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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Communication procedures

Extended video procedures and control signals for H.300-series terminals

ITU-T Recommendation H.241

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ITU-T Recommendation H.241

Extended video procedures and control signals for H.300-series terminals

Summary

This Recommendation defines the use of advanced video codecs, including ITU-T Rec. H.264, in ITU-T Recs H.310, H.320, H.321, H.322, H.323 and H.324 terminals. It also defines generic extended signalling for use with all video codecs in the H.300-series terminals.

This revised version adds clarifications regarding H.264 VCL HRD (Type I HRD) versus NAL HRD (Type II HRD) bit rate usage, sample aspect ratio capabilities for H.264, signalling for Reduced Complexity Decoding Operation (RCDO) for H.264 bitstreams, and a new Annex B, "RCDO for H.264 Baseline Profile bitstreams". Annex A has been replaced with an inclusion by reference of the recently approved RFC 3984 (without actual change in content). New Annex B specifies a reduced-complexity decoding process to be applied to H.264 Baseline profile bitstreams when such use has been negotiated using ITU-T Rec. H.241.

Source

ITU-T Recommendation H.241 was approved on 29 May 2006 by ITU-T Study Group 16 (2005-2008) under the ITU-T Recommendation A.8 procedure.

Keywords

Capability exchange, commands, H.264, H.310, H.320, H.321, H.322, H.323, H.324, signalling, video, video codec, video coding, videoconferencing, videotelephony.

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ITU-T Recommendation H.241

Extended video procedures and control signals for H.300-series terminals

1 Scope

This Recommendation defines the procedures for use of advanced video codecs, including ITU-T Rec. H.264, with H.300-series terminals, including H.310, H.320, H.321, H.322, H.323 and H.324. Such procedures include control, indication, capability exchange, and transport mechanisms.

Additionally, this Recommendation defines generic extended video control, indication, and capability signalling, applicable for use with all video codecs used in H.300-series multimedia terminals.

This revision adds clarifications regarding H.264 VCL HRD (Type I HRD) versus NAL HRD (Type II HRD) bit rate usage, sample aspect ratio capabilities for H.264, signalling for Reduced Complexity Decoding Operation (RCDO) for H.264 bitstreams, and a new Annex B, "RCDO for H.264 Baseline Profile bitstreams". Annex B specifies a reduced-complexity decoding process to be applied to H.264 Baseline profile bitstreams when such use has been negotiated using ITU-T Rec. H.241.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation H.221 (2004), *Frame structure for a 64 to 1920 kbit/s channel in audiovisual teleservices*.

– ITU-T Recommendation H.230 (2004), *Frame-synchronous control and indication signals for audiovisual systems*.

– ITU-T Recommendation H.239 (2005), *Role management and additional media channels for H.300-series terminals*.

– ITU-T Recommendation H.242 (2004), *System for establishing communication between audiovisual terminals using digital channels up to 2 Mbit/s*.

– ITU-T Recommendation H.243 (2005), *Procedures for establishing communication between three or more audiovisual terminals using digital channels up to 1920 kbit/s*.

– ITU-T Recommendation H.245 (2006), *Control protocol for multimedia communication*.

– ITU-T Recommendation H.261 (1993), *Video codec for audiovisual services at* $p \times 64$ *kbit/s*.

– ITU-T Recommendation H.262 (2000), *Information technology – Generic coding of moving pictures and associated audio information: Video*.

– ITU-T Recommendation H.263 (2005), *Video coding for low bit rate communication*.

– ITU-T Recommendation H.264 (2005), *Advanced video coding for generic audiovisual services*.

– ITU-T Recommendation H.310 (1998), *Broadband audiovisual communication systems and terminals*.

– ITU-T Recommendation H.320 (2004), *Narrow-band visual telephone systems and terminal equipment*.

– ITU-T Recommendation H.323 (2006), *Packet-based multimedia communications systems*.

– ITU-T Recommendation H.324 (2005), *Terminal for low bit-rate multimedia communication*.

– IETF RFC 3550 (2003), *RTP: A Transport Protocol for Real-Time Applications*.

– IETF RFC 3984 (2005), *RTP Payload Format for H.264 Video*.

3 Definitions

This Recommendation defines the following terms:

3.1 terminal: A terminal is any endpoint and may be a user's terminal or some other communication system such as an MCU or an information server.

3.2 picture aspect ratio: The ratio between the intended horizontal width and the intended vertical height of a displayed picture. Picture aspect ratio is expressed as h:v, where h is horizontal width and v is vertical height (in arbitrary units of spatial distance). For the purposes of this definition, a picture is the complete displayed image (including both fields in the case of interlaced-scan video). For example, the picture aspect ratio for a CIF picture according to ITU-T Rec. H.263 is 4:3.

3.3 sample aspect ratio: The ratio between the intended horizontal distance between the columns and the intended vertical distance between the rows of the luma sample array in a frame. Sample aspect ratio is expressed as h:v, where h is horizontal width and v is vertical height (in arbitrary units of spatial distance). For the purposes of this definition, a sample is an individual luma picture element (pixel) making up the complete displayed image (including both fields in the case of interlaced-scan video). For example, the sample aspect ratio for a CIF picture according to ITU-T Rec. H.263 is 12:11.

4 Abbreviations

This Recommendation uses the following abbreviations:

4CIF	4x Common Intermediate Format (see ITU-T Rec. H.263)
4SIF	4x Standard Interchange Format (see ITU-T Rec. H.262)
AL-SDU	Adaptation Layer Service Data Unit (see ITU-T Rec. H.324)
ASN.1	Abstract Syntax Notation One (see ITU-T Rec. H.245)
BAS	Bit-rate Allocation Signal (see ITU-T Rec. H.221)
C&I	Control & Indication
CIF	Common Intermediate Format (see ITU-T Rec. H.261)
IDR	Instantaneous Decoding Refresh (see ITU-T Rec. H.264)
MBE	Multiple Byte Extension (see ITU-T Rec. H.221)
OID	Object Identifier (see ITU-T Rec. H.245)
PAR	Picture Aspect Ratio
QCIF	Quarter Common Intermediate Format (see ITU-T Rec. H.263)

QVGA Quarter VGA

RCDO Reduced Complexity Decoding Operation (see Annex B)

RTP Real-time Transport Protocol (see IETF RFC 3550)

SAR Sample Aspect Ratio

SIF Standard Interchange Format (see ITU-T Rec. H.264)

5 Conventions

5.1 System terminology

In order to simplify references, this Recommendation refers to two classes of signalling systems for H.300-series terminals.

– "BAS-based systems" refers to those systems that use signalling in the H.221 BAS channel; these include H.320, H.321 and H.322 systems.

– "H.245-based systems" refers to those systems that use signalling according to ITU-T Rec. H.245; these include H.310, H.323 and H.324 systems.

5.2 Message names

In this Recommendation, signalling messages which are common to both H.245 and BAS signalling systems are referred to by their names as given in Annex A/H.245, except in cases where their use in the unique BAS signalling environment are described. Message names are presented in **bold font** to distinguish them from the other text of this Recommendation.

Table 5-1 provides a reference for corresponding H.245 and H.242/H.230 messages mentioned in this Recommendation.

Table 5-1/H.241 – Corresponding H.245 and BAS video signals

H.245 name	H.230 mnemonic
h263Options.customPictureClockFrequency	ØCPCF
h263Options.customPictureFormat	ØCSFMT
h263Options.customPictureFormat	ØCPAR
h263VideoCapability.enhancementLayerInfo	ØSCLPREF
lostPartialPicture	lostPartialPicture
lostPicture	lostPicture
recoveryReferencePicture	recoveryReferencePicture
videoBadMBs	VBMBC
videoFastUpdateGOB	videoFastUpdateGOB
videoFastUpdateMB	videoFastUpdateMB
videoFastUpdatePicture	VCU
videoFreezePicture	VCF
videoNotDecodedMBs	videoNotDecodedMBs
videoSendSyncEveryGOB	ØGHOP
videoSendSyncEveryGOBCancel	Øcancel-GHOP

5.3 Requirement terminology

In this Recommendation the following conventions are used:

– "Shall" indicates a mandatory requirement.

– "Should" indicates a suggested but optional course of action.

– "May" indicates an optional course of action rather than a recommendation that something take place.

6 Commands and indications

6.1 C&I applicable to all video codecs

For further study.

6.2 C&I for use with ITU-T Rec. H.264

The following C&I signals shall not be used with regard to any channel operating according to ITU-T Rec. H.264:

– BAS signals **ØCPCF, ØCSFMT, ØCPAR, ØSCLPREF**;

– **lostPartialPicture**;

– **lostPicture**;

– **recoveryReferencePicture**;

– **videoBadMBs**;

– **videoFastUpdateGOB**;

– **videoFastUpdateMB**;

– **videoNotDecodedMBs**;

– **videoSendSyncEveryGOB**;

– **videoSendSyncEveryGOBCancel**.

NOTE 1 – The above signals are either specific to ITU-T Rec. H.263 or have parameters which do not correspond to H.264 structures or value ranges. Replacement signals which could be used either with ITU-T Rec. H.264 or in a generic form for any video codec are for further study.

All other C&I not mentioned in this clause shall be used as specified elsewhere.

NOTE 2 – For example, the use of **videoIndicateReadyToActivate** and corresponding BAS signal **VIR** is not affected by this Recommendation.

6.2.1 videoFreezePicture command in ITU-T Rec. H.264

When a video decoder according to ITU-T Rec. H.264 receives a **videoFreezePicture** command, it shall freeze its displayed picture until one of the following events:

a) A recovery point signalled in a recovery point SEI message (D.2.7/H.264) is reached.

b) Reception of an IDR picture.

c) A timeout period of at least 6 seconds has elapsed since the **videoFreezePicture** command was received.

6.2.2 videoFastUpdatePicture command in ITU-T Rec. H.264

When a video encoder according to ITU-T Rec. H.264 receives a **videoFastUpdatePicture** command, the encoder shall enter the fast update mode by using one of the procedures specified in 6.2.2.1 or 6.2.2.2 below. The procedure in 6.2.2.1 is the preferred response in a lossless transmission environment. Both procedures satisfy the requirement to enter the fast update mode for H.264 video encoding.

NOTE 1 – The procedures re-initialize a H.264 decoder completely such that valid video frames will be decoded. Such re-initialization is effective regardless of whether or not the decoder was previously decoding any video stream from any endpoint.

The procedure should be accomplished as quickly as possible, but the re-initialization video stream shall be completely transmitted within 3 seconds of receiving the **videoFastUpdatePicture** command.

NOTE 2 – The 3-second requirement is needed to avoid timeout of the 6-second timer associated with the **videoFreezePicture** command, taking into account network and system latencies and possible cascaded MCUs. The **videoFreezePicture** command is used by MCUs as part of the video switching procedure (see 6.1.1/H.243).

6.2.2.1 IDR procedure to respond to videoFastUpdatePicture

This clause gives one possible way to respond to **videoFastUpdatePicture**.

The encoder shall, in the order presented here:

1) Immediately prepare to send an IDR picture (see clause 3/H.264).
2) Send a H.264 sequence parameter set corresponding to the IDR picture to be sent. The encoder may optionally also send other parameter sets.
3) Send a H.264 picture parameter set corresponding to the IDR picture to be sent. The encoder may optionally also send other parameter sets.
4) Send the IDR picture.
5) From this point forward in time, send or re-send any other sequence or picture parameter sets, not sent in this procedure, prior to their reference by any H.264 slice, regardless of whether such parameter sets were previously sent prior to receiving the **videoFastUpdatePicture** command. Such parameter sets may be sent all at once (within the limits of ITU-T Rec. H.264), one at a time as needed, or in any combination of these methods. Parameter sets may be re-sent at any time for redundancy.

6.2.2.2 Gradual recovery procedure to respond to videoFastUpdatePicture

This clause gives one possible way to respond to **videoFastUpdatePicture**.

The encoder shall, in the order presented here:

1) Send a recovery point SEI message (D.2.7/H.264).
2) Repeat any sequence and picture parameter sets that were sent before the recovery point SEI message, prior to their reference in a H.264 slice.

The encoder shall ensure that the decoder has access to all reference pictures for inter prediction of pictures at or after the recovery point in output order. For example, the encoder may mark all reference pictures as "unused for reference" by issuing a memory_management_control_operation equal to 5 (see 8.2.5/H.264).

The value of the recovery_frame_cnt syntax element in the recovery point SEI message shall be such that the time between the reception of the **videoFastUpdatePicture** command and completing the transmission of the access unit including the recovery point as specified in D.2.7/H.264 is less than or equal to 3 seconds.

Re-sending of parameter sets may be done all at once (within the limits of ITU-T Rec. H.264), one at a time as needed, or in any combination of these methods. Parameter sets may be re-sent at any time for redundancy.

6.2.3 Recovery point SEI message

H.264 video decoders in H.300-series terminals shall support reception of the recovery point SEI message (see D.2.7/H.264) and identify the signalled recovery point.

Upon reception of a recovery point SEI message, the decoder shall continue to decode until the recovery point regardless of apparent errors in the stream such as reference to absent pictures, and should not send a **videoFastUpdatePicture** command in response to such apparent error.

If a **videoFreezePicture** is in force, the decoder shall not display the decoded pictures, and shall continue to display the previously frozen picture. If the broken_link_flag in the recovery point SEI message is set, the decoder may choose not to display decoded pictures until the recovery point is reached.

If the decoder detects bitstream corruption between the SEI message and the recovery point in decoding order, a **videoFastUpdatePicture** command should be sent.

6.2.4 H.264-on BAS command

For BAS-based systems, the H.264-on BAS command defined in ITU-T Rec. H.221 shall be used to signal that video according to ITU-T Rec. H.264 is being transmitted. This command shall be used analogously to the BAS command H.261-on. Video shall occupy the same capacity as stipulated in ITU-T Rec. H.221 for the case of H.261 video.

7 Transport of coded video in H.300-series systems

7.1 Transport of ITU-T Rec. H.264 video streams

Regardless of which H.300-series system is in use (ITU-T Recs H.310, H.320, H.321, H.322, H.323, or H.324), all H.264 encoders should take the Maximum Transmission Unit (MTU) size of IP networks into account when choosing the maximum length of H.264 NAL Units, as H.323 gateways may be used to transport these streams on IP networks.

To be transported in a maximum-length RTP packet according to H.323, H.264 NAL Units should be less than 64 000 bytes long. This value allows a substantial margin for packet header information.

To avoid IP-layer packet fragmentation (which may increase header overhead and the probability of loss due to errors), H.264 NAL Units should be substantially shorter than the MTU size of the network. For example, on an Ethernet network with a 1472 byte MTU, a 1200 byte NAL Unit allows for addition of considerable header overhead without exceeding the MTU size of the network.

7.1.1 Parameter set transmission

H.264 parameter set information shall be transmitted in-band to the H.264 video stream (see "Note" in 7.4.1.2.1/H.264).

Terminals sending H.264 video shall transmit each sequence or picture parameter set at a time prior to its reference by any H.264 slice. These parameter sets may be re-sent at any time for redundancy.

NOTE – There is no requirement that parameter sets must be transmitted each time they are about to be referenced by a H.264 slice. The transmission may take place at any time prior to the reference. Ordinarily, many H.264 slices will refer to the same parameter set, with the parameter set being sent only once.

7.1.2 Use of H.264 in BAS-based systems

When carried in a BAS-signalling-based system, the H.264 video shall make use of the byte stream format given in Annex B/H.264.

The resulting byte stream shall be transmitted using the framing and forward error correction method given in 5.4/H.261. This procedure is the same as that used for ITU-T Recs H.261 and H.263.

Terminals encoding H.264 video may insert fill bits using the fill indicator (Fi) as described in 5.4.3/H.261.

NOTE – Insertion of such fill may be useful, for example, to reduce the effective coded video data rate within the video channel to avoid exceeding a H.264 decoder's maximum video bitrate (MaxBR) as given in Annex A/H.264.

7.1.3 Transport of H.264 streams in H.310 systems

In H.310 systems, the H.264 video shall make use of the byte stream format given in Annex B/H.264. H.264 shall be used without BCH error correction and without error correction framing.

7.1.4 Transport of H.264 streams in H.323 systems

In H.323 systems, H.264 shall be used without BCH error correction and without error correction framing. H.323 systems shall not make use of the byte stream format given in Annex B/H.264.

All H.323 systems that support H.264 shall support carriage of the H.264 video stream according to Annex A, and shall signal this in their capability set by including MediaPacketizationCapability.rtpPayload.Type.payloadDescriptor.oid, with the OID having the value {itu-t(0) recommendation(0) h(8) 241 specificVideoCodecCapabilities(0) h264(0) iPpacketization(0) h241AnnexA(0)}.

H.323 systems that support H.264 should also support RFC 3984's non-interleaved mode and may support RFC 3984's interleaved mode, in addition to Annex A.

The capability of using RFC 3984 non-interleaved mode shall be signalled by including a MediaPacketizationCapability.rtpPayloadType.payloadDescriptor.oid, with the OID having the value {itu-t(0) recommendation(0) h(8) 241 specificVideoCodecCapabilities(0) h264(0) iPpacketization(0) RFC3984NonInterleaved(1)}.

The capability of using RFC 3984 interleaved mode shall be signalled by including a MediaPacketizationCapability.rtpPayloadType.payloadDescriptor.oid, with the OID having the value {itu-t(0) recommendation(0) h(8) 241 specificVideoCodecCapabilities(0) h264(0) iPpacketization(0) RFC3984Interleaved(2)}.

NOTE 1 – Since RFC 3984's single NAL unit mode and Annex A are technically identical, the codepoints above permit the use of all packetization modes of RFC 3984.

A sender which signals one of these packetization modes in its Open Logical Channel message shall transmit video according to the corresponding mode of RFC 3984 or Annex A.

In RFC 3984 interleaved mode, senders and receivers need to have a common understanding of the required buffer sizes for the interleaving buffer. Unless signalled explicitly, these buffer sizes shall take the following values:

– sprop-interleaving-depth 80

– sprop-deint-buf-req 65536

The explicit signalling of these parameters is for further study.

NOTE 2 – See RFC 3984 section 8.1 for a description of both parameters. The values given are sufficient to support macroblock-line interleaved packetization of video signals with 1080 lines at 8 Mbit/s. See III.2.3.1/H.263 for a discussion of macroblock-line interleaved packetization.

7.1.5 Transport of H.264 streams in H.324 systems

In H.324 systems, H.264 shall be used without BCH error correction and without error correction framing, and shall make use of the byte stream format given in Annex B/H.264.

H.264 encoders shall align the Annex B/H.264 start code prefix for the first NAL unit of each access unit with the start of an AL-SDU.

7.1.6 Sample aspect ratios (informative)

Transmission of the sample aspect ratio in the VUI parameters specified in Annex E/H.264 was not required in earlier versions of this Recommendation, and many older systems do not indicate the sample aspect ratio in the H.264 video bitstream.

In the absence of a H.264 VUI parameter **aspect_ratio_idc** value in the received H.264 bitstream, and in the case of an **aspect_ratio_idc** value equal to 0, the sample aspect ratio may be assumed to have a value according to Table 7-1 below:

Table 7-1/H.241 – Assumed sample aspect ratios

Frame size (luma width × luma height)	Sample aspect ratio
128 × 96 (SQCIF)	12:11
176 × 144 (QCIF)	12:11
352 × 288 (CIF)	12:11
704 × 576 (4CIF)	12:11
720 × 576 (625 ITU-R BT.601)	12:11
352 × 576 (625 HHR)	24:11
528 × 576 (625 3/4 HR)	16:11
480 × 576 (625 2/3 HR)	18:11
352 × 240 (525 SIF)	10:11
704 × 480 (525 4SIF)	10:11
720 × 480 (525 ITU-R BT.601)	10:11
352 × 480 (525 HHR)	20:11
528 × 480 (525 3/4 HR)	40:33
480 × 480 (525 2/3 HR)	15:11
320 × 240 (QVGA)	1:1
640 × 480 (VGA)	1:1
800 × 600 (SVGA)	1:1
1024 × 768 (XGA)	1:1
1280 × 1024 (SXGA)	1:1
1600 × 1200 (UXGA)	1:1
1280 × 720 (720 HD)	1:1
1920 × 1080 (1080 HD)	1:1
1920 × 1088 (1080 HD)	1:1
other	the value which will produce a picture aspect ratio of 4:3

NOTE – All systems which send H.264 video should indicate the sample aspect ratio in the VUI parameters specified in Annex E/H.264.

8 Capability exchange signalling

8.1 General

Terminals which display received video shall be capable of displaying any picture format and frame rate for which they signal the capability. The format used to display such received video streams is not required to match the exact format transmitted.

NOTE – For example, a video conferencing system which decodes ITU-T Rec. H.264 at a given Profile and Level must display any picture format and frame rate allowed by that Profile and Level.

If during an ongoing connection a terminal which is transmitting video receives a changed capability set, the terminal shall adapt its video coding method to conform with all the limitations signalled in the received capability set.

8.2 Signalling of H.245 generic parameters in BAS-based systems

This Recommendation signals a subset of H.245 **GenericParameter** structures in BAS channel MBE messages. These messages shall be carried in BAS-based systems using the procedures of Annex A/H.239. These procedures avoid emulation of the MBE BAS code.

8.3 H.264 capabilities

8.3.1 General

H.300-series terminals may optionally support video according to ITU-T Rec. H.264.

The H.264 capability set is structured as a list of one or more H.264 capabilities, each of which includes:

- Profile (mandatory);
- Level (mandatory);
- Zero or more optional parameters.

These capabilities indicate the ability to decode using one or more H.264 Profiles. The exact syntax and semantics are given in the clauses below. In the case of H.245-based systems, each capability is contained in a **GenericCapability** structure. For BAS-based systems, all capabilities are carried in a single MBE message.

The bitrate made available for a video stream by an H.300-series system may be less than the maximum video bitrate which decoders are required to support by Annex A/H.264. Terminals are not required to decode video streams which they do not receive.

8.3.1.1 Optional parameters

For each H.264 capability, optional parameters may be signalled. These parameters permit a terminal to signal that, in addition to meeting the support requirements for the signalled Profile and Level, the terminal has additional capabilities. Such additional capabilities in decoders may permit encoders to send a video stream which takes advantage of these capabilities.

Terminals shall not signal a set of optional parameters indicating the practical capability to fully support a given Level, without also signalling support for that Level.

The optional parameters are:

1) CustomMaxMBPS – If present, indicates the decoder has a higher processing rate capability.
2) CustomMaxFS – If present, indicates the decoder can decode larger picture (frame) sizes.
3) CustomMaxDPB – If present, indicates the decoder has additional decoded picture buffer memory.

4) CustomMaxBRandCPB – If present, indicates the decoder can decode a higher video bitrate and has a correspondingly larger coded picture buffer.

5) MaxStaticMBPS – If present, indicates the maximum number of macroblocks per second the decoder could process in the hypothetical case that all macroblocks are static macroblocks (see 8.3.2.8).

6) max-rcmd-nal-unit-size – If present, indicates the maximum recommended NAL unit size in bytes. Encoders may exceed this size, but inefficiencies or an increased chance of loss due to errors might result (see 8.3.2.9).

7) max-nal-unit-size – If present, indicates the maximum NAL unit size, in bytes, that the receiver can process. The encoder shall not exceed this size (see 8.3.2.10).

8) SampleAspectRatiosSupported – If present, indicates the range of supported sample aspect ratios (see 8.3.2.11).

9) AdditionalModesSupported – If present, indicates one or more additional H.264 modes supported (see 8.3.2.12).

10) AdditionalDisplayCapabilities – If present, indicates one or more additional display capabilities (see 8.3.2.13).

If these parameters are present, the signalled values replace the MaxMBPS, MaxFS, MaxDPB, MaxBR, and MaxCPB values, respectively, in Table A.1/H.264 for the given Profile and Level, and indicate that in addition to fully conforming with the Profile and Level requirements, these additional capabilities are available at the decoder.

These optional parameters permit, for example, support of 1024 × 768 × 3 Hz while using Level 2 (CIF/30 Hz), a common mode for videoconferencing systems.

NOTE – The use of these optional parameters to signal decoder capabilities does not alter the requirement of ITU-T Rec. H.264 that the **level_idc** syntax element, set by the encoder in the video bitstream, indicate an Annex A/H.264 Level with which the bitstream fully conforms. The use of these optional parameters permits the encoder to send bitstreams with a Level higher than the Level capability of the decoder, if the bitstream exceeds the decoder's Level capability only within the limits of these optional parameters. To maximize interoperability, encoders should set **level_idc** to indicate the lowest Level of Annex A/H.264 that the bitstream fully conforms to.

All H.300-series systems which support H.264 shall support Baseline Profile, Level 1, in addition to any other Profiles, Levels or optional parameters.

8.3.2 H.264 generic capabilities for H.245

This clause defines the generic capabilities for H.264 in the H.245 signalling system.

If a terminal has the capability to decode according to more than one H.264 Profile with different Levels capabilities (for example, Baseline Profile at Level 3 and Extended Profile at Level 2) or with different optional parameters for each Profile, this may be signalled by a separate Generic Capability for each supported Profile.

NOTE – Parameter identifier value 0 is not defined, and should not be defined in the future. This value is reserved so that it can be used in the equivalent BAS-signalling-based system MBE message as a demarcation between separate capabilities within the single MBE message, as defined in Annex A/H.239.

8.3.2.1 H.264 capability identifier

See Table 8-1.

Table 8-1/H.241 – H.264 Capability Identifier

Capability name	ITU-T Rec. H.241 H.264 Video Capabilities
Capability identifier type	standard
Capability identifier value	{itu-t(0) recommendation(0) h(8) 241 specificVideoCodecCapabilities(0) h264(0) generic-capabilities(1)}
maxBitRate	This field shall be included, in units of 100 bit/s. This field represents the maximum bitrate of the H.264 Type II bitstream as defined in Annex C/H.264.
collapsing	This field shall contain the H.264 Capability Parameters as given below.
nonCollapsing	This field shall not be included.
nonCollapsingRaw	This field shall not be included.
transport	This field shall not be included.

8.3.2.2 H.264 Profile parameter

See Table 8-2.

Table 8-2/H.241 – H.264 Capability Parameter – Profile

Parameter name	Profile
Parameter description	This parameter is a Boolean array. If bit 2 (value 64) is 1, this indicates the Baseline Profile. If bit 3 (value 32) is 1, this indicates the Main Profile. If bit 4 (value 16) is 1, this indicates the Extended Profile. If bit 5 (value 8) is 1, this indicates the High Profile. If bit 6 (value 4) is 1, this indicates the High 10 Profile. If bit 7 (value 2) is 1, this indicates the High 4:2:2 Profile. If bit 8 (value 1) is 1, this indicates the High 4:4:4 Profile. All other bits are reserved, shall be set to 0, and shall be ignored by receivers. In a capability, for each bit set to 1, this means that the terminal is capable of using the indicated Profile(s) using the Level and other optional parameters in this Generic Capability. In an OpenLogicalChannel message, for each bit set to 1, this means that the logical channel contents obey all constraints of the indicated Profile(s). NOTE 1 – Additional Profiles and Additional modes can be signalled in separate parameters – for example, in the AdditionalModesSupported parameter. NOTE 2 – Bit 1 remains reserved since if the three high-order bits of this parameter are set, this could create an unintentional emulation of the MBE BAS code in ITU-T Rec. H.230.
Parameter identifier value	41
Parameter status	Mandatory. This parameter shall appear exactly once in each Generic Capability.
Parameter type	booleanArray
Supersedes	This field shall not be included.

Each H.264 Generic Capability shall include the Profile parameter. If the capability signals support only Profiles or Additional Modes which are not included in this parameter, then all bits in this Profile parameter shall be set to 0.

8.3.2.2.1 H.264 Profile parameter examples (informative)

For example, support of the Baseline Profile at Level 3 would be signalled with the following parameters:

- Profile = value 64 (Baseline: bit 2 set);
- Level = value 64 (Level 3, per Table 8-4).

For example, support of the Baseline Profile at level 2 and RCDO at Level 4 would be signalled with two H.264 Generic Capabilities, one with the parameters:

- Profile = value 64 (Baseline: bit 2 set);
- Level = value 43 (Level 2, per Table 8-4).

and the other with parameters:

- Profile = value 0 (no bits set);
- Level = value 85 (Level 4, per Table 8-4);
- AdditionalModesSupported = 64 (RCDO: bit 2 set per Table 8-13).

For example, support of the either the High 10 Profile, the Main Profile, or RCDO, all at Level 2.2 would be signalled with the parameters:

- Profile = value 36 (Main: bit 3 set, and High 10: bit 6 set);
- Level = value 57 (Level 2.2, per Table 8-4);
- AdditionalModesSupported = 64 (RCDO – bit 2 set per Table 8-13).

8.3.2.3 H.264 Level parameter

The Level parameter signals the H.264 Level.

Table 8-3/H.241 – H.264 Capability Parameter – Level

Parameter name	Level
Parameter description	Signals a value according to Table 8-4, indicating the H.264 Level. All other values are reserved and shall not be transmitted. Terminals that receive this signal with a Level parameter value less than the lowest Level parameter value shown in Table 8-4 shall ignore this capability parameter. NOTE – Such values are reserved for future use. For all other received Level parameter values, the terminal shall interpret the signalled H.264 Level number as the H.264 Level number corresponding to the highest Level parameter value in Table 8-4 which is less than or equal to the received Level parameter value.
Parameter identifier value	42
Parameter status	Mandatory. This parameter shall appear exactly once in each Generic Capability.
Parameter type	unsignedMin
Supersedes	This field shall not be included.

Table 8-4/H.241 – Level parameter values

Level parameter value	H.264 Level number
15	1
19	1b
22	1.1
29	1.2
36	1.3
43	2
50	2.1
57	2.2
64	3
71	3.1
78	3.2
85	4
92	4.1
99	4.2
106	5
113	5.1

NOTE 1 – Table 8-4 and this parameter description are constructed such that new H.264 Levels defined in the future, which are strictly between or above existing Levels, may be inserted into Table 8-4 in the future. If new Levels are defined which do not meet these constraints, they may be inserted below the lowest existing Level. In that case, new rules for interpreting such Level parameter values will be needed.

NOTE 2 – The MaxBR and MaxCBP units of Table A-1/H.264 are considered as equal to 1200 bit/s by implementers of H.310, H.320, H.323, and H.324, because these systems transport H.264 Type II bitstreams as defined in Annex C/H.264.

8.3.2.4 H.264 CustomMaxMBPS processing rate parameter

The optional CustomMaxMBPS parameter permits a decoder to signal that it is capable of decoding video at a higher rate than required by the signalled Level. Encoders may use this knowledge to, for example, send pictures of a given size at a higher frame rate.

Table 8-5/H.241 – H.264 Capability Parameter – CustomMaxMBPS

Parameter name	CustomMaxMBPS
Parameter description	CustomMaxMBPS is the maximum macroblock processing rate, in units of 500 macroblocks per second. This optional parameter, when present, may be considered by the encoder to replace the MaxMBPS value in Table A-1/H.264 for the signalled Level. The value of (CustomMaxMBPS × 500) shall not be less than the value MaxMBPS for the Level given in Table A-1/H.264.
Parameter identifier value	3
Parameter status	Optional. This parameter shall appear at most once in each Generic Capability.
Parameter type	unsignedMin
Supersedes	This field shall not be included.

8.3.2.5 H.264 CustomMaxFS frame size parameter

The optional CustomMaxFS parameter permits a decoder to signal that it is capable of decoding larger picture sizes than required by the signalled Level. Encoders may use this knowledge to, for example, send larger pictures at a proportionally lower frame rate.

Table 8-6/H.241 – H.264 Capability Parameter – CustomMaxFS

Parameter name	CustomMaxFS
Parameter description	CustomMaxFS is the maximum frame size, in units of 256 luma macroblocks. This optional parameter, when present, shall be considered to replace the MaxFS value in Table A-1/H.264 for the signalled Level. The value of (CustomMaxFS × 256) shall not be less than the value MaxFS for the Level given in Table A-1/H.264.
Parameter identifier value	4
Parameter status	Optional. This parameter shall appear at most once in each Generic Capability.
Parameter type	unsignedMin
Supersedes	This field shall not be included.

8.3.2.6 H.264 CustomMaxDPB memory parameter

The optional CustomMaxDPB parameter permits a decoder to signal that it has more than the minimum amount of decoded picture buffer memory required by the signalled Level. Encoders may use this knowledge to construct coded video streams with improved compression.

A system which signals CustomMaxDPB shall be capable of storing the following number of decoded frames in its decoded picture buffer:

Min (32768 × CustomMaxDPB ÷ (PicWidthInMbs × FrameHeightInMbs × 256 × ChromaFormatFactor), 16)

PicWidthInMbs, FrameHeightInMbs, and ChromaFormatFactor are defined in ITU-T Rec. H.264.

Table 8-7/H.241 – H.264 Capability Parameter – CustomMaxDPB

Parameter name	CustomMaxDPB
Parameter description	CustomMaxDPB is the maximum decoded picture buffer size, in units of 32 768 bytes. This optional parameter, when present, shall be considered to replace the MaxDPB value in Table A-1/H.264 for the signalled Level. The value of (CustomMaxDPB × 32 768) shall not be less than the value (MaxDPB × 1024) for the Level given in Table A-1/H.264.
Parameter identifier value	5
Parameter status	Optional. This parameter shall appear at most once in each Generic Capability.
Parameter type	unsignedMin
Supersedes	This field shall not be included.

8.3.2.7 H.264 CustomMaxBRandCPB bitrate and coded picture buffer size parameter

The optional CustomMaxBRandCPB parameter permits a decoder to signal that it is capable of decoding video streams of higher bitrate, and that it has a correspondingly larger coded picture buffer, than required by the signalled Level. Encoders may use this knowledge to, for example, send higher bitrate video to achieve improved video quality.

Table 8-8/H.241 – H.264 Capability Parameter – CustomMaxBRandCPB

Parameter name	CustomMaxBRandCPB
Parameter description	CustomMaxBRandCPB is the maximum video bitrate. The maximum coded picture buffer (CPB) size is derived from the maximum video bitrate. The units for maximum video bitrate are 25 000 bit/s for the VCL HRD parameters (see A.3.1 item i/H.264) and 30 000 bit/s for the NAL HRD parameters (see A.3.1 item j/H.264). NOTE – For transport of H.264 bitstreams in H.310, H.320, H.323, and H.324 the appropriate video bitrate unit is 30 000 bit/s, because these systems transport Type II H.264 bitstreams as defined in Annex C/H.264. The CPB size shall be derived as equal to the MaxCPB for the signalled Level (see Table A-1/H.264), multiplied by the ratio of the signalled maximum bitrate to the MaxBR for the signalled level. For example, if a terminal signals Level 1.2 with CustomMaxBRandCPB equal to 62, this indicates a maximum video bitrate of 1.550 Mbit/s for VCL HRD parameters, a maximum video bitrate of 1.860 Mbit/s for NAL HRD parameters, and a CPB size of 4 036 458 bits ((62 × 25 000)/384 000) × 1000 × 1000. This optional parameter, when present, shall be considered to replace the MaxBR and MaxCPB values in Table A-1/H.264 for the signalled Level. The bit rate signalled by the CustomMaxBRandCPB parameter shall not be less than the maximum bit rate given in the MaxBR column of Table A-1/H.264, for the Level signalled.
Parameter identifier value	6
Parameter status	Optional. This parameter shall appear at most once in each Generic Capability.
Parameter type	unsignedMin
Supersedes	This field shall not be included.

8.3.2.8 H.264 MaxStaticMBPS processing rate parameter

The optional MaxStaticMBPS parameter permits a decoder to signal that it is capable of decoding video containing static macroblocks at a higher rate than required by the signalled Level. Encoders may use this knowledge to, for example, send pictures of a given size at a higher frame rate.

In the H.264 context, static macroblocks are defined as macroblocks for which all of the following conditions are fulfilled:

1) CodedBlockPatternLuma and CodedBlockPatternChroma, when assigned a value in H.264, are both equal to 0; and

2) either of the following conditions are fulfilled:

   a) mb_type is equal to P_Skip or P_L0_16x16 and weighted_pred_flag is not equal to 1; or

   b) mb_type is equal to B_Skip, B_Direct_16x16, B_L0_16x16, or B_L1_16x16 and weighted_bipred_idc is not equal to 1;

3) only a single list X for X = 0 or 1 (List 0 or List 1) is used in the inter prediction process for the macroblock, within which the values of mvLX[0], mvLX[1], and refIdxLX are all equal to 0; and

4) either of the following conditions are fulfilled:

   a) the macroblock is a frame macroblock and the reference index value 0 refers to the immediately-preceding frame or complementary field pair in decoding order and the immediately-preceding picture in decoding order is not a non-paired field; or

   b) the macroblock is a field macroblock and the reference index value 0 refers to the immediately-preceding field of the same parity in decoding order.

   NOTE – The conditions specified above result in a decoding process for macroblocks consisting of copying samples from the same position as the current macroblock in the preceding reference picture in decoding order. The conditions specified above also identify only those macroblocks for which at most one motion vector difference is present in the bitstream.

All other macroblocks are non-static macroblocks.

Table 8-9/H.241 – H.264 Capability Parameter – MaxStaticMBPS

Parameter name	MaxStaticMBPS
Parameter description	MaxStaticMBPS is the maximum number of static macroblocks per second the decoder can process under the assumption that all macroblocks are static macroblocks, in units of 500 macroblocks per second. When this optional parameter is present the value of MaxMBPS in Table A-1/H.264 for the signalled Level should be considered by the encoder to be equal to the result of the following procedure: 1) If the optional parameter CustomMaxMBPS is signalled, set a variable *MaxMacroblocksPerSecond* equal to the value (CustomMaxMBPS × 500). Otherwise, set *MaxMacroblocksPerSecond* equal to the value of MaxMBPS for the Level given in Table A-1/H.264. 2) Set a variable $P_{non\text{-}static}$ to the proportion of non-static macroblocks in picture n. 3) Set a variable P_{static} to the proportion of static macroblocks in picture n. 4) The value of MaxMBPS in Table A-1/H.264 for the signalled Level should be considered by the encoder to be equal to: $$\frac{1}{\frac{P_{non-static}}{MaxMacroblocksPerSecond} + \frac{P_{static}}{MaxStaticMBPS \times 500}}$$ The encoder should recompute this value for each picture. The value of (MaxStaticMBPS × 500) shall not be less than the value MaxMBPS for the Level given in Table A-1/H.264, and if CustomMaxMBPS is signalled, shall not be less than the value (CustomMaxMBPS × 500). The computed value of MaxMBPS should be used by the encoder to determine the minimum interval between picture n and picture n+1, as specified in the references to MaxMBPS in Annex A/H.264.
Parameter identifier value	7
Parameter status	Optional. This parameter shall appear at most once in each Generic Capability.
Parameter type	unsignedMin
Supersedes	This field shall not be included.

8.3.2.8.1 Use of H.264 MaxStaticMBPS example (informative)

This clause does not form an integral part of this Recommendation.

For example, suppose a Level 1.2 capable decoder (MaxMBPS = 6000) with a signalled MaxStaticMBPS value of 120 (a processing rate of 60 000 static macroblocks per second) is receiving XGA video (1024 × 768 luma samples per picture), which contains 3072 luma macroblocks per picture, and that only a mouse cursor is moving in the video scene. (This example assumes the decoder has a CustomMaxFS value that permits this picture size.)

Suppose further that encoding the mouse cursor region requires only 4 macroblocks in a particular picture, so all other macroblocks can be static macroblocks. The procedure described above yields a MaxMBPS of 59 305 macroblocks per second (1 ÷ ((4 ÷ 3072) ÷ 6000) + (((3072 – 4) ÷ 3072) ÷ 60 000)).

This would permit the encoder to generate the next picture after an interval of 51.8 ms (3072 ÷ 59 305), corresponding to an instantaneous frame rate of 19.3 Hz (59 305 ÷ 3072), compared to an interval of 512 ms (3072 ÷ 6000), corresponding to an instantaneous frame rate of only 2.0 Hz without the use of MaxStaticMBPS.

8.3.2.8.2 Determination of H.264 MaxStaticMBPS value (informative)

This clause does not form an integral part of this Recommendation. It provides informative guidance regarding considerations for the determination of the MaxStaticMBPS value for a given decoder implementation.

Practical decoder implementations make use of a wide variety of hardware and software architectures, and there may be no single method of determining a decoder's value of MaxStaticMBPS that is appropriate in all cases; determination of this value is left to the implementer.

One possible method is described here solely as an example:

1) Given an implementation which can decode sequences containing only non-static macroblocks at a rate of R_{decode} macroblocks per second.

2) An encoded test video sequence with a known number of macroblocks (N), proportion of static macroblocks (P_{static}), and of non-static macroblocks ($P_{non\text{-}static} = 1 - P_{static}$) can be decoded, and the time required to decode either each picture or the entire sequence measured by experiment (T_{decode} in seconds).

3) The rate at which static macroblocks can be decoded (StaticMBPS) can be calculated by:

$$StaticMBPS = P_{static} \div (T_{decode} \div N - P_{non\text{-}static} \div R_{decode})$$

   This procedure can be repeated with different test sequences containing different proportions of static and non-static macroblocks and different picture sizes.

4) The values of StaticMBPS obtained can be plotted against varying values of P_{static} and picture size tested, and interpolation applied between the test points. (Note that in many decoder implementation architectures, the plot of StaticMBPS versus picture size will form a curve.)

5) The lowest value of StaticMBPS obtained on the plots could then be used as the value of MaxStaticMBPS.

In some decoder implementation architectures, the decoding rate is affected by a deblocking filter computation where static and non-static macroblocks are adjacent to each other. To take account of this factor, worst-case test patterns of static and non-static macroblocks can be used.

8.3.2.9 H.264 max-rcmd-nal-unit-size

The value of this parameter indicates the largest NAL unit size in bytes that the receiver can handle efficiently. The parameter value is a recommendation, not a strict upper boundary. The sender may create larger NAL units but implementers should consider that inefficiencies or an increased chance of loss due to errors might result.

Table 8-10/H.241 – H.264 Capability Parameter – max-rcmd-nal-unit-size

Parameter name	max-rcmd-nal-unit-size
Parameter description	The value of this parameter indicates the largest NAL unit size in bytes that the receiver is able to handle efficiently. The parameter may have values in the range of 0 to 4 294 967 295, inclusive.
Parameter identifier value	8
Parameter status	Optional. This parameter shall appear at most once in each Generic Capability.
Parameter type	Integer
Supersedes	This field shall not be included.

8.3.2.10 H.264 max-nal-unit-size

The value of this parameter indicates the largest NAL unit size in bytes that the receiver is able to handle at all. The sender shall not create NAL units larger than this size.

In the absence of this signal, senders shall not create NAL units larger than 1400 bytes when using the Interleaved or Non-Interleaved packetization modes. When operating in the Annex A packetization mode, senders should not create NAL units larger than 1400 bytes.

Table 8-11/H.241 – H.264 Capability Parameter – max-nal-unit-size

Parameter name	max-nal-unit-size
Parameter description	The value of this parameter indicates the largest NAL unit size in bytes that the receiver can process. The parameter can have values in the range of 0 to 4 294 967 295, inclusive.
Parameter identifier value	9
Parameter status	Optional. This parameter shall appear at most once in each Generic Capability.
Parameter type	unsigned32Min
Supersedes	This field shall not be included.

8.3.2.11 H.264 SampleAspectRatiosSupported capability

In a receive capability, the value of this parameter indicates the range of sample aspect ratios that the receiver is able to display without geometric (shape) distortion.

In an H.245 **OpenLogicalChannel** message, the value of this parameter indicates the range of sample aspect ratios that the Logical Channel will ever contain.

Table 8-12/H.241 – H.264 Capability Parameter – SampleAspectRatiosSupported

Parameter name	SampleAspectRatiosSupported
Parameter description	The value of this parameter indicates support of sample aspect ratios corresponding to H.264 **aspect_ratio_idc** values in the range from 1 to N inclusive, where N is the value of this parameter (see Table E-1/H.264). This parameter shall not take a value outside the range 1 to 254. NOTE – Support of Table E-1/H.264 Extended_SAR (**aspect_ratio_idc** value 255) may be signalled using the AdditionalDisplayCapabilities parameter.
Parameter identifier value	10
Parameter status	Optional. This parameter shall appear at most once in each Generic Capability.
Parameter type	unsignedMin
Supersedes	This field shall not be included.

Terminals that signal this parameter:

a) shall not send pictures using a sample aspect ratio outside the range signalled by the receiver in the SampleAspectRatiosSupported capability parameter; and

b) shall indicate in the VUI parameters specified in Annex E/H.264 the actual sample aspect ratio in any transmitted H.264 video streams; and

c) shall consider the sample aspect ratio as a part of the video mode when Multipoint Mode Symmetrize (MMS) according to ITU-T Rec. H.243 is in effect, or **multipointModeCommand** according to ITU-T Rec. H.245 is in effect; and

d) shall signal a SampleAspectRatiosSupported value of 1 or greater in their receive capability set; and

e) should signal a SampleAspectRatiosSupported value of 3 or greater in their receive capability set; and

f) in the absence of a received SampleAspectRatiosSupported capability parameter, shall not send any pictures except for those with either:

   1) a picture aspect ratio of 4:3; or,

   2) a sample aspect ratio in the range of 10:11 to 12:11.

NOTE 1 – The sample aspect ratio 12:11 is part of the definition of QCIF, CIF, and 4CIF format pictures.

Terminals are not required to conform with b above if they transmit a video stream derived from a source with a sample aspect ratio which is unknown.

MCUs are not required to conform with a and f above if the SampleAspectRatiosSupported capabilities expressed by the connected receivers are not identical.

NOTE 2 – In some multipoint conferences, a small minority of endpoints supports a more limited set of sample aspect ratios than the majority of endpoints. MCUs are not required to conform with a and f above, so that they are free in such cases to choose a video mode that is most appropriate for the majority of endpoints. In such cases, it should be noted that the provisions of 8.1 continue in force.

8.3.2.12 AdditionalModesSupported parameter

The optional AdditionalModesSupported parameter permits a terminal to signal that it is capable of decoding using one or more additional video modes, aside from those defined by H.264 Profiles.

Table 8-13/H.241 – H.264 Capability Parameter – AdditionalModesSupported

Parameter name	AdditionalModesSupported
Parameter description	This parameter is a Boolean array. If bit 2 (value 64) is 1, this indicates support of the Reduced Complexity Decoding Operation (RCDO) as specified in Annex B/H.241. All other bits are reserved, shall be set to 0, and shall be ignored by receivers. In a decoder capability, for each bit set to 1, this means that the terminal is capable of decoding the indicated mode(s) using the Level and other optional parameters in this Generic Capability. In an OpenLogicalChannel message, for each bit set to 1, this means that the logical channel contents obey all constraints of the indicated mode(s). NOTE 1 – If more H.264 additional modes are defined in the future than the number of reserved bits can accommodate, additional modes could be signalled by allocating another parameter for more modes. NOTE 2 – Bit 1 is reserved since if the three high-order bits of this parameter are set, the procedures of Annex A/H.239 will produce an extra byte of output to avoid unintentional emulation of the MBE BAS code in ITU-T Rec. H.230.
Parameter identifier value	11
Parameter status	Optional. This parameter shall appear at most once in each Generic Capability.
Parameter type	booleanArray
Supersedes	This field shall not be included.

NOTE – Some modes (for example, RCDO) are distinct from any Profile defined in ITU-T Rec. H.264. For the purposes of this Recommendation, such modes are signalled in this parameter as if they were independent Profiles. If a terminal has the capability to support one or more modes or Profiles with different Levels capabilities or with different optional parameters for each mode or Profile, this can be signalled by a separate Generic Capability for each supported Profile or mode.

The bits of this parameter are used in the same way as the bits of the Profile parameter. In a capability, for each bit set to 1, this means that the terminal is capable of supporting the indicated mode(s) using the Level and other optional parameters in this Generic Capability. In an OpenLogicalChannel message, for each bit set to 1, this means that the logical channel contents obey all constraints of the indicated mode(s).

For example, if a decoder is capable of supporting Baseline Profile at Level 3 and RCDO at Level 4, this shall be signalled with one capability with a Profile value of 64 (Baseline) and a Level value of 64 (Level 3), and another capability with a Profile value of 0 (no Profile), a Level value of 85 (Level 4), and an AdditionalModesSupported value of 64 (RCDO).

8.3.2.13 AdditionalDisplayCapabilities parameter

The optional AdditionalDisplayCapabilities parameter permits a terminal to signal additional abilities to display decoded video.

Table 8-14/H.241 – H.264 Capability Parameter – AdditionalDisplayCapabilities

Parameter name	AdditionalDisplayCapabilities
Parameter description	This parameter is a Boolean array. If bit 2 (value 64) is 1, this indicates support of all sample aspect ratios which are expressible using the H.264 **aspect_ratio_idc** value of 255 (Extended_SAR, see Table E-1/H.264). A terminal that sets this bit to 1 shall also signal SampleAspectRatiosSupported with a parameter value of 13 or greater. All other bits are reserved, shall be set to 0, and shall be ignored by receivers. NOTE – Bit 1 is reserved since if the three high-order bits of this parameter are set, the procedures of Annex A/H.239 will produce an extra byte of output to avoid unintentional emulation of the MBE BAS code in ITU-T Rec. H.230.
Parameter identifier value	12
Parameter status	Optional. This parameter shall appear at most once in each Generic Capability.
Parameter type	booleanArray
Supersedes	This field shall not be included.

8.3.3 H.264 capabilities for BAS-based systems

8.3.3.1 H.320 video algorithm hierarchy

The H.320 enhanced video algorithm hierarchy in Annex A/H.320 is not extended for H.264. No relative level in the hierarchy is specified for H.264 with regard to other video codecs.

8.3.3.2 H.264 capabilities MBE message format

For H.264 operation, the capabilities exchange is handled by an MBE message (see 2.2.3/H.230). This MBE message uses the type identification byte <H.264> (see Table 2/H.230). A terminal shall signal the H.264 capability by including within its capability set the message:

$$\{ \text{Start-MBE} / N / \langle H.264 \rangle / B_1 / \ldots / B_{N-1} \}$$

The H.264 capability MBE bytes B_1 through B_{N-1} may contain one or more encoding or decoding capabilities for H.264.

Each capability, which corresponds to a single H.245 **GenericCapability** message, consists of the mandatory Profile and Level parameters, and an optional set of zero or more **parameterIdentifier**/**parameterValue** pairs from the set of H.264 generic capability parameters defined in 8.3.2. These pairs are carried in the format given in 8.2 above.

Encoder capabilities are for further study.

The first two bytes of each decoder capability within the MBE shall contain the H.264 Profile parameter, followed by the H.264 Level parameter, as defined in Tables 8-2 and 8-3. No parameter identifier is included in the MBE, as these mandatory parameters are identified by their position in the decoder capability string.

Following the Profile and Level parameters, zero or more **parameterIdentifier**/**parameterValue** pairs containing the optional CustomMaxMBPS, CustomMaxFS, CustomMaxDPB, and CustomMaxBRandCPB parameters may be included, according to the syntax and semantics given for these parameters. The set of **parameterIdentifier**/**parameterValue** pairs may appear in any order within the capability.

If the H.264 capability MBE contains more than one capability, the second and succeeding capabilities within the MBE message shall be demarcated by a single byte of value zero immediately before the start of each succeeding capability.

NOTE – This zero byte appears in the position where a Parameter ID would otherwise appear. Since the H.264 generic capabilities do not define a parameter with a **parameterIdentifier** value of zero, no confusion results.

Receivers shall ignore the value of any **parameterValue** following an undefined **parameterIdentifier**.

Table 8-15 below gives an example of an MBE with a single decoder capability indicating Baseline Profile, Level 3.1, with a CustomMaxMBPS parameter of 246 000 macroblocks/second:

Table 8-15/H.241 – Baseline Profile example MBE

MBE	Value	Description
Byte 1	Start-MBE	Start of MBE. From H.230
Byte 2	6	Number of bytes to follow
Byte 3	<H.264>	Indicates H.264 MBE. From H.230
Byte 4	64	Profile parameter – indicates Baseline Profile
Byte 5	71	Level parameter – indicates Level 3.1
Byte 6	3	Parameter ID – CustomMaxMBPS
Byte 7	172	Lowest 6 bits of 492 (equals 246 000/500), ORed with 128
Byte 8	7	Remaining 7 bits of 492

Table 8-16 gives an example H.264 capability MBE for a system that supports two capabilities:

- Baseline Profile, Level 2.2; and
- Main Profile, Level 2, with CustomMaxFS supporting 800 × 600 SVGA format and CustomMaxMBPS supporting this format at a rate of 10 frames per second.

Table 8-16/H.241 – Two Profile example MBE

MBE	Value	Description
Byte 1	Start-MBE	Start of MBE. From H.230
Byte 2	10	Number of bytes to follow
Byte 3	<H.264>	Indicates H.264 MBE. From H.230
Byte 4	32	Profile parameter – indicates Main Profile
Byte 5	43	Level parameter – indicates Level 2
Byte 6	4	Parameter ID – CustomMaxFS
Byte 7	8	Indicates 2048 macroblock frame size (1900 needed for 800 × 600)
Byte 8	3	Parameter ID – CustomMaxMBPS
Byte 9	38	Indicates 19 000 macroblocks/s processing rate.
Byte 10	0	Demarcates start of new capability
Byte 11	64	Profile parameter – indicates Baseline Profile.
Byte 12	57	Level parameter – indicates Level 2.2

Annex A

H.264 transport for H.323

H.323 terminals which support the transport of video according to ITU-T Rec. H.264 shall support the single NAL unit mode of RFC 3984. H.323 terminals may additionally support other modes.

NOTE – The single NAL unit mode of RFC 3984 is technically identical to the text contained in previous editions of this annex.

Annex B

Reduced-Complexity Decoding Operation (RCDO) for H.264 Baseline Profile Bitstreams

B.1 Scope

This annex specifies a reduced-complexity decoding operation (RCDO) for use with H.264 Baseline profile bitstreams. This annex also specifies a bitstream constraint associated with RCDO and a mechanism for signalling RCDO within the bitstream that the bitstream conforms to the bitstream constraint and that the decoder should apply the RCDO decoding process to the bitstream. It also specifies that a decoder is required to apply the RCDO decoding process when the use of RCDO has been negotiated using this Recommendation.

B.2 Definitions

This annex defines the following terms:

B.2.1 RCDO bitstream: An H.264 bitstream that conforms to B.4.

B.2.2 RCDO SEI message: An H.264 user data unregistered SEI message as specified in Table B.1 that directly follows a sequence parameter set NAL unit.

B.3 General

In this annex, reference is made to specific elements of ITU-T Rec. H.264 (2005). For variables and functions that are not specified in this annex, the specifications in ITU-T Rec. H.264 shall be applied. The modifications in this annex apply only to bitstreams that obey all constraints specified for the Baseline profile of ITU-T Rec. H.264, in particular including A.2.1/H.264 (Baseline profile). For the purposes of Annex A/H.264, the Level requirements are the same for RCDO use as for the non-RCDO use of the H.264 Baseline profile. When RCDO use has been negotiated using this Recommendation, the decoder shall perform the decoding process specified as the RCDO decoding process in this annex.

B.4 RCDO bitstreams

RCDO bitstreams shall:

– conform to the Baseline profile of ITU-T Rec. H.264 (profile_idc equal to 66) and to the additional constraint specified below in B.4.1; and

– include a user data unregistered SEI message according to D.1.6/H.264 containing the values given in Table B.1 below. An RCDO SEI message shall follow immediately after each H.264 sequence parameter set NAL unit.

Table B.1/H.241 – User data unregistered SEI message indicating a bitstream encoded for RCDO

UUID_iso_iec_11578 (hexadecimal format)	a1f775a0bb0911daab1d0002a5d5c51b
Payload bytes	Exactly one payload byte shall follow. This byte shall contain the AdditionalModesSupported booleanArray according to Table 8-13. Bit 2 (value 64) of this BooleanArray shall be set equal to 1.

B.4.1 Constraint on luma inter prediction block sizes to 8 × 8 samples or larger

The value of sub_mb_type as specified in ITU-T Rec. H.264, when applicable, shall always be equal to 0.

B.5 OpenLogicalChannel signalling

In an H.245 **OpenLogicalChannel** message, bit 2 of the AdditionalModesSupported parameter in Table 8-13 shall be equal to 1 and the Profile parameter shall be equal to 0.

For the purpose of robustness to transmission errors, a decoder that is capable of using the RCDO decoding process should cross-check the presence or absence of the RCDO SEI message with the content of the OpenLogicalChannel message. When bit 2 of the AdditionalModesSupported parameter is equal to 1 and the RCDO SEI message is not detected by the decoder, a decoder should send a videoFastUpdatePicture message to the encoder to force retransmission of the RCDO SEI message.

B.6 Procedures

When the use of RCDO has been negotiated using this Recommendation and the bitstream is a conforming RCDO bitstream (as specified in B.4 above), the RCDO decoding process, as specified in this clause, shall be applied by the decoder. To avoid accumulation of "drift" error in the decoded video sequence, the encoder should model the RCDO decoding process accurately during the encoding process.

B.6.1 Reduced-complexity interpolation for inter prediction in the RCDO decoding process

The operations specified in 8.4.2.2/H.264 "Fractional sample interpolation process" shall be performed with the changes specified in this clause during operation of the RCDO decoding process. The modifications are as follows:

1) Referencing 8.4.2.2/H.264, the following modifications apply:
   - frame_num is an additional input to the process.
   - ($xFrac_c$,$yFrac_c$) is in quarter sample units instead of one-eighth sample units.
   - Rather than using Equations 8-224 through 8-227 of ITU-T Rec. H.264, the following modified equations apply:

$$xInt_C = (xA_L / SubWidthC) + ((mvCLX[0] + (frame\_num \,\&\, 1)) >> 3) + x_C \quad (8\text{-}224)$$

$$yInt_C = (yA_L / SubHeightC) + ((mvCLX[1] + (frame\_num \,\&\, 1)) >> 3) + y_C \quad (8\text{-}225)$$

$$xFrac_C = ((mvCLX[0] + (frame\_num \,\&\, 1)) >> 1) \,\&\, 3 \quad (8\text{-}226)$$

$$yFrac_C = ((mvCLX[1] + (frame\_num \,\&\, 1)) >> 1) \,\&\, 3 \quad (8\text{-}227)$$

2) Referencing 8.4.2.2.1/H.264, the following modifications apply:

– The luma prediction values at half sample positions b and s are derived by applying a 6-tap filter with tap values (1, –5, 20, 20, –5, 1).

– The luma prediction values at half sample positions h and m are derived by applying a 4-tap filter with tap values (–1, 5, 5, –1).

– Equations 8-237, 8-238, 8-241 and 8-242 to define b_1, h_1 and j_1 in ITU-T Rec. H.264 are not needed.

– Rather than using Equations 8-239, 8-240, 8-243, 8-244, 8-245, 8-250, 8-251, 8-252 and 8-253 of ITU-T Rec. H.264, the following modified equations apply:

$$b = Clip1_Y((E – 5 * F + 20 * G + 20 * H – 5 * I + J + 6) >> 5) \quad (8\text{-}239)$$

$$h = Clip1_Y((– C + 5 * G + 5 * M – R + 1) >> 3) \quad (8\text{-}240)$$

$$j = (H + M) >> 1 \quad (8\text{-}243)$$

$$s = Clip1_Y((K – 5 * L + 20 * M + 20 * N – 5 * P + Q + 6) >> 5) \quad (8\text{-}244)$$

$$m = Clip1_Y((– D + 5 * H + 5 * N – S + 1) >> 3) \quad (8\text{-}245)$$

$$f = (G + m + 1) >> 1 \quad (8\text{-}250)$$

$$i = (M + b + 1) >> 1 \quad (8\text{-}251)$$

$$k = (H + s + 1) >> 1 \quad (8\text{-}252)$$

$$q = (N + h + 1) >> 1 \quad (8\text{-}253)$$

3) Referencing 8.4.2.2.2/H.264, the following modifications apply:

– Figure B.1 depicts the position of integer and fractional chroma sample positions.

A	a	b	c	B
d	e	f	g	
h	i	j	k	m
n	p	q	r	
C		s		D

Figure B.1/H.241 – Integer sample positions (shaded blocks with upper-case letters) and fractional sample positions (un-shaded blocks with lower-case letters) for quarter sample chroma interpolation

– For further specification of integer and fractional chroma sample positions, Table 8-12/H.264 also applies for assignment of chroma prediction sample $predPartLX_C[x_C, y_C]$ by replacing subscript $_L$ by subscript $_C$, and by replacing G with A.

– To specify predPartLX$_C$[x_C, y_C], rather than using Equation 8-266/H.264, the following expressions apply:

b = (A + B) >> 1

h = (A + C) >> 1

j = (B + C) >> 1

m = (B + D) >> 1

s = (C + D) >> 1

a = (A + b + 1) >> 1

c = (B + b + 1) >> 1

d = (A + h + 1) >> 1

e = (b + h + 1) >> 1

f = (A + m + 1) >> 1

g = (b + m + 1) >> 1

i = (C + b + 1) >> 1

k = (B + s + 1) >> 1

n = (C + h + 1) >> 1

p = (h + s + 1) >> 1

q = (D + h + 1) >> 1

r = (m + s + 1) >> 1

B.6.2 Reduced-complexity deblocking filter in the RCDO decoding process

During operation of the RCDO decoding process, rather than applying the deblocking filter as specified in 8.7/H.264 "Deblocking filter process", the deblocking filter shall be applied as specified in this clause. The definitions of indexA and indexB are as specified in Equations 8-463/H.264 and 8-464/H.264.

B.6.2.1 Deblocking filter process

A conditional filtering is applied to all 4 × 4 block edges of a picture, except edges at the boundary of the picture and any edges for which the deblocking filter process is disabled by disable_deblocking_filter_idc, as specified below. This filtering process is performed on a macroblock basis after completion of the picture construction process prior to the deblocking filter process (as specified in 8.5/H.264 and 8.6/H.264) for the entire decoded picture, with all macroblocks in a picture processed in order of increasing macroblock address.

The deblocking filter process is invoked for the luma and chroma components separately. For each macroblock and each component, vertical edges are filtered first, starting with the edge on the left-hand side of the macroblock proceeding through the edges toward the right-hand side of the macroblock in their geometrical order. Then horizontal edges are filtered, starting with the edge on the top of the macroblock proceeding through the edges toward the bottom of the macroblock in their geometrical order.

Macroblocks of type I_PCM are treated as Intra macroblocks with $qP_z = 0$.

NOTE – This is in accordance with the treatment of such macroblocks in the deblocking filtering process specified in ITU-T Rec. H.264.

Table B.2/H.241 – Value of t_C and β as a function of index

index	0-15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
t_C	0	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3
β	0	6	7	8	9	10	11	12	13	14	15	16	17	18	20	22	24	26	28

To obtain t_C, use index = indexA. To obtain β, use index = indexB.

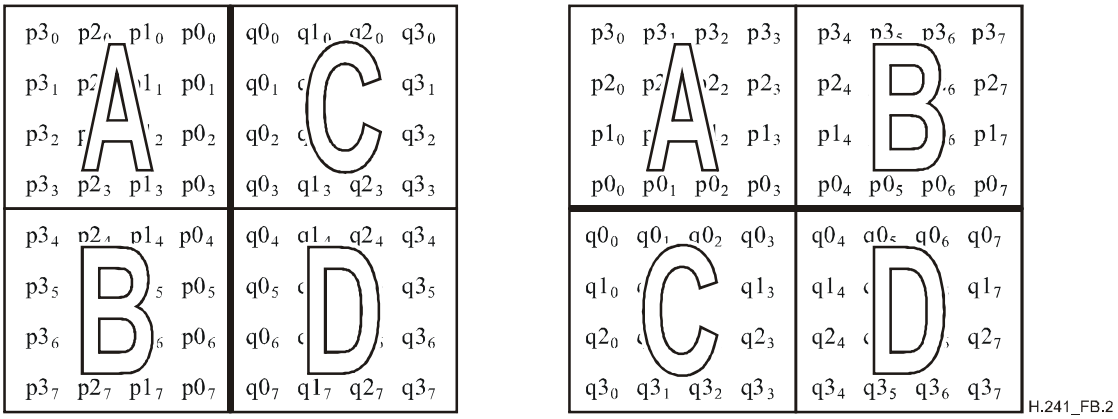
Table B.3/H.241 (concluded) – Value of t_C and β as a function of index

index	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
t_C	3	4	4	4	5	5	6	6	7	8	9	9	11	12	13	13	16	18
β	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64

To obtain t_C, use index = indexA. To obtain β, use index = indexB.

B.6.2.2 Filtering process for luma samples

Filtering of luma samples takes place within units of 8 × 8 luma samples. Figure B.2 illustrates how the 8 × 8 blocks are organized when filtering both across vertical and horizontal edges.



a) Filtering across vertical edges

b) Filtering across horizontal edges

Figure B.2/H.241 – Arrangement of 8 × 8 blocks when filtering across vertical or horizontal edges

Figure B.2 is interpreted as follows:

– A, B, C and D are 4 × 4 blocks.

– pn_i and qn_i, n = 0,3 and i = 0,7 are samples within the 8 × 8 block.

– The bold line indicates a horizontal or vertical block edge across which deblocking filtering takes place.

– The 8 × 8 blocks are arranged such that the samples ($p3_0$ to $q3_0$) or the samples ($p3_7$ to $q3_7$) are at a macroblock boundary.

The variable d, as specified below, is used for deciding whether the samples within an 8 × 8 block are modified or not. Depending on the position of the block edge, the following applies:

– If the block edge is part of a macroblock edge:

$$d = | p1_2 - p0_2 | + | q0_2 - 2*q1_2 + q2_2 | + | p1_5 - p0_5 | + | q0_5 - 2*q1_5 + q2_5 |$$

– Otherwise (the block edge is not part of a macroblock edge):

$$d = | p2_2 - 2*p1_2 + p0_2 | + | q0_2 - 2*q1_2 + q2_2 | + | p2_5 - 2*p1_5 + p0_5 | + | q0_5 - 2*q1_5 + q2_5 |$$

A determination is made of whether or not to apply filtering across a block edge as follows:

– The variable filterBlockEdge shall be equal to 1 if one or more of the following conditions are true:
  - Block A is intra coded or Block C is intra coded.
  - One or more of the blocks A, B, C and D contains non-zero transform coefficients.
  - The absolute difference between the horizontal or vertical component of the motion vectors used for block A and block C is greater than or equal to 4 in units of quarter luma frame samples.
  - Block A and block C are predicted from different reference frames.

– Otherwise, the value of filterBlockEdge shall be equal to 0.

– If one or more of the following conditions are true, no filtering across a block edge takes place.
  - disable_deblocking_filter_idc for the slice containing block D is equal to 1.
  - disable_deblocking_filter_idc for the slice containing block D is equal to 2 and block B and D belong to different slices.
  - $d \geq \beta$.
  - filterBlockEdge = 0.

– Otherwise, filtering takes place as specified below.

For block edges across which filtering is to be performed, all values pn_i, qn_i, with n = 0,1 and i = 0,7, are modified as follows.

– If the block edge is not part of a macroblock edge:

$$\Delta = \text{Clip3}(-t_C, t_C, ((q0_i + ((p2_i + q1_i) >> 1)) >> 1) - ((p0_i + ((q2_i + p1_i) >> 1)) >> 1))$$

– Otherwise (the block edge is part of a macroblock edge):

$$\Delta = \text{Clip3}(-t_C, t_C, ((q0_i + (q1_i >> 1)) >> 1) - ((p0_i + (q2_i >> 1)) >> 1))$$

When the filtering is applied, the filtered samples $p1_i$, $p0_i$, $q0_i$, $q1_i$ are derived by:

$$p0_i = \text{Clip1}_Y(p0_i + \Delta)$$

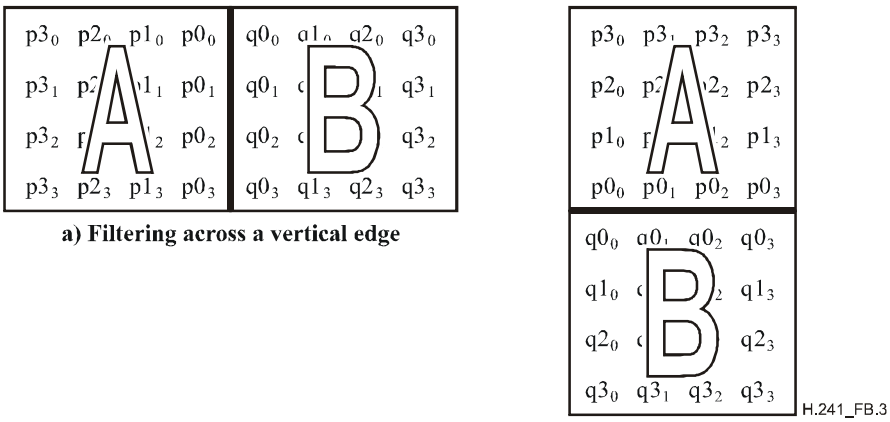
$$q0_i = \text{Clip1}_Y(q0_i - \Delta)$$

$$p1_i = \text{Clip1}_Y(p1_i + \Delta/2)$$

$$q1_i = \text{Clip1}_Y(q1_i - \Delta/2)$$

B.6.2.3 Filtering process for chroma samples

The chroma filtering process takes place across an edge between two 4 × 4 chroma blocks. Figure B.3 illustrates how two such adjacent blocks are arranged when filtering both across vertical and horizontal edges.



a) Filtering across a vertical edge

b) Filtering across a horizontal edge

Figure B.3/H.241 – Arrangement of two 4 × 4 chroma blocks when filtering across a vertical or horizontal edge

Figure B.3 is interpreted as follows:

– A and B are 4 × 4 blocks of samples.

– pn_i and qn_i, n = 0,3 and i = 0,3 are samples within the two 4 × 4 blocks.

– The bold line indicates a horizontal or vertical block edge across which deblocking filtering takes place.

A determination is made of whether or not to apply filtering across the edge between blocks A and B as follows:

– If one or more of the following conditions are true, no filtering across the block edge takes place.
  - disable_deblocking_filter_idc for the slice containing block B is equal to 1.
  - disable_deblocking_filter_idc for the slice containing block B is equal to 2 and blocks A and B belong to different slices.
  - Neither block A nor block B is coded using an intra prediction mode.

– Otherwise, filtering takes place for the block edge.

For block edges where filtering takes place, all values $p0_i$, $q0_i$ with i = 0,3 are modified in the following way:

$$\Delta = \text{Clip3}(-t_C, t_C, ((((q0_i - p0_i) << 2) + p1_i - q1_i + 4) >> 3))$$

The filtered result samples $p0_i$, $q0_i$ are derived by:

$$p0_i = \text{Clip1}_C(p0_i + \Delta)$$

$$q0_i = \text{Clip1}_C(q0_i - \Delta)$$

Appendix I

ASN.1 OIDs defined in this Recommendation

OID	Clause reference
{itu-t(0) recommendation(0) h(8) 241 specificVideoCodecCapabilities(0) h264(0) iPpacketization(0) h241AnnexA(0)}	7.1.4
{itu-t(0) recommendation(0) h(8) 241 specificVideoCodecCapabilities(0) h264(0) iPpacketization(0) RFC3984NonInterleaved(1)}	7.1.4
{itu-t(0) recommendation(0) h(8) 241 specificVideoCodecCapabilities(0) h264(0) iPpacketization(0) RFC3984Interleaved(2)}	7.1.4
{itu-t(0) recommendation(0) h(8) 241 specificVideoCodecCapabilities(0) h264(0) generic-capabilities(1)}	8.3.2.1

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