

## The Experimental Practices of VoIP Based on the Commercial Softswitch Device

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### Abstract

*A softswitch is the central device of the next-generation network (NGN) which is the hotspot in telecommunication industry. So it's of great significance for the students and related companies to carry out practical experiments and researches based on the commercial softswitch device. Three stage targets of the VoIP, from the elementary to the profound, are proposed according to the characters of the softswitch teaching. The hardware and the software queuing system of the NGN laboratory of Harbin University of Science and Technology, which was designed and built for the targets, are introduced. Students can be queued for experiments with commercial VoIP devices in the NGN laboratory. Three categories of experiments, IP to IP, IP to Phone, and Softphone application development, are designed to cultivate innovative talents.*

**Keywords:** *VoIP, Softswitch, NGN, Experimental Practice*

### 1. Introduction

A next-generation network (NGN) is a packet-based network [1], which means architectural changes in telecommunication core and access networks. The software switch (softswitch), in the control layer of NGN, is the central device of the NGN [2] which provides voice, data, video and other business call control, protocol processing, resource management, billing, authentication and other functions. In fact, the softswitch has already become a synonym for NGN. Voice over IP (VoIP) implies multimedia (voice, video and data) communication over IP or as it is often called converged services [3]. VoIP based on the softswitch is developing rapidly, and in the transport layer replacing the Public Switched Telephone Network (PSTN) gradually [4]. The requirements of the Enterprises for the Employee in the softswitch Networks are more concrete [5]. Teaching and experiments in the VoIP courses due to the devices and other experimental limitations generally stay in the stage of theory and simulation, and cannot meet the new requirements in the NGN era [4]. Aimed at these problems, Harbin University of Science and Technology established the NGN laboratory with softx3000, UMG8900 and C&C08 as the central VoIP devices, and introduced the Ebirdge software system which can queue multiple groups of students for experiments. To meet the Enterprises and students' needs, the College developed three-stage educational practices.

### 2. Education Targets

The softswitch as the core course for the NGN has the characteristics of complex concept, strong applicability, and high complexity. Learning the softswitch also needs PSTN switching and computer network as pre-courses, so the softswitch is widely regarded as a professional course difficult to carry out teaching and learning [2]. Considering the different abilities of students and in order to make the students not lost in

the complex concepts of the softswitch, the College proposed three stage targets for the students in the practices of the softswitch, from the elementary to the profound.

### **2.1. Learning the Basics and Fundamentals of Commercial VoIP Devices and NGN Knowledge**

Through device configuration, the experimental phenomena, and packet analysis by packet sniffers, the students would understand the interaction process between entities of the soft switch network in different stages of Call Control, such as establishing connection, removed connection, and voice transmission *etc.*

### **2.2. Design and Accomplish the VoIP Network for Different Customers**

The students would establish connections between IP Phones of different protocols by configuring the central VoIP devices and other network elements. To further enhance students' practical abilities and creativities and make students more flexibly use basic knowledge learned before, the College encourages the students to Scheme out and accomplish the network architectures to meet the needs of different users.

### **2.3. Development and Implementation of VoIP Softphones Based On SIP**

The two stages above could make the students know well about fundamental principles of IP phones, the related VoIP devices, and how to analyse and handle the problems of VoIP. The College offers the third stage educational practice, a kind of development work, for postgraduate students and some undergraduate students, who have free time and can sail through all the other studies, in the Innovation and Entrepreneurship Training Projects or the graduation projects. The target of this stage is that the students could study open-source VoIP software and develop a softphone program, which could communicate with commercial softphones over the Internet.

## **3. Laboratory Infrastructure**

### **3.1. The Hardware of the Laboratory**

According to the characteristics of the softswitch network and the three-stage experimental practices, the college designed the overall structure of the NGN Laboratory which are composed of an application server as the Service Management Layer, a softswitch as the Network Control Layer, Ethernet switches as the core Switch Layer, Digital Programmed Control Switch and UMG as the Edge access layer for the PSTN application, IAD and softphone as the Edge access layer for the VoIP application. Fig1 shows that the separations of the services from the control and the control from the transport make the services independent of networks.

**Table 1. IP Addresses of the Devices**

Network elements	TCP/IP links	The IP address
SoftX3000	the upload	172.20.200.2
	the service	192.168.0.2
UMG8900	the service	192.168.0.6
	the service	192.168.0.7
	the configure	129.9.0.100
NGN-BAM	the configure	129.9.0.11
	the upload	172.20.200.0
C&C08-BAM	the configure	129.9.0.10
IAD	the service	192.168.0.X
PC	the configure	129.9.0.X

A softswitch is the central device of the NGN in the VoIP system [6-7]. Huawei SoftX3000 was chosen as the softswitch here, works at the Control Layer of the NGN to mainly complete Call Control of voice, data and multimedia service based on IP protocols, connection management, and other functions. Huawei UMG8900, which has high capacity TG (Trunk Gateway), high capacity AG (Access Gateway) and internal SG (Signaling Gateway) functions, was chosen as the UMG. The union of the SoftX3000 and the UMG8900 could supply the application of the next generation Time-division multiplexing (TDM) switch, which could evolved into the NGN seamlessly, and work as the Tandem, or class-4, telephone switch and other network applications in the PSTN.

Huawei C&C08 works as Digital Programmed Control Switch to supply the PSTN function for the ordinary phones. The UMG8900 and the C&C08 are connected here by the E1 interface which could connect C&C08 with other digital switching devices to extend the connection. An Integrated Access Device (IAD) belongs to the media access layer device, is a kind of small capacity integrated access gateway, and aggregates multiple channels of information including voice and data across a single shared access link to a carrier. The Laboratory adopts the Huawei IAD102H, which could use SIP or MGCP as the VoIP protocol. Fig.2 shows how the devices of the NGN Laboratory were connected. The SOFTX3000, the UMG8900 and IADs (or other IP phone) on the student's experimental bench are connected by the service TCP/IP link. The NGN-BAM is connected with the SOFTX3000 via a TCP/IP link to upload configure data, and connected with the personal computer (PC) on the student's experimental bench via the configure TCP/IP link to receive and queue the students' configure data. The C&C08 is connected with the ordinary phones on the student's experimental bench via telephone lines distributed by the Main Distribution Frame (MDF), connected with UMG8900 via the E1 cable distributed by the Digital Distribution Frame (DDF), and connected with the C&C08-BAM which is connected with the PC on the student's experimental bench by the configure TCP/IP link. Table.1 shows the IP addresses used by these TCP/IP links.

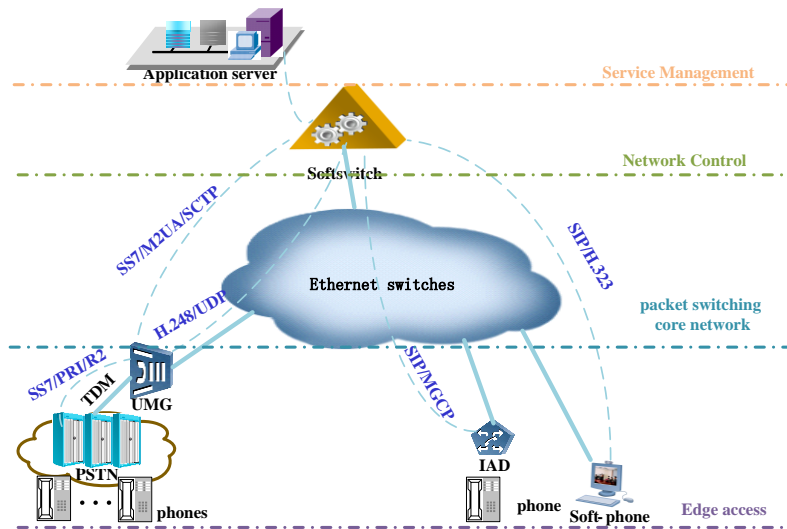


Figure 1. The Network Topology

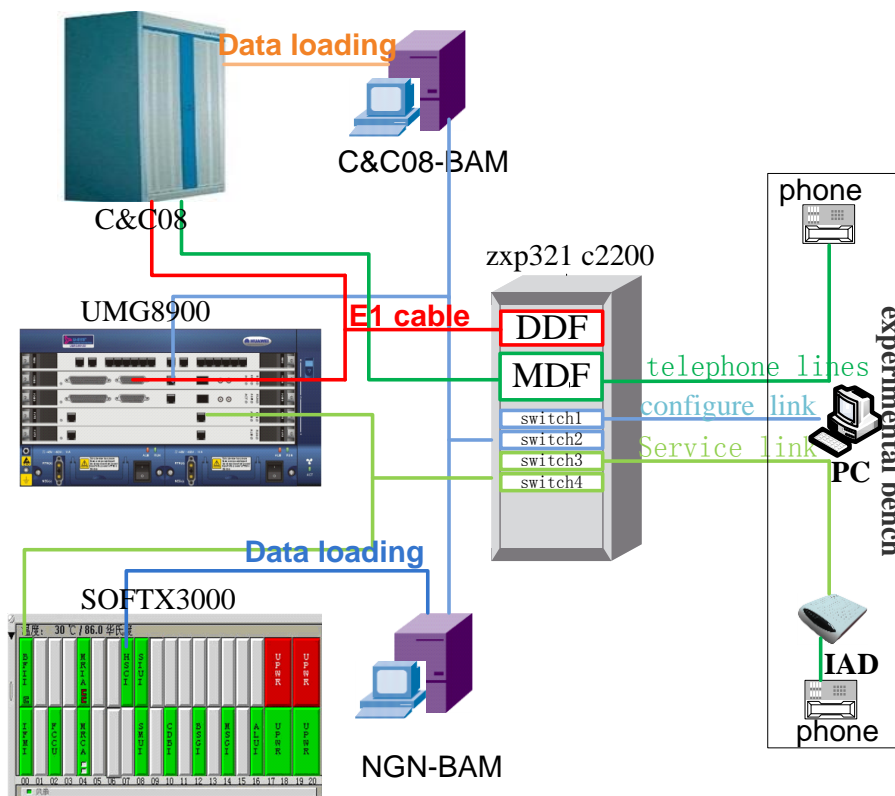
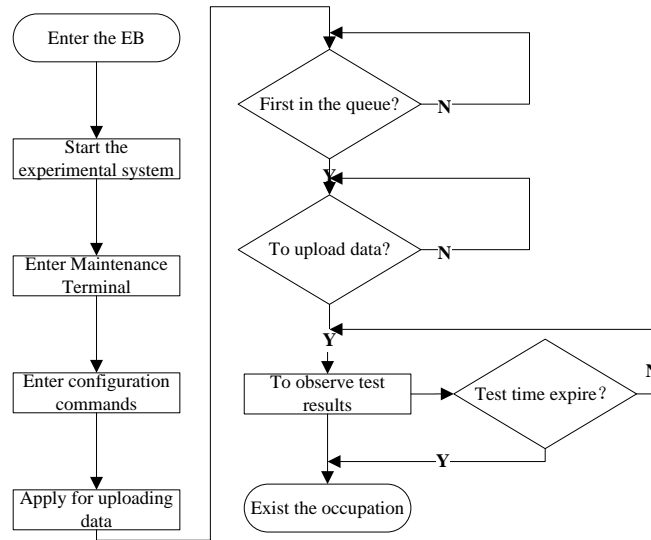


Figure 2. The Connections of the VoIP Devices

### 3.2. The Software Queuing System for Experiments

To make full use of the commercial devices in Teaching, the Ebridge (EB) software was chosen as the queuing system for the experiments. The Ebridge Server was set up in the C&C08-BAM and NGN-BAM; the Ebridge Client was set up in the PC on the student's experimental bench. So the NGN-BAM and C&C08-BAM could receive and queue the students' configure data, then send the data to the NGN and C&C08. Every experiment group could apply for uploading test data after configuration with their PC. The EB system would queue the applications and notify each group when their data could be uploaded and how long they could examine their test results. The queuing system avoids confrontations between experiment groups when they are upload data to the BAM

simultaneously, and allow students to arrange their experiment reasonably. Fig.3 shows how an experiment was done in the EB queuing system. The ways to observe the experimental results are mainly as follows: students could login to the softx3000 with Local Maintenance Terminal to check User tracking tasks, login to the device control interface of the UMG8900 with Local Maintenance Terminal to check the query panel, and Use network sniffers to record and analyze packets.



**Figure 3. The Flow Chart of an Experiment in the EB Queuing System**

#### 4. The Cultivation of Students' Practical Abilities

Many comprehensive and designable experiments could be designed and practiced in the NGN laboratory. These experiments can be mainly divided into the following 3 categories according to the three stage targets and the characters of the VoIP.

##### 4.1. IP to IP, Realize the SIP, MGCP or H.323 IP Phones with the Softx3000

VoIP could be implemented in many ways using both proprietary protocols and protocols based on open standards. In this kind of experiments, VoIP phones are connected to the softx3000, the VoIP service provider, directly, and communicate with the same protocols.

```

Telnet 192.168.100.1
=====
SERVICE PROTOCOL MODE
=====

FLASH SERVICE PROTOCOL MODE is: SIP

TERMINAL(config)#sip server 0 address 192.168.0.2 domain iadsip42.com expire-time 3600 port 5060
< <cr>!subscribe-expire<K> >:

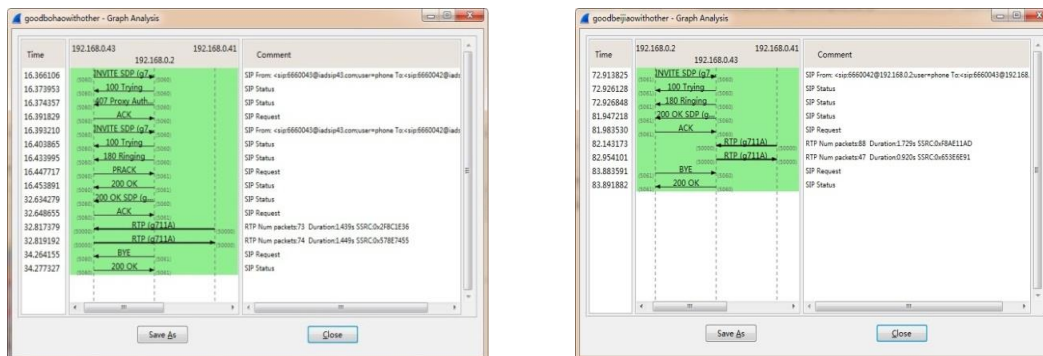
Command:
      sip server 0 address 192.168.0.2 domain iadsip42.com expire-time 3600
      port 5060
Execution of command succeeded

TERMINAL(config)#sip user 0 id 6660042 password 6660042
< <cr>!name<K>!dmdialdelay<K>!dialdelaypos<K>!digitmappos<K> >:

Command:
      sip user 0 id 6660042 password 6660042
This operation will affect the user's current services. Continue? [Y/N]:y
Execution of command succeeded

TERMINAL(config)#_
    
```

Figure 4. Configuring the SIP Parameters of the IAD102H

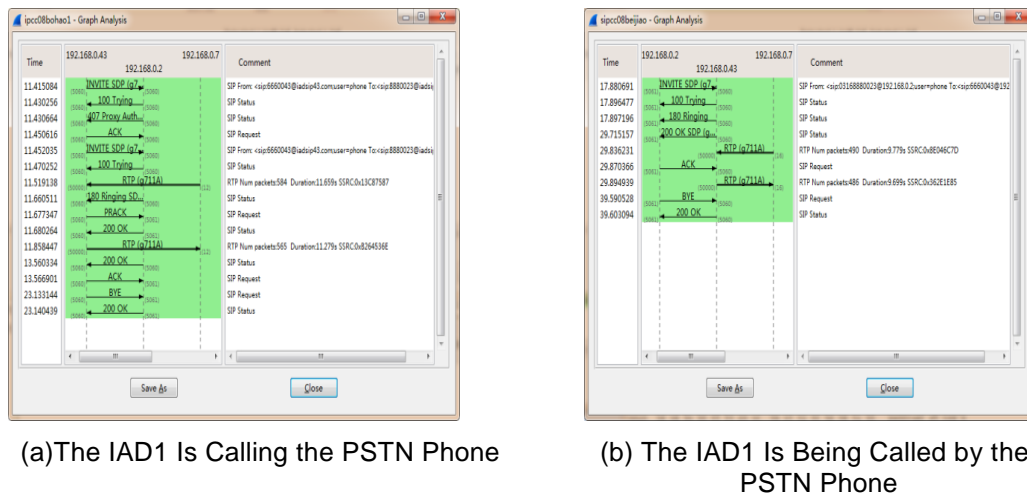


(a) The IAD1 Is Calling The IAD2                      (b) The IAD1 Is Being Called By The IAD2

Figure 5. The Graph Analyses of IP to IP

The main protocols and parameters of the SoftX3000 and the IAD102H in the SIP VoIP experiment are as follows: using ‘SIP’ as communication protocol, ‘5060’ as the port number used by the SoftX3000 for SIP requests, ‘192.168.0.2/24’ as the service IP address of the SoftX3000, ‘66600Y’ as the name, the pass word, and the phone numbers of the registered SIP user, well ‘Y’ is the terminal number of the experimental bench plus 40. Fig.4 shows how the SIP parameters of IAD102H are configured via the Telnet of the PC on the educational bench. There are at least two IADs should be used, IAD1, which are configured to use ‘192.168.0.43’ as IP address and ‘6660043’ as the phone numbers, and IAD2 which are configured to use ‘192.168.0.41’ as IP address and ‘6660042’ as the phone numbers. Fig.5 shows the graph analyses of the record packets grasped by the network sniffer [8] when the IAD1 is calling the IAD2 and being called by the IAD2. The signaling, set-up, and tear-down of VoIP calls based on SIP could be seen intuitively and clearly.

#### 4.2. IP to Phone, Realize IP Phones via the C&C08



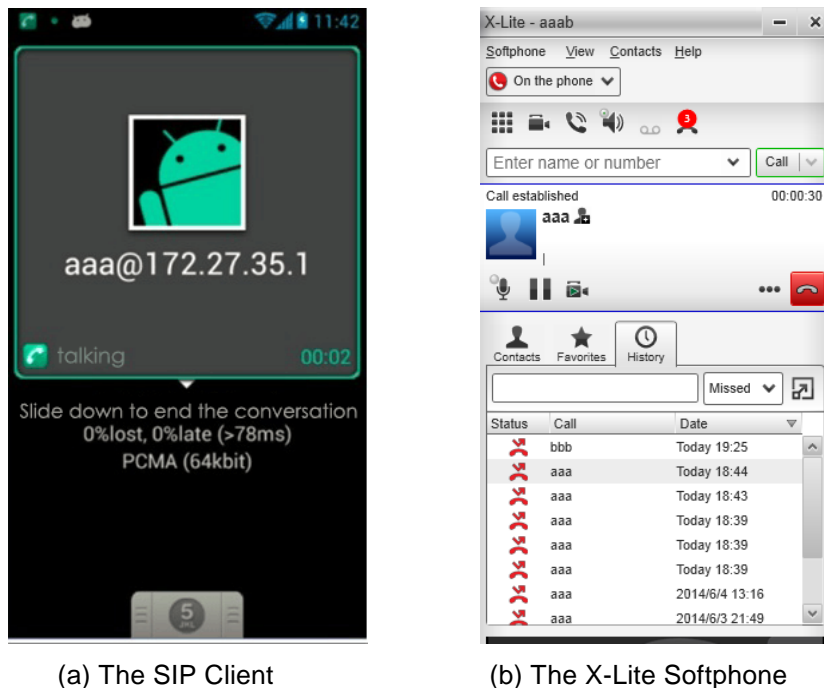
**Figure 6. The Graph Analyses of IP to Phone**

PSTN phones could connect with IP Phones over the IP networks by the VoIP telephony in this kind of experiments. So the C&C08, the UMG8900 and the SOFTX3000 should all be configured to supply the services. The main parameters for the connection of the SoftX3000 and the UMG8900 are as follows: using H.248 protocol as the control protocol between the SoftX3000 and the UMG8900, '192.168.0.6/24' as the IP address of the UMG8900 with H.248 protocol, '192.168.0.7/24' as the IP address of the UMG8900 with SIGTRAN (Signaling Transport) protocol, '2944' as local UDP port number of H.248 protocol for both the UMG8900 and the SOFTX3000. So the registered ID of the UMG8900 in the SOFTX3000 is '192.168.0.6:2944', the registered ID of the SOFTX3000 in the UMG8900 is '192.168.0.2:2944'.

Figure 6 shows the graph analyses of the record packets grasped by the network sniffer when the IAD1 is calling the PSTN phone (8880023) and being called by the PSTN phone (8880023). Comparing Figure 6 with Figure 5, different implementation ways of the IP to IP and IP to Phone based on SIP could be seen. The UMG8900 uses the SIGTRAN IP to send and receive voice packets in the Figure 6. So the UMG8900 converts between TDM voice of the PSTN to Real-time Transport Protocol (RTP), the signaling protocol used in the VoIP system. Configuring results, User states and other detailed information could be seen when login to the C&C08, the UMG8900 and the SOFTX3000. From these results, students could further understand the functions of the core devices in the VoIP.

#### 4.3. Softphone Application Development Based On SIP

Students could develop application software with software development kits for SIP softphones to realize some functions of commercial SIP softphones. For example, a SIP client application on the Android operating system was developed by the students within the Eclipse, an integrated development environment (IDE). This softphone client could communicate with the X-Lite softphone well in the NGN laboratory. Figure 7 shows that the SIP client in a smartphone is communicating with the X-Lite softphone in a PC.



**Figure 7. The SIP Client Communicate with the X-Lite Softphone**

## 5. Conclusions

The NGN laboratory could supply the students with VoIP practice conditions on IP to IP, IP to Phone, and Softphone application development. Through these three practical experiments with the commercial VoIP devices, students could master fundamental knowledge and practical abilities about VoIP networks from the elementary to the profound, could meet the requirements of related companies. The software queuing system of the NGN laboratory ensures that all the students could perform practical operations on the commercial devices, and improves the utilization rates of the commercial VoIP devices.

The practical experiments with the commercial VoIP devices definitely improve the effects of learning and practical abilities. Hope this paper and the experiences will be a salutary lesson for other colleges who want to reform their teaching or experiments of the VoIP. It is important and meaningful for the students and the related companies in the NGN era that more students with practical VoIP abilities come into the VoIP networks and mobile Internets.

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