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**Abstract**

This document provides the common test conditions (CTCs) to be used in the core experiments (CEs) and exploration experiments (EEs) of lenslet video coding (LVC) to be conducted after the 151st MPEG meeting.

1. **Introduction**

This document defines common test conditions for core experiments (CEs) [1] and exploration experiments (EEs) [2] of lenslet video coding (LVC). Input contributions should include a set of results as complete as possible, applicable to the proposal. Results should be reported using the attached Excel sheets.

1. **Paradigm**

According to the requirements for LVC, the LVC activities are foreseen to be followed in two phases. This is the first phase, where the focus will be on the technologies, namely Codec Agnostic LVC Tools (hereafter LVC tools), compatible with Versatile Video Coding (VVC) [3]. These technologies achieve higher compression efficiency for lenslet video and ensure that at least a sub-bitstream remains decodable by the VVC decoder. The encoding and decoding process for LVC is described in Figure 1.

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Figure 1. Common test procedure for lenslet video coding in phase one.

Note: The input lenslet video can be either captured by plenoptic 1.0 or 2.0 cameras, or synthetically generated from the content captured by camera array.

1. **Test Sequences**

Nine sequencesare included in the CTC, listed in Table 1. All test sequences are available in the MPEG Content repository accessible under the following URLs (MPEG password is required). Some sample central views are shown in Annex B.

Table 1. Sequence Specifications and Download Links

| Sequence name | Resolution | Frames | Frame rate | Chroma format | Bit depth | Download Links |
| --- | --- | --- | --- | --- | --- | --- |
| Origami | 2048×2048 | 0-299 | 30 | 4:2:0 | 8 | https://content.mpeg.expert/data/CfP/LVC/Sequences/Origami.zip |
| Fujita2 | 2048×2048 | 0-299 | 30 | 4:2:0 | 8 | https://content.mpeg.expert/data/CfP/LVC/Sequences/Fujita2.zip |
| TempleBoatGiantR32 | 6464×4852 | 0-299 | 30 | 4:2:0 | 8 | https://content.mpeg.expert/data/CfP/LVC/Sequences/TempleBoatGiantR32.zip |
| Boxer-IrishMan-Gladiator2 | 3840×2160 | 0-299 | 30 | 4:2:0 | 8 | https://content.mpeg.expert/data/CfP/LVC/Sequences/Boxer-IrishMan-Gladiator2.zip |
| Boys2 | 3976×2956 | 0-299 | 30 | 4:2:0 | 8 | [https://content.mpeg.expert/data/CfP/LVC/Sequences/Boys2.zip](https://content.mpeg.expert/data/CfP/LVC/LVC_test_sequences_CFP/Boys2.zip) |
| Matryoshka | 4040×3064 | 0-299 | 30 | 4:2:0 | 8 | https://content.mpeg.expert/data/CfP/LVC/Sequences/Matryoshka.zip |
| Motherboard2 | 4036×3064 | 0-299 | 30 | 4:2:0 | 8 | https://content.mpeg.expert/data/CfP/LVC/Sequences/Motherboard2.zip |
| HandTools | 4036×3064 | 0-299 | 30 | 4:2:0 | 8 | https://content.mpeg.expert/data/CfP/LVC/Sequences/HandTools.zip |
| MiniGarden2 | 4036×3064 | 0-299 | 30 | 4:2:0 | 8 | https://content.mpeg.expert/data/CfP/LVC/Sequences/MiniGarden2.zip |

Note: Downloaded test material should be verified with MD5 checksums (<https://content.mpeg.expert/data/CfP/LVC/Sequences/Readme.pdf>).

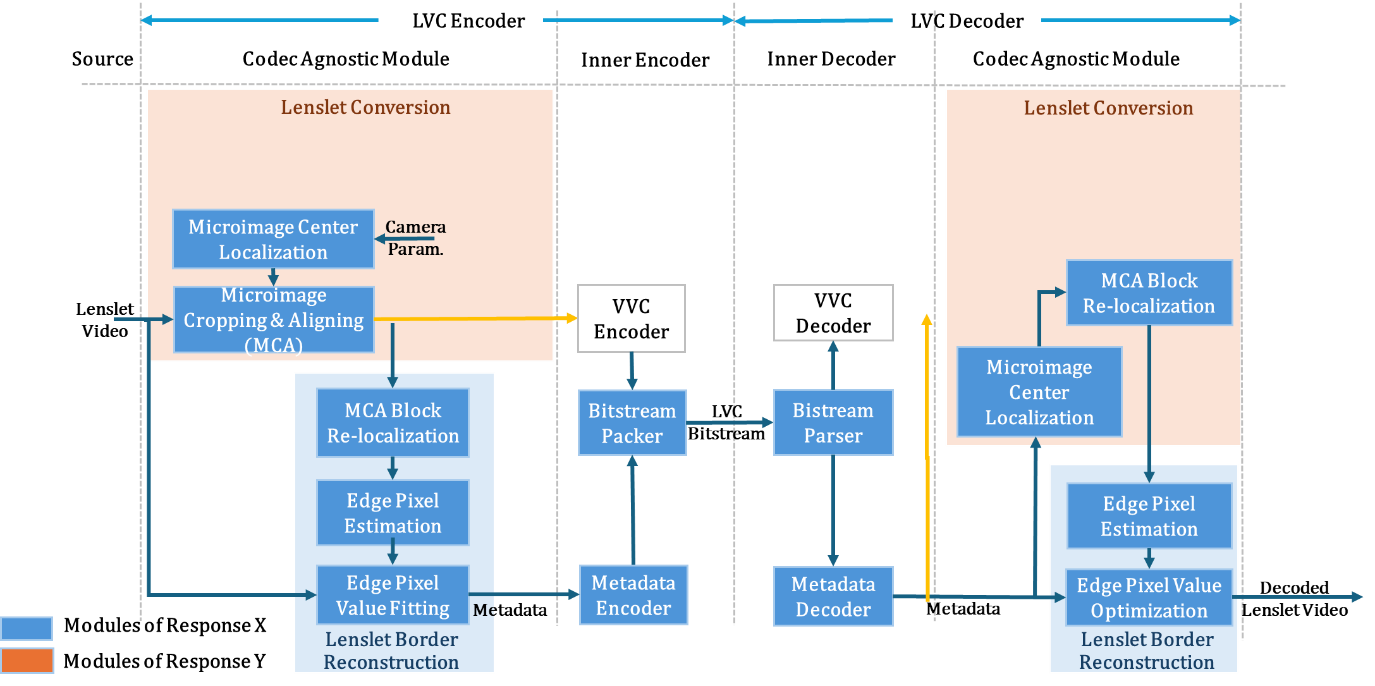
1.  **Lenslet Video Test Model (LVTM)**

Figure 2. Architecture for the first version of LVTM

The first version of the LVTM is built on Response X and has been released. Additional modules from Response Y are under performance evaluation as Core Experiments, as described in [1]. Figure 2 shows the first version of the LVTM (Lenslet Video Test Model). Further details of LVTM can be found in [4]. The software is available in the MPEG Gitlab repository at

<https://git.mpeg.expert/MPEG/Video/lvc/rs/lvtm>.

The VVC encoder and decoder used in LVTM are based on VTM-11.0, including

* VTM Encoder Version 11.0 [Linux][GCC 9.4.0][64 bit] [SIMD=AVX2]
* VTM Decoder Version 11.0 [Linux][GCC 9.4.0][64 bit] [SIMD=AVX2]

The download link for VTM-11.0 is: <https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/tree/VTM-11.0?ref_type=tags>.

The VVC encoder operates in Random Access mode. The configuration files of VVC and MCA per sequence are provided at the /config directory of the LVTM (tag v0.1).

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1. **Test conditions**

## 5.1 CE and EE

During the 151st meeting, two Core Experiments (CEs) [1] and one Exploration Experiments (EEs) [2] of LVC are provided. The test conditions of CEs and EEs are defined as follows.

* **Test condition for CEs**

During the 151st meeting, two CEs [1] are defined:

• CE1: Lenslet Data Representation

This core experiment investigates two possible lenslet data representations as follows:

CE 1.1 MCA (with and without disparity)

CE 1.2 MCA + MIST + Disparity

•. CE2: Lenslet Border Reconstruction

This core experiment investigates lenslet border reconstruction and seeks optimized parameters.

For each CE, the first 64 frames of each test sequence (shown in Table 1) are coded, while VVC encoder works in the Random Access mode. The target rate points are listed in Table 2.

Table 2. Target rate points (RPs).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sequences** | **Target RP [Kbps]** | | | |
| **RP1** | **RP2** | **RP3** | **RP4** |
| Origami | 574 | 1159 | 2352 | 4806 |
| Fujita2 | 267 | 527 | 1000 | 1939 |
| TempleBoatGiantR32 | 484 | 1007 | 1983 | 3729 |
| Boxer-IrishMan-Gladiator2 | 354 | 573 | 899 | 1375 |
| Boys2 | 820 | 1436 | 2390 | 3894 |
| Matryoshka | 154 | 272 | 471 | 786 |
| Motherboard2 | 682 | 1355 | 2519 | 3911 |
| HandTools | 604 | 1126 | 2128 | 4695 |
| MiniGarden2 | 310 | 591 | 1130 | 2632 |

* **Test condition for EEs**

For EE1-RLC (Reference Lenslet content Converter) [2], the test conditions are defined as follows:

* YUV Support: For the original lenslet videos, they need to be rendered and compared with the rendering results generated by the RLC4.0. For the compressed lenslet videos, they need to be rendered using the method proposed by proponent, and their Multiview-PSNR should be calculated and compared with that of the anchor. All datasets are tested and compared against the anchors specified in the Call for Proposals (CfP) [5], which can be available at <https://content.mpeg.expert/data/CfP/LVC/Anchors/>.
* Multi-platform Compilation: The implementation is compiled using Clang, GCC, and MSVC compilers, and tested with the Origami, Boxer, and MiniGarden sequences (10 frames per sequence) in order to ensure cross-platform compatibility.

## 5.2 Coding parameters

## The coding parameters for each test point are available in the /config directory of the provided LVTM.

* The parameter **Type** represents the camera type: Raytrix (0) and TSPC(1), where is it set according to the following table.

|  |  |
| --- | --- |
| Test material filename | Type |
| Origami | 0 |
| Fujita2 | 0 |
| TempleBoatGiantR32 | 0 |
| Boxer-IrishMan-Gladiator2 | 0 |
| Boys2 | 1 |
| Matryoshka | 1 |
| Motherboard2 | 1 |
| HandTools | 1 |
| MiniGarden2 | 1 |
| Origami | 0 |
| Fujita2 | 0 |
| TempleBoatGiantR32 | 0 |

1. **Reporting**

Proposals will be evaluated based on bit rate, objective quality metrics, and complexity. The Excel sheet is provided together with this document to report the results. Proponents are expected to deliver a full set of results for each targeted testing condition.

## 6.1 Bit rate reporting

The bitrate is calculated for the corresponding LVC bitstream. Then, two BD-rate [6] results, for decoded lenslet video and rendered multiview video, can be calculated using the datasheet provided at <https://content.mpeg.expert/data/CfP/LVC/DataSheet/DataSheet.xlsm>.

**6.2 Distortion reporting**

Lenslet-PSNR and Multiview-PSNR are measured for lenslet video and for the multiview video rendered by RLC-4.0 at each test point, respectively:

• Lenslet-PSNR: PSNR of lenslet video in YUV 4:2:0 (hereafter Lenslet-PSNR) at each rate point

• Multiview-PSNR: PSNR averaged over the rendered multiview videos in YUV 4:2:0 (hereafter Multiview-PSNR) at each rate point

The Lenslet-PSNR and Multiview-PSNR calculation method is defined in Annex A.1. An example of rendering and calculating Multiview-PSNR for one dataset is provided in Annex A.2.

**6.3 Complexity reporting**

The encoder and decoder runtimes shall be reported relative to the unmodified test model runtimes on the same system. In addition, contributions should contain the following aspects regarding codec complexity:

* execution time with respect to anchor software
* suitability of the hardware implementation, i.e., avoid floating points, memory usage, potential for parallelization

1. **Cross-check criteria**

When a technology is proposed in LVC, it shall pass a successful cross-check by an independent expert not affiliated with the proponent for consideration of adoption. The cross checker shall report bitrate, performance, encoding and decoding runtimes.

**Coordinator:**

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# References

[1] MDS25493\_WG04\_N00715, Descriptions of core experiments on lenslet video coding, ISO/IEC JTC1/SC29/WG04, Daejeon, Korea, July, 2025.

[2] MDS25495\_WG04\_N00717, Description of exploration experiments on lenslet video renderer, ISO/IEC JTC1/SC29/WG04, Daejeon, Korea, July, 2025.

[3] ITU-T H.266/ISO/IEC 23090-3, “Versatile Video Coding (VVC)”.

[4] MDS25494\_WG04\_N00716, Software manual of LVTM, ISO/IEC JTC1/SC29/WG04, Daejeon, Korea, July, 2025.

[5] MDS24907\_WG04\_N00432, Call for Proposals for Lenslet Video Coding, Geneva, Switzerland, January 2025.

[6] ITU-T HSTP-VID-WPOM - Working practices using objective metrics for evaluation of video coding efficiency experiments, 2020, <http://handle.itu.int/11.1002/pub/8160e8da-en>.

# Annex A – Objective Evaluation Metrics

The evaluation procedure is illustrated in Figure A-1. Figure A-2 provides details of the Multiview Renderer module of Figure A-1.

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Figure A-1. Evaluation procedure for objective and subjective tests.

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Figure A-2. Multiview Renderer module of Figure3.

### A.1. Objective Test method: BD rate

Objective evaluation is conducted in lenslet video and multiview video using BD rate [3] criteria.

The multiview video needs to be rendered from the uncompressed/decompressed lenslet video using RLC-4.0.

The PSNR of a lenslet video frame/view *I* (in dB) is defined as

where *MAXI* is the maximum possible pixel value of the image *I*. When the pixels are represented using 8 bits per sample, *MAXI* is 255. For detail of MSE calculation, refer to Eq. (1) in reference [3].

PSNR is measured in YUV 4:2:0 that includes Y-PSNR, U-PSNR, and V-PSNR.

Lenslet-PSNR is the average PSNR over all frames of a lenslet video.

Multiview-PSNR is the average PSNR over all rendered view videos of a lenslet video.

### A.2. Example of rendering and calculating Multiview-PSNR

25 views per test point are rendered by Reference Lenslet content Converter (RLC-4.0, available at <https://gitlab.com/mpeg-dense-light-field/rlc>) for performance evaluation. The configuration files for RLC include <sequence name>\_param.cfg and <sequence name>\_calib.xml, which are available at <https://content.mpeg.expert/data/CfP/LVC/ConfigFiles/Configs/>. Calibration files <sequence name>\_calib.xml are provided for test sequences.

This is an example of the evaluation procedure for Boys2 sequence. Command line files for all the test sequences and bitrates are provided on the server (<https://content.mpeg.expert/data/CfP/LVC/ConfigFiles/Rendering_Command_Lines.sh>). These were used for anchor generation.

***From Lenslet Video to Input of RLC***

ffmpeg -s 3976x2956 -pix\_fmt yuv420p -i Boys2\_3976x2956\_300frames\_8bit\_yuv420.yuv -start\_number 0 Boys2/Image%03d.png -y

ffmpeg version: 7.0.1-static <https://johnvansickle.com/ffmpeg/>

built with gcc 8 (Debian 8.3.0-6), BT.601.

***RLC Execution***

RLC40 <sequence name>\_Param.cfg

**Boys2\_Param.cfg**:

method 2

viewNum 5

Calibration\_xml Boys2/Boys2\_calib.xml

RawImage\_Path Boys2/Image%03d.png

Output\_Path Boys2/Frame#%03d

start\_frame 0

end\_frame 299

height 2956

width 3976

upsample 2

psizeInflate 2.598076211353316

maxPsize 0.3

patternSize 0.325

psizeShortcutThreshold 4

***From RLC output to multiview Video***

ffmpeg -start\_number 0 -i Boys2/Frame#%03d/image\_001.png -vf format=yuv420p -frames:v 300 Boys2\_1.yuv -y

...

ffmpeg -start\_number 0 -i Boys2/Frame#%03d/image\_025.png -vf format=yuv420p -frames:v 300 Boys2\_25.yuv -y

***Multiview-PSNR calculation***

For two YUV sequences from the same perspective, the Multiview-PSNR is calculated with the following instruction.

ffmpeg -s 1098x800 -pix\_fmt yuv420p -i Boys2\_1.yuv -s 1098x800 -pix\_fmt yuv420p -i Boys2\_1\_qp32.yuv -lavfi psnr -f null -

...

ffmpeg -s 1098x800 -pix\_fmt yuv420p -i Boys2\_25.yuv -s 1098x800 -pix\_fmt yuv420p -i Boys2\_25\_qp32.yuv -lavfi psnr -f null -

The average of the 25 views is then calculated.

**Annex B – Description of test sequences**

Table B-1. Sequences sample central views

|  |  |  |
| --- | --- | --- |
| 屋内, テーブル, 座る, 覆い が含まれている画像  自動的に生成された説明  Origami | 屋内, 動物, 草, 座る が含まれている画像  自動的に生成された説明  Fujita2 | 屋内, 座る, おもちゃ, テーブル が含まれている画像  自動的に生成された説明  TempleBoatGiantR32 |
| image_001  Boxer-IrishMan-Gladiator2 | 落書きされた壁の前に座る男性たち  中程度の精度で自動的に生成された説明  Boys2 | 野球, テーブル, 座る, ブルー が含まれている画像  自動的に生成された説明  Matryoshka |
| 電子機器の内部  低い精度で自動的に生成された説明  Motherboard2 | 屋内, テーブル, 座る, 自転車 が含まれている画像  自動的に生成された説明  HandTools | 草, 花, テーブル, 座る が含まれている画像  自動的に生成された説明  MiniGarden2 |