A New Approach for Implementing 3D Video Call on Cloud Computing Infrastructure

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ABSTRACT
3D video call is a set of technologies, which allow a caller to feel the depth of the other caller and to give the real-life feeling. 3D video call is a developing technology that can be presented by peer-to-peer architecture. Cloud-based technologies are driving positive changes in the way organizations can communicate. In running a global business, the need for travel and being available in meetings is a must. However, with expensive travel costs, an alternative solution to overcome this problem is required. This paper presents, a new approach that enhances current 2D video calls to 3D video calls benefiting from the unlimited features of the cloud-computing. Three technologies were implemented, OpenStack cloud, webRTC call and 3D anaglyph effect to achieve the sense of 3D video.

CCS Concepts
• **Software and its engineering→Agile software development**.

Keywords
cloud computing; peer-to-peer; Openstack; webRTC; 3D anaglyph.

1. INTRODUCTION
Currently, 3D video is entering broad in the technology market. The technology is now maturated, providing excellent quality. It becomes increasingly interesting for other applications such as home entertainment, mobile devices and 3D video systems.

Cloud Computing has become a significant research topic of the scientific and industrial communities since 2007 because of its management strategy, reliability, speed, scalability, and convenient services offered to clients [1].

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Traditional video-conferencing systems still fail to meet the challenge of providing a feasible alternative for physical business travel, which characterized by unacceptable delays, and costs [2]. 3D video call technology that presented nowadays has a problem that not scalable and expensive implementations [3].

The urgent need for 3D video call is encouraging to enhance a system that makes communication more natural and clear between people. The addressed issues were the inspiration to work on a solution that handles this issue. To deliver clear, fast, pure 3D video communication, video as a service (VaaS) shown in figure 1 applied in cloud infrastructure [4].

Figure 1. VaaS Solution and Platform

In our research, we benefit from previous research in three different disciplines, which are cloud computing, video call and 3D video. As shown in figure 2, Cloud-computing is used as an infrastructure [5] to setup a video call using webRTC technology [6]. Then, 3D video is created using image processing techniques to generate 3D video that can be watched by Red/Cyan glasses [7]. Finally, we setup cloud Virtual Machine (VM) to handle and test the performance of the 3D video call and compare it with traditional 3D peer-to-peer video call.

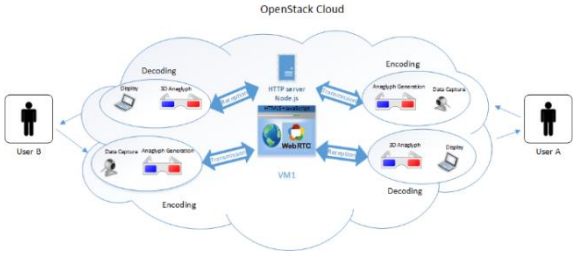

Figure 2. Research Implementation Diagram

The goal of our research is to develop for the first time a new approach that implements 3D video call on top of cloud computing infrastructure. Section II discusses the related work done in our approach research areas. Section III explain in details our proposed framework. Section IV escribes our approach conclusions and future work.

2. RELATED WORK

Real-time communication is enhancing along time started with telephone call 1876 [8], text chatting 1973 [9], voice calls 1973 [10], video calls 1980 [11] then video conferencing systems 1991 [12].

Cloud computing provides three main service models Software as a Service (SaaS), Infrastructure as a Service (IaaS) and Platform as a Service (PaaS). There are many solutions developed to put cloud computing in implementation. OpenStack is one from those communities of cloud computing platforms [5]. OpenStack as shown in figure 3, is an open source and free platform under the rules of the Apache license that has a set of tools for the creation and management of public, hybrid and private cloud computing, used because of its modularity, scalability, and flexible set of utilities [13].

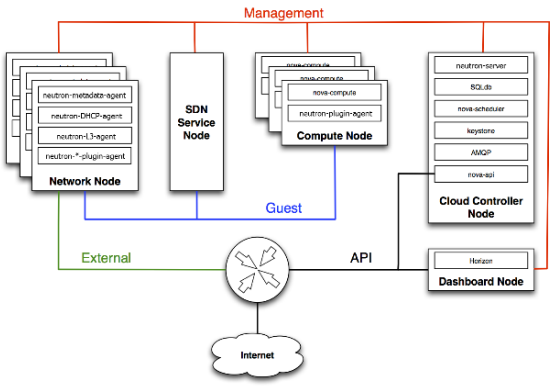

Figure 3. OpenStack cloud platform Architecture

WebRTC is a free, open source project that provides browsers and mobile applications with Real-Time Communications (RTC) capabilities via simple APIs. WebRTC, built on JavaScript Sockets programming, Communication held on between two networks with real-time video streaming feature with help of special protocol as well as reliable communication [14], rich high quality RTC can be developed on browsers and mobile platforms [15]. Figure 4 explains the webRTC architecture.

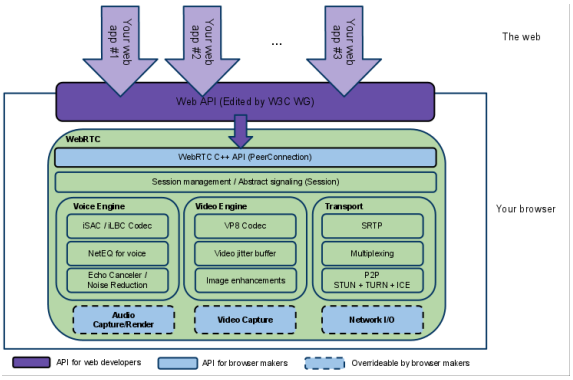

Figure 4. webRTC API components Architecture

The term of "3D" was discovered in 1850's. In 1853, the first person who presented the idea of anaglyph using blue and red lines on a black field was W. Rollman [16]. Rollman used blue and red glasses to perceive the anaglyph effect. A mixture of two images from the perspective of the right and left eyes is called anaglyph 3D image. One eye will perceive through a red filter and the other eye will perceive through a different color filter such as cyan [7]. The Anaglyph 3D method of stereoscopic visualization is both cost effective and compatible with all full-color displays [17].

3. PROPOSED FRAMEWORK

The proposed framework presents a new approach to develop 3D video call on top of cloud computing infrastructure; it is a combination of OpenStack cloud computing, webRTC technology for video chatting system and anaglyph algorithm for generating 3D video. Figure 5 shows our proposed framework. It starts by constructing cloud infrastructure to handle the video communication using OpenStack cloud architecture, create Virtual Machine (VM) to handle and test the communication, then setup video call system using webRTC on the Virtual machine. While capturing the video using video input device apply the 3D filter to generate 3D anaglyph video.

3.1 Cloud Construction

OpenStack consists of seven different service code projects to make it modular. The Virtual machine was created on top of OpenStack with nova service, which provides the service for provisioning and un-provisioning of virtual machines on-demand basis. The virtual machine created by storage service divided into two main projects Cinder and Swift. Block storage (Cinder) used to store data over running the instance and get lost when instance is terminated. Object storage (swift) allows the OpenStack users to store or retrieve files. Ubuntu operating system [18, 19] was installed on the VM using image service (Glance). A 1 Gbps network was used to connect the cloud over the Internet using Neutron. Finally, to manage and monitor the virtual machine over the cloud infrastructure dashboard (Horizon) is used. Figure 6 shows how the Virtual Machine operates on top of OpenStack infrastructure.

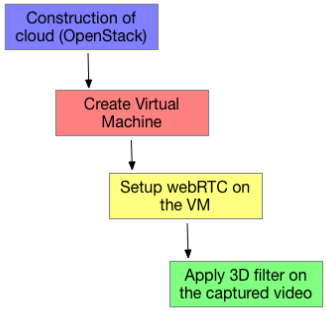

Figure 5. The proposed approach block diagram

3.2 Virtual Machine Creation

The host machine is the actual machine on which the virtualization takes place, the guest machines are the virtual machines functioning through the host [20]. OpenStack was built on top of host machine with 32 GB RAM and 500 GB storage. Then to host sufficient virtual machine on top of OpenStack minimum specification required is 8 GB RAM with 80 GB and four Virtual CPUs (vCPUs), this is considered as large VM on OpenStack infrastructure. The Operating system is installed by creating Ubuntu image using Glance service. Then to connect the VM to the internet must assign Floating IP that allows external access from outside networks or Internet to an OpenStack virtual machine, This IP used also to test connectivity of the VM by ping it from a remote computer in LAN.

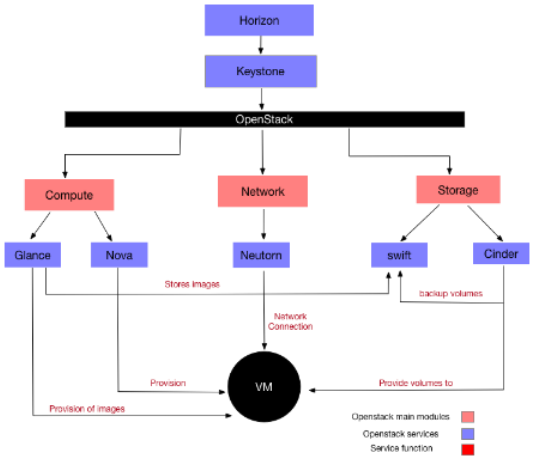

Figure 6. VM on Openstack infrastructure

3.3 WebRTC Setup

WebRTC (Web Real-Time Communication) achieves a peer-to-peer real-time multimedia communication on the web [6]. The core architecture of webRTC is based on multimedia communication process includes voice module, video module, and transmission module. In the delivery of real-time data, timeliness and low latency can be more important than reliability. In both peers of data transmission, one of the fundamental requirement is the ability to locate and identify each other on the network, in our implementation; both peers are located in the same network (cloud infrastructure) without any firewalls or NATs between them. Signaling Mechanism based on reliable data channel, what is required is session negotiation before establishment a connection between browsers, this is done by WebRTC signaling mechanism. To build signaling mechanism node.js was used and web-socket library to pass the requests between candidates. WebRTC is using many codecs to encode and decode the video and audio streams such as H.264, iSAC, Opus and VP8 [15]. When two browsers connect together, they choose the most optimal supported codec between two-users. Figure 7 shows how WebRTC technology operates on top of Cloud computing infrastructure such as OpenStack.

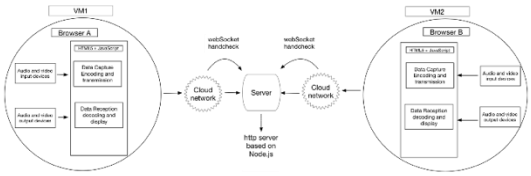

Figure 7. WebRTC on top of OpenStack

3.4 3D Video Anaglyph Construction

Anaglyph video construction is done via JavaScript and HTML5 tags to be implemented on the web. The video was captured and encoded using WebRTC technology. WebRTC capture video with 30 Frames per Second (FPS) [15]. To construct anaglyph images, two RGB images must be combined (frames). Since only one RGB image (frame) used as our input, we have to duplicate the color frame and apply pixel shifting to have right and left images to create stereoscopic view for the images [7]. Combination of these two frames will create the anaglyph image (frames) the generated frames will be assembled to generate 3D anaglyph video, then by wearing the anaglyph glasses we can feel the sense of 3D depth. Figure 8 describes the process to creating anaglyph video.

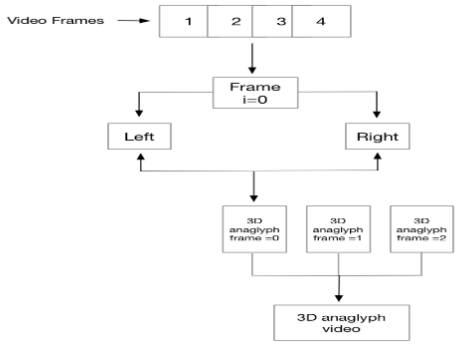

Figure 8. process of creating anaglyph video

4. Conclusion and Future Work

This paper proposed a new approach that implements 3D video call on top of cloud infrastructure OpenStack. WebRTC technology used to create the video call system. The 3D video generated by using anaglyph technique applied on 2D video. The sense of 3D video can be viewed by red/cyan glasses (anaglyph glasses).

The major challenge we faced is the difficulty in cloud computing systems to connect it with external devices such as webcams and headphones to be viewed on the VM. To overcome this difficulty, we used MP4 video to test the implementation on top of OpenStack. This obstacle can be targeted in the future for the full run of the proposed approach. Also, we must have some tests to measure the quality of generated anaglyph 3D video compared with anaglyph in the market. Also, we have to compare the quality of our generated 3D video call with another implementation such as peer-to-peer connection.

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