Technical Specification Group Services and System Aspects
Meeting #23, Phoenix, Arizona (USA)
15-18 March 2004

TSGS#23(04)0070

Source: **TSG-SA WG4**

Title: Audio codec selection tests: Reports from the Subjective Testing Labs

Document for: **Approval**

Agenda Item: **7.4.3**

The following documents, agreed at the TSG-SA WG4 meeting #30, are presented to TSG SA #23 for approval.

S4-040021	Listening laboratory report	France Telecom
S4-040023	Report on AMR-WB+ and PSS/MMS Low-Rate and High-Rate Audio Selection Tests	NTT-AT
S4-040035	PSS/MMS High Rate and AMR-WB+ and PSS/MMS Low Rate Audio Selection Test, Listening Laboratory Report	T-Systems
S4-040044	Listening laboratory report in the course of the 3GPP audio codec selection process	Coding Technologies
S4-040063	PSS/MMS selection tests - Nokia listening test lab report	Nokia
S4-040068	PSS/MMS audio codec selection - Test Lab report	Ericsson
S4-040101	Listening laboratory report in the course of the 3GPP audio codec selection process	Fraunhofer IIS
S4-040105	Dynastat Listening Laboratory Report for the 3GPP Audio Codec Selection	Dynastat

Technical Specification Group Services and System Aspects **TSGS#23(04)0070**
Meeting #23, Phoenix, AZ, USA, 15-18 March 2004

TSG-SA4#30 meeting Tdoc S4 (04)0021
February 23-27, 2004, Malaga, Spain

Source: **TSG SA WG4 (France Telecom)**
Title: **Listening laboratory report (Audio codec Selection)**
Document for: **Approval**
Agenda Item: **7.4.3**

1 Introduction

This document reports on subjective tests conducted by France Telecom for the AMR-WB+ and PSS/MMS Low-Rate Audio Selection and PSS/MMS High-Rate Audio Selection.

France Telecom has performed the tests A1b, A3b, B1b and B3b described in AMR-WB+ and PSS/MMS Low-Rate Audio Selection Test and Processing Plan as well as experiment 3 (H3) described in PSS/MMS High-Rate Audio Selection Test and Processing Plan.

2 Test process

2.1 Test method

The methodology MUSHRA was used for those five quality test. MUSHRA stands for MUlti Stimuli with Hidden Reference and Anchor points. This is a method dedicated to the assessment of intermediate quality.
It has been recommended at the ITU-R under the name BS.15341.This was developed in 1999 by the EBU Project Group B/AIM in collaboration with the ITU-R Working Party 6Q.
An important feature of this method is the inclusion of the hidden reference and bandwidth limited anchor signals. For those five mentioned tests, anchor points were the band-limited (3.5 and 7 kHz) reference signal.

2.2 Training phase

Each listener had a period of training, in order to get familiar with the test methodology, the use of the interface software and with the kind of quality they have to assess. This was as well an opportunity to adjust the restitution level that then remained constant during the test phase.
As there were 5 tests, each of them was preceded by a training phase that each listener was asked to perform.
Each training session contained 4 audio items that were different from the audio excerpts played in the tests.

2.3 User Interface

The MUSHRA method has the advantage of displaying all stimuli for one test item at a given bit-rate at the same time. The subjects were therefore able to carry out any comparison between them directly as well as to assess the quality comparing to the one of the explicit reference signal.
Implementation of MUSHRA user interface from CRC (SEAQ) was used in those tests. A screenshot of one implementation of the user interface is shown in figure 1. The buttons represent all the configurations/codecs under test including the hidden reference and both the anchor signals, and the reference, which is specially displayed on the left as "REF". Above each button, with the exception of the "REF" one, a slider is used to grade the quality of the test item according to the continuous quality scale.
For each of the test items, the signals under test were randomly assigned, with a different assignment for each subject. In addition, the test items were randomised for each subject within a session to avoid sequential effects. The session files were prepared by the host lab. There was one session file per listener.

[1] ITU-R Recommendation BS.1534 (June 2001)/ Method for the subjective assessment of intermediate quality level of coding systems.

Moreover, in case of tests H3 and B3b with network perturbations, one recording of the impact of the network on all the items was made per listener. That means that none of the listeners listened and assessed the same audio recording albeit the perturbations (packet losses rate) were on the average the same.

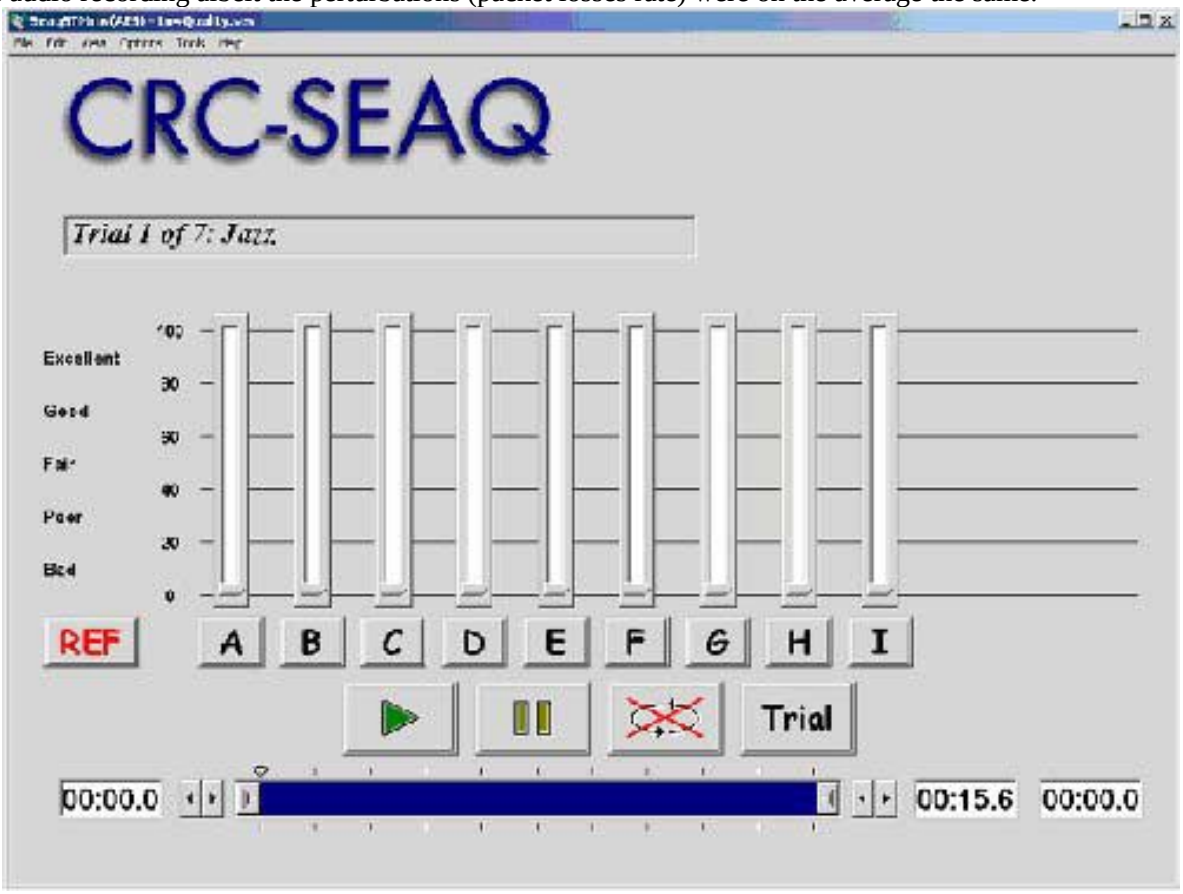

Figure 1 : MUSHRA Software

2.4 The Listening Panel

The listening panel consisted of 15 subjects, most of them experienced in audio but not only professionally involved. All of them were respectful regarding the listening instructions.

2.5 Tests duration

As mentioned above there were 5 different tests, all preceded by a training period.
The training phase took about half an hour. This time was also used to describe the listening instructions and answer listeners' questions if any.
Then, one test took approximately 2 hours (depending on listeners), including breaks. Every 20 minutes, the listener was asked to rest a bit by breathing some fresh air.
The five tests were spread over several days in order to give a chance to the listener to relax.

2.6 Listening conditions

The tests were performed on the headphone STAX Signature SR-404 (open)[2] and its amplifier SRM-006t. The subjects had the possibility to set the reproduction level individually before they started the actual test (during the training phase). The subjects were then restricted from changing the reproduction level during the test.

[2] http://www.son-video.com/Rayons/Hifi/Casques/Stax.html

The test items were stored on a Windows 2k workstation. The digital sound was played through the PC board Digigram VX 222 and converted by 24 bits DAC (3Dlab DAC 2000).
The tests were run in an acoustically neutral room dedicated to such tests.

2.7 Test agenda

Test material has been received on December 16th. Raw data of test results have been sent to global analysis laboratory on February 5th.

3. Conclusion and recommendations

No statistical analysis can be carried out due to the blind procedure. We can only statistically observe whether listeners have scored the same conditions as the hidden reference (the place of the 100 score in the excel sheet).

In Experiment 3 of PSS/MMS High-Rate Audio Selection Test and B3b of PSS/MMS low-Rate Audio Selection Test, codecs were tested in error conditions. It should be noted that error pattern were different for every codec under the same test condition. This prevents the correct use of statistical methodology on test results.

Technical Specification Group Services and System Aspects Meeting #23, Phoenix, AZ, USA, 15-18 March 2004 ***TSGS#23(04)0070***

3GPP TSG-S4#30 meeting, Malaga, Spain; February 23－27, 2004 *Tdoc S4-040023*

Title: Report on AMR-WB+ and PSS/MMS Low-Rate and High-Rate Audio Selection Tests

Source: TSG SA WG4 (NTT-Advanced Technology Corporation, NTT-AT)

Agenda items: 7.4.3

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1. Introduction [*]

NTT-AT conducted AMR-WB+ and PSS/MMS low-rate and high-rate audio selection tests. The experimental design and procedures are specified in the AMR-WB+ and PSS/MMS Low-Rate Audio Selection Test and Processing Plan, Version 2.0 (Tdoc S4-030824), and the PSS/MMS High-Rate Audio Selection Test and Processing Plan (Tdoc S4-030821).

2. General procedure

2.1 Allocation of sub-experiments to our company

According to the test plans, our company was allocated the following sub-experiments:
For the low-rate codec, sub-experiments, A2b, A4b, B2b, and B4b
For the high-rate codec, sub-experiment 2

2.2 Listening equipment and environment

(1) Headphones

Of the two types of headphones specified, we used closed-back supra-aural headphones, Sennhaiser HD25, in binaural listening mode.

(2) Listening level

The experimenter pre-adjusted the listening level to –15dB Pa using an IEC60318 coupler with a flat plate, but the subject was allowed to change the level if he/she felt it was too loud or too quiet.

(3) Test software

We conducted the listening evaluation according to MUSHRA using a CRC-SEAQ subjective test module. The multi-stimulus user interface used was the same as the example shown in the test plan.

(4) Background noise

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irii@mitaka.ntt-at.co.jp

A Hoth spectrum was generated by loudspeakers in the soundproof room and its sound level was adjusted to 30 dB A at the subject's listening position.

2.3 Subjects

Taking into account the need to make a critical judgment of quality, we chose our subjects from students in a conservatory of music. Their ages ranged from 18 to 24, ensuring that aging did not impair their hearing.

Before starting the actual test, they were given enough training in the evaluation procedure for MUSHRA.

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2.4 Samples

Processed materials were downloaded from the host laboratory, T-Systems, from its FTP site. The data size of the materials was enormous (approximately 7 GB), taking almost 2 days over a high-speed IP subscriber line using optical fiber (average transmission rate was about 50 Mbit/s). Next time, we propose to use DVD media for similar data exchanges.

2.5 Test order

Test and training orders were defined by session files (file name.ses). As far as possible, we checked the scripts of the downloaded files, which showed that some scripts for file names were missing. These were found only for training. We informed the host laboratory. Apparently the problem was caused by randomization of scripts. Mr. Ulf promised to check the process and sent correct files, but we did not receive them before we started testing. In our judgment, we therefore added insufficient file names.

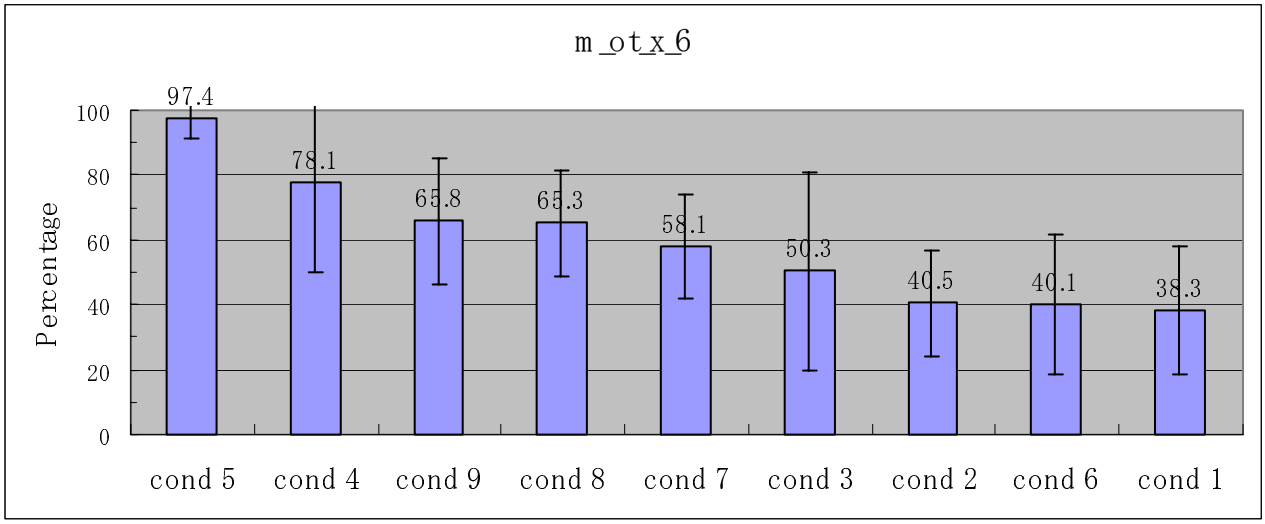
3 Results

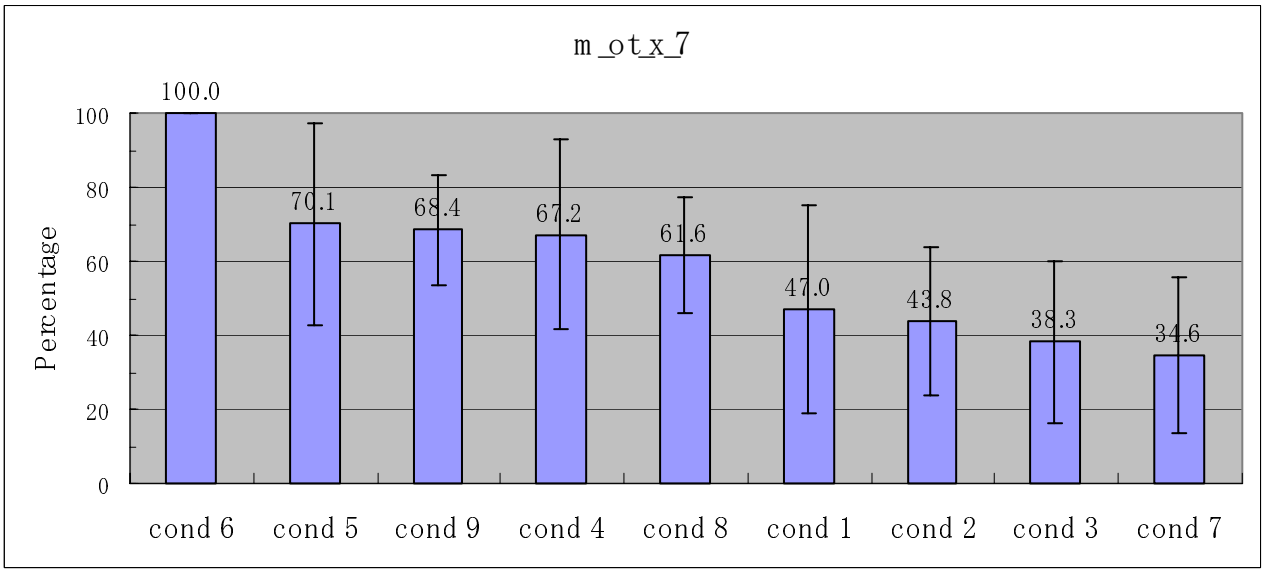
Test conditions were double-blinded. According to the procedure agreed in SA4, detailed statistical analysis is to be carried out by Global Analysis Lab. The results are therefore simply shown as averages with the standard deviations for each experiment and input signal. They are also illustrated in the graphs below. In the graphs, subjective responses are sorted in higher rank order to facilitate comparisons between conditions.

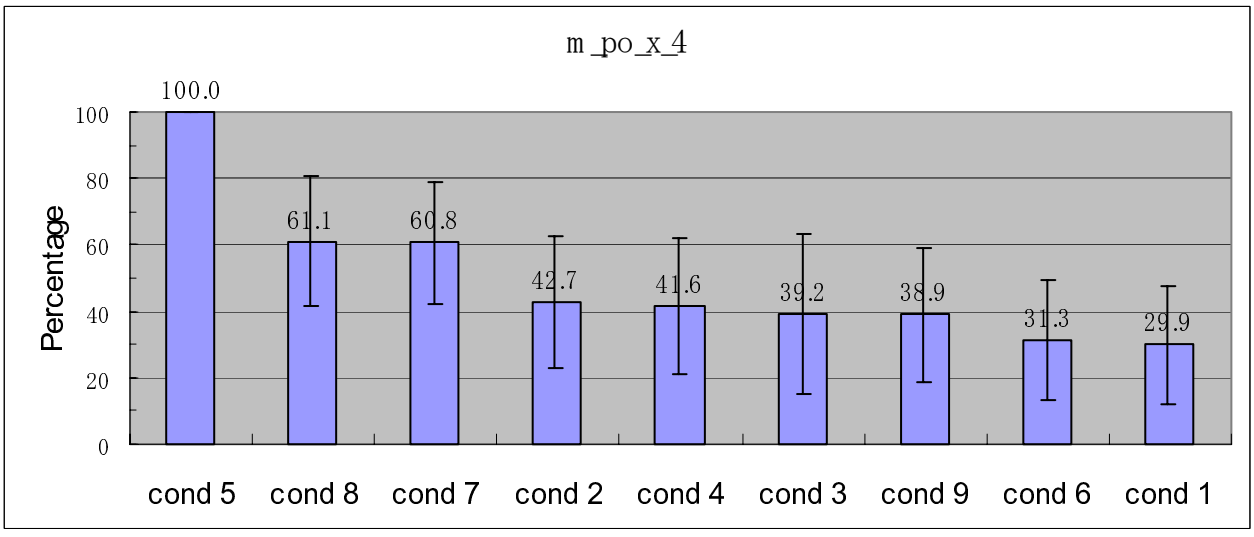
The file name used in each assessment is shown in the title of each graph. The numerical grading value of the percentage for each condition is shown at the top of each bar in the graph.

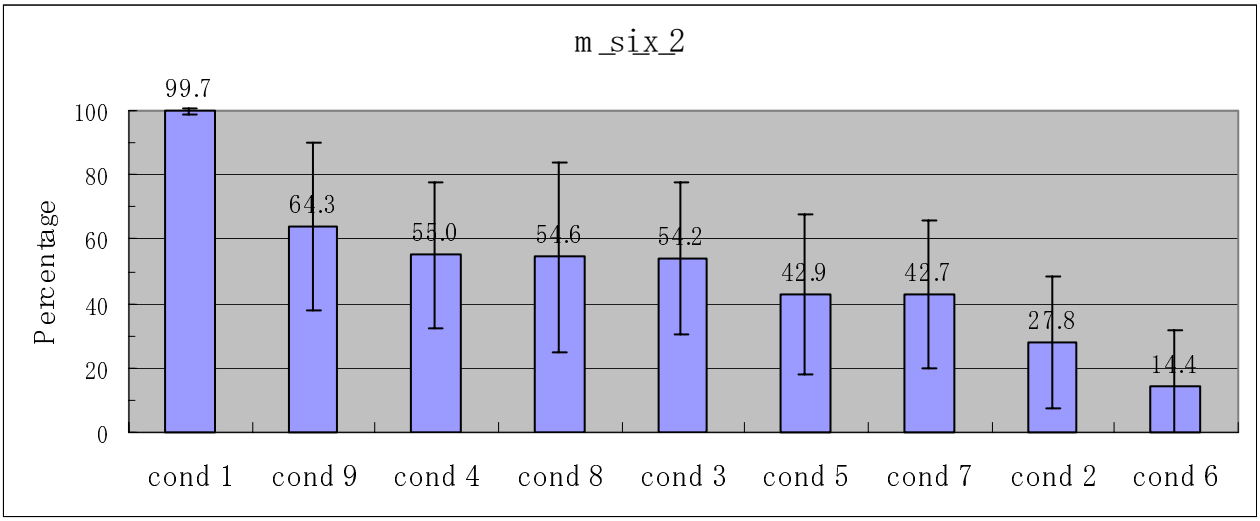
3.1 Low rate

(1) Experiment A2b (18kbps, stereo, use case A (PSS))





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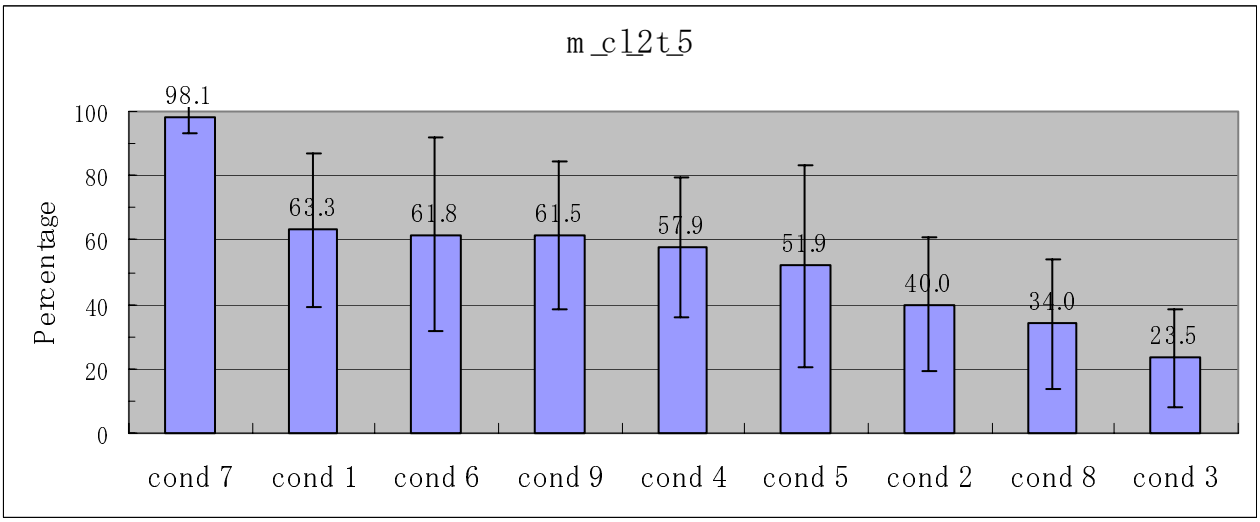
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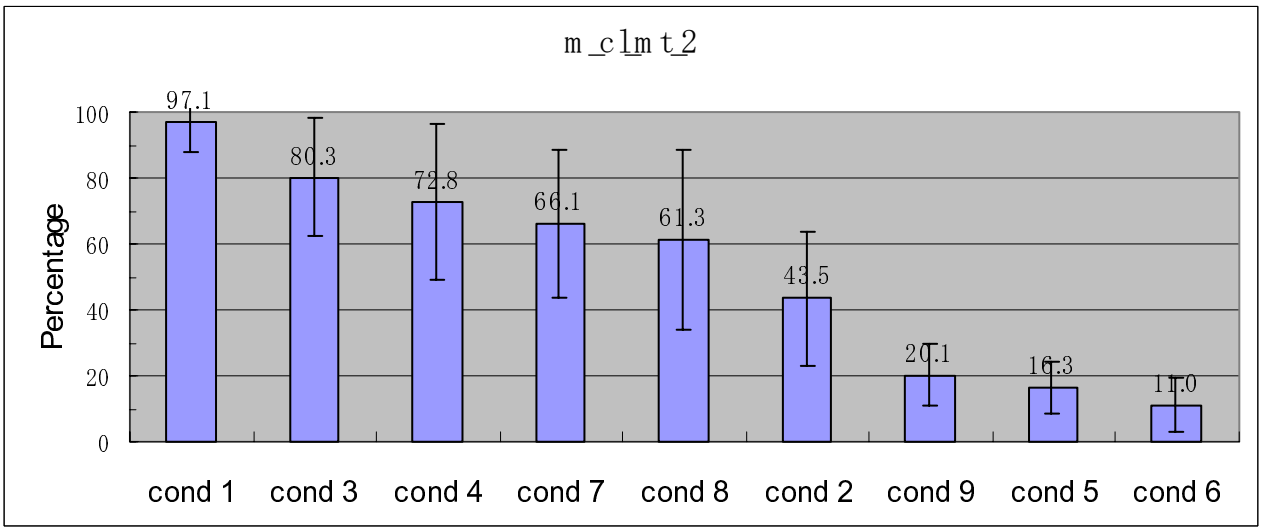
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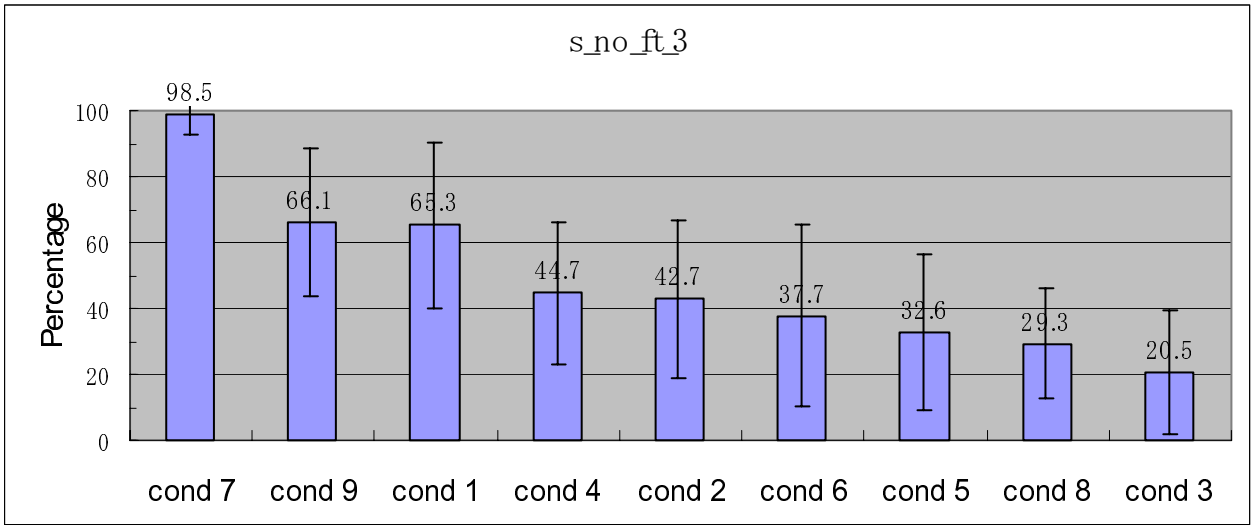
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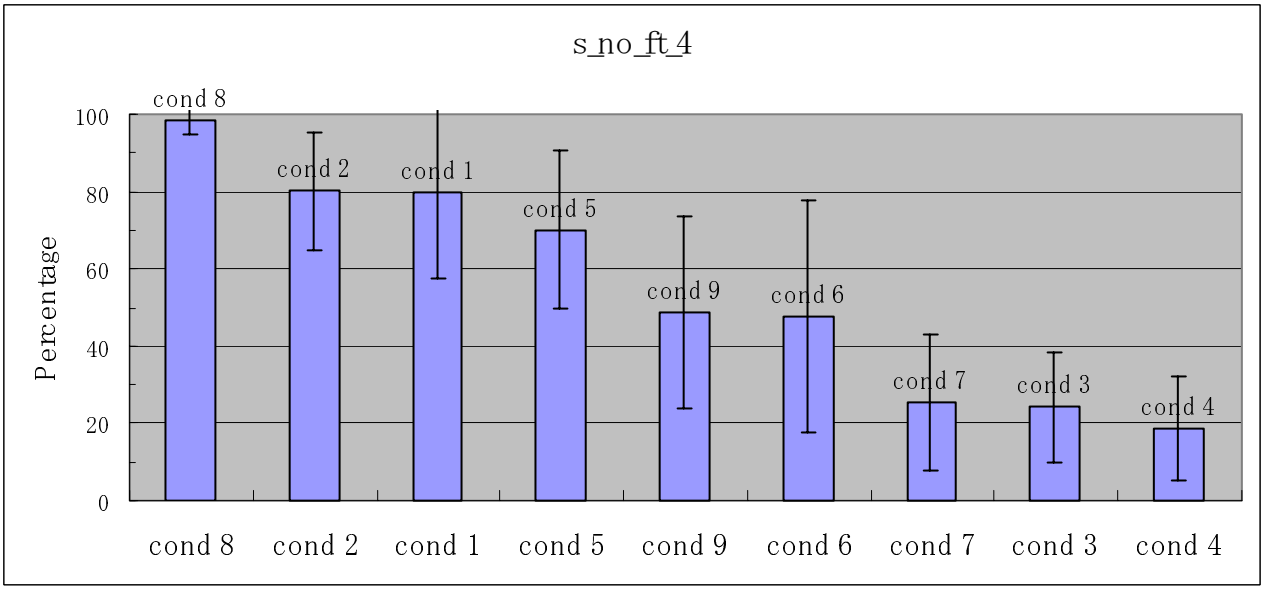
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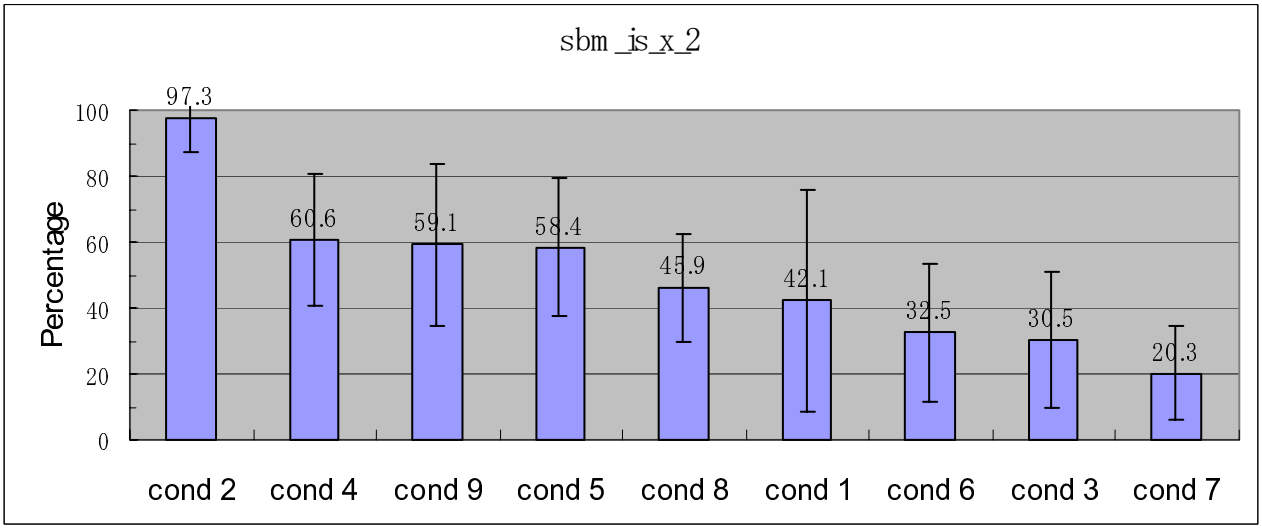
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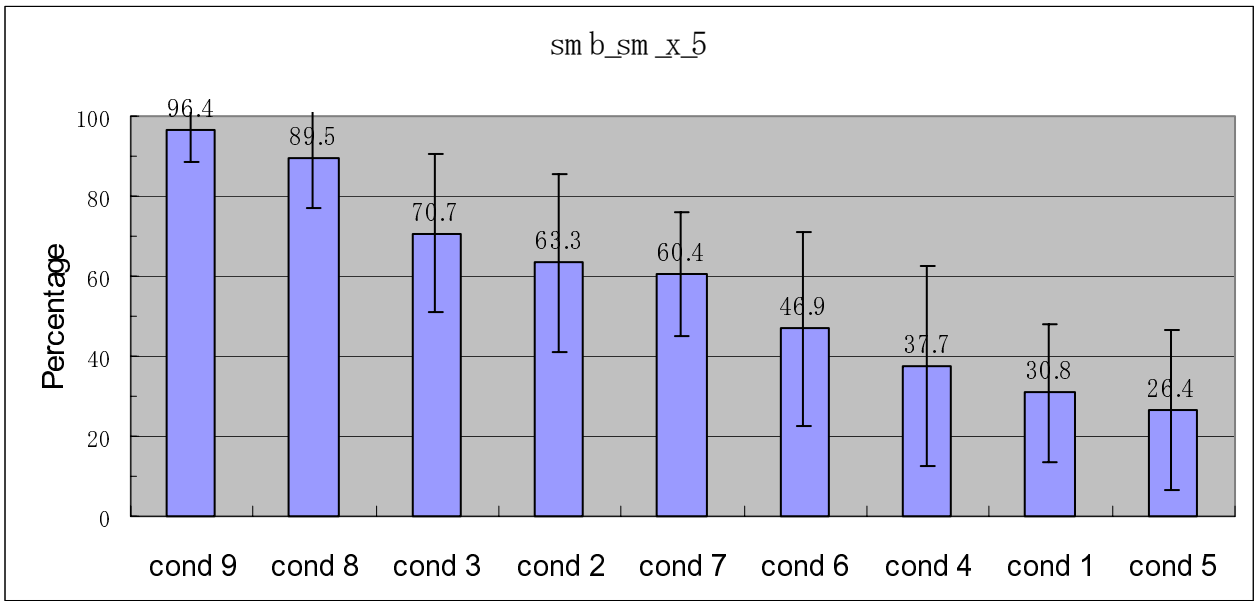
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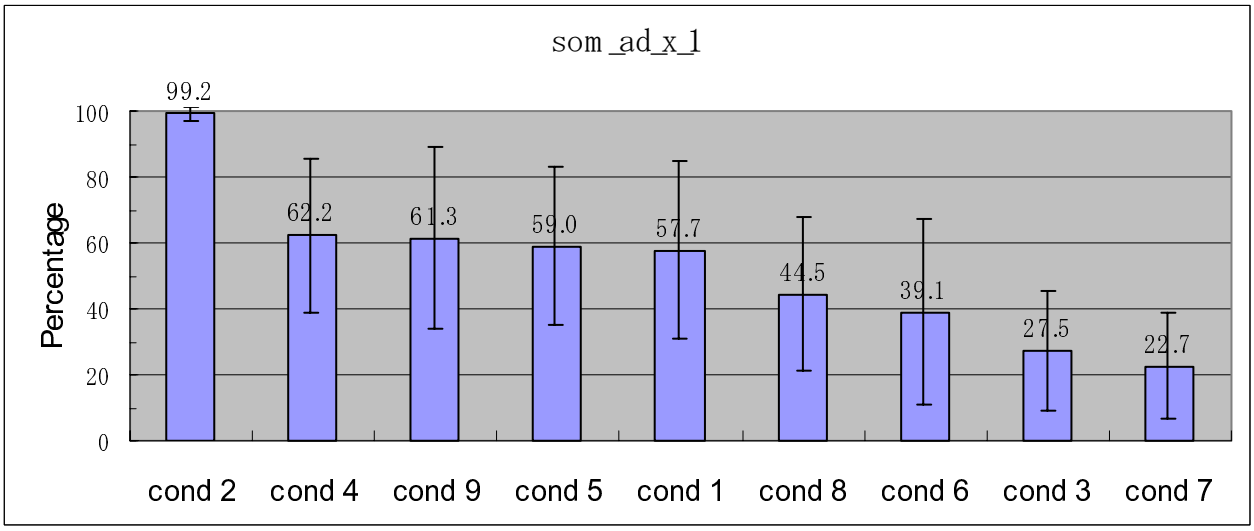
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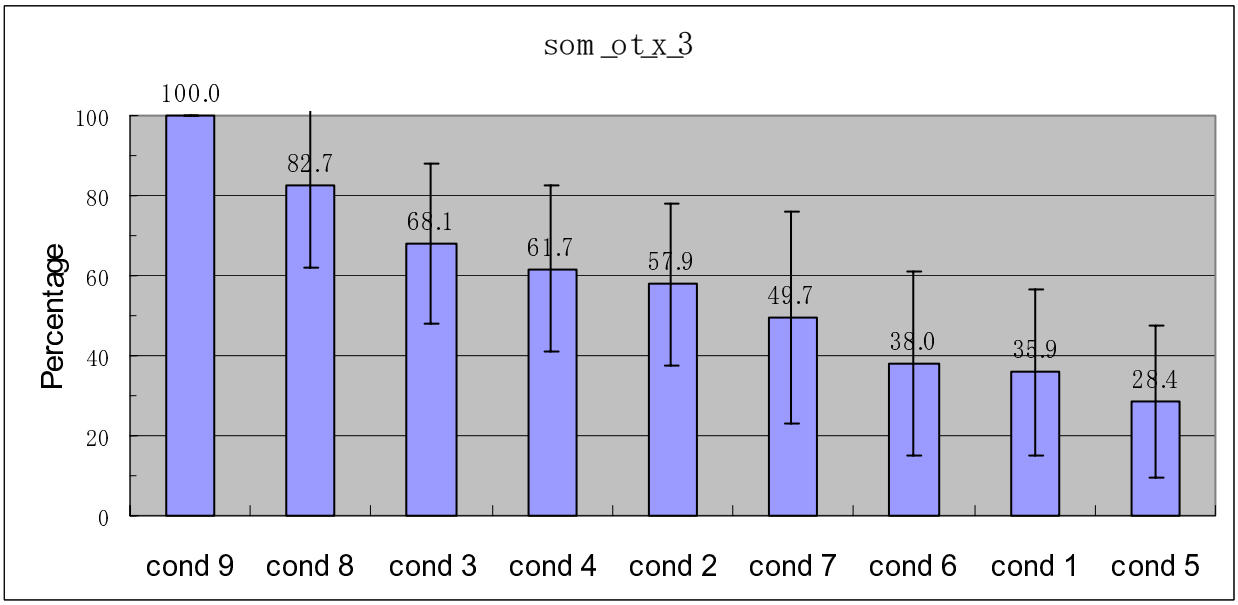
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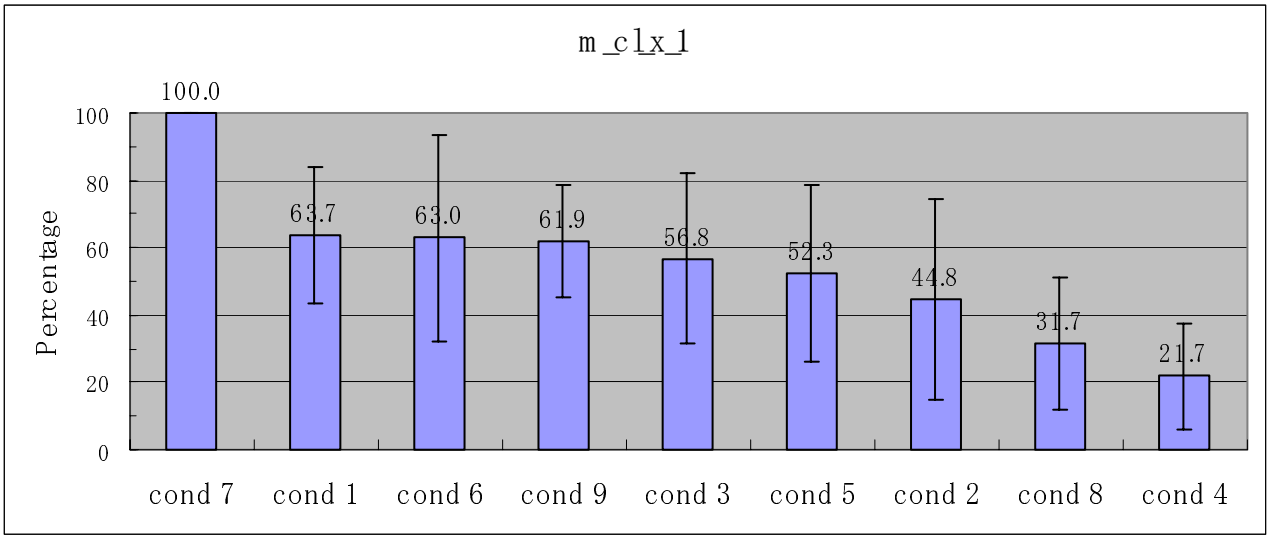
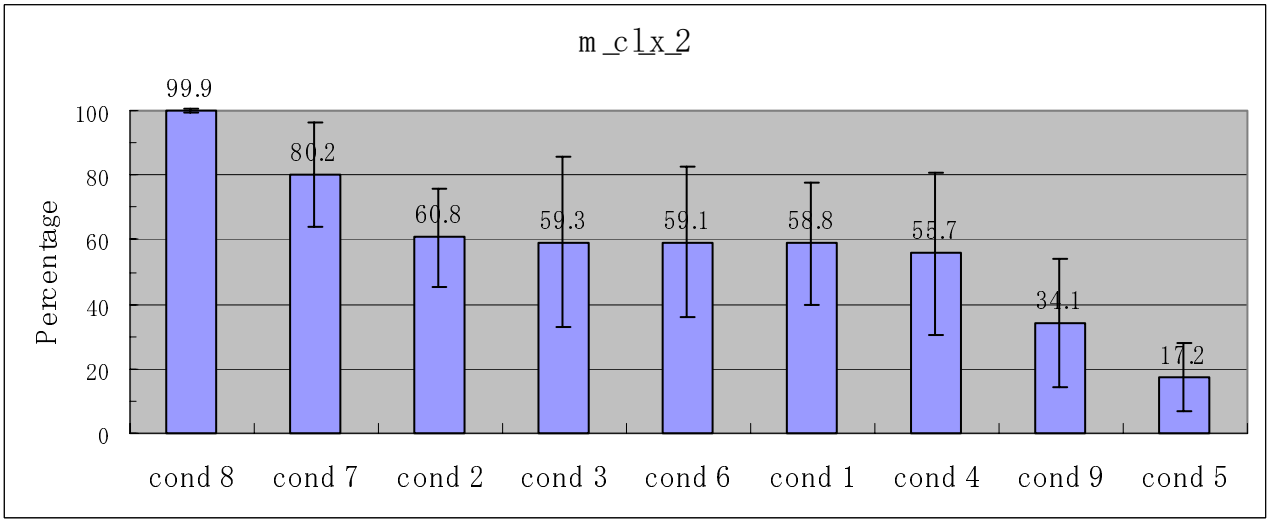
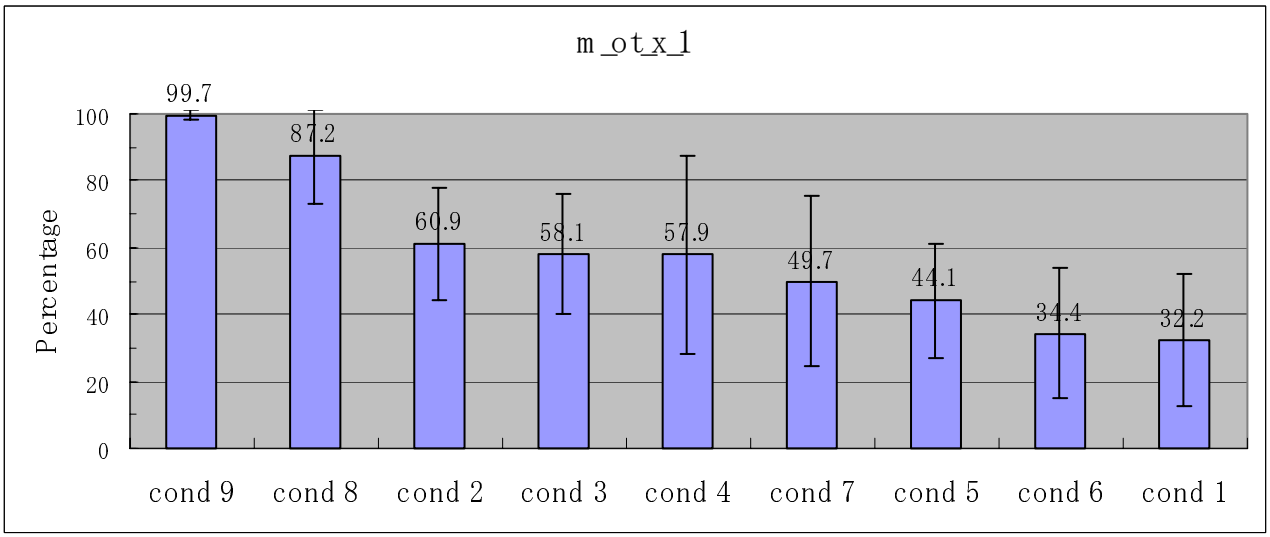
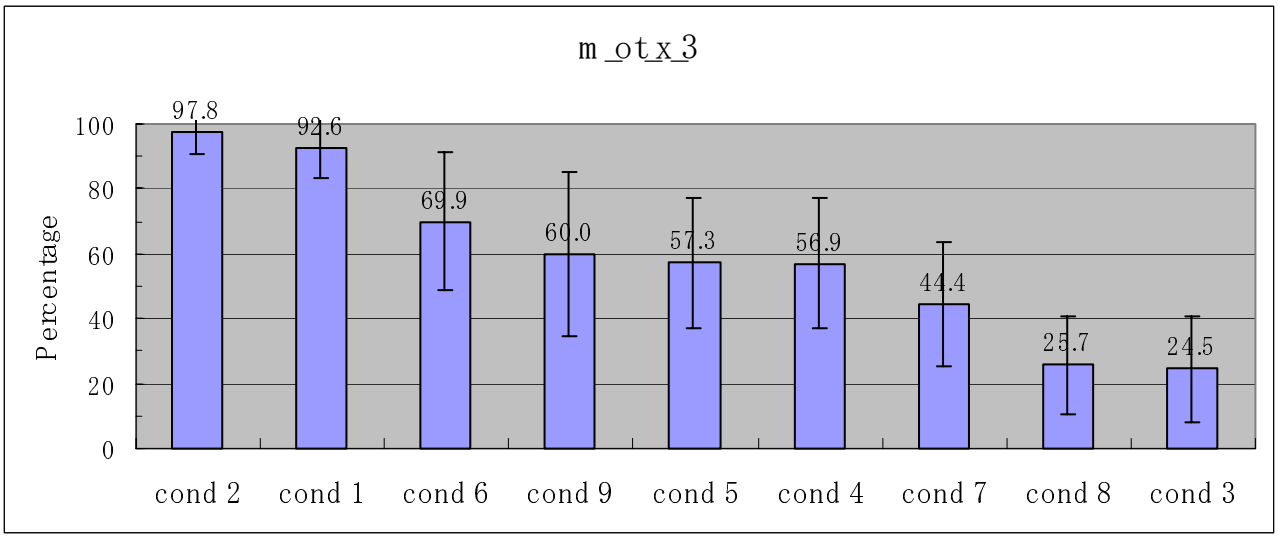
(2) Experiment A4b (24kbps, stereo, use case A (PSS))





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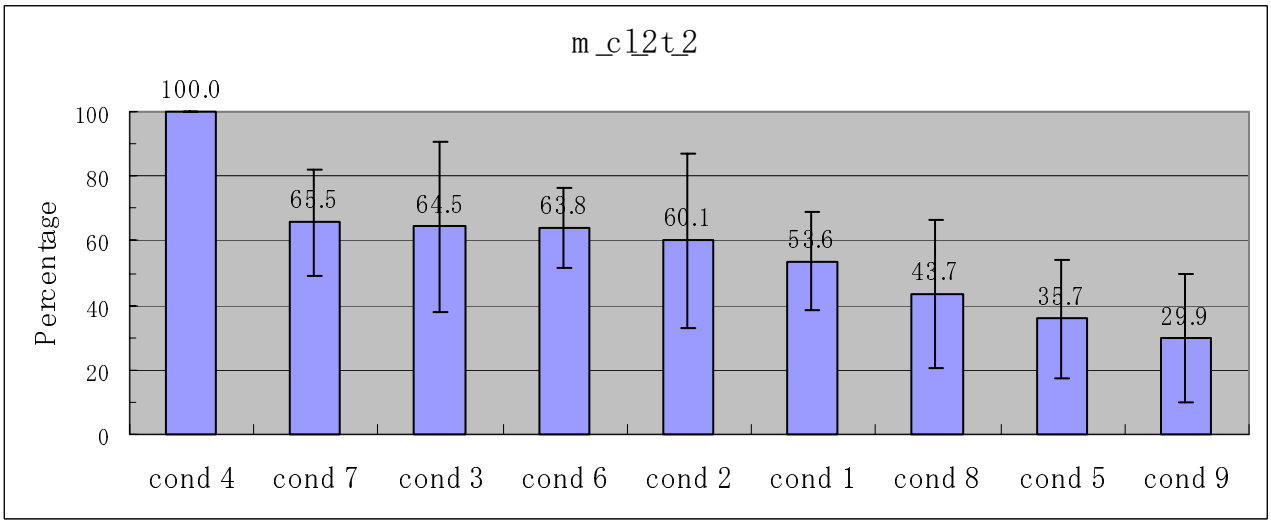
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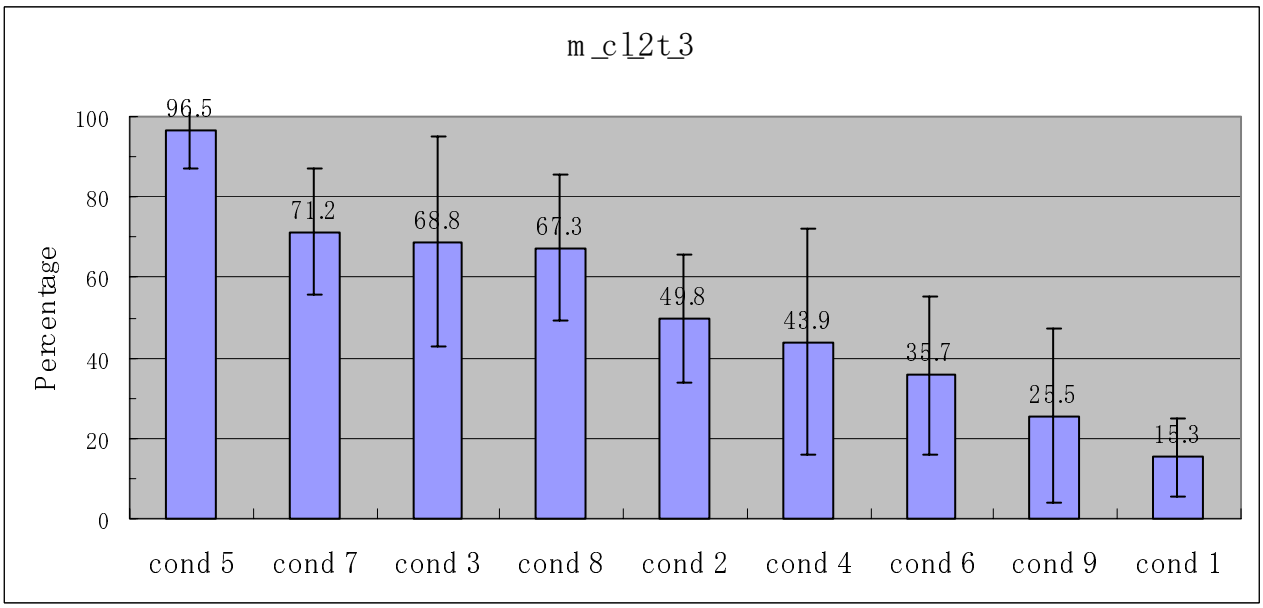
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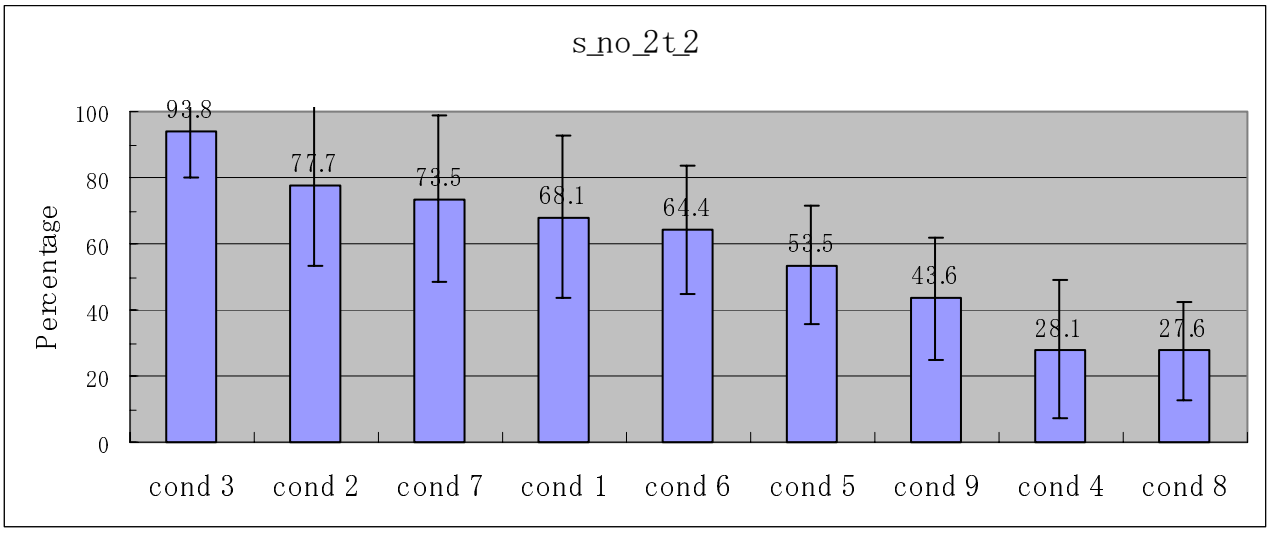
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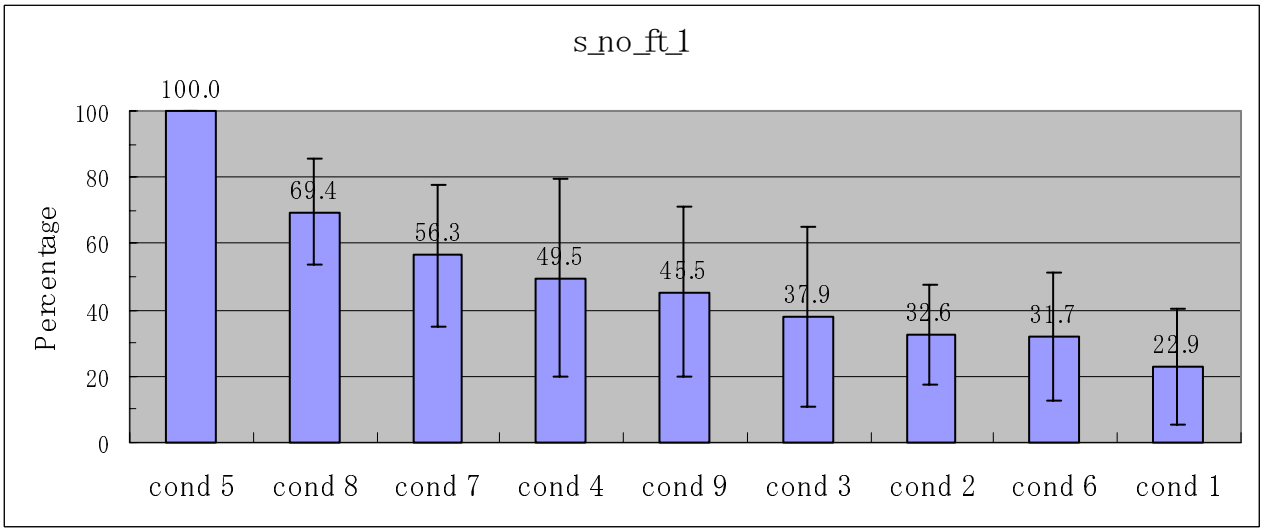
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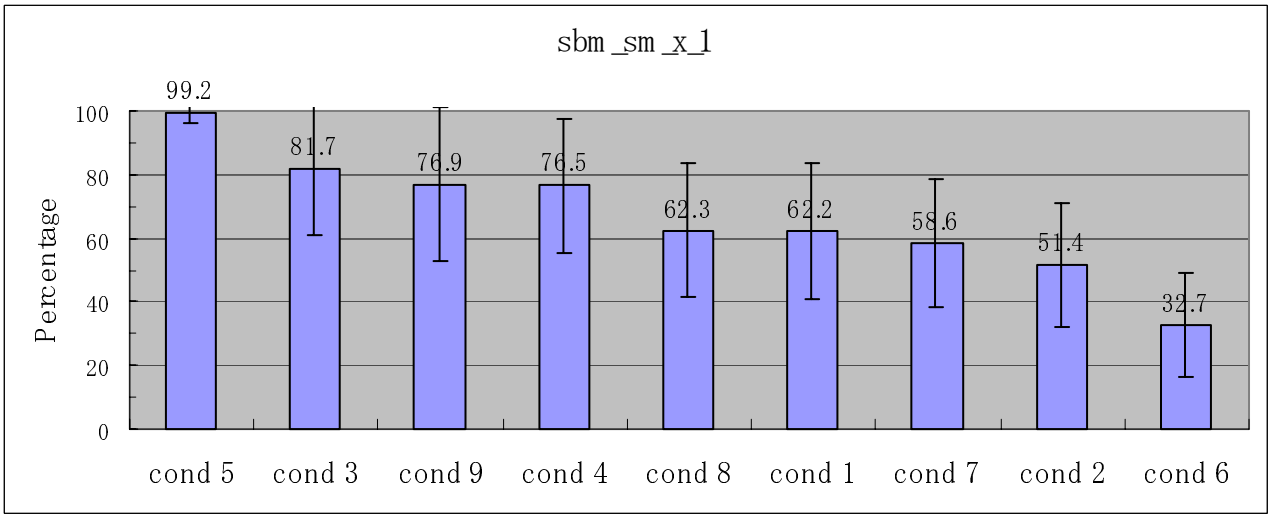
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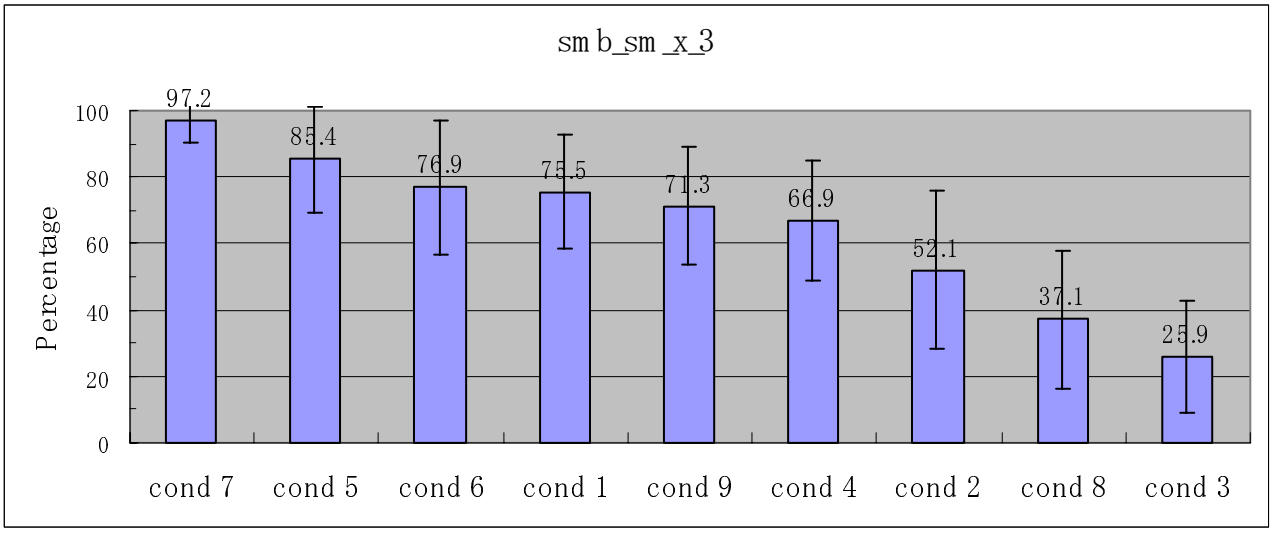
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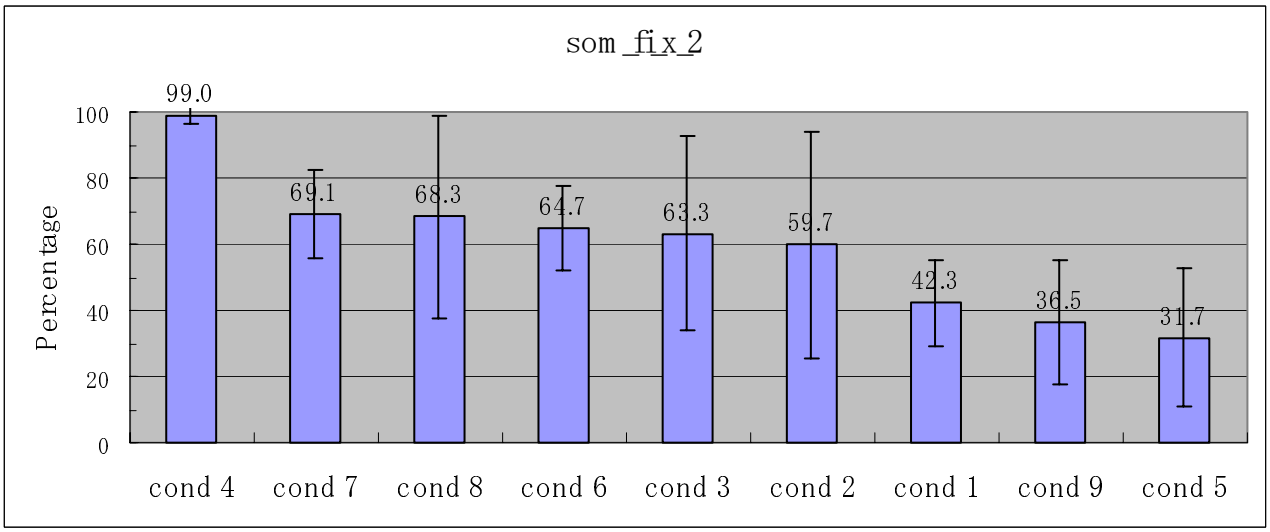
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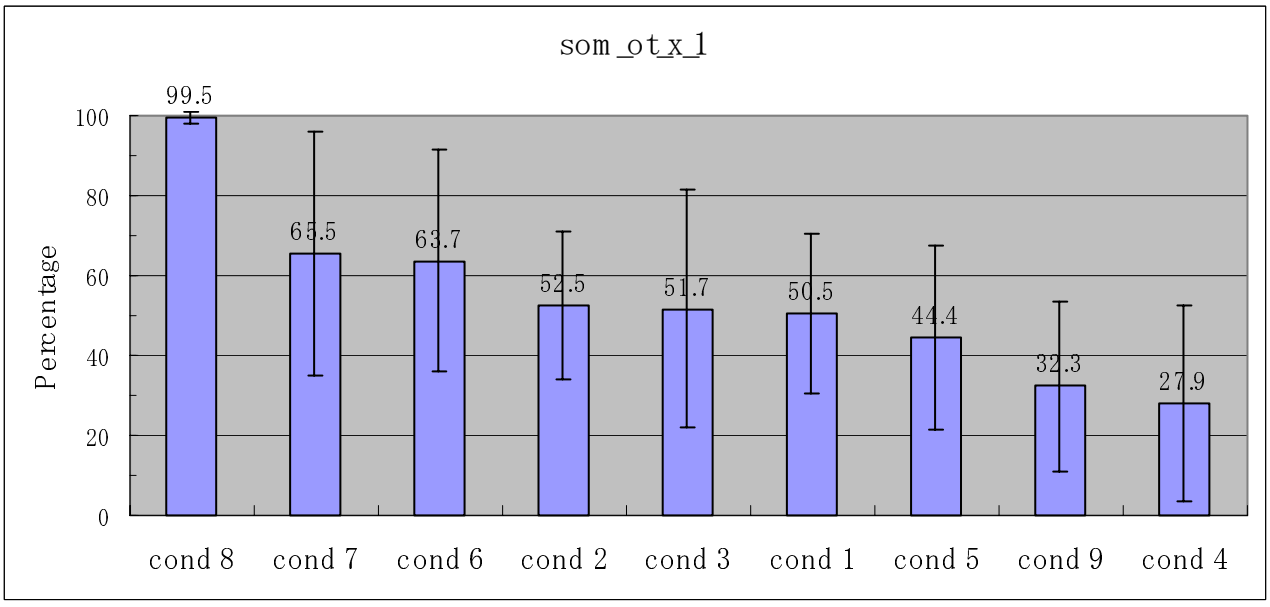
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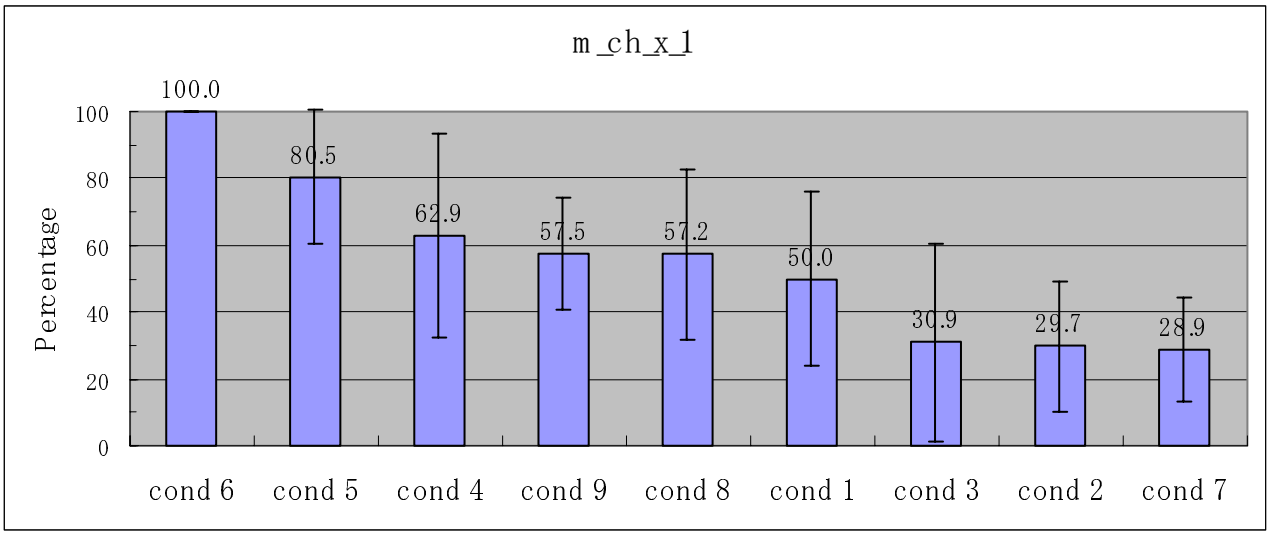
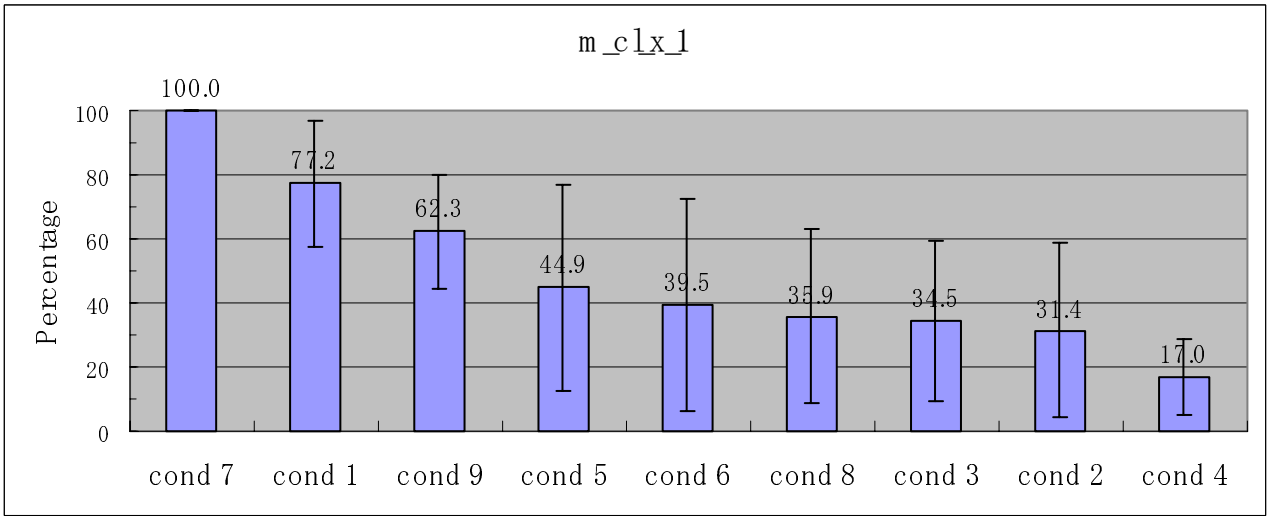
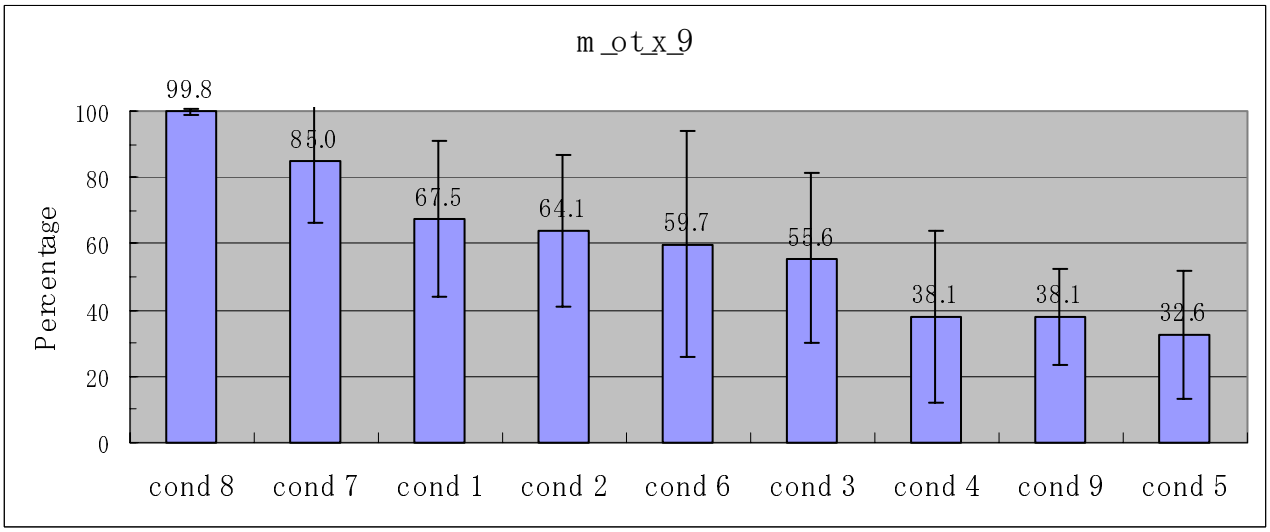
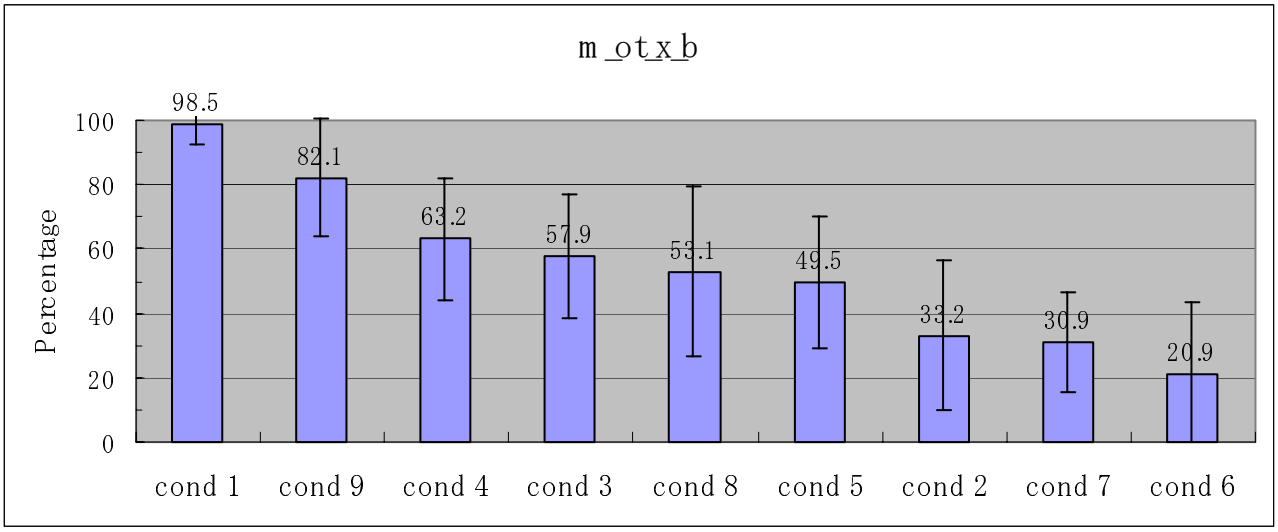
(3) Experiment B2b (18kbps, Mono, use case B (MMS))





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Percentage
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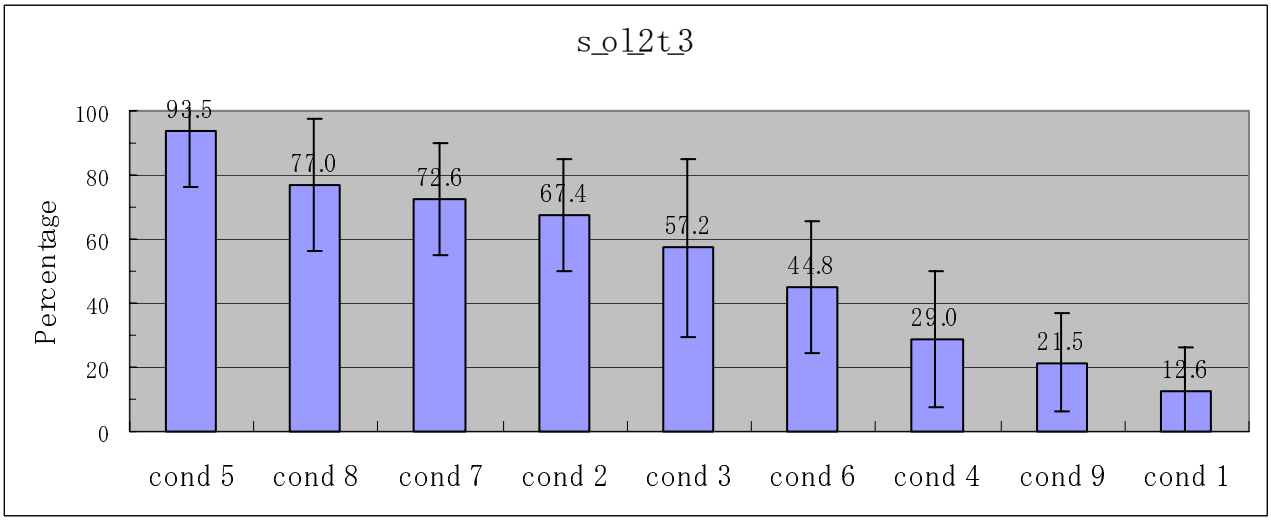
60
40
20
0
98.5
82.1
63.2
57.9
53.1
49.5
33.2
30.9
20.9
cond 1
cond 9
cond 4
cond 3
cond 8
cond 5
cond 2
cond 7
cond 6


s_ol2t_3
Percentage
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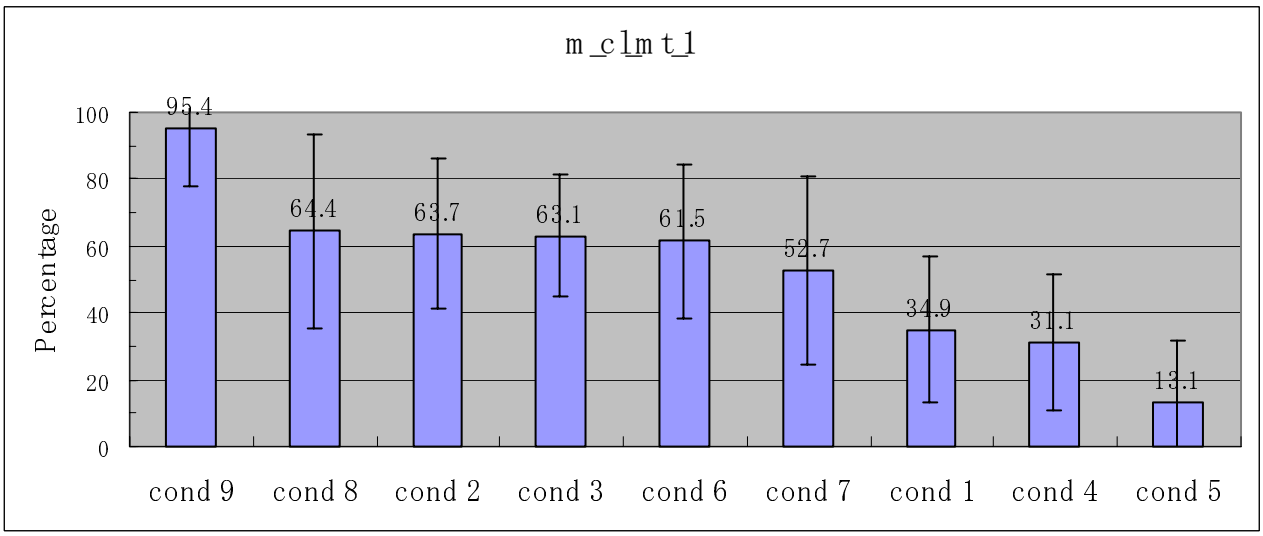
60
40
20
0
93.5
77.0
72.6
67.4
57.2
44.8
29.0
21.5
12.6
cond 5
cond 8
cond 7
cond 2
cond 3
cond 6
cond 4
cond 9
cond 1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95.4
64.4
63.7
63.1
61.5
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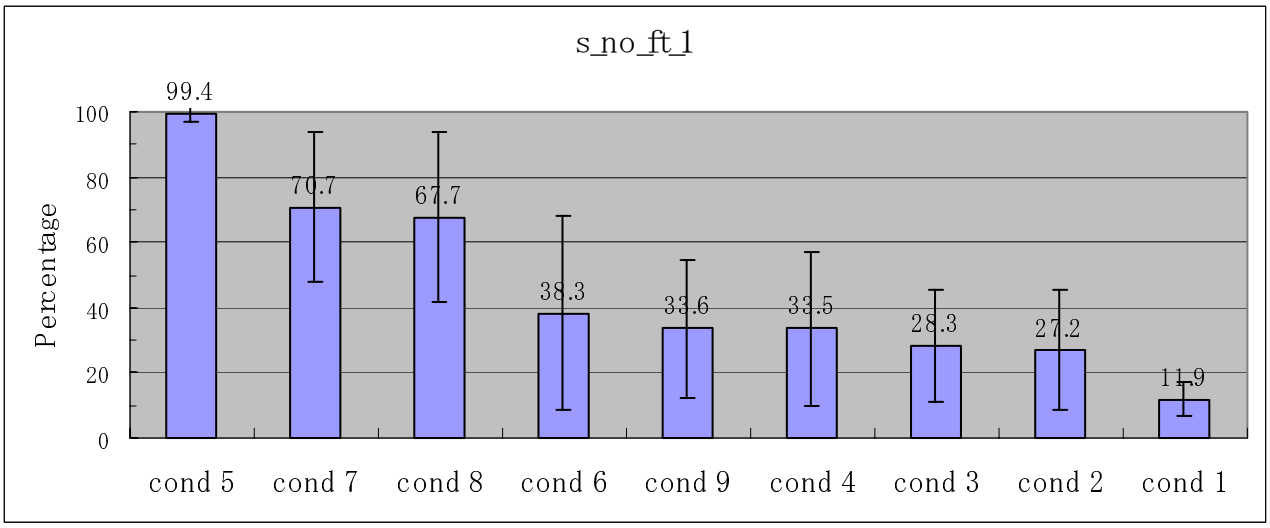
31.1
13.1
cond 9
cond 8
cond 2
cond 3
cond 6
cond 7
cond 1
cond 4
cond 5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Percentage
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20
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99.4
70.7
67.7
38.3
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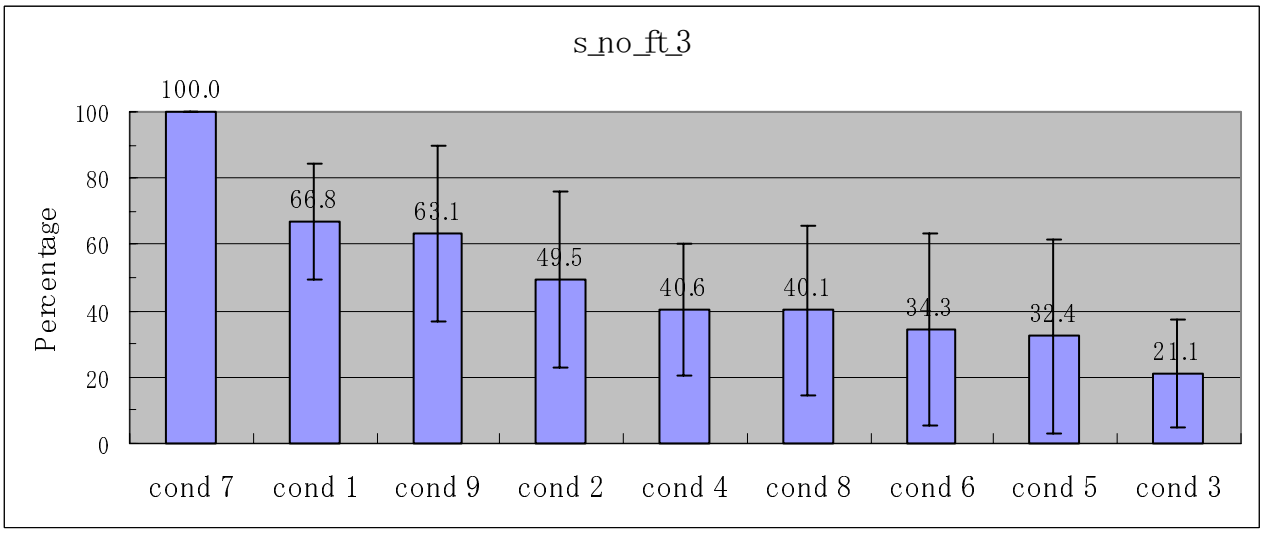
28.3
27.2
11.9
cond 5
cond 7
cond 8
cond 6
cond 9
cond 4
cond 3
cond 2
cond 1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60
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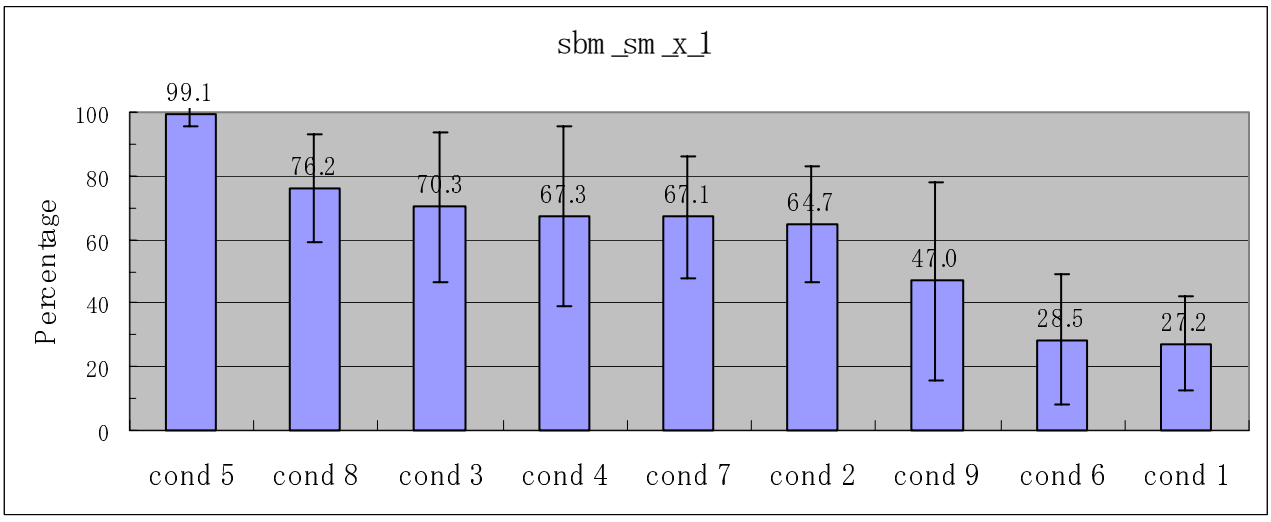
20
0
100.0
66.8
63.1
49.5
40.6
40.1
34.3
32.4
21.1
cond 7
cond 1
cond 9
cond 2
cond 4
cond 8
cond 6
cond 5
cond 3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40
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0
99.1
76.2
70.3
67.3
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64.7
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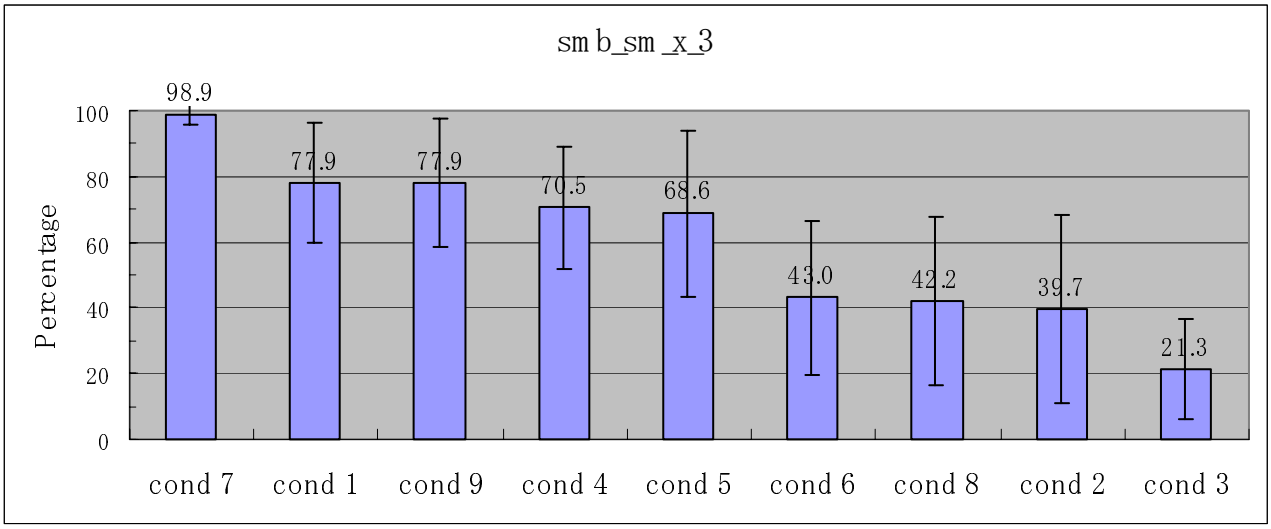
28.5
27.2
cond 5
cond 8
cond 3
cond 4
cond 7
cond 2
cond 9
cond 6
cond 1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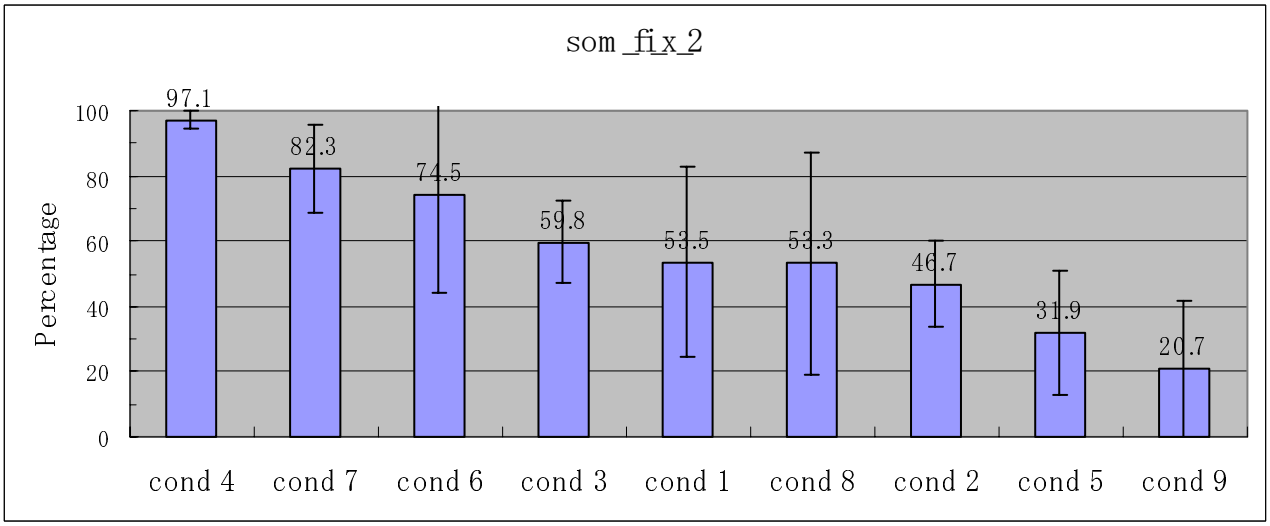
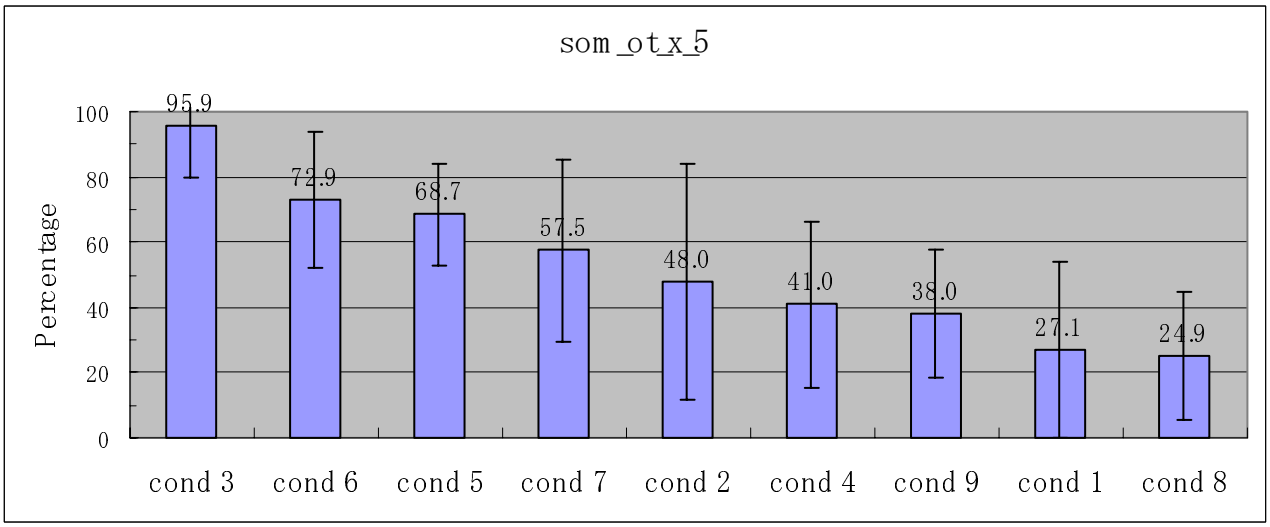
20
0
98.9
77.9
77.9
70.5
68.6
43.0
42.2
39.7
21.3
cond 7
cond 1
cond 9
cond 4
cond 5
cond 6
cond 8
cond 2
cond 3


som_fix_2
Percentage
100
80
60
40
20
0
97.1
82.3
74.5
59.8
53.5
53.3
46.7
31.9
20.7
cond 4
cond 7
cond 6
cond 3
cond 1
cond 8
cond 2
cond 5
cond 9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Percentage
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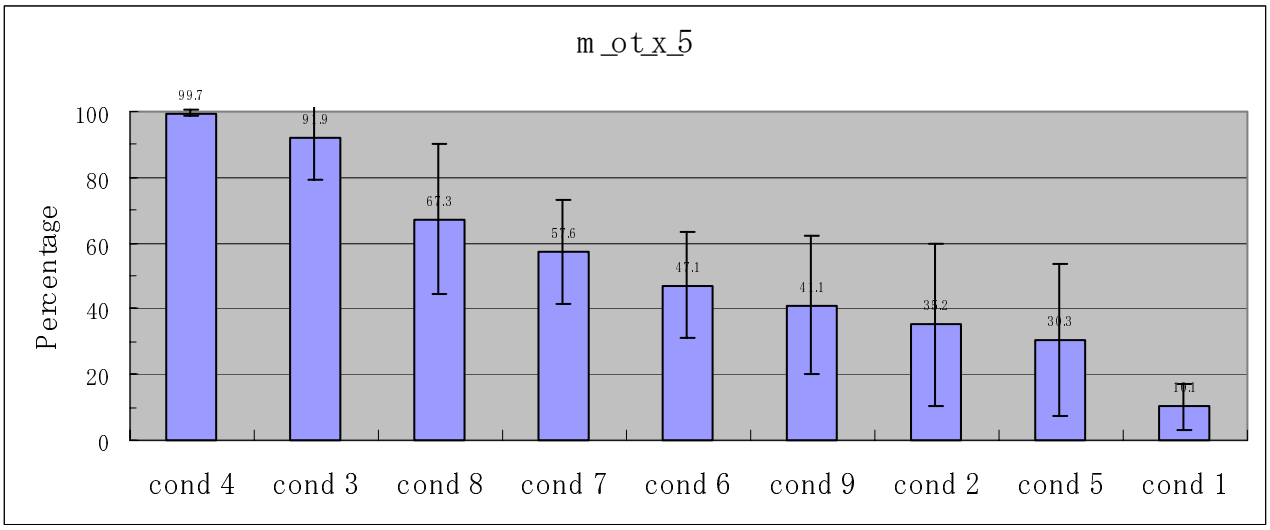
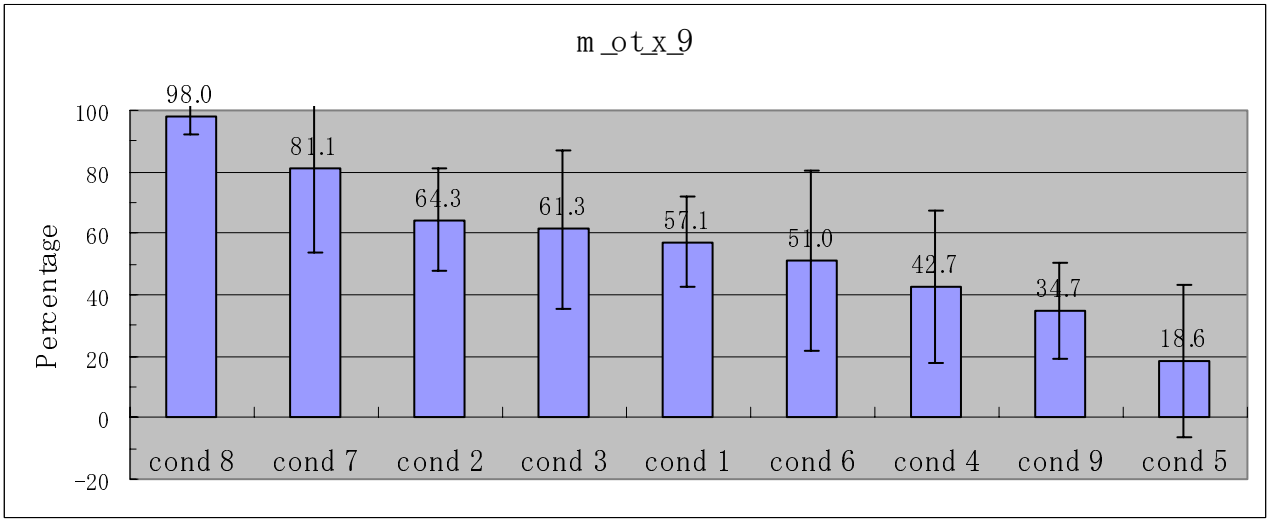
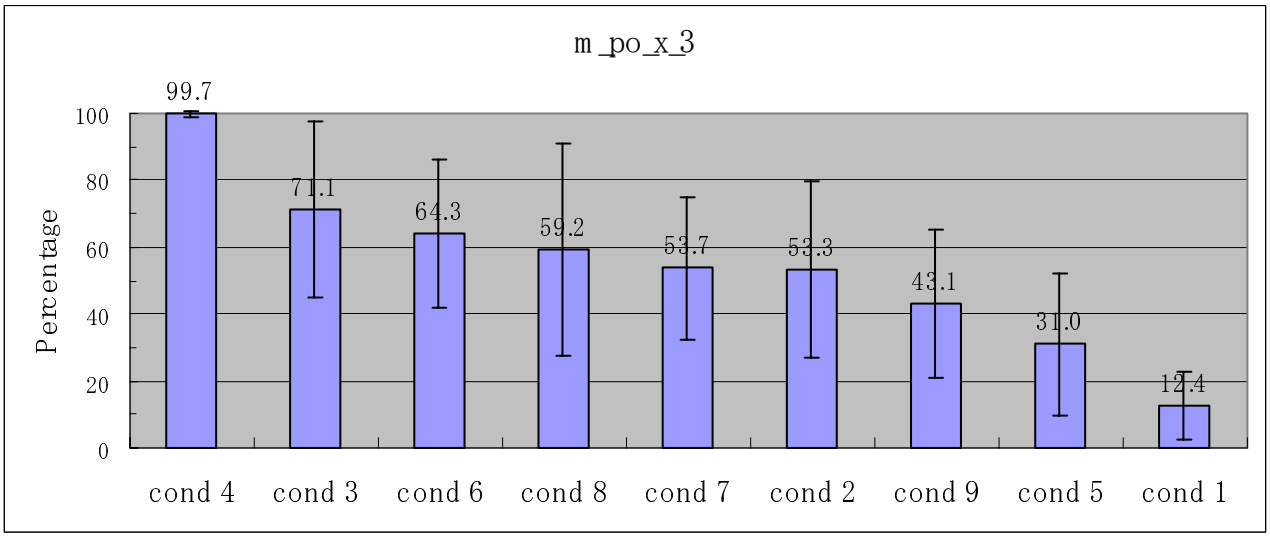
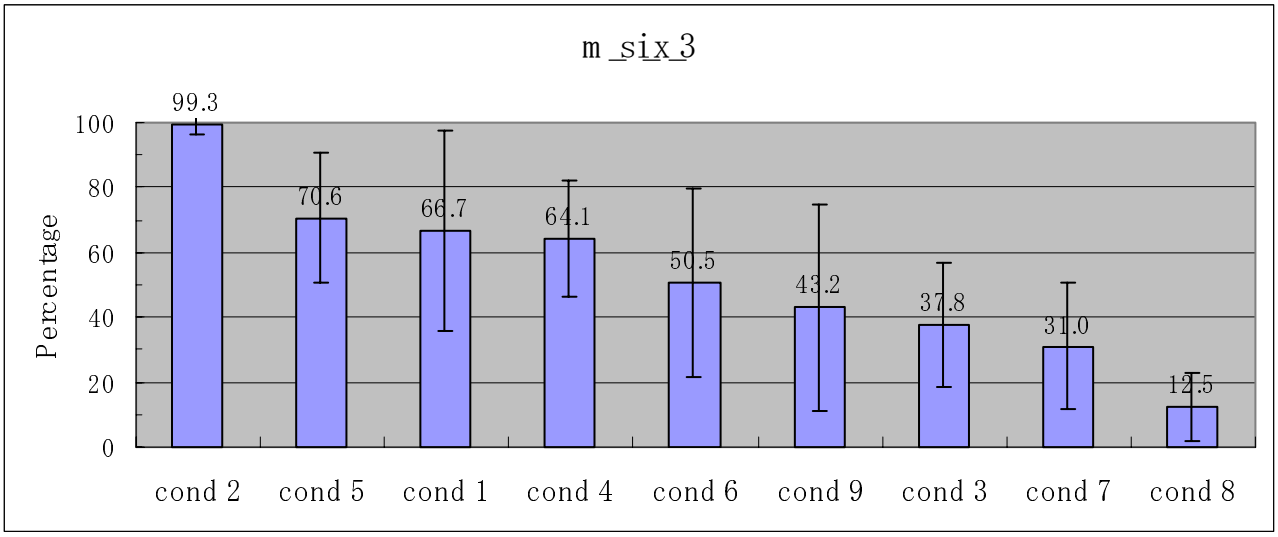
60
40
20
0
95.9
72.9
68.7
57.5
48.0
41.0
38.0
27.1
24.9
cond 3
cond 6
cond 5
cond 7
cond 2
cond 4
cond 9
cond 1
cond 8

(4) Experiment B2b (24kbps, stereo, use case B (PSS,3% FER))








m_six3
Percentage
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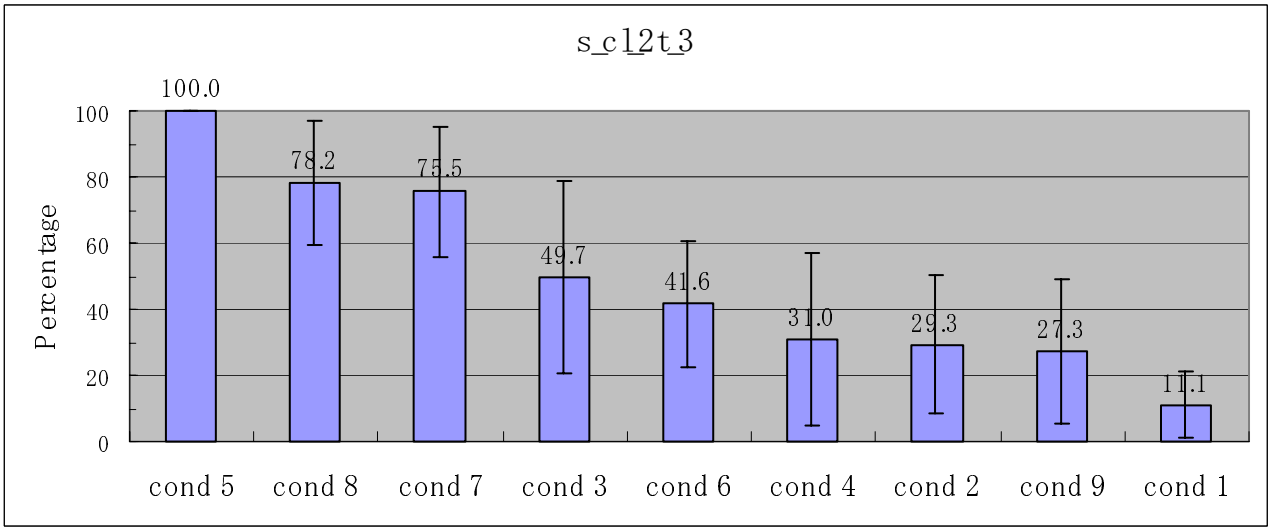
80
60
40
20
0
99.3
70.6
66.7
64.1
50.5
43.2
37.8
31.0
12.5
cond 2
cond 5
cond 1
cond 4
cond 6
cond 9
cond 3
cond 7
cond 8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20
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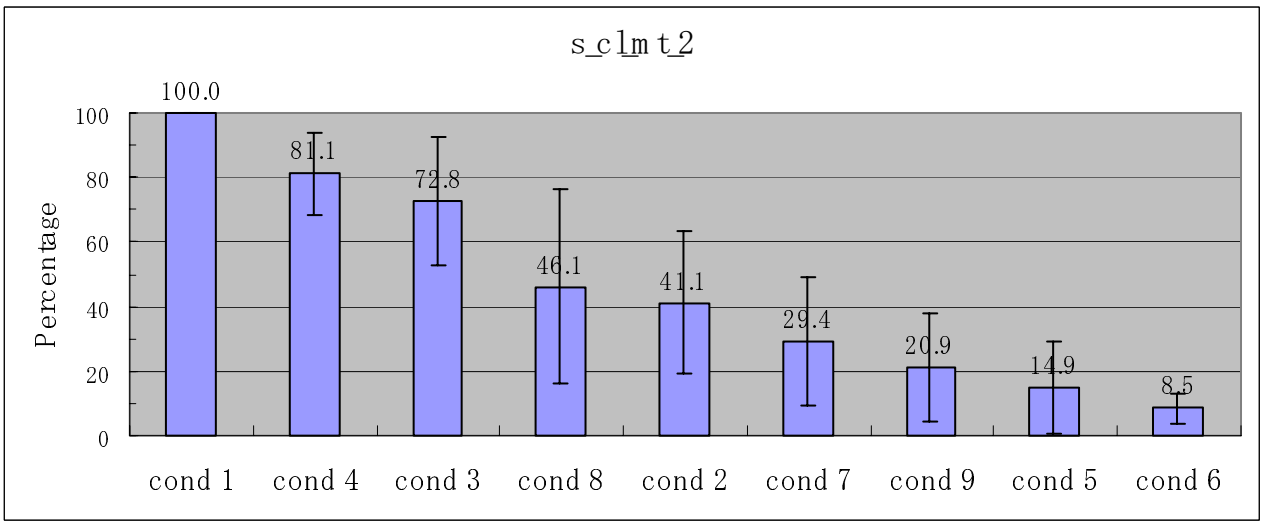
100.0
78.2
75.5
49.7
41.6
31.0
29.3
27.3
11.1
cond 5
cond 8
cond 7
cond 3
cond 6
cond 4
cond 2
cond 9
cond 1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46.1
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29.4
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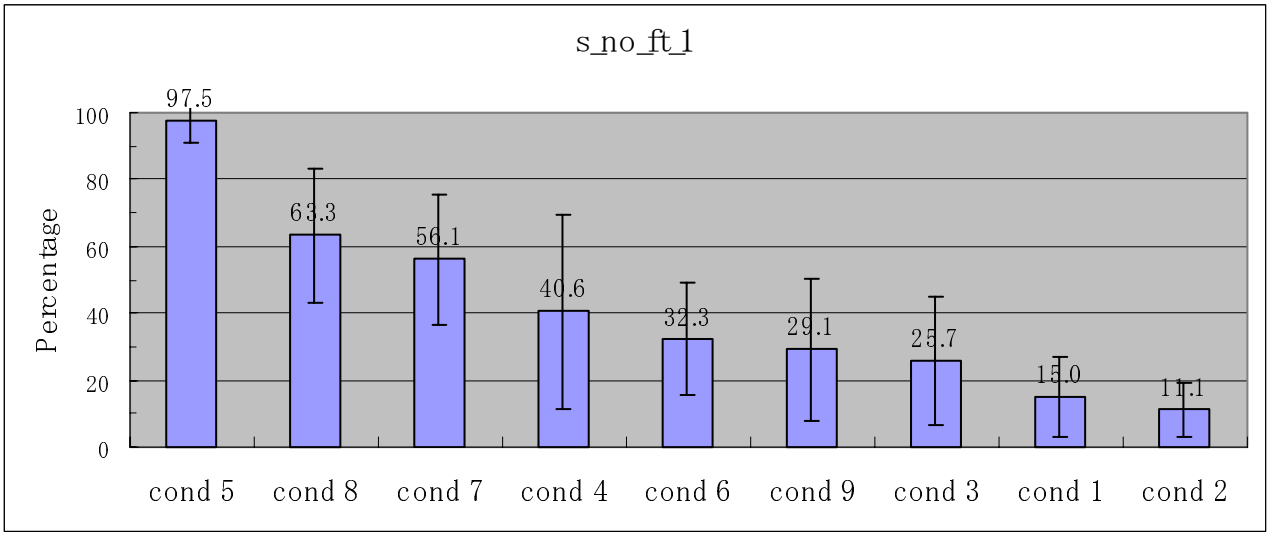
14.9
8.5
cond 1
cond 4
cond 3
cond 8
cond 2
cond 7
cond 9
cond 5
cond 6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Percentage
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40
20
0
97.5
63.3
56.1
40.6
32.3
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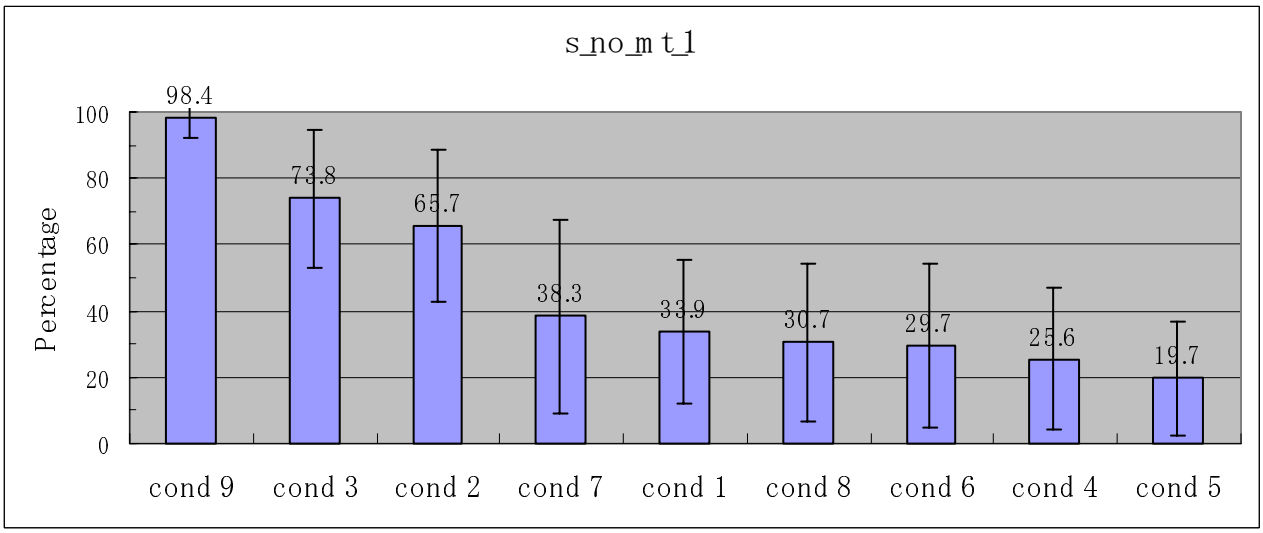
25.7
15.0
11.1
cond 5
cond 8
cond 7
cond 4
cond 6
cond 9
cond 3
cond 1
cond 2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Percentage
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40
20
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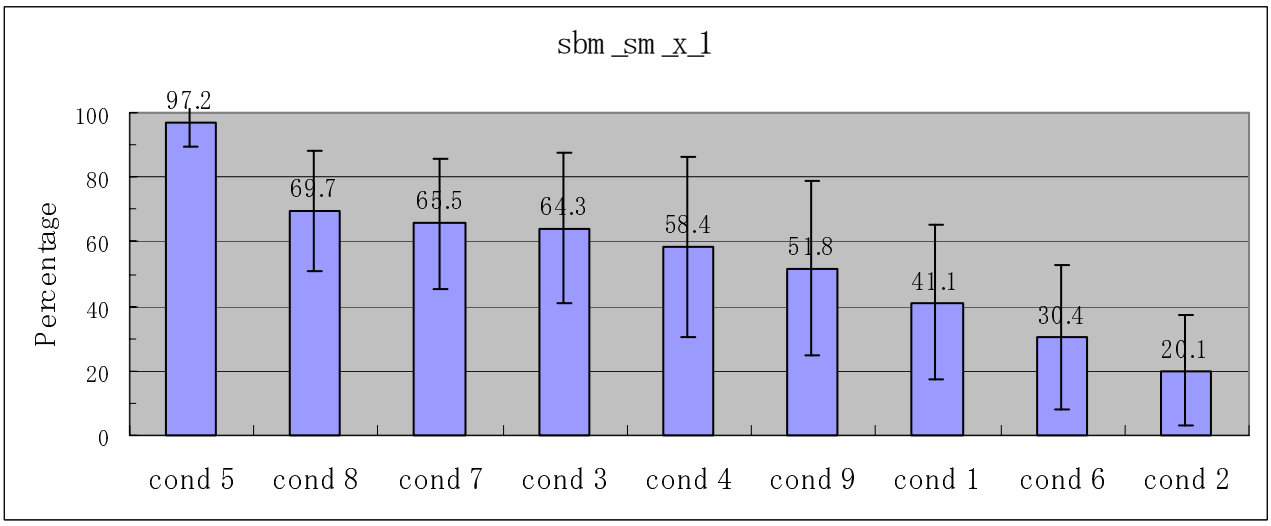
98.4
73.8
65.7
38.3
33.9
30.7
29.7
25.6
19.7
cond 9
cond 3
cond 2
cond 7
cond 1
cond 8
cond 6
cond 4
cond 5


sbm_sm_x_1
Percentage
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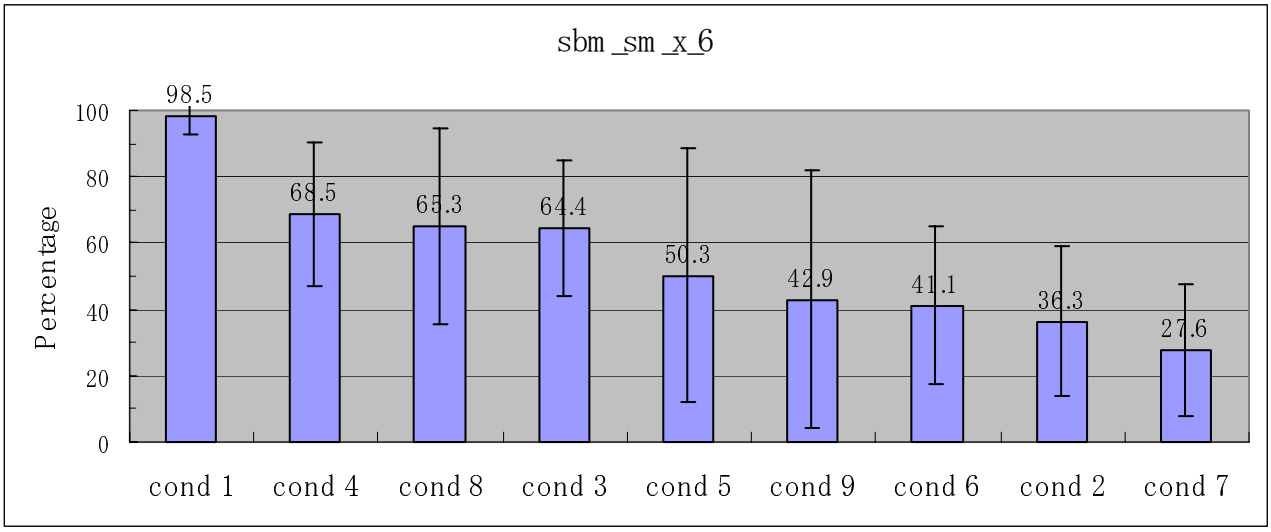
80
60
40
20
0
97.2
69.7
65.5
64.3
58.4
51.8
41.1
30.4
20.1
cond 5
cond 8
cond 7
cond 3
cond 4
cond 9
cond 1
cond 6
cond 2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Percentage
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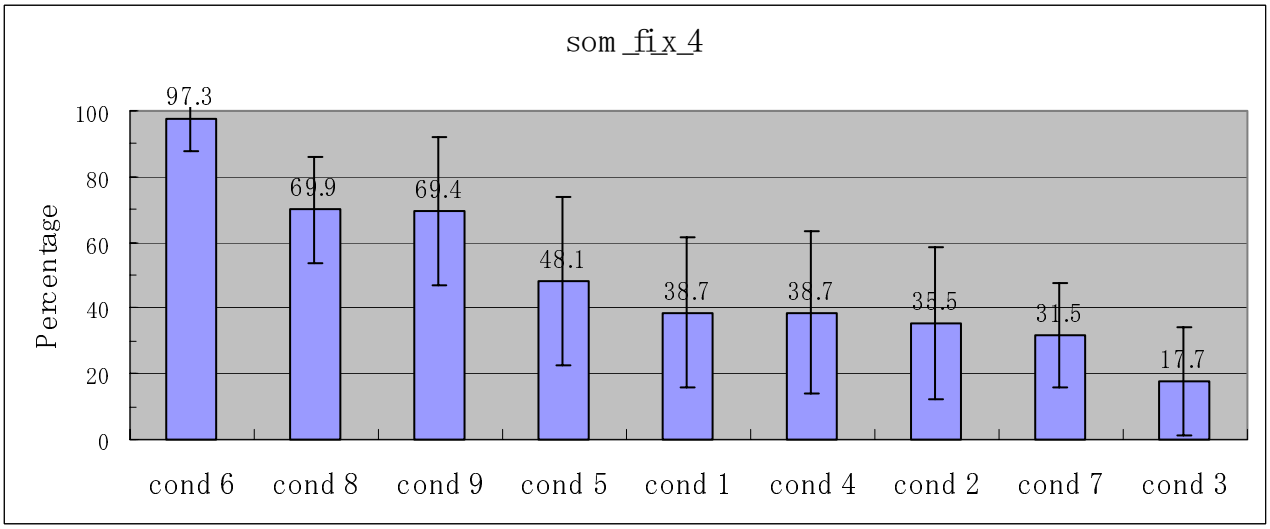
60
40
20
0
98.5
68.5
65.3
64.4
50.3
42.9
41.1
36.3
27.6
cond 1
cond 4
cond 8
cond 3
cond 5
cond 9
cond 6
cond 2
cond 7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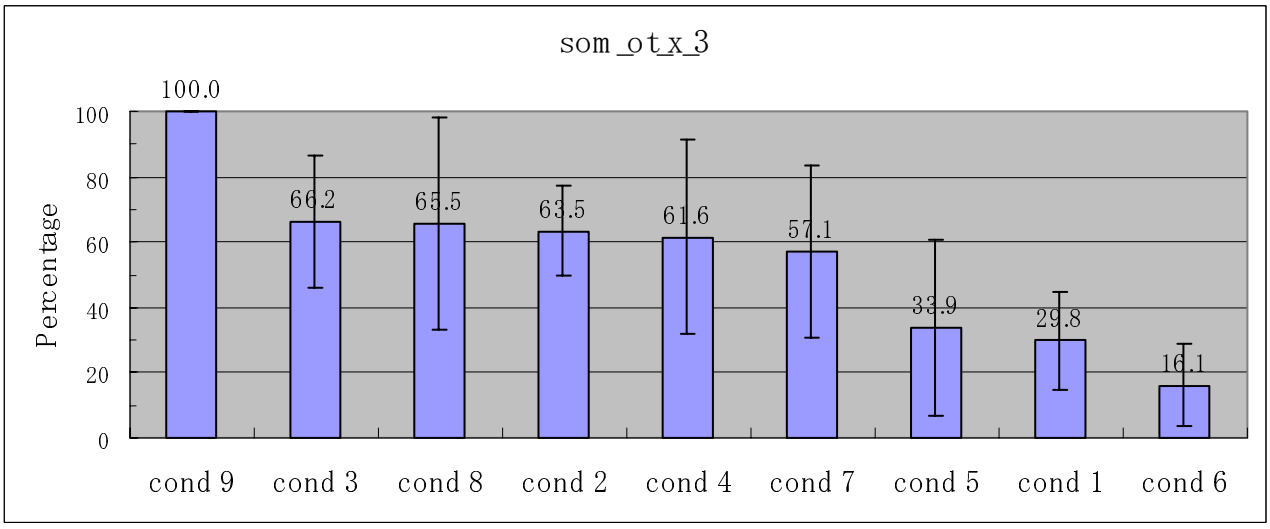
97.3
69.9
69.4
48.1
38.7
38.7
35.5
31.5
17.7
cond 6
cond 8
cond 9
cond 5
cond 1
cond 4
cond 2
cond 7
cond 3


som_otx_3
Percentage
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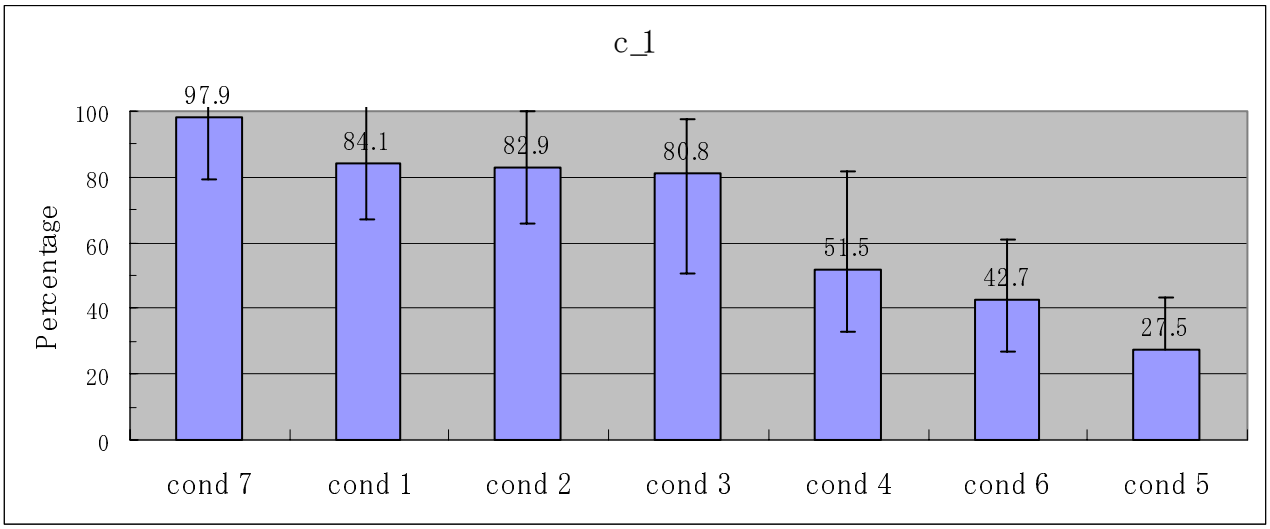
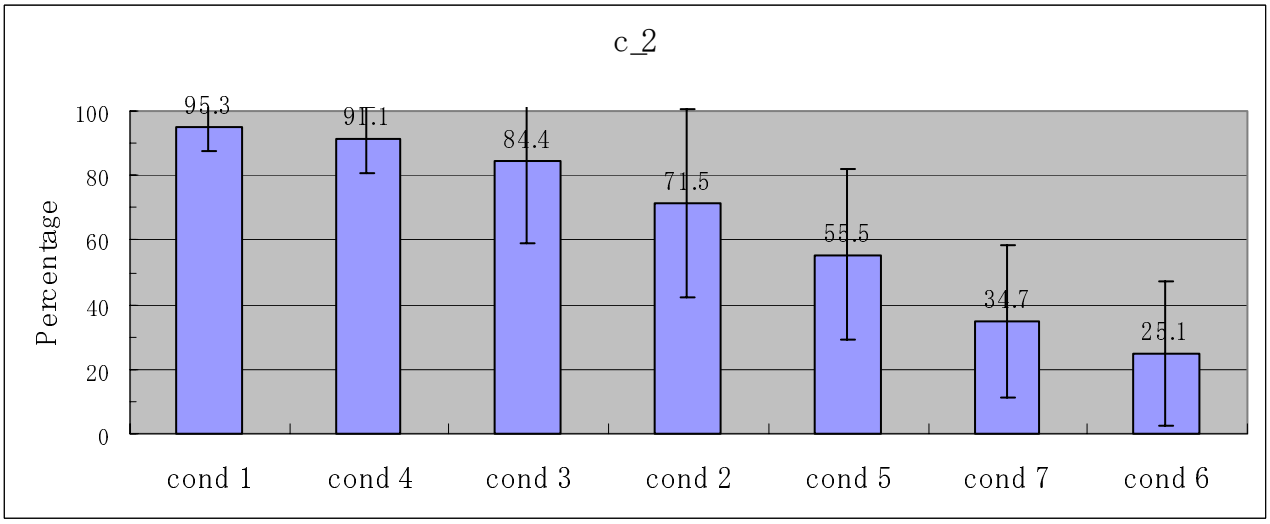
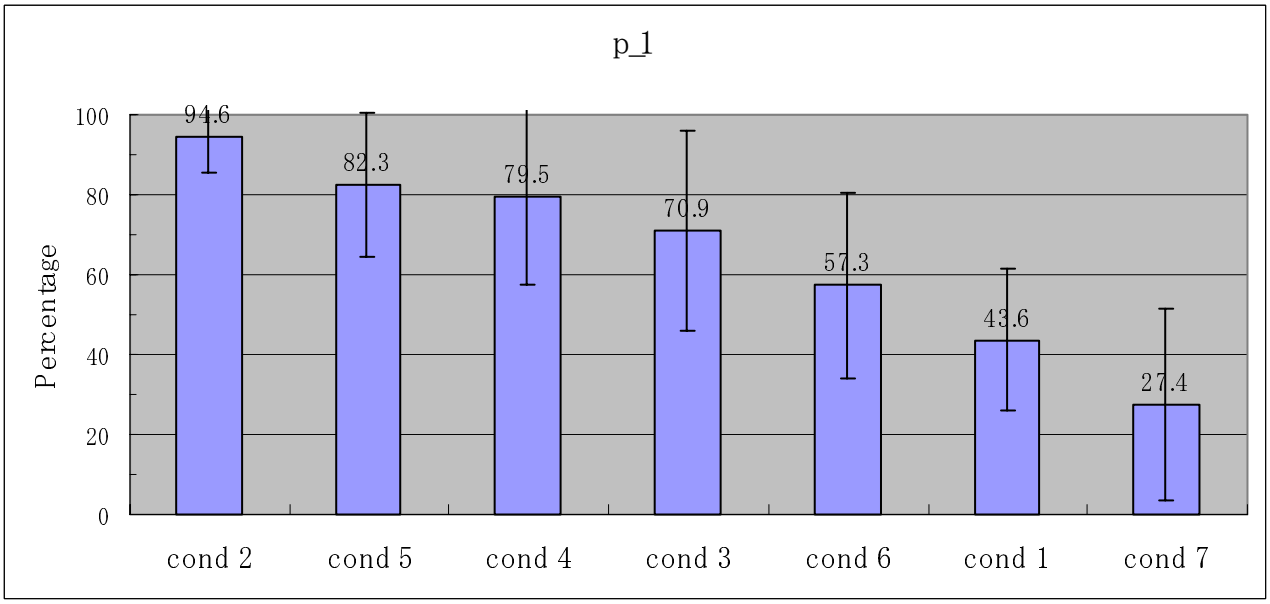
80
60
40
20
0
100.0
66.2
65.5
63.5
61.6
57.1
33.9
29.8
16.1
cond 9
cond 3
cond 8
cond 2
cond 4
cond 7
cond 5
cond 1
cond 6

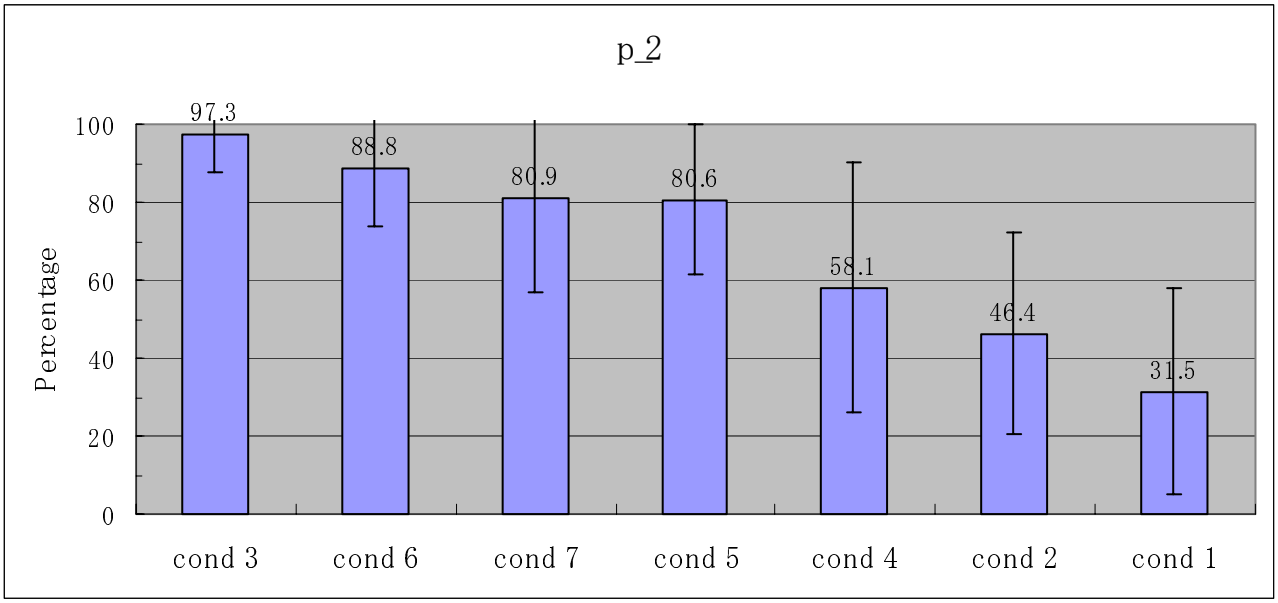
3.2 High rate

Test at 48 kbit/s stereo








p_2
Percentage
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80
60
40
20
0
97.3
88.8
80.9
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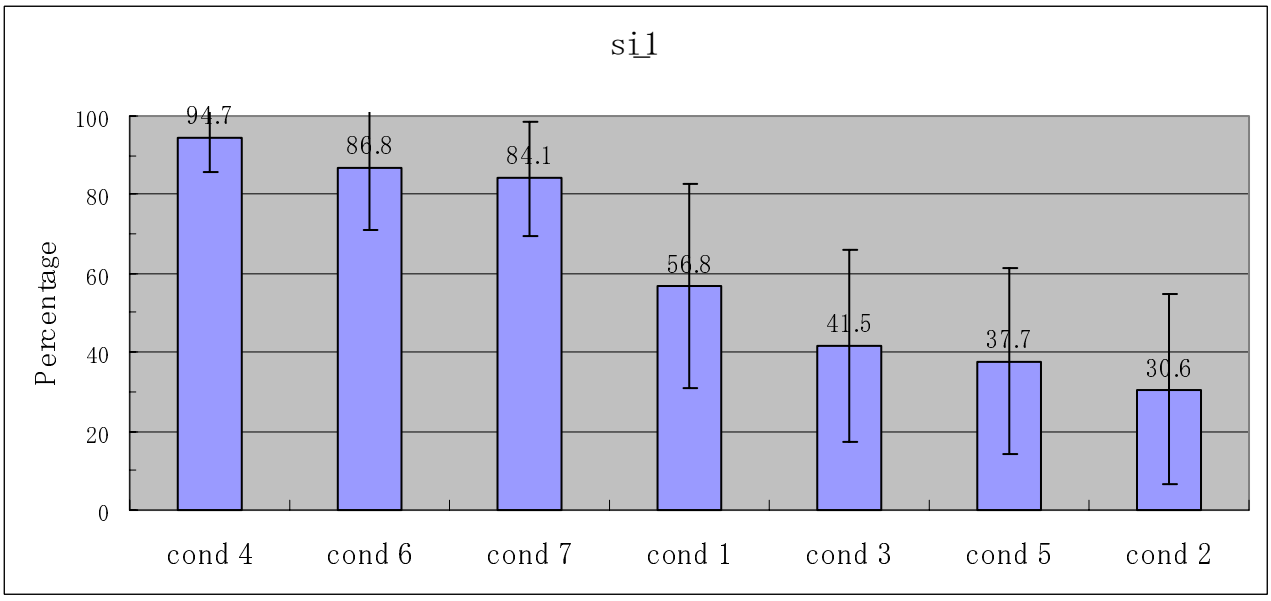
58.1
46.4
31.5
cond 3
cond 6
cond 7
cond 5
cond 4
cond 2
cond 1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Percentage
100
80
60
40
20
0
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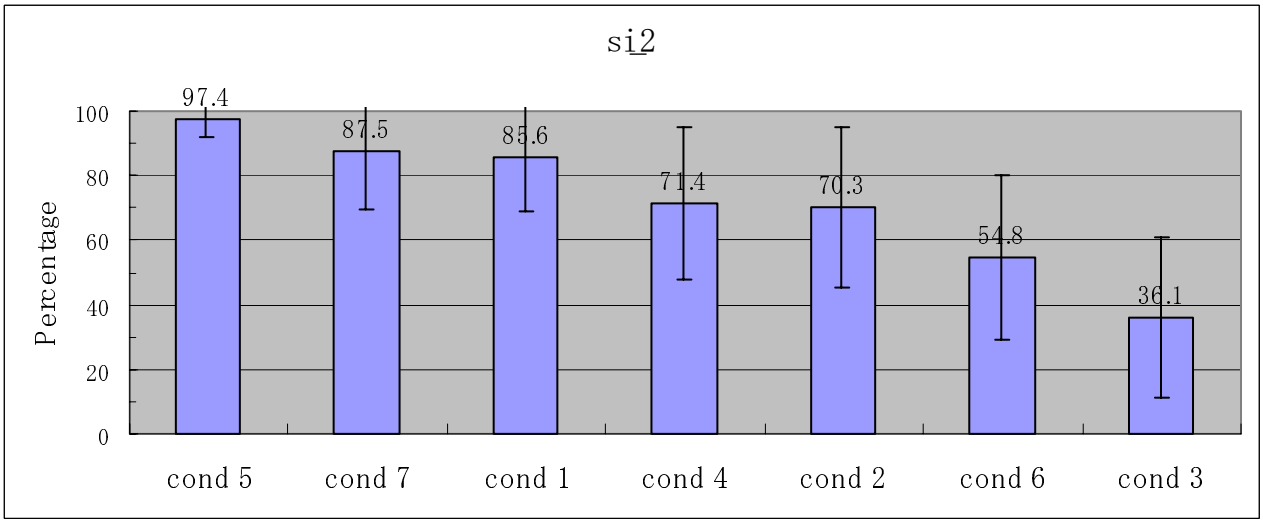
56.8
41.5
37.7
30.6
cond 4
cond 6
cond 7
cond 1
cond 3
cond 5
cond 2


si2
Percentage
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60
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20
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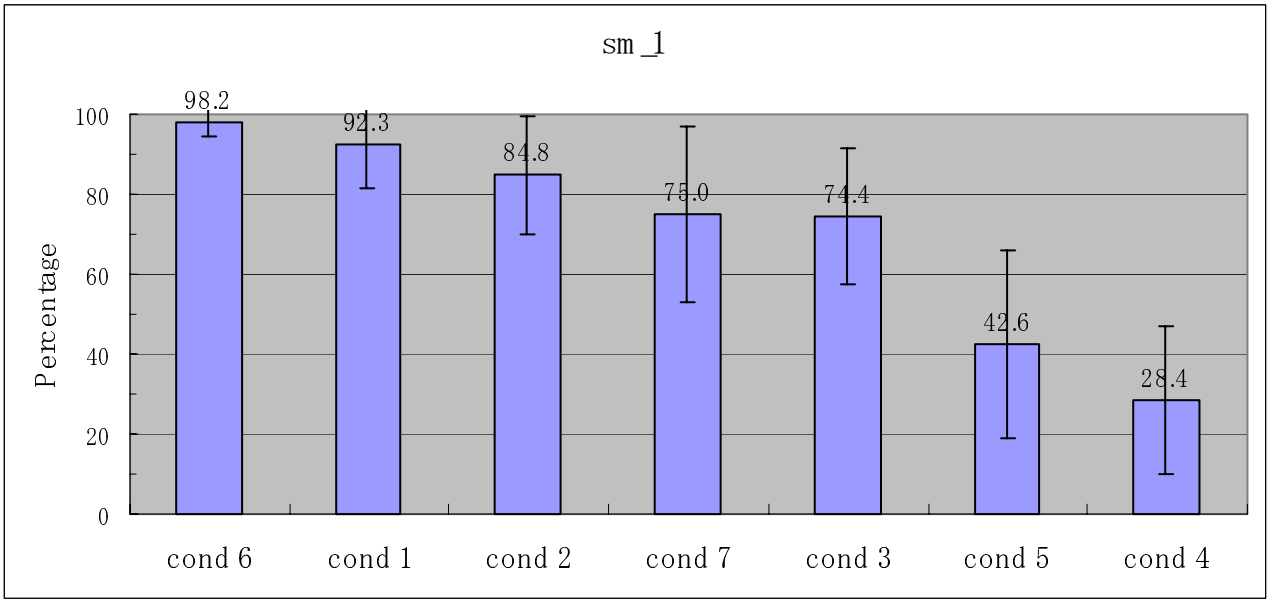
85.6
71.4
70.3
54.8
36.1
cond 5
cond 7
cond 1
cond 4
cond 2
cond 6
cond 3


sm_1
Percentage
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80
60
40
20
0
98.2
92.3
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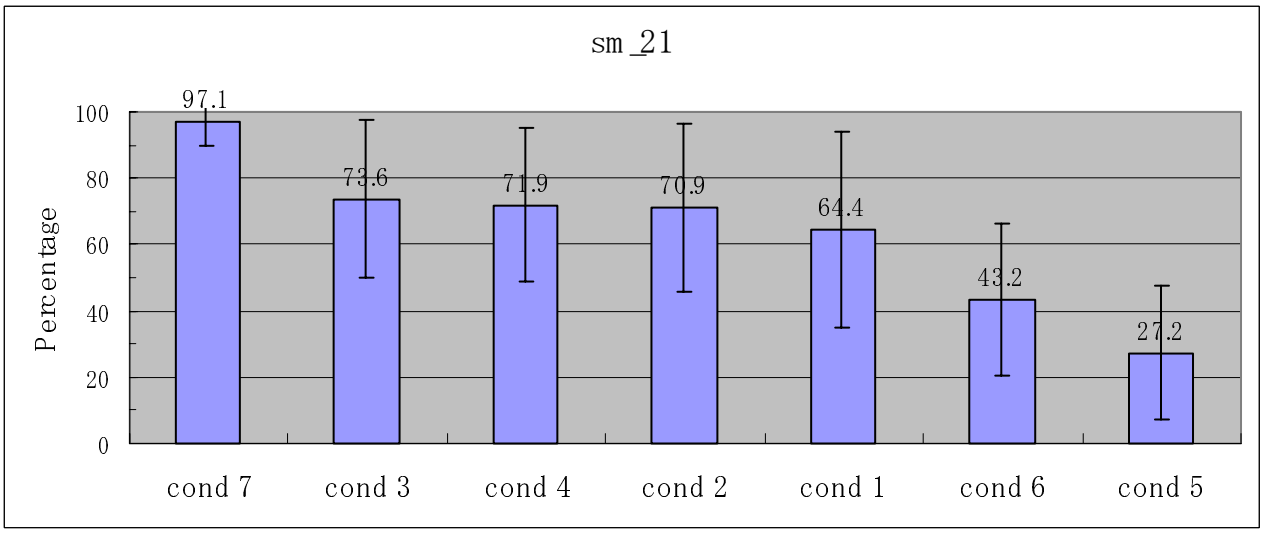
75.0
74.4
42.6
28.4
cond 6
cond 1
cond 2
cond 7
cond 3
cond 5
cond 4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Percentage
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40
20
0
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73.6
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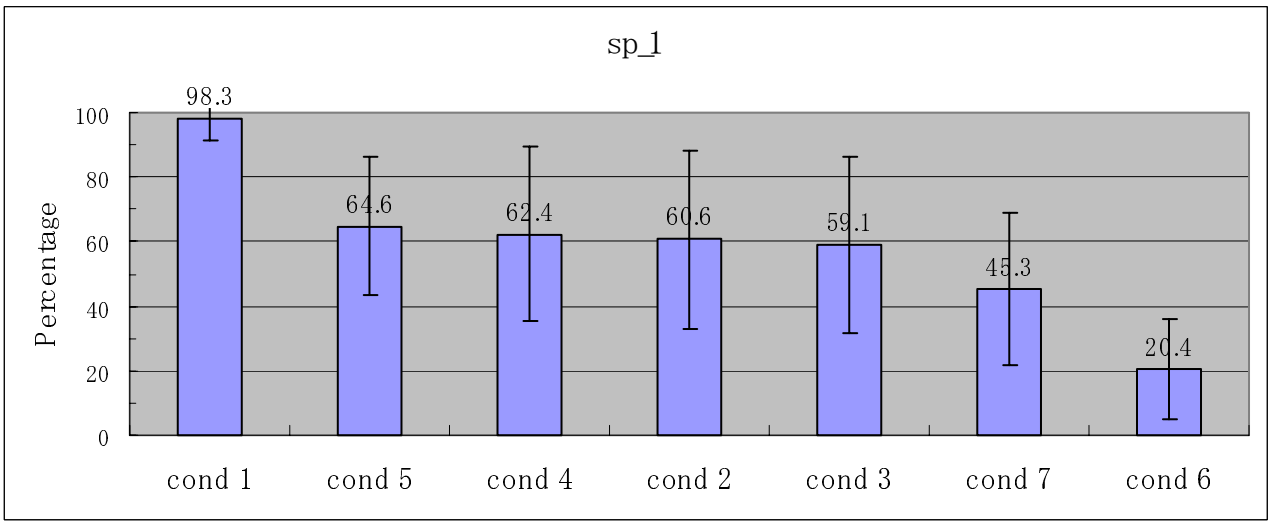
70.9
64.4
43.2
27.2
cond 7
cond 3
cond 4
cond 2
cond 1
cond 6
cond 5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Percentage
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40
20
0
98.3
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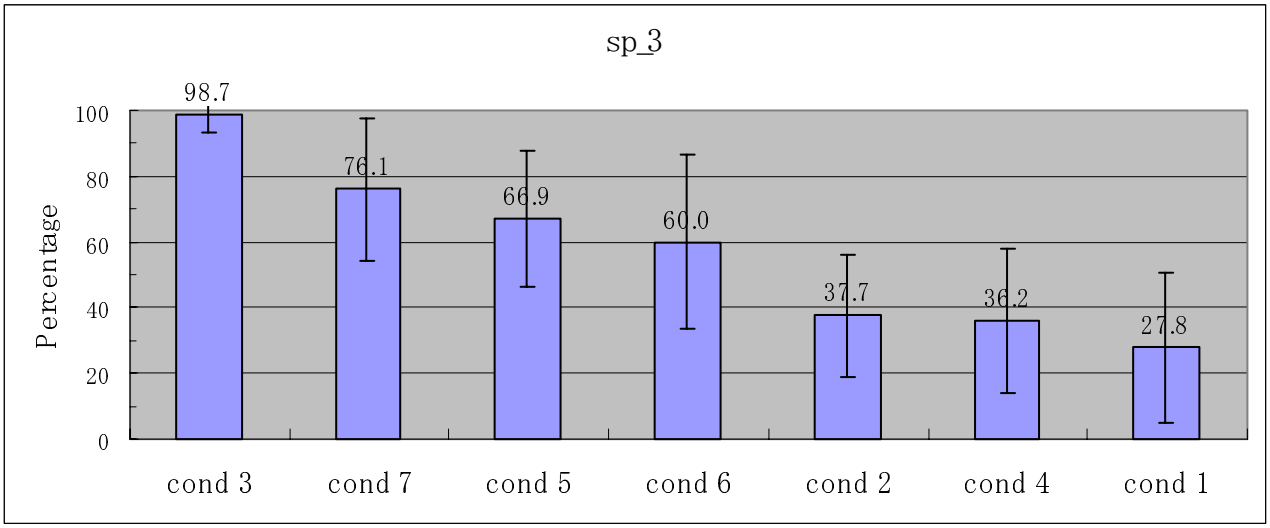
60.6
59.1
45.3
20.4
cond 1
cond 5
cond 4
cond 2
cond 3
cond 7
cond 6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Percentage
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80
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40
20
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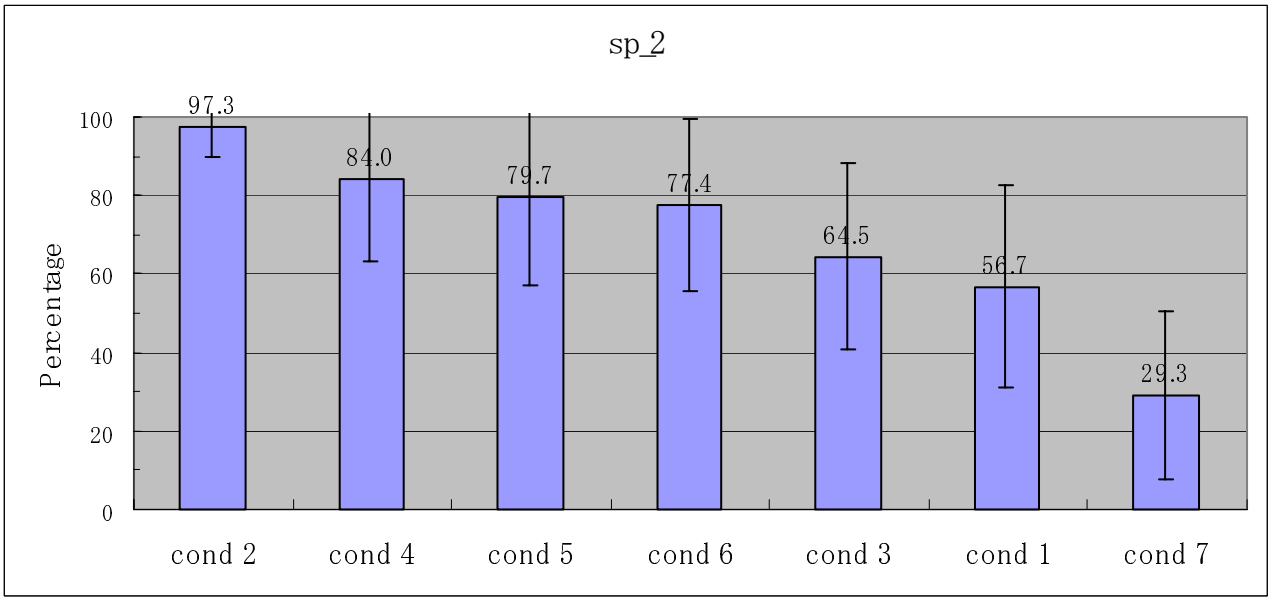
98.7
76.1
66.9
60.0
37.7
36.2
27.8
cond 3
cond 7
cond 5
cond 6
cond 2
cond 4
cond 1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Percentage
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60
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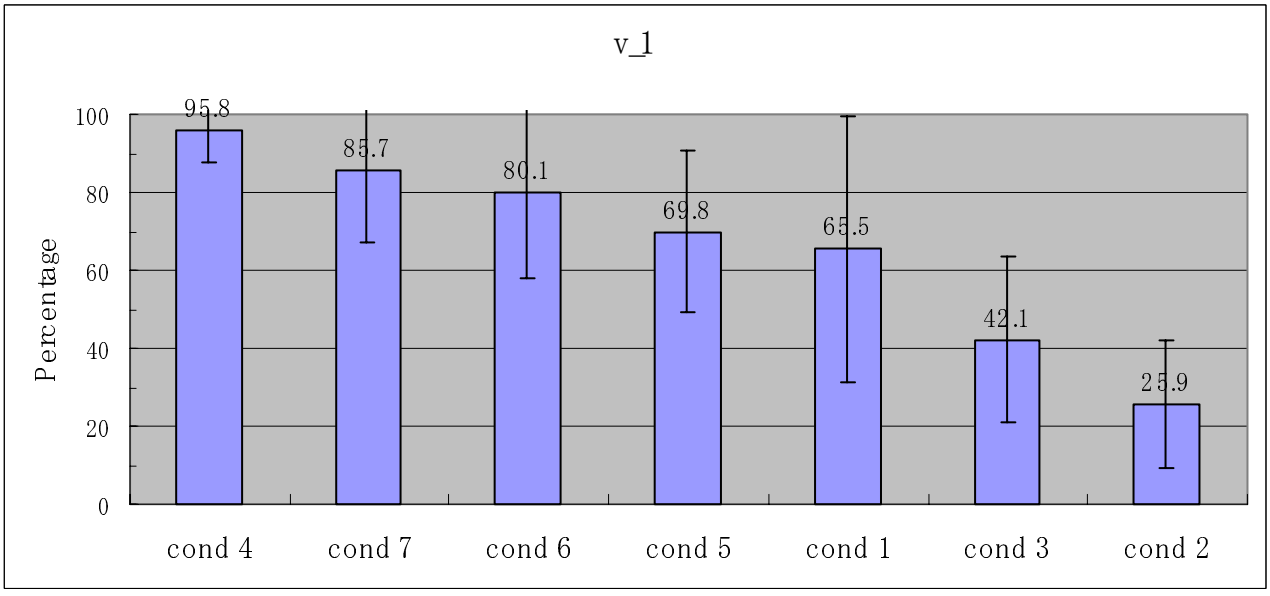
20
0
97.3
84.0
79.7
77.4
64.5
56.7
29.3
cond 2
cond 4
cond 5
cond 6
cond 3
cond 1
cond 7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Percentage
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20
0
95.8
85.7
80.1
69.8
65.5
42.1
25.9
cond 4
cond 7
cond 6
cond 5
cond 1
cond 3
cond 2

Technical Specification Group Services and System Aspects *TSGS#23(04)0070*
Meeting #23, Phoenix, AZ, USA, 15-18 March 2004

3GPP TSG-SA WG4 Meeting #30 S4-040035
Malaga, Spain, 23rd - 27th February 2004.

Source: **TSG SA WG4 (T-Systems)**

Title: **PSS/MMS High Rate and AMR-WB+ and PSS/MMS Low Rate Audio Selection Test, Listening Laboratory Report**

Agenda item: **7.4.3**

Document for: **APPROVAL**

---

1. Introduction

T-Systems conducted listening tests based on the work plan for the AMR-WB+ and PSS/MMS Low-Rate Audio Selection Test [1] and the PSS/MMS High-Rate Audio Selection Test [2].
This document describes the experimental design and the test procedure.
T-Systems accomplished the following tests as defined in [1] and [2]:

Exp.	Operational mode	Audio Material	#Codecs in test	# Reference codecs	#Anchors in test	#Refe-rences	#Items	Total
A2a	18 kbps, stereo, use case A (PSS)	Set a	3	2	3	2	12	120
A4a	24 kbps, stereo, use case A (PSS)	Set a	3	2	3	2	12	120
B2a	18 kbps, stereo, use case B (MMS)	Set a	3	2	3	2	12	120
B4a	24 kbps, stereo, use case A (PSS), 3% FER	Set a	3	2	3	2	12	120

Table 1: T-Systems sub-experiments in the AMR-WB+ and PSS/MMS Low-Rate Audio Selection Test

Exp.	Operational mode	#Codecs in test	# Reference codecs	#Anchors in test	#Refe-rences	#Items	Total
1	32 kbps, stereo	4 (use case A and use case B encoder)	2, incl. RealAudio @ 32 kbit/s stereo	2	1	12	108

Table 2: T-Systems sub-experiment in the PSS/MMS High-Rate Audio Selection Test

2. Experimental Design

2.1. Test Method

The test procedure followed that of the “MUltiple Stimulus with Hidden Reference and Anchors” (MUSHRA) [3] method for the subjective assessment of intermediate quality audio.

The subject was presented with a series of trials, each corresponding to a different one of the audio items selected for the tests. In each trial, the subject was presented with the known reference version as well as a set of signals to be graded. The set of signals consisted of the 3 coding systems under test in case of the

PSS/MMS Low-Rate Audio Selection Test. Additionally 2 reference codecs, 3 hidden anchors and a hidden copy of the reference were used, making a total of 10 signals to be graded for each trial.
The hidden anchors were bandwidth-limited versions of the unprocessed, reference signal and were chosen as:
- 3.5 kHz Low pass with significantly reduced stereo image (12 dB attenuated side channel)
- 7.0 kHz Low pass with significantly reduced stereo image (12 dB attenuated side channel) and
- 7.0 kHz Low pass slightly reduced stereo image (6 dB attenuated side channel)
as given in [1].

In case of the PSS/MMS High-Rate Audio Selection Test the set of signals consisted of the 4 coding systems, 2 reference codecs, 2 hidden anchors and a hidden copy of the reference, making a total of 9 signals to be graded for each trial.
The hidden anchors were bandwidth-limited versions of the unprocessed, reference stereo signal and were chosen as 3.5 kHz and 7 kHz for these tests.

Since the subjects can directly compare the impaired signals, this method provides the benefits of a full paired comparison test in that the subject can more easily detect differences between the impaired signals and grade them accordingly. This feature permits a high degree of resolution in the grades given to the systems. It is important to note, however, that subjects derived their grade for a given system by comparing that system to the reference signal, as well as to the other signals in each trial.

The subjects were asked to grade *basic audio quality*, a single global attribute used to judge any and all detected differences between the reference and the object in question. The scoring is done according to the Continuous Quality Scale (CQS). The CQS consists of a continuous scale, labelled with five adjectives from top to bottom:

- Excellent
- Good
- Fair
- Poor
- Bad

T-Systems test site made use of the Canadian Research Centre's, System for the Evaluation of Audio Quality (CRC-SEAQ) and a typical screen shot of the computer-controlled replay system is shown in Figure 1. The set of signals to grade were shown on buttons A to I along with the known reference. The grading scale was continuous from 0 to 100 in unit steps and grades are recorded by adjusting the slider corresponding to each to button. It was possible to switch cleanly between all of the signals at will even whilst they were playing. Additionally the subject was permitted to use looped playback if required.
The order of presentation of the trials and the allocation of the signals to be graded to the buttons A to I was randomised for every subject that took part.

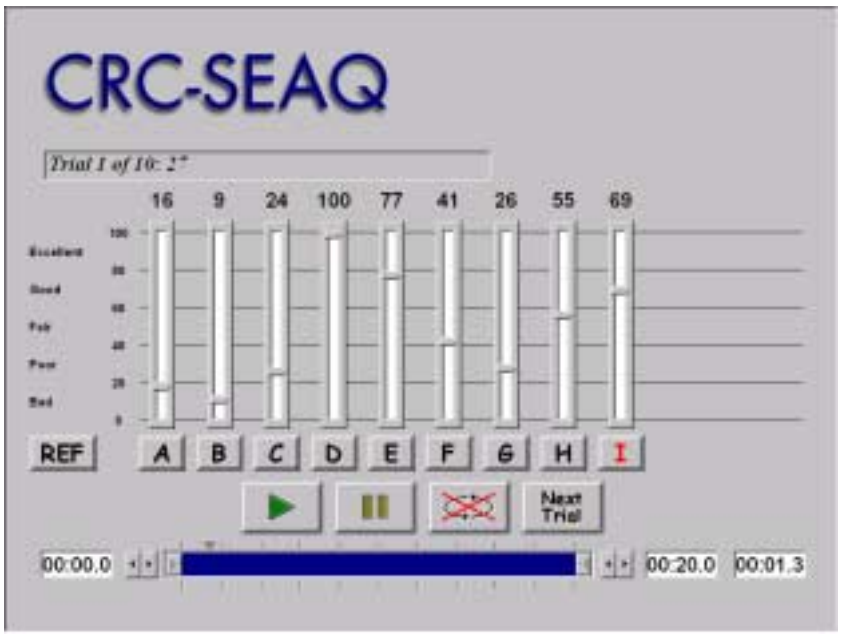

Figure 1: The Computer-Controlled Replay System Used for the Tests (CRC-SEAQ)

2.2. Training phase

Prior to the actual testing a training phase was carried out in which the test subjects are familiarized with testing methodology and environment. The training was done following the same MUSHRA methodology as the actual test, though limited to four trials.
The training was based on the same codec, anchor and reference conditions as the blind grading phase. A written introduction describing the test equipment and the test procedure was provided to every test subject.
No grades given during the training phase have been taken into account in the actual tests.

2.3. Grading phase

The overall 60 test items were group into 5 sessions each containing 12 items. Every subject conducted three sessions at the first day and two sessions at the second day of the test.
The presentation order for codecs and items were randomised. Every listener got a different order for all relations. The grading phase was preceded by a training phase and was separated by breaks in order to avoid listener fatigue.

2.4. Listening Panel

The listening panel that was in the final evaluation at T-Systems consisted of 15 subjects, two women and 13 men aged between 17 and 30 years. All listeners were experienced listeners. Most of the listeners were Tonmeisters, sound engineers or composer students. The listeners were selected with the focus to have listeners that are experienced to concentrate for long time on listening to specific audio characteristics.

2.5. Test Duration

The tests phase for any listener consisted of a total time typically about 8 hours including the training. One session took about 30 to 45 minutes. The tests for one subject were done within two days.

2.6. Post-screening of subjects

No post screening has been done due to the blind test procedure.

2.7. Listening Conditions Including Listening Test System

The tests were conducted in the listening rooms at T-Systems in Berlin, which fulfilled the requirements given in the test plan [1, 2]. A detailed description will be provided if requested. STAX Lambda Pro headphones were used as reproduction devices. The subjects had the possibility to set the reproduction level individually before they started the actual tests.
The subjects were not restricted from changing the reproduction level during the test; however they were advised to select a level at the beginning of the tests and not to change it.

The test items were stored on a Windows workstation, which had a digital sound board (RME Digi96/8). This sound board was digital connected via an ADAT interface to the Nexus Distribution System, which was also clock master. The D/A-Converters of the Nexus system were used. Specially designed software IAQ (CRC-SEAQ) was running on the PC's.

3. Test agenda

The Tests were carried out between December 15th and February 3rd. The test results were sent out to global analysis laboratory on February 10th.

4. Conclusion and recommendations

As a result of the agreed blind Test procedure no post-screening of the test subjects and no statistical analysis had been carried out.

5. References

[1] TSGS#21(03)0437 AMR-WB+ and PSS/MMS Low-Rate Audio Selection Test and Processing, Plan Version 2.0, September 2003
[2] TSGS#21(03)0438 PSS/MMS High-Rate Audio Selection Test and Processing, Plan Version 2.0, September 2003
[3] EBU Technical recommendation: MUSHRA-EBU Method for Subjective Listening Tests of Intermediate Audio Quality, Doc. B/AIM022, October 1999

Technical Specification Group Services and System Aspects *TSGS#23(04)0070*

Meeting #23, Phoenix, AZ, USA, 15-18 March 2004

3GPP TSG SA4 #30 Tdoc S4-040044

Malaga, Spain, February 23-27, 2004

Source: **TSG SA WG4 (Coding Technologies)**

Title: **Listening laboratory report in the course of the 3GPP audio codec selection process**

Agenda item: **7.4.3**

1. Introduction

Coding Technologies conducted listening tests based on the work plan for the 3GPP audio codec selection test [1]. This document describes the tests carried out at Coding Technologies and the experimental design.

2. Test cases

Coding Technologies accomplished the following tests as defined in [1]:

Exp.	Operational mode	Audio Material	#Codecs in test	# Reference codecs	#Anchors in test	#Refe-rences	#Items	Total
A1b	14 kbps, mono, use case A (PSS)	Set b	3	2	2	2	12	108
A3b	24 kbps, mono, use case A (PSS)	Set b	3	2	2	2	12	108
B1b	14 kbps, mono, 16 kHz, use case B (MMS)	Set b	3	2	2	2	12	108
B3b	14 kbps, mono, use case A (PSS), 3% FER	Set b	3	2	2	2	12	108

Table 1: Sub-experiments carried out at Coding Technologies

3. Experimental Design

3.1 Test Method

The test procedure followed that of the “Multiple Stimulus with Hidden Reference and Anchors” (MUSHRA) [2] method for the subjective assessment of intermediate quality audio. Figure 1 shows a screenshot of the user interface of the MUSHRA implementation used at Coding Technologies. The specific MUSHRA implementation is done by Fraunhofer IIS.

Figure 1: MUSHRA user interface

3.2 Training phase

Prior to the actual testing a training phase was carried out in which the test subjects were familiarized with testing methodology and environment. The training was done following the same MUSHRA methodology as the actual test, though limited to four trials. Training was carried out for every new sub-experiment.

3.3 Grading phase

Each test subject carried out only one sub-experiment per half day to allow for sufficient rest between tests. All in all 61 experiments have been carried out, thus at least 15 test subjects have been contributed to each of the four sub-experiments, for the experiment A1b actually 16 test subjects were available. In average the test subjects carried out one sub-experiment in around 45 minutes (including training session).

3.4 Test subjects

All together 18 test subjects, 2 female and 16 male, aged between 24 and 45 years took part in the testing. All listeners were experienced listeners, most of them with a background as audio engineers and musicians. From scanning the resulting test data for the original hidden reference it turned out that all test subjects found the original hidden reference in every single experiment:

3.5 Test schedule

The Tests started on December 16th and were finalized on February 3rd. The data was collected and provided to the analysis lab by February 6th.

3.6 Listening Laboratory

The tests were conducted in the listening rooms at Coding Technologies Nuremberg and Coding Technologies Stockholm. Both listening sites are equipped similarly: the audio data was replayed by a digital sound card to a high-class digital/analog converter and reproduced by STAX Lambda Pro headphones in a quiet acoustically controlled listening room.

4. Conclusion

Since the test material was blinded no statistical analysis has been carried out.

5. References

[1] SA-030437 “AMR-WB+ and PSS/MMS Low-Rate Audio Selection Test and Processing Plan Version 2.0, September 2003”

[2] EBU Technical recommendation: “MUSHRA-EBU Method for Subjective Listening Tests of Intermediate Audio Quality”, Doc. B/AIM022, October 1999

Technical Specification Group Services and System Aspects *TSGS#23(04)0070*
Meeting #23, Phoenix, AZ, USA, 15-18 March 2004

3GPP TSG-SA4#30 meeting Tdoc S4-040063
February 23-27, 2004, Malaga, Spain

Source: TSG SA WG4 (Nokia)
Title: PSS/MMS selection tests – Nokia listening test lab report
Agenda item: 7.4.3

Summary

This document preset procedures conducted by Nokia listening test laboratory for both 3GPP PSS/MMS low-rate and high-rate audio codec selection tests. Nokia performed four experiments for the low-rate tests (A2, A4, B2, B3) and one experiment for high-rate tests (exp. 2). All experiments have been performed according to the low-rate and high-rate selection test and processing plans [1][2] respectively and there were no deviations from or exceptions to the listening test procedures and specifications described the plans.

1. Introduction

Nokia conducted the following four listening test for PSS/MMS low-rate selection:

Exp.	Operational condition	Audio material
A2	18 kbs, stereo, use case A (PSS)	b
A4	24 kbs, stereo, use case A (PSS)	b
B2	18 kbs, stereo, use case B (MMS)	b
B4	24 kbs, stereo, use case A (PSS), 3% FER	b

For PSS/MMS high-rate selection tests Nokia conducted following test:

Exp.	Operational condition
2	48 kbs, stereo

2. Test material

Blinded test material was successfully transferred from the host to Nokia listening test laboratory via ftp on 16th of December 2003.

3. Listening sessions

3.1 Presentation sequences

All the listeners listened their sound items and each trial of the item in unique order.

3.2 Listeners

All the listeners were native Finnish speakers with prior experience in MUSHRA test methodology. They were all tested before listening with audiometer to have normal hearing (to fulfil ISO Standard 389 requirements). There were altogether 30 different listeners for all the experiments. Each listener participated in one experiment only once. Listener, who participated in multiple experiments, did NOT do so on the same day.

3.3 Listening environment

Listeners were placed in high quality, acoustically isolated booths. Six identical booths with internal dimensions of 1.4 x 1.1 x 2.1m were used. The background noise-rating curve of each booth fulfils the ISO NR15 requirement. The reverberation times within the booths are <300ms above 315Hz one-third octave bands. No discernible flutters are audible within the booths [3].

3.4 Environmental noise

Environmental noise was fed into the booths with the required Hoth spectrum to represent typical room noise at the required 30dBA level (as defined by ITU-T, Recommendation P.800 [4]). Two loudspeaker units (type: Genelec 1029A) per booth were used. Speakers were positioned so that the sound pressure level was 30 dBA above the center of the seat of subject's chair.

3.5 Testing facility

The listening test was controlled by remote PCs with a keyboard, mouse and an LCD screen in the booths. Six machines were used to play the samples to the listeners and to collect their answers. Each one is furnished with a high quality digital sound card (type: RME DIGI 96/8 PRO), providing 44.1kHz or 48kHz output at a resolution of 24 bits. The digital audio output signals were subsequently fed to a Studer D19 24bit multi-channel digital to analogue converter employing an AES/EBU bus. A Symmetrix 304 headphone amplifier was used. Samples were presented binaurally to the listeners over high quality Sennheiser HD580 headphones.

4. Test results

Results from all the tests Nokia conducted have been delivered to analysis laboratory on 5th of February 2004.

5. References

[1] "AMR-WB+ and PSS/MMS Low-Rate Audio Selection Test and Processing Plan"

[2] "AMR-WB+ and PSS/MMS High-Rate Audio Selection Test and Processing Plan"

[3] M. Kylliäinen et al.; Compact high performance listening spaces; Euronoise, Naples, 2003.

[4] "ITU-T; Recommendation P.800; Methods for subjective determination of transmission quality"

Technical Specification Group Services and System Aspects ***TSGS#23(04)0070***

Meeting #23, Phoenix, AZ, USA, 15-18 March 2004

TSG-SA4#30 meeting Tdoc S4 (04)0068
February 23-27, 2004, Malaga, Spain

Source:	**TSG SA WG4 (Ericsson)**
Title:	**PSS/MMS audio codec selection - Test Lab report**
Document for:	**Approval**
Agenda item:	**7.4.3**

Introduction

As one of the selected listening labs for the listening tests in the 3GPP PSS/MMS audio codec selection, Ericsson has performed five listening tests. Four of these tests are also part of the AMR-WB+ work item under investigation in 3GPP. The experimental design has been specified in documents S4-030824 (AMR-WB+ and PSS/MMS Low-Rate Audio Test and Processing Plan) and S4-030821 (PSS/MMS High-Rate Audio Selection Test and Processing Plan).

Experiments

The experiments performed were:

- A2a, 18 kbps stereo use case A (Low-Rate selection),
- A4a, 24 kbps stereo use case A (Low-Rate selection),
- B2a, 18 kbps stereo use case B (Low-Rate selection),
- B4a, 24 kbps stereo, 3% FER (Low-Rate selection),
- H3b, 32 kbps stereo, 3% FER (High-Rate selection).

Experiment data

The data was downloaded from the ftp site of the host lab (T-Systems). The amount of data was approximately 7 Gb.

Listening panel

The listening panel was selected from experienced listeners inside Ericsson. A pre-screening procedure was used were previous performance in intermediate quality audio listening tests served as an indication of the listeners' ability to judge anchors and references in a correct way, as well as the ability to repeatedly grade in a consistent manner.
The listeners, both male and female, were between 25 to 45 years of age and had all had previous experience of audio listening tests using the Mushra methodology.

No post-screening was carried out due to the blinding of the test material.

Lab setup

The listening environments were two listening labs, which both conformed to the respective test plans. Open-back circum-aural headphones were used (Sennheiser HD600) and the listeners could individually adjust the listening level to their preference. The audio was fed from the computer to the listener using M-audio USB Duo sound cards.

Mushra test software

The Mushra software has been developed in-house. It has a similar GUI as the CRC-SEAQ software shown in the test plan although there is a possibility to show the waveform of the current test item (see Appendix 1 for a screen shot). The waveform is rendered from the open reference clip, thus showing no information about the encoded clips. The software performs both inter-item and intra-item randomization of the test sequence, and provides a raw output of the test results into individual listener output files.

Listener instructions

See Appendix 1.

Results:

The results are presented as raw data in tables. The post-screening procedure described above has been done and these results are identical to those submitted to the Global Analysis lab.

Test A2a, 18 kbps stereo use case A

Subject Listener	Signal Name	cond 1	cond 2	cond 3	cond 4	cond 5	cond 6	cond 7	cond 8	cond 9
S01	m_ot_x_4	67	83	100	22	47	48	41	38	10
S01	m_ot_x_5	32	68	92	100	31	45	52	65	24
S01	m_po_x_2	70	90	100	31	53	53	68	33	27
S01	m_po_x_3	29	62	75	100	39	53	54	63	38
S01	sbm_js_x_1	100	58	77	66	31	30	62	86	54
S01	sbm_sm_x_4	52	52	19	0	48	56	49	100	36
S01	som_fi_x_3	29	51	83	82	100	45	55	51	60
S01	som_ot_x_2	86	76	35	22	53	65	57	100	47
S01	s_cl_2t_4	39	10	50	87	50	100	39	70	70
S01	s_cl_ft_3	57	56	16	9	55	76	66	100	34
S01	s_no_2t_3	58	74	46	100	31	75	89	23	4
S01	s_no_mt_1	36	50	72	36	5	49	87	78	100
S02	m_ot_x_4	45	88	100	21	72	83	5	33	25
S02	m_ot_x_5	44	57	81	100	35	59	74	65	15
S02	m_po_x_2	30	32	100	35	69	73	30	31	8
S02	m_po_x_3	57	30	51	100	34	57	76	66	35
S02	sbm_js_x_1	100	56	71	71	12	10	69	29	14
S02	sbm_sm_x_4	63	80	12	10	39	80	49	100	49
S02	som_fi_x_3	7	72	83	72	100	45	78	78	32
S02	som_ot_x_2	100	75	33	26	76	37	26	83	50
S02	s_cl_2t_4	32	10	67	79	47	100	55	67	84
S02	s_cl_ft_3	68	80	28	6	68	90	74	100	51
S02	s_no_2t_3	65	83	49	100	49	72	72	30	13
S02	s_no_mt_1	52	65	73	20	9	65	90	29	100
S03	m_ot_x_4	54	70	100	25	62	51	45	30	40
S03	m_ot_x_5	41	68	70	100	31	63	55	47	20
S03	m_po_x_2	51	64	100	26	44	40	19	31	13
S03	m_po_x_3	50	36	67	100	31	49	58	62	24
S03	sbm_js_x_1	100	50	65	66	19	16	30	60	36
S03	sbm_sm_x_4	76	55	25	12	65	69	46	100	29
S03	som_fi_x_3	30	55	70	74	100	35	63	61	48
S03	som_ot_x_2	85	85	61	49	67	74	56	100	41
S03	s_cl_2t_4	47	11	64	81	56	100	40	71	75
S03	s_cl_ft_3	67	70	46	13	62	83	76	100	40
S03	s_no_2t_3	49	69	56	100	40	84	65	25	15
S03	s_no_mt_1	40	60	68	52	20	64	73	76	100
S04	m_ot_x_4	78	83	100	33	66	70	45	53	38
S04	m_ot_x_5	46	76	86	100	30	69	72	57	39
S04	m_po_x_2	56	58	100	27	46	50	38	37	17
S04	m_po_x_3	51	47	73	100	33	65	69	58	41
S04	sbm_js_x_1	100	43	72	73	25	36	57	64	43
S04	sbm_sm_x_4	62	65	44	16	57	91	87	100	39
S04	som_fi_x_3	38	59	51	71	100	45	65	66	75
S04	som_ot_x_2	71	76	44	36	63	54	50	100	55
S04	s_cl_2t_4	35	5	57	76	46	100	36	57	65
S04	s_cl_ft_3	73	77	40	12	72	84	58	100	47
S04	s_no_2t_3	65	59	59	100	39	70	72	50	17
S04	s_no_mt_1	39	68	61	31	11	67	83	46	100
S05	m_ot_x_4	81	94	100	34	65	67	62	53	54
S05	m_ot_x_5	46	61	81	100	36	57	57	64	30
S05	m_po_x_2	51	78	100	30	61	61	67	41	44
S05	m_po_x_3	47	57	78	100	35	63	53	70	38
S05	sbm_js_x_1	100	57	78	78	53	40	71	64	53
S05	sbm_sm_x_4	63	64	31	21	53	82	73	100	47
S05	som_fi_x_3	33	62	70	77	100	43	62	69	80
S05	som_ot_x_2	90	91	45	27	68	51	58	100	51
S05	s_cl_2t_4	34	13	78	75	40	100	53	94	94
S05	s_cl_ft_3	90	91	42	24	75	93	71	100	55
S05	s_no_2t_3	78	85	49	100	57	78	92	40	24
S05	s_no_mt_1	36	68	68	21	11	58	86	32	100
S06	m_ot_x_4	61	85	100	10	85	60	49	17	18
S06	m_ot_x_5	63	79	86	100	2	62	44	79	11
S06	m_po_x_2	64	75	100	0	44	34	57	6	24
S06	m_po_x_3	25	53	86	100	11	23	23	45	33
S06	sbm_js_x_1	100	32	45	79	49	31	42	72	47

S06	sbm_sm_x_4	40	62	15	3	23	73	52	100	16
S06	som_fi_x_3	31	40	74	83	100	9	48	56	72
S06	som_ot_x_2	74	77	72	52	90	80	71	100	22
S06	s_cl_2t_4	57	9	63	100	73	100	42	73	53
S06	s_cl_ft_3	60	62	52	0	60	96	68	100	8
S06	s_no_2t_3	82	90	55	100	26	73	82	31	11
S06	s_no_mt_1	16	54	78	51	8	76	90	83	100
S07	m_ot_x_4	56	72	100	44	64	68	59	32	22
S07	m_ot_x_5	56	76	92	100	41	60	64	66	26
S07	m_po_x_2	39	43	100	36	53	60	36	14	23
S07	m_po_x_3	44	24	67	100	40	63	65	57	37
S07	sbm_js_x_1	100	42	69	69	21	12	58	37	32
S07	sbm_sm_x_4	60	65	14	3	55	58	51	100	44
S07	som_fi_x_3	25	56	64	69	100	40	59	61	46
S07	som_ot_x_2	72	76	26	20	53	38	34	100	40
S07	s_cl_2t_4	23	5	62	84	31	100	40	65	67
S07	s_cl_ft_3	69	76	17	4	65	53	47	100	39
S07	s_no_2t_3	73	68	27	100	43	77	81	19	5
S07	s_no_mt_1	40	64	68	17	4	60	74	35	100
S08	m_ot_x_4	72	84	100	56	65	82	36	44	25
S08	m_ot_x_5	39	19	90	100	55	81	81	66	14
S08	m_po_x_2	52	88	100	60	76	75	22	57	31
S08	m_po_x_3	62	15	84	100	61	81	72	34	28
S08	sbm_js_x_1	100	55	83	83	16	26	72	45	20
S08	sbm_sm_x_4	86	86	24	3	70	78	64	100	62
S08	som_fi_x_3	30	78	22	69	100	46	54	83	30
S08	som_ot_x_2	85	86	32	21	71	54	41	100	61
S08	s_cl_2t_4	32	3	79	77	38	100	69	86	92
S08	s_cl_ft_3	92	92	29	7	72	83	58	100	55
S08	s_no_2t_3	86	61	51	100	61	91	90	32	20
S08	s_no_mt_1	60	87	88	65	13	85	74	35	100
S09	m_ot_x_4	54	77	100	33	80	82	46	39	23
S09	m_ot_x_5	25	48	81	100	45	80	81	70	27
S09	m_po_x_2	31	60	100	36	75	75	60	43	18
S09	m_po_x_3	49	28	87	100	40	73	72	78	27
S09	sbm_js_x_1	100	40	74	74	26	41	56	49	33
S09	sbm_sm_x_4	79	80	20	12	71	68	62	100	37
S09	som_fi_x_3	34	49	67	82	100	41	58	57	72
S09	som_ot_x_2	80	80	21	20	76	27	27	100	40
S09	s_cl_2t_4	30	9	73	90	29	100	40	80	80
S09	s_cl_ft_3	84	85	17	11	76	50	50	100	35
S09	s_no_2t_3	72	38	20	100	50	76	77	19	12
S09	s_no_mt_1	38	85	84	24	15	74	64	32	100
S10	m_ot_x_4	64	87	100	30	80	80	44	56	30
S10	m_ot_x_5	40	51	85	100	25	65	64	70	44
S10	m_po_x_2	60	76	100	30	49	49	36	30	20
S10	m_po_x_3	31	21	84	100	31	64	64	76	51
S10	sbm_js_x_1	100	29	89	89	21	36	80	45	21
S10	sbm_sm_x_4	80	80	32	10	71	87	64	100	50
S10	som_fi_x_3	40	76	49	84	100	40	84	84	56
S10	som_ot_x_2	90	90	44	44	85	44	44	100	44
S10	s_cl_2t_4	40	8	83	93	43	100	30	83	83
S10	s_cl_ft_3	92	91	60	10	91	98	70	100	49
S10	s_no_2t_3	76	90	36	100	25	84	84	31	10
S10	s_no_mt_1	49	91	91	76	9	91	91	69	100
S11	m_ot_x_4	85	94	100	21	67	66	46	58	32
S11	m_ot_x_5	62	80	94	100	40	81	81	86	44
S11	m_po_x_2	75	82	100	29	69	67	36	57	6
S11	m_po_x_3	56	82	90	100	31	66	65	72	41
S11	sbm_js_x_1	100	51	82	81	31	17	69	87	38
S11	sbm_sm_x_4	69	70	33	10	63	88	53	100	38
S11	som_fi_x_3	33	72	58	87	100	46	76	78	59
S11	som_ot_x_2	89	89	43	29	78	59	43	100	66
S11	s_cl_2t_4	24	13	70	59	31	100	51	76	76
S11	s_cl_ft_3	81	81	23	14	70	91	41	100	59
S11	s_no_2t_3	75	68	28	100	53	81	85	39	26
S11	s_no_mt_1	22	75	76	56	34	74	87	50	100
S12	m_ot_x_4	48	62	100	32	35	41	40	27	13
S12	m_ot_x_5	35	70	82	100	41	54	55	64	26
S12	m_po_x_2	57	72	100	26	31	46	35	38	12
S12	m_po_x_3	35	32	71	100	39	53	53	25	20
S12	sbm_js_x_1	100	47	67	69	18	29	41	34	16

S12	sbm_sm_x_4	56	56	26	12	44	76	65	100	35
S12	som_fi_x_3	22	38	64	74	100	45	59	60	31
S12	som_ot_x_2	70	73	33	20	58	38	29	100	50
S12	s_cl_2t_4	31	16	63	85	38	100	43	74	74
S12	s_cl_ft_3	69	68	28	11	61	77	43	100	41
S12	s_no_2t_3	51	72	35	100	39	62	61	28	19
S12	s_no_mt_1	39	74	73	36	16	65	87	41	100
S13	m_ot_x_4	58	44	100	65	73	73	50	61	58
S13	m_ot_x_5	55	61	51	100	65	75	77	58	43
S13	m_po_x_2	32	37	100	58	68	68	36	45	48
S13	m_po_x_3	61	40	44	100	56	69	68	42	50
S13	sbm_js_x_1	100	57	75	75	40	43	61	39	41
S13	sbm_sm_x_4	65	69	42	31	69	52	51	100	60
S13	som_fi_x_3	33	66	31	45	100	63	72	72	38
S13	som_ot_x_2	75	74	34	36	68	41	41	100	60
S13	s_cl_2t_4	36	19	67	56	42	100	60	74	75
S13	s_cl_ft_3	80	92	42	35	80	77	54	100	60
S13	s_no_2t_3	73	42	39	100	60	74	74	36	31
S13	s_no_mt_1	60	84	89	49	36	84	70	49	100
S14	m_ot_x_4	78	93	100	47	68	64	72	42	21
S14	m_ot_x_5	40	75	93	100	33	62	65	52	21
S14	m_po_x_2	78	95	100	25	56	59	66	40	31
S14	m_po_x_3	72	78	92	100	35	72	63	83	46
S14	sbm_js_x_1	100	40	81	76	50	46	67	78	44
S14	sbm_sm_x_4	68	69	35	22	59	68	63	100	47
S14	som_fi_x_3	38	62	86	95	100	31	59	65	73
S14	som_ot_x_2	87	94	48	30	79	58	56	100	50
S14	s_cl_2t_4	46	15	70	94	53	100	35	77	77
S14	s_cl_ft_3	71	85	49	15	74	67	95	100	41
S14	s_no_2t_3	54	87	69	100	33	77	58	60	16
S14	s_no_mt_1	31	70	72	50	15	68	95	58	100
S15	m_ot_x_4	51	85	100	50	65	64	43	60	33
S15	m_ot_x_5	56	62	90	100	50	65	79	83	48
S15	m_po_x_2	57	85	100	42	69	66	71	48	44
S15	m_po_x_3	56	52	81	100	49	70	69	61	45
S15	sbm_js_x_1	100	49	92	84	46	46	85	84	53
S15	sbm_sm_x_4	72	75	46	22	66	92	88	100	50
S15	som_fi_x_3	43	60	59	82	100	49	69	68	77
S15	som_ot_x_2	84	91	46	39	76	54	39	100	51
S15	s_cl_2t_4	33	9	62	77	37	100	48	70	81
S15	s_cl_ft_3	72	74	29	19	66	83	68	100	48
S15	s_no_2t_3	71	76	36	100	50	72	75	29	22
S15	s_no_mt_1	49	65	74	48	8	64	80	47	100

Table 1. Listener data from experiment A2a, 18 kbps stereo use case A.

Test A4a, 24 kbps stereo use case A

Subject Listener	Signal Name	cond 1	cond 2	cond 3	cond 4	cond 5	cond 6	cond 7	cond 8	cond 9
S01	m_ch_x_1	72	43	39	87	94	100	24	51	51
S01	m_ot_x_2	91	17	56	54	90	45	31	74	100
S01	m_po_x_1	88	100	31	47	52	79	58	32	71
S01	m_si_x_1	26	39	38	64	8	39	77	75	100
S01	sbm_ms_x_1	75	53	100	35	66	48	53	18	36
S01	sbm_sm_x_2	72	58	41	80	61	100	27	51	60
S01	som_fi_x_1	75	100	97	30	52	53	97	50	51
S01	som_nt_x_1	55	93	38	55	75	90	100	39	55
S01	s_cl_2t_1	90	70	100	38	50	49	31	10	52
S01	s_cl_mt_1	25	50	50	69	4	49	87	86	100
S01	s_no_2t_1	86	100	35	49	58	64	24	48	84
S01	s_no_ft_2	67	25	67	91	87	100	38	56	63
S02	m_ch_x_1	35	38	18	63	84	100	52	66	69
S02	m_ot_x_2	100	40	72	78	47	6	28	16	56
S02	m_po_x_1	76	100	63	79	88	54	14	42	23
S02	m_si_x_1	57	68	72	7	3	39	33	23	100
S02	sbm_ms_x_1	47	10	100	63	75	76	24	18	39
S02	sbm_sm_x_2	8	56	22	31	38	100	48	67	87
S02	som_fi_x_1	48	95	100	45	70	78	87	19	59
S02	som_nt_x_1	80	56	17	29	37	67	100	63	77
S02	s_cl_2t_1	57	32	100	57	70	79	22	10	42
S02	s_cl_mt_1	56	74	80	25	13	47	62	33	100
S02	s_no_2t_1	42	100	60	80	88	37	13	65	51
S02	s_no_ft_2	27	7	71	51	19	100	60	81	86
S03	m_ch_x_1	80	69	52	74	91	100	36	61	66
S03	m_ot_x_2	100	35	58	63	87	29	54	68	85
S03	m_po_x_1	75	100	34	63	66	52	18	41	24
S03	m_si_x_1	23	45	50	10	6	39	25	32	100
S03	sbm_ms_x_1	63	26	100	51	71	71	18	32	58
S03	sbm_sm_x_2	40	55	42	74	64	100	36	60	78
S03	som_fi_x_1	50	94	100	26	65	70	74	36	53
S03	som_nt_x_1	56	75	64	50	70	93	100	34	52
S03	s_cl_2t_1	69	36	100	30	62	73	10	5	59
S03	s_cl_mt_1	35	58	75	8	3	53	68	22	100
S03	s_no_2t_1	73	100	44	72	73	58	8	62	51
S03	s_no_ft_2	44	26	71	75	50	100	39	58	65
S04	m_ch_x_1	81	56	30	73	90	100	19	45	49
S04	m_ot_x_2	100	21	60	57	80	36	50	44	88
S04	m_po_x_1	76	100	31	60	61	71	16	52	38
S04	m_si_x_1	26	65	69	36	7	56	45	60	100
S04	sbm_ms_x_1	67	60	100	26	54	49	62	38	40
S04	sbm_sm_x_2	35	51	48	66	57	100	41	62	81
S04	som_fi_x_1	71	90	100	25	50	64	85	40	61
S04	som_nt_x_1	54	77	40	51	60	85	100	31	64
S04	s_cl_2t_1	85	70	100	51	67	62	30	22	57
S04	s_cl_mt_1	46	65	70	79	19	60	85	91	100
S04	s_no_2t_1	81	100	46	72	69	76	36	64	87
S04	s_no_ft_2	55	33	60	73	51	100	41	68	70
S05	m_ch_x_1	89	76	65	100	96	100	36	69	69
S05	m_ot_x_2	100	52	84	84	100	84	85	100	100
S05	m_po_x_1	100	100	48	77	76	95	81	72	89
S05	m_si_x_1	56	80	80	89	30	76	90	97	100
S05	sbm_ms_x_1	95	80	100	59	88	88	100	88	89
S05	sbm_sm_x_2	37	88	60	94	97	100	45	84	84
S05	som_fi_x_1	96	100	100	66	80	80	100	80	80
S05	som_nt_x_1	77	100	78	78	94	100	100	49	77
S05	s_cl_2t_1	100	76	100	58	72	73	34	39	71
S05	s_cl_mt_1	30	69	94	91	11	81	98	100	100
S05	s_no_2t_1	100	100	50	74	74	100	61	71	92
S05	s_no_ft_2	96	82	72	96	100	100	50	78	88
S06	m_ch_x_1	55	49	41	53	89	100	35	60	62
S06	m_ot_x_2	100	39	56	60	80	44	48	62	84
S06	m_po_x_1	63	100	33	54	60	58	9	45	26

S06	m_si_x_1	38	59	64	22	15	49	30	47	100
S06	sbm_ms_x_1	80	31	100	46	66	65	34	29	39
S06	sbm_sm_x_2	30	54	35	44	38	100	41	62	67
S06	som_fi_x_1	47	97	100	37	62	65	89	38	57
S06	som_nt_x_1	60	68	36	50	53	89	100	40	58
S06	s_cl_2t_1	78	36	100	42	60	61	11	18	58
S06	s_cl_mt_1	40	60	65	26	9	58	70	72	100
S06	s_no_2t_1	84	100	43	67	72	57	10	60	49
S06	s_no_ft_2	47	28	56	80	39	100	38	65	75
S07	m_ch_x_1	78	71	41	83	88	100	57	66	71
S07	m_ot_x_2	100	60	72	80	90	32	86	35	92
S07	m_po_x_1	81	100	42	66	65	72	17	56	21
S07	m_si_x_1	51	72	77	20	14	60	40	87	100
S07	sbm_ms_x_1	55	67	100	50	85	89	69	60	78
S07	sbm_sm_x_2	22	42	30	53	38	100	55	66	83
S07	som_fi_x_1	73	89	100	54	73	77	81	45	69
S07	som_nt_x_1	82	90	52	69	39	85	100	52	78
S07	s_cl_2t_1	70	55	100	56	81	81	42	13	64
S07	s_cl_mt_1	59	72	93	66	13	71	78	90	100
S07	s_no_2t_1	87	100	65	76	82	44	22	76	56
S07	s_no_ft_2	78	33	65	89	47	100	55	72	70
S08	m_ch_x_1	84	49	36	60	84	100	31	74	74
S08	m_ot_x_2	100	36	64	64	78	32	36	84	89
S08	m_po_x_1	83	100	28	64	65	74	42	27	28
S08	m_si_x_1	41	73	80	38	48	36	58	65	100
S08	sbm_ms_x_1	88	41	100	49	72	71	27	41	67
S08	sbm_sm_x_2	26	79	33	71	72	100	42	61	60
S08	som_fi_x_1	86	89	100	32	56	79	90	46	57
S08	som_nt_x_1	76	88	29	35	53	83	100	26	76
S08	s_cl_2t_1	87	38	100	40	71	71	27	17	64
S08	s_cl_mt_1	37	75	75	29	19	75	75	85	100
S08	s_no_2t_1	82	100	32	50	50	60	19	42	82
S08	s_no_ft_2	35	58	64	83	46	100	49	76	75
S09	m_ch_x_1	80	64	51	55	90	100	40	64	64
S09	m_ot_x_2	100	40	65	76	84	51	64	76	92
S09	m_po_x_1	91	100	40	69	70	80	20	60	33
S09	m_si_x_1	30	76	76	70	9	44	50	84	100
S09	sbm_ms_x_1	85	40	100	40	80	91	80	60	70
S09	sbm_sm_x_2	40	80	40	45	53	100	40	67	74
S09	som_fi_x_1	84	96	100	40	76	76	93	76	76
S09	som_nt_x_1	70	84	60	69	76	92	100	40	70
S09	s_cl_2t_1	90	56	100	44	84	84	32	25	84
S09	s_cl_mt_1	40	67	74	45	9	67	91	91	100
S09	s_no_2t_1	91	100	40	76	75	84	21	70	40
S09	s_no_ft_2	80	70	84	90	80	100	40	70	84
S10	m_ch_x_1	78	70	52	84	98	100	39	68	70
S10	m_ot_x_2	100	44	72	72	92	58	67	87	92
S10	m_po_x_1	96	100	54	74	74	86	35	68	47
S10	m_si_x_1	23	78	78	71	56	44	88	95	100
S10	sbm_ms_x_1	95	57	100	51	84	84	58	76	32
S10	sbm_sm_x_2	61	56	36	90	53	100	69	79	86
S10	som_fi_x_1	94	86	100	35	81	80	93	61	72
S10	som_nt_x_1	72	80	54	69	88	97	100	43	72
S10	s_cl_2t_1	92	51	100	60	81	81	45	33	81
S10	s_cl_mt_1	44	73	72	81	38	73	88	94	100
S10	s_no_2t_1	69	100	63	80	80	74	35	80	93
S10	s_no_ft_2	75	55	82	94	62	100	42	87	88
S11	m_ch_x_1	81	51	37	68	84	100	34	58	57
S11	m_ot_x_2	100	44	68	66	84	36	59	29	90
S11	m_po_x_1	71	100	40	46	52	66	11	30	43
S11	m_si_x_1	40	52	72	33	29	47	56	62	100
S11	sbm_ms_x_1	40	25	100	47	56	57	24	29	35
S11	sbm_sm_x_2	17	54	22	39	35	100	42	70	74
S11	som_fi_x_1	76	90	100	40	57	56	84	53	45
S11	som_nt_x_1	57	85	36	56	74	81	100	40	56
S11	s_cl_2t_1	64	36	100	48	63	62	30	21	62
S11	s_cl_mt_1	38	50	51	59	21	51	76	69	100
S11	s_no_2t_1	35	100	42	60	69	40	13	62	77

S11	s_no_ft_2	23	30	65	36	23	100	48	66	66
S12	m_ch_x_1	73	58	50	62	87	100	46	67	67
S12	m_ot_x_2	100	56	70	64	91	52	63	46	94
S12	m_po_x_1	37	100	55	69	70	39	31	57	33
S12	m_si_x_1	54	62	62	34	21	55	44	49	100
S12	sbm_ms_x_1	55	37	100	60	80	80	37	40	67
S12	sbm_sm_x_2	38	48	50	43	73	100	61	63	70
S12	som_fi_x_1	60	80	92	57	74	77	100	47	69
S12	som_nt_x_1	70	39	42	70	44	81	100	60	71
S12	s_cl_2t_1	71	38	100	61	68	68	36	26	67
S12	s_cl_mt_1	56	66	67	38	31	65	68	48	100
S12	s_no_2t_1	43	100	65	71	76	48	31	60	66
S12	s_no_ft_2	39	38	77	91	39	100	60	79	76
S13	m_ch_x_1	88	58	48	72	97	100	42	61	67
S13	m_ot_x_2	100	35	61	63	83	57	57	67	94
S13	m_po_x_1	82	100	36	67	73	63	41	48	52
S13	m_si_x_1	36	84	90	43	20	50	57	67	100
S13	sbm_ms_x_1	80	58	100	34	66	61	58	55	54
S13	sbm_sm_x_2	55	42	36	73	46	100	44	62	68
S13	som_fi_x_1	84	97	98	37	74	73	100	70	60
S13	som_nt_x_1	76	93	70	64	81	100	100	42	76
S13	s_cl_2t_1	83	58	100	40	65	93	31	23	70
S13	s_cl_mt_1	38	65	78	53	18	66	81	92	100
S13	s_no_2t_1	69	100	41	53	90	45	33	58	74
S13	s_no_ft_2	56	47	65	90	42	100	35	88	94
S14	m_ch_x_1	81	67	48	84	89	100	39	62	73
S14	m_ot_x_2	100	45	74	69	81	66	68	66	92
S14	m_po_x_1	73	100	44	75	69	60	39	55	53
S14	m_si_x_1	48	71	79	47	25	63	32	38	100
S14	sbm_ms_x_1	91	56	100	48	74	86	64	69	84
S14	sbm_sm_x_2	65	74	47	81	82	100	51	66	83
S14	som_fi_x_1	78	90	100	50	65	72	76	85	65
S14	som_nt_x_1	64	76	44	64	49	90	100	47	64
S14	s_cl_2t_1	90	55	100	50	78	81	35	15	72
S14	s_cl_mt_1	48	68	78	58	21	68	85	91	100
S14	s_no_2t_1	88	100	40	74	78	63	25	67	59
S14	s_no_ft_2	49	53	70	87	92	100	48	74	79
S15	m_ch_x_1	53	69	22	57	44	100	40	74	74
S15	m_ot_x_2	100	33	71	82	61	33	49	71	79
S15	m_po_x_1	44	100	43	82	77	10	14	38	16
S15	m_si_x_1	40	68	84	24	12	43	27	51	100
S15	sbm_ms_x_1	60	21	100	48	80	86	18	24	22
S15	sbm_sm_x_2	18	77	19	35	12	100	38	59	83
S15	som_fi_x_1	67	91	100	40	77	76	84	42	74
S15	som_nt_x_1	78	18	58	60	47	50	100	58	60
S15	s_cl_2t_1	86	72	100	29	51	58	15	7	51
S15	s_cl_mt_1	35	78	78	27	13	78	83	50	100
S15	s_no_2t_1	56	100	31	77	77	37	15	65	75
S15	s_no_ft_2	28	15	70	51	17	100	63	77	75

Table 2. Listener data from experiment A4a, 24 kbps stereo use case A.

Test B2a, 18 kbps stereo use case B

Subject Listener	Signal Name	cond 1	cond 2	cond 3	cond 4	cond 5	cond 6	cond 7	cond 8	cond 9
S01	m_cl_x_2	55	58	74	54	19	37	84	100	46
S01	m_ot_x_1	34	56	56	72	39	29	73	90	100
S01	m_ot_x_8	57	69	45	13	57	90	100	33	58
S01	m_ot_x_a	10	63	66	73	40	49	25	90	100
S01	sbm_js_x_1	100	38	70	58	28	10	56	86	54
S01	sbm_sm_x_4	54	50	7	0	48	72	63	100	34
S01	som_fi_x_1	69	89	100	31	53	50	47	15	48
S01	som_ot_x_5	85	100	26	47	49	56	31	6	67
S01	s_cl_2t_4	11	0	51	84	23	100	33	50	69
S01	s_cl_2t_5	55	68	16	54	63	79	100	33	55
S01	s_no_2t_3	59	85	71	100	51	58	60	30	4
S01	s_no_ft_2	57	7	51	91	75	100	34	69	69
S02	m_cl_x_2	68	86	75	56	33	54	82	100	44
S02	m_ot_x_1	45	77	77	85	53	63	69	66	100
S02	m_ot_x_8	83	66	72	43	66	90	100	49	77
S02	m_ot_x_a	48	71	72	81	51	65	53	84	100
S02	sbm_js_x_1	100	56	80	81	30	31	72	16	31
S02	sbm_sm_x_4	80	88	31	10	74	76	70	100	57
S02	som_fi_x_1	80	95	100	33	81	87	78	41	67
S02	som_ot_x_5	80	100	49	70	71	76	37	50	65
S02	s_cl_2t_4	34	7	61	78	53	100	36	62	70
S02	s_cl_2t_5	84	66	33	72	36	74	100	50	84
S02	s_no_2t_3	65	52	49	100	30	71	81	41	9
S02	s_no_ft_2	39	15	57	45	45	100	38	71	79
S03	m_cl_x_2	66	61	73	38	30	25	93	100	45
S03	m_ot_x_1	39	59	62	71	31	51	56	75	100
S03	m_ot_x_8	70	51	54	37	35	73	100	43	65
S03	m_ot_x_a	40	69	73	55	52	58	38	83	100
S03	sbm_js_x_1	100	49	69	69	28	34	62	57	20
S03	sbm_sm_x_4	64	68	28	7	59	48	58	100	34
S03	som_fi_x_1	70	90	100	38	59	59	66	30	54
S03	som_ot_x_5	83	100	45	60	66	78	49	58	68
S03	s_cl_2t_4	11	3	64	85	15	100	48	64	65
S03	s_cl_2t_5	63	56	32	60	68	72	100	48	61
S03	s_no_2t_3	39	53	21	100	32	53	59	13	8
S03	s_no_ft_2	50	13	57	49	69	100	34	59	68
S04	m_cl_x_2	71	68	56	48	19	26	60	100	36
S04	m_ot_x_1	41	69	69	47	30	41	64	58	100
S04	m_ot_x_8	65	50	44	37	55	84	100	28	64
S04	m_ot_x_a	25	54	71	60	40	49	29	85	100
S04	sbm_js_x_1	100	52	63	76	27	23	67	71	56
S04	sbm_sm_x_4	62	76	41	10	56	71	65	100	35
S04	som_fi_x_1	49	76	100	40	65	64	60	18	34
S04	som_ot_x_5	89	100	37	62	58	70	51	45	66
S04	s_cl_2t_4	44	9	65	81	67	100	55	72	87
S04	s_cl_2t_5	71	40	16	60	56	80	100	31	65
S04	s_no_2t_3	60	64	55	100	40	73	69	45	26
S04	s_no_ft_2	61	19	65	76	53	100	45	71	81
S05	m_cl_x_2	58	63	45	38	17	22	49	100	28
S05	m_ot_x_1	19	58	60	47	27	24	36	52	100
S05	m_ot_x_8	58	39	35	18	23	44	100	29	52
S05	m_ot_x_a	27	69	58	51	36	57	44	69	100
S05	sbm_js_x_1	100	23	57	64	20	29	45	36	32
S05	sbm_sm_x_4	49	46	32	20	44	62	58	100	25
S05	som_fi_x_1	52	69	100	29	57	54	44	19	47
S05	som_ot_x_5	77	100	28	47	59	62	36	45	54
S05	s_cl_2t_4	26	8	60	74	42	100	31	62	66
S05	s_cl_2t_5	46	38	15	42	53	71	100	26	58
S05	s_no_2t_3	62	59	56	100	36	71	68	50	25
S05	s_no_ft_2	56	17	67	60	49	100	25	53	51
S06	m_cl_x_2	79	79	85	65	30	39	95	100	49
S06	m_ot_x_1	50	68	68	72	59	63	76	89	100
S06	m_ot_x_8	83	47	64	57	75	94	100	42	79

S06	m_ot_x_a	47	76	76	92	61	70	34	100	100
S06	sbm_js_x_1	100	36	83	83	22	57	83	11	60
S06	sbm_sm_x_4	83	82	42	10	82	38	52	100	44
S06	som_fi_x_1	28	100	100	33	70	70	89	51	65
S06	som_ot_x_5	100	100	53	79	80	85	69	75	94
S06	s_cl_2t_4	35	0	64	100	91	100	50	64	65
S06	s_cl_2t_5	74	87	45	70	94	100	100	58	73
S06	s_no_2t_3	78	90	84	100	56	78	79	85	10
S06	s_no_ft_2	87	17	80	97	100	100	66	80	85
S07	m_cl_x_2	65	70	39	28	32	35	45	100	47
S07	m_ot_x_1	40	60	62	48	11	24	34	43	100
S07	m_ot_x_8	67	47	30	14	20	79	100	40	64
S07	m_ot_x_a	40	71	76	50	44	47	31	74	100
S07	sbm_js_x_1	100	40	67	67	7	13	54	34	17
S07	sbm_sm_x_4	69	73	16	8	50	43	32	100	40
S07	som_fi_x_1	46	76	100	40	58	63	52	17	43
S07	som_ot_x_5	75	100	41	55	58	42	10	19	29
S07	s_cl_2t_4	20	8	59	63	29	100	40	71	75
S07	s_cl_2t_5	69	30	18	61	41	44	100	52	69
S07	s_no_2t_3	70	55	10	100	41	78	81	18	2
S07	s_no_ft_2	38	14	66	50	31	100	40	72	75
S08	m_cl_x_2	81	84	41	41	32	31	53	100	64
S08	m_ot_x_1	72	83	83	44	35	67	55	61	100
S08	m_ot_x_8	89	60	40	21	40	79	100	71	85
S08	m_ot_x_a	72	83	79	38	50	50	33	90	100
S08	sbm_js_x_1	100	80	92	89	28	40	64	48	35
S08	sbm_sm_x_4	90	90	34	20	81	62	60	100	73
S08	som_fi_x_1	51	85	100	78	82	73	80	52	57
S08	som_ot_x_5	82	100	69	82	88	51	40	33	61
S08	s_cl_2t_4	40	31	91	80	60	100	72	91	91
S08	s_cl_2t_5	91	60	50	84	71	71	100	77	90
S08	s_no_2t_3	88	41	49	100	71	89	90	36	28
S08	s_no_ft_2	40	20	70	40	31	100	61	80	90
S09	m_cl_x_2	79	92	65	40	20	28	39	100	44
S09	m_ot_x_1	44	74	82	70	29	33	24	63	100
S09	m_ot_x_8	78	51	63	22	43	84	100	41	73
S09	m_ot_x_a	44	70	70	75	38	46	28	80	100
S09	sbm_js_x_1	100	46	79	79	40	39	68	22	31
S09	sbm_sm_x_4	74	74	28	7	57	50	56	100	36
S09	som_fi_x_1	38	80	100	40	81	78	37	24	54
S09	som_ot_x_5	72	100	41	72	77	41	31	19	33
S09	s_cl_2t_4	17	6	72	56	31	100	38	77	84
S09	s_cl_2t_5	83	47	25	70	42	76	100	47	78
S09	s_no_2t_3	70	53	41	100	39	85	85	31	15
S09	s_no_ft_2	42	29	79	65	55	100	44	84	85
S10	m_cl_x_2	81	86	88	60	25	34	94	100	49
S10	m_ot_x_1	16	69	70	76	25	36	40	84	100
S10	m_ot_x_8	80	40	60	30	20	85	100	40	80
S10	m_ot_x_a	36	76	76	76	36	50	24	94	100
S10	sbm_js_x_1	100	49	80	80	16	41	67	29	29
S10	sbm_sm_x_4	80	80	31	0	71	30	56	100	30
S10	som_fi_x_1	75	100	100	24	64	64	80	36	64
S10	som_ot_x_5	80	100	26	60	60	69	25	40	50
S10	s_cl_2t_4	40	0	81	94	49	100	29	80	80
S10	s_cl_2t_5	71	60	20	80	60	90	100	44	80
S10	s_no_2t_3	83	95	70	100	30	83	88	49	9
S10	s_no_ft_2	49	30	80	94	44	100	50	89	89
S11	m_cl_x_2	84	84	89	52	25	44	95	100	60
S11	m_ot_x_1	29	69	68	81	35	51	88	94	100
S11	m_ot_x_8	89	74	79	33	65	67	100	52	90
S11	m_ot_x_a	57	75	75	87	63	38	20	98	100
S11	sbm_js_x_1	100	66	91	92	39	48	84	57	34
S11	sbm_sm_x_4	94	94	43	32	89	71	66	100	79
S11	som_fi_x_1	47	90	100	59	75	75	79	44	68
S11	som_ot_x_5	90	100	67	75	74	77	62	45	87
S11	s_cl_2t_4	39	10	82	92	53	100	68	79	82
S11	s_cl_2t_5	70	84	32	65	48	91	100	59	70
S11	s_no_2t_3	86	77	57	100	65	86	95	53	10

S11	s_no_ft_2	70	28	90	67	60	100	79	95	95
S12	m_cl_x_2	69	86	70	50	17	27	55	100	43
S12	m_ot_x_1	40	74	73	42	24	17	33	46	100
S12	m_ot_x_8	73	46	38	12	51	78	100	31	63
S12	m_ot_x_a	40	70	70	51	30	46	29	89	100
S12	sbm_js_x_1	100	47	73	69	17	27	66	35	17
S12	sbm_sm_x_4	66	67	39	25	46	78	83	100	42
S12	som_fi_x_1	63	88	100	36	71	52	59	27	43
S12	som_ot_x_5	56	100	26	45	49	38	33	18	52
S12	s_cl_2t_4	26	10	46	55	29	100	39	71	72
S12	s_cl_2t_5	73	37	21	62	39	40	100	37	73
S12	s_no_2t_3	53	61	28	100	39	66	70	32	13
S12	s_no_ft_2	19	16	60	41	34	100	41	72	68
S13	m_cl_x_2	88	82	64	56	49	44	70	100	70
S13	m_ot_x_1	62	72	72	53	34	65	41	40	100
S13	m_ot_x_8	83	76	73	55	60	68	100	63	81
S13	m_ot_x_a	49	78	68	75	47	60	48	81	100
S13	sbm_js_x_1	100	60	81	82	39	40	70	50	39
S13	sbm_sm_x_4	63	60	31	20	59	43	38	100	50
S13	som_fi_x_1	66	90	100	50	76	72	77	41	66
S13	som_ot_x_5	80	100	50	78	63	60	58	58	74
S13	s_cl_2t_4	38	5	70	58	45	100	60	78	76
S13	s_cl_2t_5	78	45	32	66	50	47	100	56	79
S13	s_no_2t_3	82	56	30	100	56	87	89	40	16
S13	s_no_ft_2	47	24	64	42	36	100	60	78	83
S14	m_cl_x_2	82	66	92	53	18	33	81	100	49
S14	m_ot_x_1	31	63	68	58	24	38	53	81	100
S14	m_ot_x_8	73	64	56	27	44	96	100	39	72
S14	m_ot_x_a	31	65	71	66	46	39	24	90	100
S14	sbm_js_x_1	100	37	82	78	16	33	66	57	43
S14	sbm_sm_x_4	59	69	24	7	68	76	53	100	44
S14	som_fi_x_1	82	98	100	48	78	78	86	43	73
S14	som_ot_x_5	93	100	22	60	56	72	37	44	71
S14	s_cl_2t_4	26	3	68	87	39	100	45	77	83
S14	s_cl_2t_5	79	61	35	85	53	60	100	51	73
S14	s_no_2t_3	90	67	51	100	38	96	76	46	9
S14	s_no_ft_2	56	17	72	67	40	100	48	86	90
S15	m_cl_x_2	69	73	57	54	34	22	89	100	45
S15	m_ot_x_1	45	76	75	76	55	65	68	85	100
S15	m_ot_x_8	76	33	44	16	16	33	100	50	64
S15	m_ot_x_a	47	76	76	62	57	55	30	90	100
S15	sbm_js_x_1	100	65	85	77	26	40	74	56	36
S15	sbm_sm_x_4	74	81	14	1	68	57	37	100	48
S15	som_fi_x_1	44	90	100	50	76	81	70	50	67
S15	som_ot_x_5	90	100	47	69	69	76	50	49	60
S15	s_cl_2t_4	15	0	63	86	39	100	48	63	75
S15	s_cl_2t_5	78	57	47	62	63	83	100	50	63
S15	s_no_2t_3	73	56	34	100	49	73	85	29	11
S15	s_no_ft_2	53	31	60	64	73	100	49	61	83

Table 3. Listener data from experiment B2a, 18 kbps stereo use case B.

Test B4a, 24 kbps stereo 3% FER

Subject Listener	Signal Name	cond 1	cond 2	cond 3	cond 4	cond 5	cond 6	cond 7	cond 8	cond 9
S01	m_ot_x_4	80	91	100	44	63	62	73	55	15
S01	m_ot_x_8	67	76	67	16	83	92	100	51	69
S01	m_po_x_2	79	85	100	46	69	73	55	64	25
S01	m_po_x_7	84	84	67	87	29	62	69	100	48
S01	sbm_js_x_2	60	100	43	75	76	27	53	23	53
S01	sbm_sm_x_2	39	63	31	67	44	100	53	79	84
S01	som_fi_x_3	43	21	92	53	100	69	83	83	60
S01	som_ot_x_5	87	100	40	68	68	83	72	20	78
S01	s_cl_2t_1	70	52	100	64	85	85	43	27	64
S01	s_cl_2t_5	82	70	46	26	90	72	100	58	81
S01	s_no_2t_1	44	100	67	75	76	80	41	22	90
S01	s_no_ft_3	81	86	47	55	77	57	100	36	81
S02	m_ot_x_4	71	75	100	46	56	69	61	49	24
S02	m_ot_x_8	56	70	44	15	64	85	100	21	50
S02	m_po_x_2	42	65	100	16	31	34	60	26	10
S02	m_po_x_7	62	61	74	56	40	72	76	100	36
S02	sbm_js_x_2	71	100	36	55	56	68	30	45	63
S02	sbm_sm_x_2	53	45	41	76	56	100	31	80	68
S02	som_fi_x_3	25	20	80	90	100	16	69	40	85
S02	som_ot_x_5	90	100	27	57	59	85	48	24	71
S02	s_cl_2t_1	90	49	100	37	60	70	44	17	55
S02	s_cl_2t_5	50	70	40	50	81	74	100	32	50
S02	s_no_2t_1	56	100	37	70	61	76	29	45	80
S02	s_no_ft_3	76	76	33	18	51	56	100	44	76
S03	m_ot_x_4	64	79	100	31	56	53	72	36	16
S03	m_ot_x_8	59	65	52	16	34	76	100	42	51
S03	m_po_x_2	38	47	100	38	46	46	36	52	13
S03	m_po_x_7	63	63	69	54	25	50	76	100	44
S03	sbm_js_x_2	45	100	46	67	66	44	35	29	39
S03	sbm_sm_x_2	49	54	26	53	61	100	44	70	69
S03	som_fi_x_3	19	31	41	81	100	47	69	68	75
S03	som_ot_x_5	86	100	41	55	58	82	35	26	47
S03	s_cl_2t_1	36	33	100	56	76	76	26	25	42
S03	s_cl_2t_5	80	27	54	34	48	48	100	57	80
S03	s_no_2t_1	40	100	46	70	70	67	30	60	63
S03	s_no_ft_3	72	54	32	29	44	38	100	51	73
S04	m_ot_x_4	57	93	100	35	49	52	72	50	18
S04	m_ot_x_8	56	78	45	16	65	89	100	34	61
S04	m_po_x_2	60	65	100	35	53	56	65	49	25
S04	m_po_x_7	62	69	35	56	20	81	100	95	25
S04	sbm_js_x_2	60	100	37	80	77	68	47	35	49
S04	sbm_sm_x_2	24	64	38	77	42	100	37	66	83
S04	som_fi_x_3	44	35	71	83	100	38	60	62	94
S04	som_ot_x_5	94	100	38	62	65	91	51	34	74
S04	s_cl_2t_1	63	40	100	42	90	90	32	32	45
S04	s_cl_2t_5	74	64	49	36	47	78	100	44	76
S04	s_no_2t_1	58	100	35	75	91	57	38	26	67
S04	s_no_ft_3	86	63	50	32	66	54	100	32	68
S05	m_ot_x_4	80	90	100	44	76	76	90	64	31
S05	m_ot_x_8	72	71	60	30	64	84	100	49	71
S05	m_po_x_2	71	75	100	30	64	64	44	64	11
S05	m_po_x_7	69	70	70	50	31	80	94	100	31
S05	sbm_js_x_2	89	100	30	64	64	84	45	40	75
S05	sbm_sm_x_2	44	68	31	56	51	100	51	84	88
S05	som_fi_x_3	49	40	71	76	100	44	64	64	70
S05	som_ot_x_5	92	100	40	76	76	92	49	30	76
S05	s_cl_2t_1	91	40	100	50	84	84	40	9	70
S05	s_cl_2t_5	84	96	60	70	90	100	100	59	85
S05	s_no_2t_1	90	100	36	80	80	91	36	60	64
S05	s_no_ft_3	70	80	50	30	60	80	100	49	70
S06	m_ot_x_4	60	83	100	34	74	74	86	67	17
S06	m_ot_x_8	85	84	71	17	44	44	100	29	81
S06	m_po_x_2	61	44	100	37	56	78	29	50	15

S06	m_po_x_7	78	77	69	44	15	65	77	100	31
S06	sbm_js_x_2	31	100	28	76	76	31	45	11	59
S06	sbm_sm_x_2	36	52	16	57	52	100	27	77	77
S06	som_fi_x_3	17	28	66	47	100	36	81	81	47
S06	som_ot_x_5	93	100	32	81	80	94	45	12	64
S06	s_cl_2t_1	62	36	100	67	80	80	27	12	50
S06	s_cl_2t_5	85	52	51	20	51	51	100	35	84
S06	s_no_2t_1	44	100	33	76	76	44	20	45	70
S06	s_no_ft_3	75	62	62	23	57	49	100	42	73
S07	m_ot_x_4	35	91	100	42	62	86	70	75	17
S07	m_ot_x_8	87	78	61	19	70	91	100	55	82
S07	m_po_x_2	52	85	100	42	71	60	67	48	21
S07	m_po_x_7	73	68	81	64	20	50	89	100	40
S07	sbm_js_x_2	50	100	40	80	82	68	31	19	61
S07	sbm_sm_x_2	30	76	17	59	21	100	51	70	87
S07	som_fi_x_3	32	19	66	91	100	58	76	84	93
S07	som_ot_x_5	93	100	45	80	74	89	57	20	60
S07	s_cl_2t_1	80	49	100	70	88	88	50	11	29
S07	s_cl_2t_5	86	41	79	54	68	94	100	49	74
S07	s_no_2t_1	69	100	61	87	81	88	20	34	41
S07	s_no_ft_3	93	89	57	29	60	74	100	49	80
S08	m_ot_x_4	62	92	100	23	44	46	78	50	0
S08	m_ot_x_8	72	77	70	10	55	79	100	40	72
S08	m_po_x_2	71	95	100	36	50	50	70	39	13
S08	m_po_x_7	55	54	68	54	10	79	69	100	28
S08	sbm_js_x_2	44	100	27	69	65	62	59	0	73
S08	sbm_sm_x_2	51	69	10	74	57	100	35	52	70
S08	som_fi_x_3	23	18	74	73	100	31	53	49	77
S08	som_ot_x_5	90	100	34	53	52	83	51	0	75
S08	s_cl_2t_1	93	51	100	38	67	72	52	14	43
S08	s_cl_2t_5	70	71	46	50	90	78	100	33	69
S08	s_no_2t_1	68	100	39	50	51	76	30	31	75
S08	s_no_ft_3	70	94	63	6	79	82	100	26	66
S09	m_ot_x_4	70	89	100	29	51	51	83	55	7
S09	m_ot_x_8	57	22	48	4	43	51	100	30	52
S09	m_po_x_2	45	81	100	23	33	41	49	31	6
S09	m_po_x_7	52	64	45	45	6	69	92	100	29
S09	sbm_js_x_2	51	100	24	61	65	46	9	6	49
S09	sbm_sm_x_2	20	38	9	62	28	100	36	56	67
S09	som_fi_x_3	16	10	78	90	100	46	59	65	65
S09	som_ot_x_5	85	100	33	48	57	67	24	8	37
S09	s_cl_2t_1	75	15	100	34	48	53	12	2	17
S09	s_cl_2t_5	61	77	16	49	68	85	100	41	49
S09	s_no_2t_1	56	100	33	58	65	47	6	6	45
S09	s_no_ft_3	63	38	29	14	70	34	100	43	56
S10	m_ot_x_4	78	56	100	30	74	83	48	68	13
S10	m_ot_x_8	84	50	24	4	64	79	100	35	73
S10	m_po_x_2	40	84	100	29	67	67	76	40	2
S10	m_po_x_7	72	89	56	62	12	54	67	100	43
S10	sbm_js_x_2	53	100	34	74	73	59	43	4	44
S10	sbm_sm_x_2	38	72	3	80	80	100	51	76	84
S10	som_fi_x_3	22	1	35	93	100	61	79	83	61
S10	som_ot_x_5	79	100	51	82	81	80	56	44	87
S10	s_cl_2t_1	74	33	100	67	74	75	24	4	22
S10	s_cl_2t_5	83	63	79	9	76	91	100	53	83
S10	s_no_2t_1	65	100	51	77	88	85	30	17	60
S10	s_no_ft_3	90	26	29	3	49	19	100	59	76
S11	m_ot_x_4	48	96	100	31	57	70	67	58	28
S11	m_ot_x_8	85	40	76	17	71	96	100	50	86
S11	m_po_x_2	51	100	100	40	60	67	70	52	15
S11	m_po_x_7	72	68	25	75	11	54	100	100	42
S11	sbm_js_x_2	97	100	28	66	68	35	56	10	76
S11	sbm_sm_x_2	63	70	9	92	47	100	34	85	84
S11	som_fi_x_3	20	30	60	93	100	34	81	80	25
S11	som_ot_x_5	100	100	38	65	66	90	72	42	39
S11	s_cl_2t_1	33	31	100	52	91	91	22	8	39
S11	s_cl_2t_5	86	19	54	70	49	29	100	64	86
S11	s_no_2t_1	95	100	51	82	67	59	32	15	72

S11	s_no_ft_3	85	33	52	13	92	72	100	38	86
S12	m_ot_x_4	68	87	100	35	64	61	81	51	13
S12	m_ot_x_8	65	58	53	8	49	77	100	38	74
S12	m_po_x_2	44	92	100	31	50	49	66	38	14
S12	m_po_x_7	56	55	64	39	8	47	76	100	28
S12	sbm_js_x_2	72	100	34	63	63	72	44	18	56
S12	sbm_sm_x_2	26	43	19	67	52	100	33	54	76
S12	som_fi_x_3	18	12	42	53	100	31	50	50	46
S12	som_ot_x_5	93	100	35	64	63	71	45	13	48
S12	s_cl_2t_1	86	61	100	34	70	69	47	17	50
S12	s_cl_2t_5	58	55	38	47	83	76	100	32	65
S12	s_no_2t_1	51	100	39	54	60	63	28	43	78
S12	s_no_ft_3	64	51	35	17	46	52	100	28	54
S13	m_ot_x_4	62	90	100	38	54	54	69	47	40
S13	m_ot_x_8	63	55	56	33	47	83	100	39	63
S13	m_po_x_2	58	79	100	32	47	49	65	45	37
S13	m_po_x_7	61	61	49	54	54	56	78	100	39
S13	sbm_js_x_2	66	100	34	49	52	65	42	51	60
S13	sbm_sm_x_2	46	48	37	68	34	100	37	56	74
S13	som_fi_x_3	31	43	51	42	100	37	67	66	42
S13	som_ot_x_5	80	100	38	59	59	58	36	44	67
S13	s_cl_2t_1	54	45	100	38	53	53	38	18	34
S13	s_cl_2t_5	65	56	55	63	73	79	100	54	63
S13	s_no_2t_1	47	100	38	63	68	69	24	49	69
S13	s_no_ft_3	60	51	51	39	49	53	100	41	52
S14	m_ot_x_4	66	53	100	50	59	70	51	60	31
S14	m_ot_x_8	80	60	78	37	61	72	100	51	80
S14	m_po_x_2	64	63	100	53	60	56	44	53	38
S14	m_po_x_7	69	70	40	47	27	30	38	100	56
S14	sbm_js_x_2	49	100	60	81	81	48	39	36	51
S14	sbm_sm_x_2	56	44	36	41	56	100	49	69	69
S14	som_fi_x_3	40	38	57	55	100	60	73	73	55
S14	som_ot_x_5	93	100	58	69	69	54	39	42	65
S14	s_cl_2t_1	57	59	100	60	83	70	49	24	40
S14	s_cl_2t_5	69	39	59	37	47	41	100	54	70
S14	s_no_2t_1	44	100	51	66	66	47	36	38	49
S14	s_no_ft_3	76	55	36	35	56	51	100	61	76
S15	m_ot_x_4	50	63	100	38	56	60	67	40	14
S15	m_ot_x_8	61	46	40	13	54	70	100	37	58
S15	m_po_x_2	34	39	100	32	52	58	44	13	6
S15	m_po_x_7	60	63	33	26	18	41	44	100	35
S15	sbm_js_x_2	67	100	41	62	64	43	36	16	54
S15	sbm_sm_x_2	30	32	15	41	29	100	44	65	67
S15	som_fi_x_3	13	20	50	71	100	40	61	63	77
S15	som_ot_x_5	64	100	40	61	63	56	41	23	47
S15	s_cl_2t_1	46	21	100	40	62	65	28	5	39
S15	s_cl_2t_5	60	68	26	38	82	86	100	47	59
S15	s_no_2t_1	48	100	41	62	64	50	10	35	67
S15	s_no_ft_3	67	44	26	24	41	32	100	37	66

Table 4. Listener data from experiment B4a, 24 kbps stereo 3% FER.

Test H3b, 32 kbps stereo 3% FER

Subject Listener	Signal Name	cond 1	cond 2	cond 3	cond 4	cond 5	cond 6	cond 7	cond 8	cond 9
S01	c_1	44	44	58	58	82	79	24	48	100
S01	c_2	100	45	45	82	82	72	73	29	50
S01	p_1	41	100	41	37	59	59	72	69	19
S01	p_2	30	49	100	35	26	73	62	78	65
S01	si_1	17	24	58	100	38	13	50	19	59
S01	si_2	60	55	17	53	100	48	48	62	53
S01	sm_1	42	67	59	31	50	100	34	30	50
S01	sm_2	78	71	69	63	29	57	100	48	33
S01	sp_1	35	41	29	70	41	22	58	100	48
S01	sp_2	37	31	60	55	73	69	24	48	100
S01	sp_3	100	17	17	39	29	61	33	24	50
S01	v_1	56	100	40	25	52	28	52	27	18
S02	c_1	36	35	72	77	90	72	24	50	100
S02	c_2	100	67	67	100	90	83	75	42	73
S02	p_1	66	100	66	45	56	58	78	83	28
S02	p_2	26	62	100	17	16	16	15	40	34
S02	si_1	78	24	67	100	58	42	41	40	78
S02	si_2	52	40	45	93	100	38	41	60	72
S02	sm_1	63	87	63	26	69	100	52	28	79
S02	sm_2	79	83	83	83	37	67	100	49	29
S02	sp_1	15	23	29	31	30	30	69	100	19
S02	sp_2	46	41	100	54	89	77	28	69	89
S02	sp_3	100	32	25	49	39	85	51	39	74
S02	v_1	75	100	39	18	53	42	58	40	33
S03	c_1	37	28	59	73	96	92	32	55	100
S03	c_2	100	79	60	94	81	83	87	55	71
S03	p_1	53	100	37	46	67	78	98	94	36
S03	p_2	32	55	100	47	38	82	74	93	87
S03	si_1	66	25	50	100	42	35	66	64	85
S03	si_2	86	88	37	57	100	67	46	96	79
S03	sm_1	98	94	99	35	59	100	59	53	91
S03	sm_2	77	51	85	58	17	40	100	25	19
S03	sp_1	53	85	58	89	75	28	46	100	35
S03	sp_2	36	26	85	63	92	72	25	42	100
S03	sp_3	100	33	32	68	39	77	64	28	55
S03	v_1	55	100	38	31	86	71	84	69	30
S04	c_1	3	22	72	34	92	92	40	51	100
S04	c_2	100	60	28	86	38	81	30	42	76
S04	p_1	87	100	37	30	69	67	62	57	40
S04	p_2	51	67	100	49	42	57	20	78	28
S04	si_1	31	77	68	100	54	41	96	88	91
S04	si_2	94	54	60	96	100	43	54	59	35
S04	sm_1	76	96	73	42	87	100	48	38	95
S04	sm_2	78	68	58	54	38	87	100	27	19
S04	sp_1	38	52	31	52	26	55	88	100	16
S04	sp_2	84	49	78	73	74	69	40	95	100
S04	sp_3	100	18	13	52	31	69	38	40	93
S04	v_1	86	100	29	19	63	36	74	42	53
S05	c_1	28	28	58	57	75	71	38	67	100
S05	c_2	100	46	47	97	100	83	83	38	63
S05	p_1	58	100	36	37	52	51	83	83	31
S05	p_2	39	61	100	44	35	42	38	81	51
S05	si_1	51	45	76	100	36	36	74	44	83
S05	si_2	72	79	51	85	100	61	69	85	87
S05	sm_1	94	96	96	49	74	100	58	58	94
S05	sm_2	76	61	65	69	40	55	100	27	27
S05	sp_1	32	65	65	82	69	43	59	100	32
S05	sp_2	54	53	95	95	93	96	47	69	100
S05	sp_3	100	29	28	64	64	100	82	56	71
S05	v_1	78	100	57	46	81	69	81	69	40
S06	c_1	32	21	72	47	67	67	34	54	100
S06	c_2	100	58	64	88	87	88	87	37	45
S06	p_1	51	100	47	50	77	76	81	74	15

S06	p_2	32	29	91	66	55	90	62	100	77
S06	si_1	81	19	50	100	24	37	56	36	72
S06	si_2	70	76	36	86	100	55	68	68	65
S06	sm_1	78	73	65	8	39	100	34	21	75
S06	sm_2	70	77	76	73	20	52	100	36	31
S06	sp_1	38	69	76	74	59	34	50	100	55
S06	sp_2	68	70	92	78	92	92	38	51	100
S06	sp_3	100	24	26	80	56	72	72	43	81
S06	v_1	40	100	25	24	60	71	57	58	20
S07	c_1	11	11	79	75	84	81	31	39	100
S07	c_2	100	51	40	88	66	88	56	49	71
S07	p_1	54	100	30	57	50	71	75	67	37
S07	p_2	45	65	100	39	36	80	74	89	76
S07	si_1	36	48	56	100	41	40	89	30	74
S07	si_2	43	44	50	100	100	100	68	76	46
S07	sm_1	68	77	61	45	57	100	37	25	76
S07	sm_2	87	88	88	89	50	72	100	36	35
S07	sp_1	61	72	77	57	57	50	64	100	62
S07	sp_2	75	18	83	34	85	28	44	78	100
S07	sp_3	100	24	20	62	42	94	88	51	82
S07	v_1	85	100	30	30	46	46	46	43	54
S08	c_1	52	52	86	79	76	87	44	75	100
S08	c_2	100	65	65	93	87	92	83	51	72
S08	p_1	59	100	50	54	88	70	96	71	31
S08	p_2	25	73	100	25	21	74	36	66	40
S08	si_1	36	21	64	100	36	31	73	30	83
S08	si_2	100	100	30	100	100	100	100	100	100
S08	sm_1	64	91	69	9	62	100	49	30	71
S08	sm_2	70	49	88	92	31	55	100	47	39
S08	sp_1	37	44	44	49	88	29	85	100	51
S08	sp_2	60	12	85	55	91	60	31	71	100
S08	sp_3	100	15	15	46	53	76	69	45	81
S08	v_1	76	100	55	9	65	8	65	22	10
S09	c_1	21	26	82	80	69	54	41	47	100
S09	c_2	100	53	57	85	88	80	85	36	64
S09	p_1	75	100	35	33	68	44	82	84	21
S09	p_2	34	72	100	33	24	58	51	90	42
S09	si_1	70	31	56	100	45	44	75	53	83
S09	si_2	92	55	21	71	100	47	41	94	54
S09	sm_1	85	97	94	26	56	100	49	43	74
S09	sm_2	78	65	92	74	36	58	100	47	24
S09	sp_1	42	72	45	85	66	24	69	100	48
S09	sp_2	46	49	90	78	86	83	31	69	100
S09	sp_3	100	26	21	56	49	68	51	38	91
S09	v_1	68	100	58	18	62	38	90	36	35
S10	c_1	53	53	80	80	90	90	40	70	100
S10	c_2	100	69	69	100	100	85	84	40	69
S10	p_1	67	100	44	44	85	84	84	84	40
S10	p_2	40	70	100	60	60	84	84	91	84
S10	si_1	83	40	60	100	60	60	83	83	92
S10	si_2	88	80	40	91	100	80	80	91	80
S10	sm_1	84	84	84	40	64	100	56	49	84
S10	sm_2	92	92	96	96	40	71	100	44	36
S10	sp_1	52	90	80	90	80	40	71	100	56
S10	sp_2	64	64	93	87	94	87	40	76	100
S10	sp_3	100	30	29	71	71	100	100	40	71
S10	v_1	90	100	70	60	84	84	84	84	40
S11	c_1	27	27	64	66	89	85	35	49	100
S11	c_2	100	55	42	74	36	69	35	37	45
S11	p_1	47	100	27	25	58	64	71	81	34
S11	p_2	37	43	100	35	28	59	51	77	71
S11	si_1	81	39	44	100	34	26	57	61	81
S11	si_2	33	25	36	77	100	41	35	48	26
S11	sm_1	26	89	33	38	44	100	51	15	70
S11	sm_2	59	44	74	51	33	39	100	25	27
S11	sp_1	28	62	44	77	40	47	61	100	32
S11	sp_2	35	46	81	59	85	71	39	68	100
S11	sp_3	100	19	15	51	38	90	44	42	76

S11	v_1	54	100	42	34	85	74	83	68	35
S12	c_1	49	49	66	65	76	76	40	60	100
S12	c_2	100	59	59	71	78	87	82	41	64
S12	p_1	73	100	49	51	71	74	81	81	45
S12	p_2	41	73	100	31	30	67	57	67	57
S12	si_1	47	44	71	100	54	33	76	33	74
S12	si_2	46	52	66	70	100	35	38	52	42
S12	sm_1	84	92	84	49	67	100	74	71	93
S12	sm_2	91	90	83	84	42	66	100	36	36
S12	sp_1	49	57	50	69	48	56	72	100	61
S12	sp_2	47	48	93	94	87	87	56	71	100
S12	sp_3	100	24	14	38	29	91	77	21	51
S12	v_1	75	100	25	26	52	47	63	44	39
S13	c_1	30	30	74	46	93	61	70	80	100
S13	c_2	100	89	88	100	100	100	100	60	81
S13	p_1	80	100	54	55	77	71	78	70	64
S13	p_2	60	73	100	69	35	100	46	100	47
S13	si_1	39	60	70	100	80	49	90	31	91
S13	si_2	100	65	40	92	100	87	66	100	74
S13	sm_1	35	69	49	63	74	100	55	27	84
S13	sm_2	100	66	81	76	60	88	100	41	29
S13	sp_1	43	93	87	100	100	69	81	100	42
S13	sp_2	72	60	100	50	88	60	69	91	100
S13	sp_3	100	59	16	66	53	81	15	79	90
S13	v_1	90	100	13	5	50	33	43	13	70
S14	c_1	39	40	90	65	87	88	70	80	100
S14	c_2	100	61	57	92	67	88	85	72	87
S14	p_1	72	100	24	26	42	58	71	83	64
S14	p_2	63	80	100	42	34	76	54	90	69
S14	si_1	81	70	78	100	35	53	68	77	88
S14	si_2	86	61	80	88	100	56	49	92	81
S14	sm_1	86	90	70	61	68	100	31	38	81
S14	sm_2	70	92	92	81	74	87	100	40	40
S14	sp_1	35	71	51	80	76	64	77	100	34
S14	sp_2	59	59	93	90	93	93	80	86	100
S14	sp_3	100	31	31	74	76	89	94	62	80
S14	v_1	79	100	55	28	80	40	87	42	71
S15	c_1	43	42	59	55	72	68	27	60	100
S15	c_2	100	60	51	76	66	76	73	29	60
S15	p_1	61	100	44	37	65	64	75	66	26
S15	p_2	28	66	100	63	58	73	66	75	71
S15	si_1	56	26	60	100	40	41	63	54	70
S15	si_2	67	64	28	59	100	55	50	69	75
S15	sm_1	63	71	58	24	59	100	47	49	76
S15	sm_2	70	66	77	76	24	60	100	47	53
S15	sp_1	54	69	66	76	75	29	61	100	51
S15	sp_2	47	50	75	73	83	85	24	59	100
S15	sp_3	100	11	7	53	55	79	72	26	61
S15	v_1	67	100	50	44	59	55	67	63	29

Table 5. Listener data from experiment H3b, 32 kbps stereo 3% FER.

Irregularities

Nothing to report

Conclusion

After acting as a listening lab for the 3GPP PSS/MMS audio selection tests in both high-rate and low-rate, we conclude by stating that the testing process worked as intended, although we experienced a delay in the start of the tests due to some inconsistencies regarding the processing of the test material. Further, due to a non-alphabetical order of the test items in the results template sheet another complicating factor was introduced. However, we believe that we have fulfilled our obligations as a test lab for these experiments and regard our task as finalized.

Appendix, listener instruction

Listener instructions for 3GPP audio selection test

1 Training phase

The first step for the listening tests is to become familiar with the testing process. This phase is called a training phase and it precedes the formal evaluation or blind grading phase.

The purpose of the training phase is to allow you, as an evaluator, to learn how to use the test equipment and the grading scale.

In the training phase you will make a short test similar to the one you will make in the blind grading phase of the test.

No grades given during the training phase will be taken into account in the actual tests.

2 Blind grading phase

The purpose of the blind grading phase is to invite you to assign your grades using the quality scale. Your grades should reflect your subjective judgment of the quality level for each of the sound excerpts presented to you. Each trial will contain different signals to be graded. Each item is approximately 5 to 10 s long. You should listen to the reference and all the test conditions by clicking on the respective Play buttons. In a first step it is recommended to browse through all signals within each trial in order to get a coarse impression of the offered quality range. Then you may listen more carefully and start to rank the signals. You may listen to the signals in any order, any number of times. Use the slider for each signal to indicate your opinion of its quality. When you are satisfied with your grading of all signals you should click on the “Next” button at the bottom of the screen.

You will use the quality scale as given in Fig. 1 when assigning your grades.

The grading scale is continuous from “excellent” to “bad”. In evaluating the sound excerpts, please note that one or more excerpts must be given the maximum “Excellent” grade because the unprocessed reference signal is included as one of the excerpts to be graded. However, you should not necessarily give a grade in the “bad” category to the sound excerpt with the lowest quality in the test.

At the bottom of the screen you will see the waveform of the sound excerpt. If you highlight a region in this window you are able to listen to just that region when clicking on the respective Play buttons.

You should not discuss your personal interpretation or your gradings with the other subjects at any time during the test.

When you have read and understood the instructions:

1. Start the pretest.
    - Click on the icon “PSS_MSS_audio_selection”.
    - Adjust the playback volume on the amplifier according to your individual preference.

2. When the pretest is ready, start the test.
    - Take a pause when needed.
    - If any problem occurs contact a test leader

3. When the test is finished, click on the “finish” button and then on the “quit” button.
   Thanks for your help!

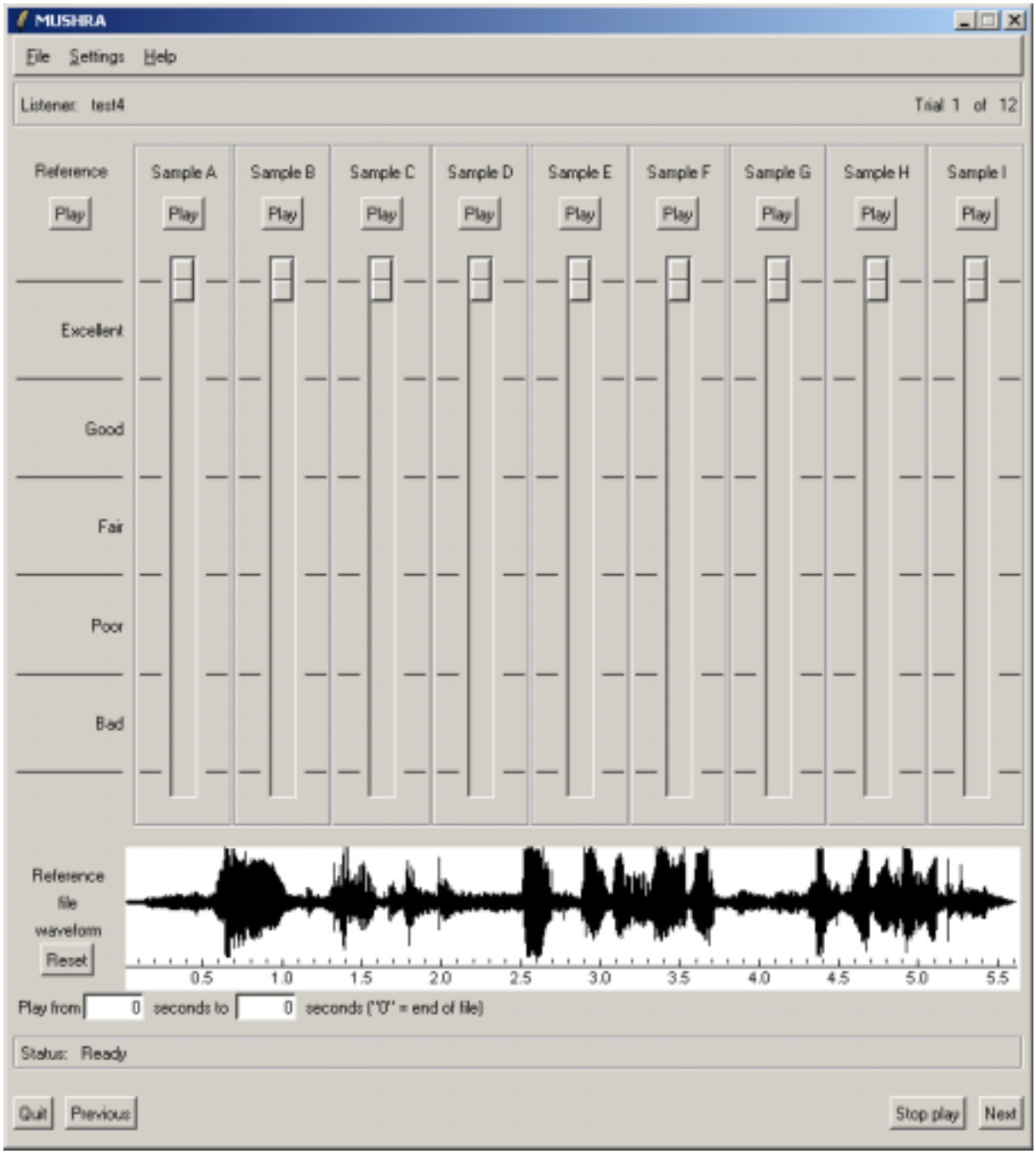

Figure 1: **An example of the user interface used in the blind grading phase**

Technical Specification Group Services and System Aspects *TSGS#23(04)0070*

Meeting #23, Phoenix, AZ, USA, 15-18 March 2004

3GPP TSG SA4 #30 Tdoc S4-040101

Malaga, Spain, February 23-27, 2004

Source: **TSG SA WG4 (Fraunhofer IIS)**

Title: **Listening laboratory report in the course of the 3GPP audio codec selection process**

Agenda item: **7.4.3**

1. Introduction

Fraunhofer IIS conducted listening tests based on the work plan for the 3GPP audio codec selection test [1]. This document describes the tests carried out at Fraunhofer IIS and the experimental design.

2. Test cases

Fraunhofer IIS accomplished the following tests as defined in [1]:

Exp.	Operational mode	Audio Material	#Codecs in test	# Reference codecs	#Anchors in test	#Refe-rences	#Items	Total
A1a	14 kbps, mono, use case A (PSS)	Set a	3	2	2	2	12	108
A3a	24 kbps, mono, use case A (PSS)	Set a	3	2	2	2	12	108
B1a	14 kbps, mono, 16 kHz, use case B (MMS)	Set a	3	2	2	2	12	108
B3a	14 kbps, mono, use case A (PSS), 3% FER	Set a	3	2	2	2	12	108

Table 1: Sub-experiments carried out at Fraunhofer IIS

3. Experimental Design

3.1 Test Method

The test procedure followed that of the “Multiple Stimulus with Hidden Reference and Anchors” (MUSHRA) [2] method for the subjective assessment of intermediate quality audio. Figure 1 shows a screenshot of the user interface of the MUSHRA implementation. The specific MUSHRA implementation has been done by Fraunhofer IIS.

Figure 1: MUSHRA user interface

3.2 Training phase

Prior to each actual testing a training phase was carried out in which the test subjects were familiarized with testing methodology and environment. The training was done following the same MUSHRA methodology as the actual test, though limited to four trials. Training was carried out for every new sub-experiment.

3.3 Grading phase

Each test subject carried out only one sub-experiment including a training session per day to allow for sufficient rest between tests. All in all 60 experiments have been carried out, thus 15 test subjects have been contributed to each of the four sub-experiments. In average the test subjects carried out one sub-experiment in around 45 to 60 minutes (including training session).

3.4 Test subjects

All together 19 test subjects, 3 female and 16 male, aged between 22 and 37 years took part in the testing. All listeners were experienced listeners, most of them with a background as audio engineers and musicians.

3.5 Test schedule

The Tests started on December 19th, 2003 and were finalized on January 27th, 2004. The data was collected and provided to the analysis lab by February 5th via FTP transfer.

3.6 Listening Laboratory

The tests carried out at Fraunhofer have taken place in an acoustically controlled listening room (sound lab). For the presentation of the audio signal, the digital sound output of an SGI workstation has been connected to an external Digital-to-Analog converter. STAX Lambda Pro headphones have been used for reproduction.

4. Conclusion

Since the test material was blinded no statistical analysis has been carried out.

5. References

[1] SA-030437 “AMR-WB+ and PSS/MMS Low-Rate Audio Selection Test and Processing Plan Version 2.0, September 2003”

[2] EBU Technical recommendation: “MUSHRA-EBU Method for Subjective Listening Tests of Intermediate Audio Quality”, Doc. B/AIM022, October 1999

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Source: **TSG SA WG4 (Dynastat, Inc.)[1]**

Title: **Dynastat Listening Laboratory Report for 3GPP Audio Codec Selection**

Agenda item: **7.4.3**

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1. Introduction

Dynastat performed listening tests in accordance with the test plans for the AMR-WB+ and PSS/MMS Low-Rate Audio Selection Test [1] and the PSS/MMS High-Rate Audio Selection Test [2]. These documents describe the experimental design and test procedures. Dynastat conducted the tests listed in Table 1 and 2 as defined in the test plans.

Exp.	Operational mode	Audio Material	#Codecs in test	#Reference codecs	#Anchors in test	#Refe-rences	#Items	Total
A1a	14 kbps, mono, use case A (PSS)	Set a	3	2	2	2	12	108
A3a	24 kbps, mono, use case A (PSS)	Set a	3	2	2	2	12	108
B1a	14 kbps, mono, use case B (MMS)	Set a	3	2	2	2	12	108
B3a	14 kbps, mono, use case A (PSS), 3% FER	Set a	3	2	2	2	12	108

Table 1: Dynastat sub-experiments in the Low-Rate Audio Selection Test

Exp.	Operational mode	#Codecs in test	# Reference codecs	# Anchors in test	#Refe-rences	# Items	Total
1	32 kbps, stereo	2 (use case B encoder)	2, incl. RealAudio @ 32 kbit/s stereo	2	1	12	84

Table 2: Dynastat experiment in the High-Rate Audio Selection Test

2. Experimental Design

2.1. Test Method

The test procedure followed that of the "Multiple Stimulus with Hidden Reference and Anchors" (MUSHRA) [3] method for the subjective assessment of intermediate audio quality.

The subject was presented with a series of trials, each corresponding to a different item from the set of audio items selected for the tests. In each trial, the subject was presented with the open reference version as well as a set of signals to be graded.

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In the Low-Rate Audio Selection Tests, the set of signals consisted of the three candidate codecs under test plus two reference codecs, three hidden anchors and a hidden copy of the open reference for a total of nine

signals to be graded in each trial. The hidden anchors were bandwidth-limited versions of the unprocessed reference signal and were defined as 3.5 kHz Low pass and 7.0 kHz Low pass by the test plan [1].

In the High-Rate Audio Selection Test, the set of signals consisted of three candidate codecs, two reference codecs, two hidden anchors, and a hidden copy of the open reference for a total of eight signals to be graded in each trial. The hidden anchors were bandwidth-limited versions of the unprocessed, reference stereo signal and were defined as 3.5 kHz and 7 kHz for these tests.

An in-house MUSHRA presentation and data collection interface program was used for this effort. A sample MUSHRA presentation screen for the Dynastat proprietary interface is shown in Figure 1.

The open reference was shown on one button followed spatially by buttons, labelled A to I, for the set of signals to be graded. The grading scale varied from 0 to 100 in unit steps and grades were recorded by adjusting the slider associated with each button. The MUSHRA presentation program allowed clean switching among all of the signals even during play-back.

The order of presentation of the trials and the allocation of the signals to the buttons (A to I) was randomized for all subjects.

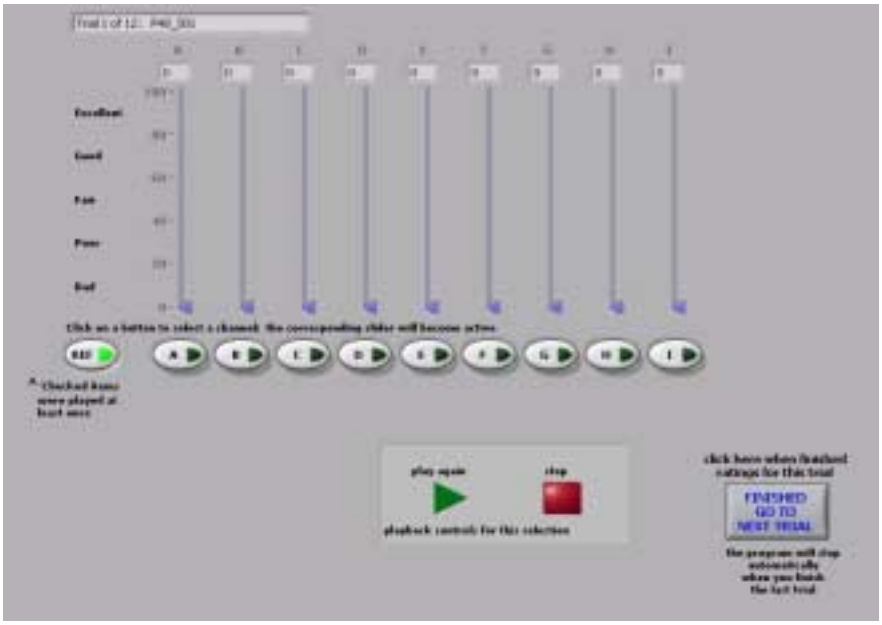

Figure 1: Sample Presentation Screen for the Dynastat MUSHRA Interface Program.

2.2. Training phase

Prior to the actual grading of the test signals, a training phase was conducted in which the test subjects were familiarized with the testing methodology and testing environment. The training phase adhered to the same MUSHRA methodology as the grading phase, but was limited to four trials. Subjects were provided with written instructions prior to participating in any experiment.

2.3. Grading phase

The presentation order for conditions was randomised as was the signals within conditions. Every listener received a different randomised presentation sequence of conditions and signals within conditions. The grading

phase was preceded by the training phase and was separated from the training phase by a forced rest break. In order to mitigate the effects of fatigue, subjects were required to take two rest breaks during a test session. In addition, the tests were self-paced so subjects could take additional breaks if they wanted.

2.4. Listening panels

A total of 22 subjects, 14 men and 8 women were used for this effort. All listeners were experienced listeners and between the ages of 19 and 42. Listeners that participated in multiple experiments were had to wait at least two days before participating in another experiment.

2.5. Post-screening of subjects

No post-screening of subjects was possible due to the blinding of the test items by the mirror host lab.

2.6. Listening environment

The tests were performed in sound isolation booths at Dynastat in Austin, Texas, USA, which met the requirements specified in the test plans [1, 2]. The audio materials were presented over Sennheiser HD-600 open-back circum-aural headphones. The audio level was set by the subject at the beginning of the training phase. Level adjustments were not permitted during the test session.

The audio files were stored on a Windows 2000 workstation which had a digital interface board (Lynx One Studio). This board was connected to an external Lucid DA9624 digital-to-analog converter and presented over the headphones.

2.7 Schedule

The five experiments were conducted over the period December 19, 2003 to January 28, 2004. The test results were delivered to the Global Analysis Laboratory on February 5.

3. Conclusion and recommendations

The test items were blinded to the listening laboratory so no post-screening of subjects was possible. The MUSHRA standard [3] recommends that the listening laboratory post-screen subjects for consistency and performance in detecting the Hidden Reference and tracking the Hidden Anchors in MUSHRA trials. The blinding process precluded this important step in the performance of the listening lab activities. The blinding process also precluded any statistical analysis by the listening laboratory.

4. References

[1] SA-030437 AMR-WB+ and PSS/MMS Low-Rate Audio Selection Test and Processing, Plan Version 2.0, September 2003.

[2] SA-030438 PSS/MMS High-Rate Audio Selection Test and Processing, Plan Version 2.0, September 2003.

[3] EBU Technical recommendation: MUSHRA-EBU Method for Subjective Listening Tests of Intermediate Audio Quality, Doc. B/AIM022, October 1999.