

# Experimental Verification of Docker-based Immutable Secured Mobile VoIP in South-East Asia Zone

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## Abstract

Cloud computing paradigm has been driving the cloud-leveraged refactoring of existing ICT services including VoIP. In this paper, we design and prototype secured mobile Voice over Internet Protocol (VoIP) services with open-source Asterisk Private Branch Exchange (PBX) software by employing Docker lightweight virtualization for mobile devices with immutable concept of Continuous integration and Continuous deployment (CI/CD). We also experimentally verify the quality of secured voice and the associated communication delay over distributed connectivity environment of South-East Asia zone.

**Keywords:** security, mobile VoIP, docker, cloud computing

## 1 Introduction

Recently, Cloud Computing specifically among several keywords of Information & Communication Technology (ICT) sector is in a situation which is continuing to be discussed with Gartner Group [9], Amazon, Google, and etc. And 5G wireless communication will make more services and add benefits to the world over 4G. As detailed trend, the Docker lightweight virtualization technology has emerged in Linux camp. Also, the political and social issues are in the situation where eavesdropping on security incidents and continue to rise. To simplify and enhance the security of the voice communications in smartphone is the object of this study. Voice over IP (VoIP) [16] is a methodology and group of technologies for the delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks, such as the Internet. VoIP systems employ session control and signaling protocols to control the signaling, set-up, and tear-down of calls. They transport audio streams over IP networks using special media delivery protocols that encode voice, audio, video with audio codecs, and video codecs as Digital audio by streaming media. VoIP is available on many smartphones, personal computers, and on Internet access devices. In order to support secure voice communication using VoIP to examine how to guarantee the Quality of Service (QoS) of VoIP and survey the security issues of VoIP. The minimum response strategy and network tuning for packet loss, packet delay in transmission, the jitter and others are required to guarantee QoS of voice communication in the IP network. In addition, the 10 items of VoIP security issues and National Institute of Standards and Technology (NIST)'s 7 items for the VoIP service quality are contemplated. Based on the previous mentioned the objects of this study are to support Mobile VoIP and secured voice communication as Software-as-a-Service (SaaS). We design and prototype secured mobile VoIP services with open-source Asterisk PBX(private branch exchange) software by employing Docker lightweight virtualization for mobile devices with immutable concept of Continuous integration

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*IT CoNvergence PRActice (INPRA)*, volume: 4, number: 4 (December 2016), pp. 11-17

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and Continuous deployment (CI/CD)[1]. Also experimentally verify the quality of secured voice and the associated communication delay over distributed connectivity environment of South-East Asia zone.

## 2 Related Work

In this section, we described the foundation concepts of Mobile VoIP, security issues of VoIP, Docker lightweight virtualization technology to implement secured Mobile VoIP, and 5th generation wireless systems.

### 2.1 Mobile VoIP, SW PBX Asterisk, and Security Issues of VoIP

Mobile VoIP(m-VoIP) is an extension of mobility to a Voice over IP network [14]. The short range type and wider area type of communication are generally supported: cordless/DECT/PCS protocols for short range or campus communications where all base stations are linked into the same Local Area Network (LAN), and wider area communications using 3G/4G protocols. And there are several methodologies that allow a mobile handset to be integrated into a VoIP network. One implementation turns the mobile device into a standard Session Initiation Protocol (SIP) client, which uses a data network to send and receive SIP messaging, and to send and receive Real-time Transport Protocol (RTP) for the voice communication path. This methodology requires the mobile handset support, at minimum, high speed IP communications. In this application, standard VoIP protocols (typically SIP) are used over any broadband IP-capable wireless network connection. Asterisk [8] is a software implementation of a telephone Private Branch Exchange (PBX); it allows attached telephones to make calls to one another, and to connect to other telephone services, such as the Public Switched Telephone Network (PSTN) and Voice over Internet Protocol (VoIP) services. Matthew Ruck [13] and NIST [11] published the documents on the security of VoIP. Matthew has noted 10 security issues relating to VoIP security, as follows: VoIP traffic might be internet bound, Gateway security options for VoIP are limited, patching problems, VoIP security is only as reliable as the underlying network security, many call processing systems run on common operating systems, and they have their own security issues to worry about, Denial of Service (DoS) takes down telephony, eavesdropping on calls using VOMIT or SipTap, Spam over IP telephony (SPIT), more ports open more ports to secure, and wireless phones require advanced wireless security. Specially, NIST are summarized into 7 items for Service Quality of VoIP issues as follows: Latency, Jitter, Packet Loss, Bandwidth and Effective Bandwidth, Throughput Speed, Power Failure and Backup Systems, and Quality of Service Implementations for Security.

### 2.2 Docker Lightweight Virtualization Technology

Docker [10] is an open-source project that automates the deployment of applications inside software containers, by providing an additional layer of abstraction and automation of operating-system-level virtualization on Linux. Docker uses the resource isolation features of the Linux kernel such as cgroups and kernel namespaces, and a union-capable filesystem such as aufs and others to allow independent "containers" to run within a single Linux instance, avoiding the overhead of starting and maintaining virtual machines. The Linux kernel's support for namespaces mostly isolates an application's view of the operating environment, including process trees, network, user IDs and mounted file systems, while the kernel's cgroups provide resource limiting, including the CPU, memory, block I/O and network. In recent years, it has begun to show a tendency to replace the Docker supporting virtualization than hypervisor [15]. The main concept of Docker represents the immutable infrastructure concept, and the features of immutable infrastructure are summarized as follows: Easy to Manage, Scalability, Testability, and Portability.

### 2.3 5th Generation Wireless Systems

5G [5], [12] will make more services and add benefits to the world over 4G. 5G technology will provide very high band width that the users have never experienced before. The 5G technology has all type of advanced features which makes it a most powerful tool of wireless communications. With 5G pushed over a VoIP enabled device, people will experience a level of call volume and data transmission never experienced before. 5G technology will offer the high quality of services in the field of Product Engineering, IoT(IoE, AtO)[4], I2oT (Industrial IoT), and supporting electronic transactions (e-Payments[7], e-transactions) etc.

## 3 Implementation and Verification of Docker-based Secured Mobile VoIP

### 3.1 Implementation of Docker-based Secured Mobile VoIP with immutable concept of CI/CD

To support lightweight virtualization, the secured m-VoIP based on Docker can be implemented by utilizing open source SW PBX Asterisk with H/W on single board or PC instance of high performance servers. In order to support secured mobile VoIP app, Backend system had installed Docker-based SW PBX Asterisk and dash board FreePBX [3]. Figure 1 (a) shows the architecture of Docker-based SW PBX Asterisk and dash board FreePBX. As shown in Figure 1 (b), Dockerfile keywords used to generate Docker image are presented. Docker can build images automatically by reading the instructions from a Dockerfile, a text file that contains all the commands, in order, needed to build a given image. This functions of Dockerfile will be support CI/CD. The idea of CI/CD behind it is that we should create jobs that perform certain operations like building, testing, deploying, and so on. Those jobs should be chained together to create a CI/CD pipeline.

Figure 1 (c) and (d) show UI screen of secured mobile VoIP app based on Android device for secured voice communication service. Specially, in order to prevent eavesdropping on calls using VOMIT or SipTap, Figure 1 (c) shows secure key generation processing to support securing voice communication including voice sampling step, white-noise removal step, and secure key generation step [6].

### 3.2 Verification of Secured Voice Test

In this subsection, we performed the verification testing between users' original voice and users' secured voice for secured voice communication. We performed the verification testing of secured voice communication using Android-based secured mobile VoIP app and Docker-based SW PBX Asterisk with PC to support lightweight virtualization. Figure 2 shows the user B's original voice signal and secured voice signal through secure key generation processing of Figure 1 (c). Figure 2 (a) and (b) present original voice signal and FFT (Fast Fourier Transformation [2]) signal of original voice signal. Figure 2 (c) and (d) present secured voice signal and FFT signal of secured voice signal.

## 4 Verification in Domestic and South-East Asia Zones

In this section, we performed the real voice communication testing of domestic and South-East Asia Zone communication environments using developed secured mobile VoIP based on Docker.

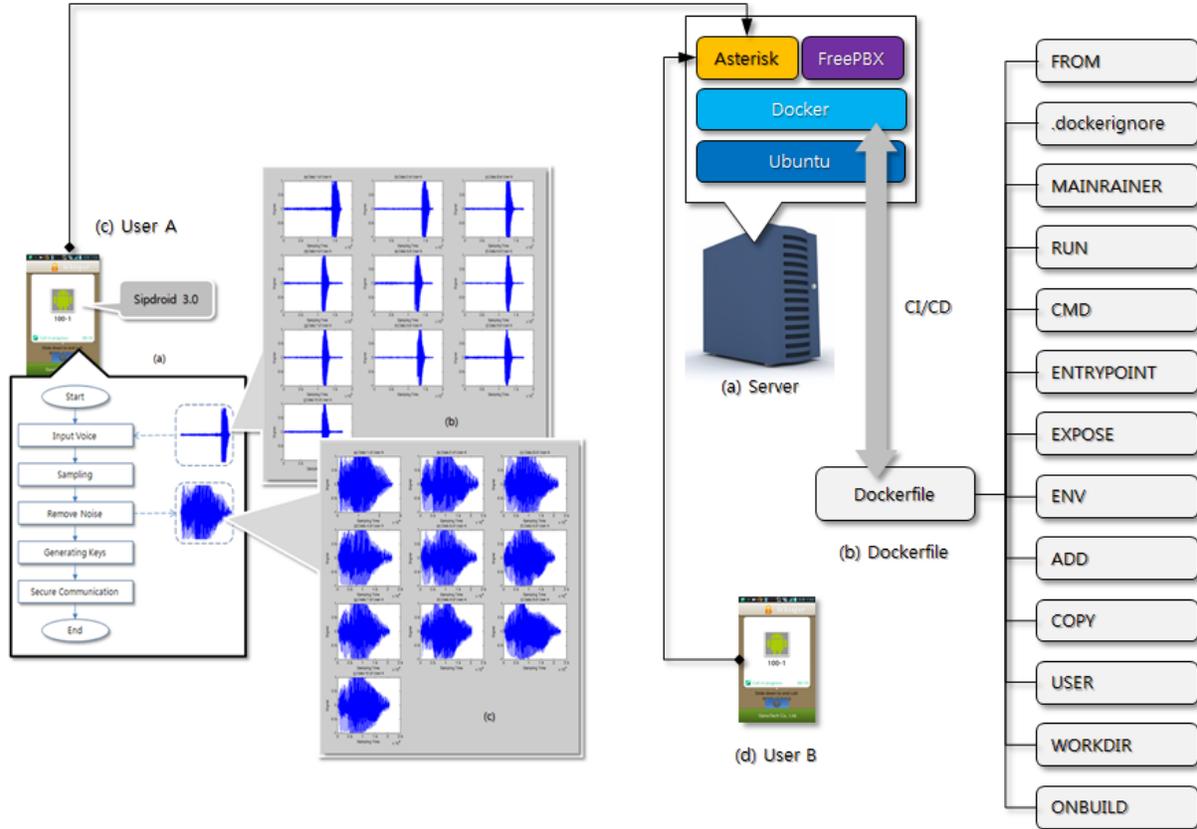


Figure 1: Architecture of Docker-based SW PBX Asterisk and Secure Key Generation Processing

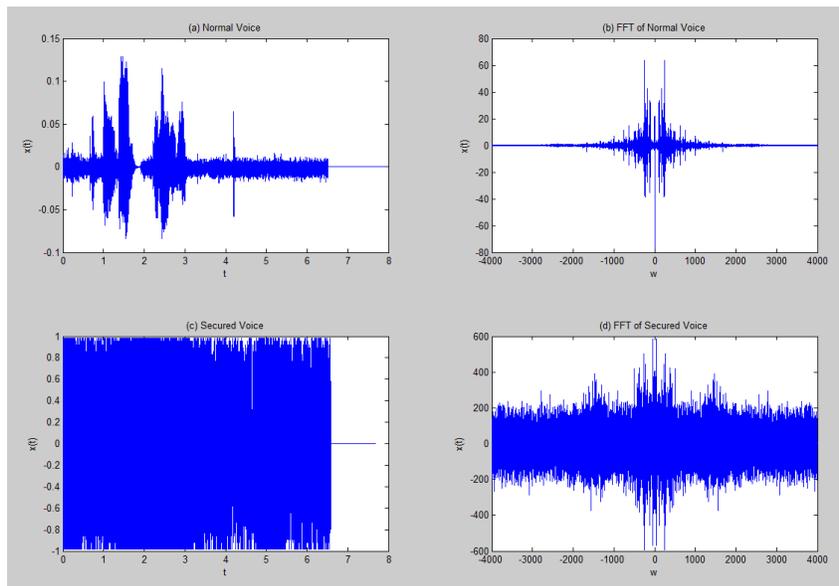


Figure 2: User B's Original Voice, Secured Voice, and FFT Transformed Voice and Secured Voice Signals

### 4.1 Verification of Domestic Voice Communication Test

The domestic real voice communication testing of the secured mobile VoIP are conducted in the metropolitan area, Gangneung and Jeju Island in central Gwangju metro-city as shown in Figure 3. The right side of Figure 3 shows the domestic real voice communication test result between Gwangju metro-city and Juje Island. The real voice communication speed of two-way are approximated distributed in the range of min 133 ms and max 145 ms.

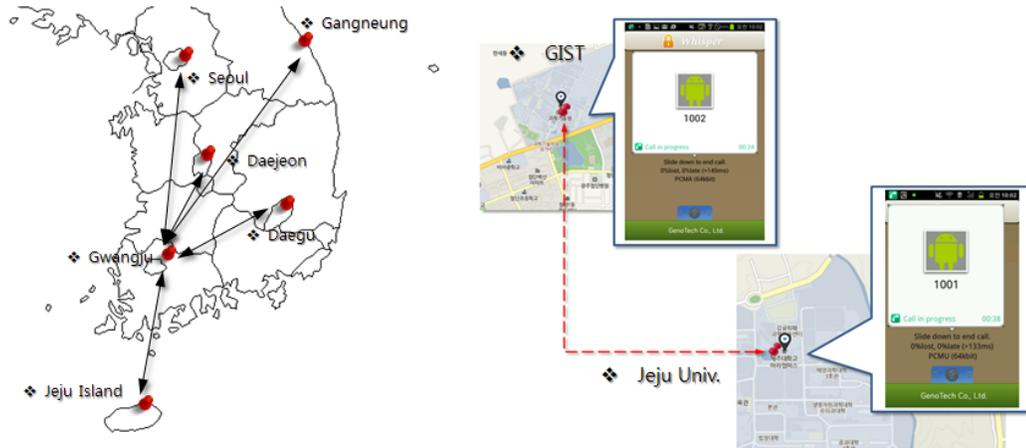


Figure 3: Verification of Domestic Voice Communication Test

### 4.2 Verification of Voice Communication Test in East-South Asia Zone

The real voice communication testing in South-East Asia zone of the secured mobile VoIP are conducted among the Malaysia, Myanmar, and Okinawa of South-East Asia zones in central Gwangju metro-city as shown in Figure 4. The right side of Figure 4 presents the real voice communication test result between Gwangju metro-city and Malaysia in South-East Asia. The real voice communication speed of two-way are approximated distributed in the range of min 108 ms and max 140 ms.

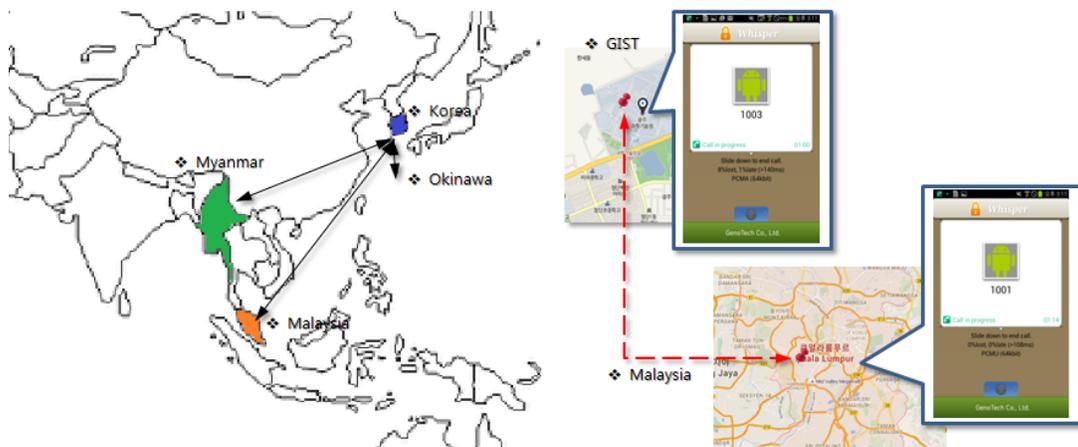


Figure 4: Verification of Voice Communication Test in South-East Asia Zone

## 5 Conclusion

Recently, the computing paradigm has been changing and VoIP technology is being revisited to support various services in ICT field. In this paper, we design and prototype secured mobile VoIP services with open-source Asterisk PBX software by employing Docker lightweight virtualization for mobile devices with immutable concept of CI/CD. We also experimentally verify the quality of secured voice and the associated communication delay over distributed global and domestic connectivity environment. Specially, the global real voice communication test is consisted by South-East Asia zone. The real voice communication speed of South-East Asia Zone is considering variable real communication speed of South-East Asia zone.

## Acknowledgments

This work was supported by the Human Resource Training Program for Regional Innovation and Creativity through the Ministry of Education and National Research Foundation of Korea (2015H1C1A1035823) and Institute for Information & communications Technology Promotion(IITP) grant funded by the Korea government(MSIP) (No. No. B0190-15-2030).

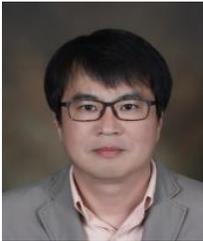
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