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Minimum delay achievement in video online broadcasting

Modern technologies are moving forward constantly. Video plays one of the most important roles in the society life. The last century progress began with telephones. Now people can not only hear each other, but also see at the thousand kilometers distance. People massively use Skype conferences and webinars in Adobe Connect or Zoom, arrange live video-broadcasts in social networks etc. Broadcast video is needed for online auctions and competition tote. For example, horse races are held in Australia, but Southeast Asia players make bets on them. In this case, there is a problem that can cost a lot of money for players. It is 5-10 seconds delay of video transmission.

The delay is the time between taking a frame and its appearance on the final device screen. Schematically the video delivery chain can be divided into 6 stages: filming, compression, transmission over the local network from the encoder to the media server, transmission via the Internet, decoding and displaying on the user's device. What expenses appear at each stage of video delivery chain and how they can be reduced are in the focus of this paper.

1. *Filming.* The delay depends on the camera used in the filming. In this case, the delay is usually less than 1 ms as well as it is at the displaying (last step).

2. *Compression.* Video compression (encoding) is the original video processing, the main purpose of which is to reduce the size of the transmitted data. Its goal is to compress the stream, using an appropriate codec.

Currently the de-facto standard is the H.264 video with AAC audio. The work at this step affects the whole following chain. It is better to give preference to hardware solutions, because software adds the operating system overhead and the time needed to work with resources.

A correctly configured encoder does not add any appreciable delay, but it specifies the resulting stream bitrate and its type. There are two types of bitrate: variable (VBR) and constant (CBR). The main VBR advantage is that it produces a stream with the best ratio of image quality and engaged amount of data. However, it requires more computing power. In addition, if this element is final, then it must entail buffering at the decoding stage. Therefore, CBR is more recommended to be used for real-time video transmission because of its small delay. At the same time, CBR is not so simple either. In fact, the constant bitrate is not constant at any one time, because the H.264 stream contains frames of different sizes. Therefore, in the encoder, there is control over the averaging of the bit rate at certain time intervals, to make the amount of data the same throughout the entire broadcast. Averaging deteriorates the quality too. If the averaging period is smaller, the buffer at the decoding stage is smaller too and the transmitted video quality is worse.

3. *Transmission from the encoder to the media server***.** In general, at this step the delay is determined by the network operation between the encoder and the media

server. The buffer settings at compression and the media protocol overhead do matter here. That is why for the encoder buffer it is necessary to specify the minimum number of frames and to put it as close to the media server as possible. The data transfer protocol should be selected based on the encoder and media server capabilities, which will distribute data to end users. RTSP, RTMP or MPEG2-TS are the most suitable for real-time video transmission.

4. Transmission via the Internet to user's device. Usually the greatest delay appears at this stage. The first factor in this chain is the buffering inside the media server at the time of flow transcribing (repackaging) from one protocol to another. The second factor is related to the specifics of each protocol. HTTP-based protocols increase delay significantly. For real-time transmission, you need to use RTMP or RTSP. The last factor is almost impossible to influence: it is connected with the pumping rate and the Internet communication channels. The transmission rate should be added to the total delay value. The decoder will fix possible problems by buffering.

5. Decoding. This step affects the transmission rate greatly. In order to correct a possible data shortage during transmission, the playback buffer should contain data of one complete average period, including network delays. Therefore, the buffer can contain from several groups of pictures up to several frames. It depends on the encoder parameters and network status. Many players take 1 second as the minimum value of the playback buffer and change it in the course of work. The minimum possible buffer is achieved by using hardware decoders (players), for example, based on Raspberry Pi.

The possible effective transmission chain with minimum delay could operate as following. After the filming step, video goes to a hardware encoder Beneston VMI-EN001-HD. Then using RTMP the stream goes to Nimble Streamer, which is configured for maximum performance. At the end of chain, the data travel also through RTMP. In the reception room, the Raspberry Pi is located for decoding and displaying on large monitors. Ping is 140 ms. In the Raspberry Pi's RTMP-player the buffer is set to 300 ms. The resulting signal delay for the 1080p30 stream varies between 500 and 600 milliseconds. Through HLS on mobile devices, the picture is displayed with 3-4 seconds delay.

Ultimately, live broadcasting is difficult in any sense. High performance indicators achieving is a serious task, and the delay reduction requires the selection of the correct components and their thorough adjustment.

References:

1. *H.264 standard specifications* [online]. Available at http://forum.mediacoderhq.com/viewtopic.php?t=11026. Accessed 03.03.2017.
2. *The value of east coast ping*. [online]. Available at https://ro.my.com/forum/thread/22896-guide-blademaster-dps-priority-rotation/?pageNo=3. Accessed 03.03.2017.