Enriching Mobile Multimedia Applications using Cloud Mobile Media

Saleem Malik .S & Shivaprasad B.J

CSE Dept, KVGCE, Sullia

Abstract – Cloud Mobile Gaming (CMG), an approach that enables rich multiplayer Internet games on mobile devices, where compute intensive tasks like graphic rendering are executed on cloud servers in response to gaming commands on a mobile device, and the resulting video has to be streamed back to the mobile device in near real time, making it the most challenging of the Cloud Mobile Media (CMM) applications. Subsequently, an adaptive mobile cloud computing technique to address the CMG challenges is developed. A rendering adaptation technique, which can dynamically vary the richness and complexity of graphic rendering depending on the network and cloud computing constraints also proposed.

Keywords – Cloud mobile media, Multimedia, Cloud mobile gaming

I. INTRODUCTION

Cloud Mobile Media (CMM) applications and services, which will enable mobile users to not only access rich media from any mobile device and platform, but even more importantly, which will enable mobile users to engage in new, rich media experiences, through the use of mobile cloud computing, that are not possible otherwise from their mobile devices. CMM will also enable service providers and network operators to offer services much more efficiently, with lower cost and better user experience. As more consumers adopt smartphones and tablets as one of their primary media experience platforms, CMM has the potential of significantly boosting the revenue of cloud Software-as-a-Service (SaaS) providers. Some of the media rich CMM services will require new and richer platform and infrastructure capabilities as explained in the next sections, thereby providing a new set of revenue opportunities for cloud platform and infrastructure providers[1]. And finally, CMM offers new opportunities for mobile network operators to close the growing gap between growth in data usage and data revenue by offering innovative CMM services and experiences, outside of conventional application stores where their participation has not been strong so far. The rapidly increasing power of personal mobile devices

(smartphones, tablets, etc.) is providing much richer contents and social interactions to users on the move.

Tough challenges arise on how to effectively exploit cloud resources to facilitate mobile services, especially those with stringent interaction delay requirements[2].

In the rest of the paper, section II explain briefly about different types of possible CMM applications including their advantages, and also challenges that will be faced in making them successful. Section III discusses a few major challenges of CMM applications: user experience including response time, cloud computing cost, mobile network bandwidth, and ability to scale to a large number of CMM users, also illustrates the challenges using Cloud Mobile Gaming (CMG), one of the most compute and mobile bandwidth intensive CMM applications. Subsequently section IV an adaptive mobile cloud computing technique to address the challenges associated with CMG is proposed.

II. CLOUD MOBILE MEDIA ARCHITECTURE AND APPLICATIONS

Utilizing available cloud computing and storage resources, we expect a heterogeneous set of Cloud Mobile Media services and applications to emerge, with different types of consumer experiences and advantages enabled. Figure 1 shows the overall architecture, including end-to-end flow of control and data between the mobile devices and the Internet cloud servers, for a typical CMM application.

Fig. 1: Cloud Mobile Media architecture, showing control and data flows.

Though a CMM application may utilize the native resources of the mobile device, like GPS and sensors, it primarily relies on cloud computing Infrastructure as a Service (IaaS) and Platform as a Service (PaaS) resources, like elastic computing resources and storage resources, located in Internet public, private, or federated (hybrid) clouds. A typical CMM application has a small footprint client on the mobile device, which provides the appropriate user interfaces (gesture, touchscreen, voice, text based) to enable the user to interact with the application[5]. The resulting control commands are transmitted uplink through cellular Radio Access Networks (RAN) or WiFi Access Points to appropriate gateways located in operator Core Networks (CN), and finally to the Internet cloud. Subsequently, the multimedia data produced by the cloud, either as a result of processing using the cloud computing resources, and/or retrieval from cloud storage resources, is transmitted downlink through the CN and RAN back to the mobile device[3]. The CMM client then decodes and displays the results on the mobile device display. As shown in Fig 1, a typical CMM application will be highly interactive, with some types of applications needing near real-time response times. Note that for certain types of CMM applications, the control and data flow may deviate from that shown in Fig 1.

A. Major Challenges

One of the primary advantages of using cloud services is to eliminate capital expenses, and depend on the elasticity of cloud computing, and the cloud utility or on-demand pricing model, to scale to varying capacity needs. There will be challenges faced by computing and bandwidth intensive CMM applications like cloud based mobile gaming, in terms of prohibitively high operating expenses when using on-demand cloud pricing models[3]. Besides the potentially high cloud operating expenses, and cloud scalability concern, CMM applications can have very high demand on wireless network bandwidth, having implications on the capacity of the mobile networks, in particular during peak demand periods, potentially negatively impacting network latency, packet loss, and response time, with the consequent negative impact on user experience. Moreover, the high wireless bandwidth requirement may prohibitively increase the wireless data bills of mobile users, making CMM applications impractical. Among all CMM applications, cloud based rendering applications are the most communication bandwidth and computation intensive. The challenges of ensuring acceptable user experience, low cloud and mobile network costs, and scalability, will be more critical for cloud based rendering applications than most other CMM applications[5]. Hence in the next section, addressing the above challenges for cloud based rendering, and specifically Cloud Mobile Gaming is focused.

III. RENDERING ADAPTATION APPROACH TO ADDRESS CLOUD AND NETWORK CHALLENGES

An innovative rendering adaptation approach, which can dynamically vary the richness and complexity of graphic rendering depending on the network and server conditions, thereby impacting both the bit rate of the rendered video that needs to be transmitted from the cloud server to the mobile device, and the computation load on the cloud servers[4]. While the proposed rendering adaptation approach can be widely used for any cloud based rendering applications, A Cloud Mobile Gaming (CMG) is used as a running example to introduce and validate our approach in details.

A. Overview of Proposed Rendering Adaptation Approach

Graphic rendering is the process of generating an image from a graphic scene file, which usually contains geometry, viewpoint, texture, lighting, and shading information as a description of the virtual scene. It is configurable by a set of rendering parameters. The term “rendering setting” usually denotes a setting which consists of different values of these rendering parameters. Communication Complexity (CommC) and Computation Complexity (CompC) is introduced associated with each rendering setting in the CMG approach. The proposed rendering adaptation approach will dynamically vary the CommC and CompC of graphic rendering by changing the rendering settings, such that the resulting video bit rate and computation need can meet the available network bandwidth and cloud server computing resource respectively, thereby achieving network and server scalability for the CMG approach while ensuring a good mobile gaming user interface for each user.

The Communication Complexity (CommC) of a rendering setting denotes the level of how much bit rate is needed to deliver CMG video with this rendering setting. While the video bit rate is determined by the video compression ratio used, it is largely affected by the video content complexity. The Computation Complexity (CompC) of a rendering setting indicates the level of GPU computation resource needed to render the game with this rendering setting.

The above principles of rendering adaptation look promising to let the CMG application scale the video bit rate need and server computation need by dynamically adapting the rendering setting with proper CommC and CompC. However, since the number of different rendering settings possible may be very large, finding the optimal rendering setting for given available cloud server computing resource and network bandwidth may be time consuming. On the other hand, to be effective, rendering adaptation should be performed in real time in response to rapid changes in network and server conditions[6]. To resolve the above conflict, partitioning the rendering adaptation approach into two

parts: offline and online steps is proposed. The offline steps will characterize and pre-determine the optimal rendering settings

Fig. 2: Proposed rendering adaptation methodology

for different levels of CommC and CompC, thereby allowing the online steps to select and vary the rendering settings in real time in response to the fluctuations of network and server resources. Two key principles how rendering adaptation can be used to affect CommC and CompC. The first principle is to reduce the number of objects in the graphic scene file, as not all of these objects are necessary for playing the game.

Fig 2 gives an overview of the proposed rendering adaptation approach which involves the above mentioned offline and online steps. In the first offline step, rendering parameters are identified which can affect the communication and computation complexities of the game. Subsequently, for each possible rendering setting involving the selected parameters, CommC and CompC values are derived. This will result in a complexity model, which is a mapping of rendering settings to CommC and CompC values. Next, several rendering levels are selected, each of which reflects a certain CommC and a certain CompC. Then using the complexity model, optimal rendering settings are derived that meet the CommC and CompC targets of each rendering level, leading to a rendering levels model.

During an online gaming session, adaptation technique which is used in this paper, can select in real time a proper rendering level and the corresponding optimal rendering setting, using the rendering levels model. Adapting both rendering and video encoding jointly will necessitate understanding the optimal values of encoding bit rate or rendering level that can be used when encoding or rendering is adapted respectively. Also shown in Fig.2 are the online steps. Depending on the network and server conditions, proposed system decides if the rendering level and encoding bit rate level needs to be adapted. If either of them is changed, it will check the joint adaptation model to decide if the other one needs to be changed correspondingly. If rendering level is to be changed, it will select the optimal rendering setting based on rendering levels model and

update the game engine consequently to effect the rendering level change.

IV. CONCLUSION AND FUTURE WORK

An adaptive mobile cloud computing approach to address the challenges associated with Cloud Mobile Gaming, one of the most computing and communication intensive Cloud Mobile Media applications. One of the biggest challenges for mobile cloud computing, is ensuring scalability for large number of simultaneous users, both from the high cloud costs that may be incurred, and the limited capacity of mobile networks. A promising direction is to develop Mobile Cloud Scheduling techniques, which can simultaneously consider the cloud computing and storage resources, together with the network availabilities for each CMM client, including the availability of alternative network accesses like WiFi to offload CMM traffic, such that the number of simultaneous CMM users is maximized, while minimizing cloud cost.

Current cloud scheduling techniques address the problem of efficiently assigning diverse cloud resources to heterogeneous requirements of application tasks, with the objective of ensuring fairness among requesting tasks or reduce cloud cost; however, these techniques do not consider the mobile network constraints, which is an important scalability challenge for CMM applications. Proposed system presented here, for developing mobile cloud scheduling techniques for Cloud Mobile Gaming has the ability to significantly increase the number of simultaneous CMG users using available network resources, while reducing cloud cost. In the future, mobile cloud scheduling techniques will need to be developed for other CMM applications, as well as consider capacity limited computing and storage resources in the Mobile Cloud.

V. REFERENCES

- [1] J. Santos, D. Gomes, S. Sargento, R. L. Aguiar, N. Baker, M. Zafar, and A. Ikram, "Multicast/broadcast network convergence in next generation mobile networks," *Comput. Netw.*, vol. 52, pp. 228–247, January 2008.
- [2] T. Coppens, L. Trappeniniers, and M. Godon, "AmigoTV: towards a social TV experience," in *Proc. of EuroITV*, 2004.
- [3] R. Schatz, S. Wagner, S. Egger, and N. Jordan, "Mobile TV becomes Social - Integrating Content with Communications," in *Proc. of ITI*, 2007.
- [4] W. Zhu, C. Luo, J. Wang, and S. Li, "Multimedia cloud computing," *IEEE Signal Processing Magazine*, vol. 28, pp. 59–69, 2011.

- [5] R. Pereira and K. Breitman, "A cloud based architecture for improving video compression time efficiency: The split & merge approach," in DCC'11, 2011, pp. 471–471.
- [6] F. Chang, J. Dean, S. Ghemawat, W. C. Hsieh, D. A. Wallach, M. Burrows, T. Chandra, A. Fikes, and R. E. Gruber, "Bigtable: A Distributed Storage System for Structured Data," in Proc. of OSDI, 2006.