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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Communication procedures

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

Recommendation ITU-T H.241

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Recommendation ITU-T H.241

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

Summary

Recommendation ITU-T H.241 defines the use of advanced video codecs, including those based on Recommendation ITU-T H.264, in ITU-T H.300-series terminals, including ITU-T H.310, ITU-T H.320, ITU-T H.321, ITU-T H.322, ITU-T H.323 and ITU-T H.324 terminals. It also defines generic extended signalling for use with all video codecs in the ITU-T H.300-series terminals.

This revised version introduces a number of enhancements and clarifications to the previous version. Clarification concerns primarily the description on the signalling for ITU-T H.264 Annex G Scalable Baseline and Scalable High Profiles, a procedure for selecting the operating point of a scalable video coding (SVC) video stream, and the Capability Class of ITU-T H.241 capabilities. This version incorporates clause 6.2.5 introduced in ITU-T H.241 (2006) Amd. 1 (2008), allowing for the negotiation of particular video submodes of ITU-T H.264 encoding. It also incorporates clause 8.3.2.14, defining a new optional ITU-T H.264 capability parameter (MaxFPS), and Appendix II which contains non-normative examples describing the use of clause 6.2.5. Clause 8.3.2.14 and Appendix II were both introduced in ITU-T H.241 (2006) Amd. 2 (2009).

History

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FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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Recommendation ITU-T H.241

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

1 Scope

This Recommendation defines the procedures for use of advanced video codecs, including those based on [ITU-T H.264], in ITU-T H.300-series terminals, including ITU-T H.310, ITU-T H.320, ITU-T H.321, ITU-T H.322, ITU-T H.323 and ITU-T H.324 terminals. 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 ITU-T H.300-series multimedia terminals.

Annex A specifies ITU-T H.264 transport for ITU-T H.323 systems, including Annex G of [ITU-T H.264] (Scalable Video Coding).

Annex B specifies a reduced-complexity decoding process to be applied to ITU-T H.264 Baseline profile bitstreams when such use has been negotiated using [ITU-T 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 H.221] Recommendation ITU-T H.221 (2009), *Frame structure for a 64 to 1 920 kbit/s channel in audiovisual teleservices*.

[ITU-T H.230] Recommendation ITU-T H.230 (2009), *Frame-synchronous control and indication signals for audiovisual systems*.

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

[ITU-T H.242] Recommendation ITU-T H.242 (2009), *System for establishing communication between audiovisual terminals using digital channels up to 2 Mbit/s*.

[ITU-T H.243] Recommendation ITU-T H.243 (2005), *Procedures for establishing communication between three or more audiovisual terminals using digital channels up to 1 920 kbit/s*.

[ITU-T H.245] Recommendation ITU-T H.245 (2011), *Control protocol for multimedia communication*.

[ITU-T H.261] Recommendation ITU-T H.261 (1993), *Video codec for audiovisual services at p ×64 kbit/s*.

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

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

[ITU-T H.264] Recommendation ITU-T H.264 (2011), *Advanced video coding for generic audiovisual services*.

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

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

[ITU-T H.323] Recommendation ITU-T H.323 (2009), *Packet-based multimedia communications systems*.

[ITU-T H.324] Recommendation ITU-T H.324 (2009), *Terminal for low bit-rate multimedia communication*.

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

[IETF RFC 6184] IETF RFC 6184 (2011), *RTP Payload Format for H.264 Video*.

[IETF RFC 6190] IETF RFC 6190 (2011), *RTP Payload Format for Scalable Video Coding*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 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 common intermediate format (CIF) picture according to [ITU-T H.263] is 4:3.

3.2.2 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 H.263] is 12:11.

3.2.3 terminal: A terminal is any end point and may be a user's terminal or some other communication system such as a multipoint control unit (MCU) or an information server.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

4CIF 4x Common Intermediate Format

4SIF 4x Standard Interchange Format

AL-SDU Adaptation Layer Service Data Unit

ASN.1	Abstract Syntax Notation One
BAS	Bit-rate Allocation Signal
C&I	Control and Indication
CIF	Common Intermediate Format
IDR	Instantaneous Decoding Refresh
MBE	Multiple Byte Extension
MCU	Multipoint Control Unit
OID	Object Identifier
PAR	Picture Aspect Ratio
QCIF	Quarter Common Intermediate Format
QVGA	Quarter VGA
RCDO	Reduced Complexity Decoding Operation
RTP	Real-time Transport Protocol
SAR	Sample Aspect Ratio
SEI	Supplemental Enhancement Information
SIF	Standard Interchange Format
SVC	Scalable Video Coding
VUI	Video Usability Information

5 Conventions

5.1 System terminology

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

– "BAS-based systems" refers to those systems that use signalling in the ITU-T H.221 bit-rate allocation system (BAS) channel; these include ITU-T H.320, ITU-T H.321 and ITU-T H.322 systems

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

5.2 Message names

In this Recommendation, signalling messages which are common to both ITU-T H.245 and BAS signalling systems are referred to by their names, as given in Annex A of [ITU-T H.245], except in cases where their use in the unique BAS signalling environment is 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 ITU-T H.245 and ITU-T H.242/ITU-T H.230 messages mentioned in this Recommendation.

Table 5-1 – Corresponding ITU-T H.245 and BAS video signals

ITU-T H.245 name	ITU-T 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 Control and îndication (C&I) applicable to all video codecs

For further study.

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

The following C&I signals shall not be used with regard to any channel operating according to [ITU-T 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 H.263] or have parameters which do not correspond to ITU-T H.264 structures or value ranges. Replacement signals which could be used either with [ITU-T 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 H.264

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

a) a recovery point signalled in a recovery point service end interface (SEI) message (D.2.7 of [ITU-T H.264]) is reached

b) reception of an instantaneous decoding refresh (IDR) picture

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

6.2.2 videoFastUpdatePicture command in ITU-T H.264

When a video encoder according to [ITU-T H.264] receives a **videoFastUpdatePicture** command, the encoder shall enter the fast update mode by using one of the procedures specified in clause 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 ITU-T H.264 video encoding.

NOTE 1 – The procedures re-initialize an ITU-T H.264 decoder completely so 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 end point.

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

NOTE 2 – The 3-second requirement is needed to avoid timeout of the six-second timer associated with the **videoFreezePicture** command, taking into account network and system latencies and possible cascaded MCUs. The **videoFreezePicture** command is used by multipoint control units (MCUs) as part of the video switching procedure (see clause 6.1.1 of [ITU-T 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 of [ITU-T H.264])

2) send a ITU-T 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 ITU-T 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 ITU-T 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 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 (supplemental enhancement information (SEI) message (D.2.7 of [ITU-T 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 ITU-T H.264 slice.

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

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

Re-sending of parameter sets may be done all at once (within the limits of [ITU-T 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

ITU-T H.264 video decoders in ITU-T H.300-series terminals shall support reception of the recovery point SEI message (see clause D.2.7 of [ITU-T 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 ITU-T H.264-on BAS command

For BAS-based systems, the ITU-T H.264-on BAS command defined in [ITU-T H.221] shall be used to signal that video according to [ITU-T H.264] is being transmitted. This command shall be used analogously to the BAS command ITU-T H.261-on. Video shall occupy the same capacity as stipulated in [ITU-T H.221] for the case of ITU-T H.261 video. The use of ITU-T H.264 Annex G scalable video coding (SVC) in BAS-based systems is for further study.

6.2.5 Set submode procedure

This clause defines a procedure that may be used by ITU-T H.320 and ITU-T H.245 systems to negotiate the use of a particular ITU-T H.264 video encoding submode. Such a submode may limit the ITU-T H.264 encoding to a specified group of sample aspect ratios (SARs), picture aspect ratios (PARs), and picture heights while it is in force. It may also reduce the MaxMBPS value in Table A.1 of [ITU-T H.264] (or its optional replacement CustomMaxMBPS in Table 8-5) to a lower value. Additionally, it may reduce the MaxStaticMBPS value in Table 8-9 to a lower value.

Some examples illustrating the use of this procedure are given in Appendix II.

6.2.5.1 SetSubmode capability

ITU-T H.320 and ITU-T H.245 systems may optionally support the set submode procedure.

In [ITU-T H.320], this capability shall be signalled as a BAS message <h264SetSubmode> (see clause 3.1 of [ITU-T H.230]). <h264SetSubmode> is a BAS SBE message.

In [ITU-T H.245], this capability shall be signalled in a generic capability message, as shown in Table 6-1.

Table 6-1 – ITU-T H.241 set submode capability identifier

Capability name	ITU-T H.241 set submode capability
Capability identifier type	Standard
Capability Class	Video
Capability identifier value	{itu-t(0) recommendation(0) h(8) h241(241) specificVideoCodecCapabilities(0) h264(0) set-submode(2)}
maxBitRate	This field shall not be included.
collapsing	This field shall not be included.
nonCollapsing	This field shall not be included.
nonCollapsingRaw	This field shall not be included.
transport	This field shall not be included.

6.2.5.2 C&I messages

C&I messages are used in this clause to indicate sets of submodes that are supported by the sender of the ITU-T H.264 encoding for that specific encoding, to request a submode of that sender, and to positively or negatively acknowledge such a request.

The C&I messages defined in this clause shall not be used if video sent on the channel associated with the signalled channelID AMC is not encoded with ITU-T H.264.

All C&I messages defined in this clause shall be carried as follows.

6.2.5.3 Signalling of messages for the set submode procedure

For ITU-T H.245, each message shall consist of a **GenericRequest**, **GenericResponse** or **GenericIndication** according to Table 6-2 containing GenericMessage.messageIdentifier with the set submode capability OID as defined in Table 6-1, and a **subMessageIdentifier**. Each particular **subMessageIdentifier** listed in Table 6-2 has an associated **messageContent** syntax given in the following clauses.

For ITU-T H.320, each set submode message shall be carried by a separate MBE message (see clause 2.2.3 of [ITU-T H.230]) which shall contain the same **subMessageIdentifier** value and parameter sequence as its ITU-T H.245 equivalent, coded according to the procedures in Annex A of [ITU-T H.239]. This MBE message uses the BAS code <H.264Submode-message> (see Table 2 of [ITU-T H.230]). The MBE contents are in the format:

{ Start-MBE / N / <H.264Submode-message> / subMessageIdentifier / zero or more message content bytes }

ITU-T H.320-ITU-T H.245 gateways that signal the SetSubmode capability shall translate these messages between the ITU-T H.320 and ITU-T H.245 signalling systems as specified in Annex A of [ITU-T H.239].

Except for ITU-T H.320/ITU-T H.245 gateways, devices that receive **MessageContent** containing an unrecognized **parameterIdentifier** shall ignore such **parameterIdentifiers** and any associated **parameterValues**.

6.2.5.4 SetSubmode messages

Table 6-2 lists all messages defined in the SetSubmode procedure.

Table 6-2 – Set submode procedure messages

subMessageIdentifier	Message name	Message type (for ITU-T H.245)
1	setSubmodeRequest	GenericRequest
2	setSubmodeResponse	GenericResponse
3	setSubmodeIndication	GenericIndication
4	cancelSubmodeRequest	GenericRequest
5	cancelSubmodeResponse	GenericResponse

For each message, the clauses below present a table indicating the message content and syntax. The sequence of **GenericParameters** in the **messageContent** shall be transmitted in the order given in each table. The parameter names given in each table correspond to those in Table 6-2 above. Parameters shall be sent as indicated in the "required presence" column of each table.

6.2.5.5 Generic parameters used in SetSubmode messages

Table 6-3 lists the **GenericParameters** used in all **messageContent** sequences in the SetSubmode messages.

Table 6-3 – Set submode message parameters

Parameter identifier	Parameter name	Parameter type	Parameter value
40	channelID	unsignedMin	Integer (0..65535)
1	par	booleanArray	Integer (0..255)
2	parX	unsignedMin	Integer (0..65535)
41	parY	unsignedMin	Integer (0..65535)
3	sar	unsignedMin	Integer (0..255)
4	sarX	unsignedMin	Integer (0..65535)
42	sarY	unsignedMin	Integer (0..65535)
5	submodeMaxMBPS	unsignedMin	Integer (0..65535)
6	submodeMaxStaticMBPS	unsignedMin	Integer (0..65535)
7	height	unsignedMin	Integer (0..65535)
8	maximumHeight	unsignedMin	Integer (0..65535)
9	minimumHeight	unsignedMin	Integer (0..65535)
128	acknowledge	logical	None
129	reject	logical	None
130	allowAnyHeight	logical	None

6.2.5.5.1 channelID

The channelID parameter shall be the AMC channel ID on ITU-T H.230 systems in Table 9 of [ITU-T H.239]. On ITU-T H.245 systems, it shall be a **logicalChannelNumber**. Intermediary devices such as gateways and MCUs that forward these parameters shall convert the parameter value to the appropriate AMC channel ID or **logicalChannelNumber** for the device to which the message is forwarded.

6.2.5.5.2 par

This value is a Boolean array of picture aspect ratios (PARs). The PAR is the ratio of picture width to picture height, measured in units of distance (not samples).

If bit 2 (value 64) is 1, this indicates a PAR of 4:3.

If bit 3 (value 32) is 1, this indicates a PAR of 16:9.

If bit 4 (value 16) is 1, this indicates a PAR of 5:4.

If bit 5 (value 8) is 1, this indicates a PAR of 16:10.

All other bits are reserved, shall be set to 0, and shall be ignored by receivers.

6.2.5.5.3 parX

The parX parameter is the numerator of a picture aspect ratio (computed as parX/parY). The parX parameter shall be immediately followed by the picture aspect ratio denominator parY. parX is an unsigned integer between 1 and 65535.

6.2.5.5.4 parY

The parY parameter is the denominator of a picture aspect ratio. It is an unsigned integer between 1 and 65535. The values of parX and parY shall be relatively prime.

6.2.5.5.5 sar

The value of this parameter indicates the sample aspect ratio (SAR). The sar is the ratio of sample width to sample height. It shall be the ITU-T H.264 **aspect_ratio_idc** values defined in Table E.1 of [ITU-T H.264], or the value 255.

The value of 255 shall only be used in the setSetmodeIndication message. In that message, it signifies the set of all SARs that may be carried on the video channel.

6.2.5.5.6 sarX

The sarX parameter is the numerator of a sample aspect ratio (computed as sarX/sarY). The sarX parameter shall be immediately followed by the sample aspect ratio denominator sarY. sarX is an unsigned integer between 1 and 65535.

6.2.5.5.7 sarY

The sarY parameter is the denominator of a sample aspect ratio. It is an unsigned integer between 1 and 65535. The values of sarX and sarY shall be relatively prime.

6.2.5.5.8 submodeMaxMBPS

The submodeMaxMBPS parameter is the maximum macroblock processing rate, in units of 500 macroblocks per second.

6.2.5.5.9 submodeMaxStaticMBPS

The submodeMaxStaticMBPS parameter is the static macroblock processing rate, under the assumption that all macroblocks are static macroblocks, in units of 500 macroblocks per second.

6.2.5.5.10 height

This is the height of the picture in samples.

6.2.5.5.11 maximumHeight

This is the largest height of the picture in samples (used in a setSubmodeRequest message).

6.2.5.5.12 minimumHeight

This is the smallest supported picture height in samples (used in a setSubmodeResponse message).

6.2.5.5.13 acknowledge

This parameter, if present, indicates a positive acknowledgment of a request.

6.2.5.5.14 reject

This parameter, if present, indicates a rejection of a request.

6.2.5.5.15 allowAnyHeight

This parameter, if present, indicates that any requested picture height will be positively acknowledged for the specified combination of SARs and PARs.

6.2.5.6 setSubmodeIndication

This message indicates the combinations of SARs and PARs that are available for the ITU-T H.264 video encoding on a specified video channel. These combinations shall be sent as a series of one or more groups, each group comprising a SAR and one or more PARs. The full set of combinations that are available is the union of the combinations of all the groups in the message.

The SAR shall be signalled as either a single sar parameter or as a single sarX, sarY parameter pair. A sar parameter value of 255 in a group shall indicate that all SARs that can be carried on the channel are combined with the PARs for that group.

The PARs shall be signalled as either a single par parameter or as a list of one or more parX, parY parameter pairs. The par parameter may indicate more than one PAR. The omission of par or parX, parY from a group shall indicate that all the SARs in that group are combined with all possible PARs.

The presence of the allowAnyHeight parameter from a group shall indicate that all picture heights that can be carried on the channel are available for each SAR and PAR combination that is included in that group.

The absence of the allowAnyHeight parameter from a group shall indicate that one or more unspecified picture heights are available for each SAR and PAR combination that is included in that group. Those heights may differ for each combination.

When a video channel is opened to a device which signals support for the set submode procedure, the device transmitting the video channel shall send the setSubmodeIndication. The setSubmodeIndication message shall also be sent whenever the available combinations of SARs and PARs change.

On ITU-T H.320 connections, setSubmodeIndication shall be sent periodically.

Table 6-4 – setSubmodeIndication syntax

<table>
<tr><th>GenericParameter order</th><th>Parameter name</th><th colspan="2">Required presence</th></tr>
<tr><td>1</td><td>channelID</td><td colspan="2">Mandatory</td></tr>
<tr><td rowspan="3">2</td><td>sar</td><td rowspan="3">Either one sar or one sarX, sarY shall be present in each group.</td><td rowspan="5">This group of parameters may be present multiple times.</td></tr>
<tr><td>sarX</td></tr>
<tr><td>sarY</td></tr>
<tr><td rowspan="3">3</td><td>par</td><td rowspan="3">Either one par or multiple parX, parY pairs may be present.</td></tr>
<tr><td>parX</td></tr>
<tr><td>parY</td></tr>
<tr><td>4</td><td>allowAnyHeight</td><td>allowAnyHeight may be present in each group.</td></tr>
</table>

6.2.5.6.1 setSubmodeIndication examples (informative)

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

For example:

A setSubmodeIndication contains one group, with sar=255 and allowAnyHeight.

This message indicates that the sender is capable of sending a picture of any size within its capability set with any sample aspect ratio and picture aspect ratio.

For example:

A setSubmodeIndication contains two groups. The first group has sar=1 and allowAnyHeight. The second group has sar=255, par=96.

The first group indicates that the sender is capable of sending pictures with square samples at any PAR and any desired picture height. This is equivalent to saying that the sender is capable of sending pictures with square pixels of any size.

The second group indicates that the sender is capable of sending pictures with any SAR as long as the overall picture aspect ratio is either 4:3 or 16:9. Since allowAnyHeight is not specified, only some picture sizes (perhaps only one size) are available for this group.

A picture with a SAR of 1:1 and an aspect ratio of 4:3 is a member of both groups. Because one of the groups signals allowAnyHeight, such pictures are available at any size.

For example:

A setSubmodeIndication contains 4 groups. The first group has sar=1, par=120 and allowAnyHeight. The second group has sar=2 and par=64. The third group has sar=3 and par=64. The fourth group has sar=7 and par=64.

The first group indicates the ability to send pictures with square samples at picture aspect ratios of 4:3, 16:9, 5:4 or 16:10. These pictures can be sent at any size.

The second group indicates the ability to send pictures with the sample aspect ratio used for PAL with a picture aspect ratio of 4:3. Not all sizes are available, perhaps only QCIF and CIF.

The third group indicates the ability to send pictures with the sample aspect ratio used for NTSC, with a picture aspect ratio of 4:3. Not all sizes are available, perhaps only QSIF and SIF.

The last group indicates the ability to send pictures with the sample aspect ratio used for interlaced NTSC, with a picture aspect ratio of 4:3. Not all sizes are available, perhaps only 352×480.

6.2.5.7 setSubmodeRequest

This message requests that the video encoding on the specified channel be changed to one of the submodes specified in the request.

setSubmodeRequest shall include at least one of the following: SAR, PAR or picture height. It shall include at most one SAR, and at most one PAR, and at most one maximumHeight. It shall not include both maximumHeight and height.

SAR, if present, shall be specified using either the sar parameter or a sarX, sarY pair. The sar parameter shall not signal the value of 255.

PAR, if present, shall be specified using either the par parameter or a parX, parY pair. The par parameter shall only signal one PAR.

The maximumHeight parameter, if present, shall specify that the set of submodes includes all picture heights less than or equal to the value carried by the parameter.

One or more height parameters, if present, shall specify that the set of submodes includes the specific list of picture heights. The picture heights shall be listed in preference order, with the most desired height first.

The submodeMaxMBPS parameter, if present, shall specify that the set of submodes is limited to modes in which the macroblock rate is less than or equal to the maximum number of macroblocks per second carried in the parameter value.

The submodeStaticMaxMBPS parameter, if present, shall specify that the subset of submodes is limited to modes in which the static macroblock rate is less than or equal to the maximum number of static macroblocks per second carried in the parameter value.

Table 6-5 – setSubmodeRequest syntax

GenericParameter order	Parameter name	Required presence
1	channelID	Mandatory
2	sar	Optional Either sar or sarX, sarY may be present.
	sarX	
	sarY	
3	par	Optional Either par or parX, parY may be present.
	parX	
	parY	
4	height	Optional Either one or more height parameters or at most one maximumHeight may be present.
	maximumHeight	
5	submodeMaxMBPS	Optional
6	submodeMaxStaticMBPS	Optional

6.2.5.7.1 setSubmodeRequest examples (informative)

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

For example:

A device sends a setSubmodeRequest with par=64 and maximumHeight of 288.

This request is satisfied by any submode with a picture aspect of 4:3, as long as the picture height does not exceed 288. Common intermediate format (CIF), standard interchange

format (SIF) and quarter common intermediate format (QCIF) (among others) are all acceptable responses.

For example:

A device sends a setSubmodeRequest with par=64, and a height list of 288 and 144.

This request is satisfied by any submode with a picture aspect ratio of 4:3, as long as the picture height is either 288 or 144 samples. CIF and QCIF are both acceptable responses, with CIF being preferred over QCIF.

Since the SAR is omitted, there are other possible responses. For instance, the request is satisfied by a picture with square samples, a picture width of 384 and a picture height of 288.

For example:

A device sends a setSubmodeRequest with sar=1, par=32 and height=720.

This request is only satisfied by a picture with a SAR of 1:1, a PAR of 16:9 and a picture size of 1280×720.

In all cases, if the device receiving the request does not support a submode that satisfies the request, it rejects the request.

6.2.5.8 setSubmodeResponse

The setSubmodeResponse message shall be sent in response to every received setSubmodeRequest message.

The channelID parameter shall carry the same value as the channelID in the associated setSubmodeRequest.

The setSubmodeResponse message shall not carry both the acknowledge and the reject parameter.

6.2.5.8.1 setSubmodeRequest acknowledge

If the receiver of the setSubmodeRequest supports one or more submodes that satisfy the request on the specified channel, the setSubmodeResponse shall include the acknowledge parameter. The receiver shall select a submode from the set specified in the request. The SAR, PAR and picture height of the selected submode shall be sent in the setSubmodeResponse.

An ITU-T H.264 video usability information (VUI) message signalling the SAR of the submode as specified in Annex E of [ITU-T H.264] shall be sent in the video bitstream.

ITU-T H.245 receivers of the setSubmodeRequest should not close and reopen the video logical channel when switching to the new submode.

Terminals may include the acknowledge parameter in their response even if multipoint mode symmetrize (MMS) according to [ITU-T H.243] is in effect, or **multipointModeCommand** according to [ITU-T H.245] is in effect.

6.2.5.8.2 setSubmodeRequest reject

If the receiver of the setSubmodeRequest does not support any submodes that satisfy the request, the setSubmodeResponse shall include the reject parameter. The receiver shall not switch to a different submode.

The response should include some indication of heights that are available with the requested SAR and PAR.

Multiple instances of the height parameter may be present, containing heights that are available with the requested SAR and PAR

If the setSubmodeRequest contained maximumHeight, a single instance of minimumHeight may be present, indicating the smallest available height that is available with the requested SAR and PAR.

A setSubmodeResponse message shall not contain both minimumHeight and height.

Table 6-6 – setSubmodeResponse syntax

GenericParameter order	Parameter name	Required presence
1	channelID	Mandatory
2	acknowledge	Either acknowledge or reject shall be present.
	reject	
3	sar	Either sar or sarX, sarY shall be present if acknowledge is present, and shall contain the selected SAR. sar, sarX and sarY shall not be present if reject is present.
	sarX	
	sarY	
4	par	Either par or parX, parY shall be present if acknowledge is present, and shall contain the selected PAR. par, parX and parY shall not be present if reject is present.
	parX	
	parY	
5	height	If acknowledge is present, a single instance of height parameter shall be present, and shall contain the selected picture height. If reject is present, height or minimumHeight may be present.
	minimumHeight	

6.2.5.8.3 setSubmodeResponse examples (informative)

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

For example:

Device A sends a setSubmodeIndication containing one group, with sar=255 and allowAnyHeight.

The receiver (device B) sends setSubmodeRequest sar=1 and height=480.

Device A determines that the request can be satisfied by sending a 640x480 picture with a SAR of 1:1 and a PAR of 4:3.

Device A sends a setSubmodeReponse of acknowledge, sar=1, par=64, height=480.

For example:

Device A sends a setSubmodeIndication containing two groups. The first group has sar=1 and allowAnyHeight. The second group has sar=255, par=96.

The receiver (device B) sends setSubmodeRequest sar=1 and par=64

Device A determines that the request can be satisfied by sending either a 640×480 or a 1 024×768 picture with a SAR of 1:1 and a PAR of 4:3. Device A chooses to send the 1 024×768 picture.

Device A sends a setSubmodeReponse of acknowledge, sar=1, par=96, height=768.

For example:

Device A sends a setSubmodeIndication containing two groups, one with sar=1 and par=64, the other with sar=2, par=64.

The receiver (device B) sends setSubmodeRequest with sar=2 and par=64 and height=576.

Device A determines that the request cannot be satisfied because the picture size is too large. It supports heights of 288 and 144 for this SAR and PAR combination.

Device A sends a setSubmodeReponse of reject, sar=1, height=288, height=144.

Device B sends a second setSubmodeRequest with sar=2, par=64, height=288.

Device A sends a setSubmodeResponse of acknowledge, sar=2, par=64, height=288.

For example:

Device A sends a setSubmodeIndication containing two groups, one with sar=1, par=64, the other with sar=2, par=64.

The receiver (device B) sends setSubmodeRequest with sar=2, par=64 and maximumHeight=576.

Device A determines that it supports heights of 288 and 144 for this SAR and PAR combination.

Device A sends a setSubmodeResponse of acknowledge, sar=2, par=64, height=288.

6.2.5.9 cancelSubmodeRequest

The cancelSubmodeRequest message indicates that the video encoding on the specified channel may revert to sending any video mode allowed by applicable procedures.

Each received cancelSubmodeRequest shall be acknowledged by a cancelSubmodeResponse.

Table 6-7 – cancelSubmodeRequest syntax

GenericParameter order	Parameter name	Required presence
1	channelID	Mandatory

6.2.5.10 cancelSubmodeResponse

The cancelSubmodeResponse message indicates that the cancelSubmodeRequest message was received.

Table 6-8 – cancelSubmodeResponse syntax

GenericParameter order	Parameter name	Required presence
1	channelID	Mandatory

6.2.6 Set scalable video coding (SVC) mode procedure

This clause defines a procedure that may be used by ITU-T H.245 systems to negotiate the use of a particular ITU-T H.264 SVC scalability mode. Such a scalability mode consists of a particular operation point that is selected by a receiver, and determined after a sender has provided a description of its available scalable encoding structure(s).

The sender provides a description of its scalable video coding structure, including the different available operation points, using the "sprop-scalability-info" parameter as defined in 7.1 of [IETF RFC 6190]. The "sprop-scalability-info" parameter is the base64 encoding of the scalability information SEI message defined in clause G.13.1.1 of [ITU-T H.264].

If the "sprop-scalability-info" is provided by a sender, a receiver can optionally select a particular operation point. If no such selection takes place, then the sender should transmit the full SVC stream.

The use of this procedure in BAS-based systems is for further study.

6.2.6.1 SetSVCmode capability

ITU-T H.245 systems may optionally support the set SVC mode procedure.

In [ITU-T H.245], this capability shall be signalled in a generic capability message, as shown in Table 6-9.

Table 6-9 – ITU-T H.241 set SVC mode capability identifier

Capability name	ITU-T H.241 set SVC mode capability
Capability identifier type	Standard
Capability Class	Video
Capability identifier value	{itu-t(0) recommendation(0) h(8) h241(241) specificVideoCodecCapabilities(0) h264(0) set-SVCmode (3)}
maxBitRate	This field shall not be included.
collapsing	This field shall not be included.
nonCollapsing	This field shall not be included.
nonCollapsingRaw	This field shall not be included.
transport	This field shall not be included.

6.2.6.2 Control and Indication messages

C&I messages are used in this clause to indicate the scalability modes that are supported by the sender of the ITU-T H.264 SVC encoding for that specific encoding, to request a scalability mode of that sender, and to positively or negatively acknowledge such a request.

The C&I messages defined in this clause shall not be used if video sent on the channel associated with the signalled channelID AMC is not encoded with ITU-T H.264 SVC.

All C&I messages defined in this clause shall be carried as follows.

6.2.6.3 Signalling of messages for the set SVC mode procedure

For ITU-T H.245, each message shall consist of a GenericRequest, GenericResponse, or Generic Indication according to Table 6-10 containing GenericMessage.messageIdentifier with the set SVC mode capability OID as defined in Table 6-9, and a subMessageIdentifier. Each particular subMessageIdentifier listed in Table 6-10 has an associated messageContent syntax given in the following clauses.

6.2.6.4 SetSVCmode messages

Table 6-10 lists all messages defined in the SetSVCmode procedure.

Table 6-10 – Set SVCmode procedure messages

subMessageIdentifier	Message name	Message type (for ITU-T H.245)
1	setSVCmodeRequest	GenericRequest
2	setSVCmodeResponse	GenericResponse
3	setSVCmodeIndication	GenericIndication

For each message, the clauses below present a table indicating the message content and syntax. The sequence of GenericParameters in the messageContent shall be transmitted in the order given in each table. The parameter names given in each table correspond to those in Table 6-10 above. Parameters shall be sent as indicated in the "required presence" column of each table.

6.2.6.5 Generic parameters used in SetSVCmode messages

Table 6-11 lists the GenericParameters used in all messageContent sequences in the SetSVCmode messages.

Table 6-11 – Set SVCmode message parameters

Parameter identifier	Parameter name	Parameter type	Parameter value
40	channelID	unsignedMin	Integer (0..65535)
43	SSEI	octetString	
44	layers_not_present	octetString	
45	layer_dependency_change	octetString	
46	scalable_layer_id	unsignedMin	Integer (0..255)

6.2.6.5.1 channelID

On ITU-T H.245 systems, channelID shall be a logicalChannelNumber.

6.2.6.5.2 SSEI

This value shall be identical to the value of the parameter "sprop-scalability-info" as defined in [IETF RFC 6190] (i.e., the base64 encoding of the scalability information SEI message defined in [ITU-T H.264] Annex G). It contains the scalability information SEI message of the ITU-T H.264 SVC video.

6.2.6.5.3 layers_not_present

This value shall be equal to the base64 encoding of the layers_not_present SEI message defined in clause G.13.1.5 of [ITU-T H.264]. This message is used to indicate that NAL units of a particular subset of layers (identified by their layer_id) from the set of layers identified in the associated SSEI are not present in the bitstream.

6.2.6.5.4 layer_dependency_change

This value shall be equal to the base64 encoding of the layer_dependency_change SEI message defined in clause G.13.1.6 of [ITU-T H.264]. This message is used to indicate that the interdependencies between particular scalable layers indicated by the associated SSEI message are changed.

6.2.6.5.5 scalable_layer_id

The scalable_layer_id parameter identifies a particular layer within the data structure provided by the SSEI parameter, and is identical to the "scalable-layer-id" parameter defined in [IETF RFC 6190].

6.2.6.6 setSVCmodeIndication

This message indicates the scalability information for the ITU-T H.264 SVC encoding on a specified video channel. If the sender has suspended transmission of layers of the SVC bitstream, then the optional parameter layers_not_present parameter shall be included as well. If the decoding dependency is different than what is described in the SSEI parameter, then the optional layer_dependency_change parameter shall be included as well.

This message may be transmitted periodically to enable receivers to know the scalability structure after the connection is set up.

Table 6-12– setSVCmodeIndication syntax

GenericParameter order	Parameter name	Required presence
1	channelID	Mandatory
2	SSEI	Mandatory
3	layers_not_present	Optional
4	layer_dependency_change	Optional

6.2.6.7 setSVCmodeRequest

This message requests that scalable layers of the video encoding on the specified channel be changed to the mode specified in the request.

setSVCModeRequest shall include a single scalable_layer_id indication.

The value of the scalable_layer_id parameter shall be equal to one of the layer_id values contained in the SSEI parameter that has been communicated in the associated setSVCmodeIndication message.

The value of the scalable_layer_id parameter shall be equal to one of the layer_id values contained in the SSEI parameter that has been communicated in the associated setSVCmodeIndication message.

Table 6-13– setSVCmodeRequest syntax

GenericParameter order	Parameter name	Required presence
1	channelID	Mandatory
2	scalable_layer_id	Mandatory

6.2.6.8 setSVCmodeResponse

The setSVCmodeResponse message shall be sent in response to every received setSVCmodeRequest message.

The channelID and scalable_layer_id parameters shall carry the same value as the channelID and scalable_layer_id in the associated setSVCRequest.

Table 6-14– setSVCmodeResponse syntax

GenericParameter order	Parameter name	Required presence
1	channelID	Mandatory
2	scalable_layer_id	Mandatory

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

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

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

To be transported in a maximum-length RTP packet according to [ITU-T H.323], ITU-T 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), ITU-T H.264 NAL Units should be substantially shorter than the MTU size of the network. For example, on an Ethernet network with a 1 472 byte MTU, a 1 200 byte NAL Unit allows for addition of considerable header overhead without exceeding the MTU size of the network.

7.1.1 Parameter set transmission

ITU-T H.264 parameter set information shall be transmitted in-band to the ITU-T H.264 video stream (see Note in 7.4.1.2.1 of [ITU-T H.264]).

Terminals sending ITU-T H.264 video shall transmit each sequence or picture parameter set at a time prior to its reference by any ITU-T 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 an ITU-T H.264 slice. The transmission may take place at any time prior to the reference. Ordinarily, many ITU-T H.264 slices will refer to the same parameter set, with the parameter set being sent only once.

7.1.2 Use of ITU-T H.264 in BAS-based systems

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

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

Terminals encoding ITU-T H.264 video may insert fill bits using the fill indicator (Fi) as described in clause 5.4.3 of [ITU-T 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 an ITU-T H.264 decoder's maximum video bitrate (MaxBR) as given in Annex A of [ITU-T H.264].

7.1.3 Transport of ITU-T H.264 streams in ITU-T H.310 systems

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

7.1.4 Transport of ITU-T H.264 streams in ITU-T H.323 systems

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

All ITU-T H.323 systems that support ITU-T H.264 shall support carriage of the ITU-T 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) h241(241) specificVideoCodecCapabilities(0) h264(0) iPpacketization(0) h241AnnexA(0)} and a capability class of Video.

ITU-T H.323 systems that support ITU-T H.264 should also support the non-interleaved mode of [IETF RFC 6184] and may support the interleaved mode of [IETF RFC 6184], in addition to Annex A.

ITU-T H.323 systems that support ITU-T H.264 Annex G profiles shall support the non-interleaved mode of [IETF RFC 6184]. Furthermore, ITU-T H.323 systems that support ITU-T H.264 Annex G profiles shall support carriage of the ITU-T H.264 SVC stream with the single-session transmission mode of [IETF RFC 6190]. The use of the multi-session transmission mode of [IETF RFC 6190] in ITU-T H.323 systems is for further study.

The capability of using the non-interleaved mode of [IETF RFC 6184] shall be signalled by including a MediaPacketizationCapability.rtpPayloadType.payloadDescriptor.oid, with the OID having the value {itu-t(0) recommendation(0) h(8) h241(241) specificVideoCodecCapabilities(0) h264(0) iPpacketization(0) rfc6184NonInterleaved(1)} and a capability class of Video. The capability of using the interleaved mode of [IETF RFC 6184] shall be signalled by including a MediaPacketizationCapability.rtpPayloadType.payloadDescriptor.oid, with the OID having the value {itu-t(0) recommendation(0) h(8) h241(241) specificVideoCodecCapabilities(0) h264(0) iPpacketization(0) rfc6184Interleaved(2)} and a capability class of Video.

NOTE 1 – Since the single NAL unit mode of [IETF RFC 6184] and Annex A are technically identical, the codepoints above permit the use of all packetization modes of [IETF RFC 6184].

A sender which signals one of these packetization modes in its Open Logical Channel message shall transmit video according to the corresponding mode of [IETF RFC 6184] or Annex A.

In the interleaved mode of [IETF RFC 6184], 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 65 536

The explicit signalling of these parameters is for further study.

NOTE 2 – See IETF RFC 6184 section 8.1 for a description of both parameters. The values given are sufficient to support macroblock-line interleaved packetization of video signals with 1 080 lines at 8 Mbit/s. See clause III.2.3.1 of [ITU-T H.263] for a discussion of macroblock-line interleaved packetization.

7.1.5 Transport of ITU-T H.264 streams in ITU-T H.324 systems

In ITU-T H.324 systems, ITU-T 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 of [ITU-T H.264].

ITU-T H.264 encoders shall align the Annex B of ITU-T 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 of [ITU-T H.264] was not required in earlier versions of this Recommendation, and many older systems do not indicate the sample aspect ratio in the ITU-T H.264 video bitstream.

In the absence of an ITU-T H.264 VUI parameter **aspect_ratio_idc** value in the received ITU-T 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 – 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
1 024 × 768 (XGA)	1:1
1 280 × 1 024 (SXGA)	1:1
1 600 × 1 200 (UXGA)	1:1
1 280 × 720 (720 HD)	1:1
1 920 × 1 080 (1080 HD)	1:1
1 920 × 1 088 (1080 HD)	1:1
other	the value which will produce a picture aspect ratio of 4:3

NOTE – All systems which send ITU-T H.264 video should indicate the sample aspect ratio in the VUI parameters specified in Annex E of [ITU-T 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 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 ITU-T H.245 generic parameters in BAS-based systems

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

8.3 ITU-T H.264 capabilities

8.3.1 General

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

The ITU-T H.264 capability set is structured as a list of one or more ITU-T 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 ITU-T H.264 Profiles. The exact syntax and semantics are given in the clauses below. In the case of ITU-T 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 ITU-T H.300-series system may be less than the maximum video bitrate which decoders are required to support by Annex A of [ITU-T H.264]. Terminals are not required to decode video streams which they do not receive.

8.3.1.1 Optional parameters

For each [ITU-T 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 or constraints.

For ITU-T H.264 SVC, the optional parameters are also used to indicate that one of the scalable profiles is used. This is performed via the AdditionalModesSupported parameter as explained below.

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 that the decoder has a higher processing rate capability.
2) CustomMaxFS – If present, indicates that the decoder can decode larger picture (frame) sizes.
3) CustomMaxDPB – If present, indicates that the decoder has additional decoded picture buffer memory.
4) CustomMaxBRandCPB – If present, indicates that 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 that the decoder could process in the hypothetical case that all macroblocks are static macroblocks (see clause 8.3.2.8).
6) max-rcmd-nal-unit-size – If present, indicates in bytes the maximum recommended NAL unit size. Encoders may exceed this size, but inefficiencies or an increased chance of loss due to errors might result (see clause 8.3.2.9).

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

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

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

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

11) MaxFPS – If present, indicates the maximum picture rate that can be efficiently received or the maximum picture rate that can be sent (see clause 8.3.2.14).

If these parameters are present, the signalled values replace the MaxMBPS, MaxFS, MaxDPB, MaxBR, and MaxCPB values, respectively, in Table A.1 of [ITU-T 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 1 024 × 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 H.264] that the **level_idc** syntax element, set by the encoder in the video bitstream, indicate an Annex A of [ITU-T 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 of [ITU-T H.264] that the bitstream fully conforms to.

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

8.3.2 ITU-T H.264 generic capabilities for ITU-T H.245

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

If a terminal has the capability to decode according to more than one ITU-T 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 of [ITU-T H.239].

8.3.2.1 ITU-T H.264 capability identifier

See Table 8-1.

Table 8-1 – ITU-T H.264 capability identifier

Capability name	ITU-T H.241 H.264 Video Capabilities
Capability identifier type	standard
Capability Class	Video
Capability identifier value	{itu-t(0) recommendation(0) h(8) 241 specificVideoCodecCapabilities(0) h264(0) generic-capabilities(1)}

Table 8-1 – ITU-T H.264 capability identifier

maxBitRate	This field shall be included, in units of 100 bit/s. This field represents the maximum bitrate of the ITU-T H.264 Type II bitstream as defined in Annex C of [ITU-T H.264].
collapsing	This field shall contain the ITU-T 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 ITU-T H.264 Profile parameter

See Table 8-2.

Table 8-2 – ITU-T 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 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 ITU-T 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 ITU-T 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 ITU-T 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 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 ITU-T H.264 Level parameter

The Level parameter signals the ITU-T H.264 Level.

Table 8-3 – ITU-T H.264 capability parameter – Level

Parameter name	Level
Parameter description	Signals a value according to Table 8-4, indicating the ITU-T 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 ITU-T H.264 Level number as the ITU-T 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 – Level parameter values

Level parameter value	ITU-T 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
120	5.2

NOTE 1 – Table 8-4 and this parameter description are constructed such that new ITU-T 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 of [ITU-T H.264] are considered as equal to 1 200 bit/s by implementers of [ITU-T H.310], [ITU-T H.320], [ITU-T H.323], and [ITU-T H.324], because these systems transport ITU-T H.264 Type II bitstreams as defined in Annex C of [ITU-T H.264].

8.3.2.4 ITU-T 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 – ITU-T 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 of [ITU-T 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 of [ITU-T 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 ITU-T 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 – ITU-T 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 of [ITU-T 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 of [ITU-T 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 ITU-T 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 value of (CustomMaxDPB × 256/3) macroblocks in its decoded picture buffer.

Table 8-7 – ITU-T H.264 capability parameter – CustomMaxDPB

Parameter name	CustomMaxDPB
Parameter description	CustomMaxDPB is the maximum decoded picture buffer size, in units of 256/3 macroblocks. This optional parameter, when present, shall be considered to replace the MaxDpbMbs value in Table A.1 of [ITU-T H.264] for the signalled Level. The value of (CustomMaxDPB × 256/3) shall not be less than the value (MaxDpbMbs) for the Level given in Table A.1 of [ITU-T 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 ITU-T 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 – ITU-T 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 and 30 000 bit/s for the NAL HRD parameters. NOTE – For transport of ITU-T H.264 bitstreams in ITU-T H.310, ITU-T H.320, ITU-T H.323, and ITU-T H.324 the appropriate video bitrate unit is 30 000 bit/s, because these systems transport Type II ITU-T H.264 bitstreams as defined in Annex C of [ITU-T H.264]. This parameter does not use units of cpbBrVclFactor and cpbBrNALFactor, (see Table A.1 of [ITU-T H.264] and Table A.2 of [ITU-T H.264]). The CPB size shall be derived as equal to the MaxCPB for the signalled Level (see Table A.1 of [ITU-T 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) × 1 000 × 1 000. This optional parameter, when present, shall be considered to replace the MaxBR and MaxCPB values in Table A.1 of [ITU-T 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 of [ITU-T 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 ITU-T 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 ITU-T 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 ITU-T 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 – ITU-T 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 of [ITU-T 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 of [ITU-T 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 of [ITU-T 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 of [ITU-T 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 of [ITU-T 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 ITU-T 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 = 6 000) with a signalled MaxStaticMBPS value of 120 (a processing rate of 60 000 static macroblocks per second) is receiving XGA video (1 024 × 768 luma samples per picture), which contains 3 072 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 / 3 072) / 6 000) + (((3 072 – 4) / 3 072) / 60 000)).

This would permit the encoder to generate the next picture after an interval of 51.8 ms (3 072 / 59 305), corresponding to an instantaneous frame rate of 19.3 Hz (59 305 / 3 072), compared to an interval of 512 ms (3 072 / 6 000), corresponding to an instantaneous frame rate of only 2.0 Hz without the use of MaxStaticMBPS.

8.3.2.8.2 Determination of ITU-T 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:

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

   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 ITU-T 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 – ITU-T 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 ITU-T 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 1 400 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 1 400 bytes.

Table 8-11 – ITU-T 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 ITU-T 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 ITU-T 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 – ITU-T H.264 capability parameter – SampleAspectRatiosSupported

Parameter name	SampleAspectRatiosSupported
Parameter description	The value of this parameter indicates support of sample aspect ratios corresponding to ITU-T 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 of [ITU-T H.264]). This parameter shall not take a value outside the range 1 to 254. NOTE – Support of Table E.1 of ITU-T 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 of [ITU-T H.264] the actual sample aspect ratio in any transmitted ITU-T 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 H.243] is in effect, or **multipointModeCommand** according to [ITU-T 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 end points supports a more limited set of sample aspect ratios than the majority of end points. 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 end points. In such cases, it should be noted that the provisions of clause 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 ITU-T H.264 Profiles. AdditionalModesSupported also permits a terminal to signal that is capable of decoding one or more scalable profiles of ITU-T H.264 SVC.

Table 8-13 – ITU-T 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. If bit 3 (value 32) is 1, this indicates the Scalable Baseline profile as specified in Annex G of [ITU-T H.264]. If bit 4 (value 16) is 1, this indicates the Scalable High profile as specified in Annex G of [ITU-T H.264] . 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 ITU-T 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 of [ITU-T H.239] will produce an extra byte of output to avoid unintentional emulation of the MBE BAS code in [ITU-T 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 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 – ITU-T 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 ITU-T H.264 aspect_ratio_idc value of 255 (Extended_SAR, see Table E.1 of [ITU-T 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 of [ITU-T H.239] will produce an extra byte of output to avoid unintentional emulation of the MBE BAS code in [ITU-T 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.

8.3.2.14 ITU-T H.264 MaxFPS frame rate parameter

The value of this parameter in a receive capability indicates the maximum picture frame rate that the receiver can efficiently handle. Any encoder that understands the parameter semantics shall constrain the frame rate to rates up to that specified. A receiver should have the ability to process video from a sender that does not understand this parameter.

If the parameter is absent, the encoder is free to choose any value for the frame rate that satisfies the other parameters.

When included in an **openLogicalChannel** message or a transmit capability, the value of this parameter indicates the maximum picture rate that shall be sent. For example, when encoding an NTSC 480p source, the value of MaxFPS in the **openLogicalChannel** message would be 5994 (59.94 pictures per second). When encoding an NTSC 480i source, the value of MaxFPS would be 2997 (29.97 pictures per second).

Table 8-14a – ITU-T H.264 capability parameter – MaxFPS

Parameter name	MaxFPS
Parameter description	MaxFPS is the maximum picture rate at which frames should be sent, in units of hundredths of frames per second.
Parameter identifier value	13
Parameter status	Optional
Parameter type	unsignedMin
Supersedes	This field shall not be included

8.3.3 ITU-T H.264 capabilities for BAS-based systems

8.3.3.1 ITU-T H.320 video algorithm hierarchy

The ITU-T H.320 enhanced video algorithm hierarchy in Annex A of [ITU-T H.320] is not extended for ITU-T H.264. No relative level in the hierarchy is specified for ITU-T H.264 with regard to other video codecs.

8.3.3.2 ITU-T H.264 capabilities MBE message format

For ITU-T H.264 operation, the capabilities exchange is handled by a multiple byte extension (MBE) message (see clause 2.2.3 of [ITU-T H.230]). This MBE message uses the type identification byte <H.264> (see Table 2 of [ITU-T H.230]). A terminal shall signal the ITU-T 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 ITU-T H.264 capability MBE bytes B_1 through B_{N-1} may contain one or more encoding or decoding capabilities for ITU-T H.264.

Each capability, which corresponds to a single ITU-T 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 ITU-T H.264 generic capability parameters defined in clause 8.3.2. These pairs are carried in the format given in clause 8.2 above.

Encoder capabilities are for further study.

The first two bytes of each decoder capability within the MBE shall contain the ITU-T H.264 Profile parameter, followed by the ITU-T 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 ITU-T 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 ITU-T 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 – Baseline Profile example MBE

MBE	Value	Description
Byte 1	Start-MBE	Start of MBE. From ITU-T H.230
Byte 2	6	Number of bytes to follow
Byte 3	<H.264>	Indicates ITU-T H.264 MBE. From ITU-T 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 ITU-T 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 – Two Profile example MBE

MBE	Value	Description
Byte 1	Start-MBE	Start of MBE. From ITU-T H.230
Byte 2	10	Number of bytes to follow
Byte 3	<H.264>	Indicates ITU-T H.264 MBE. From ITU-T 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 2 048 macroblock frame size (1 900 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

ITU-T H.264 transport for ITU-T H.323

(This annex forms an integral part of this Recommendation.)

ITU-T H.323 terminals which support the transport of video according to [ITU-T H.264] shall support the single NAL unit mode of [IETF RFC 6184]. ITU-T H.323 terminals which support the transport of video according to ITU-T H.264 Annex G profiles shall support the non-interleaved mode of [IETF RFC 6184] and the single-session transmission mode of [IETF RFC 6190]. ITU-T H.323 terminals may additionally support other modes.

NOTE – The single NAL unit mode of [IETF RFC 6184] is technically identical to the text contained in previous editions of this annex.

Annex B

Reduced-complexity decoding operation (RCDO) for ITU-T H.264 Baseline Profile bitstreams

(This annex forms an integral part of this Recommendation.)

B.1 Scope

This annex specifies a reduced-complexity decoding operation (RCDO) for use with ITU-T H.264 Baseline profile bitstreams. This annex also specifies a bitstream constraint associated with the RCDO, and a mechanism for signalling the 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 ITU-T H.264 bitstream that conforms to clause B.4.

B.2.2 RCDO SEI message: An ITU-T 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 H.264]. The modifications in this annex apply only to bitstreams that obey all constraints specified for the Baseline profile of [ITU-T H.264], in particular including clause A.2.1 of ITU-T H.264 (Baseline profile). For the purposes of Annex A of [ITU-T H.264], the Level requirements are the same for RCDO use as for non-RCDO use of the ITU-T 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 H.264 (profile_idc equal to 66) and to the additional constraint specified below in clause B.4.1; and

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

Table B.1 – 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 H.264], when applicable, shall always be equal to 0.

B.5 OpenLogicalChannel signalling

In an ITU-T 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 clause 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 clause 8.4.2.2 of [ITU-T 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 clause 8.4.2.2 of [ITU-T 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 8-227 through 8-230 of [ITU-T H.264], the following modified equations apply:

$$xInt_C = (xA_L / SubWidthC) + ((mvCLX[0] + (frame\_num \,\&\, 1)) >> 3) + x_C \quad (8\text{-}227)$$

$$yInt_C = (yA_L / SubHeightC) + ((mvCLX[1] + (frame\_num \,\&\, 1)) >> 3) + y_C \quad (8\text{-}228)$$

$$xFrac_C = ((mvCLX[0] + (frame\_num \,\&\, 1)) >> 1) \,\&\, 3 \quad (8\text{-}229)$$

$$yFrac_C = ((mvCLX[1] + (frame\_num \,\&\, 1)) >> 1) \,\&\, 3 \quad (8\text{-}230)$$

2) Referencing 8.4.2.2.1 of [ITU-T 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 8-241, 8-242, 8-245 and 8-246 to define b_1, h_1 and j_1 in [ITU-T H.264] are not needed.
   - Rather than using Equations 8-243, 8-244, 8-247, 8-248, 8-249, 8-254, 8-255, 8-256 and 8-257 of [ITU-T H.264], the following modified equations apply:

$$b = Clip1_Y((E – 5 * F + 20 * G + 20 * H – 5 * I + J + 6) >> 5) \quad (8\text{-}243)$$

$$h = Clip1_Y((– C + 5 * G + 5 * M – R + 1) >> 3) \quad (8\text{-}244)$$

$$j = (H + M) >> 1 \quad (8\text{-}247)$$

$s = Clip1_Y((K – 5 * L + 20 * M + 20 * N – 5 * P + Q + 6) >> 5)$ (8-248)

$m = Clip1_Y((– D + 5 * H + 5 * N – S + 1) >> 3)$ (8-249)

$f = (G + m + 1) >> 1$ (8-254)

$i = (M + b + 1) >> 1$ (8-255)

$k = (H + s + 1) >> 1$ (8-256)

$q = (N + h + 1) >> 1$ (8-257)

3) Referencing 8.4.2.2.2 of [ITU-T H.264], the following modifications apply:

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

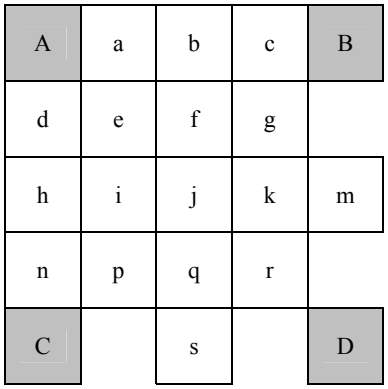


Figure B.1 – Integer sample positions (shaded blocks with upper-case letters) and fractional sample positions (un-shaded blocks with lower-case letters) for quarter sample chroma interpolation

– For further specification of integer and fractional chroma sample positions, Table 8-12 of [ITU-T 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 8-270 of [ITU-T 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 of [ITU-T 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 8-454 of [ITU-T H.264] and 8-455 of [ITU-T 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 8.5.14 of [ITU-T 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 H.264].

Table B.2 – 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.

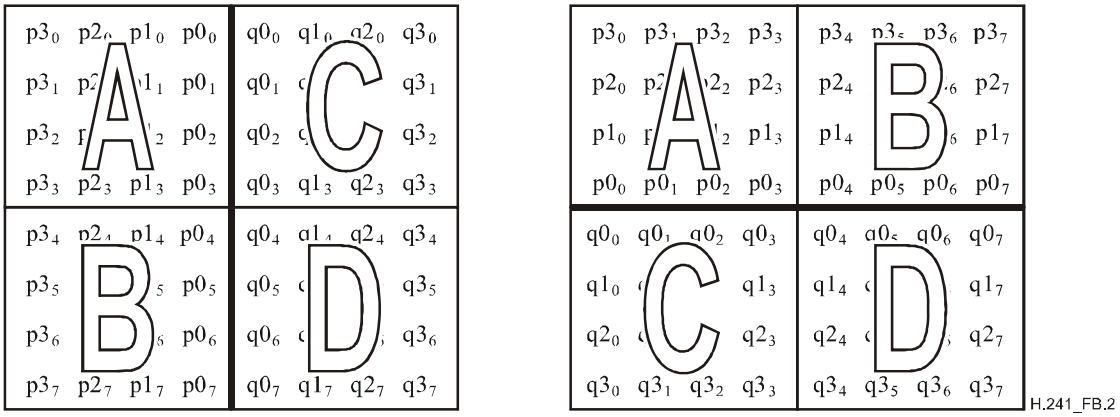
Table B.3 (concluded) – Value of t_C and β as a function of index

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 – 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 blocks B and D belong to different slices.

  • $d \geq \beta$.

  • filterBlockEdge is equal to 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:

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

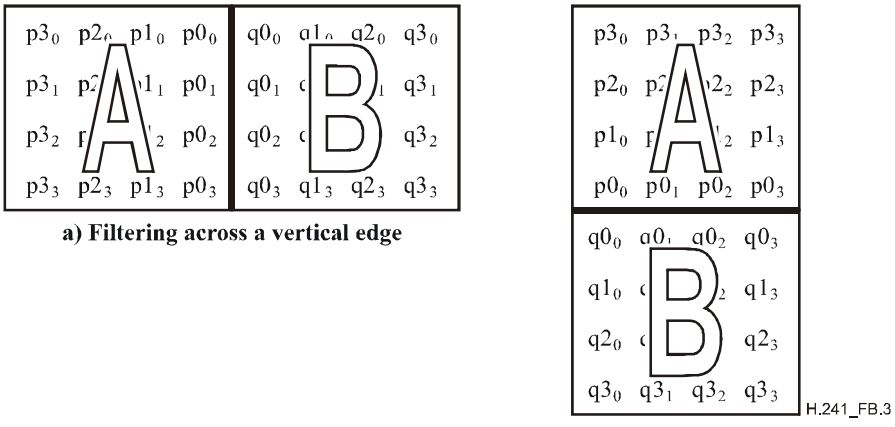
$$q0_i = \text{Clip1}_Y(q0_i - \Delta)$$

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

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

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 – 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

(This appendix does not form an integral part of this Recommendation.)

OID	Clause reference
{itu-t(0) recommendation(0) h(8) h241(241) specificVideoCodecCapabilities(0) h264(0) set-submode(2)}	6.2.5.1
{itu-t(0) recommendation(0) h(8) h241(241) specificVideoCodecCapabilities(0) h264(0) set-SVCmode (3)}	6.2.6.1
{itu-t(0) recommendation(0) h(8) h241(241) specificVideoCodecCapabilities(0) h264(0) iPpacketization(0) h241AnnexA(0)}	7.1.4
{itu-t(0) recommendation(0) h(8) h241(241) specificVideoCodecCapabilities(0) h264(0) iPpacketization(0) rfc6184NonInterleaved(1)}	7.1.4
{itu-t(0) recommendation(0) h(8) h241(241) specificVideoCodecCapabilities(0) h264(0) iPpacketization(0) rfc6184Interleaved(2)}	7.1.4
{itu-t(0) recommendation(0) h(8) h241(241) specificVideoCodecCapabilities(0) h264(0) generic-capabilities(1)}	8.3.2.1

Appendix II

Examples of the set submode procedure

(This appendix does not form an integral part of this Recommendation.)

This appendix provides informative guidance and examples illustrating the use of the set submode procedure defined in clause 6.2.5.

The ITU-T H.264 capabilities defined by clause 8.3 usually allow more than one set of encoding parameters to be used by the video source.

For instance, the capabilities specify the ability to receive a maximum picture size of CustomMaxFS macroblocks. The video source may choose to send any picture height and width combination that does not exceed that total. Although the receiver is required by this Recommendation to be capable of rendering these picture sizes, it is frequently desirable to negotiate further constraints on the picture size. For example, an MCU that can control the picture height and width sent from each terminal can create a more functional picture composition.

There are four common cases where constraining the encoding with the set submode procedure is useful:

– to optimize the picture aspect ratio for a specific display or a sub-picture in a composition
– to limit the picture frame rate to match the frame rate of a specific picture composition
– to eliminate the adverse effects of rescaling on the picture quality
– to improve bandwidth utilization by negotiating a picture size that does not exceed the limits of a display or the size of a sub-picture in a composition.

The use of the set submode procedure is illustrated for each of these cases by the following clauses.

II.1 Optimization of the picture aspect ratio

In this example, the video channel is constrained to carry a picture which has a specific picture aspect ratio. The sample aspect ratio and the picture size are not constrained.

The video source indicates which SAR and PAR combinations can be carried on this video channel in a setSubmodeIndication message.

The video receiver requests a specific PAR which is included in that indication by sending a setSubmodeRequest.

The video source selects an image height and SAR that it can send using the requested PAR.

The video source positively acknowledges the request, including the SAR, PAR and the image height by sending a setSubmodeResponse. It then switches to the new submode, sending the SAR in the ITU-T H.264 VUI message per Table E.1 of [ITU-T H.264].

→ setSubmodeIndication: channelID, list of (SAR, list of (PAR), [allowAnyHeight]

← setSubmodeRequest: channelID, PAR

→ setSubmodeResponse: channelID, acknowledge, SAR, PAR, height

II.2 Limiting the picture frame rate

The setSubmode procedure does not allow the picture frame rate to be directly constrained. However, it does allow macroblocks per second (submodeMaxMBPS) to be limited. Therefore, in order to limit frame rate, the video stream must be constrained to carry a picture of a specific size and also limited to a maximum macroblocks-per-second rate. This results in a constrained picture frame rate.

First, the video source indicates which SAR and PAR combinations can be carried on this video channel by sending a setSubmodeIndication.

The video receiver then requests a specific height, and a submodeMaxMBPS value that achieves the desired frame rate for the requested picture size by sending a setSubmodeRequest. It may also request any specific SAR and PAR combination that is included in the indication message.

The video source positively acknowledges the request by sending a setSubmodeResponse that includes the SAR, PAR and the image height. It then switches to the new submode, sending the SAR in the ITU-T H.264 VUI message per Table E.1 of [ITU-T H.264].

→ setSubmodeIndication: channelID, list of (SAR, list of (PAR), [allowAnyHeight]

← setSubmodeRequest: channelID, SAR, PAR, height, submodeMaxMBPS

→ setSubmodeResponse: channelID, acknowledge, SAR, PAR, height

II.3 Eliminating the adverse effects of picture rescaling

In order to eliminate the adverse effects of scaling, the video channel is constrained to carry a picture of specific PAR, SAR and picture size. Three different examples are presented. The first example describes the case where the video source is capable of re-scaling its image to any requested size. The second and third examples describe cases where the video source does not have this capability.

II.3.1 Video source is capable of arbitrary scaling

The video source first indicates which SAR and PAR combinations can be carried on this video channel by sending a setSubmodeIndication.

The video receiver sends a setSubmodeRequest to request a specific SAR and PAR combination which is included in the indication. Since the selected SAR and PAR include the allowAnyHeight designation, the video receiver also requests a specific height.

The video source positively acknowledges the request by sending a setSubmodeResponse that includes the SAR, PAR and the image height. It then switches to the new submode, sending the SAR in the ITU-T H.264 VUI message per Table E.1 of [ITU-T H.264].

→ setSubmodeIndication: channelID, list of (SAR, list of (PAR), [allowAnyHeight])

← setSubmodeRequest: channelID, SAR, PAR, height (SAR and PAR have allowAnyHeight set)

→ setSubmodeResponse: channelID, acknowledge, SAR, PAR, height

II.3.2 Video source is not capable of arbitrary scaling

The video source first indicates which SAR and PAR combinations can be carried on this video channel by sending a setSubmodeIndication.

The video receiver requests a specific PAR and SAR combination which is included in the indication by sending a setSubmodeRequest. Since the selected PAR and SAR does not include the allowAnyHeight designation, the video receiver offers a list of acceptable heights, in preference order.

The video source selects the first height on the list that it is capable of sending.

The video source then positively acknowledges the request, including the PAR, SAR and the image height in its setSubmodeResponse. It then switches to the new submode, sending the SAR in the ITU-T H.264 VUI message per Table E.1 of [ITU-T H.264].

→ setSubmodeIndication: channelID, list of (SAR, list of (PAR))

← setSubmodeRequest: channelID, SAR, PAR, list of (height)

→ setSubmodeResponse: channelID, acknowledge, SAR, PAR, height

However, if the video source does not find a height in the request that it is capable of sending, it responds with a rejection in its setSubmodeResponse, which includes the list of heights it can send with the requested SAR and PAR combination.

The video receiver then selects one of those specific heights and sends a new setSubmodeRequest.

The video source then positively acknowledges the request, including the PAR, SAR and the image height in its setSubmodeResponse. It then switches to the new submode, sending the SAR in the ITU-T H.264 VUI message per Table E.1 of [ITU-T H.264].

→ setSubmodeIndication: channelID, list of (SAR, list of (PAR))

← setSubmodeRequest: channelID, SAR, PAR, list of (height)

→ setSubmodeResponse: channelID, reject, list of (height) (requested heights were not supported)

← setSubmodeRequest: channelID, SAR, PAR, height

→ setSubmodeResponse: channelID, acknowledge, PAR, SAR, height

II.4 Improving bandwidth utilization by limiting maximum picture size

Reducing the picture size frequently improves the picture quality by reducing compression artefacts. It can also reduce the bandwidth required to send the picture. In this case, it is often useful to further constrain the video channel through the use of flow control.

The video source sends a setSubmodeIndication which indicates which PAR and SAR combinations can be carried on this video channel.

The video receiver then sends a setSubmodeRequest message choosing a specific PAR and SAR combination which is included in the indication, and also the maximum image height.

The video source selects an image height that it is capable of sending that is less than or equal to the maximum.

The video source then positively acknowledges the request, including the PAR, SAR and the image height in its setSubmodeResponse message. The image height is less than the requested maximum height. It then switches to the new submode, sending the SAR in the ITU-T H.264 VUI message per Table E.1 of [ITU-T H.264].

→ setSubmodeIndication: channelID, list of (SAR, list of (PAR))

← setSubmodeRequest: channelID, [SAR], [PAR], maximumHeight

→ setSubmodeResponse: channelID, acknowledge, SAR, PAR, height

If the smallest height that the video source can send exceeds the maximum height requested, the video source rejects the request, including the smallest height it can send in the reject message.

The video receiver then sends a new setSubmodeRequest with a new maximum height that can be accommodated by the video source.

The video source then positively acknowledges the second request, including the PAR, SAR and the image height in its setSubmodeResponse. It then switches to the new submode, sending the SAR in the ITU-T H.264 VUI message per Table E.1 of [ITU-T H.264].

Finally, the video receiver constrains the channel bandwidth using the ITU-T H.245 flowControlCommand

→ setSubmodeIndication: channelID, list of (SAR, list of (PAR))

← setSubmodeRequest channelID, [SAR], [PAR], maximumHeight

→ setSubmodeResponse: channelID, reject, minimumHeight (requested height was too large)

← setSubmodeRequest: channelID, [SAR], [PAR], maximumHeight

→ setSubmodeResponse: channelID, acknowledge, SAR, PAR, height

← flowControlCommand: channelID, maximumBitRate

Bibliography

[b-IETF RFC 4648] IETF RFC 4648 (2006), *The Base16, Base32, and Base64 Data Encodings*.

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