Cloud-Computing-Based Video/Voice over IP with BPNN Adaptation

Bao Rong Chang
Department of Computer Science and Information Engineering
National University of Kaohsiung, Kaohsiung, Taiwan
brchang@nuk.edu.tw

Hsiu Fen Tsai
Department of Marketing Management
Shu Te University, Kaohsiung, Taiwan
soenfen@stu.edu.tw

Zih-Yao Lin and Chi-Ming Chen
Department of Computer Science and Information Engineering
National University of Kaohsiung, Kaohsiung, Taiwan
{m0995507; m1005513}@mail.nuk.edu.tw

Chien-Feng Huang
Department of Computer Science and Information Engineering
National University of Kaohsiung, Kaohsiung, Taiwan
cfhuang15@nuk.edu.tw

Abstract

In this paper we have implemented a real-time video/voice over IP (VVoIP) applications on an Ubuntu Enterprise Cloud (UEC) cloud computing system and it is denoted CLC-IHU. It really outperforms the previous VVoIP using P2P connection (called SCTP-IHU) due to the easy-to-use and high-performance on video phone call. User does not need to know what is a real IP and web interface achieves interaction by adopt TCP-based RMTP instead of PR-SCTP so that CLC-IHU scheme reduces both computation load and power consumption dramatically at thin clients. We employed a back-propagation neural network (BPNN) to tune key factors appropriately for optimally adapting path handoff and analyzing network traffic at any time. As a result it takes just about 1.631 sec for the seamless handoff between base stations under mobile wireless network. In access control for preventing illegal intrusions from the outside of the cloud, the rapid facial recognition and fingerprint identification via cloud computing has been done successfully within 2.2 seconds to identify the legal user.

Keywords: Video/voice over IP, Ubuntu Enterprise Cloud, BPNN, RMTP, SCTP-IHU, CLC-IHU.

I. INTRODUCTION

It is well-known that audio stream transmitted are through Real-Time Transport Protocol (RTP) [1] relying on UDP, which provides no loss recovery (unreliable). Using TCP-based RMTP rather than UDP, it may cause long delay to get obsolete data at receiver side. In the previous work [2], a video phone based on video/voice over IP (VVoIP) is constructed in ARM-based embedded platform rather than the earlier project implemented on x86 machines [3] for the purpose of the use of mobile video phone call operated on P2P connection [4]. In order to tackle three crucial problems: head-of-line blocking, handover interruption, and non-real-time transmission, we have adopted PR-SCTP protocol [5] instead of TCP. However, the computation load for real-time video phone call is so big and has caused ARM-based embedded platform [6] no longer with power-saving. Moreover, VVoIP need to know their respective IP address between two mobile devices before P2P connection.

In order to resolve the problems as mentioned above, this study is to realize a real-time video/voice over IP (VVoIP) applications implemented by an Ubuntu Enterprise Cloud (UEC) cloud computing [7] denoted CLC-IHU. Next based on client/server architecture users employ web interface to achieve VVoIP connection with thin clients and video phone call adopts an easy TCP-based RMTP connection instead of the complicated PR-SCTP protocol because of web interface not supported by PR-SCTP. User does not need to know what is a real IP used to ring a video phone call. In addition, cloud computing server has been protected by the access control according to the management of authentication, authorization, and accounting (AAA) [8]. UEC cloud computing together with access control employing the rapid face and fingerprint identification has been realized in order for preventing illegal intrusions from the outside of the cloud. Here, we utilize the standard J2ME [9] in embedded devices, where JamVM [10] virtual machine is employed to achieve J2ME environment and GNU Classpath [11] is used as the Java Class Libraries. In terms of the quality of services (QoS) in VVoIP, we have to tackle some of crucial problems about jitter, loss, latency, and throughput so as to maintain the smooth video/voice streaming over internet. We employed a back-propagation neural network (BPNN) [12] to tune key factors appropriately for adapting seamless handoff and analyzing network traffic over time.

II. VIDEO/VOICE OVER IP ON CLOUD COMPUTING

Cloud computing is an emerging and increasingly popular computing paradigm, which provides the users massive computing, storage, and software resources on demand. How to program efficient distributed parallel applications is really a tough issue. How to dispatch a large scale task executed in cloud computing environments is a big challenge as well. Currently the most popular cloud computing services are categorized into several business models such as public cloud, private cloud, community/open cloud, and hybrid cloud. A number of remarkable cloud computing related firm, as we know, are indicated as follows: (a) public cloud like Goggle App Eng [13], Amazon Web Services [14], and Microsoft Azure [15]; (b) private cloud like Microsoft MCloud [16], IBM Blue Cloud [17], and SalesForce.com [18]; (c) open cloud: Open Nebula [19], Eucalyptus [20], Apache Hadoop [21], and NCDM Sector/Sphere [22]; (d) hybrid cloud like IBM Blue Cloud [17].

Two famous companies related to IP phone on cloud computing are voice over IP in a Cloud, IIS 2009 [23] and VoIP in cloud computing, Skpye in 2010 [24]. In Taiwan, Chunghwa Telecom provides Hicloud with two services: CaaS and StaaS [25], Innovative DigiTech-Enabled Applications & Services Institute at III [26] gives public cloud computing services, National Center for cloud computing at NARL delivers training courses for cloud computing [27], and Cloud computing Center for Mobile Application at ITRI contributes the efforts in Container Computer, Cloud OS, and Application [28].

In this study, the VVoIP application program does not need to be installed inside mobile devices. It has been set up in the UEC cloud computing server [29], where virtual box [30] is a container to include UEC, so that web interface is applicable to run and browse video phone call between cloud computing server and thin clients as shown in Fig. 1. Therefore, instead of complicate PR-SCTP protocol a simple and easy control transmission protocol TCP-based RMTP is employed in such a client/server structure rather than P2P connection as we did before. Video/voice streaming over IP can be implemented in such a bidirectional connection between thin clients (i.e., Linux or WinCE embedded platforms). Users do not need to get both actual IPs in advance; instead they get into UEC cloud computing server to catch VVoIP service directly for initiating video phone call connection and cloud computing will be looking for the other side to accomplish phone call link between two client sites.

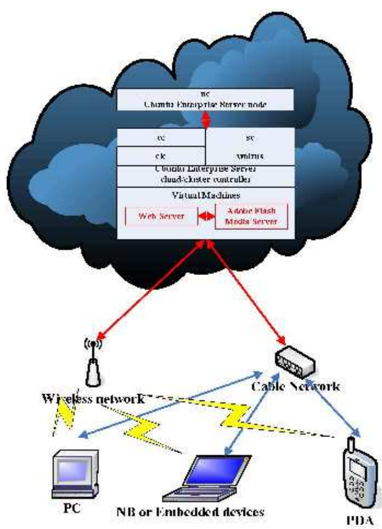


Figure 1. Mobile devices linked to UEC cloud computing server over Ethernet or WiFi.

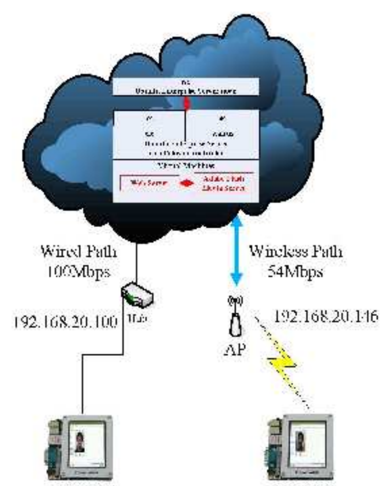
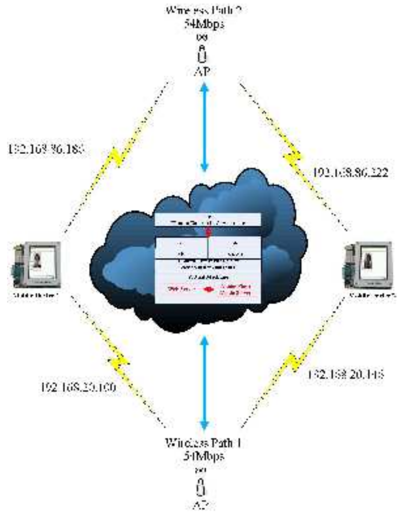


Figure 2. Handoff between wired and wireless network.



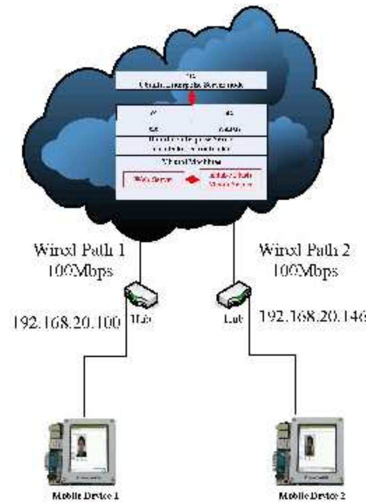


Figure 3. Handoff between wireless networks. Figure 4. Handoff between wired networks.

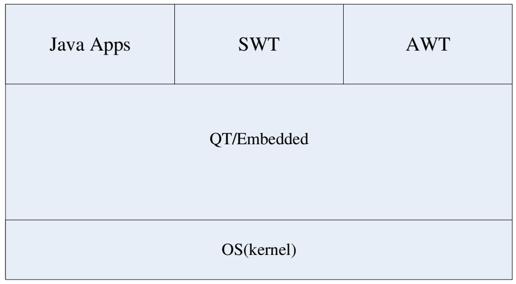
III. REALIZATION OF CLOUD COMPUTING SYSTEM

3.1 Deploying UEC cloud computing

Once a UEC cloud computing has been established in server site, we have to test a number of seamless handoffs between clients and UEC cloud computing system as shown in Fig. 2, 3, and 4. In order to setup a programming environment for Python or Java, an Eclipse IDE [31] is applied to develop the application program (AP) at local site. It is noted that please remember to install Java JDK [32] before you setup an Eclipse IDE in local site. If AP has been done and is waiting for dispatching itself to UEC cloud computing server, we deploy this AP via the path of LAN or WiFi. Finally we take a look at HBase in UEC server to make sure that the cloud computing is ready for the task.

3.2 Establishing thin client and installing access control

In terms of thin client, JamVM is treated as the framework of programming development; however the virtual machine JamVM has no way to perform the drawing even through their core directly, and thus it must call other graphics library to achieve the drawing performance. Here some options we have are available, for example, GTK+DirectFB, GTK+X11, QT/Embedded [33]. As shown in Fig. 5, this study has chosen QT/Embedded framework instead of GTK series, in such a way that achieves GUI interface functions. In Fig. 6, no matter SWT or AWT in JamVM they apply Java Native Interface (JNI) [34] to communicate C- written graphics library. Afterward QT/Embedded gets through the kernel driver to activate graphic function as shown in Fig. 7. Cloud computing here can perform rapid fingerprint identification [35] and facial recognition [34] in order to fulfill the access control system [36]. We will see whether or not a quick response to client is confirmed. The access control system is shown in Fig. 8.



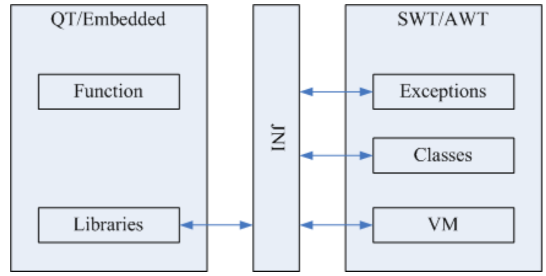
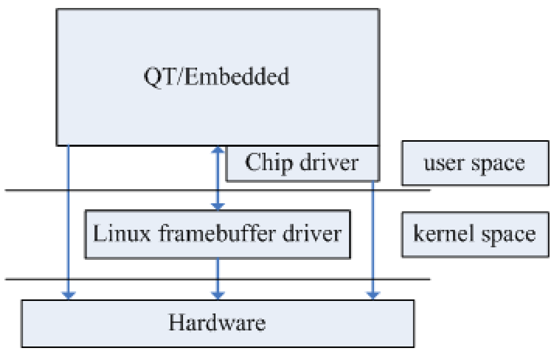


Figure5. Terminal node with QT/Embedded.

Figure 6. Communication between SWT/AWT and QT/Embedded.



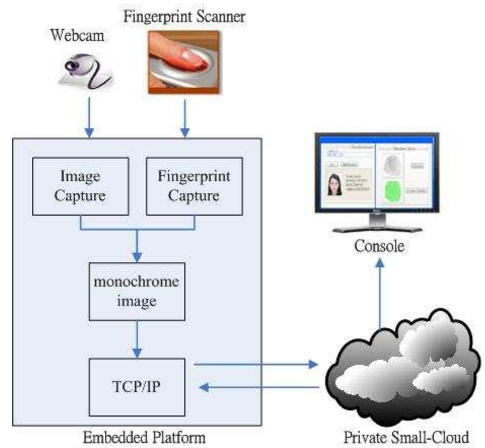


Figure 7. QT/embedded communicates with Figure 8. Access control system.network.
the Linux Framebuffer. computing server over
Ethernet or WiFi.

3.3 Implementing VVoIP at UEC with web interface

(1) According to an open source IHU (a voice over IP application program), we have established a video/voice over IP application on Linux system to develop VVoIP over two PCs as shown in Fig. 9.

(2) Activating a database in a cloud computing server to record the necessary information like account, IP address and so on.

(3) Constructing the web services in order to connect a database in UEC cloud computing server for implementing the VVoIP applications, user account and login, as shown in Figs. 10 and 11.

(4) Transplanting the video/voice over IP application into cloud computing server incorporation with web interface and database.

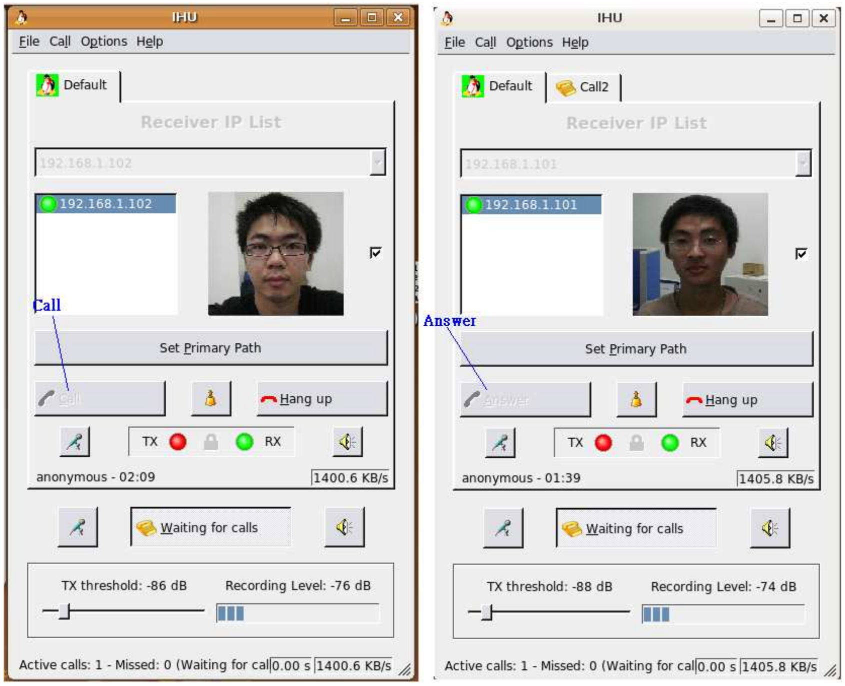


Figure 9. P2P-based VVoIP implementation between two PCs.

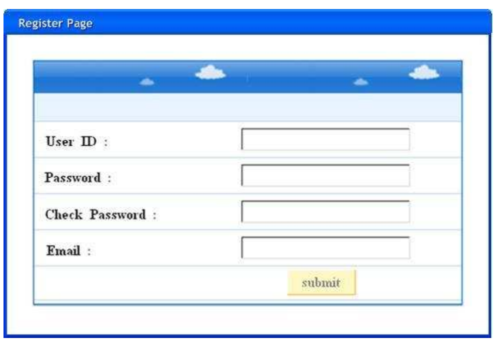


Figure 10. Web registration at UEC cloud computing server before launching VVoIP application.

Figure 11. Web login interface at UEC cloud computing server before launching VVoIP application.

3.4 Intelligent adaptation for VVoIP on cloud computing

In terms of quality of services (QoS) implemented in the video phone call over IP, we have to tackle some of crucial problems about jitter, loss, latency, and throughput so as to maintain the smooth video/voice streaming over internet. This study herein introduces a way of intelligent adaptation for key factors to tune video/audio parameters appropriately in UEC cloud computing system while an on-line video phone call between clients. As shown in Fig. 12 the diagram illustrates an intelligent adaptation using a back-propagation neural network (BPNN) [12], where R, D, S, V, and W denote the normalized CPU clock rate, the size of SDRAM, the size of SRAM, dB value of noise, and network bandwidth, respectively, to adjust the time for frame delay while video streaming is transmitting and receiving at the same time each other. Besides, the same scheme of BPNN is applied to audio parameters tuning for the size of video buffer and the least volume in dB for receiver as shown in Fig. 13. We have collected a lot of data by the manner of trial-and-error during the experiments. Once the data collection has completed, those of data have been put into the BPNN for training and validating so that we can get a trained BPNN system for infer the key parameters such as the frame delay for video, the least volume in dB for voice receiver, and the size of audio buffer. After that, the video/voice over IP has been tested in the cloud computing system based on Web interface and as a result it performs very well on video phone call over IP.

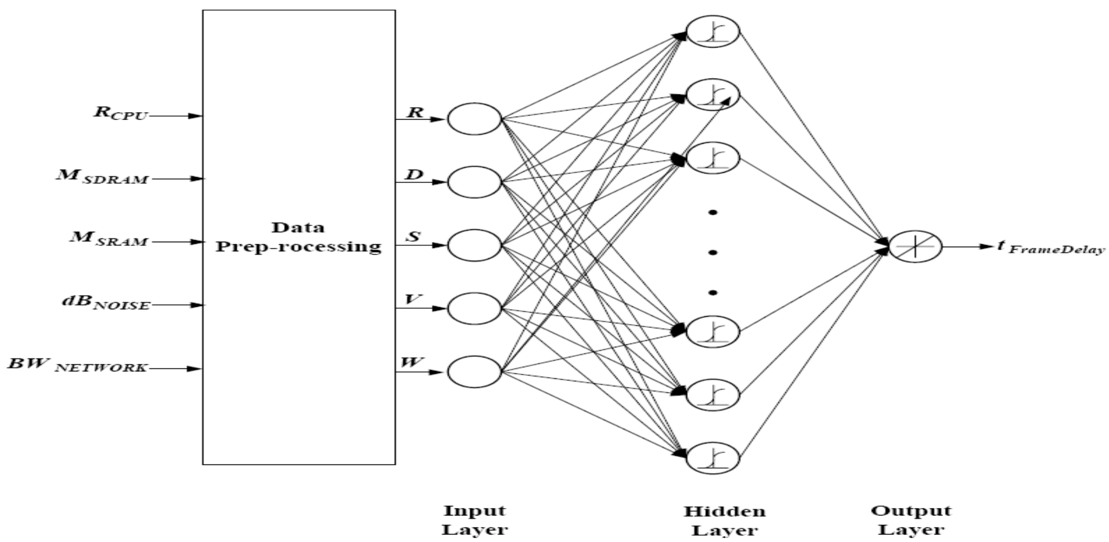


Figure 12. BPNN adaptation for a video frame delay.

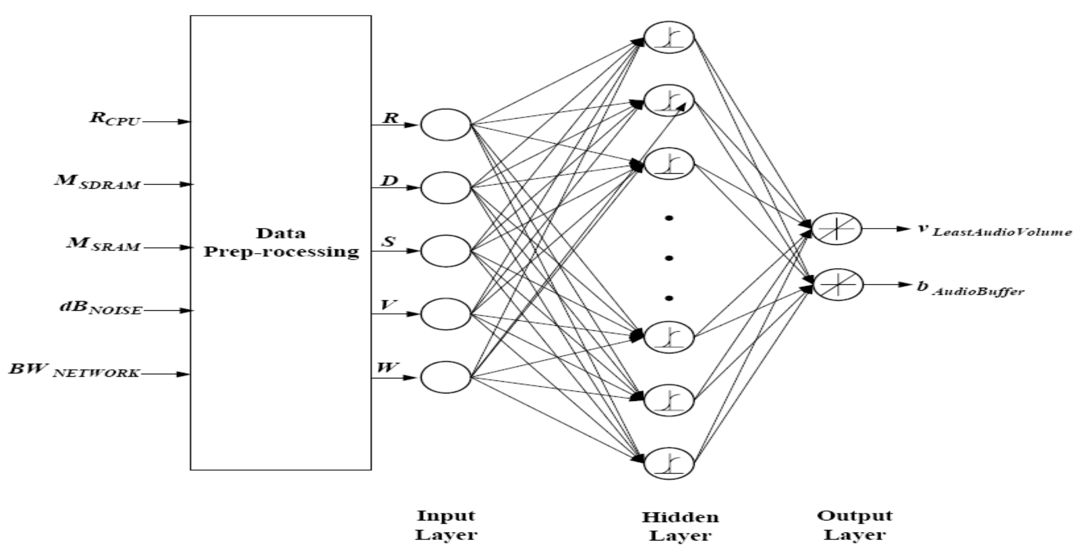


Figure 13. BPNN adaptation for audio volume & buffer.

IV. EXPERIMENTAL RESULTS AND DISCUSSIONS

A client/server scheme of VVoIP application running on UEC cloud computing will be denoted CLC-IHU in the following experiments, as shown in Figs. 14, 15, and 16, and discussions. Two remarkable benchmarks for the performance comparison of access security are revealed in FACE ID2 [38] and ZKS-F20 [39] where Equal Error Rate (EER), for the processes on facial recognition and fingerprint verification, and Response Time are two most concerned measures in the control of access security. As listed in Table 1, the comparison of performance with three models, FACE ID2, ZKS-F20, and CLC-IHU, is consequently shown that the method we proposed here outperforms the other alternatives due to fast response and low misclassification rate in access security.

Figure 14. Binarization processing automatically running in a program.

Figure 15. Processing fingerprint features to reduce the amount of information.

Figure 16. Information sent to the cloud and cloud displays the results of recognition on the consol.

Figure 17. VVoIP over two embedded platform on mini2440 via P2P connection.

In comparison to the previous work as shown in Fig. 17, the result of the experiment on VVoIP at UEC cloud computing, as shown in Figs. 18 and 19, is really to highly improve the network traffic for video/audio streaming, and easy-to-use TCP-based RMTP protocol instead of PR-SCTP. A well-known benchmark for QoS measures is USHA scheme [40] where low latency and low packet loss are two most critical design issues in USHA scheme. As a result, the comparison of QoS with three models, USHA, SCTP-IHU, and CLC-IHU, as listed in Table 2 is shown that the approach we proposed here is good enough to realize a real-time on-line video phone call between embedded platforms. In addition, we also emphasizes that real-time streaming multimedia with cloud computing scheme to achieve the least losses of transmitted packets, below 2% on average for video streaming, which is acceptable for four types of handoff. This result show the head-of-line blocking and handoff interruption can be resolved somehow by fast re-connection and parallel computation. According to the specification for mini2440 [41], ARM-based embedded platform, it is noticed that the power consumption is really reduced dramatically in mobile device when we adopt cloud computing scheme, CLC-TCP, for a real-time on-line video phone call.

Figure 18. CLC-IHU implementing VVoIP over two embedded platform mini2440 on user A.

Figure 19. CLC-IHU implementing VVoIP over two embedded platform mini2440 on user B.

In the application of VVoIP running in UEC cloud computing, the handoff delay time can achieve less than 1.7 sec as shown in Table 2. In order to verify the effectiveness and efficiency in access control for preventing illegal intrusions from the outside of the cloud, the rapid face recognition and fingerprint identification in UEC cloud computing has been done successfully within 2.2 seconds, as shown in Table 1, to exactly cross-examine the subject identity. As a result the proposed approach outperforms the other alternatives due to fast response and low misclassification rate like EER in access control.

Table 1. The Performance Comparison of Access Security

Performance	FACE ID2	ZKS F20	CLC-IHU
Equal Error Rate (EER)	<0.1%	<0.01%	<0.01%
Response Time	<5.5 sec	<3.7 sec	<2.2 sec

Table 2. The QoS Comparison of VVoIP

Performance	USHA	SCTP-IHU	CLC-IHU
Handoff Delay	2.5 sec	1.865 sec	1.631 sec
Power Consumption at	—	10.53mAV~ 11.7mAV	6.295mAV~ 7.08mAV

V. CONCLUSIONS

In the previous work, application programs for VVoIP have installed in thin client. In this study we have moved the VVoIP applications from thin client to a UEC cloud computing system where access control has been set up there using rapid facial and fingerprint identifications. User does not need to know what is a real IP and web interface achieves interaction by adopt TCP-based RMTP instead of PR-SCTP so that CLC-IHU scheme reduces computation load and power consumption dramatically at thin clients. In addition, we employed a BPNN to tune key factors appropriately for adapting seamless handoff and analyzing network traffic over time. As a result it takes a very short delay for the seamless handoff between base stations under mobile wireless network. We finally draw the conclusion that the approach we proposed here achieves a better performance and efficiency than the previous works.

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具有倒傳遞類神經網路調適之基於雲端計算網路視訊通話

張保榮
國立高雄大學資訊工程學系
brchang@nuk.edu.tw

蔡秀芬
樹德科技大學行銷與流通管理系
soenfen@stu.edu.tw

林子堯、陳峻浩
國立高雄大學資訊工程學系
{m0995507; m1005513}@mail.nuk.edu.tw

黃健峰
國立高雄大學資訊工程學系
cfhuang15@nuk.edu.tw

摘要

在這篇論文中，我們已經運用 Ubuntu 企業雲的雲計算系統，實現了雲端計算即時網路視訊通話(VVoIP)的應用，並簡稱為 CLC-IHU。由於它具有易於使用和高性能視頻電話，它確實比以前使用 P2P 連線方式的 VVoIP(稱為 SCTP-IHU)更加優越。用戶不需要知道什麼是真正的 IP 地址以及採用基於 TCP 的 RMTP 協定而不是 PR-SCTP，實現互動網頁介面，使 CLC-IHU 設計可以大大減少了客戶機端的計算量和功率消耗。我們採用了一倒傳遞類神經網路(BPNN)適當地調適關鍵因素，以優化隨時連線路徑切換和分析網路流量。因此，它在移動無線網路基地站之間的無縫切換約需 1.631 秒。在門禁管制方面，為防止從雲端外面非法入侵，通過雲計算的快速人臉識別和指紋辨識，能夠在 2.2 秒內成功地判斷出是否為合法的使用者登入。

關鍵詞: 網路視訊通話、Ubuntu 企業雲、 倒傳遞類神經網路、RMTP 協定、SCTP-IHU 設計、CLC-IHU 設計。