Media Operations Use Case for an Augmented Reality Application on Edge Computing Infrastructure

https://tools.ietf.org/html/draft-krishna-mops-ar-use-case-00

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Introduction

- InterDigital has acquired a division of Technicolor and is active in various video related efforts:
  - We develop technology for AR/VR products
    - E.g., At MWC 2019, we demonstrated our technology for 360^o Video Experience with Adaptive Streaming, Volumetric Technology for Video, and Virtual Reality Video Streaming.
  - We are active in SDOs such as ISO/IEC/MPEG, ITU-T/VCEG, JVET and 3GPP SA4

- https://tools.ietf.org/html/draft-ietf-mops-streaming-opcons-02 Internet Draft provides an overview of operational networking issues that pertain to QoE in delivery of video and other high-bitrate media over the Internet. Our draft intends to be complementary to that draft by covering the increasingly large number of applications with Augmented Reality (AR) characteristics and their requirements on ABR algorithms.

Proposed Use Case

A group of tourists are being conducted in a tour around the historical site of the Tower of London. As they move around the site and within the historical buildings, they can watch and listen to historical scenes in 3D that are generated by the AR application and then overlaid by their AR headsets onto their real-world view. The headset then continuously updates their view as they move around.

Proposed Use Case

- The AR application processes the scene that the walking tourist is watching in real-time and identifies objects that will be targeted for overlay of high-resolution videos.
  - It then generates high resolution 3D images of historical scenes related to the perspective of the tourist in real-time.
  - These generated video images are then overlaid on the view of the real-world as seen by the tourist
- In order to achieve hard timing constraints of a few milliseconds, computationally intensive tasks can be offloaded to Edge devices.
  - The Edge device providing the computation and storage is itself limited in such resources compared to the Cloud and can be overwhelmed by a sudden surge in demand. Additionally, the throughput to the user over the wireless link will suffer.
  - The user will perceive a fall in QoE of the Video being rendered on her AR device.
- In such a scenario, the client AR applications will need to use Adaptive Bit Rate (ABR) algorithms that choose bit-rates policies tailored in a fine-grained manner to the resource demands and playback the videos with appropriate QoE metrics as the user moves around with the group of tourists.

Proposed Requirements

- **Offloading Computationally-intensive tasks to the Edge**: Offloading to the remote Cloud is not feasible for applications with AR characteristics as the end-to-end delays must be within the order of a few milliseconds. In order to achieve such hard timing constraints, computationally intensive tasks can be offloaded to Edge devices.
- **In-situ techniques to select appropriate bit rates**: Learning models developed in-situ rather than in simulations are more accurate in their adaptation decisions.
- **Dynamically changing ABR parameters**: The ABR algorithm must be able to dynamically change parameters given the fat-tailed nature of network throughput. This, for example, may be accomplished by AI/ML processing on the Edge Computing on a per client or global basis.
- **Handling conflicting QoE requirements**: QoE goals often require high bit-rates, and low frequency of buffer refills. However in practice, this can lead to a conflict between those goals. For example, increasing the bit-rate might result in the need to fill up the buffer more frequently as the buffer capacity might be limited on the AR device. The ABR algorithm must be able to handle this situation.
- **Handling side effects of deciding a specific bit rate**: For example, selecting a bit rate of a particular value might result in the ABR algorithm not changing to a different rate so as to ensure a non-fluctuating bit-rate and the resultant smoothness of video quality . The ABR algorithm must be able to handle this situation.

Informative references

- Yan, Francis Y., et al. "Learning in situ: a randomized experiment in video streaming." 17th {USENIX} Symposium on Networked Systems Design and Implementation ({NSDI} 20). 2020.
  - Streamed 38.6 years of data with 63,508 distinct users
  - Compared the performance of several ABR algorithms: Pensieve, Fugu, BBR, MPC-HM and RobustMPC-HM

- [ABR_1] Mao, H., Netravali, R., and M. Alizadeh, "Neural Adaptive Video Streaming with Pensieve", In Proceedings of the Conference of the ACM Special Interest Group on Data Communication, (pp. 197-210), 2017.
  - Documents the problems with current ABR algorithms