Clearer, faster, smoother: Improving online video watching on cellular networks

January 7 2020, by Gabriel Wainer and Ala'a Al-Habashna

Credit: AI-generated image (disclaimer)

Each one of us could be watching an online video at some point on any given day. We could be following the news, listening to a report, learning from a how-to video, taking in sports highlights or watching a TV show.

Online video streaming has had a great impact on our lives, changing

many aspects including entertainment, education and marketing. YouTube alone is full of how-to videos, tutorials and lectures that are beneficial to people around the world.

As on-demand TV streaming has increased in popularity, many consumers have canceled their cable TV subscriptions in favor of platforms such as YouTube, Netflix and Vevo. With such subscriptions, users pay less and can watch their favorite movies and TV shows at anytime and anywhere.

Video on the move

Due to advances in mobile devices such as phones and tablets, and the popularity of video streaming, the demand for streaming over cellular networks has increased exponentially during the past few years. Recent traffic forecast reports have shown that video traffic accounted for 60 percent of the total mobile data traffic in 2016. By 2021, 78 percent of the world's mobile data traffic will be video. More than half of the global online video viewing now takes place over mobile devices.

This explosive demand for video streaming presents a serious challenge for cellular network operators as the increase in video traffic outpaces the advancement on cellular networks. New techniques for video transmission and delivery over mobile networks are needed to help serving this traffic.

Another problem is that users expect their content to load with minimum delay to start playing and minimum re-buffering during the video play. The download rate at which video contents are delivered to the end user must be high enough to keep the users satisfied and not ruin their viewing experience.

Satisfying viewers

Achieving user satisfaction has become a concern for cellular network operators. This is becoming more important considering that available video quality is improving. YouTube and Vimeo, for example, have videos available in very high-resolution format, while others are available in much lower quality. Videos streamed in high quality are usually large in size and need higher download rates than lower quality videos.

Online video viewing itself is a complex process that involves many factors that affect user satisfaction. For instance, when a user requests a video (for example, by tapping a video on YouTube), the parts of the video to be viewed are cached on the user's device first. Such cached video parts will provide a buffer that prevents video interruption, because such contents are already available on the user's device. As such, if a user pauses the video temporarily before its end, the device has time to cache more video contents and decrease the chance of video interruption, which can improve the video streaming experience.

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The user's location is also a major factor: if they are at the edge of the coverage area, quality can degrade due to poor transmission rates and interference. Likewise, indoor data rates can influence the video quality.

Assessing user satisfaction using traditional measures such as the download rate is not useful. Instead, Quality of Experience (QoE) provides a way to measure user's satisfaction. QoE, the overall acceptability of the service as perceived by the user is a better metric, as when a user is dissatisfied with the streaming service, they normally switch to different service provider.

Major content providers lost US$2.16 billion in 2012 due to low QoE; revenue loss due to poor QoE is expected to surpass US$20 billion.

Improved streams

We need new techniques that take into consideration the complex, dynamic and delay-sensitive nature of streaming traffic to provide end users with good QoE. Our research team, in co-operation with Ericsson Canada, developed new techniques to improve the QoE for users of video streaming over cellular networks.

The developed techniques, which resulted in six different patents, employ advanced methods that were introduced by the LTE Advanced mobile communication standard to improve communications in 5G networks.

One of the technologies that we focus on and employ in our research is device-to-device communications (D2D). With D2D communication, mobile devices within proximity of each other can exchange video content instead of fetching the content from a distant server. This allows mobile devices that have video contents cached locally to share such contents with nearby devices.

We developed different communication protocols and algorithms (the rules and policies that allow two or more devices to communicate) that allow User Equipment (UE) —smart phones, tablets, iPads, etc. —to exchange video content. Base-Stations (BS) are the cellular towers these protocols run, governing the interaction between the UEs.

Our various performance evaluation studies showed a significant reduction in initial delays, rebufferings and an improvement on the quality of the streamed video. This improved the QoE of the video streaming service by speeding up the delivery of video contents to requesting users and avoiding factors like rebuffering that could would negatively affect the QoE.

Our team and other researchers in this field are working to make sure that reliable video streaming service would be always available over cellular networks, despite the continuous increase in demand and volume of video traffic.

These techniques are very important because they do not only improve QoE under normal conditions, but can also be used to reduce the service cost (video contents obtained from nearby users can be free of charge). In addition, such communication techniques can be used to improve the coverage of the cellular network and make video viewing possible when the devices are far away from the base station (where it might not be possible otherwise).

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Citation: Clearer, faster, smoother: Improving online video watching on cellular networks (2020, January 7) retrieved 25 April 2024 from https://techxplore.com/news/2020-01-clearer-faster-smoother-online-video.html

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