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Abstract

This document provides requirements for a video codec designed
mainly for use over the Internet. In addition, this document
describes an evaluation methodology needed for measuring the
compression efficiency to ensure whether the stated requirements are
fulfilled or not.

Table of Contents

1. Introduction

   In this document, the requirements for a video codec designed mainly
   for use over the Internet are presented. The requirements encompass
   a wide range of applications that use data transmission over the
   Internet including Internet video streaming, IPTV, peer-to-peer
   video conferencing, video sharing, screencasting, game streaming and
   video monitoring / surveillance. For each application, typical
   resolutions, frame-rates and picture access modes are presented.
   Specific requirements related to data transmission over packet-loss
   networks are considered as well. In this document, when we discuss
   data protection techniques we only refer to methods designed and
   implemented to protect data inside the video codec since there are
   many existing techniques that protect generic data transmitted over
   packet-loss networks. From the theoretical point of view, both
   packet-loss and bit-error robustness can be beneficial for video
   codecs. In practice, packet losses are a more significant problem
   than bit corruption in IP networks. It is worth noting that there is
   an evident interdependence between possible amount of delay and the
   necessity of error robust video streams:

   o   If an amount of delay is not crucial for an application, then
       reliable transport protocols such as TCP that resends undelivered
       packets can be used to guarantee correct decoding of transmitted
       data.

   o   If the amount of delay must be kept low, then either data
       transmission should be error free (e.g., by using managed
       networks) or compressed video stream should be error resilient.

   Thus, error resilience can be useful for delay-critical applications
   to provide low delay in packet-loss environment.

2. Applications

   In this chapter, an overview of video codec applications that are
   currently available on the Internet market is presented. It is worth
   noting that there are different use cases for each application that
   define a target platform, and hence there are different types of
   communication channels involved (e.g., wired or wireless channels)
   that are characterized by different quality of service as well as
   bandwidth; for instance, wired channels are considerably more error-
   free than wireless channels and therefore require different QoS
   approaches. The target platform, the channel bandwidth and the
   channel quality determine resolutions, frame-rates and quality or
   bit-rates for video streams to be encoded or decoded. By default,

color format YCbCr 4:2:0 is assumed for the application scenarios
listed below.

2.1. Internet Video Streaming

Typical content for this application is movies, TV-series and shows,
and animation. Internet video streaming uses a variety of client
devices and has to operate under changing network conditions. For
this reason, an adaptive streaming model has been widely adopted.
Video material is encoded at different quality levels and different
resolutions, which are then chosen by a client depending on its
capabilities and current network bandwidth. An example combination
of resolutions and bitrates is shown in a Table 1 below.

Resolution *	Frame-rate, fps	PAM
4K, 3840x2160	24/1.001, 24, 25,	RA
2K (1080p), 1920x1080	30/1.001, 30, 50,	RA
1080i, 1920x1080*	60/1.001, 60, 100,	RA
720p, 1280x720	120/1.001, 120	RA
576p (EDTV), 720x576	The set of frame-rates	RA
576i (SDTV), 720x576*	presented in this table	RA
480p (EDTV), 720x480	is taken from Table 2	RA
480i (SDTV), 720x480*	in [1]	RA
512x384		RA
QVGA, 320x240		RA

Table 1. Internet Video Streaming: typical values of resolutions,
frame-rates, and RAPs

NB *: Interlaced content can be handled at the higher system level
and not necessarily by using specialized video coding tools. It is
included in this table only for the sake of completeness as most
video content today is in progressive format.

A video encoding pipeline in on-demand Internet video streaming typically operates as follows:

o Video is encoded in the cloud by software encoders.

o Source video is split into chunks, each of which is encoded separately, in parallel.

o Closed-GOP encoding with 2-5 second intra-picture intervals (or more) is used.

o Encoding is perceptually optimized. Perceptual quality is important and should be considered during the codec development.

Characteristics and requirements of this application scenario are as follows:

o High encoder complexity (up to 10x and more) can be tolerated since encoding happens once and in parallel for different segments.

o Decoding complexity should be kept at reasonable levels to enable efficient decoder implementation.

o Support and efficient encoding of a wide range of content types and formats is required:

   o High Dynamic Range (HDR), Wide Color Gamut (WCG), high resolution (currently, up to 4K), high frame-rate content are important use cases, the codec should be able to encode such content efficiently.

   o Coding efficiency improvement at both lower and higher resolutions is important since low resolutions are used when streaming in low bandwidth conditions.

   o Improvement on both "easy" and "difficult" content in terms of compression efficiency at the same quality level contributes to the overall bitrate/storage savings.

   o Film grain (and sometimes other types of noise) is often present in the streaming movie-type content and is usually a part of the creative intent.

o Significant improvements in compression efficiency between generations of video standards are desirable since this scenario typically assumes long-term support of legacy video codecs.

   o Random access points are inserted frequently (one per 2-5
      seconds) to enable switching between resolutions and fast-forward
      playback.

   o Elementary stream should have a model that allows easy parsing
      and identification of the sample components.

   o Middle QP values are normally used in streaming, this is also the
      range where compression efficiency is important for this
      scenario.

   • Scalability or other forms of supporting multiple quality
      representations are beneficial if they do not incur significant
      bitrate overhead and if mandated in the first version.

2.2. Internet Protocol Television (IPTV)

   This is a service for delivering television content over IP-based
   networks. IPTV may be classified into two main groups based on the
   type of delivery, as follows:

   o unicast (e.g., for video on demand), where delay is not crucial;

   o multicast/broadcast (e.g., for transmitting news) where zapping,
      i.e. stream changing, delay is important.

   In the IPTV scenario, traffic is transmitted over managed (QoS-
   based) networks. Typical content used in this application is news,
   movies, cartoons, series, TV shows, etc. One important requirement
   for both groups is Random access to pictures, i.e. random access
   period (RAP) should be kept small enough (approximately, 1-5
   seconds). Optional requirements are as follows:

   o Temporal (frame-rate) scalability;

   o Resolution and quality (SNR) scalability.

   For this application, typical values of resolutions, frame-rates,
   and RAPs are presented in Table 2.

   +----------------------+------------------------+----------------+
   | Resolution * | Frame-rate, fps | PAM |
   +----------------------+------------------------+----------------+
   +----------------------+------------------------+----------------+
   | 2160p (4K),3840x2160 | 24/1.001, 24, 25, | RA |

Resolution	Frame-rate	RAP
1080p, 1920x1080	30/1.001, 30, 50,	RA
1080i, 1920x1080*	60/1.001, 60, 100,	RA
720p, 1280x720	120/1.001, 120	RA
576p (EDTV), 720x576	The set of frame-rates	RA
576i (SDTV), 720x576*	presented in this table	RA
480p (EDTV), 720x480	is taken from Table 2	RA
480i (SDTV), 720x480*	in [1]	RA

Table 2. IPTV: typical values of resolutions, frame-rates, and RAPs

NB *: Interlaced content can be handled at the higher system level
and not necessarily by using specialized video coding tools. It is
included in this table only for the sake of completeness as most
video content today is in progressive format.

2.3. Video conferencing

This is a form of video connection over the Internet. This form
allows users to establish connections to two or more people by two-
way video and audio transmission for communication in real-time. For
this application, both stationary and mobile devices can be used.
The main requirements are as follows:

o Delay should be kept as low as possible (the preferable and
   maximum end-to-end delay values should be less than 100 ms [7]
   and 320 ms [2], respectively);

o Temporal (frame-rate) scalability;

o Error robustness.

Support of resolution and quality (SNR) scalability is highly
desirable. For this application, typical values of resolutions,
frame-rates, and RAPs are presented in Table 3.

Resolution	Frame-rate, fps	PAM
1080p, 1920x1080	15, 30	FIZD

Resolution	Frame-rate, fps	RAP
720p, 1280x720	30, 60	FIZD
4CIF, 704x576	30, 60	FIZD
4SIF, 704x480	30, 60	FIZD
VGA, 640x480	30, 60	FIZD
360p, 640x360	30, 60	FIZD

Table 3. Video conferencing: typical values of resolutions, frame-rates, and RAPs

2.4. Video sharing

This is a service that allows people to upload and share video data (using live streaming or not) and to watch them. It is also known as video hosting. A typical User-generated Content (UGC) scenario for this application is to capture video using mobile cameras such as GoPro or cameras integrated into smartphones (amateur video). The main requirements are as follows:

o Random access to pictures for downloaded video data;

o Temporal (frame-rate) scalability;

o Error robustness.

Support of resolution and quality (SNR) scalability is highly desirable. For this application, typical values of resolutions, frame-rates, and RAPs are presented in Table 4.

Resolution	Frame-rate, fps	PAM
2160p (4K),3840x2160	24, 25, 30, 48, 50, 60	RA
1440p (2K),2560x1440	24, 25, 30, 48, 50, 60	RA
1080p, 1920x1080	24, 25, 30, 48, 50, 60	RA
720p, 1280x720	24, 25, 30, 48, 50, 60	RA
480p, 854x480	24, 25, 30, 48, 50, 60	RA

```
+-----------------------+-------------------------+----------------+
| 360p, 640x360         | 24, 25, 30, 48, 50, 60 |       RA       |
+-----------------------+-------------------------+----------------+
```
Table 4. Video sharing: typical values of resolutions, frame-rates
[8], and RAPs

2.5. Screencasting

   This is a service that allows users to record and distribute
   computer desktop screen output. This service requires efficient
   compression of computer-generated content with high visual quality
   (up to visually and mathematically lossless) [9]. Currently, this
   application includes business presentations (powerpoint, word
   documents, email messages, etc.), animation (cartoons), gaming
   content, data visualization, i.e. such type of content that is
   characterized by fast motion, rotation, smooth shade, 3D effect,
   highly saturated colors with full resolution, clear textures and
   sharp edges with distinct colors [9]), virtual desktop
   infrastructure (VDI), screen/desktop sharing and collaboration,
   supervisory control and data acquisition (SCADA) display,
   automotive/navigation display, cloud gaming, factory automation
   display, wireless display, display wall, digital operating room
   (DiOR), etc. For this application, an important requirement is the
   support of a wide range of video formats (e.g., RGB) in addition to
   YCbCr 4:2:0 and YCbCr 4:4:4 [9]. For this application, typical
   values of resolutions, frame-rates, and RAPs are presented in
   Table 5.

Resolution	Frame-rate, fps	PAM
Input color format: RGB 4:4:4		
5k, 5120x2880	15, 30, 60	AI, RA, FIZD
4k, 3840x2160	15, 30, 60	AI, RA, FIZD
WQXGA, 2560x1600	15, 30, 60	AI, RA, FIZD
WUXGA, 1920x1200	15, 30, 60	AI, RA, FIZD
WSXGA+, 1680x1050	15, 30, 60	AI, RA, FIZD
WXGA, 1280x800	15, 30, 60	AI, RA, FIZD
XGA, 1024x768	15, 30, 60	AI, RA, FIZD

SVGA, 800x600	15, 30, 60	AI, RA, FIZD
VGA, 640x480	15, 30, 60	AI, RA, FIZD
Input color format: YCbCr 4:4:4		
5k, 5120x2880	15, 30, 60	AI, RA, FIZD
4k, 3840x2160	15, 30, 60	AI, RA, FIZD
1440p (2K), 2560x1440	15, 30, 60	AI, RA, FIZD
1080p, 1920x1080	15, 30, 60	AI, RA, FIZD
720p, 1280x720	15, 30, 60	AI, RA, FIZD

Table 5. Screencasting for RGB and YCbCr 4:4:4 format: typical values of resolutions, frame-rates, and RAPs

2.6. Game streaming

This is a service that provides game content over the Internet to different local devices such as notebooks, gaming tablets, etc. In this category of applications, server renders 3D games in cloud server, and streams the game to any device with a wired or wireless broadband connection [10]. There are low latency requirements for transmitting user interactions and receiving game data in less than a turn-around delay of 100 ms. This allows anyone to play (or resume) full featured games from anywhere in the Internet [10]. An example of this application is Nvidia Grid [10]. Another category application is broadcast of video games played by people over the Internet in real time or for later viewing [10]. There are many companies such as Twitch, YY in China enable game broadcasting [10]. Games typically contain a lot of sharp edges and large motion [10]. The main requirements are as follows:

o Random access to pictures for game broadcasting;

o Temporal (frame-rate) scalability;

o Error robustness.

Support of resolution and quality (SNR) scalability is highly desirable. For this application, typical values of resolutions, frame-rates, and RAPs are similar to ones presented in Table 5.

2.7. Video monitoring / surveillance

   This is a type of live broadcasting over IP-based networks. Video
   streams are sent to many receivers at the same time. A new receiver
   may connect to the stream at an arbitrary moment, so random access
   period should be kept small enough (approximately, ~1-5 seconds).
   Data are transmitted publicly in the case of video monitoring and
   privately in the case of video surveillance, respectively. For IP-
   cameras that have to capture, process and encode video data,
   complexity including computational and hardware complexity as well
   as memory bandwidth should be kept low to allow real-time
   processing. In addition, support of high dynamic range and a
   monochrome mode (e.g., for infrared cameras) as well as resolution
   and quality (SNR) scalability is an essential requirement for video
   surveillance. For this application, typical values of resolutions,
   frame-rates, and RAPs are presented in Table 6.

Resolution	Frame-rate, fps	PAM
2160p (4K),3840x2160	12	RA, FIZD
5Mpixels, 2560x1920	12	RA, FIZD
1080p, 1920x1080	25	RA, FIZD
1.3Mpixels, 1280x960	25, 30	RA, FIZD
720p, 1280x720	25, 30	RA, FIZD
SVGA, 800x600	25, 30	RA, FIZD

Table 6. Video monitoring / surveillance: typical values of
resolutions, frame-rates, and RAPs

3. Requirements

   Taking the requirements discussed above for specific video
   applications, this chapter proposes requirements for an internet
   video codec.

3.1. General requirements

   3.1.1. The most basic requirement is coding efficiency, i.e.
   compression performance. It should provide higher coding efficiency
   over state-of-the-art video codecs such as HEVC/H.265 and VP9, at

least by 20-25% in accordance with the methodology described in Section 4.1 of this document. For higher resolutions, the coding efficiency is expected to be higher than for lower resolutions.

3.1.2. Good quality specification and well-defined profiles and levels are required to enable device interoperability and facilitate decoder implementations. An example of codec levels to be supported is presented in Table 7.

Level	Example picture resolution at highest frame rate
1	128x96(12,288*)@30.0 176x144(25,344*)@15.0
2	352x288(101,376*)@30.0
3	352x288(101,376*)@60.0 640x360(230,400*)@30.0
4	640x360(230,400*)@60.0 960x540(518,400*)@30.0
5	720x576(414,720*)@75.0 960x540(518,400*)@60.0 1280x720(921,600*)@30.0
6	1,280x720(921,600*)@68.0 2,048x1,080(2,211,840*)@30.0
7	1,280x720(921,600*)@120.0 2,048x1,080(2,211,840*)@60.0
8	1,920x1,080(2,073,600*)@120.0 3,840x2,160(8,294,400*)@30.0 4,096x2,160(8,847,360*)@30.0
9	1,920x1,080(2,073,600*)@250.0 4,096x2,160(8,847,360*)@60.0
10	1,920x1,080(2,073,600*)@300.0 4,096x2,160(8,847,360*)@120.0
11	3,840x2,160(8,294,400*)@120.0 8,192x4,320(35,389,440*)@30.0
	3,840x2,160(8,294,400*)@250.0

```
|     12      |            8,192x4,320(35,389,440*)@60.0           |
+-------------+---------------------------------------------------+
|             |            3,840x2,160(8,294,400*)@300.0           |
|     13      |            8,192x4,320(35,389,440*)@120.0          |
+-------------+---------------------------------------------------+
```
Table 7. Codec levels

NB *: The quantities of pixels are presented for such applications where a picture can have an arbitrary size (e.g., screencasting)

3.1.3. High-level syntax should allow extensibility, so that new features can be supported easily by using metadata (e.g., such as SEI messages, VUI, headers).

3.1.4. Any elementary stream should have a model that allows easy parsing and identification of the sample components (such as ISO/IEC14496-10, Annex B or ISO/IEC 14496-15).

3.1.5. Perceptual quality tools (such as adaptive QP and quantization matrices) should be supported by the codec bit-stream.

3.1.6. The codec specification shall define a buffer model, such as hypothetical reference decoder (HRD).

3.1.7. Specifications providing integration with system and delivery layers should be developed.

3.2. Basic requirements

3.2.1. Input source formats:

o Bit depth: 8- and 10-bits (up to 12-bits for a high profile) per color component;

o Color sampling formats:

   o YCbCr 4:2:0;

   o YCbCr 4:4:4, YCbCr 4:2:2 and YCbCr 4:0:0 (preferably in different profile(s)).

o For profiles with bit depth of 10 bits per sample or higher, support of high dynamic range and wide color gamut.

o Support of arbitrary resolution for such applications where a picture can have an arbitrary size (e.g., in screencasting)

3.2.2. Coding delay:

o   Support of configurations with zero structural delay also
    referred to as "low-delay" configurations.

        o Note 1: end-to-end delay should be up to 320 ms [2] but it's
          preferable value should be less than 100 ms [7]

o   Support of configurations with non-zero structural delay (such as
    out-of-order or multi-pass encoding) for applications without
    low-delay requirements if such configurations provide additional
    compression efficiency improvements.

3.2.3. Complexity:

o   Feasible real-time implementation of both an encoder and a
    decoder supporting a chosen subset of tools for hardware and
    software implementation on a wide range of state-of-the-art
    platforms. The real-time encoder tools subset should provide
    sufficient improvement in compression efficiency and take into
    account complexity of hardware and software encoder
    implementations.

o   High-complexity software encoder implementations used by offline
    encoding applications can have 10x or more complexity increase
    compared to state-of-the-art video compression technologies such
    as HEVC/H.265 and VP9.

3.2.4. Scalability:

o   Temporal (frame-rate) scalability should be supported.

3.2.5. Error resilience:

o   Error resilience tools that are complementary to the error
    protection mechanisms implemented on transport level should be
    supported.

o   The codec should support mechanisms that facilitate packetization
    of a bitstream for common network protocols.

o   Packetization mechanisms should enable frame-level error recovery
    by means of retransmission or error concealment.

3.3. Optional requirements

   3.3.1. Input source formats

   o Bit depth: up to 16-bits per color component;

   o Color sampling formats: RGB 4:4:4.

   o Auxiliary channel (e.g., alpha channel) support.

   3.3.2. Scalability:

   o Resolution and quality (SNR) scalability that provide low
      compression efficiency penalty (up to 5% of BD-rate [12] increase
      per layer with reasonable increase of both computational and
      hardware complexity) can be supported in the main profile of the
      codec being developed by the NETVC WG. Otherwise, a separate
      profile is needed to support these types of scalability.

   o Computational complexity scalability(i.e. computational
      complexity is decreasing along with degrading picture quality) is
      desirable.

   3.3.3. Complexity:

   Tools that enable parallel processing (e.g., slices, tiles, wave
   front propagation processing) at both encoder and decoder sides are
   highly desirable for many applications.

   o High-level multi-core parallelism: encoder and decoder operation,
      especially entropy encoding and decoding, should allow multiple
      frames or sub-frame regions (e.g. 1D slices, 2D tiles, or
      partitions) to be processed concurrently, either independently or
      with deterministic dependencies that can be efficiently pipelined

   o Low-level instruction set parallelism: favor algorithms that are
      SIMD/GPU friendly over inherently serial algorithms

4. Evaluation methodology

4.1. Compression performance evaluation

   As shown in Fig.1, compression performance testing is performed in 3
   ranges that encompass 12 different bit-rate values:

   o Low bit-rate range (LBR) is the range that contains the 4 lowest
      bit-rates of the 12 specified bit-rates;

o Medium bit-rate range (MBR) is the range that contains the 4
   medium bit-rates of the 12 specified bit-rates;

o High bit-rate range (HBR) is the range that contains the 4
   highest bit-rates of the 12 specified bit-rates.

To avoid any rate control mechanisms that can significantly impact
evaluation results, just nominal values of bit-rates should be
specified in a separate document on Internet video codec testing.
The deviation between nominal and actual values of bit-rates
obtained for both reference and tested codecs should be less than
the threshold value defined in the above-mention document on
Internet video codec testing. This deviation is calculated as
follows:

$$D = abs((BRa - BRn)/ BRn)*100\%,$$

where BRn is a nominal value of bit-rate, BRa is an actual value of
bit-rate obtained for either reference or tested codecs.

```
                                                      Bit-rate
    ---------------------------------------------------------------->
    BR0   BR1    BR2   BR3   BR4   BR5   BR6   BR7   BR8  BR9  BR10  BR11
     ^                        ^     ^                 ^    ^          ^
     |------LBR------|        |------MBR------|       |------HBR------|
```
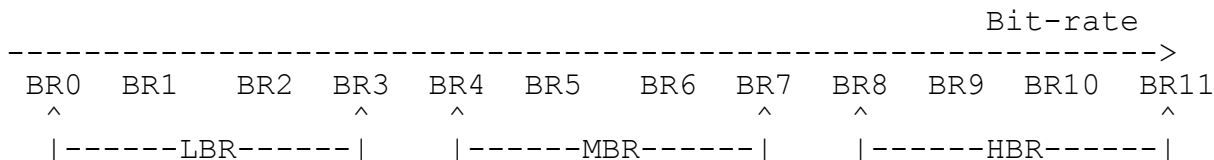
Figure 1 Bit-rate ranges for the CBR mode

To assess the quality of output (decoded) sequences, two indexes,
PSNR [3] and MS-SSIM [3,11], should be separately calculated for
each color plane. For obtaining an integral estimation, BD-rate [12]
should be computed for each range and each quality index. Finally,
18 values should be obtained for a color format, which contains 3
color planes (e.g., for YCbCr or RGB). A list of video sequences
that should be used for testing as well as the 6 values of bit-rates
are defined in a separate document. Testing processes should use the
information on the codec applications presented in this document. As
the reference for evaluation, the HEVC/H.265 codec [4,5] must be
used. The reference source code of the HEVC/H.265 codec can be found
at [6]. The HEVC/H.265 codec must be configured according to [13]
and Table 8.

Intra-period, second	HEVC/H.265 encoding mode according to [13]
AI	Intra Main or Intra Main10

RA	Random access Main or Random access Main10
JIZD	Low delay Main or Low delay Main10

Table 8. Intra-periods for different HEVC/H.265 encoding modes according to [13]

In addition to the objective quality measures defined above, subjective evaluation must also be performed before adopting any new tool and a final codec standard. For subjective tests, the MOS-based evaluation procedure must be used as described in section 2.1 of [3]. For perception-oriented tools that primarily impact subjective quality, additional tests may also be individually assigned even for intermediate evaluation, subject to a decision of the NETVC WG.

4.2. Reference software

Reference software provided to the NETVC WG for candidate codecs should comprise a fully operational encoder supporting necessary rate controls, subjective quality optimization features and some degree of speed optimization and a "real-time" decoder.

5. Security Considerations

This document itself does not address any security considerations. However, it is worth noting that a codec implementation (for both an encoder and a decoder) should cover the worst case of computational complexity, memory bandwidth, and physical memory size (e.g., for decoded pictures used as references). Otherwise, it can be considered as a security vulnerability and lead to denial-of-service (DoS) in the case of attacks.

6. Conclusions

In this document, an overview of Internet video codec applications and typical use cases as well as a prioritized list of requirements for an Internet video codec are presented. An evaluation methodology for this codec is also proposed.

7. References

7.1. Normative References

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Appendix A. Abbreviations used in the text of this document

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| Abbreviation |                      Meaning                      |
+-------------+----------------------------------------------------+
|      AI      | All-Intra (each picture is intra-coded)           |
|   BD-Rate    | Bjontegaard Delta Rate                            |
|     GOP      | Group of Picture                                  |
|     HBR      | High Bit-rate Range                               |
|     HDR      | High Dynamic Range                                |
|     HRD      | Hypothetical Reference Decoder                    |
|     PAM      | Picture Access Mode                               |
|      RA      | Random Access                                     |
|     RAP      | Random Access Period                              |
|     IPTV     | Internet Protocol Television                      |
|     FIZD     | just the First picture is Intra-coded, Zero       |
|              | structural Delay                                  |
|     LBR      | Low Bit-rate Range                                |
|     MBR      | Medium Bit-rate Range                             |
|     MOS      | Mean Opinion Score                                |
|   MS-SSIM    | Multi-Scale Structural Similarity quality index   |
|     OTT      | Over-The-Top                                       |
|     PSNR     | Peak Signal-to-Noise Ratio                        |
|     QoS      | Quality of Service                                |
|      QP      | Quantization Parameter                            |
|     SEI      | Supplemental Enhancement Information               |
|     UGC      | User-Generated Content                            |
|     VDI      | Virtual Desktop Infrastructure                    |
|     VUI      | Video Usability Information                        |
|     WCG      | Wide Color Gamut                                  |
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```

Appendix B. Used terms

Term	Meaning
High dynamic range imaging	is a set of techniques that allow a greater dynamic range of exposures or values (i.e., a wide range of values between light and dark areas) than normal digital imaging techniques. The intention is to accurately represent the wide range of intensity levels found in such examples as exterior scenes that include light-colored items struck by direct sunlight and areas of deep shadow [14].
Random access period	is the period of time between two closest independently decodable frames (pictures).
Visually lossless compression	is a form or manner of lossy compression where the data that are lost after the file is compressed and decompressed is not detectable to the eye; the compressed data appearing identical to the uncompressed data [14].
Wide color gamut	is a certain complete color subset (e.g., considered in ITU-R BT.2020) that supports a wider range of colors (i.e., an extended range of colors that can be generated by a specific input or output device such as a video camera, monitor or printer and can be interpreted by a color model) than conventional color gamuts (e.g., considered in ITU-R BT.601 or BT.709).

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