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Title **Comparison of multiview compression performance using MPEG-4 MVC and prospective HVC technology**
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1. The goal of this contribution

As a result of recent works on High Efficiency Video Codling (HEVC) standard, a new coding standard is about to emerge. As shown during Dresden meeting, several proponents in the responses to Call for Proposals managed to achieve coding gains of up to 30% compared to previous standard – MPEG-4 AVC. It is necessary to note that the proposed new codecs do not provide compatibility with MPEG-4 AVC. It is therefore doubtful whether the new 3D Video coding standard should be backward compatible with MPEG-4 MVC standard, which is basically an annex to MPEG-4 AVC standard.

In this document we compare compression performance of MPEG-4 MVC standard codec against prospective HEVC technology used for multiview video material compression. Results of our experiments, presented below, undermine the sense of maintaining backward compatibility with MVC in the new 3D Video coding standard.

More exactly, we are going to compare two codecs used for compression standard multiview video:

- standard MPEG-4 MVC video codec,
- one of the best codecs proposed for HEVC working in simulcast.

We are going to show that simulcasting of the bitstreams corresponding to prospective HEVC technology outperforms MPEG-4 MVC codec.

2. Backward compatibility

Backward compatibility is currently defined in [1] as:

The compressed data format shall include a mode which is backwards compatible with existing MPEG coding standards that support stereo and mono video. In particular, it should be backwards compatible with MVC.

moreover section 3.2.1 Compression efficiency clearly says:

Video and supplementary data should not exceed twice the bit rate of state-of-the-art compressed single video. It should also be more efficient than state-of-the-art coding of multiple views with comparable level of rendering capability and quality.

A state-of-the-art compression technique for single video is soon going to be HEVC standard, currently being under development. As it will be shown later in this document, the requirement stated in the quoted sentence will be hard to meet, while keeping the MPEG-4 MVC compatibility requirement.

3 Experiment results

In this section we present the results of comparison between MPEG-4 MVC coding technology and prospective HVC technology represented by codecs submitted in response to Call for Proposals on HVC coding standard.

As an MPEG-4 MVC coder we use reference software JMVM 6.0. For HEVC coder we chose codec provided by Samsung [3] because of availability of its source code and its good results during evaluation of the CfP. This codec is one of the best proposals for HEVC technology. Future HEVC technology will provide compression performance greater than that of this proposal. Obviously this proposal does not provide inter-view prediction mechanism as its designed to encode single view sequences only. However the coded defined in the proposal may be used successfully for multiview compression in simulcast mode.

We have performed a series of simple tests using a full HD sequence Poznan Street [2]. 200 frames were coded for each view in this experiment.

We consider 2 scenarios:

- Stereo pair encoding
- Three view encoding

3.1. Stereo pair encoding

We compressed the texture and depth for views 3 and 5 with both: MPEG-4 MVC and Samsung HEVC proposal. The results are the following.

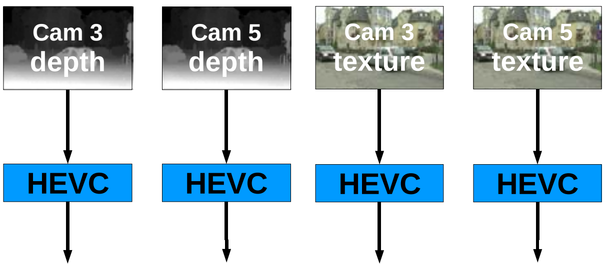

Fig 1. Compression scenario for simulcast HEVC proposal.

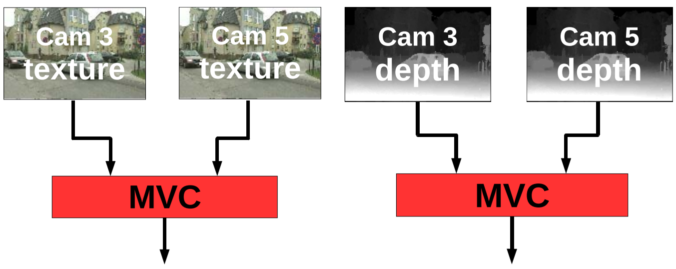

Fig 2. Compression scenario for MPEG-4 MVC.

Table 1. Results of coding texture video stereo pair

stereo pair (view 3 and 5)			
	QP	view bitrate [Mbps]	average PSNR [dB]
MPEG-4 MVC	25	4.427	39.06
	28	2.613	37.84
	32	1.397	36.10
	35	0.932	34.85
Samsung HEVC	25	3.543	39.49
	28	1.710	38.13
	32	0.880	36.47
	35	0.550	35.28

Table 2. Results of coding depth video stereo pair

stereo depth (view 3 and 5)			
	QP	depth bitrate [Mbps]	average PSNR [dB]
MPEG-4 MVC	25	1.323	46.01
	28	0.856	44.53
	32	0.494	42.62
	35	0.337	41.26
Samsung HEVC	25	0.951	46.30
	28	0.597	44.86
	32	0.322	43.12
	35	0.205	41.89

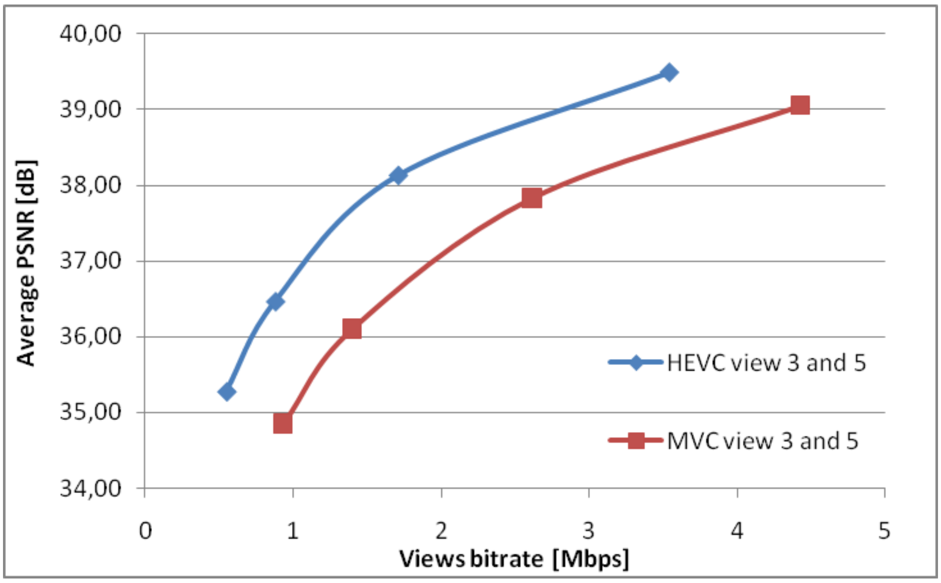

Fig 3. Results of coding texture video stereo pair

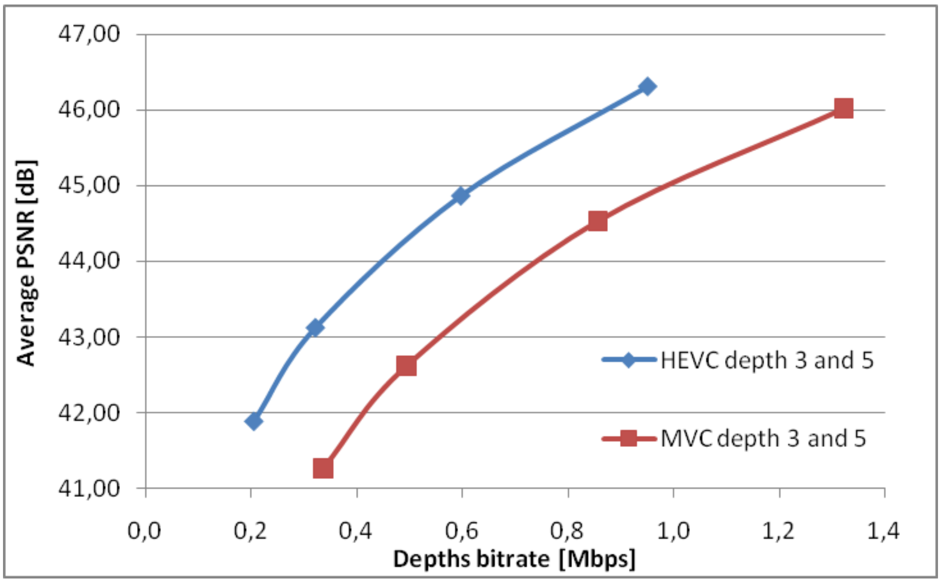

Fig 4. Results of coding depth video stereo pair

Judging from Figures 3 and 4 it is clear that Samsung HEVC proposal outperforms MPEG-4 MVC significantly.

3.2. View synthesis – Stereo pair encoding - 2 views and 2 depth maps

In order to evaluate usefulness of coded materials for 3DV purposes we synthesized texture for view 4 using the reconstructed data for all possible QP-QD pairs from the set. We measured the quality of synthesized view against real texture of view 4 as a reference. The results for MPEG-4 MVC and HEVC proposal case are the following.

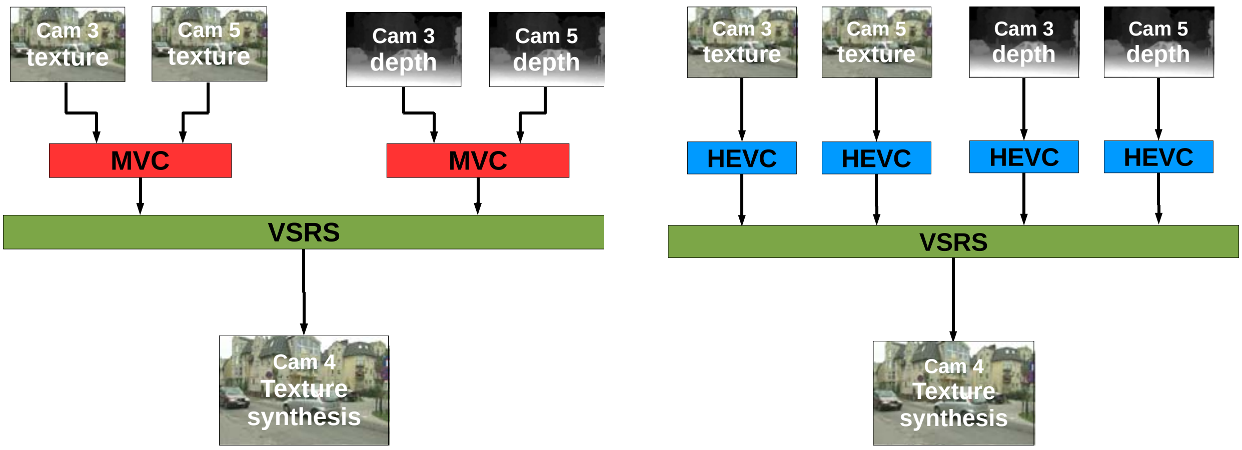

Fig 5. Middle view synthesis scenario for both HEVC proposal and MPEG-4 MVC.

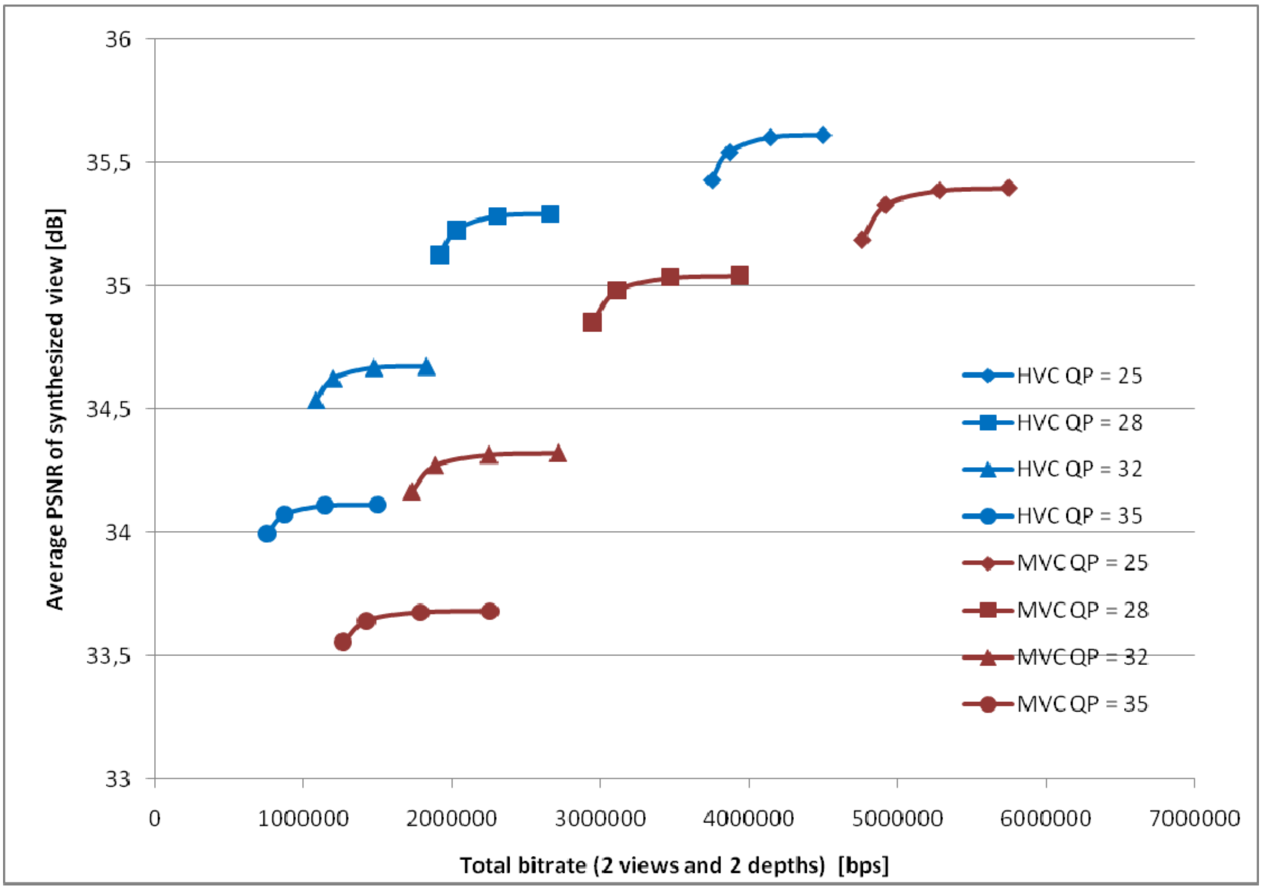

Fig 6. Results of synthesis performance vs. total bitrate for both HEVC proposal and MPEG-4 MVC.

In this experiment it is also clearly visible that Samsung HEVC proposal is suitable for 3DV purposes and outperforms MPEG-4 MVC.

3.3. Three view encoding

We compressed the texture for views 3, 4 and 5 of the sequence with both, MPEG-4 MVC and Samsung HEVC proposal. The results are the following.

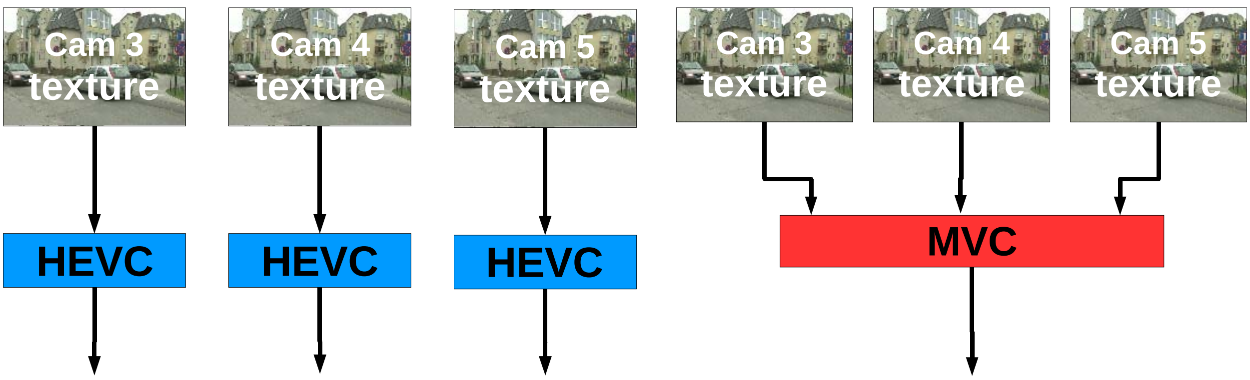

Fig 7. Compression scenario for both HEVC proposal and MPEG-4 MVC.

Table 3. Results of coding three view case for texture video only.

Three view case (cam 3, 4 and 5)			
	QP	total bitrate [Mbps]	average PSNR
MVC	25	5.703	39.11
	28	3.281	37.90
	32	1.747	36.19
	35	1.178	34.96
Samsung HEVC	25	5.283	39.50
	28	2.534	38.15
	32	1.303	36.50
	35	0.815	35.31

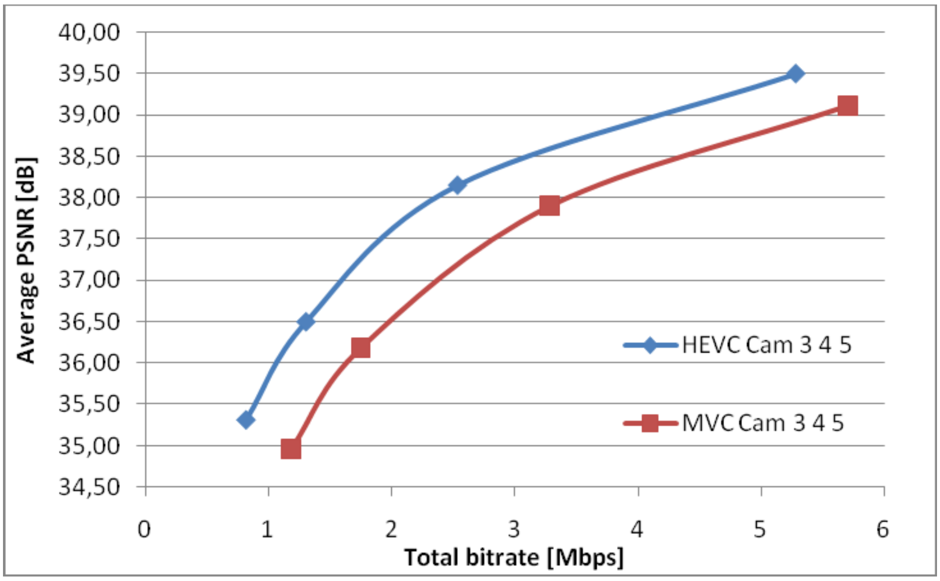

Fig 8. Results of coding three view case for texture video only.

The Samsung HEVC proposal coding efficiency is much higher also in this case. However, in the three view case it is interesting to note the view 4 behaviour. Compared to independently coded by HEVC, the MPEG-4 MVC coded texture of this view is better – PSNR is higher for the same bitrate (Table 3, Fig 9). This is due to the inter view prediction that is used in MPEG-4 MVC. However, the difference is marginal compared to the gain offered by HEVC for two other views.

Table 3. Results of coding view 4 (texture video only).

view 4 (middle view) in 3 view case			
	QP	total bitrate [Mbps]	average PSNR
MVC	25	1.276	39.21
	28	0.668	38.03
	32	0.351	36.36
	35	0.246	35.19
Samsung HEVC	25	1.740	39.54
	28	0.824	38.20
	32	0.423	36.56
	35	0.265	35.38

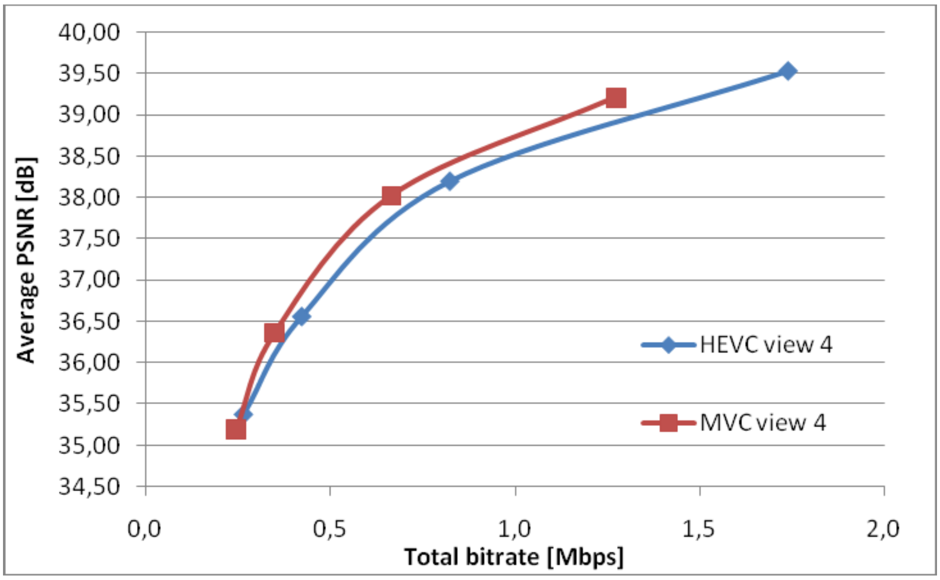

Fig 9. Results of coding view 4 (texture video only).

For the view 3 (the first view in MVC scheme), the results are different. Here HEVC is undisputably better (Table 3, Fig. 10).

Table 3. Results of coding view 3 (texture video only)

view 3 (first view) in 3 view case			
	QP	total bitrate [Mbps]	average PSNR
MVC	25	2.618	39.12
	28	1.673	37.95
	32	0.955	36.26
	35	0.655	35.00
Samsung HEVC	25	1.754	39.49
	28	0.861	38.10
	32	0.444	36.41
	35	0.278	35.20

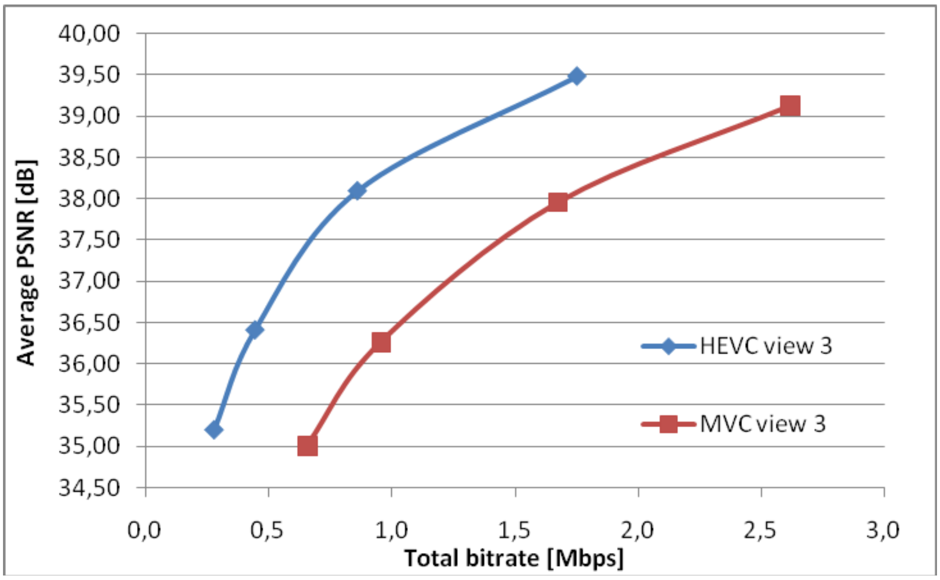

Fig 10. Results of coding view 3 (texture video only).

4. Summary

The abovementioned results show that even initially proposed HEVC codec even used in simulcast mode outperforms MPEG-4 MVC codec in all tested scenarios. Final HEVC coding standard will have even better performance. Moreover it is expected that implementing in HEVC tools from MPEG-4 MVC (like inter view prediction) would increase the coding efficiency of HEVC even further. These tests are preliminary and should be extended onto other multiview test sequences. Nevertheless, the results for "Poznan street" are very clear.

Therefore we conclude that the requirement of backward compatibility with MPEG-4 MVC might compromise compression performance of the future .3D video standard codecs.

With respect to the results presented above, we propose to exclude the requirement of backward compatibility with MPEG-4 MVC from the Call for Proposals for 3D Video coding technique.

5. References

[1] Video and Requirements Group, "Applications and Requirements on 3D Video Coding," ISO/IEC JTC1/SC29/WG11 N11061, Xian, China, October 2009.

[2] M. Domański, T. Grajek, K. Klimaszewski, M. Kurc, O. Stankiewicz, J. Stankowski, K. Wegner "Poznań Multiview Video Test Sequences and Camera Parameters", ISO/IEC JTC1/SC29/WG11 M17050, Xian, China, October 2009

[3] K. McCann, W.-J. Han, I.-K. Kim, J.-H. Min, E. Alshina, A. Alshin, T. Lee, J. Chen, V. Seregin, S. Lee, Y.-M. Hong, M.-S. Cheon, N. Shlyakhov, "Video coding technology proposal by Samsung (and BBC)" JCTVC-A124 Joint Collaborative Team on Video Coding (JCT-VC), Dresden, Germany, April 2010