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ABSTRACT

In this paper, we proposed quality of experience/service (QoE/S) framework for valuation of gaming services on the fog network. Fog computing has been conceptualized to encourage the sending of new services that cloud computing cannot provide, especially those requesting QoE guarantees. The proposed model is useful in Fog computing that offers cloud like services at the edge network to support users with low latency response requirements. Our proposed model for QoE/QoS of multimedia and gaming services of fog computing based on the objective and subjective QoE which will captured automatically by using agent technology and user feedback form. This framework monitors, analyses, generate reports and changes policy without intervention of administrators.

CCS Concepts

• Networks~Network measurement • Networks~Network performance analysis

Keywords

Quality of Experience (QoE); Fog computing; Gaming services; Service level agreement (SLA).

1. INTRODUCTION

Cloud gaming and multimedia services are known as bandwidth killer because of both required high network speed for delivery of contents from cloud to users [1, 2]. Multimedia services are unidirectional so somehow service providers manage to provide quality of service (QoS) for low-quality videos but gaming required bidirectional high-speed networks for receive and send gaming data in multiplayer gaming situation [3, 4]. Cloud process the gaming data fast and send to both players for quality gaming but the middle network is a big issue for gaming players because both players did not same network speed and some network load is the peak.

Mostly game videos are compressed and video player built-in browsers like flash player and HTML5 video player decode video to play which will also require high processing but most of the devices did not have high processing to execute fast which also make delay and quality degradation of video which decreases the QoE [5, 6]. Playing of cloud gaming is also required high bandwidth to transfer the action of users to cloud and render game data on cloud which also required high processing units [7]. Clouds have enough processing unit to render game data fast but the problem is the delivery of data to end-users on due to latency and bandwidth [8, 9]. The QoE of users are very worse in cloud gaming if multiplayer play same game against and have different networks.

Providing services with QoE is unwieldy for cloud service providers, so it is essential to design and develop new paradigms which provide services according to user needs and increase satisfaction [10, 11]. This leads to researcher and academia to fog computing, which reduces the processing burden of cloud by executing data on the edge of the network with avoiding transferring to cloud processing units. Cloud limitation are latency, limited, bandwidth and Internet connectivity are the major concerns which decrease the QoE of end-users for particular services [12]. In this situation, fog computing/edge computing provides a solution for low-speed middle networks by processing most of the data at the edge of user's devices such as routers, switches, Internet-connected devices, and servers by avoiding sending to the cloud [13, 14].

Fog computing is an extension of cloud computing which supports or fasten the services of cloud to end-users. Fog computing defined as Fog Computing is an advanced or prolonged modification of cloud computing where the computing ensues at the edge of the system. There are several groups as of now expenditure a significant quantity of research on this idea like Cisco and so on [15, 16]. It is like cloud computing, however, is far denser in land spreading what's more, area and its nearness to end-users is more, which implies they give a faster end-client happenstance than distributed computing and have improved execution. Fog computing supports physical distribution, real-time interaction, mobility, and heterogeneous devices.

Quality of Experience techniques is used to get user's data about the services which they receive [17, 18]. QoE is tossed in two way, one is objective is taken the technical factor of QoS data and objective human factors which are related to the human physiological and cognitive system. Second is subjective QoE which is based on the interviews, web surveys and questionnaire [19]. Our proposed model is QoE/QoS for multimedia and gaming services of fog computing based on the objective and subjective QoE which will be captured automatically by using agent technology and user feedback form.

The rest of the paper is organized in sections. In section II, we provide related work based on the overview of the existing QoE/QoS based platforms for gaming services. Section III provides a proposed model of fog computing for QoE/QoE Gaming Services and finally, in section IV, we conclude the work and provide future directions.

2. LITERATURE REVIEW

QoE framework for cloud gaming was developed by several researchers by using network parameters, video compression, remote rendering, and remote rendering. Most popular and commercial cloud gaming platforms are the GaiKai [20], Ubitus [21] and OnLive [22]. GamingAnyWhere is open, cross-platform, efficient and modularized [23]. Y. Lin and H. Shen were proposed Cloudfog lightweight system [23]. In this proposed gaming system supernodes are used as fog based concept at the middle between the cloud and end-users. Cloud process, render the graphics of games and overall computations of a new level of the virtual world and update to supernodes and every user is connected to supernodes nearby location received data of games. User did not have fast network link to access the cloud, which received apprise of the virtual world and rendered videos of game and cloud did not shift the whole game video to faraway users. This technique supports high QoE on slow networks and shortens the response time, rise user coverage and decrease bandwidth cost. The Cloudfog was compared with GamingAnywhere: [23] and EdgeCloud [24] models and it provide better QoS for the game without a long delay. In CloudFog users are near to supernodes, so user received videos from near supernodes instead of long-distance servers.

In summary, most research has been done on QoE framework of cloud gaming and only one proposed Cloudfog lightweight system in previous research which did not describe the QoE type is used and how QoE will collect from fog environment. There is no mechanism provided by researcher for distinguish between the positive and negative feedback of game players so to overcome the this problem we proposed QoE/QoS model for gaming services in fog computing which automatically collect objective QoE/QoS and provide option to game player to submit subjective QoE of services s/he will receive.

3. PROPOSED MODEL OF FOG COMPUTING FOR QOE/QOE GAMING SERVICES

Video decode on the edge of network devices to reduce the processing burden from the end user's device. Executing game data on the edge of the network by avoiding execution on the cloud will provide fast response and conventional gaming, only the core engine data of games will load from cloud to edge of networks. This makes only communication between users to fog computing for processing of data and fog to cloud to retrieve core modules and data of games. QoE/QoS model of fog gaming and data transfer scenario from cloud to fog and fog to end-users are given in Figure 1.

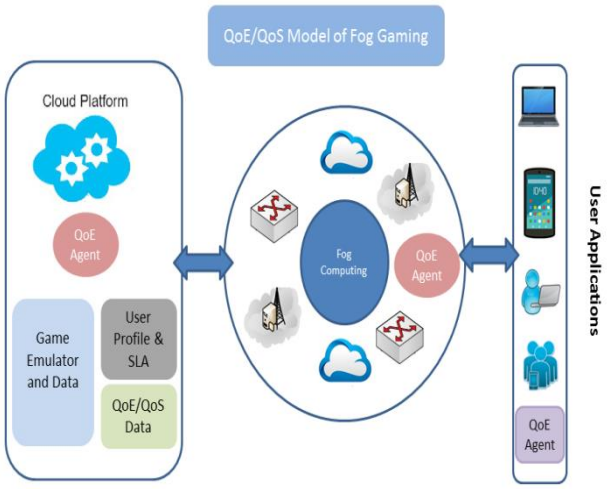

Figure 1. QoE/QoS model of Fog Gaming

The proposed fog gaming model is based on the three layers, which contains cloud, middle network/edge/fog nodes, and client layer. The cloud layer contains games and their emulator, either free or commercial games based on the pay for play. User profile and service level agreement (SLA), QoE agents for internal cloud monitoring and QoE/QoS database which contains the information of fog nodes/network delay, data execution, free and utilize resource and data migration information and also client submitted subjective and automatically objective QoE/QoS data. The middle layer, which based on the fog nodes (network device/servers etc.) and user layer which contains different user devices with different heterogeneous applications to access the game data to play the game from clouds.

Client-side based on the QoE agents which automatically monitor the client device information such as free and utilized resources, running applications, network traffic in and out. This all information stored on the cloud side and also users have the option to submit QoE feedback forms if they did not receive QoS of gaming, which is given in Figure 2. This form provides the facility to user to submit their complaints about the service quality of game access from cloud and rendered on fog environment. The form contains four sections; users can input their information and game type which they play, visual quality information of game during the playing and network behavior and also add comments about the satisfaction of games services.

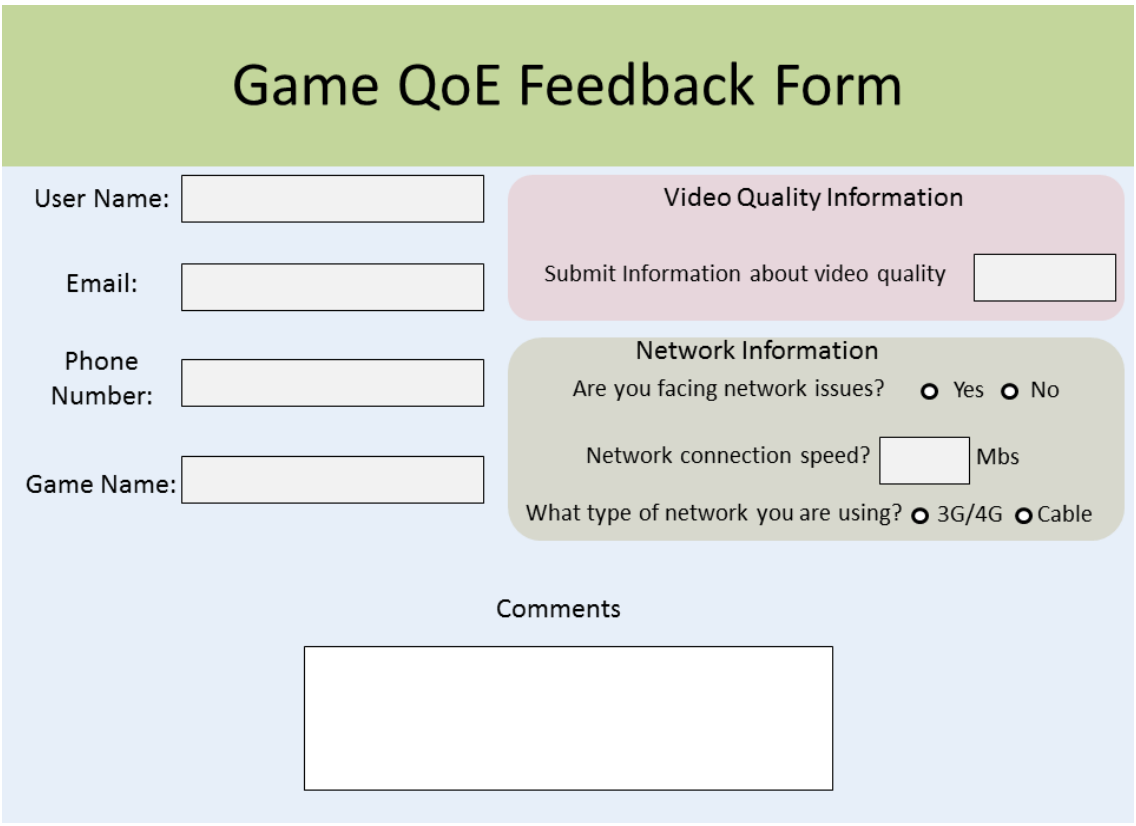

Figure 2. Feedback submission form

If the user did not receive QoS he submits feedback form and provides information on what type of problem s/he faced during the gameplay such as network delay/loss or low graphics quality of the game video. Cloud admin analyze the QoS monitored and user-submitted data, to check user provide accurate information that s/he did not receive QoS of games or some time greedy behaviour of user-submitted wrong feedback to get more high priority services from the cloud. Cloud admin also check more detailed information such as which game type is played (low or high graphics quality), single-player or multiple player games, the distance between the users and also from the cloud.

From the submitted feedback form, cloud admin extracts the information and stores in the user profile and analyse it, QoE framework could develop user profile as per user's requirements. A predefined policy of a reasonable QoE level can be established based on the results of a subjective experiment with computer specialist. So that at each instance a client submits QoE information, it is assessed against the predefined QoE policy and the QoS based service level agreement (SLA). Admin examines the quality of gaming services whether to meet SLA or not. In case of services breaking SLA limits, then cloud admin upgrades the service requirements, otherwise, it stores information for future use.

The proposed Fog computing framework enabled with agent-based technology, which checks the resources utilization and of client system as well fog environment. Sometime client have low resources to play a particular game or play the video which also has a higher impact on the play games smoothly this situation also has an impact on the QoE of the end-user. Low resources of system cause wait condition between the processes for execution due to interleaving scheduling policy of the operating system. If the user did not receive QoS service due to insufficient resources of user device then the framework will send alert to the user that your device did not have the resource to execute or receive quality services. The resource discovery service works like grid computing, where Globus toolkit software components run on the client system and monitoring resource utilization and report to the service provider [25].

4. CONCLUSION

In this paper, we presented QoE based framework for fog gaming services based on the agent technology which automatically monitors objective QoE from service provider to client and device and also enables to users to submit their feedback about the services. This framework upgrades services to ensure QoS when the user did not receive services according to SLA in peak hour of usage and provide better service to maintain QoE level during the usage of the services. This is on-going work, in future we intend to develop a complete framework and provide more results which lead to industry to implement.

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