Source : **Nortel Networks**

Title : **Characterisation test plan and Error patterns for UTRA FDD**

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1. Introduction

TSG-S4 has asked TSG-R1, TSG-R2 and TSG-R3 in [1] to provide information of the support of the speech service over the Radio Access Network in order for them to complete the AMR Speech Codec specifications in time for the approval of the 3GPP Release 99. Additionally, SA4 asked TSG-R1 to approve a representative set of operational conditions , the corresponding error patterns to perform characterization testing being derived by S4 and provided for approval to RAN WG1. That request from SA4 led to the creation of the joint RANWG1/SA4 group that is meeting for the first time at this specific meeting. In the mean time exchange of information took place between RAN WG1 and SA4 on the support of AMR and the set of tools provided by the physical layer to support AMR [1][2][3] and constraints on how to configure these.

In this document we would like to go into more details on the error pattern generation, highlighting which parameters to configure for all allowed mappings. We also address the issue of the definition of a set of operational conditions defined in terms of environments, speed, SIR patterns by describing a proposal for a possible set of realistic scenarii to start the definition of the characterization testing.

2. References

[1]: LS to TSG-R1, TSG-R2 and TSG-R3, “Support of Speech Service in RAN”, TSG-S4 Codec Working Group, TSGR1#6(99)803

[2] : R1-99e31, Liaison statement on Support of Speech Service in RAN, from RAN WG1,

[3] : **R1-99e32**, Liaison statement on Support of Speech Service in RAN for FDD, from RAN WG1, , To SA 4, TSG-R2, TSG-R3, TSG-R4, TSG-RAN, TSG-T2.

[4] : **R1-99e51**, Liaison statement on Support of Speech Service in RAN, from RAN WG4, , To RAN WG1, copy : TSG-R2, TSG-R3, TSG-R4

[5] : 25.212

[6] : **R1-99g24**, A draft answer to the liaison statement regarding SSDT, NEC

[7] : B-99-255 ETSI SMG11 "AMR Characterisation Report"

[8] : S4-99-273 "AMR speech quality function of FER/RBER", Bell South Mobility DCS

[9] : S4 LS to TSG-R1 “Response to the TSG-R1 LS on Speech Services” Tdoc 185R/99, TSG-S4#3, March 24-26, 1999, Yokosuka, Japan

[10] : S4 LS to ETSI SMG11 SQ “ Inputs for the preparation of the AMR 3G Characterisation Test Plan ” Tdoc S4-158/99

3. Error patterns

3.1 Definition of error patterns

It is our understanding that error patterns to be considered for the characterisation test will be similar to error pattern used for the static tests in GSM. This means that the error patterns will correspond to soft bits errors at the output of the demodulator/Rake receiver. When performing the characterisation tests, the error pattern will be applied on the flow of encoded data bits before channel decoding and speech decoding operations. If TFCI is used rather than Blind transport format detection then error patterns will also concern the TFCI bits .

The use of error patterns is illustrated in the figure below :

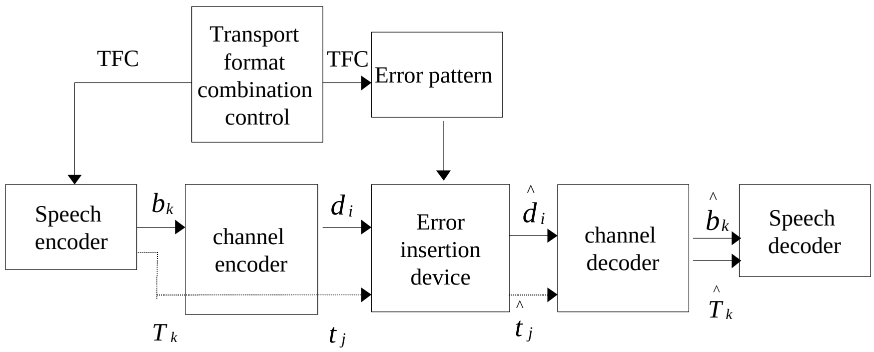

Fig-1 : Use of error patterns for the Static tests

where

- b_k are the speech bits corresponding to the AMR mode for the selected Transport format combination (TFC).
- d_i are the data bits resulting from the encoding of b_k
- T_i corresponds to the 6 bit TFCI information for the selected TFC
- t_j are the result of the encoding of the bits T_i, through the bi-orthogonal code (This will only if TFCI bits are used)
- $\hat{d}_i$ are the data bits at the output of the demodulator/rake receiver and correspond to the XOR of d_i with the soft bit error as contained from the error pattern.
- $\hat{t}_j$ are the estimated TFCI bits at the output of the demodulator/Rake receiver. They correspond to the application of the error patterns on the t_j bits
- $\hat{T}_i$ corresponds to the decoded/estimated TFC information for the selected TFC. This correspond either to the decoding of the $\hat{t}_j$ bits or the estimation of the TFC from the data bits themselves when Blind transport format detection is applied.
- $\hat{b}_k$ are the decoded speech bits

A block transport format control is included in the diagram. This is to identify that different error patterns may be used in the same test. An error pattern is associated to a given Transport format combination (TFC). As explained in the following when the TFC changes a number of physical layer parameters can vary, such as the gain factor between the DPDCH, and DPCCH, the spreading factor, the slot format. The TFC can vary in a number of cases :

- If VAD/DTX is part of the test
- If Compressed mode is part of the test

3.2 Set of parameters to define error patterns

As indicated in [2][3], the physical layers provides a set of tools which can be configured for the support of speech, the tools being defined in a very generic way. In this section we list the parameters which should be set to generate the error patterns. The set of allowed parameters will effectively define the number of error patterns types to be produce for each operational conditions to test.

3.2.1. Uplink/downlink

The mapping is not symmetrical in downlink and uplink as will be further clarified below. As a consequence error pattern should be produced for both directions and clearly flagged as applying for the up or downlink.

3.2.2. Bits for which error pattern are to be produced

Error pattern should be produced for the DPDCH field and for the TFCI bits when applicable (that is to say when TFCI is used). If DTX is applied on part of the DPDCH which is the case on the downlink, then only part of these error indication will effectively been used.

3.2.3. Slot structures

The error patterns are to be produced for different slot structures. A slot structure is defined by a number of the number of bits in each of the following fields : TFCI, FBI (for uplink only), pilot bits and data bits. There are two separate sets of slot structures for compressed frames and normal frames.

a) TFCI/BTFD – Fixed position/flexible position

In the downlink TFCI (Transport format combination indicator) can be inserted in the DPCCH field or can be absent. In the later case Blind Transport Format Detection (BTFD) is to be applied at the UE and two cases can be further considered, fixed position or dynamic position. The use of fixed vs. Flexible position does not impact the error pattern themselves which are to be produced for the data bits and are not related to the mapping itself. There has be not agreement so far on the restriction in terms of usage of TFCI vs. BTFD therefore both cases should be considered for the production of error patterns.

For the uplink, the TFCI is to be inserted when there is more than 1 transport format combination in the transport format combination set. This will typically be the case for AMR since each AMR mode corresponds at least to one transport format combination, and possibly more when considering more when dedicated signalling can be transmitted together with speech. Therefore for the uplink, the use of TFCI will be assumed and error patterns are to be produced for that case only.

b) Spreading factors

For the downlink proposal for the mapping of AMR have been made for SF=256 and SF=128. For SF=256 the set of AMR modes possible to be mapped onto SF=256 is restricted. The spreading factor and more generally the slot structure remains unchanged from frame to frame whatever transport format combination is used apart from compressed frames that may rely on a separate slot format (different SF) if method B of compressed mode is used. [5]

For the uplink, the spreading factor can be dynamically changed for the DPDCH part as a function of the Transport format combination**.** Whereas the SF of the DPCCH is fixed and equal to 256, the minimum set of SF to consider for the DPDCH should be 256, 128 as a minimum.

c) FBI bits

The inclusion of FBI bits applies only for the uplink. FBI bits were introduced to provide a feed-back signalling channels for the support of downlink transmit diversity with feed-back and/or Site selection transmit diversity. FBI bits are obtained by the reduction of the number of pilot bits. Although the slot with and without FBI do not lead to the same performance, the difference is expected to be small

d) Compressed frame vs. Normal frames

A separate set of slot formats is defined for compressed frames vs. Normal frames for both up and downlinks, that set ensuring that there is a minimum of 32 TFCI bits whatever the number of idle slots in the radio frame. Error patterns may cover the whole radio frame, but only some slots in these frames would be effectively used depending on the compressed mode parameters as follows :

- the number of idle slots per frame
- the position of the idle slots
- the compressed mode pattern, that is to say the periodicity scheme for the compressed frames
- the compressed mode method (indeed for method B this means that the SF is dynamically changed for the downlink).

Since only some frames are compressed, then multiple error patterns would be run at the same time, and used in an alternate way.

e) Downlink transmit diversity/beam forming – number of pilot bits

The use of downlink transmit diversity or beam forming impact the number of dedicated pilot bits in the downlink Number of pilot bits

3.2.4. Gain factors

For the uplink a gain factor is applied between the DPDCH and DPCCH. The gain is a function of the transport format combination and is set at radio link set-up. For a given transport format combination set configured at radio link set up there can be as many gain factors use as Transport Format Combination. There is a set of 16 gain factors defined in 25.213. At maximum all of these gain factors should be considered, which means 16 error patterns, just to reflect the allowed cases of distribution of energy between the DPDCH and DPCCH, for each slot structure for the DPDCH.

For the downlink, gain factor may also be used between the different fields in the DPCCH and DPDCH. It is still to be clarified whether these fields can be dependent on the TFC or not. The range of the fields is still unclear. However error pattern should reflect what is currently allowed or anticipated in terms of power offsets.

3.3 Summary of the set of parameters to define error patterns

A summary of parameters is given in the Table below. The set of error patterns will allow to perform static tests with and without VAD/DTX and with or without compressed mode. The set of error patterns defined by the table will have to be produced for each of the operating conditions defined in terms of environment, speed, Eb/No.

Parameters	**Cases to consider/ comments**
Up/downlink	Both links
Slot formats set	**Downlink** • Both slots with and without TFCI • Number of pilot bits: if slots for beam forming is considered then slot with higher number of pilot bits to consider in addition to the slot with 2 pilot bits • Slots format for normal frames as a minimum and slot formats for compressed frames if compressed mode considered • SF= 128 and SF=256 in, and SF=64 for compressed mode for compressed mode method B if applicable **Uplink** • Slot format with TFCI, without FBI (unless intention to test SSDT or Closed loop Dl transmit diversity) • Slots format for normal frames as a minimum and slot formats for compressed frames if compressed mode considered • SF= 128, 256 for DPDCH for both normal mode and compressed mode
Gain factors	**Downlink** • Gain factors are allowed on the downlink **Uplink** • all 16 allowed gain factors to consider

4. Characterisation test plan

The objective of the characterisation of AMR is to give a set of performance results in terms of subjective quality regarding the basic speech service over UTRA in FDD mode. The same testing will be conducted for the TDD mode and the multimedia services later. These performance results obtained for certain conditions will provide a basis for operators and constructors to choose their Radio Access Network adequate tuning and parameterisation in order to offer a certain quality of service. This is the beginning of a full characterisation of the AMR in 3G systems

The following is a proposal for the subset of the communication scenarii with AMR over UTRA describing the type of radio conditions and the layer 1 parameter's settings to produce the adequate error patterns as well as the appropriate channel coding. Then, we describe a proposal for experimental conditions to be tested during the characterisation.

4.1 Definition of parameters for the generation of error patterns

The set of error patterns needed for the characterisation phase is not covering all cases since it would lead to a much too high number of testing conditions. In the following we give proposals to extract a subset of these possible error patterns. This does not preclude the possibility for the committee to produce error patterns in more cases as a support for future development.

4.1.1. Radio Propagation Link parameters :

The radio propagation conditions for the UTRA FDD access are set according to what should be the highest proportion of speech traffic at the start of the introduction of the UTRA.

a) UE speed : 3km/h (outdoor) and 50km/h (indoor vehicular)

b) Environment : Urban propagation model

c) SIR targets and SIR :

The definition of the SIR targets and SIR has to be addressed. See section 4.2.2 a.

4.1.2. Layer 1 parameters :

Layer 1 parameters are set in accordance to RAB attributes and radio constraints to provide the quality of service asked.

a) Power Control

At least the inner power control loop must be enabled during the pattern generation. The outer loop which calculates the SIR target is not enabled. Therefore, a different error pattern will be produced for each SIR target used in the test. It is not clear if a static SIR target is suitable for the propagation conditions. If it is not, a solution might be to use ideal power control.

b) No compressed mode

In order to reduce the number of cases of error conditions, we suggest to limit the testing to the normal mode.

c) One slot structure for downlink :

Again, in order to reduce the number of cases of error conditions, we suggest to limit the testing to one slot structure and one transport format detection scheme, i.e. the explicit transport format detection using TFCI bits.

(1) With TFCI bits (no BTFD)

(2) 2 pilot bits

d) One slot structure for uplink :

Same as downlink.

(1) With TFCI

(2) 2 pilot bits

(3) no FBI bits

e) Gain factors :

The gain factors are set by the layer 1 differently for each TFC. All patterns corresponding to the used gain factors will have to be produced.

f) No downlink transmit diversity/beam forming

This is in line with the fact that only one slot structure is used.

g) Spreading factor of 256 for a subset of AMR modes

It has been shown that not all the AMR modes would fit using a SF of 256. Only the subset : VAD/DTX, 4.75, 5.15, 5.9, 6.7, and 7.4 are matching SF 256 with TFCI.

h) Spreading factor of 128 for all AMR modes

All AMR modes including the SID mode fit in an SF of 128.

i) Channel Coding

The channel coding used for the transport of the AMR speech frames during the characterisation should follow an Unequal Error Protection scheme since it is agreed that it would provide some gain.. The exact channel coding has no impact on the error pattern generation. It is part of the TFC attributes. We give in section 5.3 some guidelines for the design of such a scheme.

4.2 Realistic communication scenarii

The aim is to set communication scenarii that will be probably matching the first operational conditions :

Connection with a fixed access

Connection with another UTRA FDD

Connection with a BSS GSM with FR or HR

For all cases, since the quality with mode switching between AMR modes has already been assessed in the GSM system, there is no need to test the communication with the - network or radio - adaptation turned-on on the UTRA FDD side. Anyhow, it is to be discussed whether the adaptation should be turned on when the GSM BSS is on one side with no TFO.

We identified the following communication scenarii :

- Scenario A : UTRA FDD <--> CN (TC- TC) <--> Fixed access
- Scenario B : UTRA FDD 1 <--> CN (TC- TC) <--> UTRA FDD 2
- Scenario C : UTRA FDD 1 <--> CN (no transcoding) <--> UTRA FDD 2
- Scenario D : UTRA FDD <--> CN (TC- TC) <--> GSM BSS in Full Rate mode
- Scenario E : UTRA FDD <--> CN (No transcoding) <--> GSM BSS in Full Rate mode

4.3 Channel coding example definition

To design an example channel coding scheme suitable for the AMR transport over the UTRA FDD, target BER have to be set for each mode and each protection class of the AMR mode. This problem has already been addressed in a LS to R1 [9]. The FER requirement was then set to 0.5% considering class A of any AMR mode.

We can also use for example the results given by the AMR characterisation in GSM with the FER/RBER performance results given by the GSM AMR channel coding to derive more precise targets for different AMR Mode. These results were compiled in [8]. We give here the maximum FER figures for class 1a bits (equivalent to class A bits to avoid any speech degradations compared to the same mode without errors -I.e. to obtain the maximum quality for the current mode rate-.

These value should be taken as guidelines for the design of the channel coding. They don't "guarantee" the level of quality if they are met.

	Maximum allowable FER over Class A bits	Maximum allowable FER over Class A bits	Maximum allowable FER over Class A bits
AMR Mode rate	(around - 0.1 DeltaMOS) for clean speech	(around - 0.25 DeltaMOS) for car noise	Maximum FER
12.2 kbps	0.1%	0.7%	0.1%
10.2 kbps	0.5%	0.8%	0.5%
7.95 kbps	0.2%	1.0%	0.2%
7.4 kbps	0.1%	0.5%	0.1%
6.7 kbps	0.1%	0.8%	0.1%
5.9 kbps	0.6%	0.6%	0.6%
5.15 kbps	0.9%	0.1%	0.1%
4.75 kbps	0.2%	0.2%	0.2%

For the design of the channel coding we suggest that the TrCH follow the mapping of error protection classes when the target BER are different. That way, only 3 TrCH would be defined for each rates. Moreover, because adaptation is not turned-on, for the sake of simplicity, we suggest to align the channel coding to the most demanding rate so that only 3 TrCh would be defined for all rates (same coding rate) differing only in the number of bits. In order to perform error detection, an 8 bits CRC should be included in the TrCh that corresponds to class A.

4.4 Definition of experiments

The aim is to concentrate on performances over 3G channels. So, the parameter of interest is more the sensitivity to 3G error prone channels than the quality of the AMR codec itself. As stated in [10], some of the AMR codec performances obtained from its characterisation in GSM [7] are independent of the system. In particular, results for experiments : "Exp. 6 Influence of the input speech level and tandeming" and "Exp. 2 Interoperability performances" were obtained in error free conditions. This hopefully will help to reduce the number of experiments needed.

Though a first list of experiments was given in [10] that covered FDD Mode, TDD Mode and Multimedia services, we provide here another version of the experiment list that concentrates on the UTRA FDD mode and the interoperability with other systems. The UTRA TDD Mode will be tackled later as well as the AMR for the multimedia services.

The aim is to assess performances in clean speech, in background noise, under several error conditions, with AMR VAD1 DTX and AMR VAD2 DTX, with tandeming of codecs or TFO or TrFO.

Experiment	Description
Experiment 1	Performance of the AMR speech codec modes under clean speech and UTRA FDD error conditions with VAD/DTX on. Communication scenario A : UTRA FDD <->CN<->Fixed Access SF 128 for AMR122 to AMR475 SF 256 for AMR 74 to AMR475 No errors and several SIR Urban : Outdoor 3kmph and/or and 50 kmph vehicular model Uplink and Downlink
Experiment 2a	Performance of the AMR speech codec modes under car background noise and UTRA FDD error conditions. Communication scenario A : UTRA FDD <->CN<->Fixed Access SF 128 for AMR122 to AMR475 SF 256 for AMR 74 to AMR475 No errors and several SIR Urban : 50 kmph vehicular model Uplink only
Experiment 2b	Performance of the AMR speech codec modes under street background noise and UTRA FDD error conditions. Communication scenario A : UTRA FDD <->CN<->Fixed Access SF 128 for AMR122 to AMR475 SF 256 for AMR 74 to AMR475 No errors and several SIR Urban : Outdoor 3kmph Uplink only
Experiment 3a	Performance of the AMR speech codec modes under street background noises, UTRA FDD error conditions in tandem conditions. Communication scenario B : UTRA FDD <->CN<-> UTRA FDD with transcoding in CN Communication scenario D : UTRA FDD <->CN<-> GSM BSS Full Rate with transcoding in CN Mode combinations (same and different mode for the two sides) : - SF 128 for AMR122 to AMR475 - EFR, FR, AMR122 to AMR475 in GSM FR channel [with adaptation turned-on when in AMR] No errors and several SIR on UTRA FDD sides No errors and C/I = 7, 10, 13dB on GSM FR BSS side (TU 3km/h Ideal FH) Urban : Outdoor 3kmph Uplink and Downlink
Experiment 3a	Performance of the AMR speech codec modes under street background noises, UTRA FDD error conditions in tandem free operation conditions. Communication scenario C : UTRA FDD <->CN<-> UTRA FDD with no transcoding in the CN Communication scenario E : UTRA FDD <->CN<-> GSM BSS Full Rate with no transcoding in the CN Mode combinations (same mode for the two sides): - SF 128 for AMR122 to AMR475 - AMR122 to AMR475 in GSM FR channel No errors and several SIR on UTRA FDD sides No errors and C/I = 7, 10, 13dB on GSM FR BSS side (TU 3km/h Ideal FH) Urban : Outdoor 3kmph Uplink and Downlink

5. Conclusion

This contribution identifies a number of parameters to take into account when producing the error patterns in addition to what was considered for GSM testing and set of values to take for each of these parameters

Agreement needs to be reached on several assumptions for the link level simulator that will generate the error patterns. The modelling of power control is one of the topics but other topics are also to be considered (number of Rake receiver fingers...).

This contribution also addresses the issue of the characterisation testing and the choice of parameters and communication scenarii.