TSGS#10(00)0580
Agenda Item: 7.4.3

Approval of Deliverables from the 3G AMR-NB testing laboratories

Presentation to:	**TSG SA Meeting #10**
Document for presentation:	**Deliverables from the 3G AMR-NB testing laboratories**
Presented for:	**Approval**
Agenda Item:	**7.4.3**

Title of document: Deliverables from the 3G AMR-NB testing laboratories

Content of the document:

This document contains the Deliverables from the 3G AMR-NB testing laboratories.

All Deliverables have been already agreed by TSG-SA WG4#14 Plenary Meeting.

The approval of the Deliverables related to the 3G AMR-NB exercise, is requested to TSG-SA#10 Plenary, being a necessary step (approval to be minuted in the TSG-SA#10 Plenary Report), to start the procedure of payment, c/o of ETSI, of the laboratories that performed the work, for a total budget of 60 kEURO (project funded by 3GPP PCG in 1999, now completed).

TSG-SA WG4 will include the main results in TR 26.975.

List of Deliverables:

TD S4-000628 **AMR-NB 3G Characterisation - Host Laboratory Report (ARCON)**

TD S4-000587 **AMR-NB 3G Characterization - Experiment 1A Results, (Dynastat Inc.)**

TD S4-000561 **AMR-NB 3G Characterization - Experiment 1B Results (LMGT)**

TD S4-000645 **AMR-NB 3G Characterization - Experiment 1C Results (NTT-AT)**

TD S4-000627 **AMR-NB 3G Characterisation - Experiment 2A Results (ARCON)**

TD S4-000629R **AMR-NB 3G Characterisation - Global Analysis (revised, ARCON)**

3GPP TSG-S4#14 meeting *Tdoc. S4 (00)0628*
Nov.27-Dec.1, 2000, Bath, UK

Title: **AMR-NB 3G Characterization Host Laboratory Report**

Source*: **ARCON Corp.**

Summary

This document provides an overview of the Host Laboratory effort undertaken by ARCON Corp. for the AMR-NB 3G Characterization Test effort. Issues concerning the test plan [1] or processing documentation [2] and problems that affected the overall schedule are discussed.

1. Introduction

ARCON Corporation was the Host Laboratory for the AMR-NB 3G Characterization Test effort. ARCON processed source material for two experiments through the TS 26.073 V.3.1.0 AMR-NB speech codec as well as reference coders and calibration systems. The Host Laboratory function was defined in the AMR-NB 3G Characterization Test Plan [1]. ARCON performed the Host Laboratory function in full compliance to the latest version of this document. Host Lab activity was organized in 3 phases: pre-processing, processing, and post processing.

Table 1 summarizes materials received by ARCON. Table 2 summarizes materials delivered by ARCON.

Table 1: Deliverables provided to ARCON as input for the Host Laboratory function

Source	***Transfer Method***	***Received***	***Purpose/Comments***
Pre-processing phase			
ARCON	FTP	05-Oct	Preprocessed English Input Material – Exp_2
Dynastat	Passwd email	06-Oct	Preprocessed English Input Material – Exp_1A
LMGT	FTP	05-Oct	Preprocessed Korean Input Material – Exp_1B
NTT-AT	FTP	15-Oct	Japanese Input Material – Exp_1C
Other materials			
AMR NB Codec – 3GPP	FTP	10-Oct	
Noise files – ETSI			Same Files as used in AMR-NB Characterization
EFR Error Patterns – ETSI			Same Files as used in AMR-NB Characterization
Error Patterns and EID – NTT DoCoMo	FTP & email	05-Oct	
Error Patterns – Nortel	FTP & email	09-Oct	

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Table 2: Materials delivered by ARCON as part of the Host Laboratory function

Destination	*Transfer Method*	*Sent*	*Purpose*
Listening Labs			
ARCON	CD-R	20-Oct	Processed English Test Material – Exp_2
Dynastat	CD-R	20-Oct	Processed English Test Material – Exp_1A
LMGT	CD-R	20-Oct	Processed Korean Test Material – Exp_1B
NTT-AT	CD-R	20-Oct	Processed Japanese Test Material – Exp_1C

2. Pre-Processing and Input Deliverables

Pre-processed speech and noise material was received as 16kHz sampled, 16 bit, PCM format files in Intel/PC byte order. Noise material for Experiment 2 was preprocessed and added to the speech. All pre-processing took place on an Intel/PC platform under MS-DOS. 8Khz sampled pre-processed files were produced.

The Host Lab performed the preprocessing of the Japanese material.

3. Processing Effort

Processing scripts for the main processing were based on the Test Plan [1]. Ambiguities were resolved between the Host Lab and the test plan editors throughout the Host Lab process. These resolutions included but were not limited to:

Preliminary Stimulus and Conditions – The MNRU preliminary conditions were changed to using noisy input for Exp_2 to be consistent with the MNRU test conditions. Talker/Stimulus assignments were modified to ensure the use of all talker and stimuli assigned to preliminary conditions. The EFR coder with an EP7 error pattern replaced the FR coder that was in the preliminary list but not contained in the body of the test.

Noise File Mapping – The assignment of noise files to talkers

Test Conditions – A duplicate test condition number was found for Exp_2. In order to keep presentation orders and the correct number of test conditions, the G726 coder was removed from the test.

Processing calls – A redundant scaling call (scaldemo) was removed from the Processing functions document.

All processing took place on a Win98/PC platform. A systematic approach was taken to develop scripts that accomplished all processing steps. Systems were continually backed-up to assure that no data would be lost. The scripts produced output logs that could be referenced.

3.1 Error Conditions

The majority of this host Lab effort involved the application of channel error patterns to the various AMR modes. Tables 3-6 show the type of error patterns and the source by Experiment. These error patterns were supplied for the various rates of the AMR codec. Table 7 shows the mapping of error patterns to the AMR codec rates. The use of two different labs to produce the error patterns resulted in a slightly different naming convention for the Exp_2 error patterns (ECxD_aaa.ep and Ecx2_aaa.ep). Fortunately, both file-naming conventions were unique and it was a simple matter to determine the files that were appropriate for a given condition.

Table 3: Error conditions for Experiment 1, sub-experiment A

EC	Direction	Path Profile	Speed	Target	Source
EC1A	Uplink	Vehicular-B	50 km/h	0.5% FER	Nortel Networks
EC2A	Uplink	Vehicular-B	50 km/h	1% FER	Nortel Networks
EC3A	Uplink	Vehicular-B	50 km/h	3% FER	Nortel Networks
EC4A	Downlink	Vehicular-B	120 km/h	0.5% FER	NTT DoCoMo
EC5A	Downlink	Vehicular-B	120 km/h	1% FER	NTT DoCoMo
EC6A	Downlink	Vehicular-B	120 km/h	3% FER	NTT DoCoMo
EC7A	Uplink	Pedestrian-B	3 km/h	0.5% FER	Nortel Networks
EC8A	Uplink	Pedestrian-B	3 km/h	1% FER	Nortel Networks
EC9A	Uplink	Pedestrian-B	3 km/h	3% FER	Nortel Networks

Table **4:** Error conditions for Experiment 1, sub-experiment B

EC	Direction	Path Profile	Speed	Target	Source
EC1B	Downlink	Vehicular-B	50 km/h	0.5% FER	NTT DoCoMo
EC2B	Downlink	Vehicular-B	50 km/h	1% FER	NTT DoCoMo
EC3B	Downlink	Vehicular-B	50 km/h	3% FER	NTT DoCoMo
EC4B	Uplink	Indoor-A	3 km/h	0.5% FER	Nortel Networks
EC5B	Uplink	Indoor-A	3 km/h	1% FER	Nortel Networks
EC6B	Uplink	Indoor-A	3 km/h	3% FER	Nortel Networks
EC7B	Downlink	Pedestrian-B	3 km/h	0.5% FER	NTT DoCoMo
EC8B	Downlink	Pedestrian-B	3 km/h	1% FER	NTT DoCoMo
EC9B	Downlink	Pedestrian-B	3 km/h	3% FER	NTT DoCoMo

Table **5:** Error conditions for Experiment 1, sub-experiment C

EC	Direction	Path Profile	Speed	Target	Source
EC1C	Uplink	Vehicular-B	120 km/h	0.5% FER	Nortel Networks
EC2C	Uplink	Vehicular-B	120 km/h	1% FER	Nortel Networks
EC3C	Uplink	Vehicular-B	120 km/h	3% FER	Nortel Networks
EC4C	Downlink	Indoor-A	3 km/h	0.5% FER	NTT DoCoMo
EC5C	Downlink	Indoor-A	3 km/h	1% FER	NTT DoCoMo
EC6C	Downlink	Indoor-A	3 km/h	3% FER	NTT DoCoMo
EC7C	Uplink	Pedestrian-A	3 km/h	0.5% FER	Nortel Networks
EC8C	Uplink	Pedestrian-A	3 km/h	1% FER	Nortel Networks
EC9C	Uplink	Pedestrian-A	3 km/h	3% FER	Nortel Networks

Table **6:** Error conditions for Experiment 2

EC	Direction	Path Profile	Speed	Target	Source
EC1D	Downlink	Pedestrian-B	3 km/h	0.5% FER	NTT DoCoMo
EC2D	Downlink	Pedestrian-B	3 km/h	1% FER	NTT DoCoMo
EC32	Uplink	Vehicular-A	50 km/h	0.5% FER	Nortel Networks
EC42	Uplink	Vehicular-A	50 km/h	1% FER	Nortel Networks
EC52	Uplink	Vehicular-B	120 km/h	0.5% FER	Nortel Networks
EC62	Uplink	Vehicular-B	120 km/h	1% FER	Nortel Networks

Table 7: Patterns to produce for each AMR mode

	Direction	12.2	10.2	7.95	7.4	6.7	5.9	5.15	4.75
EC0	both	×	×	×	×	×	×	×	×
EC1A	Uplink	×		×		×		×	
EC2A	Uplink	×		×		×		×	
EC3A	Uplink	×		×		×		×	
EC4A	Downlink	×		×		×		×	
EC5A	Downlink	×		×		×		×	
EC6A	Downlink	×		×		×		×	
EC7A	Uplink		×		×		×		×
EC8A	Uplink		×		×		×		×
EC9A	Upink		×		×		×		×
EC1B	Downlink	×		×		×		×	
EC2B	Downlink	×		×		×		×	
EC3B	Downlink	×		×		×		×	
EC4B	Uplink		×		×		×		×
EC5B	Uplink		×		×		×		×
EC6B	Uplink		×		×		×		×
EC7B	Downlink		×		×		×		×
EC8B	Downlink		×		×		×		×
EC9B	Downlink		×		×		×		×
EC1C	Uplink	×		×		×		×	
EC2C	Uplink	×		×		×		×	
EC3C	Uplink	×		×		×		×	
EC4C	Downlink	×		×		×		×	
EC5C	Downlink	×		×		×		×	
EC6C	Downlink	×		×		×		×	
EC7C	Uplink		×		×		×		×
EC8C	Uplink		×		×		×		×
EC9C	Uplink		×		×		×		×
EC1D	Downlink		×		×		×		×
EC2D	Downlink		×		×		×		×
EC32	Uplink	×		×		×		×	
EC42	Uplink	×		×		×		×	
EC52	Uplink		×		×		×		
EC62	Uplink		×		×		×		

Table 8 shows the two additional error patterns used for the GSM-EFR reference codec. These patterns are the same as those used during the AMR-NB characterization.

Table 8: File mapping for static C/I conditions.

Condition	Error pattern file	C/I estimate file
EP7	tu3ifh07	tu3ifh07.ci
EP10	tu3ifh10	tu3ifh10.ci

Table 9 shows the mapping of car noise files to talkers as used for Exp_2. These are the same noise files as those used during the AMR-NB characterization.

Table 9: Mapping of noise files to talkers in Experiment 2

Noise Segment	Talker	File name
#1	M01	car1_msin_8-41.16k
#2	M02	car2_msin_8-41.16k
#3	F01	car3_msin_8-41.16k
#4	F02	car4_msin_8-41.16k

4. Post Processing and Output Deliverables

Post-processed material was delivered overnight on CD-R. Listening laboratories were requested to review their processed material and report any problems.

5. Conclusions, Observations and Future Recommendations

ARCON performed the Host Laboratory processing function for the AMR-NB 3G Characterization Test effort in full compliance with the latest versions of the test [1] and processing functions [2] documents. All issues that arose during the host lab process were resolved with the cooperation of the document editors.

References

[1] 3GPP TSG-SA WG4, *"Test Plan for the 3G AMR-NB Characterization",*Tdoc S4-(00)0472.

[2] 3GPP TSG-SA WG4, *"Processing Functions for AMR 3G Characterization Tests",* Tdoc S4-(00)0473.

3GPP TSG-S4#14 meeting **Tdoc. S4 (00)0587**
November 27 – December 1, 2000 , Bath UK

Title: **3G AMR-NB Characterization Experiment 1A – Dynastat Results**

Source*: **Dynastat, Inc.**

Summary

This document presents a summary of the results for the ETSI/AMR NB 3G Characterization Experiment 1A conducted by Dynastat, Inc. Dynastat performed the experiment according to the AMR NB Test Plan [1]. There were no deviations from or exceptions to the listening test procedures and specifications described in the test plan.

1. Introduction

Dynastat conducted one listening test for the ETSI/AMR-NB Characterization Phase. The experimental design and test procedures for Experiment 1A were specified in the ETSI/AMR NB Characterization Test Plan [1]. The listening test was performed using the Absolute Category Rating (ACR) method in North American English (NAE).

2. Source Material

Dynastat provided new quiet-background recordings of Harvard Sentences for use as source speech materials for the ETSI/AMR NB tests. Six sentence-pairs were provided for each of four native NAE talkers, two males and two females. The source speech materials were recorded according to specifications detailed in the AMR NB Processing Plan [2]. They were down-sampled from 48kHz to 16kHz and filtered by the appropriate weighting filter as specified in the processing plan. The source speech materials were level-adjusted (SV56) and delivered to the Host Laboratory via email.

3. Experiment Design

Experimental design and test procedures for the experiment were specified in the test plan [1]. Dynastat complied with all specified experimental design procedures. These procedures included:

- 24 naive listeners - 6 panels, four listeners per panel
- partially-blocked experimental design
- use of specific presentation sequences (i.e., randomizations) listed in the test plan, one randomization per listening panel
- 96 votes per test condition (i.e., 24 listeners x 4 talkers).

4. Processed Material

The host laboratory delivered the processed test materials to Dynastat via Internet FTP.

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5. Listening Sessions

5.1 Presentation Sequences

For each experiment, Dynastat used the presentation sequences (i.e., randomizations) specified in the test plan.

5.2 Listeners

For this experiment, 24 naïve listeners, six panels of four listeners each were used. There were equal numbers of male and female listeners

5.3 Audio Presentation

The processed speech materials were presented to listeners seated at separate, visually screened listening stations contained within a Tracoustics soundproof room. Speech materials were presented monaurally via Sennheiser HD-25 headsets with a single headphone on the listener's preferred listening ear. The listener's non-preferred ear was open. A constant background ambient noise level of 30dBA (Hoth noise) was maintained in the soundproof room as specified in the test plan. Headphones were driven by a distribution amplifier set to deliver monophonic wideband speech to the listeners at an active level of -15 dBPa (79 dB SPL). The calibration was made using a B&K 4153 Artificial Ear with circumaural headphone adapter, 4134 Microphone element and 2609 Measurement Amplifier.

The processed speech files were channeled through a Townshend Computer Tools DAT-Link+ and recorded on Digital Audio Tape (DAT) in the presentation sequence specified in the test plan. The DAT's provide a permanent record of the specific processed speech materials and presentation sequences presented to each listening panel.

5.4 Scoring

In the ACR Experiment 1A conducted by Dynastat, listeners' ratings of the speech materials were recorded using the Mean Opinion Score (MOS). In the ACR, listeners rate the overall speech quality of each sample (i.e., processed sentence-pair) using the five-point MOS scale:

5	Excellent
4	Good
3	Fair
2	Poor
1	Bad

In each listening station the appropriate rating scale was presented on a PC monitor and listeners entered their ratings using a PC keyboard. Upon completion of the listening sessions, raw ratings were scored and delivered to the Global Analysis Laboratory (GAL) using the Excel spreadsheet provided by the GAL. Raw listener ratings were also delivered to the GAL using a second Excel spreadsheet provided for that purpose.

6. Results

The test plan specified the results to be reported by the listening laboratories for each experiment. Those analyses included computation of Means and Standard Deviations for each Condition for the average of All Talkers (4), Male Talkers (2), and Female Talkers (2). Table 1 presents the results of the ACR listening test Experiment 1A conducted by Dynastat. Statistical analyses and conclusions are deferred to the GAL.

Table 1: Test Conditions for Experiment 1A

Cond.	Codec	Error	MOS(M)	SD(M)	MOS(F)	SD(F)	MOS(A)	SD(A)
1	Direct	-	4.688	0.589	4.375	0.640	4.531	0.632
2	MNRU	33 dBQ	4.583	0.613	4.042	0.944	4.313	0.837
3	MNRU	24 dBQ	3.792	0.850	2.896	1.036	3.344	1.045
4	MNRU	15 dBQ	1.750	0.700	1.500	0.684	1.625	0.700
5	MNRU	06 dBQ	1.167	0.429	1.125	0.606	1.146	0.523
6	G.726 32	EC0	4.083	0.739	3.896	0.881	3.990	0.814
7	G.723.1 6.3	EC0	4.021	0.758	3.292	0.988	3.656	0.950
8	G.729 8	EC0	4.063	0.727	3.583	0.919	3.823	0.858
9	IS-127	EC0	4.167	0.953	3.542	0.898	3.854	0.973
10	GSM FR	EC0	3.375	0.841	3.333	0.883	3.354	0.858
11	GSM EFR	EP7A	3.188	1.045	2.479	0.825	2.833	1.002
12	GSM EFR	EP10A	4.063	0.836	3.000	0.989	3.531	1.056
13	AMR 12.2	EC0	4.500	0.652	3.792	0.798	4.146	0.808
14	AMR 12.2	EC1A	4.042	0.743	3.313	0.949	3.677	0.923
15	AMR 12.2	EC2A	4.104	0.692	3.146	0.967	3.625	0.965
16	AMR 12.2	EC3A	3.146	0.922	2.708	0.944	2.927	0.954
17	AMR 12.2	EC4A	4.063	0.861	3.604	0.917	3.833	0.914
18	AMR 12.2	EC5A	4.125	0.789	3.333	0.834	3.729	0.900
19	AMR 12.2	EC6A	3.604	1.047	2.854	0.850	3.229	1.021
20	AMR 10.2	EC0	4.146	0.744	3.896	0.905	4.021	0.833
21	AMR 10.2	EC7A	4.146	0.744	3.438	0.943	3.792	0.917
22	AMR 10.2	EC8A	3.646	0.863	3.458	0.850	3.552	0.857
23	AMR 10.2	EC9A	3.458	0.922	3.146	1.031	3.302	0.985
24	AMR 7.95	EC0	4.125	0.815	3.438	0.920	3.781	0.931
25	AMR 7.95	EC1A	4.313	0.719	3.417	1.049	3.865	1.001
26	AMR 7.95	EC2A	3.938	0.755	3.208	1.110	3.573	1.013
27	AMR 7.95	EC3A	3.500	0.851	2.583	0.846	3.042	0.962
28	AMR 7.95	EC4A	3.896	0.857	3.208	0.898	3.552	0.939
29	AMR 7.95	EC5A	4.063	0.783	3.417	0.871	3.740	0.886
30	AMR 7.95	EC6A	3.146	0.967	2.708	0.967	2.927	0.987
31	AMR 7.40	EC0	3.979	0.812	3.500	0.744	3.740	0.811
32	AMR 7.40	EC7A	3.771	0.805	3.271	0.844	3.521	0.858
33	AMR 7.40	EC8A	3.958	0.850	3.042	0.771	3.500	0.929
34	AMR 7.40	EC9A	3.625	0.959	2.854	0.922	3.240	1.013
35	AMR 6.70	EC0	4.042	0.798	3.208	0.944	3.625	0.965
36	AMR 6.70	EC1A	3.917	0.846	3.125	0.815	3.521	0.917
37	AMR 6.70	EC2A	3.938	0.755	3.375	0.959	3.656	0.904
38	AMR 6.70	EC3A	3.396	1.144	2.958	0.922	3.177	1.056
39	AMR 6,70	EC4A	4.042	0.798	3.042	0.850	3.542	0.962
40	AMR 6.70	EC5A	3.813	0.842	3.313	0.903	3.563	0.904
41	AMR 6.70	EC6A	3.458	1.031	2.583	1.127	3.021	1.161
42	AMR 5.90	EC0	3.875	0.815	3.104	0.751	3.490	0.871
43	AMR 5.90	EC7A	3.729	0.869	3.167	0.834	3.448	0.893
44	AMR 5.90	EC8A	3.563	0.769	2.667	0.907	3.115	0.950
45	AMR 5.90	EC9A	3.021	0.934	2.396	0.818	2.708	0.928
46	AMR 5.15	EC0	3.542	0.771	3.000	0.799	3.271	0.827
47	AMR 5.15	EC1A	3.354	0.758	2.667	0.907	3.010	0.900
48	AMR 5.15	EC2A	3.417	0.739	2.583	0.895	3.000	0.918
49	AMR 5.15	EC3A	3.208	0.898	2.708	0.798	2.958	0.882
50	AMR 5.15	EC4A	3.583	0.795	2.813	0.867	3.198	0.913
51	AMR 5.15	EC5A	3.500	0.715	2.708	0.922	3.104	0.912
52	AMR 5.15	EC6A	3.208	0.988	2.167	0.808	2.688	1.039
53	AMR 4.75	EC0	3.708	0.824	2.875	0.841	3.292	0.928
54	AMR 4.75	EC7A	3.417	0.942	2.958	0.771	3.188	0.886
55	AMR 4.75	EC8A	3.417	0.739	2.563	0.897	2.990	0.923
56	AMR 4.75	EC9A	2.979	1.062	2.313	0.854	2.646	1.016

Legend: Cond: condition number; Codec: Reference/Coder; Error: error rate for a given condition; MOS: Mean Opinion Score; SD: Standard Deviation; (M): male talkers, (F): female talkers, (A): all talkers

References

[1] 3GPP SA4, *"Test Plan for the 3G AMR-NB Characterization (V.2.0.1)"*; Tdoc S4 (00) 0472R1.

[2] 3GPP SA4, *"Processing Functions for AMR 3G Characterization Tests(V.2.0)"*; Tdoc S4 (00) 0473.

3GPP TSG-S4#13 meeting ***Tdoc. S4 (00)0561***
Nov.27-Dec.1, 2000, Bath, UK

Title: **AMR-NB 3G Characterization Experiment 1B Results**

Source*: **LMGT**

Summary

This report describes the results obtained for the AMR-NB 3G Characterization Experiment 1B in Korean. Lockheed Martin Global Telecommunications (LMGT) performed Experiment 1B in compliance with the 3GPP-defined Test Plans [1,2]. This experiment was designed to evaluate the performance of the AMR-NB codec under a variety of 3G channel error conditions with a quiet noise background. Experiment 1 used the Absolute Category Rating (ACR) method. Overall, the AMR-NB performance was more dependent on the 3G error profile than on the AMR-NB mode (bit-rate). Additionally, the different error patterns resulted in groups of similar degradation: error profiles 0B, 4B, 7B (together in most cases with error profiles 5B and 8B); error profiles 6B and 9B; and error profiles 0, 1B, and 2B. In general, error profile 3B resulted in a significantly lower performance.

1. Introduction

LMGT performed listening Experiment 1B for the AMR-NB 3G Characterization exercise in the Korean language. The experiment used six different sentence-pairs for two male and two female talkers extracted from the speech material available in the NTT-AT speech database (plus two samples per talker for the practice material).

This experiment was designed using the Absolute Category Rating (ACR) method and aimed at evaluating the performance of the AMR-NB codec under a variety of 3G channel error conditions with a quiet noise background.

2. Source Material

LMGT performed Experiment 1B using a subset of the speech material available in the NTT-AT Speech Database for the Korean language. For the main test, six sentence-pairs were selected for two male and two female talkers from the NTT Speech Database. Two additional samples per talker were also provided for processing through the practice conditions. This database contains quiet background speech sampled at 16 kHz, for a bandwidth of 8 kHz.

The quiet background sentence pairs were filtered by the specified weighting filter (FLAT1) and level-equalized, in compliance with the specifications in the Processing Plan [2]. This material was then provided to the Host Laboratory, performed by ARCON. The Host Laboratory was responsible for the processing of the speech material.

3. Experiment Design

The experiment design for Experiment 1B is defined in Section 5 of the Subjective Test Plan [1], and is summarized in Table 1. A total of 96 votes were cast per test condition for male and female talkers combined, or 48 for each gender.

4. Processed Material

The host laboratory delivered the test material on a CD-ROM containing a total of 1792 files. These files corresponded to 1344 files for use in the main experiment (samples S01 though S06 for each talker), 8 files for the practice sessions, and 440 excess files (by-product of the processing of the practice conditions).

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5. Listening Sessions

5.1 Presentation Sequence Material

LMGT used the grouping and randomization sequences specified in the Test Plan for Experiment 1B.

5.2 Listeners

The subjective assessment was performed using 24 listeners (nominally balanced between male and female subjects), divided into six groups of four listeners each.

The listener selection criterion was compliant with the Test Plan, noting that audiometric testing was not performed on the listeners, for legal reasons. Test subjects were selected from an existing pool of Korean listeners, for which past assessment performance data exists indicating their general hearing integrity. Subject performance within this experiment was compared to the overall performance of all listeners used in each experiment as a check on the hearing integrity of each listener at the time of testing. The pre-test listener orientation used by LMGT conformed to that specified in the Test Plan.

5.3 Audio Presentation

The processed speech material was presented to groups of listeners, seated at separate, visually screened listening stations contained within an acoustically conditioned sound room meeting the requirements for an NC 20 acoustic facility. Presentation was made monaurally using an AKG K240DF open-back studio monitor headphone. The headphone was driven by a distribution amplifier set to deliver monophonic wideband speech to the listener's preferred listening ear at an active level of -15 dBPa (79 dB SPL). The calibration was made using a B&K 4153 Artificial Ear with circumaural headphone adapter, 4134 Microphone element and 2610 Measurement Amplifier.

The processed speech files were stored within the main facility computer and presented to the listeners under program control as 16 kHz samples through a 16-bit D/A coupled to the input of the distribution amplifier through a Frequency Devices 9002 Eight-pole Elliptic Filter (set for a bandpass of 200-Hz to 3.4-kHz). Auxiliary analog filtering was performed to achieve an overall modified-IRS receive characteristic.

5.4 Scoring

Within experiments using a Mean-Opinion-Score (MOS) method of assessment, the presented sentence-pairs were scored by the listeners using a five-point perceived quality scale as either Excellent, Good, Fair, Poor, or Bad. The quality designations were presented on the screen of the voting terminals and selected through the use of a pointing device. The voting screen was rendered neutral during the presentation of each new stimulus.

The listener responses were registered on auxiliary computers. Each voting station contains one of these voting terminals. The voting screen was rendered neutral during the presentation of each new stimulus and voting was only permitted following the completed presentation of each voting stimulus (in this experiment, one sentence-pair). All seated listeners were required to register responses prior to the subsequent presentation of a new stimulus. Once a group of listeners was conditioned to the dynamics of the voting procedure, the voting response time for each presented stimulus was nominally four seconds for each presented stimulus.

As all seated listeners completed their voting, the votes for all stations were transferred to the main facility computer prior to the presentation of subsequent new material. The votes of each group of listeners for each presentation set of speech material were stored as ASCII files within the main facility computer for subsequent analysis and presentation.

Upon completion of the listening sessions, all raw data were de-scrambled and consolidated into a single ASCII file, which was used to generate the raw vote file provided to the Global Analysis Laboratory (ARCON) and for the statistical analysis presented in this report.

6. Statistical Analysis

The raw data collected were used to derive combined-gender MOS, standard deviation, 95% confidence intervals, and equivalent-Q values for each sub-experiment. These data are presented in Table 1. Additionally, rank-order analyses were performed for different groupings of the data and are presented in Tables 2 and 3.

Table 1 contains the basic statistical analysis data produced by LMGT for AMR-NB 3G Characterization Experiment 1B. Each test condition received a total of 96 votes for combined talkers, or 48 votes per talker for gender-wise statistics. In the tables, *Condition* represents the test condition number, *Y* is the Mean Opinion Score, and *SD* is the standard deviation. The upper and lower 95% confidence intervals are denoted as *+95%* and *-95%*, respectively, in the table. Finally, the column label *Qeqv* contains the equivalent-Q values obtained using a non-linear fit of each experiment's data to a modified logistic function (the Q curve and parameters are given in Annex A). The error performance of the codecs is also illustrated in Figure 1.

Tables 2, 3 and 4 contain supplementary statistical analysis and data presentation. Tables 2 and 3 contain a rank-ordered presentation of the combined talker data in Table 1 with a different grouping: Table 2 groups the data by error pattern, and Table 3 groups the data by the different AMR-NB modes. The tables also contain the upper and lower 95% confidence intervals, as well as a classification of the grouped conditions in terms of their statistical equivalency (using two different criteria). Statistically equivalent test conditions are indicated using Student's t-test Least Significant Difference (LSD) criterion and Tukey-Kramer's Honestly Significant Difference (HSD) Criterion. In the table, *Condition* represents the test condition number, *Y* is the Mean Opinion Score, and the *+95%* and *–95%* columns represent the upper and lower 95% confidence interval, respectively. The *LSD* column shows which test conditions can be considered equivalent under the LSD criterion (indicated by contiguous vertical lines within each grouping) for a given impairment. The *HSD* column indicates which test conditions can be considered equivalent by the HSD criterion (indicated by contiguous vertical lines within each grouping). The LSD criterion is used to compare a pair of conditions, while the HSD criterion is used to determine groups of equivalency within a set of samples. Tables 2 and 3 provide the most convenient presentation of the test data for statistical comparisons, in particular using the HSD criterion.

It can be seen from Table 2 that for most cases no significant differences were observed for different AMR-NB modes with a given error profile. In Table 3, it can be seen that performance for a given AMR-NB mode degrades with increasingly worse error profiles. Hence, error profiles were a dominant factor in the Experiment when contrasted to the different codec modes, i.e. that codec performance was more significantly a function of the error profile than the mode in which the codec operated under each of the error profiles.

The data in Table 3 also reveals that error profiles 0, 4B, 7B, and in most cases, 5B and 8B, resulted in equivalent performance (on the higher end) for a given codec mode, as did error profiles 6B and 9B (on the lower end). Similarly, error profiles 0, 1B, and 2B resulted in equivalent performance for a given codec mode (on the higher end), while error profile 3B usually resulted in a significantly lower performance.

Finally, Table 4 presents the rank order of the error patterns for each AMR-NB mode, together with the GSM-EFR conditions tested. This table summarizes (without statistical significant assertions) how, for each of the AMR-NB modes, the AMR-NB performance ranks relative to the GSM-EFR performance with EP10 and EP7, as the different 3G error profiles are encountered.

7. Conclusion

LMGT performed Experiment 1B in compliance with the test plans [1,2] and used a subset of the speech material available in the NTT Speech Database for the Korean language. This experiment was designed using the Absolute Category Rating (ACR) method and aimed at evaluating the performance of the AMR-NB codec under a variety of 3G channel error conditions with a quiet noise background.

Overall, the AMR-NB performance was more dependent on the 3G error profile than on the AMR-NB mode (bit-rate). Additionally, the different error patterns resulted in groups of similar degradation: error profiles 0B, 4B, 7B (together in most cases with error profiles 5B and 8B); error profiles 6B and 9B; and error profiles 0, 1B, and 2B. In general, error profile 3B resulted in a significantly lower performance.

References

[1] 3GPP SA4, *"Test plan for the 3G AMR-NB Characterization (V.2.0.1)"*; Tdoc S4 (00) 0472R1.

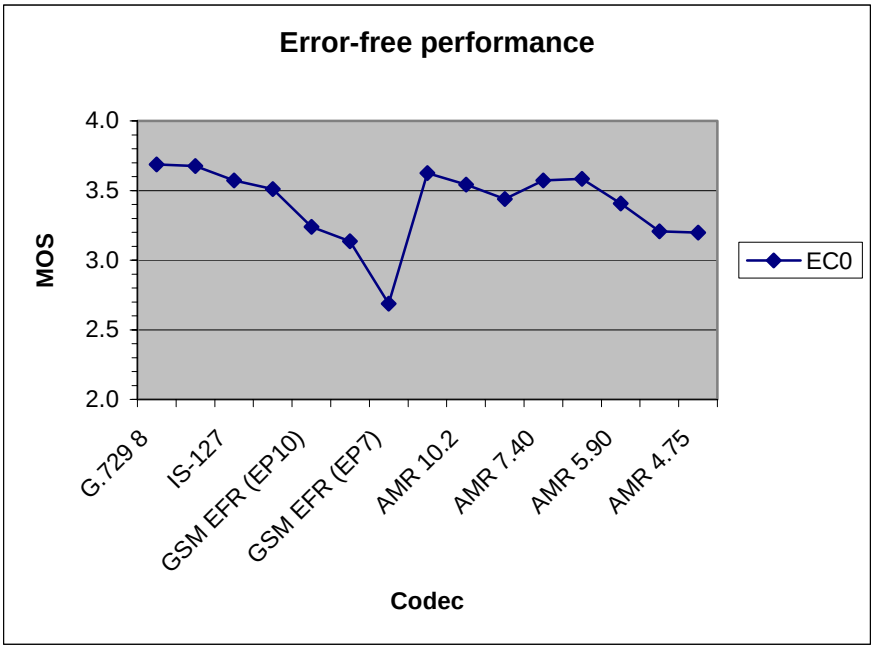
[2] 3GPP SA4, *"Processing Functions for AMR 3G Characterization Tests (V.2.0)"*; Tdoc S4 (00) 0473.

[3] ITU Rec.P.800, *"Methods for Subjective Determination of Transmission Quality"*; Geneva, August 1996.

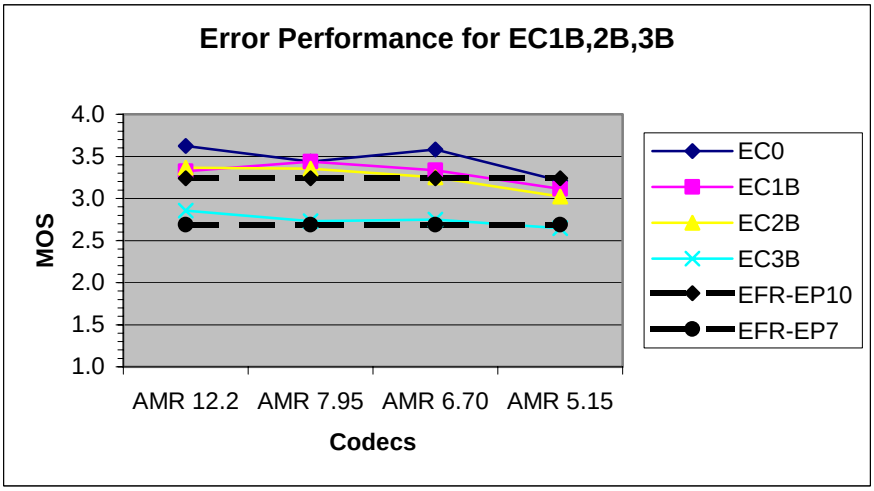
Table 1: **Test Conditions for Experiment 1B**

Condition	Codec	Error	Votes	Y(all)	SD(all)	+95%	-95%	Qeqv
1	Direct	-	96	4.521	0.649	4.651	4.391	40.869
2	MNRU 33 dBQ	-	96	4.021	0.940	4.209	3.833	33.000
3	MNRU 24 dBQ	-	96	2.750	0.858	2.922	2.578	24.000
4	MNRU 15 dBQ	-	96	1.594	0.625	1.719	1.469	15.000
5	MNRU 06 dBQ	-	96	1.167	0.474	1.261	1.072	6.000
6	G.726 32	EC0	96	3.677	0.935	3.864	3.490	30.052
7	G.723.1 6.3	EC0	96	3.510	0.754	3.661	3.360	28.845
8	G.729 8	EC0	96	3.688	0.799	3.847	3.528	30.131
9	IS-127	EC0	96	3.573	0.880	3.749	3.397	29.286
10	GSM FR	EC0	96	3.135	0.829	3.301	2.970	26.385
11	GSM EFR	EP7	96	2.688	0.837	2.855	2.520	23.612
12	GSM EFR	EP10	96	3.240	0.778	3.395	3.084	27.044
13	AMR 12.2	EC0	96	3.625	0.757	3.777	3.473	29.664
14	AMR 12.2	EC1B	96	3.323	0.761	3.475	3.171	27.583
15	AMR 12.2	EC2B	96	3.365	0.822	3.529	3.200	27.857
16	AMR 12.2	EC3B	96	2.854	0.951	3.044	2.664	24.643
17	AMR 10.2	EC0	96	3.542	0.753	3.692	3.391	29.064
18	AMR 10.2	EC4B	96	3.396	0.761	3.548	3.244	28.064
19	AMR 10.2	EC5B	96	3.417	0.816	3.580	3.253	28.204
20	AMR 10.2	EC6B	96	2.698	0.884	2.875	2.521	23.677
21	AMR 10.2	EC7B	96	3.260	0.837	3.428	3.093	27.178
22	AMR 10.2	EC8B	96	3.208	0.767	3.362	3.055	26.845
23	AMR 10.2	EC9B	96	2.448	0.928	2.633	2.262	22.090
24	AMR 7.95	EC0	96	3.438	0.805	3.599	3.276	28.344
25	AMR 7.95	EC1B	96	3.438	0.805	3.599	3.276	28.344
26	AMR 7.95	EC2B	96	3.354	0.962	3.547	3.162	27.788
27	AMR 7.95	EC3B	96	2.729	0.946	2.918	2.540	23.871
28	AMR 7.40	EC0	96	3.573	0.830	3.739	3.407	29.286
29	AMR 7.40	EC4B	96	3.469	0.894	3.648	3.290	28.557
30	AMR 7.40	EC5B	96	3.198	0.958	3.390	3.006	26.779
31	AMR 7.40	EC6B	96	2.490	0.906	2.671	2.308	22.360
32	AMR 7.40	EC7B	96	3.458	0.928	3.644	3.273	28.486
33	AMR 7.40	EC8B	96	3.167	0.777	3.322	3.011	26.581
34	AMR 7.40	EC9B	96	2.833	0.991	3.032	2.635	24.514
35	AMR 6.70	EC0	96	3.583	0.691	3.722	3.445	29.361
36	AMR 6.70	EC1B	96	3.333	0.842	3.502	3.165	27.651
37	AMR 6.70	EC2B	96	3.250	0.846	3.419	3.081	27.111
38	AMR 6.70	EC3B	96	2.750	0.906	2.931	2.569	24.000
39	AMR 5.90	EC0	96	3.406	0.776	3.561	3.251	28.134
40	AMR 5.90	EC4B	96	3.302	0.783	3.459	3.145	27.447
41	AMR 5.90	EC5B	96	3.156	0.898	3.336	2.977	26.516
42	AMR 5.90	EC6B	96	2.667	0.948	2.856	2.477	23.482
43	AMR 5.90	EC7B	96	3.313	0.744	3.461	3.164	27.515
44	AMR 5.90	EC8B	96	3.188	0.898	3.367	3.008	26.713
45	AMR 5.90	EC9B	96	2.823	0.858	2.995	2.651	24.450
46	AMR 5.15	EC0	96	3.208	0.753	3.359	3.058	26.845
47	AMR 5.15	EC1B	96	3.115	0.832	3.281	2.948	26.254
48	AMR 5.15	EC2B	96	3.021	0.821	3.185	2.857	25.671
49	AMR 5.15	EC3B	96	2.646	0.808	2.807	2.484	23.352
50	AMR 4.75	EC0	96	3.198	0.816	3.361	3.035	26.779
51	AMR 4.75	EC4B	96	3.052	0.800	3.212	2.892	25.865
52	AMR 4.75	EC5B	96	3.042	0.807	3.203	2.880	25.800
53	AMR 4.75	EC6B	96	2.667	0.867	2.840	2.493	23.482
54	AMR 4.75	EC7B	96	3.156	0.799	3.316	2.996	26.516
55	AMR 4.75	EC8B	96	3.021	0.754	3.172	2.870	25.671
56	AMR 4.75	EC9B	96	2.427	0.880	2.603	2.251	21.954

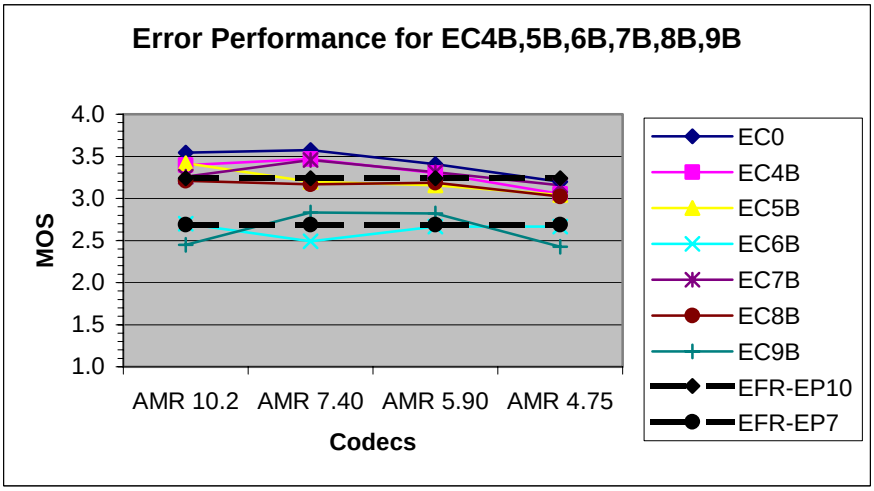
Legend: Condition is the Condition number; Y is the Mean Opinion Score, SD is standard deviation, +95% and -95% are respectively the upper and lower 95% confidence interval; Qeqv is the MNRU equivalent-Q value.



(a) Error-free performance of the AMR-NB and reference codecs



(b) Performance of the AMR modes tested with error profiles EC 1B, 2B, and 3B



(c) Performance of the AMR modes tested with error profiles EC 4B, 5B, 6B, 7B, 8B, and 9B

Figure 1: **Performance plots for the AMR modes and error patterns (GSM-EFR EP10 and EP7 are shown as reference points)**

Table 2: **Rank-ordered Test Conditions grouped by Error Pattern**

Condition	Codec	Error	Votes	Y(all)	+95%	-95%	LSD	HSD
1	Direct	-	96	4.521	4.651	4.391		
2	MNRU 33 dBQ	-	96	4.021	4.209	3.833	N	N
3	MNRU 24 dBQ	-	96	2.750	2.922	2.578	/	/
4	MNRU 15 dBQ	-	96	1.594	1.719	1.469	A	A
5	MNRU 06 dBQ	-	96	1.167	1.261	1.072		
8	G.729 8	EC0	96	3.688	3.847	3.528		
6	G.726 32	EC0	96	3.677	3.864	3.490		
13	AMR 12.2	EC0	96	3.625	3.777	3.473		
35	AMR 6.70	EC0	96	3.583	3.722	3.445		
28	AMR 7.40	EC0	96	3.573	3.739	3.407		
9	IS-127	EC0	96	3.573	3.749	3.397		
17	AMR 10.2	EC0	96	3.542	3.692	3.391		
7	G.723.1 6.3	EC0	96	3.510	3.661	3.360		
24	AMR 7.95	EC0	96	3.438	3.599	3.276		
39	AMR 5.90	EC0	96	3.406	3.561	3.251		
12	GSM EFR	EP10	96	3.240	3.395	3.084		
46	AMR 5.15	EC0	96	3.208	3.359	3.058		
50	AMR 4.75	EC0	96	3.198	3.361	3.035		
10	GSM FR	EC0	96	3.135	3.301	2.970		
11	GSM EFR	EP7	96	2.688	2.855	2.520		
25	AMR 7.95	EC1B	96	3.438	3.599	3.276		
36	AMR 6.70	EC1B	96	3.333	3.502	3.165		
14	AMR 12.2	EC1B	96	3.323	3.475	3.171		
47	AMR 5.15	EC1B	96	3.115	3.281	2.948		
15	AMR 12.2	EC2B	96	3.365	3.529	3.200		
26	AMR 7.95	EC2B	96	3.354	3.547	3.162		
37	AMR 6.70	EC2B	96	3.250	3.419	3.081		
48	AMR 5.15	EC2B	96	3.021	3.185	2.857		
16	AMR 12.2	EC3B	96	2.854	3.044	2.664		
38	AMR 6.70	EC3B	96	2.750	2.931	2.569		
27	AMR 7.95	EC3B	96	2.729	2.918	2.540		
49	AMR 5.15	EC3B	96	2.646	2.807	2.484		
29	AMR 7.40	EC4B	96	3.469	3.648	3.290		
18	AMR 10.2	EC4B	96	3.396	3.548	3.244		
40	AMR 5.90	EC4B	96	3.302	3.459	3.145		
51	AMR 4.75	EC4B	96	3.052	3.212	2.892		
19	AMR 10.2	EC5B	96	3.417	3.580	3.253		
30	AMR 7.40	EC5B	96	3.198	3.390	3.006		
41	AMR 5.90	EC5B	96	3.156	3.336	2.977		
52	AMR 4.75	EC5B	96	3.042	3.203	2.880		
20	AMR 10.2	EC6B	96	2.698	2.875	2.521		
53	AMR 4.75	EC6B	96	2.667	2.840	2.493		
42	AMR 5.90	EC6B	96	2.667	2.856	2.477		
31	AMR 7.40	EC6B	96	2.490	2.671	2.308		
32	AMR 7.40	EC7B	96	3.458	3.644	3.273		
43	AMR 5.90	EC7B	96	3.313	3.461	3.164		
21	AMR 10.2	EC7B	96	3.260	3.428	3.093		
54	AMR 4.75	EC7B	96	3.156	3.316	2.996		
22	AMR 10.2	EC8B	96	3.208	3.362	3.055		
44	AMR 5.90	EC8B	96	3.188	3.367	3.008		
33	AMR 7.40	EC8B	96	3.167	3.322	3.011		
55	AMR 4.75	EC8B	96	3.021	3.172	2.870		
34	AMR 7.40	EC9B	96	2.833	3.032	2.635		
45	AMR 5.90	EC9B	96	2.823	2.995	2.651		
23	AMR 10.2	EC9B	96	2.448	2.633	2.262		
56	AMR 4.75	EC9B	96	2.427	2.603	2.251		

Legend: Condition is the Condition number; Y is the Mean Opinion Score, +95% and -95% are respectively the upper and lower 95% confidence interval; LSD is Student's t-test Least Significant Difference; HSD is Tukey's Honestly Significant Difference.

Table 3: **Rank-ordered Test Conditions grouped by AMR mode (only AMR conditions shown)**

Condition	Codec	Error	Votes	Y(all)	+95%	-95%	LSD	HSD
13	AMR 12.2	EC0	96	3.625	3.777	3.473		
15	AMR 12.2	EC2B	96	3.365	3.529	3.200		
14	AMR 12.2	EC1B	96	3.323	3.475	3.171		
12	GSM EFR	EP10	96	3.240	3.395	3.084		
16	AMR 12.2	EC3B	96	2.854	3.044	2.664		
11	GSM EFR	EP7	96	2.688	2.855	2.520		
17	AMR 10.2	EC0	96	3.542	3.692	3.391		
19	AMR 10.2	EC5B	96	3.417	3.580	3.253		
18	AMR 10.2	EC4B	96	3.396	3.548	3.244		
21	AMR 10.2	EC7B	96	3.260	3.428	3.093		
12	GSM EFR	EP10	96	3.240	3.395	3.084		
22	AMR 10.2	EC8B	96	3.208	3.362	3.055		
20	AMR 10.2	EC6B	96	2.698	2.875	2.521		
11	GSM EFR	EP7	96	2.688	2.855	2.520		
23	AMR 10.2	EC9B	96	2.448	2.633	2.262		
24	AMR 7.95	EC0	96	3.438	3.599	3.276		
25	AMR 7.95	EC1B	96	3.438	3.599	3.276		
26	AMR 7.95	EC2B	96	3.354	3.547	3.162		
12	GSM EFR	EP10	96	3.240	3.395	3.084		
27	AMR 7.95	EC3B	96	2.729	2.918	2.540		
11	GSM EFR	EP7	96	2.688	2.855	2.520		
28	AMR 7.40	EC0	96	3.573	3.739	3.407		
29	AMR 7.40	EC4B	96	3.469	3.648	3.290		
32	AMR 7.40	EC7B	96	3.458	3.644	3.273		
12	GSM EFR	EP10	96	3.240	3.395	3.084		
30	AMR 7.40	EC5B	96	3.198	3.390	3.006		
33	AMR 7.40	EC8B	96	3.167	3.322	3.011		
34	AMR 7.40	EC9B	96	2.833	3.032	2.635		
11	GSM EFR	EP7	96	2.688	2.855	2.520		
31	AMR 7.40	EC6B	96	2.490	2.671	2.308		
35	AMR 6.70	EC0	96	3.583	3.722	3.445		
36	AMR 6.70	EC1B	96	3.333	3.502	3.165		
37	AMR 6.70	EC2B	96	3.250	3.419	3.081		
12	GSM EFR	EP10	96	3.240	3.395	3.084		
38	AMR 6.70	EC3B	96	2.750	2.931	2.569		
11	GSM EFR	EP7	96	2.688	2.855	2.520		
39	AMR 5.90	EC0	96	3.406	3.561	3.251		
43	AMR 5.90	EC7B	96	3.313	3.461	3.164		
40	AMR 5.90	EC4B	96	3.302	3.459	3.145		
12	GSM EFR	EP10	96	3.240	3.395	3.084		
44	AMR 5.90	EC8B	96	3.188	3.367	3.008		
41	AMR 5.90	EC5B	96	3.156	3.336	2.977		
45	AMR 5.90	EC9B	96	2.823	2.995	2.651		
11	GSM EFR	EP7	96	2.688	2.855	2.520		
42	AMR 5.90	EC6B	96	2.667	2.856	2.477		
12	GSM EFR	EP10	96	3.240	3.395	3.084		
46	AMR 5.15	EC0	96	3.208	3.359	3.058		
47	AMR 5.15	EC1B	96	3.115	3.281	2.948		
48	AMR 5.15	EC2B	96	3.021	3.185	2.857		
11	GSM EFR	EP7	96	2.688	2.855	2.520		
49	AMR 5.15	EC3B	96	2.646	2.807	2.484		
12	GSM EFR	EP10	96	3.240	3.395	3.084		
50	AMR 4.75	EC0	96	3.198	3.361	3.035		
54	AMR 4.75	EC7B	96	3.156	3.316	2.996		
51	AMR 4.75	EC4B	96	3.052	3.212	2.892		
52	AMR 4.75	EC5B	96	3.042	3.203	2.880		
55	AMR 4.75	EC8B	96	3.021	3.172	2.870		
11	GSM EFR	EP7	96	2.688	2.855	2.520		
53	AMR 4.75	EC6B	96	2.667	2.840	2.493		
56	AMR 4.75	EC9B	96	2.427	2.603	2.251		

Legend: Condition is the Condition number; Y is the Mean Opinion Score, +95% and -95% are respectively the upper and lower 95% confidence interval; LSD is Student's t-test Least Significant Difference; HSD is Tukey's Honestly Significant Difference.

Table 4: **Rank order of 3G error patterns for each AMR mode (referenced to GSM-EFR EP7 and EP10)**

AMR 12.2	EC0
AMR 12.2	EC2B
AMR 12.2	EC1B
GSM EFR	*EP10*
AMR 12.2	EC3B
GSM EFR	*EP7*

AMR 7.95	EC0
AMR 7.95	EC1B
AMR 7.95	EC2B
GSM EFR	*EP10*
AMR 7.95	EC3B
GSM EFR	*EP7*

AMR 6.70	EC0
AMR 6.70	EC1B
AMR 6.70	EC2B
GSM EFR	*EP10*
AMR 6.70	EC3B
GSM EFR	*EP7*

GSM EFR	*EP10*
AMR 5.15	EC0
AMR 5.15	EC1B
AMR 5.15	EC2B
GSM EFR	*EP7*
AMR 5.15	EC3B

AMR 10.2	EC0
AMR 10.2	EC5B
AMR 10.2	EC4B
AMR 10.2	EC7B
GSM EFR	*EP10*
AMR 10.2	EC8B
AMR 10.2	EC6B
GSM EFR	*EP7*
AMR 10.2	EC9B

AMR 7.40	EC0
AMR 7.40	EC4B
AMR 7.40	EC7B
GSM EFR	*EP10*
AMR 7.40	EC5B
AMR 7.40	EC8B
AMR 7.40	EC9B
GSM EFR	*EP7*
AMR 7.40	EC6B

AMR 5.90	EC0
AMR 5.90	EC7B
AMR 5.90	EC4B
GSM EFR	*EP10*
AMR 5.90	EC8B
AMR 5.90	EC5B
AMR 5.90	EC9B
GSM EFR	*EP7*
AMR 5.90	EC6B

GSM EFR	*EP10*
AMR 4.75	EC0
AMR 4.75	EC7B
AMR 4.75	EC4B
AMR 4.75	EC5B
AMR 4.75	EC8B
GSM EFR	*EP7*
AMR 4.75	EC6B
AMR 4.75	EC9B

Annex A
Equivalent-Q calculations

It should be noted that the MNRU, which is derived by contaminating a speech signal nonlinearly with multiplicative band-limited white noise, is a reference system used to map opinions to the equivalent Q scale (measured in dB) in such a way that comparisons between experiments becomes feasible. *It is particularly important to note that the numeric value of both MOS and DMOS varies from experiment to experiment for the same condition*. This is not the case with the equivalent Q value, because they tend to be both experiment- and language- independent, when the same speech spectral weighting is used. The MOS-to-equivalent Q value mapping is performed by subjectively assessing both MNRU conditions and the test conditions of interest within the same experiment, then computing the MNRU conditions' MOS (or DMOS) scores, and then using the computed relationship to map each test condition's MOS (or DMOS) value to an MNRU (or equivalent Q) value.

The computational approach used to map MOS and DMOS to equivalent Q values consists of a nonlinear least squares fit of the MNRU (D)MOS, Y_k, to a modified logistic function defined by the equation

$$Y(Qk) = D + \frac{M-1}{1+e^{-\left(\frac{Q_k - A}{B}\right)}},$$

where Q_k represents the theoretical (target) Q value for the MNRU condition Y_k value, k=1..N_Q.

In the above equation, the parameters *A*, *B*, *M*, and *D* are optimized to minimize the error function:

$$\chi^2 = \sum_{k=1}^{N_Q}\left[\frac{Y(Q_k) - Y_k}{\sigma_k}\right]^2 .$$

Once the four parameters are defined, the MOS or DMOS calculated for each test condition is mapped to equivalent Q values using the equation:

$$Q_{eqv,j} = A + B\ln\left(\frac{Y_j - D}{M - Y_j}\right)$$

Parameter "D" has been introduced here to provide a better fit of the function to the test results, and indicates the lower (low-Q values) asymptote. Parameter *A* reflects the "average" (middle) Q value for the test. Parameter *B* is related to the slope of the logistic function in the middle of the Q range, this being equal to 1/(4B). Parameter *M* indicates the upper (high-Q values) asymptote. These values can easily be used to diagnose the performance of subjective test designs.

This has been performed for the AMR-NB Experiment 1B, as shown in Figure A.1 that follows.

Parameter	Estimate
A	24.814661108
B	5.681203323
M	4.727268270
D	1.036872997

Plot

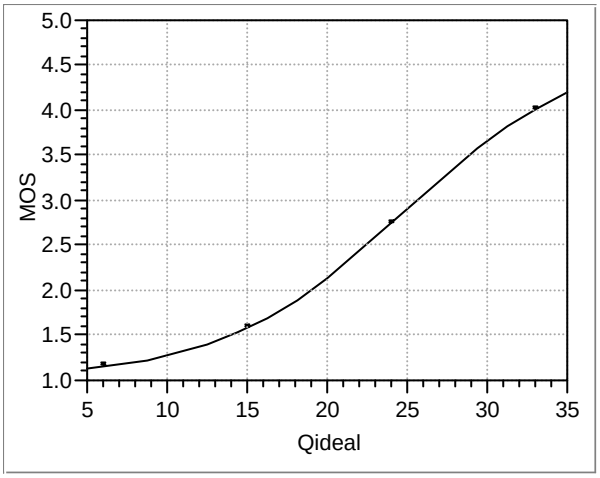


Figure A.1(a)
Equivalent-Q Curve fitting and modified logistic curve parameters for Experiment 1B

3GPP TSG-S4#13 meeting Tdoc S4-000645
Bath, UK; - November 2000

Title: AMR-NB Characterization Tests – NTT-AT's Results

Source: NTT-Advanced Technology Corporation (NTT-AT)*

1. Introduction

NTT-AT has conducted listening testing as part of the characterization phase for adaptive multi-rate (AMR) Narrowband Codec. Experiments 1C was carried out in Japanese. The experiment was designed using Absolute Category Rating. The purpose of this experiment is as follows:

Experiment 1C: evaluating clean speech performance under static error conditions in Japanese

2. Source Material

NTT-AT sent speech samples spoken by two male and two female speakers to the host laboratory (ARCON). The speakers were chosen by taking age balance into account and no talkers who had recorded samples for NTT's commercial Multilingual Speech Database 1994 version were used. Some of the sentences used were also changed.

3. Experimental Design

The test was designed according to the specification in the AMR-NB Characterization Test Plan Ver.2.0.1.

4. Processed Material

The total amount of memory required for the samples meant that FTP via international line was not a suitable way to receive them. We thus requested that ARCON provide them on CD-ROM. Not only did this obviate the need for a long down-loads, but it eliminated the possibility of transmission errors. All of the data we used was taken from the CD-ROMs, so that it was unquestionably reliable.

5. Listening Sessions

5.1 Presentation sequence

The sentences were presented in a random order, and randomization was as specified in the Test Plan.

5.2 Listeners

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All listeners were “naïve”, that is, they had no experience of subjective testing within the previous six months.

There were 24 subjects in each set, and each set was divided into 6 groups of 4 subjects each. The subjects were recruited from outside our company and assigned to sets in such a way as to balance gender and age.

5.3 Audio presentation

Following the guideline of test plan, the subjects listened to the speech materials using Sony Circumaural headphones; model MDR-Z900, in monaural mode (one ear was open). An external equalizer was used with the listening system to realize a modified IRS receiving response.

5.4 Scoring

The subjects evaluated the quality of each sentence and input their scores to a PC by pressing a keys on a key pad. Listeners voted the overall speech quality of each sample using the five-point MOS scale. The expressions used to describe the rating scale were translated to the corresponding Japanese words/phrases.

6. Results

The results are summarized in Table 1.

6.1 Reference condition

The mean opinion score for MNRU is shown in Fig. 1. The MOS changes according to the Q value. That there is no irregularity in the relationships between Q and MOS, ensures fairness of testing. The difference between the MOS given to male talker and female talker was small.

Table 1 MOS and its standard deviation for each condition

Condition No.	Codec/ MNRU	Q/Error Pattern	Males Talkers		Females Talkers		All Talkers	
			MOS	σ	MOS	σ	MOS	σ
1	Direct	-	3.98	0.699	4.10	0.722	4.04	0.710
2	MNRU	33 dBQ	3.71	0.771	3.77	0.881	3.74	0.824
3	MNRU	24 dBQ	2.77	0.831	2.67	0.953	2.72	0.891
4	MNRU	15 dBQ	1.56	0.542	1.50	0.583	1.53	0.561
5	MNRU	06 dBQ	1.08	0.279	1.04	0.202	1.06	0.243
6	G.726 32	EC0	3.46	0.824	3.06	0.783	3.26	0.824
7	G.723.1 6.3	EC0	3.13	0.789	2.98	0.863	3.05	0.826
8	G.729 8	EC0	3.13	0.761	3.00	0.945	3.06	0.856
9	IS-127	EC0	3.23	0.831	3.17	0.907	3.20	0.866
10	GSM FR	EC0	2.40	0.792	2.04	0.713	2.22	0.771
11	GSM EFR	EP7	2.73	0.707	2.38	0.761	2.55	0.752
12	GSM EFR	EP10	3.23	0.722	2.98	0.758	3.10	0.747
13	AMR 12.2	EC0	3.23	0.692	2.96	0.824	3.09	0.769
14	AMR 12.2	EC1C	3.15	0.772	3.06	0.836	3.10	0.801
15	AMR 12.2	EC2C	2.79	0.771	2.75	0.812	2.77	0.788
16	AMR 12.2	EC3C	2.54	0.683	2.48	0.799	2.51	0.740
17	AMR 12.2	EC4C	3.02	0.758	3.21	0.824	3.11	0.793
18	AMR 12.2	EC5C	2.92	0.794	2.75	0.758	2.83	0.777
19	AMR 12.2	EC6C	2.81	0.790	2.67	0.724	2.74	0.757
20	AMR 10.2	EC0	3.27	0.844	3.06	0.783	3.17	0.816
21	AMR 10.2	EC7C	3.08	0.794	2.67	0.630	2.88	0.743
22	AMR 10.2	EC8C	2.94	0.861	2.73	0.765	2.83	0.816
23	AMR 10.2	EC9C	2.50	0.684	2.23	0.627	2.36	0.667
24	AMR 7.95	EC0	3.29	0.849	3.06	0.909	3.18	0.883
25	AMR 7.95	EC1C	3.06	0.810	3.02	0.699	3.04	0.753
26	AMR 7.95	EC2C	3.04	0.743	2.88	0.914	2.96	0.832
27	AMR 7.95	EC3C	2.77	0.778	2.48	0.714	2.63	0.757
28	AMR 7.95	EC4C	3.15	0.799	3.02	0.785	3.08	0.790
29	AMR 7.95	EC5C	3.10	0.722	3.00	0.875	3.05	0.800
30	AMR 7.95	EC6C	2.60	0.818	2.48	0.799	2.54	0.807
31	AMR 7.40	EC0	2.94	0.783	3.00	0.772	2.97	0.774
32	AMR 7.40	EC7C	2.94	0.755	2.81	0.790	2.88	0.771
33	AMR 7.40	EC8C	2.75	0.700	3.02	0.729	2.89	0.724
34	AMR 7.40	EC9C	2.52	0.799	2.63	0.733	2.57	0.764
35	AMR 6.70	EC0	3.17	0.781	3.19	0.734	3.18	0.754
36	AMR 6.70	EC1C	2.96	0.651	2.85	0.714	2.91	0.682
37	AMR 6.70	EC2C	3.02	0.729	2.60	0.792	2.81	0.786
38	AMR 6.70	EC3C	2.52	0.684	2.33	0.859	2.43	0.778
39	AMR 6,70	EC4C	3.10	0.778	2.79	0.824	2.95	0.813
40	AMR 6.70	EC5C	3.08	0.794	2.90	0.722	2.99	0.761
41	AMR 6.70	EC6C	2.42	0.794	2.33	0.753	2.38	0.771
42	AMR 5.90	EC0	2.96	0.743	2.79	0.713	2.88	0.729
43	AMR 5.90	EC7C	2.83	0.694	2.79	0.713	2.81	0.701
44	AMR 5.90	EC8C	2.79	0.743	2.69	0.689	2.74	0.714
45	AMR 5.90	EC9C	2.69	0.689	2.29	0.617	2.49	0.680
46	AMR 5.15	EC0	2.98	0.758	2.92	0.794	2.95	0.773
47	AMR 5.15	EC1C	2.88	0.761	2.69	0.719	2.78	0.743
48	AMR 5.15	EC2C	2.77	0.692	2.63	0.733	2.70	0.713
49	AMR 5.15	EC3C	2.52	0.618	2.40	0.736	2.46	0.679
50	AMR 5.15	EC4C	2.88	0.570	2.75	0.729	2.81	0.654
51	AMR 5.15	EC5C	2.60	0.792	2.58	0.613	2.59	0.705
52	AMR 5.15	EC6C	2.48	0.618	2.48	0.850	2.48	0.740
53	AMR 4.75	EC0	3.00	0.715	2.88	0.761	2.94	0.737
54	AMR 4.75	EC7C	2.83	0.694	2.69	0.776	2.76	0.736
55	AMR 4.75	EC8C	2.69	0.748	2.73	0.736	2.71	0.739
56	AMR 4.75	EC9C	2.54	0.743	2.21	0.582	2.38	0.684

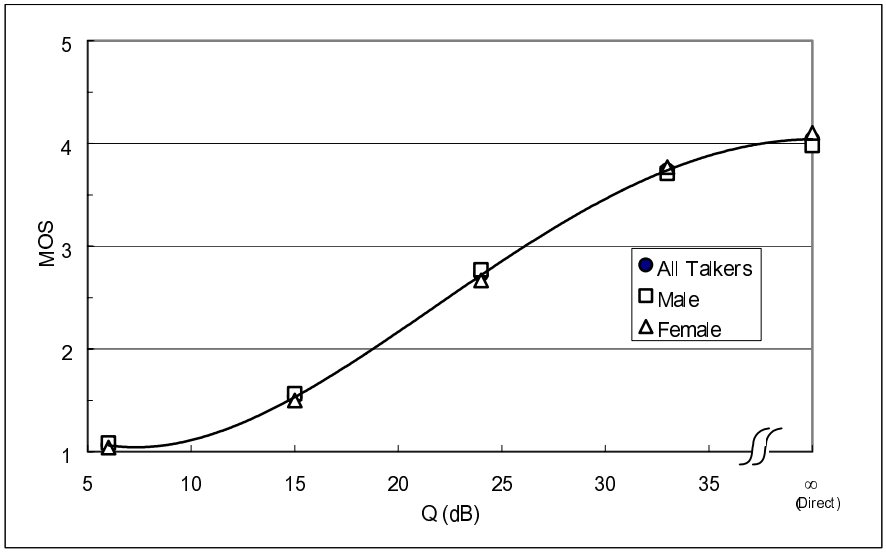

Fig. 1 MOS v.s. Q curve

For the reference codecs, the MOS values coincide with the reported values within subjective variance. Under almost all codec conditions, the MOS for male talkers was better than for female talkers.

6.2 Codec conditions

(1) Error-free conditions

The MOS for the codecs are plotted in Figs. 2, wich compares the MOS for G-Series Codecs. The performance of the AMR-NB codecs has a tendency to decrease along with the bit rate but a lower bit rate is not always rated as poorer as can be seen at 6.7 kb/s. The performance is a little lower than for a G.726 32kb/s codec, but is comparable to the performance of the other G-Series codecs.

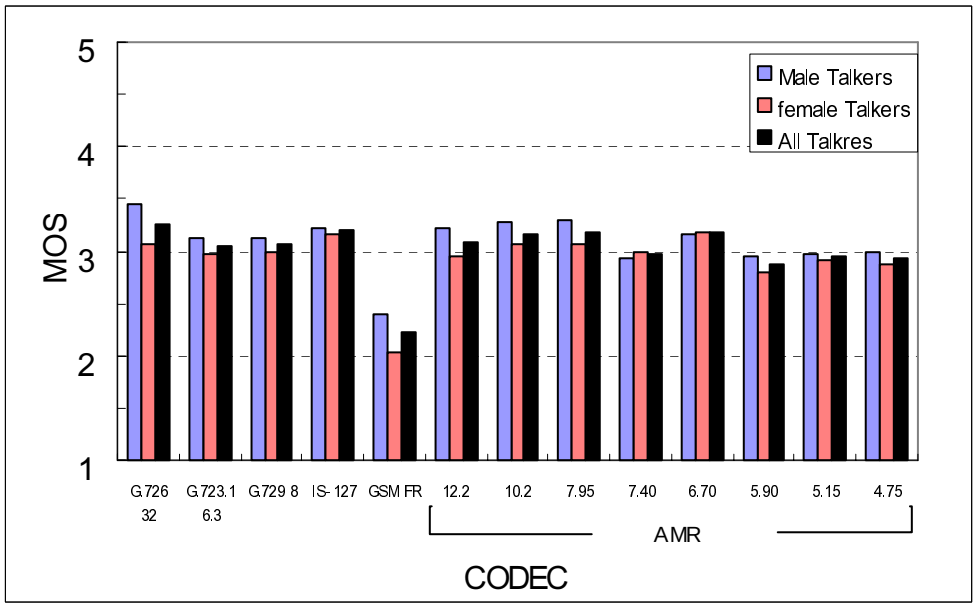

Fig. 2 MOS for reference codecs and AMR codecs at several bit rates (Error free condition)

(2) Performance with error present

The results are shown in Fig. 3.

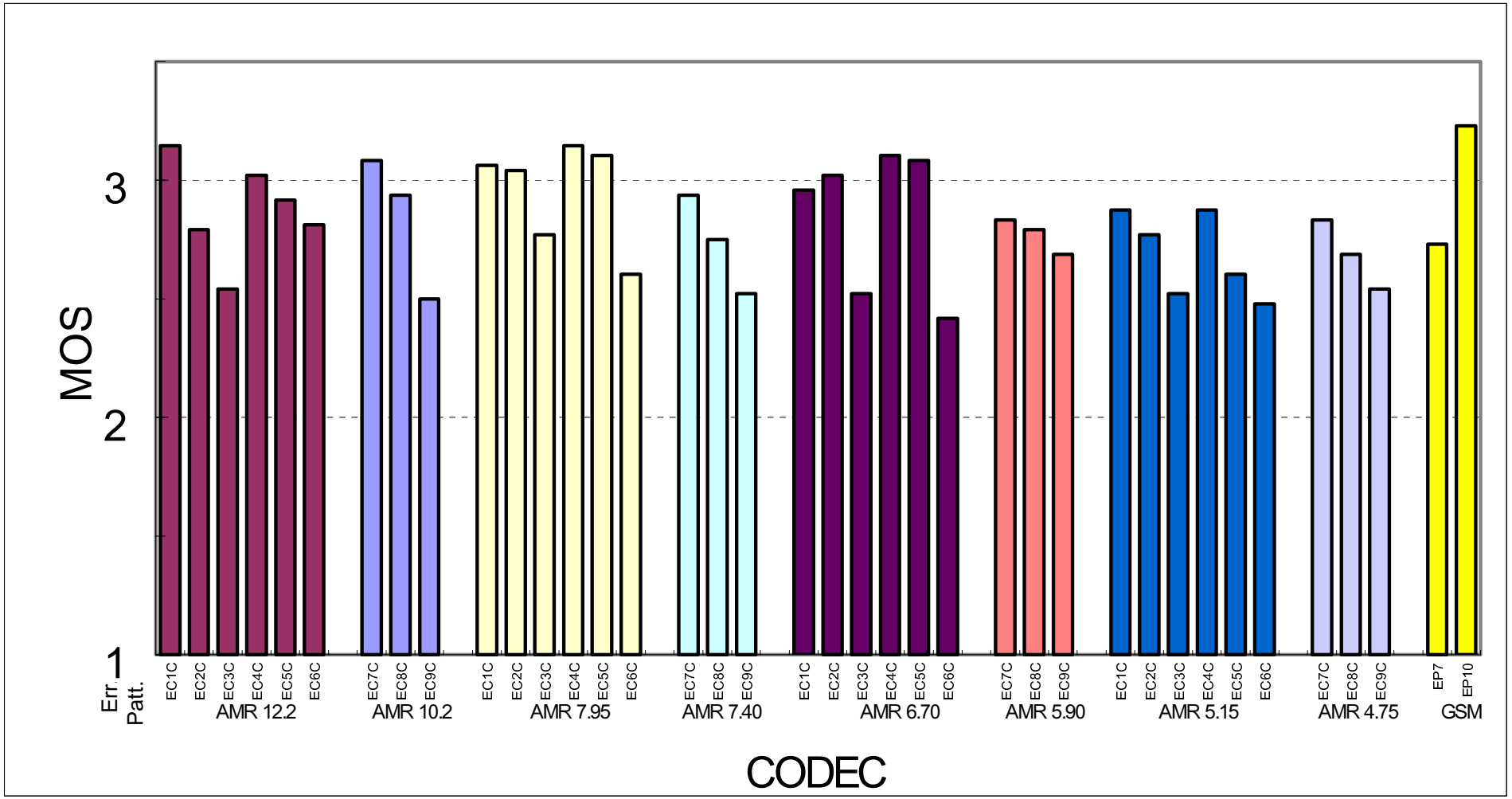

Fig. 3 MOS variation with a variety of error patterns

The performance varies according to the different error patterns at given bit rates. The maximum difference in MOS for a variation in error pattern is greater than 0.5.

7. Conclusion

Our experiments reveal that the AMR narrow-band codec has performance in terms of quality that is comparable with those of existing G. series and IS-127 codecs as long as its bit rate decreases up to 4.75 kb/s under the error free condition.

When error is inserted, the performance as reflected in the MOS decreases about 0.5 in the worst case.

Regardless, with or without transmission error, the performance for male talkers was better than for female talkers.

3GPP TSG-S4#14 meeting ***Tdoc. S4 (00)0627***
Nov.27-Dec.1, 2000, Bath, UK

Title: AMR-NB Characterization Experiment 2A Results

Source*: ARCON Corp.

Summary

This document presents a summary for 3G AMR-NB Characterization Experiment 2 conducted by ARCON Corporation. Experiment 2 investigated the performance the AMR codec for 3G static error conditions in the presence of car background noise. Four uplink and two downlink channel scenarios were evaluated across 8 AMR rates.

1.0 Introduction

ARCON Corporation's Digital Speech Testing Laboratory performed listening assessments in 3G AMR-NB Characterization Phase. Experiment 2 was designed to evaluate the performance the AMR codec for 3G static error conditions in the presence of car background noise.

> The experiment design for Experiment 2 is described in Section 6 of the Test plan for the 3G AMR-NB Characterization [Ref. 1]. Over the whole experiment, each condition had 24 different speech samples passed through it. Each of these was voted once by the 4 subjects in each of 6 groups, 96 votes per condition

All processed material was received from the host Laboratory and had been processed according to the processing document [Ref. 2].

2.0 Experimental Design

The speech material for Experiment 2 consisted of a total of 6 sentence-pairs per talker used during the main experiment for two male and two female talkers. Additionally, two sentence-pairs per talker were used for the practice sessions. The noisy source material used in Experiment 2 was produced from the summation of clean speech material with noisy speech files at appropriate levels.

Tables 2.1 to 2.3 show the preliminary and main conditions for Experiment 2 as conducted by ARCON.

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Table 2.1: Conditions and Factors for Experiment 2

Main Codec Conditions		
Codec Under Test	1	AMR
Error patterns	1	EC0: error-free
	2	EC1D,2D: Downlink
	4	EC32,42,52,62: Uplink
Intra channel rates	1 x 8	EC0: 12.2, 10.2, 7.90, 7.40, 6.70, 5.90, 5.15 and 4.75 kbit/s
	2 x 4	EC[3,4]2: 12.2, 7.95, 6.7, 5.15
	2 x 4	EC[1,2]D: 10.2, 7.4, 5.90, 4.75
	2 x 3	EC[5,6]2: 10.2, 7.4, 5.90
Input level	1	Nominal (-26dBov)
Tandeming	1	Single encoding
Background Noise	1	Car @ 15 dB SNR
VAD/CNG		VAD/CNG **off**
Input Characteristic	1	GSM Send Characteristics
Codec references		
Codecs	4	
		G.729 at 8 kbit/s (no errors)
		G.723.1 at 6.3 kbit/s (no errors)
		GSM EFR at 10 dB C/I (EP10) and 7 dB C/I (EP7)
Input level	1	Nominal (-26dBov)
BER	1	No errors
Tandeming	1	Single encoding
Background Noise	1	Car @ 15 dB SNR
VAD/CNG		VAD/CNG **off**
Noise suppression		Deactivated (when available)
Input Characteristic	1	Flat, Linear PCM
Other references		
Direct	1	Nominal level, Flat (Linear PCM, no A-Law)
MNRU	5	Nominal level, Flat (car background noise), Q= 6, 12, 18, 24 and 30 dB
Common Conditions		
3GPP Channel	1	3G FDD operation mode
Number of talkers	4	2 male and 2 female (M01, M02, F01, F02)
Stimulus type		Sentence-pairs
No. of source samples per talker	8	6 SP for main experiment, 2 SP for preliminaries
Listening Level	1	-15 dBPa (79dB SPL) at ERP (Ear Reference Point), for the Nominal Speech Input Level
Listening Instrument		Telephone handset with a modified IRS (MIRS) receiving response or 1 channel headphones with appropriate filtering
Languages	1	English
Listeners	24	Naive Listeners
Randomizations	24	6 groups of 4 listeners, 4 repeated measures per group of listeners
Rating Scale	1	Modified DCR, Degradation Quality scale
Total # of presentations	160	40 x 4
Replications	1	

Table 2.2: Conditions for 3G AMR Characterization Experiment 2 (Car noise, DCR)

Cnd	Codec	Noise	Error
1	Direct	Car	EC0
2	MNRU 30dBQ	Car	EC0
3	MNRU 24dBQ	Car	EC0
4	MNRU 18dBQ	Car	EC0
5	MNRU 12dBQ	Car	EC0
6	MNRU 06dBQ	Car	EC0
7	G.729 8	Car	EC0
8	G.723.1 6.3	Car	EC0
9	GSM EFR	Car	EP7
10	GSM EFR	Car	EP10
11	AMR 12.2	Car	EC0
12	AMR 12.2	Car	EC32
13	AMR 12.2	Car	EC42
14	AMR 10.2	Car	EC0
15	AMR 10.2	Car	EC1D
16	AMR 10.2	Car	EC2D
17	AMR 10.2	Car	EC52
18	AMR 10.2	Car	EC62
19	AMR 7.95	Car	EC0
20	AMR 7.95	Car	EC32
21	AMR 7.95	Car	EC42
22	AMR 7.40	Car	EC0
23	AMR 7.40	Car	EC1D
24	AMR 7.40	Car	EC2D
25	AMR 7.40	Car	EC52
26	AMR 7.40	Car	EC62
27	AMR 6.70	Car	EC0
28	AMR 6.70	Car	EC32
29	AMR 6.70	Car	EC42
30	AMR 5.90	Car	EC0
31	AMR 5.90	Car	EC1D
32	AMR 5.90	Car	EC2D
33	AMR 5.90	Car	EC52
34	AMR 5.90	Car	EC62
35	AMR 5.15	Car	EC0
36	AMR 5.15	Car	EC32
37	AMR 5.15	Car	EC42
38	AMR 4.75	Car	EC0
39	AMR 4.75	Car	EC1D
40	AMR 4.75	Car	EC2D

Table 2.3: Allocation of Preliminary Conditions

Number of Conditions	References MNRU/Codec	Q [dB]	Errors	Background Noise	Talker
P1	MNRU	30	-	Car	M1S07
P2	EFR	-	EP7	Car	M2S08
P3	G.729	-	No Errors	Car	F1S07
P4	MNRU	6	-	Car	F2S08
P5	DIRECT	-	-	Car	M2S07
P6	AMR 12.2	-	EC4	Car	M1S08
P7	AMR 12.2	-	No Errors	Car	F2S07
P8	MNRU	18	-	Car	F1S08

3.0 Listening Environment

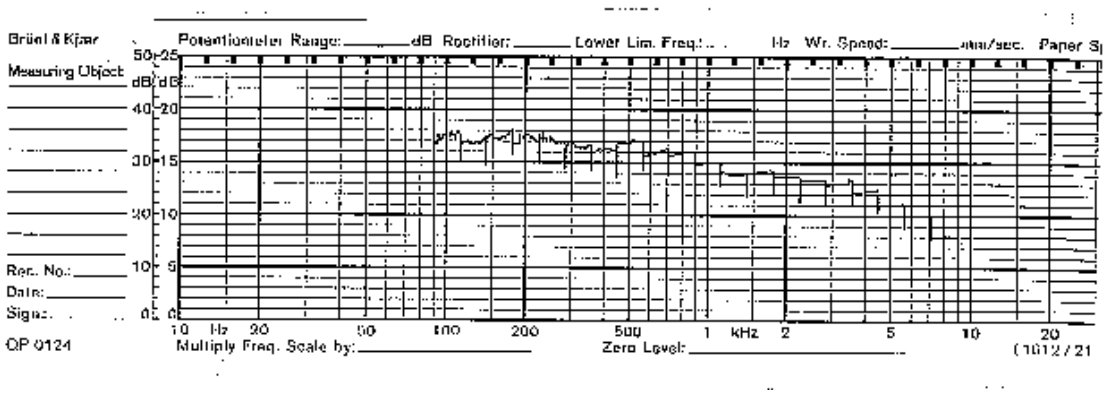
Listeners were placed an acoustic isolation room. The ambient sound pressure level within the room is 23.0dB SPL-A. The room dimensions are 20’ x 10’. Listener stations are along both long walls. Each listener position is

approximately 2 ½' long. One side has eight positions, the other has only six to allow for the doorway. The Hoth environmental noise [Ref. 2] was introduced through speakers placed in the drop ceiling. In this way, uniform noise coverage was provided to each station.

3.1 Environmental Noise

Environmental Noise was fed into the room with the required Hoth spectrum to represent typical room noise at the required 30dBA level measured with a precision sound level meter, used with the "A" weighting and the "fast" meter characteristic. In order to obtain accurate measurement resolution, the spectrum was measured at an overall SPL of 40dB SPL-A. Overall sound level was then reduced to 30dBA.

Figure 3.1 Strip Recording of Room Noise: 1/3 Octave Spectra



3.2 Environmental Noise Generation and Measurement System

Noise Generation Equipment: The following equipment was used in the generation and measurement of the listening room noise field.

Noise Source
- Stanford Research Systems Model DS335 Synthesized Function Generator

Band Limiting Filter Set
- Precision Filter Set Model 636 Anti-Alias Filters
- LP1-G-01-02 6 pole, 6 zero elliptic (Cauer) Cutoff Frequency: 10KHz
- HP1-G-01-02 6 pole, 6 zero elliptic (Cauer) Cutoff Frequency: 90Hz

Noise Shaping Filter Set
- JBL Model 5547A Graphic Equalizer, 1/3 Octave

Amplification
- Crown D-75 Power Amplifier (Mono)

Transducers:
- CSI Model SP-6C Coaxial Speakers (4 units)

The cutoff frequencies of the band limiting filter set were chosen to diminish the effect of the filters' –3dB attenuation at the cutoff frequency on the power of the uppermost and lowermost 1/3 octave bands (i.e., 100Hz and 8,000Hz). The Noise Shaping Filter Set was used to adjust the spectra as actually measured in the room. Five speaker units were used to insure uniform coverage for all four listeners in the noise field.

Noise Measurement Equipment:
Microphone - Bruel & Kjaer Type 4155 Electret Condenser Microphone
Sound Pressure Level Meter - Bruel & Kjaer Type 2230
1/3 Octave Filter Set - Bruel & Kjaer Type 1625
Strip Recorder - Bruel & Kjaer Type 2317 Level Recorder

Linear SPL Measurements were performed in 1/3 octave steps on 1/3 octave bands in the range of 100-8kHz.

4.0 Testing Procedures

The Test Plan for the 3G AMR-NB Characterization was followed for the Modified Degraded Category Rating(DCR) test procedures. Where not specific, the expertise of the ARCON Corporation test facility was used. Where clarification to instructions was needed the expertise of the ARCON Corporation testing personnel was used and is described in full. ARCON used the grouping and randomization sequences specified in the 3G AMR-NB Characterization Test Plan for Experiment 2. The test schedule was designed to maximize listener performance and minimize listener fatigue.

The subjective assessment was performed using 24 listeners (nominally balanced between male and female subjects). Each of the speech samples was presented to the listener, first the Direct (noisy, unprocessed) version and then through the test condition indicated in Table 2.1. In this adaptation of the DCR procedure, the listeners judged the degradation of the sample to be evaluated with regard to the preceding quality reference sample that was mixed with the same noise (Car noise). Each degradation judgment was collected on a 5-point degradation scale with regard to the quality reference, as follows:

5 ***Degradation is inaudible***
4 ***Degradation is audible but not annoying***
3 ***Degradation is slightly annoying***
2 ***Degradation is annoying***
1 ***Degradation is very annoying***

It should be noted that the annex provided in the Test Plan presented sample instructions with a different scale. The scale indicated above (and in the body of the Test Plan) was used by ARCON.

The listener selection criterion was consistent with that used for other AMR evaluations and audiometric examinations demonstrated hearing within normal limits for frequencies between 250 and 8000 Hz.

After hearing screens and all paper work were completed, the appropriate DCR Introduction and Training was conducted. Listeners read along as scripted instructions were read aloud. The scripted instructions included information about use of the button boxes, headset placement, in addition to the specifics required by the AMR test plan Annex. ARCON experience has demonstrated the efficacy of emphasizing the direction of comparisons, and this was done by including the words “the second compared to the first” wherever relevant. After training was complete the DCR preliminary material block was run and testing then commenced.

Questions were answered as needed during training only in reference to the use of the button boxes and specifics regarding the conduct of the test such as breaks and overall length. No information was provided which might influence decision-making.

5.0 Audio Presentation

All processed audio files were filtered with the Modified IRS (MIRS) receive response filter available in the STL2000 toolkit. Files were byte swapped to big endian and transferred to a Sun Sparcstation. Files were output to DAT in presentation order with a DatLink digital processor. The DAT output was upsampled to 48kHz with proper antialias filtering. A professional DAT playback unit under computer control presented the stimuli to the subjects. The presentation circuit consists of a Crown 75 power amplifier, a distribution network and to a single earcup of each listening station. Sony MDR-7506 circum-aural professional studio monitor headphones were used. Listeners placed the inactive earcup behind the ear.

6.0 Scoring

The categorical designations were presented at the top of the button box with each button appropriately labeled. Listener responses were collected and stored through the use of a single test administration computer. The button boxes were locked out from listener responce until the stimulus has been presented in its entirety, All listeners were required to register responses prior to the subsequent presentation of a new stimulus.

Upon completion of the listening sessions, individual test files were transferred to a single large file for the statistical analyses reported here and for presentation for global analyses.

7.0 Results

Average scores and standard deviations across all talkers, male talkers and female talkers for each condition of the are provided in Table 7.1. Details of the channel error conditions are presented in Table 7.2.

Table 7.1 Experiment 2 Results

Experiment 2A: 3G AMR-NB Test Results

Effect of Car Background Noise in Static C/I Conditions

DCR Test

Organization: ARCON **Language:** English

Conditions: 40

Vote/Condition: 4talkers*24subjects= 96

Condition	Codec/MNRU	Channel/ Level	Males Talkers		Females Talkers		All Talkers	
			MOS	σ	MOS	σ	MOS	σ
1	Direct	-	4.3750	0.7330	4.2917	0.8241	4.3333	0.7769
2	MNRU	30 dBQ	4.3125	0.7761	4.0208	1.1011	4.1667	0.9588
3	MNRU	24 dBQ	4.1667	0.9528	4.1458	1.0312	4.1563	0.9876
4	MNRU	18 dBQ	3.4792	1.1107	3.0833	0.9857	3.2813	1.0633
5	MNRU	12 dBQ	2.1875	1.1606	1.7917	0.9884	1.9896	1.0906
6	MNRU	06 dBQ	1.5208	1.0516	1.5417	0.9884	1.5313	1.0152
7	G.729 8	EC0	3.6667	1.0383	3.3542	1.0816	3.5104	1.0662
8	G.723.1 6.3	EC0	3.4375	0.8729	3.2292	0.9280	3.3333	0.9022
9	GSM EFR	EP7	2.8333	1.3101	2.2917	1.0097	2.5625	1.1948
10	GSM EFR	EP10	3.7500	0.9565	3.2917	1.1291	3.5208	1.0660
11	AMR 12.2	EC0	3.9375	0.9319	3.9167	1.0485	3.9271	0.9867
12	AMR 12.2	EC32	3.8542	0.8749	3.6250	1.0644	3.7396	0.9760
13	AMR 12.2	EC42	3.8958	1.0364	3.7917	0.9216	3.8438	0.9769
14	AMR 10.2	EC0	4.2292	0.8313	3.8750	1.0027	4.0521	0.9332
15	AMR 10.2	EC1D	3.8958	0.9507	3.5208	0.9673	3.7083	0.9724
16	AMR 10.2	EC2D	3.6250	0.8660	3.6250	0.8154	3.6250	0.8367
17	AMR 10.2	EC52	3.7500	0.7579	3.6458	0.9338	3.6979	0.8475
18	AMR 10.2	EC62	3.5625	1.0897	3.4792	1.0516	3.5208	1.0660
19	AMR 7.95	EC0	3.5833	0.9187	3.7500	0.8873	3.6667	0.9022
20	AMR 7.95	EC32	3.6042	0.9837	3.5208	0.8749	3.5625	0.9269
21	AMR 7.95	EC42	3.8125	0.8419	3.4167	0.8711	3.6146	0.8750
22	AMR 7.40	EC0	3.7292	0.8440	3.5000	1.0106	3.6146	0.9332
23	AMR 7.40	EC1D	3.5000	0.8992	3.3333	1.0176	3.4167	0.9588
24	AMR 7.40	EC2D	3.5417	1.0306	3.1250	1.1416	3.3333	1.1018
25	AMR 7.40	EC52	3.4167	1.0280	3.2500	0.9109	3.3333	0.9697
26	AMR 7.40	EC62	3.2500	0.8873	2.9167	1.0071	3.0833	0.9588
27	AMR 6.70	EC0	3.8333	0.8588	3.6458	0.9563	3.7396	0.9090
28	AMR 6.70	EC32	3.7083	0.8495	3.6667	0.8337	3.6875	0.8374
29	AMR 6.70	EC42	3.6250	0.8660	3.3333	0.8833	3.4792	0.8823
30	AMR 5.90	EC0	3.3125	1.0346	3.2708	0.9165	3.2917	0.9724
31	AMR 5.90	EC1D	3.2500	1.0000	3.1875	1.0848	3.2188	1.0382
32	AMR 5.90	EC2D	3.1458	1.1848	3.1875	1.1043	3.1667	1.1394
33	AMR 5.90	EC52	3.3750	0.9593	3.0208	0.9563	3.1979	0.9692
34	AMR 5.90	EC62	3.0417	1.1101	2.9792	0.8870	3.0104	0.9999
35	AMR 5.15	EC0	3.0625	1.0600	3.1042	1.0962	3.0833	1.0728
36	AMR 5.15	EC32	2.8125	1.0848	3.1458	1.1297	2.9792	1.1143
37	AMR 5.15	EC42	2.8750	1.0644	2.8125	1.0650	2.8438	1.0596
38	AMR 4.75	EC0	3.1042	1.0567	2.7708	1.0766	2.9375	1.0742
39	AMR 4.75	EC1D	2.9792	1.0208	2.8333	1.0176	2.9063	1.0165
40	AMR 4.75	EC2D	2.3958	1.0667	2.5208	1.2546	2.4583	1.1600

Table 7.2 Experiment 2 Channel Condition Details

EC	Direction	Path Profile	Speed	Target	Source
EC1D	Downlink	Pedestrian-B	3 km/h	0.5% FER	NTT DoCoMo
EC2D	Downlink	Pedestrian-B	3 km/h	1% FER	NTT DoCoMo
EC3D	Uplink	Vehicular-A	50 km/h	0.5% FER	Nortel Networks
EC4D	Uplink	Vehicular-A	50 km/h	1% FER	Nortel Networks
EC5D	Uplink	Vehicular-B	120 km/h	0.5% FER	Nortel Networks
EC6D	Uplink	Vehicular-B	120 km/h	1% FER	Nortel Networks

8.0 Conclusions

ARCON Corporation conducted 3G AMR-NB Characterization Experiment 2 as directed by the Test Plan.

References

Ref. 1 3GPP SA4, *"3G Characterization Tests Subjective Test Plan Version 2.0";* Tdoc S4-(00)0472

Ref. 2 3GPP-SA WG4 Processing Plan for 3G AMR Characterization

3GPP TSG-S4#14 meeting **Tdoc. S4 (00)0629R**
Nov.27-Dec.1, 2000, Bath, UK

Title: AMR-NB Characterization Global Analysis

Source*: ARCON Corporation

Executive Summary

Arcon Corporation conducted a Global Analysis of the AMR Narrowband 3G Characterization Test results in compliance with previously accepted 3GPP and ETSI practices. This analysis resulted in the calculation of a number of comparative plots, gender comparisons, and 95% confidence interval calculations over a set of four (4) experiments conducted in three languages at four subjective listening laboratories.. Where appropriote, rank order equivalance groups are calculated using independent T-test calculations. This analysis is contained in the accompanying Excel spreadsheets.

1. Introduction.

Arcon Corp. has contracted with ETSI to be the global analysis laboratory (GAL) for the subjective test results of the four (4) experiments of the AMR Narrowband 3G Charaterization Test. Table 1.1 lists the listening Laboratories, languages and experiments involved in this effort. The languages involved are North American English (NAE), Korean (K) and Japanese (JP).

Code	R	C	D	N
Test Lab	ARCON	MGT -COMSAT	Dynastat	NTT-AT
Exp1A ACR			NAE	
Exp1B ACR		K		
Exp1C ACR				JP
Exp2A DCR	NAE			

Table 1.1 AMR-NB 3G Listening Laboratory Assignments

1.1 Task

Arcon's task calls for:

1. providing the Listening laboratories with a detailed spreadsheet (the global analysis input form), containing the format for all raw data, to enable the Listening laboratories to enter and return their own raw data to the Global Analysis Laboratory.

2. performing the global analysis following the classic elaboration of subjective testing output data, including a statistical analysis.

3. producing appropriate tables and figures for the visual ranking of AMR-NB coder performance for each experiment.

The methods used for these calculations have been defined in earlier ETSI AMR efforts and are detailed in Annex D "Verification of Requirements" of the document AMR Speech Codec Development Project AMR-7b - Test plans for the Selection Phase (3). Annex E "Presentation of Results" provides a template for the format of reports. This format and the various analysis methods and tools have evolved during the various ETSI and 3GPP testing programs since 1998. All of these changes were taken into account in the design of the current GAL effort.

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2. Test Laboratory Raw Data

Recent GAL efforts of ETSI and 3GPP have required the LLs to provide the GAL with results in the form of averages and standard deviations (S.D.) for each condition of an experiment. The statistics were calculated over all subjects and talkers, all subjects and all male talkers, all talkers and female talkers. The current effort requires the LLs to provide the GAL with the raw subject response data and for the GAL to compute the average and S.D. values.

2.1 Data Forms

Arcon provided each LL with a set of data entry Excel spreadsheets. The first , "3GAMR_LabX_Raw_Data.xls", accepted all response data in for each subject in the order called for by each specific experiments group randomization. This spreadsheet could then be reordered with the Excel Data Sort command and calculated all required averages and S.D.s along with the individual talker values. The second spreadsheet, "3GAMRNB_LabX_DataEntry.xls", allowed the LLs to input independently calculated averages and S.D.s. This spreadsheet was later modified to be linked with the corresponding raw data spreadsheet and verify the calculations of averages and S.D.s.

All LLs provided Arcon with their raw data results and their independently calculated averages and S.D.s. These values were calculated from the Raw_Data spreadsheets and cross-checked against the DataEntry spreadsheets.

The file "3GAMRNB_DataEntry.xls" contains all of the LL spreadsheets with the crosscheck function and has been provided as an attachment to this report. The file is in Excel form and is locked, protected and set to be "Read Only".

3. GAL Format

Arcon has provided a analysis spreadsheet, AMRNB_3G_GAL_R.xls, which provides the various statistical analises. The spreadsheet is linked to the "3GAMRNB_DataEntry.xls" spreadsheet. The analysis spreadsheet contains the following worksheets:

Experiment Analysis

Exp1A	analysis of the Dynastat "Clean Speech Performance Under Static Error Conditions" experiment in North American English
Exp1B	analysis of the LMGT "Clean Speech Performance Under Static Error Conditions" experiment in Korean
Exp1C	analysis of the NTT-ATT "Clean Speech Performance Under Static Error Conditions" experiment in Japanese
Exp1	a set of plots providing comparisons of Exp1A, 1B and 1C
Exp2A	analysis of the ARCON "Effect of Car Background Noise in Static C/I Conditions: experiment in North American English

This spreadsheet is attached to this document. The spreadsheet has a revision update section in a worksheet named "ReadMe". The version distributed with this document is "version 1.2". The spreadsheet has been provided Locked, Protected and as Read Only file. One should be able to open the spreadsheet without reestablishing the link structure. The DataEntry spreadsheet is linked to the Raw_Data spreadsheets, Because of the size of the Raw_Data spreadsheets, they have not been included. They should not be needed. If there is a need to return to the Raw_Data, these files are available from the secretary of 3GPP TSG-SA WG4, Mr. Paolo Usai.

4. Results

All results for the Global Analysis are contained in the spreadsheet accompanying this document. Each individual experiment in each language is addressed separately The reader is referred to the spreadsheet for these results.

References

[1] 3GPP TSG-SA WG4, *"Test Plan for the 3G AMR-NB Characterization"*,Tdoc S4-(00)0472.

[2] 3GPP TSG-SA WG4, *"Processing Functions for AMR 3G Characterization Tests"*, Tdoc S4-(00)0473.

Experiment 2A: 3G AMR-NB Test Results

Effect of Car Background Noise in Static C/I Conditions

DCR Test

Organization: ARCON **Language:** English

Conditions: 40

Vote/Condition: 4talkers*24subjects= 96

t(0,05,94)	1,986	2-tailed
n/2	48	

Error conditions for Experiment 2

EC	Direction	Path Profile	Speed	Target	Source
EC1D	Downlink	Pedestrian-B	3 km/h	0,5% FER	NTT DoCoMo
EC2D	Downlink	Pedestrian-B	3 km/h	1% FER	NTT DoCoMo
EC3D	Uplink	Vehicular-A	50 km/h	0,5% FER	Nortel Networks
EC4D	Uplink	Vehicular-A	50 km/h	1% FER	Nortel Networks
EC5D	Uplink	Vehicular-B	120 km/h	0,5% FER	Nortel Networks
EC6D	Uplink	Vehicular-B	120 km/h	1% FER	Nortel Networks

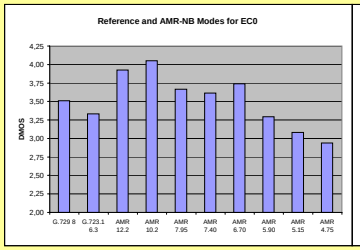
	Condition	Codec/MNRU	Channel/ Level	Males Talkers MOS	σ	Females Talkers MOS	σ	All Talkers MOS	σ	Qeq	M/F Comp.
Direct	1	Direct	-	4,3750	0,7330	4,2917	0,8241	4,3333	0,7769	41,13	Equiv.
30	2	MNRU	30 dBQ	4,3125	0,7761	4,0208	1,1011	4,1667	0,9588	27,86	Equiv.
24	3	MNRU	24 dBQ	4,1667	0,9528	4,1458	1,0312	4,1563	0,9876	27,57	Equiv.
18	4	MNRU	18 dBQ	3,4792	1,1107	3,0833	0,9857	3,2813	1,0633	17,81	Equiv.
12	5	MNRU	12 dBQ	2,1875	1,1606	1,7917	0,9884	1,9896	1,0906	10,23	Equiv.
6	6	MNRU	06 dBQ	1,5208	1,0516	1,5417	0,9884	1,5313	1,0152	6,53	Equiv.
G729@8 EC	7	G.729 8	EC0	3,6667	1,0383	3,3542	1,0816	3,5104	1,0662	19,39	Equiv.
G723.1@6.	8	G.723.1 6.3	EC0	3,4375	0,8729	3,2292	0,9280	3,3333	0,9022	18,15	Equiv.
GSM EFR E	9	GSM EFR	EP7	2,8333	1,3101	2,2917	1,0097	2,5625	1,1948	13,65	M. Bet.
GSM EFR E	10	GSM EFR	EP10	3,7500	0,9565	3,2917	1,1291	3,5208	1,0660	19,47	M. Bet.
	11	AMR 12.2	EC0	3,9375	0,9319	3,9167	1,0485	3,9271	0,9867	23,37	Equiv.
	12	AMR 12.2	EC32	3,8542	0,8749	3,6250	1,0644	3,7396	0,9760	21,33	Equiv.
	13	AMR 12.2	EC42	3,8958	1,0364	3,7917	0,9216	3,8438	0,9769	22,37	Equiv.
	14	AMR 10.2	EC0	4,2292	0,8313	3,8750	1,0027	4,0521	0,9332	25,27	Equiv.
	15	AMR 10.2	EC1D	3,8958	0,9507	3,5208	0,9673	3,7083	0,9724	21,02	Equiv.
	16	AMR 10.2	EC2D	3,6250	0,8660	3,6250	0,8154	3,6250	0,8367	20,29	Equiv.
	17	AMR 10.2	EC52	3,7500	0,7579	3,6458	0,9338	3,6979	0,8475	20,92	Equiv.
	18	AMR 10.2	EC62	3,5625	1,0897	3,4792	1,0516	3,5208	1,0660	19,47	Equiv.
	19	AMR 7.95	EC0	3,5833	0,9187	3,7500	0,8873	3,6667	0,9022	20,65	Equiv.
	20	AMR 7.95	EC32	3,6042	0,9837	3,5208	0,8749	3,5625	0,9269	19,79	Equiv.
	21	AMR 7.95	EC42	3,8125	0,8419	3,4167	0,8711	3,6146	0,8750	20,21	M. Bet.
	22	AMR 7.40	EC0	3,7292	0,8440	3,5000	1,0106	3,6146	0,9332	20,21	Equiv.
	23	AMR 7.40	EC1D	3,5000	0,8992	3,3333	1,0176	3,4167	0,9588	18,72	Equiv.
	24	AMR 7.40	EC2D	3,5417	1,0306	3,1250	1,1416	3,3333	1,1018	18,15	Equiv.
	25	AMR 7.40	EC52	3,4167	1,0280	3,2500	0,9109	3,3333	0,9697	18,15	Equiv.
	26	AMR 7.40	EC62	3,2500	0,8873	2,9167	1,0071	3,0833	0,9588	16,59	Equiv.
	27	AMR 6.70	EC0	3,8333	0,8588	3,6458	0,9563	3,7396	0,9090	21,31	Equiv.
	28	AMR 6.70	EC32	3,7083	0,8495	3,6667	0,8337	3,6875	0,8374	20,83	Equiv.
	29	AMR 6.70	EC42	3,6250	0,8660	3,3333	0,8833	3,4792	0,8823	19,16	Equiv.
	30	AMR 5.90	EC0	3,3125	1,0346	3,2708	0,9165	3,2917	0,9724	17,88	Equiv.
	31	AMR 5.90	EC1D	3,2500	1,0000	3,1875	1,0848	3,2188	1,0382	17,42	Equiv.
	32	AMR 5.90	EC2D	3,1458	1,1848	3,1875	1,1043	3,1667	1,1394	17,09	Equiv.
	33	AMR 5.90	EC52	3,3750	0,9593	3,0208	0,9563	3,1979	0,9692	17,29	Equiv.
	34	AMR 5.90	EC62	3,0417	1,1101	2,9792	0,8870	3,0104	0,9999	16,17	Equiv.
	35	AMR 5.15	EC0	3,0625	1,0600	3,1042	1,0962	3,0833	1,0728	16,59	Equiv.
	36	AMR 5.15	EC32	2,8125	1,0848	3,1458	1,1297	2,9792	1,1143	15,98	Equiv.
	37	AMR 5.15	EC42	2,8750	1,0644	2,8125	1,0650	2,8438	1,0596	15,21	Equiv.
	38	AMR 4.75	EC0	3,1042	1,0567	2,7708	1,0766	2,9375	1,0742	15,75	Equiv.
	39	AMR 4.75	EC1D	2,9792	1,0208	2,8333	1,0176	2,9063	1,0165	15,57	Equiv.
	40	AMR 4.75	EC2D	2,3958	1,0667	2,5208	1,2546	2,4583	1,1600	13,06	Equiv.

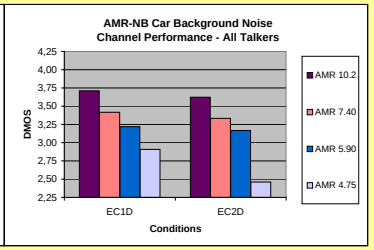
Ymax	4,33
S	0,05
M	14,23
Qmin	2,60
Qmax	25,85

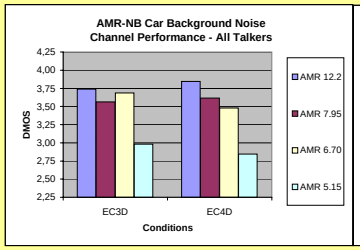
MNRU	Qi	Yi	eqQ	dydQ
1	30,00	4,17	27,86	0,022
2	24,00	4,16	27,57	0,069
3	18,00	3,28	17,81	0,153
4	12,00	1,99	10,23	0,170
5	6,00	1,53	6,53	0,089

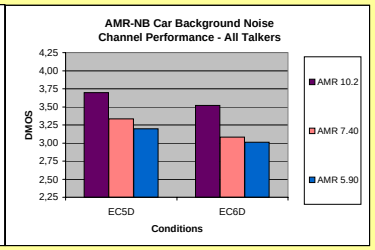
Q (dBQ)	Y
0	1,15
1	1,18
2	1,22
3	1,27
4	1,33
5	1,40
6	1,48
7	1,58
8	1,69
9	1,81
10	1,95
11	2,11
12	2,27
13	2,45
14	2,63
15	2,81
16	2,98
17	3,15
18	3,31
19	3,46
20	3,59
21	3,71
22	3,81
23	3,90
24	3,97
25	4,04
26	4,09
27	4,13
28	4,17
29	4,20
30	4,23
31	4,25
32	4,26
33	4,28
34	4,29
35	4,30
36	4,30
37	4,31
38	4,31
39	4,32
40	4,32
41	4,32
42	4,33
43	4,33
44	4,33
45	4,33
46	4,33
47	4,33
48	4,33
49	4,33
50	4,33

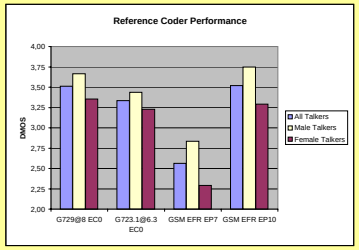
0,00	1,25	4,08		
50	1,25	4,08		

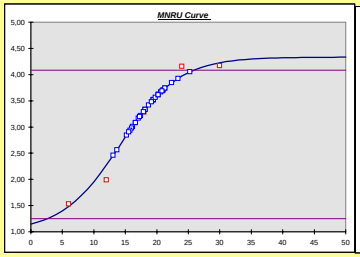


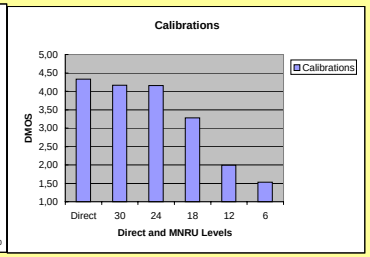












Confidence: 0,05 **Vote/Condition:** 96,00

	t(0,05,190)	1,97	2-tailed
	n/96,00		

	1	3	6,00	7,00	9,00	10,00	11,00
	Codec/	Channel/	Cont. Int.		All Talkers		
Cond.	MNRU	Level	-0,95	0,95	MOS	σ	Delta
1	Direct	-	4,18	4,49	4,33	0,78	-
2	MNRU	30 dBQ	3,97	4,36	4,17	0,96	0,17
3	MNRU	24 dBQ	3,96	4,35	4,16	0,99	0,01
14	AMR 10.2	EC0	3,87	4,24	4,05	0,93	0,10
11	AMR 12.2	EC0	3,73	4,12	3,93	0,99	0,13
13	AMR 12.2	EC42	3,65	4,04	3,84	0,98	0,08
12	AMR 12.2	EC32	3,54	3,93	3,74	0,98	0,10
27	AMR 6.70	EC0	3,56	3,92	3,74	0,91	0,00
15	AMR 10.2	EC1D	3,51	3,90	3,71	0,97	0,03
17	AMR 10.2	EC52	3,53	3,87	3,70	0,85	0,01
28	AMR 6.70	EC32	3,52	3,86	3,69	0,84	0,01
19	AMR 7.95	EC0	3,49	3,85	3,67	0,90	0,02
16	AMR 10.2	EC2D	3,46	3,79	3,63	0,84	0,04
21	AMR 7.95	EC42	3,44	3,79	3,61	0,88	0,01
22	AMR 7.40	EC0	3,43	3,80	3,61	0,93	0,00
20	AMR 7.95	EC32	3,38	3,75	3,56	0,93	0,05
10	GSM EFR	EP10	3,31	3,73	3,52	1,07	0,04
18	AMR 10.2	EC62	3,31	3,73	3,52	1,07	0,00
7	G.729 8	EC0	3,30	3,72	3,51	1,07	0,01
29	AMR 6.70	EC42	3,30	3,66	3,48	0,88	0,03
23	AMR 7.40	EC1D	3,22	3,61	3,42	0,96	0,06
8	G.723.1 6.3	EC0	3,15	3,51	3,33	0,90	0,08
24	AMR 7.40	EC2D	3,11	3,55	3,33	1,10	0,00
25	AMR 7.40	EC52	3,14	3,53	3,33	0,97	0,00
30	AMR 5.90	EC0	3,10	3,49	3,29	0,97	0,04
4	MNRU	18 dBQ	3,07	3,49	3,28	1,06	0,01
31	AMR 5.90	EC1D	3,01	3,43	3,22	1,04	0,06
33	AMR 5.90	EC52	3,00	3,39	3,20	0,97	0,02
32	AMR 5.90	EC2D	2,94	3,39	3,17	1,14	0,03
26	AMR 7.40	EC62	2,89	3,28	3,08	0,96	0,08
35	AMR 5.15	EC0	2,87	3,30	3,08	1,07	0,00
34	AMR 5.90	EC62	2,81	3,21	3,01	1,00	0,07
36	AMR 5.15	EC32	2,76	3,20	2,98	1,11	0,03
38	AMR 4.75	EC0	2,72	3,15	2,94	1,07	0,04
39	AMR 4.75	EC1D	2,70	3,11	2,91	1,02	0,03
37	AMR 5.15	EC42	2,63	3,06	2,84	1,06	0,06
9	GSM EFR	EP7	2,32	2,80	2,56	1,19	0,28
40	AMR 4.75	EC2D	2,23	2,69	2,46	1,16	0,10
5	MNRU	12 dBQ	1,77	2,21	1,99	1,09	0,47
6	MNRU	06 dBQ	1,33	1,73	1,53	1,02	0,46

	1	3	6,00	7,00	9,00	10,00	11,00
	Codec/	Channel/	Cont. Int.		All Talkers		
Cond.	MNRU	Level	-0,95	0,95	MOS	σ	Delta
1	Direct	-	4,18	4,49	4,33	0,78	-
2	MNRU	30 dBQ	3,97	4,36	4,17	0,96	0,17
3	MNRU	24 dBQ	3,96	4,35	4,16	0,99	0,01
4	MNRU	18 dBQ	3,07	3,49	3,28	1,06	0,88
5	MNRU	12 dBQ	1,77	2,21	1,99	1,09	1,29
6	MNRU	06 dBQ	1,33	1,73	1,53	1,02	0,46
14	AMR 10.2	EC0	3,87	4,24	4,05	0,93	-
11	AMR 12.2	EC0	3,73	4,12	3,93	0,99	0,13
27	AMR 6.70	EC0	3,56	3,92	3,74	0,91	0,19
19	AMR 7.95	EC0	3,49	3,85	3,67	0,90	0,07
22	AMR 7.40	EC0	3,43	3,80	3,61	0,93	0,05
7	G.729 8	EC0	3,30	3,72	3,51	1,07	0,10
8	G.723.1 6.3	EC0	3,15	3,51	3,33	0,90	0,18
30	AMR 5.90	EC0	3,10	3,49	3,29	0,97	0,04
35	AMR 5.15	EC0	2,87	3,30	3,08	1,07	0,21
38	AMR 4.75	EC0	2,72	3,15	2,94	1,07	0,15
15	AMR 10.2	EC1D	3,51	3,90	3,71	0,97	-
23	AMR 7.40	EC1D	3,22	3,61	3,42	0,96	0,29
31	AMR 5.90	EC1D	3,01	3,43	3,22	1,04	0,20
39	AMR 4.75	EC1D	2,70	3,11	2,91	1,02	0,31
16	AMR 10.2	EC2D	3,46	3,79	3,63	0,84	-
24	AMR 7.40	EC2D	3,11	3,55	3,33	1,10	0,29
32	AMR 5.90	EC2D	2,94	3,39	3,17	1,14	0,17
40	AMR 4.75	EC2D	2,23	2,69	2,46	1,16	0,71
12	AMR 12.2	EC32	3,54	3,93	3,74	0,98	-
28	AMR 6.70	EC32	3,52	3,86	3,69	0,84	0,05
20	AMR 7.95	EC32	3,38	3,75	3,56	0,93	0,13
36	AMR 5.15	EC32	2,76	3,20	2,98	1,11	0,58
13	AMR 12.2	EC42	3,65	4,04	3,84	0,98	-
21	AMR 7.95	EC42	3,44	3,79	3,61	0,88	0,23
29	AMR 6.70	EC42	3,30	3,66	3,48	0,88	0,14
37	AMR 5.15	EC42	2,63	3,06	2,84	1,06	0,64
17	AMR 10.2	EC52	3,53	3,87	3,70	0,85	-
25	AMR 7.40	EC52	3,14	3,53	3,33	0,97	0,36
33	AMR 5.90	EC52	3,00	3,39	3,20	0,97	0,14
18	AMR 10.2	EC62	3,31	3,73	3,52	1,07	-
26	AMR 7.40	EC62	2,89	3,28	3,08	0,96	0,44
34	AMR 5.90	EC62	2,81	3,21	3,01	1,00	0,07
10	GSM EFR	EP10	3,31	3,73	3,52	1,07	-
9	GSM EFR	EP7	2,32	2,80	2,56	1,19	0,96

Experiment 1C: 3G AMR-NB Test Results

Clean Speech Performance Under Static Error Conditions

ACR Test

Organization: *NTT-AT* **Language:** Japanese

Conditions: 56
Vote/Condition: 4 talkers * 24 subjects = 96

Condition	Codec/MNRU	Channel/ Level	Males Talkers MOS	Males Talkers σ	Females Talkers MOS	Females Talkers σ	All Talkers MOS	All Talkers σ
1	Direct	-	3,9792	0,6992	4,1042	0,7217	4,0417	0,7096
2	MNRU	33 dBQ	3,7083	0,7707	3,7708	0,8810	3,7396	0,8239
3	MNRU	24 dBQ	2,7708	0,8313	2,6667	0,9528	2,7188	0,8909
4	MNRU	15 dBQ	1,5625	0,5421	1,5000	0,5835	1,5313	0,5611
5	MNRU	06 dBQ	1,0833	0,2793	1,0417	0,2019	1,0625	0,2433
6	G.726 32	EC0	3,4583	0,8241	3,0625	0,7830	3,2604	0,8239
7	G.723.1 6.3	EC0	3,1250	0,7889	2,9792	0,8627	3,0521	0,8255
8	G.729 8	EC0	3,1250	0,7614	3,0000	0,9453	3,0625	0,8561
9	IS-127	EC0	3,2292	0,8313	3,1667	0,9070	3,1979	0,8660
10	GSM FR	EC0	2,3958	0,7920	2,0417	0,7133	2,2188	0,7706
11	GSM EFR	EP7	2,7292	0,7068	2,3750	0,7614	2,5521	0,7521
12	GSM EFR	EP10	3,2292	0,7217	2,9792	0,7576	3,1042	0,7466
13	AMR 12.2	EC0	3,2292	0,6916	2,9583	0,8241	3,0938	0,7688
14	AMR 12.2	EC1C	3,1458	0,7716	3,0625	0,8355	3,1042	0,8010
15	AMR 12.2	EC2C	2,7917	0,7707	2,7500	0,8121	2,7708	0,7878
16	AMR 12.2	EC3C	2,5417	0,6829	2,4792	0,7987	2,5104	0,7398
17	AMR 12.2	EC4C	3,0208	0,7576	3,2083	0,8241	3,1146	0,7930
18	AMR 12.2	EC5C	2,9167	0,7945	2,7500	0,7579	2,8333	0,7769
19	AMR 12.2	EC6C	2,8125	0,7897	2,6667	0,7244	2,7396	0,7573
20	AMR 10.2	EC0	3,2708	0,8440	3,0625	0,7830	3,1667	0,8165
21	AMR 10.2	EC7C	3,0833	0,7945	2,6667	0,6302	2,8750	0,7434
22	AMR 10.2	EC8C	2,9375	0,8606	2,7292	0,7646	2,8333	0,8165
23	AMR 10.2	EC9C	2,5000	0,6842	2,2292	0,6270	2,3646	0,6668
24	AMR 7.95	EC0	3,2917	0,8495	3,0625	0,9087	3,1771	0,8825
25	AMR 7.95	EC1C	3,0625	0,8097	3,0208	0,6992	3,0417	0,7528
26	AMR 7.95	EC2C	3,0417	0,7426	2,8750	0,9138	2,9583	0,8325
27	AMR 7.95	EC3C	2,7708	0,7784	2,4792	0,7143	2,6250	0,7574
28	AMR 7.95	EC4C	3,1458	0,7987	3,0208	0,7852	3,0833	0,7903
29	AMR 7.95	EC5C	3,1042	0,7217	3,0000	0,8752	3,0521	0,7996
30	AMR 7.95	EC6C	2,6042	0,8184	2,4792	0,7987	2,5417	0,8068
31	AMR 7.40	EC0	2,9375	0,7830	3,0000	0,7718	2,9688	0,7740
32	AMR 7.40	EC7C	2,9375	0,7553	2,8125	0,7897	2,8750	0,7712
33	AMR 7.40	EC8C	2,7500	0,6995	3,0208	0,7290	2,8854	0,7236
34	AMR 7.40	EC9C	2,5208	0,7987	2,6250	0,7330	2,5729	0,7643
35	AMR 6.70	EC0	3,1667	0,7810	3,1875	0,7339	3,1771	0,7539
36	AMR 6.70	EC1C	2,9583	0,6510	2,8542	0,7143	2,9063	0,6818
37	AMR 6.70	EC2C	3,0208	0,7290	2,6042	0,7920	2,8125	0,7856
38	AMR 6.70	EC3C	2,5208	0,6838	2,3333	0,8588	2,4271	0,7779
39	AMR 6.70	EC4C	3,1042	0,7784	2,7917	0,8241	2,9479	0,8127
40	AMR 6.70	EC5C	3,0833	0,7945	2,8958	0,7217	2,9896	0,7608
41	AMR 6.70	EC6C	2,4167	0,7945	2,3333	0,7532	2,3750	0,7712
42	AMR 5.90	EC0	2,9583	0,7426	2,7917	0,7133	2,8750	0,7291
43	AMR 5.90	EC7C	2,8333	0,6945	2,7917	0,7133	2,8125	0,7006
44	AMR 5.90	EC8C	2,7917	0,7426	2,6875	0,6890	2,7396	0,7144
45	AMR 5.90	EC9C	2,6875	0,6890	2,2917	0,6174	2,4896	0,6805
46	AMR 5.15	EC0	2,9792	0,7576	2,9167	0,7945	2,9479	0,7728
47	AMR 5.15	EC1C	2,8750	0,7614	2,6875	0,7192	2,7813	0,7427
48	AMR 5.15	EC2C	2,7708	0,6916	2,6250	0,7330	2,6979	0,7126
49	AMR 5.15	EC3C	2,5208	0,6185	2,3958	0,7363	2,4583	0,6793
50	AMR 5.15	EC4C	2,8750	0,5696	2,7500	0,7293	2,8125	0,6539
51	AMR 5.15	EC5C	2,6042	0,7920	2,5833	0,6131	2,5938	0,7045
52	AMR 5.15	EC6C	2,4792	0,6185	2,4792	0,8503	2,4792	0,7395
53	AMR 4.75	EC0	3,0000	0,7146	2,8750	0,7614	2,9375	0,7372
54	AMR 4.75	EC7C	2,8333	0,6945	2,6875	0,7761	2,7604	0,7362
55	AMR 4.75	EC8C	2,6875	0,7482	2,7292	0,7363	2,7083	0,7387
56	AMR 4.75	EC9C	2,5417	0,7426	2,2083	0,5819	2,3750	0,6844

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#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	194	146
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#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	1922	1874
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	2018	1970
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#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	2210	2162
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	2306	2258
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	2402	2354
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	2498	2450
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	[3GAMR_L	2594	2546
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