H2B2VS
D4.1.2

Standardization Report

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EXECUTIVE SUMMARY

This deliverable provides a summary of all the contributions and standardization activities produced or followed by the project partners in relation to the project related activities.

This report provides a list of the contributions with the relevant details and an abstract. Some summaries of the main contribution to standardization are available for free download on the project web site: http://h2b2vs.epfl.ch.

Three main standardization activities are highlighted in this document. First, we provide contribution of INSA de Rennes in JCT-VC on the real time SHVC decoder developed in the project. These contributions give profiling and complexity analysis of the real time scalable HEVC decoder, especially to evaluate the additional complexity of the new tools standardized in the SHVC extension.

Second, H2B2VS partners proposed to MPEG a new synchronization mechanism enabling to synchronize streams received over different networks with different delays. The TEMI technology enables different levels of synchronisation, up to a frame-accurate one. It was standardized by MPEG and was used in several applications and uses-cases developed in H2B2VS project. The partners also organized at the 110th MPEG meeting in Strasbourg a workshop on synchronization activities, where several presentations have been presented on this topic, followed by a demo session where the 4K hybrid (TEMI) demonstrator developed in the project has been demonstrated.

INSA de Rennes, UPM and EPFL have been very active on the RVC standardization. Reconfigurable Video Coding (RVC) provides a framework to efficiently support multiple codec specifications and implementations by combining functional blocks, the so-called functional units (FU), from a collection of libraries. Two MPEG standards apply in this context: 1) MPEG-B part 4, that generally defines the framework and the standard languages used to describe the components of the framework and 2) MPEG-C part 4, that defines a library of video coding tools employed in existing MPEG standards. Specification of the RVC architecture for HEVC decoder (completed by the end 2014), and development of the real time HEVC RVC decoder supporting 91 conformance bitstreams over 132 (still under development to support all conformance bitstreams).

Concerning the DVB standardization, collaborative work has been established between MPEG and DVB in order to be in a position to select the MPEG TEMI mechanism that was, at this time still in the ISO standardization process. At the technical level, the MPEG TEMI solution has been modified to better cope with the DVB requirements. This was made via several formal liaison letters or informal exchanges between H2B2VS members having some delegates on both standardization organizations.

Finally, two synchronisation solutions have been considered in the HbbTV 2.0 specification, including the MPEG-TS Presentation Time Stamps as well as the TEMI which was recommended by the H2B2VS project. The HbbTV 2.0 services are expected to be launched in 2016 enabling hybrid broadcast/broadband services thanks to TEMI technology.

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1 DOCUMENT HISTORY AND ABBREVIATIONS

1.1 Document history

Version	Date	Description of the modifications
0.1	26/02/2014	First ToC
0.2	05/03/2014	Add contributions from TVN, TPT, INSA, EPFL
0.3	15/04/2014	Add contributions from MPEG Valencia meeting
0.4	17/04/2014	Review of contents
0.5	03/09/2015	Add new contributions and review the content
1.0	06/10/2015	Final review

1.2 Abbreviations

RVC	Reconfigurable Video Coding
JCT-VC	Joint Collaborative Team Video Coding
DVB	Digital Video Broadcasting
MPEG	Motion Picture Experts Group
HbbTV 2.0	Hybrid Broadcast Broadband TV

2 INPUT/OUTPUT CONTRIBUTIONS SUMMARY

Standardization Body	Doc number	Title	Authors/Editors (partners)
JCT-VC MPEG 105	JCTVC-N0043 m29616	On software complexity: real time and parallel SHVC video decoder	W. Hamidouche, M. Raulet, O. Déforges (IETR/INSA de Rennes)
JCT-VC MPEG 106	JCTVC-O0115 m30856	Pipeline and parallel architecture for the SHVC decoder	W. Hamidouche, M. Raulet, O. Deforges (IETR/INSA de Rennes)
JCT-VC MPEG 107	m32099	Update of JCTVC-O0115 on a pipeline and parallel architecture of an SHVC decoder	W. Hamidouche, M. Raulet (IETR/INSA de Rennes)
JCT-VC MPEG 108	JCTVC-Q0046 m32722	Complexity analysis of an optimized SHVC decoder	W. Hamidouche, M. Raulet, O. Deforges (IETR/INSA de Rennes)
JCTVC-Q0050 m32726	JCTVC-Q0050 m32726	4K real time streaming with SHVC decoder and GPAC player	W. Hamidouche, M. Raulet, J. Le Feuvre (IETR/INSA de Rennes and TPT)
MPEG 104 Systems	m29227	Timeline Delivery for MPEG-2 TS enhancements	J. Le Feuvre, C. Concolato, R. Monnier, A-L. Mevel, P. Gendron, M. Mattavelli, C. Alberti, D. Renzi, F. Pescador, N. García, M. Raulet (TPT, TVN, EPFL, UPM, IETR/INSA de Rennes and TPT)
MPEG 104 Systems	w13474	WD of ISO/IEC 13818-1:201X/AMD 6 Delivery of Timeline for External Data	Jean Le Feuvre, Sam Narasimhan (TPT)
MPEG 105 Systems	m30300	Extensible Syntax and Extensions for TS Timeline	Jean Le Feuvre, Tran Min-Son, Pierre Sarda, Patrick Gendron, Raoul Monnier, Mickaël Raulet, Marco Mattavell (TPT, Nagra France, Nagra Vision, TVN, INSA de Rennes, EPFL)
MPEG 105 Systems	w13661	WD 2.0 of ISO/IEC 13818-1 :201X/AMD 6 Delivery of Timeline for External Data	Jean Le Feuvre, Sam Narasimhan (TPT)
MPEG 106 Systems		Input on WD2 of 13818-1 AMD8	Jean Le Feuvre, Patrick Gendron, Anne-Laure Mevel, Jean-François Travers, Pascal Dupain, Mickael Raulet (TPT, TVN, TDF and IETR/INSA de Rennes)
MPEG 106 Systems	m31397	a scalable HEVC demonstration within gpac player	W. hamidouche, J. Le Feuvre, M. Raulet (TPT and IETR/INSA de Rennes)
MPEG 106 Systems	m31448	Followup on Uniform Signaling for Timeline Alignment	Jean Le Feuvre (TPT)
MPEG 106 Systems	w13951	Request for ISO/IEC 13818-1:2013/AMD 6 Delivery of Timeline for External Data	Jean Le Feuvre, Sam Narasimhan (TPT)
MPEG 106 Systems	w13952	Text of ISO/IEC 13818-1:2013/PDAM 6 Delivery of Timeline for External Data	Jean Le Feuvre, Sam Narasimhan (TPT)
MPEG 106 Systems	w14015	Proposed Exploration of "Uniform Signaling for Timeline Alignment"	Jean Le Feuvre, David Singer (TPT)

MPEG 107 Systems	m32287	Update on 13818-1 DAM6	Jean Le Feuvre, Patrick Gendron (TPT, TVN)
MPEG 107 Systems	m32625	AHG on Timeline alignment	Youngkwon Lim, Jean Le Feuvre (TPT)
MPEG 107 Systems	w14117	Study of ISO/IEC 13818-1:2013/PDAM 6 Delivery of Timeline for External Data	Jean Le Feuvre, Sam Narasimhan (TPT)
MPEG 108 Systems	m33383	It's Hybrid Demo Time!	Jean Le Feuvre, Cyril Concolato, Mickael Raulet, Wassim Hamidouche (TPT and IETR/INSA de Rennes)
MPEG 103 RVC	m28171	Proposal of a Decoder Energy Management Scheme with RVC	Eduardo Juarez, Rong Ren, Jianguo Wei, Mickael Raulet, Matias Javier Garrido, Cesar Sanz, Fernando Pescador (UPM and INSA de Rennes)
MPEG 103 RVC	m28209	RVC description of an HEVC low delay decoder	M. Raulet, G. Cocherel, M. Mattavelli, D. De Saint Jorre, E. Juarez (EPFL and IETR/INSA de Rennes)
MPEG 104 RVC	m29252	Update of WD1 of FU and FN descriptions for HEVC	M. Raulet, K. Jerbi, D. de Saint Jorre, M. Mattavelli, G. Cocherel (EPFL and IETR/INSA de Rennes)
MPEG 104 RVC	m29253	RVC: HEVC decoder status on conformance test streams	M. Raulet, K. Jerbi, D. de Saint Jorre, M. Mattavelli, G. Cocherel (EPFL and IETR/INSA de Rennes)
MPEG 105 RVC	m30336	Update on Text of ISO/IEC 23002-4:201x/PDAM2 FU and FN descriptions for HEVC	Khaled Jerbi, Mickaël Raulet, Damien De Saint Jorre, Marco Mattavelli, Daniele Renzi, Claudio Alberti (EPFL and IETR/INSA de Rennes)
MPEG 105 RVC	m30337	Updates on HEVC decoder status on conformance test streams	Khaled Jerbi, Damien De Saint Jorre, Mickaël Raulet, Daniele Renzi, Marco Mattavelli, Claudio Alberti (EPFL and IETR/INSA de Rennes)
MPEG 105 RVC	m30338	On using tiles for a parallel HEVC decoder description	Khaled Jerbi, Mickaël Raulet, Damien De Saint Jorre, Marco Mattavelli, Daniele Renzi, Claudio Alberti (EPFL and IETR/INSA de Rennes)
MPEG 106 RVC	m30338	Performance Monitoring for Energy Estimation in RVC-CAL Descriptions	E. Juarez, R. Ren, M. Raulet, J. Wei, M. J. Garrido, C. Sanz, F. Pescador (UPM and IETR/INSA de Rennes)
MPEG 106 RVC	m31400	Linking SSE-optimized functions with a RVC-CAL program	Khaled Jerbi, Mickaël Raulet (IETR/INSA de Rennes)
MPEG 106 RVC	m31403	On using tiles for a parallel HEVC decoder description (post implementation)	Khaled Jerbi, Damien De Saint Jorre, Mickaël Raulet, Marco Mattavelli (EPFL and IETR/INSA de Rennes)
MPEG 107 RVC	m32310	Updates on HEVC decoder status on conformance test streams	Khaled Jerbi, Damien De Saint Jorre, Mickaël Raulet, Marco Mattavelli, Daniele Renzi, Claudio Alberti (EPFL and IETR/INSA de Rennes)
MPEG 108 RVC	m33115	Energy-Aware Reconfiguration Based on a Just-In-Time	Rong Ren, Eduardo Juarez, Mickael Raulet, Jianguo Wei,

		Adaptive Decoder Engine (JADE)	Matias J. Garrido, Cesar Sanz, Fernando Pescador (UPM and IETR/INSA de Rennes)
MPEG 108 RVC	m33241	Updates on HEVC decoder status on conformance test streams	Khaled Jerbi, Damien De Saint Jorre, Mickaël Raulet, Marco Mattavelli, Daniele Renzi, Claudio Alberti (EPFL and IETR/INSA de Rennes)
MPEG 108 RVC	m33242	Update on Text of ISO/IEC 23002-4:201x/PDAM2 FU and FN descriptions for HEVC	Khaled Jerbi, Damien De Saint Jorre, Mickaël Raulet, Marco Mattavelli, Daniele Renzi, Claudio Alberti (EPFL and IETR/INSA de Rennes)
MPEG 109 RVC	m34345	Updates on HEVC decoder status on conformance test streams	Khaled Jerbi, Damien De Saint Jorre, Mickaël Raulet, Marco Mattavelli, Daniele Renzi, Claudio Alberti (EPFL and IETR/INSA de Rennes)
MPEG 111 RVC	m35868	Update on Text of ISO/IEC 23002-4:201x/PDAM2 FU and FN descriptions for HEVC	Khaled Jerbi, Damien De Saint Jorre, Mickaël Raulet, Marco Mattavelli, Daniele Renzi, Claudio Alberti (EPFL and IETR/INSA de Rennes)
MPEG 111 RVC	m35864	Updates on HEVC decoder status on conformance test streams	Khaled Jerbi, Damien De Saint Jorre, Mickaël Raulet, Marco Mattavelli, Daniele Renzi, Claudio Alberti (EPFL and IETR/INSA de Rennes)
MPEG 111 RVC	m35870	Miscellaneous optimizations on the dataflow description of HEVC decoder	Khaled Jerbi, Damien De Saint Jorre, Daniele Renzi, Marco Mattavelli, Claudio Alberti (EPFL and IETR/INSA de Rennes)
MPEG 111 RVC	m35764	Towards a parallel scalable profile of the dataflow HEVC decoder	Khaled Jerbi, Wassim Hamidouche, Olivier Deforges and Mattavelli Marco (EPFL and IETR/INSA de Rennes)
MPEG 112 RVC	m36512	Updates on HEVC decoder status on conformance test streams	Khaled Jerbi, Damien De Saint Jorre, Marco Mattavelli, Daniele Renzi, Claudio Alberti (EPFL and IETR/INSA de Rennes)
MPEG 112 RVC	m36653	Update :Towards a parallel scalable profile of the dataflow HEVC decoder	Khaled Jerbi, Wassim Hamidouche, Olivier Deforges and Mattavelli Marco (EPFL and IETR/INSA de Rennes)
MPEG 110	m35365	Presentations of the MPEG Workshop on Media Synchronisation for Hybrid Delivery	Marco Mattavelli, Jean Le Feuvre, Youngkwon Lim, Ali Begen, Mickaël Raulet, Patrick Gendron, Emmanuel Thomas (EPFL, TVN and IETR/INSA de Rennes)
MPEG 112	m36498	Update of the White Paper on Reconfigurable Media coding	Marco Mattavelli, Eduardo Juarez, Simone Casale-Brunet, Endri Bezati, Euvgeny Upnik, Alejo Arias (EPFL and UPM)

Table 1- Summary of the H2B2VS contributions

3 JOINT VIDEO COLLABORATIVE TEAM (JCT-VC)

The main contributions to JCT-VC have been around the real time SHVC decoder developed by INSA de Rennes under the H2B2VS project. These contributions provide profiling and complexity analysis on the new tools defined in the scalable HEVC extension in the context of real time decoder framework.

3.1.1 105th meeting in Vienna, AU. August 2013.

3.1.1.1 JCTVC-N0043 On software complexity: real time and parallel SHVC video decoder

This contribution provides an open source SHVC software decoder implementing the reference index based SHVC solution. The wave-front parallel processing approach is used to perform in parallel the video decoding of both the base layer and the enhancement one. Experimental results carried out on a laptop fitted with a core Intel i7 processor show that the proposed software decoder achieves the decoding of 1280×720 base layer and 1920×1080 enhancement layer video sequences at 25 fps when using four concurrent threads.

3.1.2 106th MPEG meeting in Geneva, CH. October 2013.

3.1.2.1 JCTVC-O0115 Pipeline and parallel architecture for the SHVC decoder

This contribution provides a complete implementation of the SHVC decoder under the *GPAC* player. The SHVC decoder is based on the open source software *OpenHEVC*, which implements a conforming HEVC decoder. The proposed pipeline and parallel SHVC decoder enables two levels of parallelism. The first level decodes the base layer and the enhancement layer frames in parallel. The second level of parallelism performs the decoding of both the base layer and the enhancement layer in parallel through the HEVC high-level parallel processing solutions (wave-front and tile).

Experimental results carried out on a computer fitted with an Intel Xeon processor running at 3.4 GHz showed that the pipeline SHVC decoder achieves the decoding of 1920x1080 base layers and 2560x1600 enhancement layer at 45 frames per second when using six concurrent threads.

3.1.3 107th MPEG meeting in San José, USA. January 2014

3.1.3.1 JCTVC-P0169 Update of JCTVC-O0115 on a pipeline and parallel architecture of an SHVC decoder

This contribution provides an update of contribution JCTVC-O0115 that provides a complete implementation of the SHVC decoder under the *GPAC* player. The SHVC decoder is based on the open source software *OpenHEVC*, which implements a conforming HEVC decoder. A parallel processing architecture is proposed to reduce both the decoding time and the latency of the SHVC decoder. The proposed solution combines the high level parallel processing solutions defined in the HEVC standard with an extension of the frame-based parallelism. The latter solution enables the decoding of several spatial and temporal SHVC frames in parallel to enhance both decoding frame rate and latency. The wavefront parallel processing solution is used for more coarse level of granularity.

The proposed hybrid parallel processing approach achieves a near optimal speedup and provides a good trade-off between decoding time, latency and memory usage. On a 6 cores Xeon processor, the parallel SHVC decoder performs a real time decoding of 1600p60 video resolution.

3.1.4 108th MPEG meeting in Valencia, Spain. April 2014

3.1.4.1 JCTVC-Q0046 Complexity analysis of an optimized SHVC decoder

This contribution provides a complexity assessment of an optimized Scalable High efficiency Video Coding (SHVC) decoder. The SHVC decoder is based on a real time and parallel HEVC decoder developed under the open source *OpenHEVC* project. The main time-consuming operations

introduced in the SHVC standard including the up-sampling of the lower layer picture and the up-scaling of its Motion Vectors (MVs) are optimized in Single Instruction Multiple Data (SIMD) operations.

The optimized SHVC decoder archives a real time decoding of 1080p50 enhancement layer on single core of an Intel i7 processor running at 2.6 GHz (Macbook Pro Retina, end 2013, turbo boost 3.4GHz). The SHVC decoder decoding two layers introduces in average 50%-80% extra complexity in respect to the single layer HEVC decoder. Moreover, the up-sampling and up-scaling operations, in the case of spatial scalability and inter coding configuration, represent around 16% of the whole decoding time. Finally, the low level optimizations jointly with a hybrid parallelism approach enable the decoding of 1600p enhancement layer at 88 frames per second on a 4 cores i7 processor.

3.1.4.2 JCTVC-Q0050 4K real time streaming with SHVC decoder and GPAC player

This contribution provides a 4K end-to-end video streaming demonstration with using an optimized SHVC decoder under the openHEVC/FFmpeg library (openHEVC project) and the GPAC player. On the one hand, the optimized and parallel SHVC decoder enables a real time decoding 2160p30 video sequence associated with low frame latency. The SHVC decoder was integrated in the openHEVC/FFmpeg library enabling this open source library to support the decoding of a conforming SHVC bitstream. On the other hand, the GPAC player implements tools to encapsulate the conforming SHVC bitstream into the mp4 file format.

At the server side, the GPAC player broadcasts the mp4 content in MPEG2-TS. At the receiver side, the GPAC player feeds the openHEVC/FFmpeg SHVC decoder with the received video packets. The FFmpeg library through the SHVC decoder decodes the requested SHVC video layers and pushes YUV pictures corresponding to the highest decoded layer for rendering by the GPAC layer. This demonstration also provides at the receiver side an interactive interface to switch between the decoded SHVC layers: HD and 4K for x2 spatial scalability.

4 MPEG

4.1 MPEG Reconfigurable Video Coding

Reconfigurable Video Coding (RVC) provides a framework to efficiently support multiple codec specifications and implementations by combining functional blocks, the so-called functional units (FU), from a collection of libraries. Two MPEG standards apply in this context: 1) MPEG-B part 4, that generally defines the framework and the standard languages used to describe the components of the framework and 2) MPEG-C part 4, that defines a library of video coding tools employed in existing MPEG standards.

This section lists the project's contributions to MPEG related to Reconfigurable Video Coding and summarizes their impact on output documents.

4.1.1 103rd MPEG meeting in Geneva, CH. January 2013

4.1.1.1 m28171 Proposal of a Decoder Energy Management Scheme with RVC

This document presents a proposal for a decoder energy management scheme based on RVC. The structure of the contribution is as follows. Section 2 details why RVC constitutes an opportunity to manage the energy usage of a decoder and describes the proposal of an energy management scheme based on the RVC framework and energy estimates. Section 3 presents energy estimation results for an RVC-CAL Constrain Baseline profile AVC decoder that can be employed within the previous scheme. At last, in Section 4, the conclusions are drawn.

4.1.1.2 m28209 RVC description of an HEVC low delay decoder

This contribution presents the development status of a low delay HEVC decoder and extends the contributions submitted to the 101st and 102ng MPEG meetings in Stockholm and Shanghai respectively. The HEVC RVC decoder has been tested on HM9.0 bitstreams available at ftp://ftp.kw.bbc.co.uk/hevc/hm-9.0-anchors/. It supports i_main, lp_main and ld_main bitstreams. The current version of the XDF decoder does not include inloop filters but they have already been written in CAL and tested over the same bitstreams. It supports decoding of only 8 bit bitstreams.

4.1.2 104th MPEG meeting in Incheon, KR. April 2013

4.1.2.1 m29252 Update of WD1 of FU and FN descriptions for HEVC

Compared to the previous WD, the reference SW is attached to this contribution. It adds different HM10 capabilities: CABAC parsing, SAO and DBF filtering (in track changes, the difference on the WD1) and MD5 checking.

4.1.2.2 m29253 RVC: HEVC decoder status on conformance test streams

This contribution extends the previous 4 contributions by updating the HEVC RVC decoder to HM.10. The decoder supports now the DBF and SAO filters. It supports also the streams with disabled TMVP. In this contribution, the authors added also an MD5 check. All these updates are detailed in an annexed Excel document.

The design was successfully tested on Anchor streams (i_main, ld_main, lp_main and ra_main). Concerning the JCTVC conformance streams, the results are summarized in an xls file joint to the submission where we added 3 new columns "pass", "Uflag" and "MD5": pass error means that the simulation is blocked, Uflag error means that the stream contains unsupported cases such as weightedPred !=0 and MD5 error means that the stream is supported but the displayed video is not correct.

4.1.3 105th meeting in Vienna, AU. August 2013.

4.1.3.1 m30336 Update on Text of ISO/IEC 23002-4:201x/PDAM2 FU and FN descriptions for HEVC

This document provides a paragraph to be added to Clause 2 of the mentioned document and an entire new clause (Clause 9) to be added. Clause 9 describes FUs for building the HEVC Main Profile decoder.

4.1.3.2 m30337 Updates on HEVC decoder status on conformance test streams

This document provides an update on the ongoing conformance tests of the RVC HEVC decoder. It is accompanied by an Excel sheet summarizing the status with respect to the set of conformance bitstreams.

4.1.3.3 m30338 On using tiles for a parallel HEVC decoder description

The HEVC codec was conceived to manage huge sizes of image such as 4K videos. To take profit of the existing multi-core platforms and the parallel hardware architectures, the standard introduced the notion of Tiles. Indeed, a tile is a completely independent part of an image that can be decoded separately from other tiles.

In this contribution, the authors focus on the decoding part and they explain how the parser generates the required information for each tile. Then, the authors detail a perspective of parallelizing the process using dynamic reconfiguration to generate the required number of parsing units for each tile.

4.1.4 106th MPEG meeting in Geneva, CH. October 2013.

4.1.4.1 m30338 Performance Monitoring for Energy Estimation in RVC-CAL Descriptions

This contribution proposes a set of procedure primitives to monitor performance events in RVC-CAL descriptions. In addition, a model which relates event occurrence to energy is presented. At last, the results obtained applying the model to a PHP AVC and HEVC RVC-CAL decoder descriptions are discussed. This work extends contribution m28171 presented at the 103rd meeting in Geneva.

4.1.4.2 m31400 Linking SSE-optimized functions with a RVC-CAL program

This document describes how it is possible to increase the performance of a decoder with the optimization of some recurrent functions on a specific platform. In ffmpeg/libav some functions were optimized for x86 architectures using SSE. In this contribution, the authors show how they tried to rewrite some highly repeated functions analogically to the way they were developed in the SSE optimized version. The authors linked the projects generated with the c-back-end of Orcc to the optimized functions and they noticed a gain of 14% for a 480p sequence.

4.1.4.3 m31403 On using tiles for a parallel HEVC decoder description (post implementation)

This contribution is a continuity of m30336 presented in Vienna: "FU and FN descriptions for HEVC (ISO/IEC 23002-4) document presented in the last meeting". The authors present the final architecture of the parallelized design and provide some implementation results.

4.1.5 107th MPEG meeting in San José, USA. January 2014

4.1.5.1 m32310 Updates on HEVC decoder status on conformance test streams

In this document, the authors summarize the newly supported streams in the JCTVC conformance database. This database contains 130 conformance streams. 121 streams are coded in 8 bits and 9 streams are coded in 10 bits but not yet supported in the RVC dataflow design. Among the 121 8-bits streams the RVC design supports 56.

4.1.6 108th MPEG meeting in Valencia, Spain. April 2014

4.1.6.1 m33115 Energy-Aware Reconfiguration Based on a Just-In-Time Adaptive Decoder Engine (JADE)

This contribution proposes an implementation of a new set of primitives to include within the scenario specification of the Just-In-Time Adaptive Decoder Engine (JADE). JADE is an open source tool which implements the Reconfigurable Vide Coding (RVC) framework. The goal of the proposal is to provide a mechanism to reconfigure a decoder based on energy consumption criteria. An energy-aware manager has been implemented in JADE to select a decoder description (DD) among those available at the decoder side.

4.1.6.2 m33241 Updates on HEVC decoder status on conformance test streams

In this document, we summarize the newly supported streams in the JCTVC conformance database. This database contains 141 conformance streams. 132 streams are coded in 8 bits and 9 streams are coded in 10 bits but not yet supported in the RVC dataflow design. Among the 132 8-bits streams the RVC design supports 78 ones. An excel sheet is attached.

4.1.6.3 m33242 Update on Text of ISO/IEC 23002-4:201x/PDAM2 FU and FN descriptions for HEVC

Some additional ports for the functional units are added.

4.1.7 109th MPEG meeting in Sepporo, Japan. July 2014

4.1.7.1 m34345 Updates on HEVC decoder status on conformance test streams

This document presents the newly supported streams from the JCTVC conformance database.
This database contains 141 conformance streams. 132 streams are coded in 8 bits and 9 streams are coded in 10 bits but not yet supported in the RVC dataflow design. Among the 132 8-bits streams the RVC design supports 78 ones.

4.1.8 111th MPEG meeting in Geneva, Switzerland. February 2015

4.1.8.1 m35868 Update on Text of ISO/IEC 23002-4:201x/PDAM2 FU and FN descriptions for HEVC EPFL and INSA

4.1.8.2 m35864 Updates on HEVC decoder status on conformance test streams

This document presents the newly supported streams from the JCTVC conformance database. Before this contribution, the database contains 141 conformance streams. 132 streams are coded in 8 bits and 9 streams are coded in 10 bits but not yet supported in the RVC dataflow design. Among the 132 8-bits streams the RVC design supports 89 ones.

4.1.8.3 m35870 Miscellaneous optimizations on the dataflow description of HEVC decoder

To improve the performance of the dataflow HEVC decoder, some optimizations are applied and involve modifications in the architecture.

In this document, we present a set of optimizations applied on the intra prediction (IntraPred), the inverse integer transform (xIT), the QP generator (QP_gen) and the reconstruction (SelectCU) actors. These optimizations are currently applied on a testing temporary architecture. In a revision view of the document, we put the difference that would be involved on the architecture compared with m33242_AMD (108 meeting in Valencia).

4.1.8.4 m35764 Towards a parallel scalable profile of the dataflow HEVC decoder

In this contribution, we present ongoing works aiming at developing dataflow architecture for the scalable HEVC decoder within the RVC framework.

4.1.9 112th MPEG meeting in Warsaw, Poland, June 2015

4.1.9.1 m36512 Updates on HEVC decoder status on conformance test streams

This document presents the newly supported streams from the JCTVC conformance database. At the time of this writing, the database contains 143 conformance streams. 132 streams are coded in 8 bits and 11 streams are coded in 10 bits but not yet supported in the RVC data-flow design. Among the 132 of the 8-bits streams, the RVC design supports 91.

4.1.9.2 m36653 Update :Towards a parallel scalable profile of the dataflow HEVC decoder

In this contribution, we present ongoing works aiming at developing dataflow architecture for the scalable HEVC decoder within the RVC framework.

4.1.9.3 m36498 Update of the White Paper on Reconfigurable Media coding

The objective of this white paper is to provide an overview of the MPEG Reconfigurable Media Coding framework. Initially started with the intention of covering only MPEG video compression technology, it now includes also 3D Graphics compression standards. The framework is composed by normative elements and by non-normative tools. Normative is the standard library of functional units that can be connected into various decoder configurations building high level dataflow based functional specifications of decoders. Non-normative tools provide simulation, analysis and executable code synthesis capabilities for the generation of implementations running on different platforms of any RMC specification.

4.1.10RVC Core experiments

Since the 103rd MPEG meeting held in Geneva in January 2013 MPEG has conducted Core Experiments on RVC.

The reference output documents are: w13338, w13568, w13761, w13930, w14224

The goal of the experiments is to specify FUs composing the HEVC decoder in such a way that it can be split in order to provide more parallelism. The HEVC toolbox has been written in a compact number of FU. The goal of these CEs is to provide a finer HEVC description to provide more flexibility and parallelism.

The work plan is the following:

1. to identify bottlenecks of the decoder description
2. to split FU when possible
3. to provide more parallelism
4. to re-write such FUs

4.2 Timeline and Hybrid Delivery

4.2.1 104th MPEG meeting in Incheon, KR. April 2013

4.2.1.1 m29227 Timeline Delivery for MPEG-2 TS enhancements

The work presented in this contribution focuses on enhancing broadcast MPEG-2 Transport streams with broadband media. Various use cases for possible enhancements exist, and can be classified as follows:

- Enhancement with no synchronization or loose synchronization: in these cases, existing tools from already deployed TSs are sufficient to estimate the current time of the broadcast service with little accuracy, typically up to a few seconds or more;
- Enhancement requiring subjective synchronization: in these use cases, timing has to be computed with the same precision as regular inter-media synchronization (A/V sync, Text/Video sync …), which is usually a few tens of milliseconds up to a few hundred;
- Enhancement requiring frame accurate: in these cases, timing has to be perfectly reconstructed (synchronization error tolerance is zero), otherwise either the decoding or the presentation of one media fails.

In this contribution, we mainly focus on the last type of use cases, as solutions covering this type also cover the use cases requiring subjective synchronization. However, examples of both subjective synchronization and frame accurate synchronization use cases are given in order to better understand the differences and constraints.

4.2.1.2 w13474 WD of ISO/IEC 13818-1:201X/AMD 6 Delivery of Timeline for External Data

The systems group reviewed the contributions m29227 on timeline streaming for synchronized external enhancements of TS services, follow-up of the contributions m26903 and m28136 presented during the 102nd and 103rd MPEG Meetings.

The group agreed to enable transport of a media timeline in an MPEG-2 TS program, in order to provide a stable media time not sensitive to PCR discontinuities, and to signal the location of current and potentially upcoming external media enhancements.

The group agrees to follow a generic design independent of the media enhancement type; the technologies included in this AMD can be used to locate and synchronize external content with an MPEG-2 TS program, regardless of the external content packaging or coding types. The group agrees that in order to suppress potential PCR discontinuities that typically occur in an MPEG- 2 TS network, and provide frame-accurate timeline alignments, the mapping between the embedded timeline and PCR clock should be achieved through PES PTS values, hence implying a PES stream for the timeline transport.

The following provides the text under consideration for signaling of all these agreements based on the contributions cited above. MPEG welcomes comments on this document and further contributions. This working draft is expected to progress to a proposed draft amendment (PDAM 6) to ISO/IEC 13818-1:2012 for the 105th MPEG meeting.

4.2.2 105th meeting in Vienna, AU. August 2013.

4.2.2.1 m30300 Extensible Syntax and Extensions for TS Timeline

In 104th MPEG Meeting in Incheon, a proposed working draft was issued to allow carriage of synchronization information for external media add-ons, in N13474. The current syntax in the working draft is compact in order to fit in a single TS packet, but is not extensible for other metadata. In this contribution, we propose to provide an extended syntax for the WD. We also propose new tools to be included in the WD.

In this proposal, we suggest to define the payload syntax of the timeline extension as a set of descriptors, similar to other descriptors used in the general MPEG-2 Transport Stream part. We also propose to have an optional CRC32 check at the end of the TEMI payload.

4.2.2.2 w13661 WD 2.0 of ISO/IEC 13818-1:201X/AMD 6 Delivery of Timeline for External Data

The systems group reviewed the contributions m29227 and m30300 on timeline streaming for synchronized external enhancements of TS services, follow-up of the contributions m26903 and m28136 presented during the 102nd and 103rd MPEG Meetings.

The group agreed to enable transport of a media timeline in an MPEG-2 TS program, in order to provide a stable media time not sensitive to PCR discontinuities, and to signal the location of current and potentially upcoming external media enhancements.

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The following provides the text under consideration for signaling of all these agreements based on the contributions cited above. MPEG welcomes comments on this document and further contributions. This working draft is expected to progress to a proposed draft amendment (PDAM 6) to ISO/IEC 13818-1:2013 for the 106th MPEG meeting.

4.2.3 106th MPEG meeting in Geneva, CH. October 2013.

4.2.3.1 m31446 Input on WD2 of 13818-1 AMD8

In 105th MPEG Meeting in Incheon, a stable syntax for carriage of media timeline and external resource location has been proposed in W13661. Following the meeting, a number of discussions on the topic have taken place in the H2B2VS and other standard organizations such as DVB or HbbTV, and some companies have raised interest on the general topic and concerns on bandwidth overhead. This contribution reviews the bandwidth overhead introduced by TEMI and proposes an alternate transmission mode of timing. This contribution also proposes fixes and improvements to the working draft.

4.2.3.2 m31397 a scalable HEVC demonstration within GPAC player

This contribution describes the different steps for playing SHVC contents with GPAC and an opensource decoder based on OpenHEVC. GPAC encapsulates SHVC (SHM2.0 compatible bitstream) into ISOBMFF. The SHVC decoder is based on the open source software *OpenHEVC (build upon ffmpeg/libav)*, which implements a conforming HEVC decoder. The SHVC decoder, pipeline and parallel, enables two levels of parallelism.

The GPAC player allows the user to smoothly switch between layers. As the decoder is multiple loop base layer can be obtained instantaneously whereas Enhancement layer has to be delayed until an IRAP is encountered.

4.2.3.3 m31448 Follow up on Uniform Signaling for Timeline Alignment

In Incheon meeting an exploration on Uniform Signaling for Timeline Alignment was started, in order to investigate the required tools at the systems level to allow a media presentation packaged and delivered in one format over one network type to be "augmented" by another media presentation, possibly using different packaging and/or delivery means. More specifically, the exploration welcomes feedback on the topics of:

- timeline alignment of media packaged in different containers and delivered over different networks
- discovery of the add-on media enhancing an existing presentation
- tools allowing event signaling related to the add-on or enabling pre-fetch of add-on media

MPEG has a key role to play in this area, and should propose guidelines and technologies in a well-identified manner in order to ensure interoperability in the connected media CE market. Other standard bodies such as HbbTV (ETSI) are currently looking for solutions to recommend in their products for what they usually refer to as "Hybrid Delivery" (they planned to release their new technologies before mid 2014).

In this regard, this contribution reviews existing MPEG and IETF technologies that can be used to achieve the goal listed in the exploration activity for all the topics previously stated.

This contribution is the logical continuation of long online, offline or face-2-face discussions on the topic of "hybrid delivery" aver the last year, and the author lost count of all participants in the debates- let them be thanked. The author would like to address special thanks to the experts that patiently reviewed this contribution, especially David Singer and Ali C. Begen.

4.2.3.4 w13951 Request for ISO/IEC 13818-1:2013/AMD 6 Delivery of Timeline for External Data

Delivery of additional media to enhance MPEG-2 transport stream programs is being deployed in many markets, from broadcast to IPTV delivery. Current deployments rely on proprietary solutions and loose (i.e. not frame-accurate) synchronization of media. This amendment to ISO/IEC 13818-1 | ITU-T Recommendation H.222.0 provides a simple framework to allow signaling, pre-fetching and splicing of additional media enabled frame-accurate services including deployment of upcoming SHVC standard. The amendment introduces a new stream type for PES carriage of timing and signaling descriptors, and an extension mechanism in the adaptation field for in-band insertion of descriptors for low bit-rates environments.

4.2.3.5 w13952 Text of ISO/IEC 13818-1:2013/PDAM 6 Delivery of Timeline for External Data

This amendment to ISO/IEC 13818-1:2013 enables signaling and synchronization of external enhancements of programs carried over MPEG-2 Transport Stream. Specifically, it enables transport of a media timeline in an MPEG-2 TS program, in order to provide a stable media timeline not sensitive to PCR discontinuities, and signaling of the location of current and potentially upcoming external media enhancements. The technologies included in this AMD can be used to locate and synchronize external content with an MPEG-2 TS program, regardless of the external content packaging or coding types; to accommodate the different application use cases, the signaling information and the timing information may be sent at different frequencies.

In order to provide frame-accurate timeline alignments despite potential PCR discontinuities that typically occur in an MPEG- 2 TS network, different types of time codes can be inserted into the TS. The information can be sent in a dedicated PES stream identified in the program's PMT, for cases where bandwidth requirements are not too constrained, or can be inserted in the adaptation field of the media PID when the overhead of sending one TS packet per time code would be too high; for example, the typical bitrates for time code signaling for each frame of a 60 Hz video is around 90 kbps using PES only carriage and between 4 and 7 kbps using adaptation field scheme.

4.2.3.6 w14015 Proposed Exploration of "Uniform Signaling for Timeline Alignment"

In a number of scenarios, ancillary timed content can be made available that enhances the experience of consuming some primary content. Examples include not only accessibility optional sub-titling or captions, but also content that enhances the user's experience in other ways.

It is desirable that the availability and alignment of this ancillary media for the primary media be signaled using standard techniques and terms, in a uniform way, with only the manner in which it is stored in the formats varying.

Delivery of multimedia services using a combination of different transport protocols and formats is currently being investigated by many broadcasters (for example as part of HbbTV 2.0 requirements), and has been under discussion at MPEG during the 102nd (see contribution m26903) and the 103rd (m28136) MPEG meetings.

This exploration proposes to investigate this signaling, and how it may be embedded in a number of common formats, particularly those under MPEG control. The document integrates some ideas from contribution m31448.

4.2.4 107th MPEG meeting in San José, USA. January 2014

4.2.4.1 m32287 Update on 13818-1 DAM6

WG11 has sent a liaison letter to DVB informing of the on-going work on timeline signaling in MPEG-2 TS, 13818-1:2013 DAM6.

Some fruitful discussions happened in DVB CSS group, including some members of the H2B2VS project, and a liaison letter was sent back to MPEG (m31817). This contribution addresses the technical questions in this liaison.

4.2.4.2 w14117 Study of ISO/IEC 13818-1:2013/PDAM 6 Delivery of Timeline for External Data

This amendment to ISO/IEC 13818-1:2013 enables signaling and synchronization of external enhancements of programs carried over MPEG-2 Transport Stream. Specifically, it enables transport of a media timeline in an MPEG-2 TS program, in order to provide a stable media timeline not sensitive to PCR discontinuities; it also enables signaling of the location of current and potentially upcoming external media enhancements. The technologies included in this AMD can be used to locate and synchronize external content with an MPEG-2 TS program, regardless of the external content packaging or coding types; to accommodate the different application use cases, the signaling information and the timing information may be sent at different frequencies.

In order to provide frame-accurate timeline alignments despite potential PCR discontinuities that typically occur in an MPEG- 2 TS network, different types of time codes can be inserted into the TS. The information can be sent in a dedicated PES stream identified in the program's PMT, for cases where bandwidth requirements are not too constrained, or can be inserted in the adaptation field of the media PID when the overhead of sending one TS packet per time code would be too high; for example, the typical bitrates for time code signaling for each frame of a 60 Hz video is around 90 kbps using PES only carriage and between 4 and 7 kbps using adaptation field scheme.

4.2.5 108th MPEG meeting in Valencia, Spain. April 2014

4.2.5.1 m33383 It's Hybrid Demo Time !

With the parallel development of scalable extensions for HEVC (SHVC, MV-HEVC) and timeline and external media information carriage in MPEG-2 TS (TEMI), MPEG is creating the foundation of future services for the broadcast industry: flexibility and extensibility in media coding, carried over using heterogeneous networks, including broadcast and broadband networks.

As part of the H2B2VS project, Telecom ParisTech and INSA/IETR have been working on a tight integration of scalable coding and transport layers through their respective open-source projects GPAC and OpenHEVC.

This contribution demonstrates the combined usage of HEVC/SHVC, multicast MPEG-2 Transport Stream and on-demand MPEG-DASH in a prototype demonstration. The components of the demonstration are:

- a two layered SHVC video, using WPP for optimal parallelism processing; the video (and the SHVC video decoder)follows the SHM4 syntax,
- a multicast MPEG-2 Transport Stream simulating the broadcast channel. The transport stream only carries the base HEVC layer. The transport stream carries TEMI information to signal:
    - the location of an add-on for this program (URL sent at 1hz rate)
    - the media timeline used by this add-on (media timestamp information injected at each video frame)
- The TEMI descriptors are embedded in the adaptation field of the video PES, to keep the signaling overhead low.
- An MPEG-DASH presentation used to carry the scalable enhancement layer; the encapsulation is done in ISO Base Media File Format using the latest version of the WD of part 15 for SHVC carriage.

The scalable layer can also be played from file rather than from DASH. The use of DASH allows simpler seeking in the media presentation by requesting the closest segment to the live point, rather than downloading and seeking the file containing the enhancement layer.

4.2.6 110th MPEG meeting in Strasbourg, France. October 2014

4.2.6.1 m35365 Presentations of the MPEG Workshop on Media Synchronisation for Hybrid Delivery

This document collects the following presentations discussed during the workshop.

- An overview of MPEG systems technologies providing advanced media synchronization, Youngkwon Lim, Samsung
- Hybrid Broadcast - Overview of DVB TM-Companion Screens and Streams specification, Oskar van Deventer, TNO
- Hybrid Broadcast-Broadband distribution for new video services : a use cases perspective, Raoul Monnier, Thomson Video Networks
- HEVC and Layered HEVC for UHD deployments, Ye Kui Wang, Qualcomm
- A fingerprinting-based audio synchronization technology, Masayuki Nishiguchi, Sony Corporation
- Media Orchestration from Capture to Consumption, Rob Koenen, TNO

5 DVB

End 2012, DVB, based on work starting in its commercial module (DVB-COS group) decided to set up a Study Mission to study Companion Streams and Screens. The main objective of the TM-SM-CSS was an initial comparative technical evaluation of relevant technologies and existing standards that can be used to provide enhancement of the overall viewing experience through the use of personal devices (i.e. companion screens) and through the use of additional streams (i.e. companion streams).

Based in the result of the Study Mission, it was decided to move forward with some specific actions regarding key technical areas for which the initial Study Mission had identified some missing answers. Synchronization of the broadcast/broadband streams was one of these technical areas and a work was started in H1/2013 to issue a call for technologies on synchronization mechanisms.

Even if the target of the TM-CSS is to define proper mechanism to synchronize streams carried by different networks (broadcast/broadband) and displayed on separate devices (the main TV set and a tablet for example), the requested mechanism can be also relevant to synchronize two streams received by a single device (e.g. a connected TV receiving both broadcast and broadband streams). Those streams can be further combined and displayed on a single device.

As a basis of the discussion on synchronization mechanism, TM-CSS defined different classes based on the required accuracy:

- None: No synchronization is expected or attempted.
- Best effort: there is no explicit synchronization, but playback is usually started approximately co-timed in the hope the presentation of the elements retains synchronization.
- Loose: there is explicit synchronization, but permits errors in synchronization of up to a defined tolerance (perhaps a fraction of a second to a few seconds)
- Tight: there is explicit synchronization, and it is aimed at supporting lipsync levels of synchronization (a few tens of milliseconds maximum).
- Video Frame accurate: there is explicit synchronization that guarantees all frames are presented at the same time, for current and expected frame rates. This is probably close or identical to tight synchronization.
- Very Tight: supporting multi-channel audio where each stream is to one device that supports a single channel, yet results in a coherent sound stage.

Depending on the required accuracy, different protocols/methods could be used. Nevertheless for video frame accuracy, among existing technologies, only DVB SAD and PCR/PTS based solutions could be used.

Both previously mentioned technologies have drawback either in term of Bandwidth efficiency (DVB SAD) or robustness on the whole delivery network (PCR/PTS based mechanism).

The TM-CSS group started then to draft a specification and published it as a blue book in 07/2014 which became an official ETSI Technical Specification in 05/2015 as part 2 of TS103 286. The synchronization mechanism was one of the important topics of this specification.

During all the DVB specification work, collaborative work has been established between MPEG and DVB in order to be in a position to select the MPEG TEMI mechanism that was, at this time still in the ISO standardization process. At the technical level, the MPEG TEMI solution has been modified to better cope with the DVB requirements. This was made via several formal liaison letters or informal exchanges between H2B2VS members having some delegates on both standardization organizations. As DVB cannot be 100% sure that the ISO/MPEG track will deliver on time an appropriate amendment of the Transport stream specification, DVB has been working on an alternative mechanism to carry the Timeline. This mechanism called TSAP (stands for Transport Stream Adaptation Private data)

On the other side, Adaption field descriptors for Timed External Media Information (TEMI) has followed the full process of amendment to the MPEG Systems specification ISO/IEC 13818-1 that defines a mechanism for carriage of a timeline in the adaptation field of a transport stream packet that contains a PES stream with PTS declared in the PES header.

As of today, both options are included in the DVB specification, being technically very closed but as stated in the DVB specification, as MPEG has now finalized (and published) the amendment of ISO/IEC 13818-1 describing TEMI, the TSAP timeline is now deprecated..

One important point to consider was the very tight timing as DVB wanted to deliver a specification by mid-2014 at the latest (which was almost achieved in 07/2014 through a blue book) whereas the ISO process has been finalized for MPEG TEMI end of 2014 at the technical level, with technically stable draft available by mid-2014.

Finally, as of today both MPEG (ISO/IEC 13818-1) and DVB (ETSI doc TS103 286.part2) are now published

6 HbbTV

HbbTV specified a system of Interactive TV for Hybrid broadcast broadband receiver in 2010. It has been standardized by ETSI in 2011 with the reference TS 102 796.

In 2013, it was decided to publish a new version of the standard that would:
- Introduce new technologies such as HTML 5
- Improve some features such as multi-stream synchronization.

The Requirement Group of HbbTV gave a very tight schedule to draft the technical specification. Indeed, the official objective was to launch HbbTV V2.0 services by early 2015. To achieve that goal technical work Technical specifications should be prepared in 2013 V2 published Q1 2014.

HbbTV has no real technical group. It refers to subset of existing standards published by bodies such as ETSI/ISO-CEA-IOPF.

A liaison was created with DVB to harmonize the work between both bodies and have a consistent solution. This has been possible thanks to DVB political changes: DVB accepted HbbTV as standard for connected TV and not only the connected version of MHP.

This liaison took also the HbbTV schedule constraints and DVB accepted to speed up its work. The text proposed to DVB-CSS were simultaneously presented and discussed inside HbbTV consortium. In that context TEMI was introduced and supported by H2B2VS members.

As a result, two solutions have been defined for inter streams synchronization (broadcast and a broadband):

- The MPEG-TS Presentation Time stamps,
- The TEMI which is the recommended solutions

TSAP is not mentioned.

These solutions were consistent with what was described by H2B2VS in Deliverable D.2.2.1 "Specification of synchronization mechanisms".