	symmetric	symmetric	**10**

For AMR-WB the preference is determined by the OACS: A combination with the highest mode in the OACS has preference. If the highest mode in OACSs for at least two combinations is identical, then the preference level as given in Table 11.6.2-1 shall decide.

Examples:
The configuration (OFR_AMR-WB, UMTS_AMR-WB, OACS={6,60, 8,85, 12,65, 23,85}) is preferred to (OFR_AMR-WB, OFR_AMR-WB, OACS={6,60, 8,85, 12,65, 15,85}).
The configuration (OFR_AMR-WB, OFR_AMR-WB, OACS={6,60, 8,85, 12,65}) is preferred to (OFR_AMR-WB, UMTS_AMR-WB, OACS={6,60, 8,85, 12,65}).

Table 11.6.2-2 Codec Type Combination Preference List, Part 2

distant → ↓ local	**UMTS_AMR_2**	**FR_AMR**	**UMTS_AMR**	**OHR_AMR**	**HR_AMR**
UMTS_AMR_2	**11**	**12**	~~**14**~~ **15** (Note)	**17**	**20**
FR_AMR	symmetric	**13**	Not compatible	**18**	**21**
UMTS_AMR	symmetric	Not compatible	~~**15**~~ **14**	Not compatible	Not compatible
OHR_AMR	symmetric	symmetric	Not compatible	**19**	**22**
HR_AMR	symmetric	symmetric	Not compatible	symmetric	**23**

Note: only for single mode ACSs

Table 11.6.2-3 Codec Type Combination Preference List, Part 3

distant → ↓ local	**GSM_EFR**	**GSM_FR**	**GSM_HR**
GSM_EFR	**16**	Not compatible	Not compatible
GSM_FR	Not compatible	**24**	Not compatible
GSM_HR	Not compatible	Not compatible	**25**

All other possible codec type combinations not listed in these table 11.6.2.3-1/2/3 are not compatible.

The codec type FR_AMR-WB is preferred to the AMR-NB codec types, because it still provides significantly better speech quality.

The two equivalent combinations FR_AMR-WB ⇔ UMTS_AMR-WB and UMTS_AMR-WB ⇔ FR_AMR-WB should not exist in parallel, because these two AMR-WB codec types are not offered by one side simultaneously.

The speech quality of some AMR-WB codec type combinations involving FR_AMR-WB, UMTS_AMR-WB and OHR_AMR-WB are very similar. Therefore within category 1 the OACSs of the possible combinations are evaluated. For details on this evaluation see clause 12.3.2.2 .

The codec type UMTS_AMR_2 is the most preferred AMR-NB codec type, because it is compatible with all other AMR codec types. ~~Note: Whenever UMTS_AMR_2 is available, then the UMTS_AMR and FR_AMR shall not be included in the Codec_List, see Annex F (Operator¥s Guide).~~

The codec type FR_AMR is preferred to UMTS_AMR because UMTS_AMR is not compatible with FR_AMR and HR_AMR.

3GPP TSG-SA WG4 Meeting #33 ***S4-040621***

Helsinki, Finland. 22th to 26th November 2004.

CR-Form-v7.1

CHANGE REQUEST

⌘ **28.062** **CR** **044** ⌘ **rev** **-** ⌘ Current version: **6.0.0** ⌘

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

Proposed change affects: | UICC apps⌘ ☐ ME ☐ Radio Access Network **X** Core Network **X**

Title:	⌘	TFO/TrFO Compatibility of UMTS_AMR and UMTS_AMR2
Source:	⌘	TSG-SA WG4
Work item code:	⌘	TrFO-OoBTC
Date:	⌘	2004-12-14
Category:	⌘	**A**
Release:	⌘	Rel-6

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

Use one of the following releases:
Ph2 (GSM Phase 2)
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R99 (Release 1999)
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Rel-5 (Release 5)
Rel-6 (Release 6)
Rel-7 (Release 7)

Reason for change: ⌘ **Essential correction**

TS 26.103 (4.3.0, 5.5.0, 6.0.0) states:

ìFor the UMTS AMR2 this Codec Mode Adaptation can be performed every 20ms for the downlink traffic channel, but only every 40ms for the uplink radio channel. Ö
By this definition the UMTS AMR2 Codec Type is TFO and TrFO compatible to the FR AMR, HR AMR, UMTS AMR and UMTS AMR2 Codec Types.î

TS 28.062 (4.5.0, 5.4.0, 6.0.0) states:

Table 11-1: Compatibility of AMR Codec Types

distant → ↓ local	UMTS_AMR_2	UMTS_AMR	FR_AMR	HR_AMR	OHR_AMR
UMTS_AMR_2	compatible	compatible	compatible	compatible	compatible
UMTS_AMR	compatible	compatible	-	-	-
FR_AMR	compatible	-	compatible	compatible	compatible
HR_AMR	compatible	-	compatible	compatible	compatible
OHR_AMR	compatible	-	compatible	compatible	compatible

The UMTS_AMR_2 is the preferred Codec Type for 3G systems.

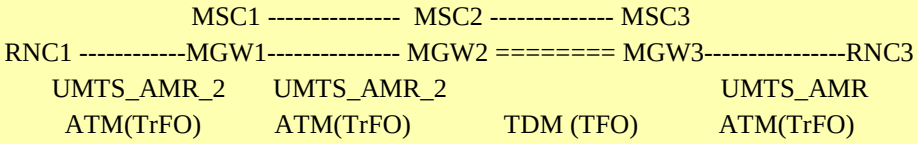
TS 23.153 (4.10.0 and 5.8.0) states:

> "The UMTS_AMR_2 is a superset of the UMTS_AMR. It behaves as a FR_AMR codec in the UL and as a UMTS_AMR codec in the DL. This allows UMTS terminals to operate in TFO with GSM terminals. The UMTS_AMR_2 is fully compatible with UMTS_AMR in TFO and TrFO and fully compatible with R99 CN nodes (TC in MGW)."

In other words: UMTS_AMR_2 is TFO/TrFO compatible to UMTS_AMR and FR_AMR; but UMTS_AMR and FR_AMR (indeed all GERAN versions) are not compatible.

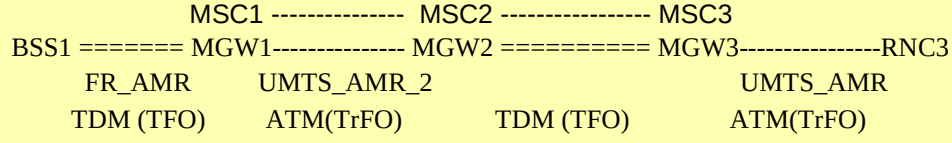
These statements are true for end-to-end TFO scenarios and end-to-end TrFO scenarios with these two Codec Types. But this may cause problems in a more complex networks supporting TFO/TrFO interworking, as explained in the following:

Let us assume that a call is set up from an UE1 served by RNC1 towards an UE3 served by RNC3. UE1 supports UMTS_AMR_2, UE3 only UMTS_AMR. For the first part of the connection, UMTS_AMR_2 is negotiated via BICC OoBTC. MSC2/MGW2 and MSC3/MGW3 are connected via a TDM link and may belong to different PLMNs. Nevertheless, all the MSCs are configured so that the same active codec mode set (ACS) is selected both for UMTS_AMR_2 and UMTS_AMR.



When the TFO peer entities in MGW2 and MGW3 exchange the locally used codec types and codec configurations via TFO in-band signalling, they will come to the conclusion that immediate TFO operation is possible, since UMTS_AMR and UMTS_AMR_2 are termed ìTFO compatibleî. The result will be an concatenation of tandem free and transcoder free links: it will be end-to-end transcoding free.
(Note that according to TS 29.232, MSC2 and MSC3 will not be informed that TFO operation was actually successfully established. Furthermore, MSC2 will not be informed that MGW3 is actually using UMTS_AMR, unless MSC2 explicitly asked MGW2 for a list of all distant codecs.).
So far so good.

But now:
Subsequently, UE1 performs an inter-system handover to GERAN. The new codec assigned by BSS1 is FR_AMR, again with the same ACS. Now, the TFO peer entities in BSS1 and MGW1 start TFO in-band signalling and go to immediate TFO operation, since FR_AMR and UMTS_AMR_2 are TFO compatible. So we end up with a **concatenation of links using FR_AMR, UMTS_AMR_2 and UMTS_AMR**. With the information locally available at MSC1/MGW1 and MSC2/MGW2, both nodes come to the conclusion that TFO/TrFO is possible, but **end-to-end, FR_AMR and UMTS_AMR are not compatible**. Since the UMTS_AMR codec does not comply with the rate control rules of the FR_AMR codec, the result will be a higher frequency of bad speech frames in downlink direction towards UE1. This can seriously **deteriorate the speech quality**.



For a solution to avoid this kind of path configuration it should be taken into account that

a) apart from R99 'UMTS only' UEs, all other UTRAN capable UEs support the UMTS_AMR_2. And it can be expected that R99 'UMTS only' UEs will soon become a small minority. Therefore, calls without involvement of an UMTS_AMR codec should be affected by the solution as little as possible.

   For this reason we do not want to require MSC1 to perform a codec modification or mid-call codec negotiation on the link between MGW1 and MGW2 after each inter-system handover of UE1, since such a requirement would apply to any call using AMR codecs. But codec changes in the core network should be avoided, if possible, since each re-initialization of the user plane will cause a short interruption of the speech transmission. Furthermore, such a requirement would create an unnecessarily high signalling load between MSC1 and MSC2 and their associated MGWs. And, most important to note: a transcoder would have to be inserted somewhere in the path.

b) Nowadays, many operating UMTS networks use the UMTS_AMR codec only in 12.2 kbit/s single mode configuration. For AMR codecs in single mode configuration, the difference in the rate control becomes meaningless.

c) Since MSC3/MGW3 can be located in a different PLMN, anywhere in the world, it cannot be excluded that in this foreign PLMN the UMTS_AMR codec is used in a multi-mode configuration with TFO.

For these reasons we propose the following solution:

i) UMTS_AMR and UMTS_AMR_2 shall only be considered as TFO- and TrFO- compatible, when used in a single mode configuration.

In the scenario above, this would mean that for an UMTS_AMR in multimode configuration immediate TFO between MGW2 and MGW3 would not be possible. MGW2 (using the new compatibility rule, for example) would terminate the TFO-negotiation. Provided that MSC2 asked MGW2 for a list of all distant codecs , MSC2 would be informed by MGW2 that UMTS_AMR was the codec used by the distant TFO partner. It would then be up to MSC2 to take appropriate measures. (Note that a codec modification from UMTS_AMR_2 to UMTS_AMR on the link between MGW1 and MGW2 would not improve this situation, because then the FR_AMR in BSS1 and the UMTS_AMR in MGW1 are not TFO-compatible. Only the point, where the transcoder is inserted, would be shifted from MGW2 to MGW1.)

ii) Since UMTS_AMR and UMTS_AMR_2 are no longer considered as TFO/TrFO-compatible in all cases, it shall be possible to discriminate clearly between the two codecs in the BICC OoBTC signalling. I.e. the UMTS_AMR_2 codec in the Supported Codecs List or Available Codecs List shall not include also the UMTS_AMR codec.

E.g. the originating MSC might want to offer in the Supported Codecs List the preferred (multimode) configuration 1 only for UMTS_AMR_2, but not for UMTS_AMR. Then the terminating MSC should not be allowed to reply with UMTS_AMR in preferred configuration 1 (which would currently be allowed according to subclause TS 23.153, 5.6).
(Note: in order to allow TrFO connections with R99 UMTS only UEs, the originating MSC can additionally include UMTS_AMR in preferred (single) mode configuration 7 to the Supported Codecs List. Or it can include UMTS_AMR in configuration 1, then the terminating MSC may select between all offers.)

Summary of change: ⌘ i) UMTS_AMR and UMTS_AMR_2 shall only be considered as TFO- and TrFO-compatible, when used in a single mode configuration with the same mode.

		ii) UMTS_AMR and UMTS_AMR_2 are treated as fully separate codec types in BICC OoBTC signalling. I.e. the UMTS_AMR_2 codec in the Supported Codecs List or Available Codecs List no longer includes also the UMTS_AMR codec.
Consequences if not approved:	⌘	Without the change (i), the network may set up a connection consisting of links using different codecs (FR_AMR, UMTS_AMR_2, and UMTS_AMR) that cannot be combined in TFO/TrFO end-to-end (FR_AMR and UMTS_AMR), although locally, at each node, the used codecs (FR_AMR and UMTS_AMR_2, or UMTS_AMR_2 and UMTS_AMR, respectively) are TFO/TrFO compatible. Since the UMTS_AMR codec does not comply with the rate control rules of the FR_AMR codec, the result will be a higher frequency of bad speech frames in downlink direction towards the UE using the FR_AMR codec. This can **seriously deteriorate the speech quality**. Without the change (ii), it is not possible for the originating MSC to restrict the use of UMTS_AMR to single mode configurations: if the originating MSC offers UMTS_AMR_2 in a multi mode configuration the terminating MSC could select the UMTS_AMR in the same multi mode configuration as Selected Codec.

Clauses affected:	⌘	11 and 11.6.2 in TS 28.062			
Other specs affected:	⌘	**Y** / **N** **X** / ( ) ( ) / **X** ( ) / **X**	Other core specifications Test specifications O&M Specifications	⌘	TS 26.103, TS 23.153
Other comments:	⌘				

How to create CRs using this form:

Comprehensive information and tips about how to create CRs can be found at http://www.3gpp.org/specs/CR.htm. Below is a brief summary:

1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

First Change

11 TFO Decision Algorithm

The TFO decision algorithm defines the processes invoked in both transcoders in order to examine the possibility for TFO establishment. Codec Types are in general only compatible to itself.

All members of the AMR-NB Codec Type family, except UMTS_AMR, are compatible, when both Codec Types use compatible multi-mode ACSs. In any multi-mode configuration the UMTS_AMR shall be regarded as only compatible to itself, not to any other AMR-NB Codec Type, to avoid incompatibilities in TFO-TrFO-TFO interworking scenarios. In single mode configuration, UMTS_AMR and UMTS_AMR_2 are compatible, when both Codec Types use the same single rate ACS. The UMTS_AMR_2 is the preferred AMR-NB Codec Type for 3G systems.

All members of the AMR-WB Codec Type family are compatible, when both codec types use compatible multi-mode ACSs.

For the AMR Codec Type family the following tables 11-1 and 11-2 illustrate the compatible combinations (Table 11-1 for AMR-NB codec types, table 11-2 for AMR-WB codec types):

Table 11-1: Compatibility of AMR-NB Codec Types

distant → ↓ local	UMTS_AMR_2	UMTS_AMR	FR_AMR	HR_AMR	OHR_AMR
UMTS_AMR_2	compatible	compatible (Note)	compatible	compatible	compatible
UMTS_AMR	compatible (Note)	compatible	-	-	-
FR_AMR	compatible	-	compatible	compatible	compatible
HR_AMR	compatible	-	compatible	compatible	compatible
OHR_AMR	compatible	-	compatible	compatible	compatible

Note: only for single mode ACSs.

~~The UMTS_AMR_2 is the preferred Codec Type for 3G systems.~~

Table 11-2 Compatibility of AMR-WB Codec Types

distant → ↓ local	FR_AMR-WB	UMTS_AMR-WB	OFR_AMR-WB	OHR_AMR-WB
FR_AMR-WB	compatible	compatible	compatible	compatible
UMTS_AMR-WB	compatible	compatible	compatible	compatible
OFR_AMR-WB	compatible	compatible	compatible	compatible
OHR_AMR-WB	compatible	compatible	compatible	compatible

Second Change

11.6.2 Preference List of TFO candidates

The preference list of TFO candidates orders all possible TFO combinations~~configurations~~ according to the speech quality they provide.

Table 11.6.2-1: Codec Type Combination Preference List, Part 1

distant → ↓ local	OFR_AMR-WB	UMTS_AMR-WB	FR_AMR-WB	OHR_AMR-WB
OFR_AMR-WB	**1**	**2**	**4**	**7**
UMTS_AMR-WB	symmetric	**3**	**5**	**8**

FR_AMR-WB	symmetric	symmetric	**6**	**9**
OHR_AMR-WB	symmetric	symmetric	symmetric	**10**

For AMR-WB the preference is determined by the OACS: A combination with the highest mode in the OACS has preference. If the highest mode in OACSs for at least two combinations is identical, then the preference level as given in Table 11.6.2-1 shall decide.

Examples:
The configuration (OFR_AMR-WB, UMTS_AMR-WB, OACS={6,60, 8,85, 12,65, 23,85}) is preferred to (OFR_AMR-WB, OFR_AMR-WB, OACS={6,60, 8,85, 12,65, 15,85}).
The configuration (OFR_AMR-WB, OFR_AMR-WB, OACS={6,60, 8,85, 12,65}) is preferred to (OFR_AMR-WB, UMTS_AMR-WB, OACS={6,60, 8,85, 12,65}).

Table 11.6.2-2 Codec Type Combination Preference List, Part 2

distant → ↓ local	**UMTS_AMR_2**	**FR_AMR**	**UMTS_AMR**	**OHR_AMR**	**HR_AMR**
UMTS_AMR_2	**11**	**12**	~~**14**~~ **15** (Note)	**17**	**20**
FR_AMR	symmetric	**13**	Not compatible	**18**	**21**
UMTS_AMR	symmetric	Not compatible	~~**15**~~ **14**	Not compatible	Not compatible
OHR_AMR	symmetric	symmetric	Not compatible	**19**	**22**
HR_AMR	symmetric	symmetric	Not compatible	symmetric	**23**

Note: only for single mode ACSs

Table 11.6.2-3 Codec Type Combination Preference List, Part 3

distant → ↓ local	**GSM_EFR**	**GSM_FR**	**GSM_HR**
GSM_EFR	**16**	Not compatible	Not compatible
GSM_FR	Not compatible	**24**	Not compatible
GSM_HR	Not compatible	Not compatible	**25**

All other possible codec type combinations not listed in these table 11.6.2.3-1/2/3 are not compatible.

The codec type FR_AMR-WB is preferred to the AMR-NB codec types, because it still provides significantly better speech quality.

The two equivalent combinations FR_AMR-WB ⇔ UMTS_AMR-WB and UMTS_AMR-WB ⇔ FR_AMR-WB should not exist in parallel, because these two AMR-WB codec types are not offered by one side simultaneously.

The speech quality of some AMR-WB codec type combinations involving FR_AMR-WB, UMTS_AMR-WB and OHR_AMR-WB are very similar. Therefore within category 1 the OACSs of the possible combinations are evaluated. For details on this evaluation see clause 12.3.2.2 .

The codec type UMTS_AMR_2 is the most preferred AMR-NB codec type, because it is compatible with all other AMR codec types. ~~Note: Whenever UMTS_AMR_2 is available, then the UMTS_AMR and FR_AMR shall not be included in the Codec_List, see Annex F (Operator¥s Guide).~~

The codec type FR_AMR is preferred to UMTS_AMR because UMTS_AMR is not compatible with FR_AMR and HR_AMR.