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Title **Approximate video bitrate estimation for television services**

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1 Introduction

In the recent years, the compressed video has become the dominant component of the traffic in the telecommunication networks worldwide [1]. Thus, estimation of the necessary bitrates appears as an important task.

On the other hand, the contemporary television technology exploits video in various resolutions. Moreover, three major compression technologies have been already applied to various video resolutions. The plethora of the combinations of the resolutions and the compression technologies results in problems in even rough estimation of the video bitrates needed for a particular resolution – technology pair.

In this contribution, a simple formula is proposed for rough assessment of the bitrates for the compressed video in the television applications. The formula may be used by the network engineers for very rough and preliminary assessment of the bitrates of compressed video streams.

2 Broadcast quality

Obviously, the bitrate depends strongly on the quality of the decoded video. For the television applications, so called broadcast quality is required. It means that the coding artefacts should be either invisible or hardly visible but rather in some unusual viewing conditions.

This means that the required quality level is very roughly predefined for most content in the television applications.

3 Content and resolution

The rate-distortion relation depends strongly on the video content. For the purpose of the formula development, let assume the more demanding television content, like movie or sports. For broadcast quality such content usually requires the bitrate that is not much less than the upper bitrate limit set for the statistical multiplexing.

In the video broadcast applications, there exist three major "quality-resolution" classes:

1. Standard Definition (SD), 720 × 576, 25 fps (Europe) or 720 × 480, 30 (29,94) fps (USA) :
2. High Definition (HD), like 1920 × 1080, 25 fps ;
3. Ultra High Definition (UHD) with the format 3840 × 2160, 50 fps.

Television predominantly uses constant bitrate mode of bitrate control. Therefore, for broadcast applications, for a given content complexity and a given video resolution, the bitrate may be roughly estimated for a given compression technology.

4 Compression technology generations

The rate-distortion relation depends strongly on the video content. For the purpose of the formula development, we have assumed the demanding class of television content, like movie or sports. Therefore the bitrate range may be roughly determined for a given resolution and a given codec type.

In the last two decades, consecutive video coding technologies, i.e. MPEG-2 [2], AVC [3], and HEVC[4] have been developed thanks to huge research efforts (cf. Fig. 1). For example, the development and the optimization of HEVC needed an effort that may be measured in thousands of man-years.

When considering the three abovementioned representative video coding standards, some regularity is visible [5]. For each next generation, for a given quality level, the bitrate is halved. The temporal intervals of about 9 years was between the consecutive technology generations of video coding (cf. Fig. 1). During such an interval the available computational power is increasing by a factor of about 20, according to the Moore law. After each such an interval, this increase may be consumed by the more sophisticated codecs of the next generation.

Therefore we observe a rule:

About each 9 years we have a new video compression generation that provides halved bitrates.

Of course, this "rule" was observed during two cycles only. It is probably too short time to establish a rule that may be used to forecast the future developments. Nevertheless, recently MPEG has started the exploration activities aimed at creation of a new compression technology that should be capable to reduce the bitrates again, possibly by the factor of about two. As its name is not fixed yet, this future technology is named "Ultra High Efficiency Video Coding" in Fig. 1. The expectations are to have this technology standardized about 2020-2021, which would be roughly compliant with the abovementioned rule.

It should be noted that a compression technology does not define directly the rate-distortion characteristic of the encoder. For a given standard, the bitrate for the broadcast quality may change dramatically from the first encoders on the market until mature sophisticated designs available after some years (e.g. [6]). Nevertheless, each video coding standard is related to some reference software that provides very high compression ratio that can beaten only slightly using mature sophisticated designs (see Fig. 2). Therefore the rate-distortion performance of the reference software (also sometimes named as a test model) is good model for a given compression technology.

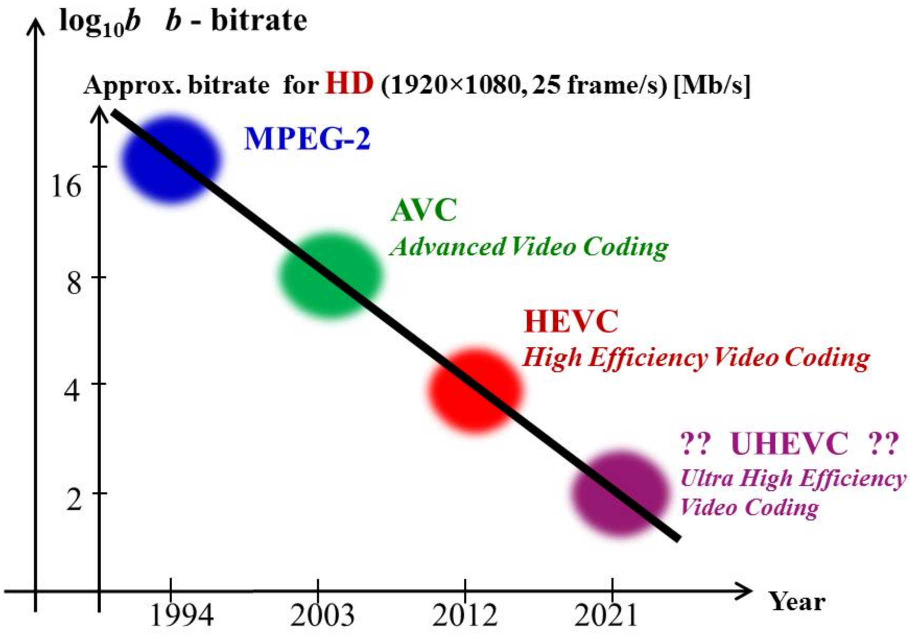

Figure 1. Video coding technologies for television applications.

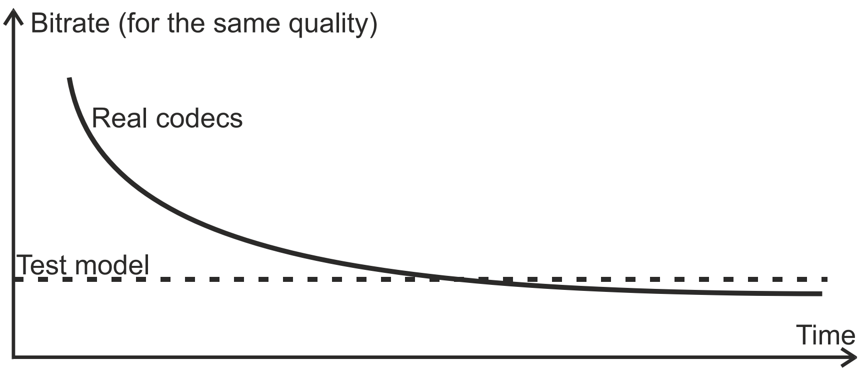

Figure 2. Bitrate for the same quality over time for singe compression standard.

5 A simple formula for rough estimation of bitrate

Having in mind the abovementioned assumptions and observations, the following formula may be used for rough estimation of video bitrate in broadcast applications [7]

$$B \approx A \cdot V \quad [\mathrm{Mbps}] \,, \tag{1}$$

where *A* is technology factor, where

- $A = 4$ for MPEG-2,
- $A = 2$ for AVC,
- $A = 1$ for HEVC,
- $A = 0.5$ for “UHEVC”,

and *V* is video-format factor, where

- V=1 for SDTV (either 720×576, 25*i* or 720×480, 30*i*),
- V=4 for HDTV (1920×1080, 25*i*),
- V=16 for UHDTV (3840×2160, 50*p*).

Several examples of experimental data may be found that are aligned with Eq. 1. For the sake of brevity, their examples will be omitted here.

6 Conclusions

The very simple formula (1) may be used for very rough approximation of the video bitrate for television broadcasting. The formula is also useful by teaching video technology, as it may be easily used by students to realize the bitrate range.

Acknowledgement

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References

[1] Cisco, “Visual Networking Index: Forecast and Methodology”, 2014–2019.

[2] “Generic coding of moving pictures and associated audio information: Video”, ISO/IEC Int. Standard 13818-2: 2013 and ITU-T Rec. H.262 (V3.1) (2012).

[3] “Coding of audio-visual objects”, Part 10: Advanced Video Coding, ISO/IEC Int. Standard 14496-10: 2014 and “Advanced video coding for generic audiovisual services”, ITU-T Rec. H.264 (V9) (2014).

[4] “High efficiency coding and media delivery in heterogeneous environment: High efficiency video coding”, ISO/IEC Int. Standard 23008-2: 2015 and „High efficiency video coding”, ITU-T Rec. H.265 (V3) (2015).

[5] M. Domański, T. Grajek, D. Karwowski, J. Konieczny, M. Kurc, A. Łuczak, R. Ratajczak, J. Siast, J. Stankowski, K. Wegner, “Coding of multiple video+depth using HEVC technology and reduced representations of side views and depth maps,” 29th Picture Coding Symposium, PCS, Kraków, May 2012.

[6] G. Davidson, M. Isnardi, L. Fielder, M. Goldman, C. Todd: “ATSC video and audio coding”, Proceedings of the IEEE, vol. 94, January 2006, s. 60-76.

[7] M. Domański, A. Dziembowski, T. Grajek, A. Grzelka, Ł. Kowalski, M. Kurc, A. Łuczak, D. Mieloch, R. Ratajczak, J. Samelak, O. Stankiewicz, J. Stankowski, K. Wegner, “Methods of high efficiency compression for transmission of spatial representation of motion scenes”, IEEE Int. Conf. Multimedia and Expo, Torino 2015 (to be published soon).