Project

Report

03.05.2010 Picture Quality Analysis of the SDTV MPEG-2 Encoder Ericsson EN8100

Dagmar Driesnack, IRT

V1.1

Institut für Rundfunktechnik IRT

Content

[This page intentionally left blank]

1 Executive Summary

1.1 Introduction to IRT

The Institut für Rundfunktechnik (IRT) is the central research and development centre for 14 public broadcasting companies in Germany (ARD, ZDF, DRadio), Austria (ORF), and Switzerland (SRG/SSR). Since its foundation in 1956, IRT has been committed to preserving broadcasting and accompanying the adjustment of the broadcasting idea to new market environments and requirements. Further, IRT is cooperating with numerous clients from the broadcasting, media, communications, and information technology industries, as well as with various research institutions and academies.

With its offices in Munich, IRT supports broadcasting on a national and international scale with its spectrum of services. With more than 100 engineers IRT covers all topics related to digital media technology – from TV and radio production systems via network technologies as well as internet applications to transmission systems and frequency management.

The experts from IRT represent German broadcasters in major national and international standardisation bodies, such as the International Telecommunication Union (ITU), Digital Video Broadcasting Project (DVB), WorldDMB and the European Broadcasting Union (EBU).

Examples where IRT has played a key role in system development and successful introduction into practical operation are:

1967 Electronic slow motion: Television scenes can be instantly replayed

1974 ARI traffic radio: Broadcasting of traffic information

1975 Teletext: Text information embedded in the television signal

1985 Eduard-Rhein-Award for VPS: Video programming system for video recorders

1988 Digital Radio: First DAB transmission

1992 HDTV via satellite: Digital HDTV broadcasting via satellite

1999 KEM omni-directional microphone: More freedom of movement for speakers and artists

2000 Emmy Award: Development of the ISO MPEG Layer II audio encoding standard

2004 HDTV: First uncompressed HDTV recordings in 720p/50

2006 Regional Radio Communications Conference: Realignment of the broadcast frequency spectrum for digital terrestrial radio communications

2009 Hybrid-TV: HbbTV-standard merges TV-programmes with the internet

1.2 Test Summary

The measurements and subjective evaluations show that the Ericsson EN8100 provides the best performance for video quality at lower bit-rates and better to identical performance at higher bit-rates (above 4 to 6 Mbit/s) when compared to state of the art distribution encoders for Standard Definition Television encoded in MPEG-2. The EN8100 has shown a significant performance improvement of the video quality for the known SD MPEG-2 encoding technology.

The encoder has some more possibilities to configure the video adjustments (different GOP structures, buffer adjustments, use of statistical multiplexing, etc.) to even further improve the picture quality with these adjustments.

2 Evaluation of Video Quality

2.1 *Description of evaluation method*

2.1.1 Basic Principle

There exists a series of methods for picture quality evaluation, amongst them the subjective tests according to ITU, methods proposed by the SAMVIQ group, or other methods like the JND metric implemented in products available in the market for SD quality evaluation (PQA 200 / Tektronix). It is well known that in general all automated methods do not correctly reflect the subjective assessment and that pure subjective assessment is extremely costly and time-consuming. So-called “Expert views” are a method to reduce the resources required for subjective testing, but bear the risk that a result is not backed by enough statistical data.

Therefore, the codec performance has been evaluated in a dual-step approach that combines

- an automated PSNR measurement with
- a correction of the PSNR figures by subjective assessment during an experts view.

This method also allows to evaluate longer sequences than just 10s as in many other approaches for subjective testing.

2.1.2 Infrastructure

Fig. 1 gives an overview on the infrastructure used for the codec evaluation: All test sequences were available as uncompressed YUV 4:2:2 (8 bit) sequences and had never been compressed before. Each test sequence was preceded by a short so-called “align-sequence” that allows to automatically identify the first frame of the sequence for an automated downstream PSNR analysis, as well as to detect gain or contrast mismatches.

For evaluation of hardware encoders, the signal was fed via SD-SDI links to the encoder under test and the encoded transport stream was recorded.

All recorded transport streams were live decoded to YUV files including YUV 4:2:2, 8 bit by a hardware decoder and recorded on a transparent server (DVS Clipster). The decoded signal was then used for the PSNR calculation. It was confirmed that no other processing, such as colour space transformations, implicit compressions or wrapping to any other file format was applied.

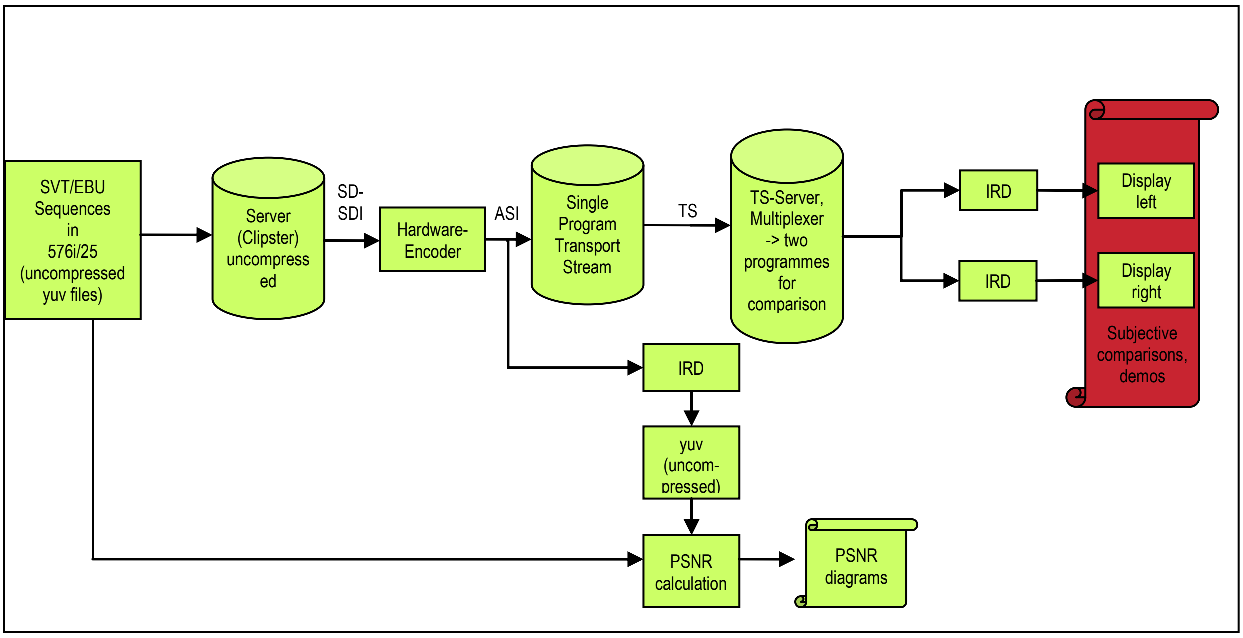


Fig. 1 Infrastructure for codec quality evaluation

The PSNR values were calculated on a frame by frame basis. A white level of 255 (corresponding to signal values from 2^8-1 in 8 bit systems) was applied as peak reference. For calculation of average PSNR figures for the whole sequence, the mean square error for all frames was added and then the logarithmic results of all frames were averaged according to the following formula:

$$PSNR = 20 \cdot \frac{1}{frames} \sum_{0}^{frames-1} \lg\left(\frac{255}{\sqrt{\frac{1}{lines \cdot pixel} \sum_{0}^{lines-1} \sum_{0}^{pixel-1} (coded - reference)^2}} \right)$$

For subjective adjustment and confirmation of the PSNR results, two selected streams from the set of recordings were multiplexed, modulated and decoded by professional decoders (Tandberg RX1290, software version v3.12.0) which were connected via SD-SDI links to two identical 50’’ PDP Flat Panels (Panasonic TH-50PF9EK). The 50 inch displays were used to reflect a high-end “HD capable”-infrastructure at the user’s home - although the tested signals were SDTV. The displays were mounted next to each other in a viewing room with controlled lighting conditions (Fig. 2). The “experts viewers” were able to select and play any of the recorded streams for direct comparison through a special user interface (Fig. 3). The playout of the two transport streams was synchronised to less than one second difference.

Fig. 2 Setup for experts viewing

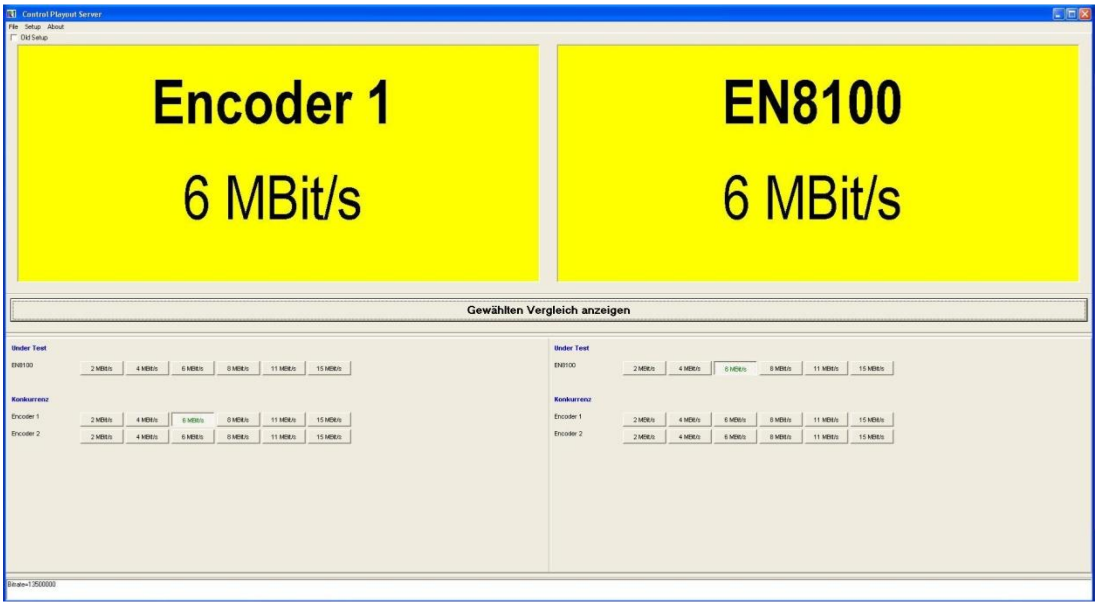


Fig. 3 Example of the user interface for comparison of test streams

2.2 Test sequences

The following test sequence was used for quality evaluation according to the described method.

EBU/SVT (length 160s)

> This material was shot by SVT on 65mm film at 50 frames/s (!), and down-converted to 1080i/25, 720p/50 and also 576i/25 using a documented algorithm. Thus, the same content was available in several sampling structures. This sequence is used for the PSNR-analysis. [see http://tech.ebu.ch/docs/hdtv/svt-multiformat-conditions-v10.pdf]

The test sequence is of substantial length and consists of several shots. Sample screen-shots are given inFig. 4.

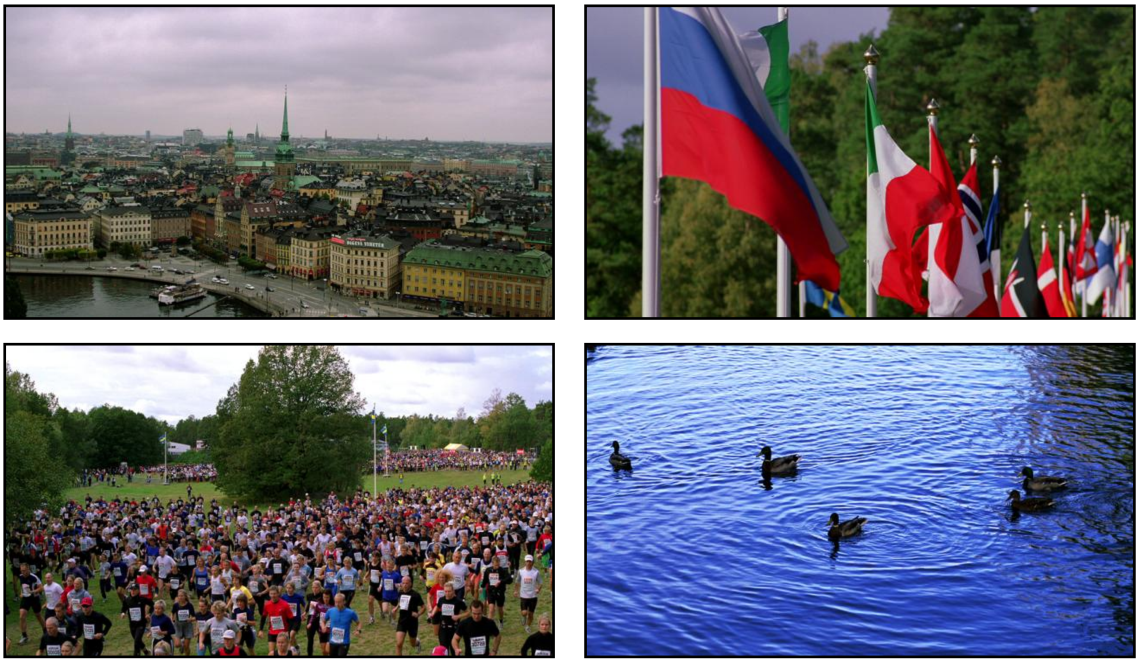


Fig. 4 Sample screenshots from sequence "EBU/SVT"

2.3 Encoder under test

Two different hardware encoders were used to compare the quality of the Ericsson EN8100 (system release v1.2.9 incl. Software release v1.2.3), amongst them the Thomson DBE 4120 and the Adtec mediaHUB-HD 422 which was adjusted to encode SDTV MPEG-2 in MP@ML.

For reasons of neutrality, no direct reference to a specific product is given in the diagrams annexed to this report with the exception of the Ericsson EN8100. However, it can be confirmed that both competitors are state-of-the-art encoders which were used by the broadcasters today.

2.4 Encoding parameters

All encoders used for the comparison were adjusted according to the following guidelines:

- any pre-processing (noise reduction, etc.) disabled, if available
- GOP structure set to N12M3 for 576i/25
- MP@ML (4:2:0)
- Full horizontal resolution
- Constant bit-rate CBR
- Target quality: 85 (adjusted by Ericsson)
- Adaptive GOP: on
- Field/Frame coding: auto
- Scene cut detection: on
- Auto concatenation: off (because of uncompressed material)
- Seamless buffer delay: 3200ms (adjusted by Ericsson)
- Min seamless bit-rate: 500 kbit/s (adjusted by Ericsson)

2.5 Results of quality evaluation using the EBU/SVT-sequence

Annex A gives the results of the objective PSNR quality measurements. The Encoder Ericsson EN8100 has been tested and compared to other representative encoders available on the market (see 2.3).

2.6 Conclusions on quality

The picture quality was compared to both hardware encoders described in chapter 2.3. Both encoders are referenced anonymously (HW corresponds to Hardware). The normal viewing distance is about five times picture height (5H) for SDTV (as defined in ITU-R BT 500-10). The viewing distance can also vary but this is then separately mentioned in the following tables.

The conclusions make use of the 4-grade so called “impairment scale” which is frequently used for subjective evaluations:

- Imperceptible
- Just perceptible
- Perceptible
- Clearly perceptible

In summary the following conclusions can be drawn:

a) Ericsson EN8100 compared to HW-1 (see diagram):

EN8100, 2 MBit/s	**HW-1, 2 MBit/s**
○ Clearly perceptible more resolution ○ Clearly perceptible less coding artifacts (blocking, noise)	

EN8100, 2,5 MBit/s	**HW-1, 2,5 MBit/s**
○ Cleary perceptible more resolution ○ Clearly perceptible less coding artifacts (blocking, noise)	

EN8100, 3 MBit/s	**HW-1, 3 MBit/s**
○ Perceptible more resolution ○ Perceptible less coding artifacts (blocking, noise)	

EN8100, 4 MBit/s	**HW-1, 4 MBit/s**
○ Just perceptible more resolution ○ Just perceptible less coding artifacts (blocking, noise)	

EN8100, 6 MBit/s	**HW-1, 6 MBit/s**
○ Nearly identical	○ At closer viewing distance (1H) the picture became busy (e.g. first artifacts became just perceptible)

EN8100, 8 MBit/s to 15 MBit/s	**HW-1, 8 MBit/s to 15 MBit/s**
○ identical	

b) Ericsson EN8100 compared to HW-2 (see diagram):

EN8100, 2 MBit/s	**HW-2, 2 MBit/s**
○ Clearly perceptible more resolution ○ Clearly perceptible more coding stability ○ Less blocking	

EN8100, 2,5 MBit/s	**HW-2, 2,5 MBit/s**
○ Perceptible more resolution ○ Perceptible more coding stability ○ Less blocking	

EN8100, 3 MBit/s	**HW-2, 3 MBit/s**
○ Just perceptible more resolution ○ Just perceptible more coding stability ○ Less blocking	

EN8100, 4 MBit/s	**HW-2, 4 MBit/s**
○ Nearly identical	

EN8100, 6 MBit/s to 15 MBit/s	HW-2, 6 MBit/s to 15 MBit/s
○ identical	

2.7 *Conclusions on the coding quality of the EN8100*

- The encoder has a very good coding quality across the range of tested bit rates, which is significantly better compared to the products under test.
- At lower bit rates there is a “clearly perceptible” visible quality advantage when compared to the state-of-the-art encoders
- At lower bit-rates there is a possible bit-rate saving of about 15 to 40% compared to the products under test
- At about 6 to 8 MBit/s and at higher bit rates, the differences are no longer perceptible
- A rate control optimization at higher bit rates was carried out during the evaluation process (see annex B)

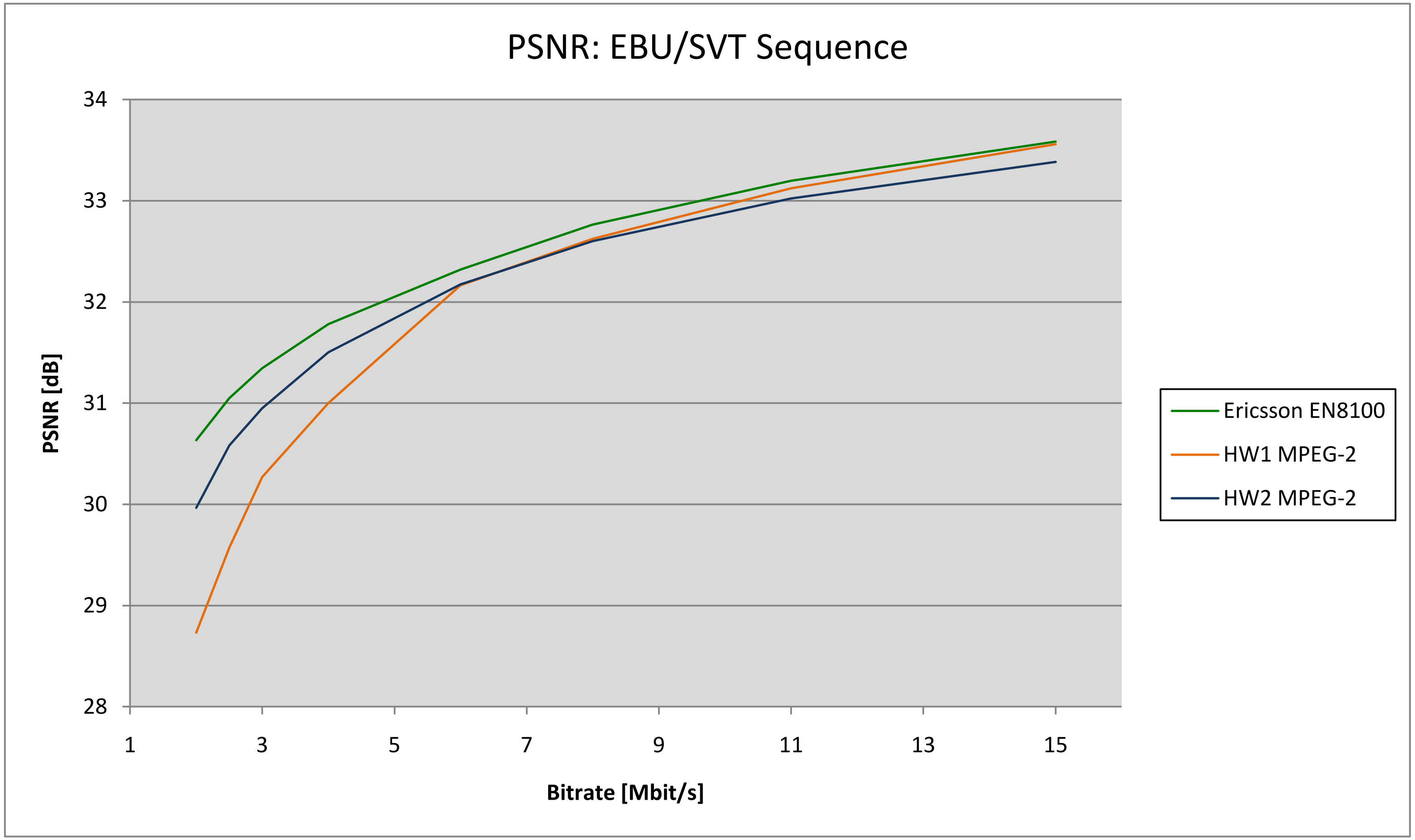
2.8 *Coding Latency and Lipsync*

The measurement of the coding plus decoding delay and the lipsync was carried out with a bit-rate of 4 MBit/s as being a typical average bit rate for SDTV within the DVB network. For audio the MPEG1L2-encoding was used. Both, latency and the lipsync measurements were made with the IRD Tandberg/Ericsson RX1290 (software version 3.12.0).

The following results were obtained:

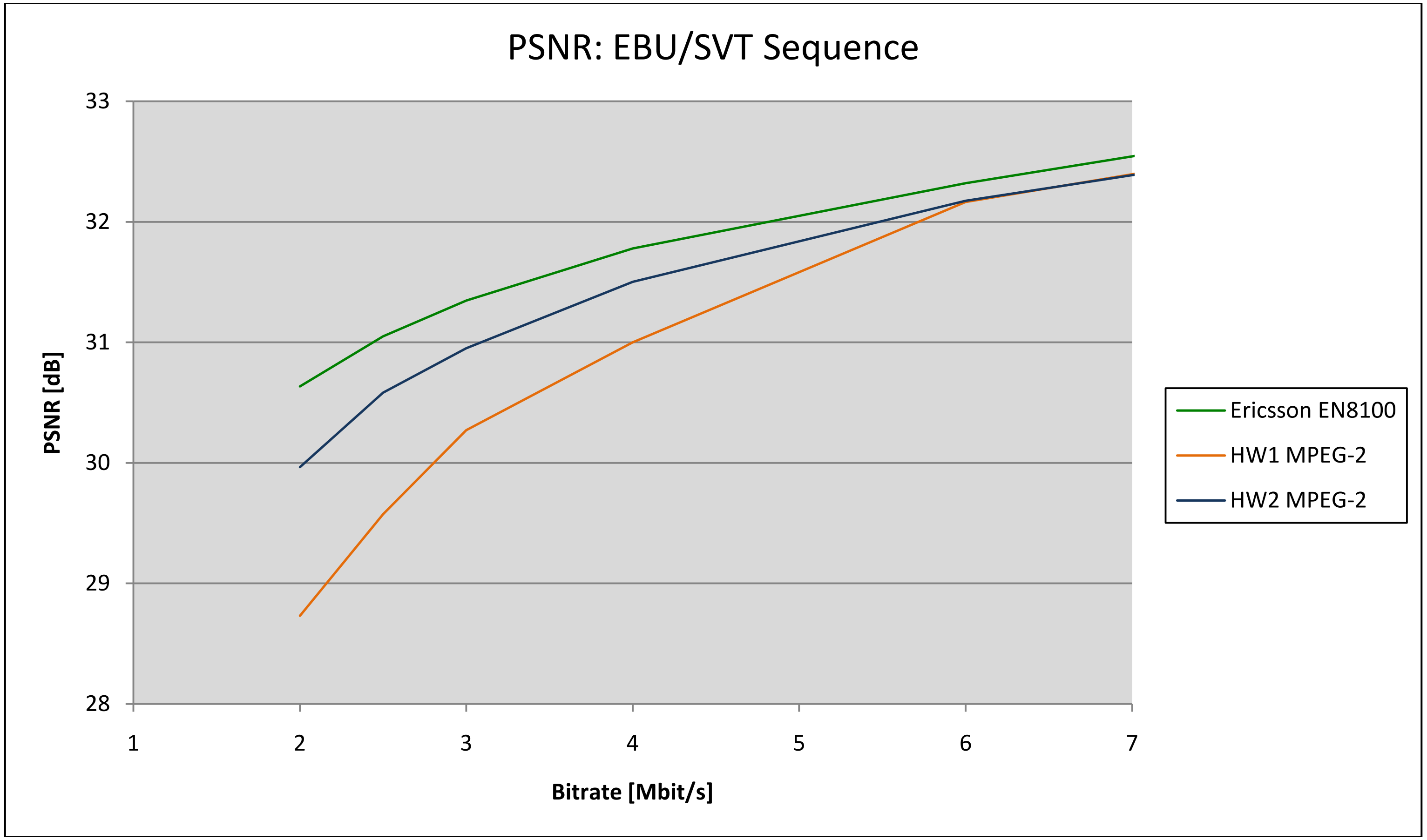
Resolution	Latency adjusted for MPEG1L2	Latency	Lipsync
576i/25	0 ms	2,39 sec	2,9 ms audio in advance

3 Annex A: PSNR-Diagrams EBU/SVT-sequence



PSNR-values over all bit rates

Note: The visibility threshold for PSNR differences is typically 0.5 to 0.7 dB



Cut out: PSNR-values at lower bit rates

4 Annex B: Optimization of the rate control algorithm

At 6 MBit/s the EN8100 (system release v1.2.9 incl. software release v1.2.3) has shown a short buffer miss-management (blocking, blurring) at a certain part of the test sequence (content from critical to easy). There is a trade-off between resolution and blocking on critical sequences visible see Fig. 5(16:9 anamorph). Even at more critical parts of the sequence the performance was running well at 6 MBit/s (without the above described artefacts).

Fig. 5 Screenshot EN8100: 4 MBit/s (left) compared to 6 MBit/s (right)

The manufacturer provided a sample transport stream of a rate control optimized version of the encoder software (system release v1.2.13 incl. software release v1.2.4) and IRT could confirm the optimization.

Institut für Rundfunktechnik GmbH
Floriansmuehlstraße 60
80939 Munich
Germany
www.irt.de
Phone +49 (0) 89 | 323 99 - 0
Fax +49 (0) 89 | 323 99 - 351
presse@irt.de

Register Court Munich HRB 5191