Quality of Service Measurements of Video Encoded Sequences Over an Emulated Ka Band Satellite Environment

Nedo Celandroni, Stefano Vignola, Sandro Zappatore, Andrea Zinicola
ISTI-CNR Institute of National Research Council (CNR),
CNR Pisa Research Area, Via Moruzzi 1, 56100 Pisa, Italy
CNR Pisa Research Area, Via Moruzzi 1, 56100 Pisa, Italy
CNR, Pisa Research Area, Via Moruzzi 1, 56100 Pisa, Italy
CNR, Pisa Research Area, Via Moruzzi 1, 56100 Pisa, Italy
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Scope and motivation

The goal is to quantify the quality of the received video stream in an objective mode. Several multimedia applications over the Internet make extensive use of video encoding techniques, like H.261 and MPEG2-MPEG4, which are transported over a RTP/UDP/IP platform. In crossing satellite channels, data generated by these applications may face different situations, according to the network and data link layer characteristics.

Within this setting, it makes sense to undertake an evaluation of the impact of video sequence. These different scenarios may have a strong impact on the quality of the decoded video sequence. In an environment characterized by a non-negligible bit error probability (BER),

- direct transmission of MPEG of H.261 over DVB
- IP over DVB
- IP over HDLC-like data link protocols
- e.g.

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- In different satellite channel quality conditions, the goal is to quantify the quality of the received video stream in an objective mode.

- Several multimedia applications over the Internet make extensive use of video encoding techniques, like H.261 and MPEG2-MPEG4, which are transported over a RTP/UDP/IP platform. In crossing satellite channels, data generated by these applications may face different situations, according to the network and data link layer characteristics.
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Scope and motivation

We present the measured results of an evaluation of H.261 video sequences over both IP and DVB, performed in a laboratory testbed, where an accurate emulation of the Italsat Ka band satellite channel is carried on.

We have decided to start our investigation from this coding method, delivery over heterogeneous network platforms, where CNT was involved, we based on the usage of H.261 in a number of projects devoted to distance learning.
Ending up in a decoded sequence that disturbs the observer’s view.

frames, thus significantly reducing the visual quality and, in some cases, leading to a large area of distortion in a series of the decoded sequence, leading to a large distorted area may propagate spatially and temporally through the resulting distorted area may propagate spatially and temporally through

lead to a magnification of the error.

Basically, decoding and decompressing coded data from a video sequence, data is lost or corrupted, the decoded sequence may be significantly distorted.

Video coding techniques (such as MPEG and H.26x families) are highly

CHARACTERISTICS OF THE CODING SCHEMES
In order to evaluate the effect of different levels and patterns of errors on the visual quality of the sequence, it is necessary to use subjective and/or analytical testing methods to determine the visual quality of the sequence of the decoded video. The commonly used subjective assessment is the perceptual quality, called the mean opinion score (MOS), which requires several observers and many tests in order to provide a reasonable statistical spread of results.

The reference measures used for an objective video quality assessment are the mean squared error (MSE), calculated on the difference signal between the original error-free sequence and the received decoded sequence, and the peak signal to noise ratio (PSNR), measured in dB, defined as:

$$\text{PSNR} = 10 \log_{10} \left( \frac{2^n - 1}{\text{MSE}} \right) \text{ [dB]}$$

where # of bits/pixel

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CODER STRUCTURE AND DECODER CHOICES

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H.261 video is organized into a hierarchy of layers. The defined layers are:

- Picture
- Group of Blocks (GOB)
- Macro Block
- Block
- Each layer is built from the lower one, and it contains its data payload and a header composed by the parameters used for bit stream generation. As a result of this hierarchical structure, in order to decode a MB, the knowledge of the picture and GOB headers the MB belongs to is sufficient.

...
the missing one. In this case, the evaluation of the PSNR is still possible.

The temporary loss of data in this situation also requires a choice of the strategy to recover the synchronization mechanism. Losses might occur at the video decoder, which would require a synchronization data link protocol would deliver the entire received bit stream, synchronization is not able, in general, to handle all types of errored sequences. Thus, even though the H.26i case, because the video decoder is not FEC code, without discarding data blocks affected by errors that cannot be recovered by the decoder the whole content of the video stream, including the corrupted parts, will be necessary that the transmission medium.

To evaluate MSE and PSNR it would be necessary that the transmission medium.

(continued)
LOGICAL DATA FLOW DIAGRAM
EXPERIMENTAL SETUP CONFIGURATION

We have set various signal to noise ratio (S/N) values suitable for evaluating PSNR and MSE at constant bit rates. Furthermore, we have set various signal to noise ratio (S/N) values suitable for
Two situations of transmission chains have been implemented:

- relatively long IP packets (1500 byte Maximum Transfer Unit - MTU, with average length of 347 bytes), carried within a PPP (point-to-point protocol) data link, which discards corrupted PDUs.

- DVB frames, carrying a payload of 184 bytes per packet. In this second case, packets in error are not discarded but, for the previously said synchronization loss reason, the H.261 decoder is generally unable to decode them.
Two cases are reported: the first one refers to an IP stream over PPP, while in the second one the stream is directly packetized according to a DVB format. Transmissions of a H.261 coded sequence.
The "no errors" line represents the overhead introduced at the MB level.

The "no errors" line represents the overhead introduced in the DVB case by the higher layer information that must be repeated at the MB level.

For two BER levels, the Goodput difference between DVB and IP transmissions.
Percentage of lost Macro Blocks vs. time during a transmission of IP over PPP and direct DVB on a satellite link with BER $10^{-4}$. 

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PPP and direct DVB on a satellite link with BER $10^{-4}$.
Percentage of lost Macro Blocks vs. time during a transmission of IP over PPP and direct DVB on a satellite link with BER 10^{-5}. The graph shows the comparison of lost data over time for both protocols.
PPP and direct DVB on a satellite link with BER 10^{-7} Percentage of lost macro blocks vs. time during transmission of IP over PPP and direct DVB.
Number of occurrences of consecutive corrupted frames for different BER levels.
The pattern indicated as "B", which corresponds to a quite severe fading, causes a temporary sync loss at the demodulator.
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Percentage of lost Macro Blocks vs. time for a transmission of IP over PPP and direct DVB, when the satellite link is affected by the fading pattern "A".

The fade pattern "A" directly affects DVB, whereas IP traffic remains unaffected by the same pattern. The graph shows the percentage of lost Macro Blocks over time for both IP and DVB transmission types.
Affected by the fading pattern, PSNR and MSE vs. time for an IP over PPP transmission, when the satellite link is affected by the fading pattern.
PSNR and MSE vs. time for a DVB transmission, when the satellite link is affected by the fading pattern “B”
affected by the fading pattern "A"
By the fading pattern, PSNR and MSE vs. time for a DVB transmission, when the satellite link is affected.
FUTURE WORK

Finally, when access to a KA band satellite will become available, some transmission should be employed, in order to evaluate the effects of fading on multimedia channels.

Improving the robustness of the streams transmitted over the satellite links.

The research carried out in the Image Coding Field also suggests the comparison with MPEG2 over DVB, which is currently undertaken. As well as audio coders should be considered for testing in KA band MPEG2, as well as audio coders should be considered for testing in KA band MPEG2, as well as audio coders should be considered for testing in KA band.

At the moment, only the H.261 video stream coder was taken into account.