   **Media Operations Use Case for an Augmented Reality Application on Edge
                        Computing Infrastructure
                    draft-krishna-mops-ar-use-case-00**

Abstract

   A use case describing transmission of an application on the Internet
   that has several unique characteristics of Augmented Reality (AR)
   applications is presented for the consideration of the Media
   Operations (MOPS) Working Group. One key requirement identified is
   that the Adaptive-Bit-Rate (ABR) algorithms' current usage of
   policies based on heuristics and models is inadequate for AR
   applications running on the Edge Computing infrastructure.

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1. Introduction

The MOPS draft, [I-D.ietf-mops-streaming-opcons], provides an
overview of operational networking issues that pertain to Quality of
Experience (QoE) in delivery of video and other high-bitrate media
over the Internet. However, it does not cover the increasingly large
number of applications with Augmented Reality (AR) characteristics
and their requirements on ABR algorithms.

Future AR applications will bring several requirements for the
Internet and the mobile devices running these applications. AR
applications require a real-time processing of video streams to
recognize specific objects. This is then used to overlay information
on the video being displayed to the user. In addition some AR
applications will also require generation of new video frames to be
played to the user. In order to run future applications with AR
characteristics on mobile devices, computationally intensive tasks
need to be offloaded to resources provided by Edge Computing.

Edge Computing is an emerging paradigm where computing resources and
storage are made available in close network proximity at the edge of
the Internet to mobile devices and sensors [EDGE_1], [EDGE_2].

Adaptive-Bit-Rate (ABR) algorithms currently base their policy for
bit-rate selection on heuristics or models of the deployment
environment that do not account for the environment's dynamic nature
in use cases such as the one we present in this document.
Consequently, the ABR algorithms perform sub-optimally in such
deployments [ABR_1].

2. Conventions used in this document

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
   document are to be interpreted as described in [RFC2119].

3. Use Case

   A use case that considers an application with AR systems'
   characteristics is now described where 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.

   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.

   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.

4. Requirements

   As discussed above an AR application requires offloading of its
   components to resources provided by Edge Computing. These components
   perform tasks such as real-time generation and processing of high-
   quality video content that are too computationally intensive for the
   mobile device.

   In addition, such applications require high bandwidth and low jitter
   to provide a high QoE to the user. Another consequence of running
   such computationally intensive applications on AR devices such as AR
   glasses is the excessive heat generated by the chip-sets that are
   involved in the computation [DEV_HEAT_1]. Finally, the battery on
   such devices discharges quickly when running such applications if
   some processing is not off-loaded to the Edge Computing.

   Note that the Edge device providing the computation and storage is
   itself limited in such resources compared to the Cloud. So, for

example, a sudden surge in demand from a large group of tourists can
overwhelm that device. This will result in a degraded user
experience as their AR device experiences delays in receiving the
video frames. In order to deal with this problem, 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.

Thus, once the offloaded computationally intensive processing is
completed on the Edge Computing, the video is streamed to the user
using an optimal ABR algorithm. This imposes the following
requirements on the ABR algorithm [ABR_1]:

o 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.

o 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.

o 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.

5. Informative References

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