Technical Report 008

HDTV
Contribution
Codecs

EBU **TECHNICAL**

Your reference in media technology and innovation

Geneva
March 2010

EBU·UER

Contents

Acknowledgements

This report marks the conclusion of a first study on new HD contribution compression systems conducted jointly by the EBU, IRT, RTVE and RAI within the EBU N/HDCC Project group.

Special thanks are extended to all group members and in particular to Daniele Airola, Giorgio Dimino (RAI), Dagmar Driesnack, Sonia Langhans (IRT), Gaetano Amatucci (HR Online) and Damien Ruiz Coll (RTVE) for their dedicated commitment and participation in this work.

The EBU should also like to thank TVIPS and NEVION for providing the JPEG2000 equipment and ATEME and NTT Electronics for providing their H.264/AVC 4:2:2 systems.

° Issued by EBU TECHNICAL
L'Ancienne Route 17A
1218 Le Grand-Saconnex
Switzerland

tech@ebu.ch

HDTV Contribution Codecs
technology evaluation

Keywords: HDTV Contribution Compression, JPEG2000, H.264/AVC

1. Introduction

For several years, MPEG-2 has been the reference compression system for broadcast applications in general. While it was successfully replaced in distribution by H.264/AVC systems, it has remained the front runner for HDTV contribution applications. However, challenger technologies such as JPEG2000 and H.264/AVC contribution products are emerging as potential replacements.

The EBU N/HDCC project group was created to evaluate the coding gain of new JPEG2000 and H.264/AVC compression technology compared to legacy MPEG-2 for HDTV contribution applications. Two vendor implementations of each compression technology were tested to avoid being biased by a particular implementation of the standard.

This report describes the results of the study undertaken; it is in the nature of a technology evaluation to provide guidance on the performances of each technology compared to existing HD contribution compression systems.

2. Description of the Study

As illustrated in Figure 1, a contribution link was simulated by passing a signal twice through the codec under test,with a spatial pixel shift introduced between codec passes. This is equivalent to a signal passing through a pair of cascaded codecs that would typically be encountered on a contribution link.

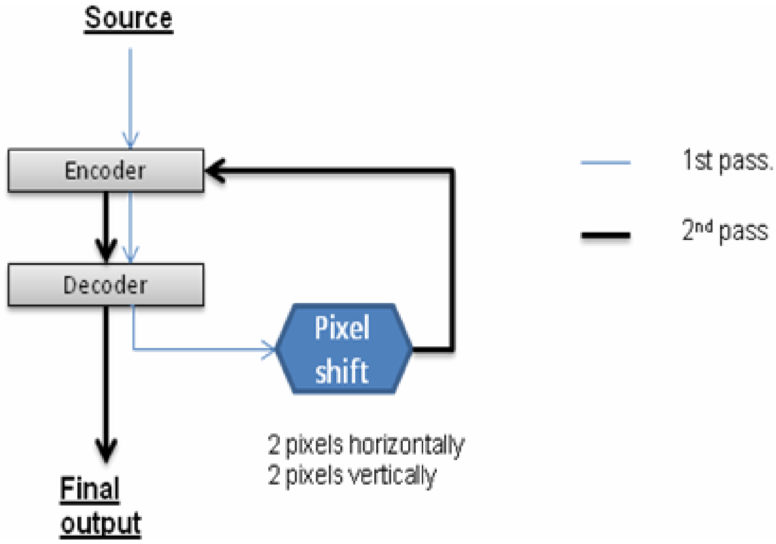


Figure 1: Simulation of a typical Contribution Link

The test sequences were selected so as to represent typical contribution content and consisted of excerpts from sports, a live concert, general scenes, etc. (see Figure 2). The sequences used were 10-bit 4:2:2 uncompressed and in both 720p/50 and 1080i/25 image formats. A description of all the test sequences is given in **Annex A**.

Some post-produced content (i.e. the 'treno' sequence; number 4 in **Annex A**) was also used. This sequence was available uncompressed, as a 4th generation of AVC-I cascading (at 100 Mbit/s) and as a 4th generation MPEG-2-long GOP (XDCAM HD at 50 Mbit/s).

All the codecs that were tested support 4:2:2 colour sampling, which is required for professional contribution applications.

Figure 2: An overview of test sequences (see Annex A)

Since the aim of the study was to measure the quality gain in using the H.264/AVC or JPEG2000 technologies over the MPEG-2 compression system, encodings were performed assuming, in a first instance, an error free channel.

According to the codec (product) capabilities, bit-rates between 15 Mbit/s to 250 Mbit/s were tested as they are in the range of the commonly used bit rates over fibre (> 100 Mbit/s) or satellite (up to 60[1] Mbit/s).

MPEG-2 encodings of test sequences at bit-rates of 30, 45, 60, and 100 Mbit/s were used as comparison anchors. The equivalent quality using H.264/AVC was found subjectively by viewing the H.264/AVC sequences at different bit-rates, starting at half the MPEG-2 bit-rate and increasing it by steps of 10% (of the MPEG-2 reference bit rate) until the quality of the MPEG-2 encoded sequence and that of the H.264/AVC encoded sequence was judged to be equivalent.

As an example, if the reference to be matched is 30 Mbit/s MPEG-2, then the H.264/AVC evaluation will start at 15 Mbit/s (50% of MPEG-2 reference rate) and if the quality is judged equivalent at this bit-rate the potential coding gain of H.264/AVC over MPEG-2 would be 50%, if equivalence was achieved at 18 Mbit/s (60% of MPEG-2 reference rate) the potential coding gain of H.264/AVC over MPEG-2 would then be 40%, and so on.

[1] Maximum satellite bit-rate on a 36 MHz transponder using DVB-S2 Modulation.

The bit-rate considered here represents the coded video bit-rate. It does not include the transport stream (TS) overhead.

The GOP (group of pictures) coding structures tested were the following:

- I –Intra Frame only.
- IP – (low delay mode structure)
- IBP
- IBBP
- 'Manufacturer' – those settings proposed by manufacturers that could provide a good trade-off between latency and visual quality (mainly adaptive GOP).

GOP alignment was not applied during the cascading. The comparison was done using sequences encoded with the same GOP structures. For instance, the JPEG2000 encodings were only compared with their I-frame only MPEG-2 counterparts.

3. Assessment Methodology

3.1 Objective measurement

As an indication of the objective quality of the sequences, the peak signal to noise ratio (PSNR) was used. This measurement is useful to identify trends in the behaviour of the different compression systems under test in a cascaded environment.

3.2 Subjective analysis

Expert viewings were performed on carefully aligned 50" Pioneer PDP 5000 EX plasma displays using the TSCES assessment method developed at the EBU (Figure 3)[1]. The MPEG-2 anchor is displayed on the middle screen while both manufacturer's implementations are simultaneously displayed on top and bottom displays, all synchronised with the reference at various bit-rates until a visual match is found by the viewers or a cross point in quality can be determined (i.e. system under test becoming better than the reference from one bit-rate to another).

Figure 3: EBU TSCES quality assessment rig

The subjective evaluation mainly tested the 2nd generation sequences, which can actually allow better discrimination of the feeds than the 1st generation. Only the Intra, IP and IBBP GOP structures were reviewed during the subjective evaluation since those are the most relevant structures in contribution applications. The aim of the viewing was to match the quality of the reference MPEG-2 feed.

4. Results

4.1 *Objective measurements*

4.1.1 Implementation differences

The H.264/AVC implementations used in this study were, objectively speaking, relatively close. The only striking difference that could be noted (see Figures 4 & 5) for the Intra GOP structure coding was a difference of up to 3.5 dB (3.5 dB for 1080i/25 and 2.5 dB for 720p/50). The difference for the other GOP structures was below 0.5 dB which can be considered negligible. The latter differences were image format agnostic and were still visible at the 2nd generation. This very high degree of similarity is re-assuring when making the assumption that the result of this study can be applied to other implementations of the same technology.

H.264/AVC PSNR Differences

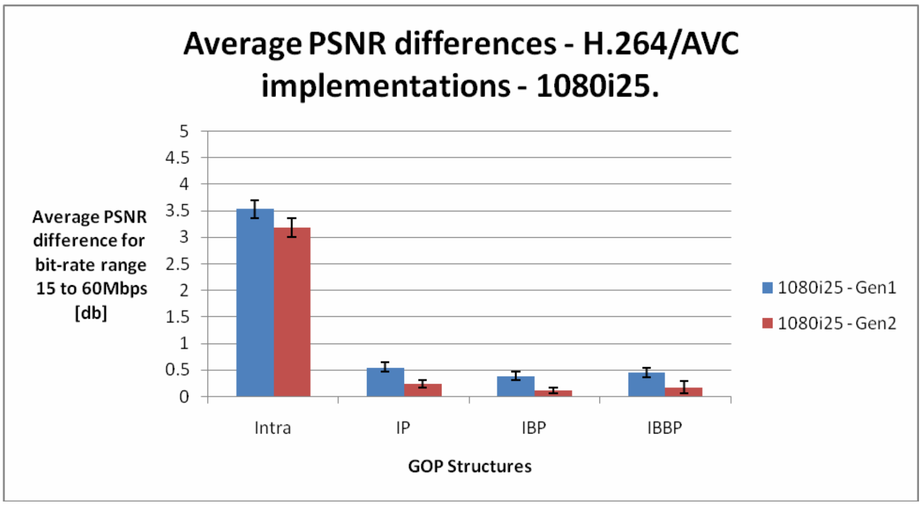


Figure 4: H.264/AVC implementation differences with 1080i/25 coding

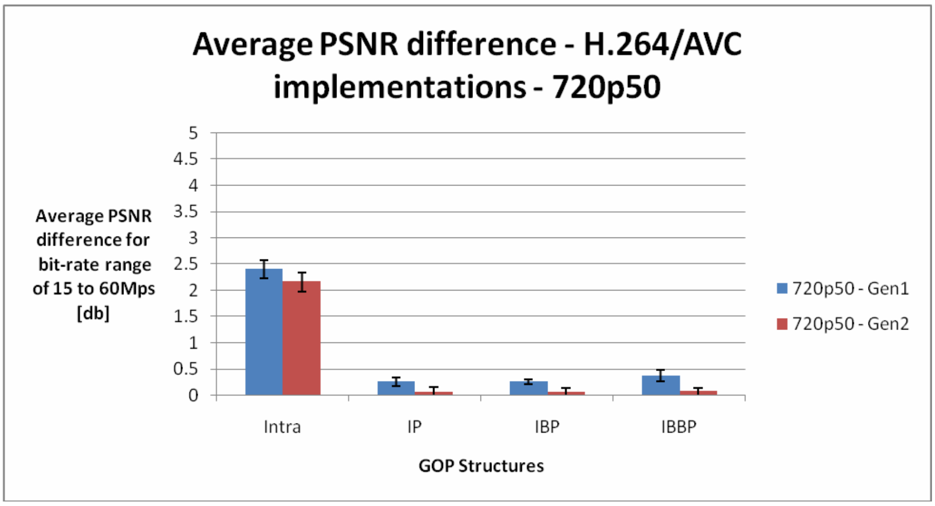


Figure 5: H.264/AVC Implementation differences with 720p/50 coding.

H.264/AVC Cascading Losses

Concerning the cascading losses exhibited by the H.264/AVC systems, a difference of less than 0.3 dB could be identified (see Figure 6) between them.

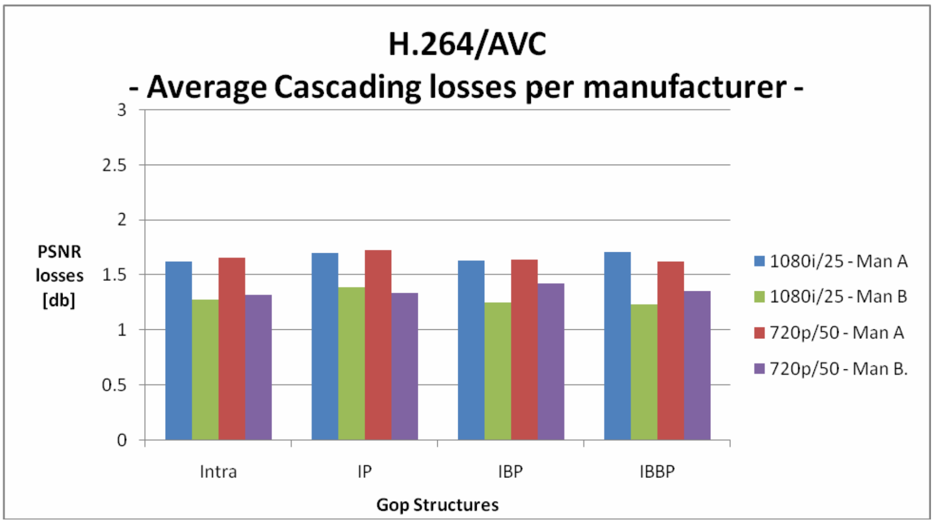


Figure 6: H.264/AVC average cascading losses per manufacturer

Both systems exhibited a linear, constantly increasing characteristic as shown in Figures 7 & 8.

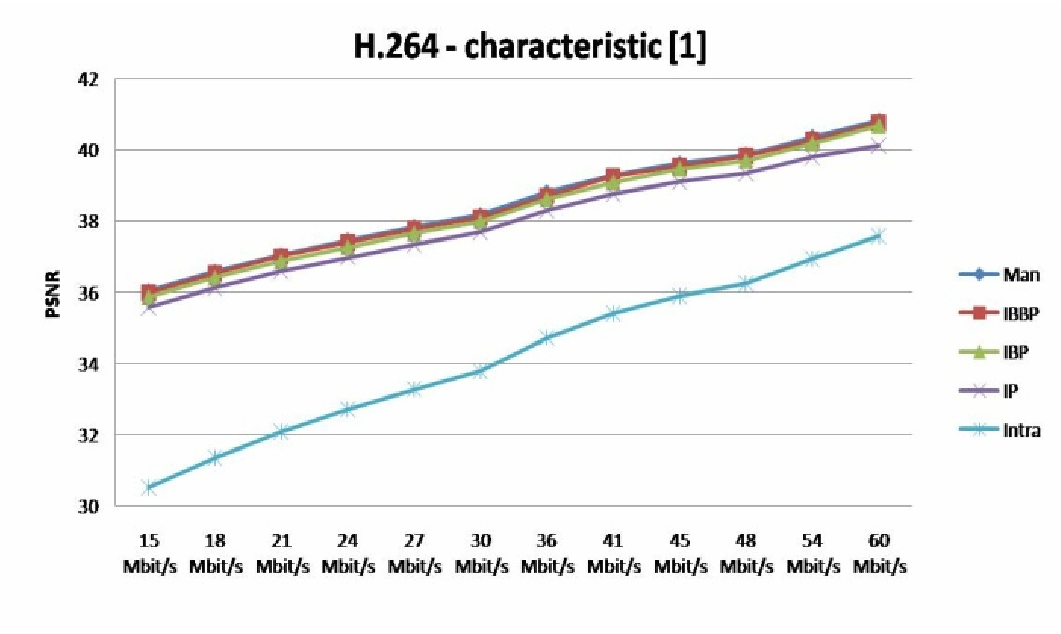


Figure 7: H.264/AVC system (1) characteristics

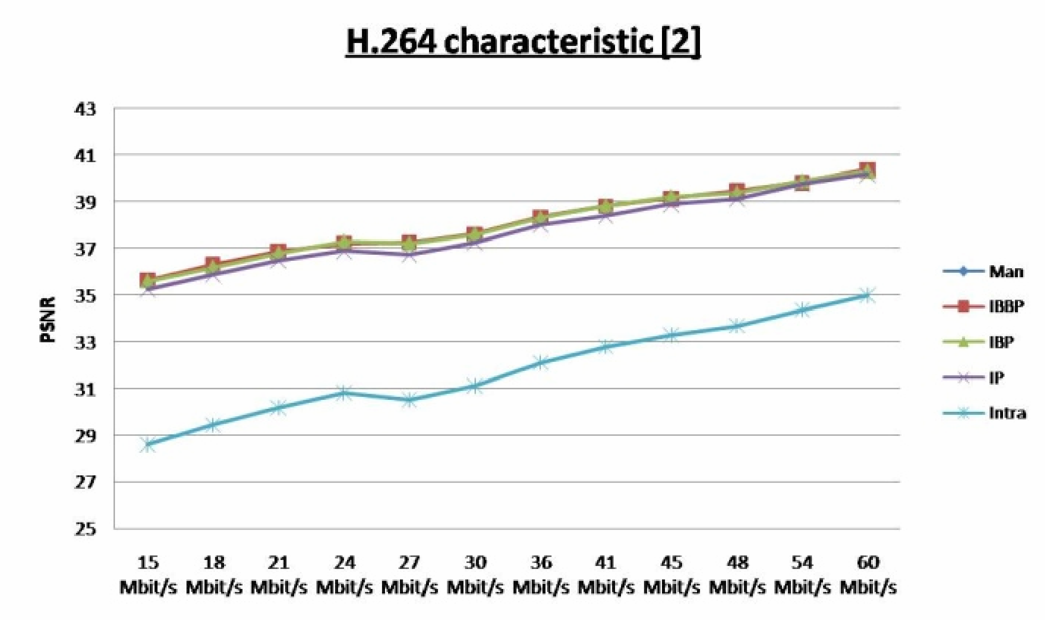


Figure 8: H.264/AVC system (2) characteristics

JPEG2000 PSNR Differences

As for the two JPEG2000 implementations, in addition to their different maximum coding rates, both systems had an underlying linear, constantly increasing PSNR with increasing bit-rate, but one of the systems' characteristic was much less stable, as shown in Figures 10 & 11. For this reason, only the more linear JPEG2000 system was considered in the subsequent subjective viewing assessments.

JPEG2000 Cascading Losses

Both JPEG2000 systems had a different response to cascading depending on the image format under test. As shown in Figure 9, one system had an excellent behaviour using 720p/50 (only 0.5 dB lost) while the other implementation had almost the same losses for both image formats (nearly 2.7 dB).

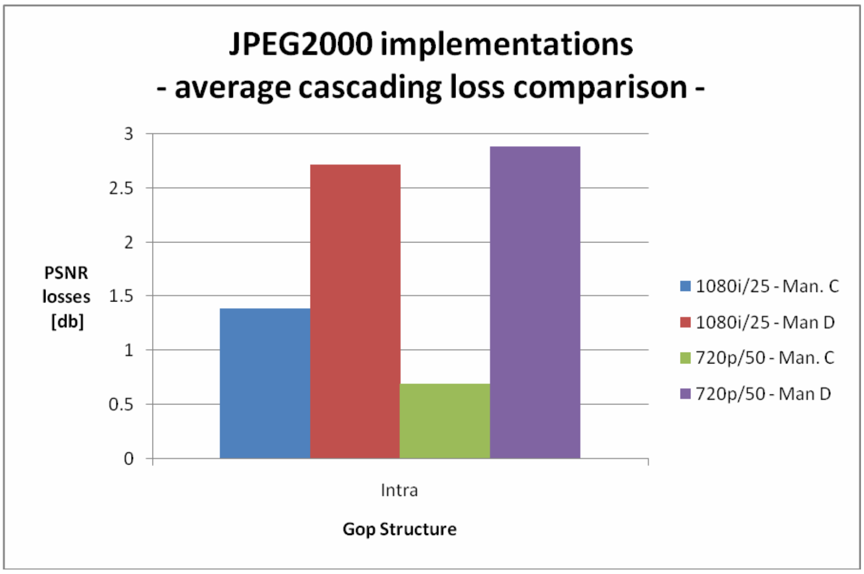


Figure 9: JPEG2000 average cascading losses

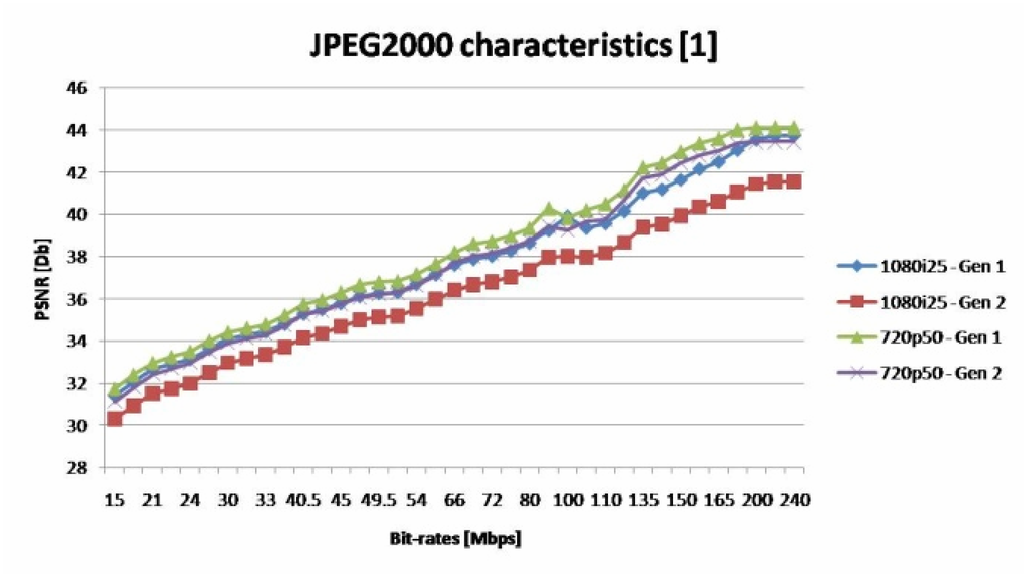


Figure 10: JPEG2000 system (1) characteristics

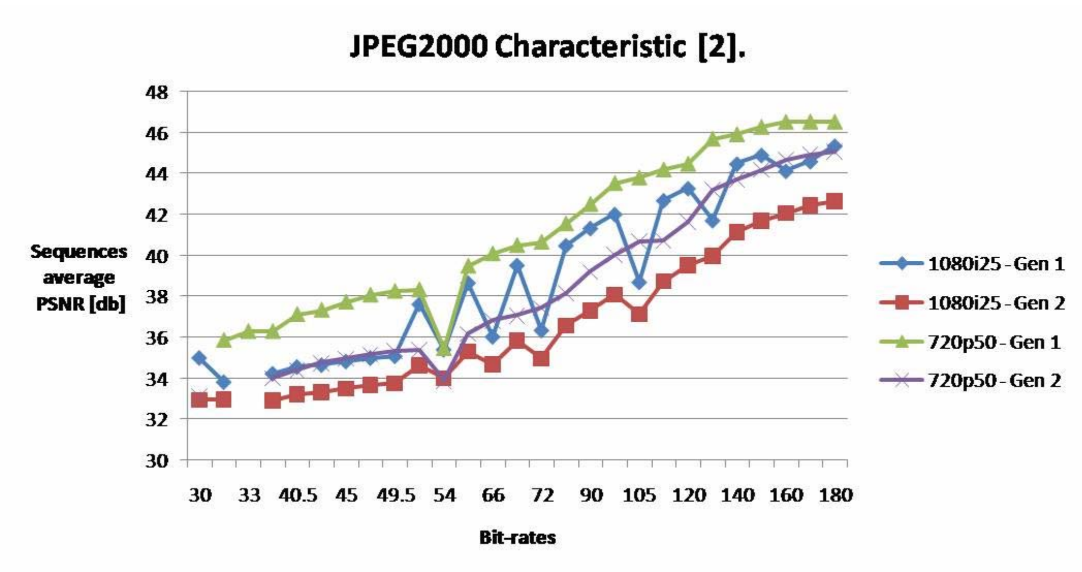


Figure 11: JPEG2000 system (2) characteristics

4.1.2 H.264/AVC versus MPEG-2

The MPEG-2 system used in the tests had very similar cascading losses to the H.264 systems at about 1.5 dB losses on average for both formats (compare Figures 6 & 12). Therefore the conclusion objectively drawn at the first generation can be applied with confidence to the second generation.

The detailed results of the objective comparison (based on PSNR) between H.264/AVC and MPEG-2 are given in Table 1, below. According to these results, a minimum PSNR-gain of 40% can be expected from H.264 with regard to MPEG-2. A decay of 10% can be observed for Intra GOP structures from one generation to the next, while it remains constant for all other GOPs tested. The PSNR gain is observed to be even higher for Intra GOP structure and for rates below 45 Mbit/s. Due to the drastic difference in coding intra frames from one H.264 manufacturer to another, this PSNR gain should not be considered as a valid quality gain until it is verified by proper subjective evaluation.

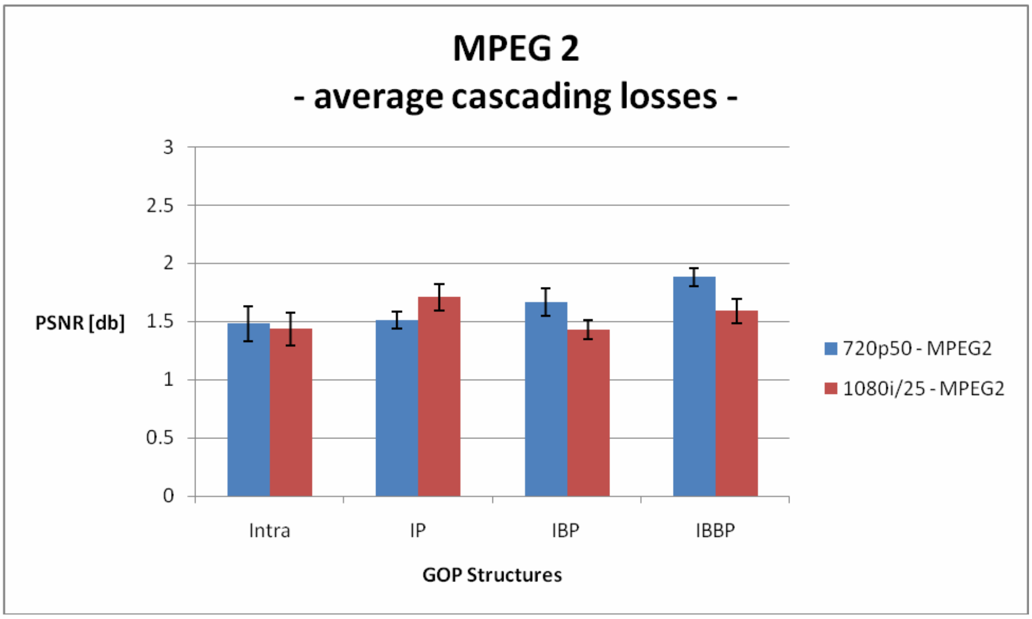


Figure 12: MPEG-2 average cascading losses

Table 1: H.264/AVR PSNR results

H264		1080i/25				720p/50			
	Ref. bit-rate (Mbit/s)	Equivalence range Gen 1 (Mbit/s)	Gain %	Equivalence range Gen 2 (Mbit/s)	Gain %	Equivalence range Gen 1 (Mbit/s)	Gain %	Equivalence range Gen 2 (Mbit/s)	Gain %
Intra	30	<15	>50	<15	>50	<15	>50	<15	>50
	45	[21 ; 24]	<60	[27 ; 30]	<50	[21 ; 24]	<60	[24 ; 27]	<50
	60	[30 ; 36]	<50	[36 ; 41]	<40	[30 ; 36]	<50	[30,36]	<40
	100	>60	N/A	>60	N/A	>60	N/A	>60	N/A
IP	30	[15 ; 18]	<50	[15 ; 18]	<50	[15 ; 18]	<50	[15 ; 18]	<50
	45	[27 ; 30]	<50	[27 ; 30]	<50	[27 ; 30]	<50	[27 ; 30]	<50
	60	[36 ; 41]	<40	[36 ; 41]	<40	[36 ; 41]	<40	[36 ; 41]	<40
	100	>60	N/A	>60	N/A	>60	N/A	>60	N/A
IBP	30	[15 ; 18]	<50	[15 ; 18]	<50	[15 ; 18]	<50	[15 ; 18]	<50
	45	[27 ; 30]	<50	[27 ; 30]	<50	[27 ; 30]	<50	[27 ; 30]	<50
	60	[36 ; 41]	<40	[36 ; 41]	<40	[36 ; 41]	<40	[36 ; 41]	<40
	100	>60	N/A	>60	N/A	>60	N/A	>60	N/A
IBBP	30	[18 ; 21]	<40	[18 ; 21]	<40	[18 ; 21]	<40	[18 ; 21]	<40
	45	[30 ; 36]	<45	[30 ; 36]	<45	[30 ; 36]	<45	[30 ; 36]	<45
	60	[45 ; 48]	<25	[45 ; 48]	<25	[36 ; 41]	<40	[36 ; 41]	<40
	100	>60	N/A	>60	N/A	>60	N/A	>60	N/A

Note: the above equivalence range results are in the form [Man. A ; Man. B]

Looking at this minimum objective gain, it is tempting to state that the 50% gain of H.264/AVC acknowledged for HD distribution rates can also be met for contribution rates. The subjective evaluation will help clarify this statement.

4.1.3 JPEG2000 versus MPEG-2

The detailed results of the objective comparison (based on PSNR) between JPEG2000 and MPEG-2 are given in Table 2.

Table 2: JPEG2000 PSNR results

JPEG 2000		1080i/25				720p/50			
	Ref. bit-rate (Mbit/s)	Equivalence range Gen 1 (Mbit/s)	Gain %	Equivalence range Gen 2 (Mbit/s)	Gain %	Equivalence range Gen 1 (Mbit/s)	Gain %	Equivalence range Gen 2 (Mbit/s)	Gain %
Intra	30	<15	>50	<15	>50	<15	>50	<15	>50
	45	[22.5 ; 24]	<60	[22.5 ; 24]	<60	[18 ; 21]	<60	[15 ; 18]	<70
	60	[33 ; 36]	<45	[33 ; 36]	<45	[27 ; 30]	<55	[24 ; 27]	<70
	100	[60 ; 66]	<40	[54 ; 60]	<40	[50 ; 54]	<50	[40.5,42]	<60

Note: the above equivalence range results are in the form [Man. C ; Man. D]

According to these objective measurements, JPEG2000 can provide more than 50% gain over MPEG-2 Intra mode, which betters the performance of H.264/AVC in intra mode. However, knowing that **PSNR values do not always correlate with subjective quality it should thus not be considered as a valid quality comparison metric unless verified by proper subjective evaluation**.

The PSNR values may nevertheless be used to assess the behaviour of both systems to cascading losses. Indeed, it can be agreed by comparing the cascading losses in PSNR that JPEG2000 has better sustainability than the other systems.

4.1.4 PSNR comparisons at the sequence level

By analysing the PSNR values at the sequence level, it was possible to identify critical sequences for each of the codec types. As can be seen in Figures 13 & 14, '*Parkjoy*' and '*CrowdRun*' are the most critical sequences overall (lowest PSNR values).

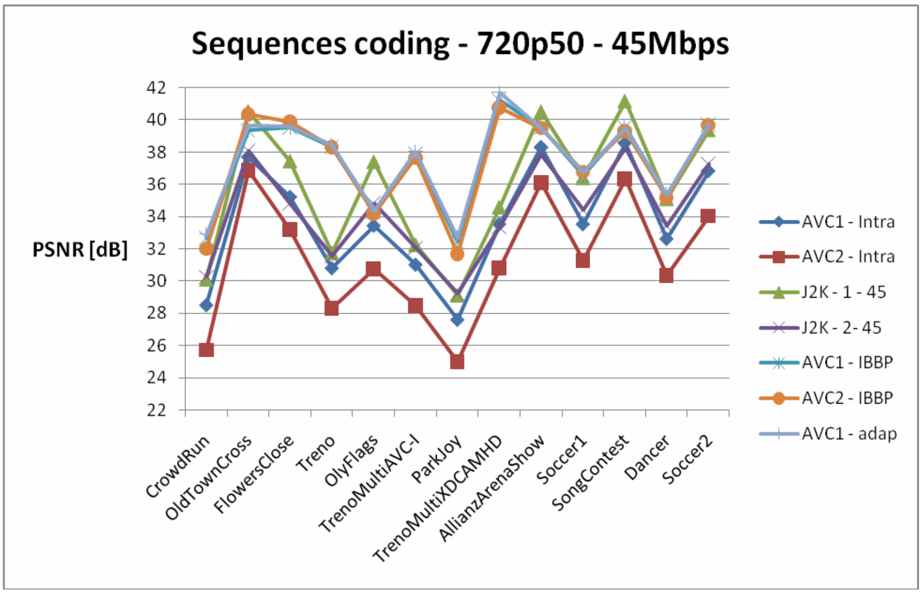


Figure 13: PSNR comparison of sequences. All systems encoded at 45 Mbit/s

These two sequences were generated from film (65 mm, 50fps, scanned to 2K resolution) which is less representative of typical contribution content. This criticality is due to the level of noise and the complex motion component that the sequences have. Noisy content can also be encountered depending on the shooting conditions and/or the camera sensor capabilities. A description of the nature of the source material is provided in **Annex A**.

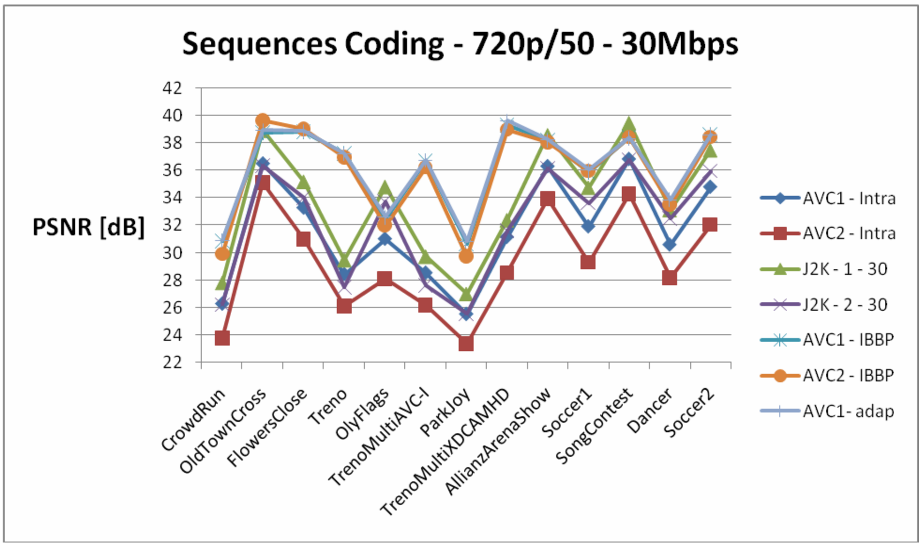


Figure 14: PSNR comparison of sequences. All systems encoded at 30 Mbit/s

Both H.264/AVC systems have better PSNR performances than the JPEG2000 systems when used in IBBP mode even though over all the sequences they still attract the smallest PSNR values. This is again due to the combined effect of the de-noising filters and the prediction tools of H.264/AVC.

The sequence '*OlyFlags*', with heavily complex motion but with less noise than both '*CrowdRun*' and '*Parkjoy*', is not at all critical for intra mode compression which preserves the motion components (this is also corroborated by the subjective evaluation). '*Olyflags*' nevertheless becomes highly critical as soon as inter frame coding is involved. It can thus be stated that as long as the necessary transmission bandwidth is available, intra systems should be used for contribution of content with a high motion complexity.

Some manufacturers advise the use of adaptive GOP, wherein the system effectively inserts prediction frames at intervals that depend on the estimated motion complexity. Based on the results of the objective measurements, such an approach can improve the quality of complex sequences such as '*OlyFlags*' by only a few dBs (0.3 dB), however the overall motion portrayal of the sequence is improved. Such a setting does not influence the latency (no variation) since the maximum buffer size allocated during set up for the prediction remains constant. Only the picture size is adapted as a function of the prediction needs.

Most of the test sequences included in the test were provided uncompressed and un-processed (direct output of the camera, no post-production). The '*Treno*' sequence was also processed both to 4th generation AVC-I and to 4th generation MPEG-2 long GOP to simulate the use for contribution of a production (acquisition) chain output. The subjective results are given in the table below. As can be seen, the AVC-I compressed system exhibits the same behaviour as the uncompressed version of the sequence (it has a similar PSNR) while the MPEG-2 long GOP version exhibited a higher PSNR value. By definition, the PSNR value measures the level of noise introduced by the system under test between the reference and the encoded version. The PSNR values in Figure 12 can be interpreted as if the AVC-I system was transparent to the source (in terms of texture, image complexity and noise) whilst the MPEG-2 long GOP has an impact on the source.

4.2 Subjective evaluation results

Expert viewings were performed according to the TSCES assessment method developed at the EBU [1], using carefully aligned 50” pioneer PDP plasma displays. The MPEG-2 anchor was shown in the middle screen while the manufacturer’s implementations were displayed above and below the reference. The data rates of the codecs under assessment were varied, whilst keeping all three images synchronised, and when a visual quality match was found or when a cross-point in quality (i.e. when the system under test became better than the reference from one data-rate to another) was seen by the viewers, the data-rates of the codecs were noted.

The subjective evaluations mainly tested the 2nd generation output of the codecs, which can actually allow better discrimination of the feeds than can the 1st generation. Only the Intra, IP and IBBP GOP structures were reviewed since those are the most relevant contribution structures. The aim of the viewing was to match the quality of the reference MPEG-2 feed.

Table 3: H.264/AVC subjective evaluation

H264		1080i/25			720p/50		
	Reference bit-rate (Mbit/s)	Equivalence range (Mbit/s)	Gain %	Comments	Equivalence range (Mbit/s)	Gain %	Comments
Intra	30	N/A	N/A	Ungradable since reference has too low quality. H.264/AVC artefacts less annoying.	N/A	N/A	Same comment.
	45	[41 ; 45]	<10	Lower bound with slightly less resolution	[36 ; 41]	<20	Equivalence at lower bound
	60	[54 ; 60]	<10	Lower bound with slightly less resolution	[54 ; 60]	<10	Equivalence at lower bound
	100	>60	N/A	Reaching visual transparency	>60	N/A	
IP	30	[21 ; 24]	<30	Less noise and better resolution than reference	[21 ; 24]		
	<30	Equivalence at lower bound					
	45	[30 ; 36]	<25	Less noise and better resolution than reference	[30 ; 36]	<25	Equivalence at lower bound
	60	[45 ; 48]	<25	Less noise and better resolution than reference	[41 ; 45]	<25	Equivalence at lower bound
	100	>60	N/A	Similarities on some sequences. Close to visual transparency.	>60	N/A	Equivalence at lower bound
IBBP	30	[18 ; 21]	<40		[18 ; 21]	<40	Equivalence at lower bound
	45	[27 ; 30]	<40		[27 ; 30]	<40	Equivalence at lower bound
	60	[30 ; 36]	<50		[30 ; 36]	<50	Equivalence at lower bound
	100	>54	N/A	Similarities on some sequences. Close to visual transparency.		>54	

Note: the above equivalence range results are in the form [Man. A ; Man. B]

As can be seen in Tables 3 & 4, the results of the subjective evaluation differ from the assertion drawn from the objective results. The gain varies from one GOP structure to another (Intra min 10%, IP 25% to 30%.IBBP 40% to 50% at 2nd generation). The gain progression follows the use of

B-frames in the sequence coding.

H.264/AVC efficiency mainly relies on the use of its provided toolbox. One of its major tools is the hierarchical B-frame; this, together with the new macro block size and slices help the H.264/AVC algorithm to perform better prediction. Without the predicted frames (B and P), H.264/AVC is different from MPEG-2 in intra mode only.

Other aids of H.264/AVC are the de-blocking/de-noising loop filters that provide it with less annoying artefacts and less noisy sequences than MPEG-2. During the viewing sessions, even if an H.264/AVC sequence had slightly less resolution than the equivalent MPEG-2 sequence, it was still preferred because it was less noisy (i.e. H.264 artefacts are rapidly less annoying than those of MPEG-2). It should be noted that the 720p/50 format had better performance than the 108i/25 format by matching the quality equivalence at the lower bound of the defined range. This was not always the case for the 1080i/25 format.

Concerning JPEG2000, the results of the viewing sessions were drastically different from those of the objective evaluations. This was due to the objective metric used. Indeed, the PSNR is known for not correlating well with subjective evaluation. JPEG2000 processes the image by a succession of low- and high-pass filtering stages resulting in image sequences with blurry artefacts and with cleaner images. The JPEG2000 PSNR values can thus appear very high while the structural quality of the video might be different (contouring, overall blur for complex images with high activity).

Table 4: JPEG2000 subjective evaluation

JPEG 2000		**1080i/25**			**720p/50**		
	Reference bit-rate (Mbit/s)	**Equivalence range (Mbit/s)**	**Gain %**	**Comments**	**Equivalence range (Mbit/s)**	**Gain %**	**Comments**
Intra	30	N/A	N/A	Ungradable since reference has too low a quality. JPEG2000 artefacts less annoying.	N/A	N/A	Same comment.
	45	[48 ; 54]	<20	Below 45 Mbit/s. Better quality for some sequences but worse quality for very noisy sequences such as *CrowdRun* and strong colour bleeding	<50	<-10	Equivalence at lower bound
	60	[70]	<-20	Below 60 Mbit/s. Better quality for some sequences but worse quality for very noisy sequences such as *CrowdRun*. Lighter colour bleeding.	[60 ; 70]	<-20	
	100	[100 ; 105]	N/A	Below 100 Mbit/s. Better quality for some sequences but worse quality for very noisy sequences such as *CrowdRun*	[80 ; 90]	<20	

Note: the above equivalence range results are in the form [Man. C ; Man. D]

JPEG2000 was assessed as not being equivalent to MPEG-2 quality on specific references and rates because it can exhibit markedly different behaviour from one sequence to another. For example, JPEG2000 had astonishing performances (even at bit-rates below the reference MPEG-2 rate) on sequences such as '*OlyFlags*' which appeared to be highly critical both for H.264/AVC and for MPEG-2. Noisier sequences such as '*CrowdRun*' or '*ParkJoy*' were more critical to JPEG2000 and brought its overall performance down. As soon as the bit-rate exceeded 60 Mbit/s, however, the criticality of the abovementioned sequences became less of a problem. This can explain the gain of 20% over the 100 Mbit/s MPEG-2 (for 720p/50). The variation of gain compared to 1080i/25 once again shows the suitability of progressive formats over interlaced formats. The performance of JPEG2000 may vary depending on the interlaced coding scheme (field based or frame based), as with H.264/AVC.

JPEG2000 implements what can be incorrectly termed "Region of interest coding" at bit-rates lower than the MPEG-2 reference. JPEG2000 preserved the fidelity of coarse objects in the scene such as football players while the highly-detailed grass is lost. The same observation was made on the '*CrowdRun*' sequence, where the runners were still recognisable. This is simply the manifestation of JPEG2000's graceful degradation feature whereby the high frequency components (highly detailed areas such as grass) of the image are dropped. These fine details are gradually recovered as JPEG2000's bit-rate is increased.

Even if JPEG2000 does provide significant coding gain (which is normal for an Intra codec) it should be recalled, as described in [2], that JPEG2000 has a significant resistance to cascading losses (only experiencing losses at the 1st generation without shift) while the losses of an MPEG-2 system are additive throughout the generations.

5. Conclusions

To summarize the foregoing results it can be said that:

H.264/AVC can provide bit-rate savings of up to 40%-50% depending on the GOP structure (Intra mode 10%, IP 25% to 30%, IBBP 40% to 50% at 2nd generation) at the 1st and 2nd generation while still providing equivalent quality to MPEG-2. The latter results consider the best of the tested implementation and thus a safety margin of ±5% should be taken into account for the performance of other implementations. The outlined saving considers the full set of sequences, which had different criticality. Depending on the latter criteria and more specifically motion criticality, the bit-rate saving can be reduce by 5 to 10%.

JPEG2000 needs 20% more bit-rate for reference rates below 60 Mbit/s to provide better quality than MPEG-2 intra for all sequence types (i.e. below 60 Mbit/s, JPEG2000 artefacts on noisy sequences are much more annoying than those of MPEG-2). However it provided stunning picture quality for content known for its high motion criticality for DCT-based systems. In this regard, JPEG2000 would be more suitable for high quality contribution of high motion content such as sport as long as the additional transmission capacity is available.

Starting at 80 Mbit/s, JPEG2000 provides better quality for all sequences and significant coding gain. It is thus recommended for high bit-rate contribution applications.

As explained in this report, PSNR values can exhibit low correlation with the subjective quality of the content, depending on the coding technology used. It is thus advised that PSNR should be used as a trend analyser for 'JPEG2000-like' systems or more generally, when comparing different coding technologies. In such cases it should not be used as a quality metric since it does not always correlate with the observed visual quality. Subjective quality assessment must always be done alongside any PSNR measurements to verify the system's performance.

In the near future a reference setting test that defines the bit-rate at which a certain compression system can be considered to fulfil a contribution reference quality (i.e. a quality level providing sufficient headroom for additional post-production) will be developed. This part involves a cascade with a distribution encoder to assess the quality at the end-user side.

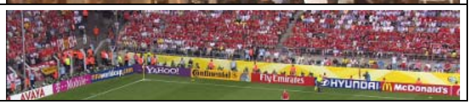
In addition, the relevance of 10-bit coding versus 8-bit coding in contribution applications will also be investigated.

6. References

[1] H.Hoffmann, D. Wood, T. Itagaki,T. Hinz, T. Wiegand "A Novel method for picture quality assessment and further studies of HDTV formats".

[2] H.Hoffmann, A. Kouadio, L. Overmeire, "The JPEG2000 suite: Chapter 15 – Broadcast applications" Wiley 2009.

Annex A: Description of Test Sequences

N°	Name	Format	History	Thumbnail
1	CrowdRun	1080i/25	conversion from 2K version scanned from 65mm film 50fps	
		720p/50	conversion from 2K version scanned from 65mm film 50fps	
2	ParkJoy	1080i/25	conversion from 2K version scanned from 65mm film 50fps	
		720p/50	conversion from 2K version scanned from 65mm film 50fps	
3	OlyFlags	1080i/25	Original source material shot using digital HD camera	
		720p/50	Converted from 1080i/25 version	
4	Treno	1080i/25	Software conversion from 1080p/50 master	
		720p/50	Software conversion from 1080p50 master	
5	Dancer	1080i/25	Software conversion from 1080p/50 master	
		720p/50	Software conversion from 1080p/50 master	
6	Concert	1080i/25	Software conversion from 720p/50 master	
		720p/50	Original shooting format	
7	Soccer1	1080i/25	Software conversion from 1080p/50 master	

N°	Name	Format	History	Thumbnail
		720p/50	Software conversion from 1080p/50 master	
8	Stockholm	1080i/25	conversion from 2K version scanned from 65mm film 50fps	
		720p/50	conversion from 2K version scanned from 65mm film 50fps	
9	Soccer2	1080i/25	Software conversion from 1080p/50 master	
		720p/50	Software conversion from 1080p/50 master	