Proposal for Google Research Awards (PhD. level) - Latin America

1 Overview

Proposal Title: Multi-tier Video Delivery for Future Generation of Smart Cities
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2 Proposal Body

Abstract

Video Streaming based on Dynamic Adaptive Streaming over HTTP (DASH) has been widely adopted by the Internet video technology companies such as Google, Netflix, Akamai HD and others, where the client-side video player can dynamically pick the bitrate level according to the perceived available bandwidth. At the same time, currently, the video streaming services represents the majority of the internet traffic, the cisco forecast [1] estimates that in 2021 70% of all internet traffic will be dominated by the video streaming, whereas for mobile devices this estimate represent 78% of all mobile data traffic. To accommodate this traffic, a good cloud-level architecture partially solves some issues related to the live stream and Video on Demand (VoD) services, however, it introduces new ones such as higher latency and core network congestion. To overcome these issues, this work explores the edge/cloud network communication to design a cooperative DASH video streaming in Smart Cities Environments, deploying cache services models to offer the best-possible Quality of Experience (QoE) for the end-users. A cache schemes service can reduce the traffic load and delay, since multimedia content may be readily available closer to the users. This service can be deployed in a container, virtual machine, web browser plug-in or even as an module in video applications. The video streaming can be tailored according to the user's device profile and network characteristics. It is essential to provide a adequate use of the bandwidth available for network nodes. To take advantage of this features in DASH-based video streaming, a service model for deploy a cooperative multimedia delivery may be used in different scenarios, for example, a local mobile area network, regional networks using different Points of Presence to caching the multimedia content. Beyond that, during flash crowds where having bandwidth may be not sufficient to accommodate the end-users, devices with different configurations can work together to provide the necessary resources. Designing an efficient data transfer scheme for such service models is a non-trivial task.

Research Goals

Considering a reliable and high-quality video delivery DASH-based to be used in the Smart Cities Environments [1, 2]. The proposed scheme will take advantage of several network-related technologies such as Cloud, Fog, and Edge Computing, as well as intelligent service placement and chaining. Figure 1 on the left-side depicts a multi-tier network architecture, which is composed of a heterogeneous set of devices and applications using the resources and also offers a multi-access communication technology, such as 5G and WiFi. Based on these premises, as a

[1] Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update. Link: `http://shorturl.at/hjAZ1`. Accessed: July 26, 2019.

novelty, we will consider users to have a simultaneous multipath connectivity in DASH video streaming [3, 4]. On the right-side, we describe part of the parameters that should be assessed to define what services needed to be deployed and what is the most suitable tier to deploy them. Notice that the parameters in the bottom tier for feedback are distinct from the others tiers. The assessed parameters include, but are not limited to, the user's profile, the load of the local cell, the link quality, the motion complexity of the videos, and also smart city details such as the location and the traced route in case of users with mobility. Some of the nodes can be stationary, but others can range from low to high mobility patterns.

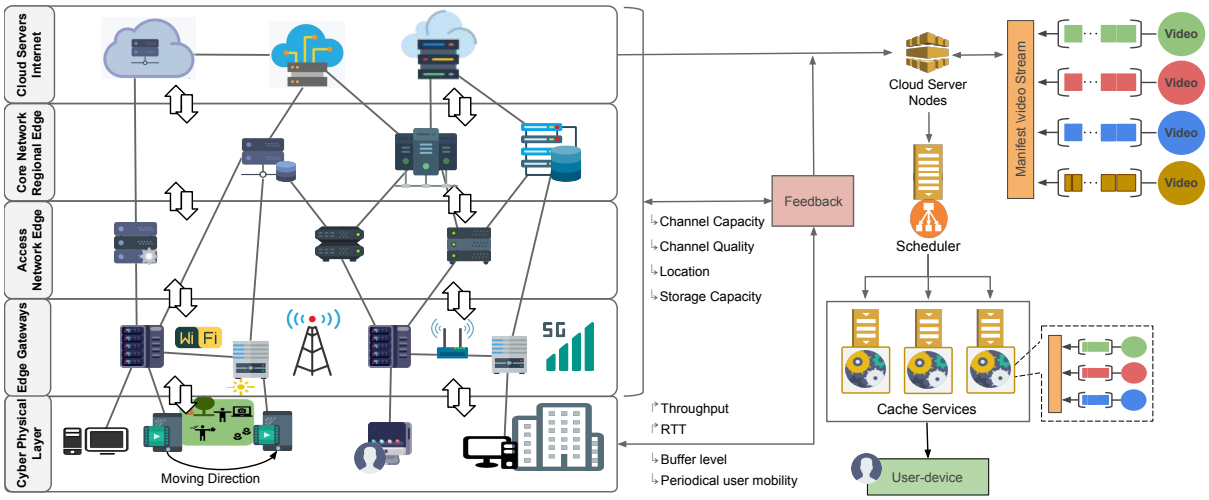

Figure 1: DASH-based Adaptive Multimedia Delivery System in an Smart City Environment.

Given the multi-tier edge/cloud environment and service model architecture aforementioned, this work aims to tackle some of the following research questions: *i)* Use location information to estimate best paths in real time and how to dynamically estimate the gain between the different proximity perspectives of the nodes. You need to redistribute or just add the unsolicited video chunks on the other nodes when the end-user changes; *ii)* Facilitates video streaming through multiple sources at the same time; *iii)* Analyze the influence of video chunk size variation on bitrate adaptation algorithms; *iv)* How to determine the best tiers to service placements.

Contributions

Design a hierarchical DASH-based adaptive streaming delivery in order to optimize the video delivery services existent and enhance the stream's quality. Such services will be deployed taking into considerations key challenges in smart cities in order to efficiently use the urban infrastructure, which in turns, leads to a better quality of life for its citizens. In addition, this PhD proposal is aligned with INCT InterSCity [2] project.

Related Work

Zhang *et al.* [5] focuses on the client-side, performing the average bitrate level by the bitrate adaptation algorithm and the influence of chunk size variation for improve the QoE, while Shen *et al.* [6] works with a set of cache proxy services to analyze the cache miss occurrences. This

[2] http://interscity.org

work implements a reactive approach where cache proxies download the chunks of multimedia content when requested. Rosário *et al.* [7] describes a multi-tier environment that provides a live migration service from the cloud to the different tiers. The experimental scenarios delivery a video stream between different tiers with QoE support. Poliakov *et al.* [3] deploy a DASH video streaming with multiple sources. The DASH-client player can download the chunks, at the same time, through different connections on the cloud. Archer *et al.* [8] proposes an algorithm to deal with the cache replicas for flash bandwidth video provisioning, which is a critical bottleneck.

The proposed approaches could decrease the traffic load and improve the QoE, but more issues arises when the Smart Cities scenarios, such as user mobility, collaborative cache schemes over multi-edges, and number of users during flash crowds timestamps, are not fully considered. Poliakov work, differently the others, built a model in which a client can receive many chunks at the same time, but did not address previous issues related to Smart Cities scenarios.

References

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3 Data Policy

The results from this project will be available through publications in conferences and/or journals as well as in technical reports. The expected results include: 1 international journal paper, 2 international conference paper, 2 national conference paper. Additionally, the source codes and datasets will also be made available on platforms such as sourceforge or github and on our personal webpages.