Quality of Experience Driven Video Encoding Adaptation Strategies for Cloud Gaming under Network Constraints

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***Abstract*— The main objective of this research is to specify video encoding adaptation strategies to optimize end user QoE for cloud gaming under variable system and network conditions. The video encoding adaptation strategies will be based on proposed QoE models for cloud gaming, developed based on empirical user studies examining the impact of network resource availability and objective game characteristics on end user QoE. The research hypothesis is that the novel and context-aware video encoding adaptation strategies can be exploited to improve end user QoE in comparison with state-of-the-art approaches for cloud gaming service adaptation in light of constrained system or network resources.**

Keywords— Cloud gaming, QoE, Adaptation strategies, QoE modelling

I. MOTIVATION

The cloud gaming paradigm is commonly characterized by game content delivered from a server to a client as a video stream, with game controls sent from the client to the server (Fig. 1). The execution of the game logic, rendering of the 3D virtual scene, and video encoding are performed at the server, while the client is responsible for video decoding and capturing of client input. While cloud gaming reduces client hardware requirements and provides other benefits, most such games are traffic intensive and may significantly increase the network requirements necessary to secure a good level of Quality of Experience (QoE). With available system and network resources varying over time, subject to issues such as varying access network conditions or a varying number of players accessing a bottleneck link, there is a need for efficient and dynamic service adaptation strategies on the game server to meet different system and network availability constraints [1]. Given high bandwidth and strict latency requirements, a key challenge faced by cloud game providers lies in configuring the video encoding parameters so as to maximize player QoE while meeting resource availability constraints (Fig. 2). Current developed QoE models [2-4] can for the most part be applied to only one specific game for which they were primarily derived for due to significant differences (in terms of graphics detail, gameplay pace, input rate, etc.) between games that are assigned to the same game category based on present game genre classification. Therefore, there is a need to design an appropriate game taxonomy for cloud gaming based on objective game characteristic that can be later used as a tool when aiming to develop accurate QoE models for derived game categories. Consequently, such a taxonomy could then be used for determining optimal adaptation strategies for classes of games, which could in the future automate the process of deciding on the best encoding adaptation strategy for a particular game, alleviating the need to conduct subjective studies for additionally considered (or newly emerging) games.

This research is supported by the Croatian Science Foundation under the project UIP-2014-09-5605 (Q-MANIC).

II. METHODOLOGY

The research will be conducted in several phases (Fig. 3). In the first phase, a detailed analysis of digital game characteristics will be conducted to identify game aspects which can be used to identify the differences between video streams of different games in cloud gaming. The results of an empirical study performed in the scope of this dissertation [4] indicate that different video adaptation policies should likely be applied for different types of games when aiming to maximize QoE, and that objective video metrics may be used to classify games for the purpose of choosing an appropriate and QoE-driven video codec configuration strategy. The second phase will include user studies to gather empirical data to develop QoE models for digital game categories derived from the proposed game categorization for cloud gaming. The main goal of the user studies is to investigate how and to what extent video encoding parameters affect perceived QoE for each of the game categories under variable system and network conditions. The next phase of the research consists of proposing video encoding adaptation strategies with respect to system and network resource availability and digital game category. The final phase will include validation of the proposed video encoding adaptation strategies. A case study will be designed to demonstrate utilization of the proposed video encoding adaptation strategies to optimize QoE under various service and network resource availability constraints.

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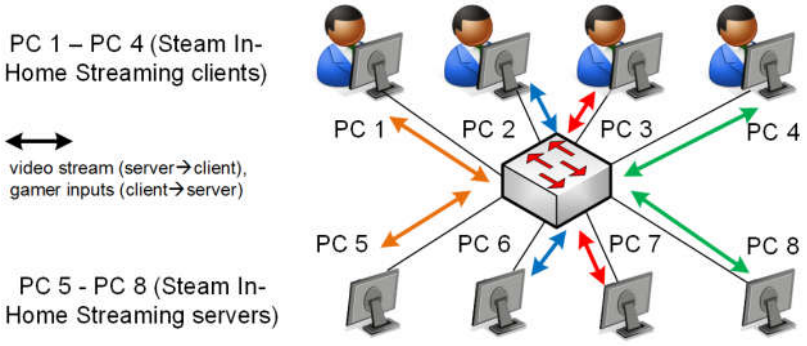

Figure 1 Cloud gaming testbed: multiple simultaneous users using the cloud gaming service

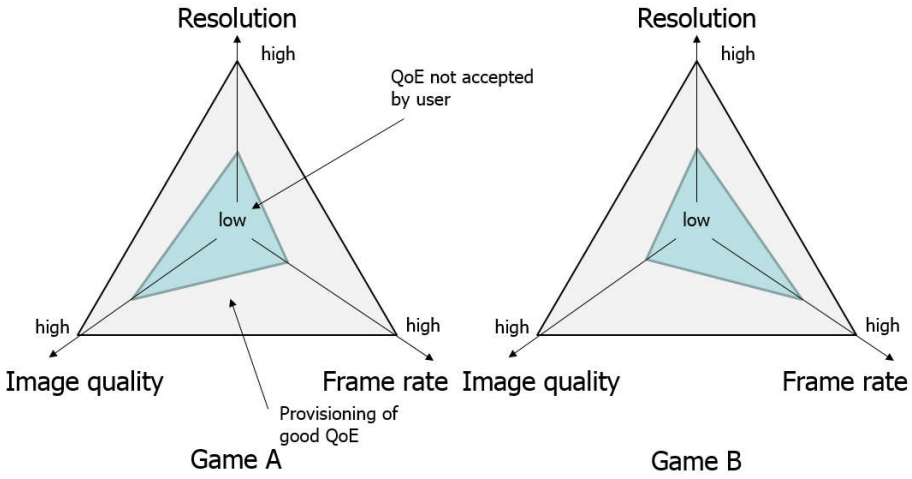

Figure 2 Video encoding adaptation strategies: by manipulating video encoding parameters, we can achieve different QoE levels for different types of games

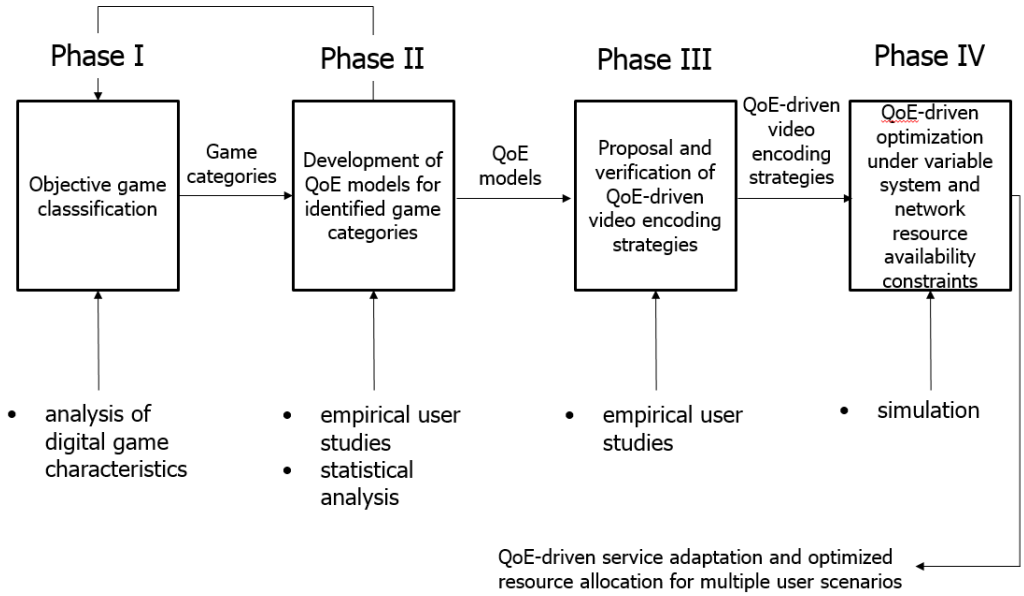

Figure 3 Methodology and plan of research