H.324 Video Telephony Activity Group

3G-324M Interoperability Test Specification

Draft 1.10

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1 # History

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Version	*Date*	*Name*	*Reason*
1.0	08-23-01	B. Wimmer	First draft
1.1	06-17-02	B. Wimmer	Bit stream exchange chapter added
1.2	06-19-02	B. Wimmer	New style and minor editorial changes, e.g. H.245 V6 Test case for video via AL2 added. Some parts of this document that relate to the procedure of the tests are shifted to an external document.
1.3	06-29-02	Albert Wong Dilithium Networks	Add H.223 Annex C to test criteria. Update versions of standards. Minor editorial changes. Extend context of G.723.1 DTX.
1.4	07-16-02	Albert Wong Dilithium Networks	Add specification on storing G.723.1 silence period to file. Add call setup delay measurement criteria. Append reference list.
1.5	07-24-02	Albert Wong Dilithium Networks	Rewrite Section 8.5 Call Setup Delay Measurement
1.6	11-20-02	Sebastian Purreiter	Error simulation test scenarios specified.
1.7	04-15-03	Sebastian Purreiter	section 5.1 updated
1.8	11-26-03	Albert Wong	Appended Section 3 Versions of Standards and fixed minor typos.
1.9	02-08-04	S. Purreiter	Update of Sec. 8.5 Time Setup Measurement; Introduced clarifications on section 8.1 and 8.1.6 based on input from A. Basso. Test for bit exactness on audio bit steams added.
1.10	03-02-04	S. Purreiter	Restriction of bit exact AMR reference bit stream verification to fix point encoded streams

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Tables

1 Introduction

The purpose of this document is to define

- the purpose of the tests performed at IMTC
- the set of features that are mandatory by the 3GPP specifications
- the procedure of tests

The results of the various tests will not be made public.

2 Purpose and Overview of the Test

The purpose of this test in to guarantee interoperability of 3G-324M implementations with respect to the mandatory features, defined by the appropriate 3GPP specifications, TS 26.111 [1], TS 26.110 [2] and TR 26.911[3]. As these specifications may change due to change requests, the interoperability test shall always refer to the valid specifications of the last approved release. This is indicated in the title of this test document. In a future step also the appropriate specification of 3GPP2 may be included to the test cases.

The specification 3G-324M was designed to operate via the wireless and mobile network of UMTS over 64kbit/s circuit-switched lines. The focus of this test is purely on the protocol and codec layer of 3G-324M without taking the wireless air-interface into account. Therefore the interoperability test does not include call-setup. The physical connection well already be established when the tests start. The tests will be conducted via a digital interface, for example via a serial RS-232 interface.

The tests are organized into several categories with the focus on

- Multiplex / Demultiplex (H.223) [6, 7, 8, 9, 10]
- Adaptation Layer (H.223)
- Control (H.245) [12]
- Codecs (H.263 [13], MPEG4 visual [14], AMR-NB [15] and G.723.1 [16])

First all tests are performed without transmission errors. If requested a transmission error simulator will be made available that introduces bit errors to the digital bit stream.

The results of the tests have to be documented in the score sheet.

3 Versions of Standards

In order to maximize the chance of successful connectivity the primary standards and the versions are listed:

Standards	Version or date
H.324 [11]	02/98
H.223	03/96
H.223 Annex A	02/98
H.223 Annex B	02/98
H.223 Annex C	02/98
H.245	02/2000 (version 6)
H.263	02/98
AMR-NB	7.5 (SW version for fixed point)
MPEG4 visual simple profile @ level 0	2001
G.723.1	03/96
3GPP TS 26.111	3.4.0 (R99)
3GPP TS 26.110	3.1.0 (R99)
3GPP TR 26.911	3.3.0 (R99)

4 Multiplex / Demultiplex

4.1 Layer Concept

The layer concept is described in H.324 Annex C.

4.2 Initial and Dynamic Level Setup

In the initial level setup process both terminals find synchronization by scanning the incoming bit-stream for a particular synchronization flag. This flag depends on the level the far-end terminal supports.

4.3 Dynamic Level Change

During an existing connection a party may change to a higher or lower level.

4.4 CCSRL Segmentation

The control channel is used to segment long H.245 messages into smaller parts and is used on top of NSRP protocol.

4.5 Test issues

The tests shall prove that your terminal is able to operate (in sending and receiving part) at level 0 or/and level 1 or/and level 2 or/and level 3. This shall include

- Initial mobile level setup at level 0/1/2,
- Dynamic change of level at initial mobile level setup phase if the far-end terminal supports a lower level
- Operation at that level during audio/visual conference

All mandatory features of H.223 [6], H.223 Annex A [7] and H.223 Annex B [8] should be tested with high priority. Other features, such as optional headers, double synchronization flag, dynamic level change or Annex C [9] / Annex D [10] (level 3) may be tested as well.

5 Adaptation Layer

5.1 General

The adaptation layer defines a big set of error protection methods. H.324 classifies the adaptation layers AL1, AL2 and AL3. In addition, H.223 Annex C/D adds AL1M, AL2M and AL3M. In 3G-324M, at least AL1, AL2 and AL3 have to be supported.

In Table 1 all possible test cases can be found.

Table 1: Test Cases of the Adaptation Layer

ID	AL	Supported Features	Channels
AL1-ftm	AL1	framed transfer mode	control, data
AL1-uftm	AL1	unframed transfer mode	audio, data
AL2-crc	AL2	CRC-only	audio, video
AL2-sncrc	AL2	Sequence number + CRC	audio, video
AL3-crc	AL3	CRC-only	video
AL3-7sncrc	AL3	7-bit sequence number + CRC	video
AL3-15sncrc	AL3	15-bit sequence number + CRC	video
AL3-7sncrcRT	AL3	7-bit sequence number + CRC + Retransmission capability	video
AL3-15sncrcRT	AL3	15-bit sequence number + CRC + Retransmission capability	video

5.2 Test Cases

The following adaptation layer settings shall at least be provide (mandatory):

- AL1: Control via AL1-ftm
- AL2: Audio via AL2-crc
- AL3: Video via AL3-crc

In order to reduce the transmission delay of video for AL3 with retransmission capability, Video via AL2-sncrc should also be tested.

6 H.245 Control Protocol

[tbd.]

7 Codecs

This section covers the codecs. The IMTC interoperability tests do not verify the video or audio quality. According to 3G-324M specification the frame rate shall not exceed 15fps and the image size shall not be larger than QCIF (176x144).

7.1 H.263

H.263 baseline (H.263 V1) is mandatory. The test of additional annexes is very welcome.

7.2 MPEG4 visual simple profile @ L0

MPEG4 vsp @ L0 is optional, however it should be included into the tests.

7.3 AMR

The adaptive multi-rate code (narrow band) is mandatory for 3G-324M. AMR supports 8 different coding modes and optionally a silence suppression mode. A manufacturer is free to decide which AMR coding modes / silence mode to use and whether to switch dynamically during a session or stay in one particular mode. It has to be guaranteed that the dynamical switching between the coding modes performs error-free.

7.4 G.723.1

The voice codec G.723.1 may be used in 3G-324M but is mandatory if H.324. It supports 2 different coding rates and DTX based on VAD and CNG.

8 Test Specification

8.1 Bit Stream Exchange

This section describes the bit stream exchange procedure. A test point defines parameters such as bit rate, frame rate or optional features.

The test aims to archive interoperability among the different codec implementations of the different testing parties. Each implementer shall test his en-/decoder capability using a reference de-/encoder before starting the bit stream exchange phase. This testing with a reference coded is not part of the here described test procedures.

The reference raw bit streams will be provided for the purpose of the interoperability testing cycle and may not be used for other purpose.

The PREFIX defines the sequence and the company that encoded the sequence. First the name of the sequence and then the first 3 characters of the providing company should be used. For example an AMR stream (12.2 kbit/s and DTX) is derived from

- Sequence name: HelloWorld
- Proving company: Go4Video
- PREFIX: helloworld_go4_
- Final sequence name: “helloworld_go4_122dtx.amr”
- Final sequence name if original was changed, e.g. due to errors: “helloworld_go4_122dtx_2.amr”

8.1.1 AMR-NB Test Points

Raw AMR-NB streams should be provided in the octet-aligned structure, as defined in Annex A “AMR Interface Format 2 (with octet-alignment) in [5]. Please note that this is different as defined in IETF AMR RTP format (see daft-ietf-avt-rtp-amr-13.txt), because the RTP contains additional fields and the first octet of the first audio frame may not be byte aligned. For each rate a pair of files (w/o DTX) is defined, according to the following table.

Table 2: AMR-NB – Test Sequences

AMR-NB Stream	Description
PREFIX-475.amr PREFIX-475dtx.amr	AMR-NB, 30 seconds at 4.75 kbit/s
PREFIX-515.amr PREFIX-515dtx.amr	AMR-NB, 30 seconds at 5.15 kbit/s
PREFIX-590.amr PREFIX-590dtx.amr	AMR-NB, 30 seconds at 5.90 kbit/s
PREFIX-670.amr PREFIX-670sid.amr	AMR-NB, 30 seconds at 6.70 kbit/s
PREFIX-740.amr PREFIX-740dtx.amr	AMR-NB, 30 seconds at 7.40 kbit/s
PREFIX-795.amr PREFIX-795dtx.amr	AMR-NB, 30 seconds at 7.95 kbit/s

PREFIX-102.amr PREFIX-102dtx.amr	AMR-NB, 30 seconds at 10.2 kbit/s
PREFIX-122.amr PREFIX-122dtx.amr	AMR-NB, 30 seconds at 12.2 kbit/s
PREFIX-cycle.amr PREFIX-cycledtx.amr	AMR-NB, 30 seconds with mode changing, see below

In the mode cycling mode, the sequence should use the following mode (MR) order:

MR122 -> MR102 -> MR795 -> MR740 -> MR 670 -> MR590 -> MR515 -> MR475 -> MR515 -> MR590 -> MR670 -> MR740 -> MR795 -> MR102 -> MR122 -> MR102 -> MR795 -> … (until end of file).

The encoding mode should change every 50 frame. If DTX is used, the SID and NO_DATA frames have to be included to achieve the correct time line of the entire sequence.

To achieve bit-exactness of all encoded bit streams a bitwise comparison with the AMR reference encoder should be performed by each party in case that the AMR fix point encoder was used for encoding.

8.1.2 Voice: G.723.1 – Test Points

The codec G.723.1 allows both

- 2 different coding modes (5.3 and 6.3 kbit/s) and
- DTX.

All modes generate octet-aligned frames. Therefore the following test points should be tested:

Table 3: G.723.1 Test Sequences

G.723.1 Stream	Description
PREFIX-53.723 PREFIX-53dtx.723	G723.1 with 5.3 kbit/s
PREFIX-63.723 PREFIX-63dtx.723	G.723.1 with 6.3 kbit/s

For situation when there is no data to send, an indicator may be used to indicate the silence period. If the indicator is used, the G.723.1 reserved mode should be used to represent the silence period. The reserved mode is defined as RATEFLAG = 1 and VADFLAG = 1. This shall be byte-aligned and therefore is 1 byte long. All other unused bits should be filled with 0. In other words, each byte represents one equivalent audio frame period during the silence period. Note that this mode shall be used only after at least one audio silence frame is transmitted. (See section 6.7 of [11].)

To achieve bit-exactness of all encoded bit streams a bitwise comparison with the G.723.1 reference encoder should be performed by each party.

8.1.3 Video H.261 – Test Points

The following test points should be tested:

Table 4: H.261 Test Sequences

H.261 Stream	Description

PREFIX-qcif_r32.261	32 kbit/s, QCIF
PREFIX-qcif_r64.261	64 kbit/s, QCIF

8.1.4 Video H.263 – Test Points

Baseline of H.263 should be tested. However additional Annexes are welcome. The test sequences should use the following naming convention:

Table 5: H.263 Test Sequences

H.263 Stream	Description
PREFIX-qcif_r32.263	32 kbit/s, QCIF
PREFIX-qcif_r64.263	64 kbit/s, QCIF
PREFIX-qcif_rXY_annexZ.263	XY kbit/s, QCIF, Annex Z (optional)

8.1.5 Video: MPEG4 Visual Simple Profile @ Level 0 – Test Points

The following tests points should be supplied. The test sequences should use the following naming convention:

Table 6: MPEG4 VSP @ L0 Test Sequences

MPEG4 VSP @ L0 – Streams	Description
PREFIX-qcif_r32.mx4	32 kbit/s, QCIF
PREFIX-qcif_r64.mx4	64 kbit/s, QCIF
PREFIX-qcif_r64_dp.mx4	64 kbit/s, QCIF, data partitioning
PREFIX-qcif_r64_dp_rvlc.mx4	64 kbit/s, QCIF, data partitioning, RVLC
PREFIX-qcif_r64_svh.mx4	64 kbit/s, QCIF, short video header mode

8.1.6 H.223 – Test Point Handling

This section describes the usage of the test point handling for the H.223 AL and MUX protocols. Particular tests points are found in section 4.5 and 5.2. There are many combinations possible. Therefore, this section gives some hints how to perform the H.223 testing points.

In order to test H.223 sequences additional information is requires, such as:

- MUX and DEMUX table configurations
- AL configurations
- Codec configurations

Due to the fact that no "real" setup with the exchange of H.245 commands is done, these parameters have to be provided in the "PREFIX_h223.cfg" file. In order to verify the correctness of the decoded H.223 stream the basic media streams should be supplied. Therefore 2 data files should be provided:

1. Basic media stream as defined in the media sections above, e.g. AMR-NB
2. Text file (ASCII) providing a sequential number and the length of each AL-PDU transmitted within one MUX-PDU.

By using these two files it is simple to detect the exact place an error occurred.

The "mux-ed" H.223 stream should be provided in the "PREFIX_options.223" file. It may contain voice, video and H.245 messages. However the correct decoding of the H.223 sequence should not require the interpretation of the H.245 messages. Please note that a dynamical behavior of the terminal under test can not be tested. Therefore NSRP/SRP response frames and AL3 retransmission requests must be ignored.

Please note that this test should also cover the verification of the interface to MUX for MPEG4 video and H.263, please refer also to section 6.6.1 of [1]. Please note this test is optional as H.223 testing is also covered within the mandatory interop testing of the following sections.

8.2 Basic Test Procedures Over Digital Serial Connection

Basic tests are performed without any errors over the transmission link. The main focus is the verification of the protocols and codecs. No tests of the call-setup (dialing) will be done.

The following figure shows the test environment.

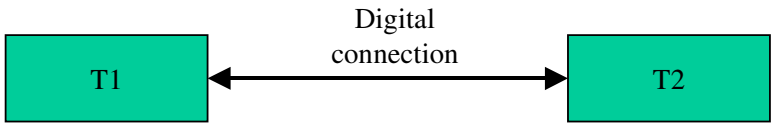

Figure 1: Digital Connection

In this Figure T1/T2 denotes the terminals. Both terminals are connected via a digital connection, e.g. via RS-232. The following RS-232 settings shall be taken into account:

Bit-rate	115 kbit/s
Parity	No
Data bits	8
Stop bits	1
Flow control	None

For virtual interoperability tests the RS-232 may be replaced by a 64-kbit/s transparent data channel via ISDN.

Both terminals shall send a maximum bit-rate of 64kbit/s via the digital connection. The terminals shall take into account that the data may arrive with some jitter at the RX-part of RS-232. In the case of ISDN this will not happen.

The terminals shall start with level setup procedure, followed by the H.245 procedures, followed by the transmission of video and audio data and finally close the connection as defined by H.324.

8.3 Enhanced Test Procedures Over Digital Connection With Errors

The enhanced test procedures introduce a channel error unit into the digital connection. This can be seen in the following picture.

Figure 2: Error Simulator

ES denotes the error simulator. ES introduces bit error into the digital bit stream.

The ES shall reside at the receiving end of either both terminals. This shall assure that each testing party can verify possible interoperability failures introduced by each ES. The result of all performed tests (in terms of interoperability) shall be, that under each condition it must be assured that the connection can be established, a communication under this unreliable and below described conditions could be performed and terminated correctly by the end users. This requires that the H.245 control protocol communications are reliable and are working properly under all described conditions , only the coded audio and video bit streams degrade in terms of quality

The first simulation of an unreliable connection test consists in a simulation of a AWGN channel by applying equally distributed bit errors to the H.223 multiplexed bit stream at the receiving end by simply XOR the bit at the error position with a fixed BER of 10^{-5}, 10^{-4}, 10^{-3}. The testing parties agree on the different BER settings.

As a further test, document Q11-F-05 from ITU STUDY GROUP 16 is used to apply error patterns created for different use cases under consideration of a 64kbps W-CDMA channel to the H.223 multiplexed bit stream.

(downloadable from ftp://standards.pictel.com/lbc-site/LBCmobile/error_pattern/wcdma-64kb-error-files.zip).

Each testing party shall assure, that after performing tests with all the different error patterns available, a session setup, communication with audio/video and successful session termination can be granted.

8.4 Interface to ISDN

For the setting of ISDN using CAPI [4], the following parameters shall be taken into account:

- CIP-mask: 2^{nd} bit set (unrestricted digital information) [4, p. 64]
- B1-protocol: setting 1 (64 kbit/s bit-transparent operation with byte framing from the network), see [4, p.110]
- B2-protocol: setting 1 (Transparent) , see [4, p.110]
- B3-protocol: setting 0 (Transparent (default)) , see [4, p.111]

By these settings 64 kbit/s a transparent connection is available.

After reception of <CONNECT_RESP> the terminal shall start with the level setup sequence. This procedure shall apply for both endpoints.

8.5 Call Setup Delay Measurement

The following call setup reference points should be used for time measurement:

- Setup digital link (t_1): relative time between requested action (t_0) (call, pickup) to the digital link bearer and establishment of the digital link. (optional measurement)
- Initial mobile level setup (t_2): relative time between setup of digital link (t_1) and detection of incoming level by H.223 demultiplexer. (optional measurement)
- Session setup (t_3): time measured between the points in time, established digital link (t_1) and arrival of first media bits from both audio and video channels in H.223 demultiplexer.

All points in time are measured in a relative time basis at the near end terminal. The resulting value will be converted into a standard time base of milliseconds. In case that no time basis is available on the implementation/equipment under test an estimated time (e.g. counting seconds on wrist watch, etc.) shall be given.

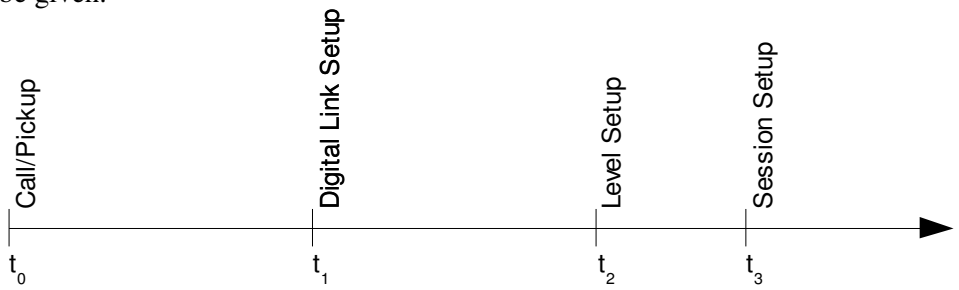

Figure 3: Setup reference time points

The following values should also be determined from a series of time measurements for reporting in the test score sheet (requires at least 2 successful tests reaching those points in time):

- worst time
- average time
- best time

9 Handling of Errors and Reports

The results of the tests have to be documented in the available score sheets for 3G-324M, please refer to score sheet document. The results will not be made public! If problems found that results are in the need to introduce changes to a specification, the chairman will take action to forward a liaison statement to the appropriate standardization body. The chairman will write a short report about each testing event; however, no names or particular results will be included, except if a major problem in one of the specifications is found. If there is consensus of the test participants, additional information may be included.

10 References

[1] TS 26.111 V3.4.0, 3GPP, “Codec for circuit switched multimedia telephony service; Modifications to H.324”, R’99, see http://www.3gpp.org

[2] TS 26.110 V3.1.0, 3GPP, “Codec for circuit switched multimedia telephony service; General description”, Rel’99, see http://www.3gpp.org

[3] TR 26.911 V3.3.0, 3GPP, “Codec(s) for Circuit Switched Multimedia Telephony Service Terminal Implementor’s Guide” R’99, see http://www.3gpp.org

[4] Common-ISDN API- v.2.0, June 2001, part 1; see http://www.capi.org/document/capi20-1.pdf

[5] 3GPP TS 26.101, "AMR Speech Codec Frame Structure", version 3.3.0 (2001-06), 3rd Generation Partnership Project (3GPP).

[6] ITU-T Recommendation H.223 (03/96): “Multiplexing protocol for low bit rate multimedia mobile communication”, see http://www.itu.int

[7] ITU-T Recommendation H.223 Annex A (02/98): “Multiplexing protocol for low bit rate multimedia mobile communication over low error-prone channels”, see http://www.itu.int

[8] ITU-T Recommendation H.223 Annex B (02/98): “Multiplexing protocol for low bit rate multimedia mobile communication over moderate error-prone channels”, see http://www.itu.int

[9] ITU-T Recommendation H.223 Annex C (02/98): “Multiplexing protocol for low bit rate multimedia mobile communication over highly error-prone channels”, see http://www.itu.int

[10] ITU-T Recommendation H.223 Annex D (05/99): “Optional Multiplexing protocol for low bit rate multimedia mobile communication over highly error-prone channels”, see http://www.itu.int

[11] ITU-T Recommendation H.324 (02/98): “Terminal for low bitrate multimedia communication”, see http://www.itu.int

[12] ITU-T Recommendation H.245 (02/2000): “Control protocol for multimedia communication”, see http://www.itu.int

[13] ITU-T Recommendation H.263 (02/98): “Video coding for low bitrate communication”, see http://www.itu.int

[14] ISO/IEC 14496-2 (2001): "Information technology - Coding of audio-visual objects - Part 2: Visual", see http://www.iso.org

[15] 3GPP TS 26.090: "Adaptive Multi-Rate (AMR); Transcoding functions", see http://www.3gpp.org

[16] ITU-T Recommendation G.723.1 (03/96): "Dual rate speech coder for multimedia communication transmitting at 5,3 and 6,3 kbit/s", see http://www.itu.int

11 Annex A – Overview of the 3G-324M Protocols and Codecs

	Mandatory	Recom-mended	Optional	R'99	Rel 4	comments
H.263 baseline	X			X		
H.263 Annex I		X		X		
H.263 Annex J		X		X		
H.263 Annex T		X		X		
H.263 Annex K		X		X		
H.261			X	X		
MPEG4 visual simple profile @ level 0			X	X	X	In R'99 level 1 was recommend with particular 3GPP changes. These 3GPP version was standardized by ISO/MPEG
AMR-NB	X			X		
G.723.1		X		X		For interoperability reason for H.324 and H.324M.
H.223, H.223 Annex A, H.223 Annex B	X			X		
H.223 Annex C, H.223 Annex D			X	X		
H.324, H.324 Annex C	X			X		
H.324 Annex H						
H.245	X			X		At least version 3 has to be supported. For support of H.324 Annex H, version 6 has to be used.