Flash based Platform for Teaching Stored Program-Controlled Switching Courses

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***Abstract*—Stored program controlled switching (SPCS) is crucial to communication, especially to the Public Service Telephone Network (PSTN). With the rapid development of telecommunication, networking and switching technology the SPCS course is showing its importance in Electrical/Communication Engineering (ECE) or other related engineering disciplines in communication. In this paper, a Macromedia Flash based platform is developed for undergraduate SPCS course. Because there are many complex processes in signaling and switching, such as calling process, operation of different switching mode and signaling system in SPCS course, it is too difficult for undergraduate students to understand these concepts. All those concepts in SPCS course are animated with Macromedia Flash, and related texts and sounds are followed by the animation. Comparing with the traditional methods, the platform showed better efficiency during the SPCS course teaching because of visualizing many theories in the course.**

***Index Terms*—Stored program-controlled switching, Macromedia Flash, Animation, Teaching, Switching.**

I. INTRODUCTION

Stored program controlled switching (SPCS) have become an important discovery of science and engineering and has developed rapidly over the past 5 decades. In resent years, SPCS is extremely popular and play a very important role in modern society since it is one of the essential tools for telecommunication network. SPCS really has brought great convenience to our life, has enabled to User to call anyone who is in the network anytime and anywhere. SPCS is offers the combining of telecommunication network with Internet and also provides more and more new services such as telegraph network, telephone network, telex network and data network for clients in verity of networks [1], [2].

In recent years, many researchers presented their research based on various conducted studies for SPCS field, and their research results [1-9], technical reports [10], [11] and patents [12], [13] have important roles about the development of the SPCS technology and the telecommunication networks. Thus the SPCS are enriched both on theoretical and practical knowledge. SPCS course including many complicated formulas, expressions, algorithms, waveforms, flowcharts and procedure of signal transmission and switching. It is far from easy to understand the undergraduates in some times. Many computer-based educational tools applied in SPCS education, some of them are conventional contents of text based on programming languages, such as Matlab [14], CCITT languages [5], Authorware [15] etc and some of them are graphical programming environments, that is, Simulink [16], MaxplusII EDA [17]. Others are used platforms which called firmware, and including both software and hardware. for example, Filed-Programmable Gate array (FPGA) chips are used for hardware and Verilog is used for programming in [18]; In report [19] Complex Programmable Logic Device (CPLD) are also used for hardware design and Very high speed integrated Hardware Description Language (VHDL) is used for implementing the software part of the switching system. Li [20] supported that multi-frequency controlling using digital signal processing (DSP) chip (TMS320VC5402). A computer network which is based digital switching experiment facility is implemented using Visual C++ and a number of chips such as MT 8870D, MT 8965AE etc [21]. Although, it's very helpful to using these methods in SPCS teaching, however, they are demanding that its own special environments in hardware or software aspects and it's necessary for teachers or students to acquaint with SPCS algorithm and have some programming capacity to use.

Macromedia Flash is one of the graphics animation programs which is written and proposed by Macromedia [22]. The software was designed for designing web animation originally. With the ceaseless upgrading of Macromedia Flash, not only Macromedia Flash has became more and more powerful, but also it is application area are increasingly widespread. Nowadays, the macromedia flash has increasingly became an indispensable part of multifunctional openness diversely, application software, which can be used for web apps, music production, advertisement creativeness, game development and design of webs, especially, for making courseware. Flash is very popular with it's the simple operate and powerful. Macromedia Flash, Matlab and Question mark Perception based multimedia learning objects were used for teaching a course, DSP in Communication Systems [23]. But there is no detailed report about using Macromedia Flash based platform in SPCS course teaching or Macromedia Flash based animations for SPCS course theories.Teaching method of using Macromedia Flash based animation for SPCS course is discussed in this paper. There are concepts and theories in the course to animate such as speech signal modulation, switch mode, call processing procedure and signaling systems. The platform illustrates the efficiency of SPCS teaching.

II. THE STRUCTURE OF THE PLATFORM

The aim of this platform is to show the signaling and switching procedure of the communication system, especially, the telephone network with animation to students. The platform was "hands-on" with computers and became an indispensable part of the classroom environment. Although traditional classroom lectures has expressed the

underlying theory of SPCS with Microsoft Power Point and can be animated some of part of it, but it is not enough to show vividly the whole process of calling, signaling, switching and other movements. Our goal has been to offer computer demonstration which is relates the theory to real-world signals and applications for every lechers and the Macromedia Flash based animation is the best choose for this. The outline of the platform is indicated as Fig. 1

It is clear from the Fig.1 that there are four main parts in the platform such as, speech signal, switch mode, call processing steps and signaling system (SS). Each of them includes several contents that are animated. They are introduced briefly as the following.

A. Speech Signals

In this section we study time division switching in which a common wire path is available to many simultaneous users separated by time slots. The digital information will be either Pulse Code Modulated (PCM) or Delta Modulated (DM). Our approach will be to briefly describe PCM and apply it to switching using various generic switch architectures while explaining functional operations. We follow this treatment of PCM switching by examining digital networks and their topology, network timing and synchronization, and conclude by discussing network degradation mechanisms and performance.

The elementary function of a time switch is to interchange TDM time slots. We learn later under the signaling topics that a time slot in PCM consists of 8 bits. A simple frame lasts 125us in transmission (the actual transfer of the bit sequence from the transmitter into the medium in contrast with propagation). In the European CEPT 30+2 systems the frame has 32 time slots while in the North American DS1 system it has 24. In either case, then, each time slot lasts 125/32 = 3.906us and 125/24 = 5.208 us, respectively. A time switch maps a time slot in the incoming bit stream into a desired outgoing time slot to connect two users assigned the respective time slots as shown in Fig. 2.

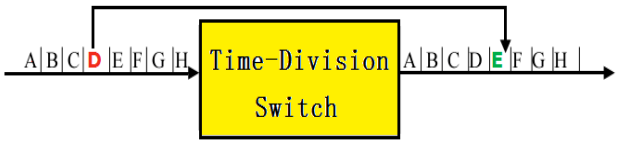

Figure 2. A simplified time-division switch showing user D connecting to user E

B. Switch mode.

Switch is important part of telecommunication network [3], [5], [7]. There are two types of basic switch: Time switch and space switch and the two types of switches are combined in different ways to use in SPCS systems.

The switch mode part of the platform is composed of time switch, space switch, time-space-time (TST) switch and space-time-space (STS) switch and formed whole switching process of it. The time switch and the space switch are contained different two kinds of process, respectively called input control mode and output control mode.

(1) Time-Space-Time (TST) Switch.

Switches are used in many places in telecommunications networks. For instance, class-5 switches are used at local central offices (CO) to switch voice calls; class-4 switches are used at tandem central offices to switch interoffice voice calls [13]. The space, time, and time space switching are presented mainly in SPCS course. Since the theory of switching is widely discussed in the report [13-15], the operation of space and time switches are briefly discussed in here.

(2) The space (S) switch

The space (S) switch consists of control memory (CM) and a matrix with N×N switching points (designed as electronic gates). Where, N is refers to incoming and outgoing channels. A diagram of space switch with 3channels indicated as the following Fig. 3.

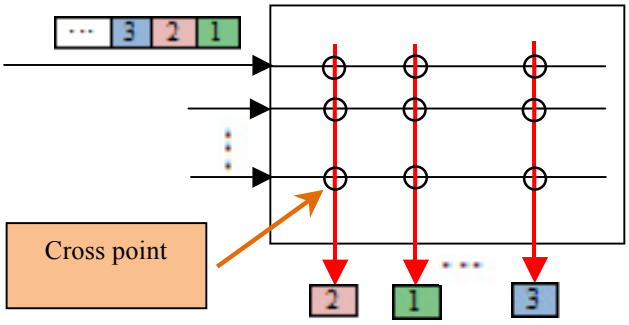

Figure 3. Space switch.

The function of space switch is to transfer information between incoming and outgoing channels. It has two types of operation modes: input controlling mode and output controlling mode. Each column of the matrix is related to one additional CM with the same number of positions as the number of internal time slots in the switch. The control memory specifies which cross points are to be set up in the matrix. One matrix cross point is activated per column during each internal time slot. The CM is incremented by one step, and a new cross point pattern is formed in the matrix in the shift to the next internal time slot.

(3) The time (T) switch

It consists of speech memory (SM) and control memory (CM). It also has input controlling mode and output controlling mode. The function of time switch is to transfer information between time slots (TS). Each incoming time slot is stored in sequence in a SM. The CM determines in which order the time slots are to be read from the SM. This means that a voice sample can be "moved" from incoming time slot 1 (TS1) to outgoing time slot 3 (TS3). Before the actual conversation is started, the information in the CM is obtained in the signaling phase. A diagram of time switch with 32 time slots indicated as the following Fig 4.

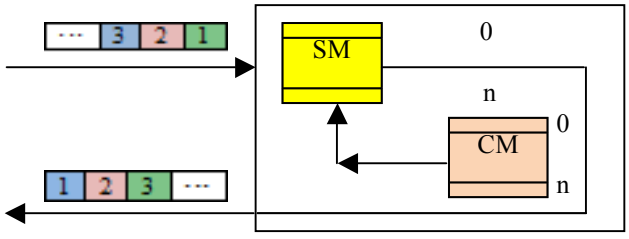

Figure 4. Time switch

Additional switches or switching resources are needed in switching networks when the number of channels to the group switch exceeds the capacity of a single space switch

or single time switch. Thus, single switches are connected together to composing the multi-stage switches. For example, there is a system that can interlink the two switches if the stream (subscriber) A for the moment is connected to one time switch and the stream (subscriber) B is connected to another one. The space switch is handy in this kind of connection. This complex structure is referred to as "time-space-time" (TST) switching. A brief architecture of TST switch is indicated as Fig.5 in annex.

TST switch is one of the common switches presented in CPCS course. Its theory and operation explained taking example of TST switch indicated in Fig. 6. The TST switch in the Fig. 6 has two digital line systems, each containing 32 time slots. The incoming signals are directly fed into the first T switch; the output of the switch feeds the S switch in the middle. The output of the S switch feed into second T switch to which the outgoing signals are connected. The Fig. 6 shows timeslots 1 and 2 in incoming port (stream A) are switched to timeslot 32 in the outgoing stream B and A, respectively. The S switch in the middle can switch the incoming highways (channel) to any outgoing highway without change of time slot. The second T switch can interchange time slots again and ensure that multiple timeslots in one incoming stream are not superimposed or blocked. Having more stages can further improve the switch capacity and performance. In addition to TST, some of the more common structures used in commercially available systems are TSST, TSSST, STS, TSSST, SSTSS, TSTST.

The complicated theory and switching procedure of TST switch is animated using Macromedia Flash. The animation includes texts, figures of T and S switch, and voices. The whole switching process can be controlled based on the speeding of explanation. A frame of the TST switching indicated as the following Fig. 6.

There are 3 channels (incoming or outgoing highways) in the TST switching network in Fig.6. The controlling mode of first and second T switch is must be different, and other information about them indicated as Table1.

C. Call Processing Procedure

Call processing is one of the most fundamental and common services of SPCS systems. Call processing steps included many issues from the calling subscriber off hook and dial the digits to the called (or calling) subscriber on-hook, and call processing procedure parts of the platform is present the whole call processing steps.

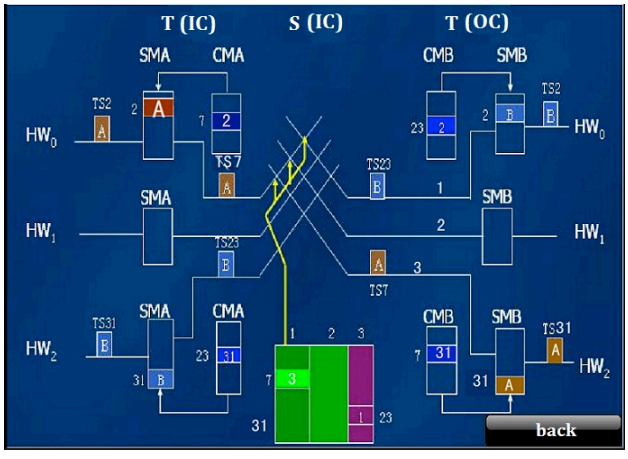

Figure 6. A frame of TST switching.

TABLE I.
RELATIONS BETWEEN SIGNLE SWITCH AND TST SWITCH

Switch	Basic aspect of switch		
	Operation mode	***Switching object***	***Capacity***
T(first)	Input control (IC) mode	Time slot	3×32=96
S	No requirement	Channel	32×32=1024
T (second)	Output control (OC) mode	Time slot	3×32=96
TST	Determined by consisted switches		3×32×32=3072

D. Signaling System

Signaling system part includes from Signaling System No.1 (SS1) to Signaling System No.7 (SS7) of the switching process, and also includes switching of backward signals. The command that implement to inter call between each block is “gotoAndPlay ( )”, in the platform’s structure model, and it’s form is indicated as the following box:

```
on (release) {gotoAndPlay(“Calling process procedure”, 1); }
```

Where, “Call processing” is indicated the scene, and “1” is indicated the frame.

III. SOME EXAMPLES OF THE PLATFORM

The Flash based platform include 10 different animation scene, and it is described taking 3 of them as example.

A. The call processing procedure

The main reason of exchanging information in telecommunication systems is that two or more end points (or subscriber) are usually connected respectively. Usually, there are two parts required to accomplish this work. The first part is the actual transmission of information and it is accomplished by using circuit switching or packet switching, the other part embodies the intelligence to determine and end points to connect and to direct the systems to make these connections [12]. This is the call processing.

The call processing is the fundamental and most common task for switches of Public Switched Telephone Network (PSTN). The circuit switching based on traditional telephone service and it is mainly presented in SPCS course. The call processing procedures include many issues such as calling subscriber off hook, get the dial tone from switch, dial the digits, analyzing digits by switch , locate the called subscriber, and send ring to him etc which from the calling subscriber off hook and dial the digits to the called (or calling) subscriber on-hook. In other cases, in the different parts of a telecom system the sequence of events and messages is displayed by a time-space diagram. Time space diagram in a simple (local) network was indicated in Fig.7.

It can be seen in Fig.7 that, various horizontal positions illustrate different physical devices such as calling subscriber set, End Office Switch (EOS), Transit Switch (TS), etc in the system. Time increases in downward direction.

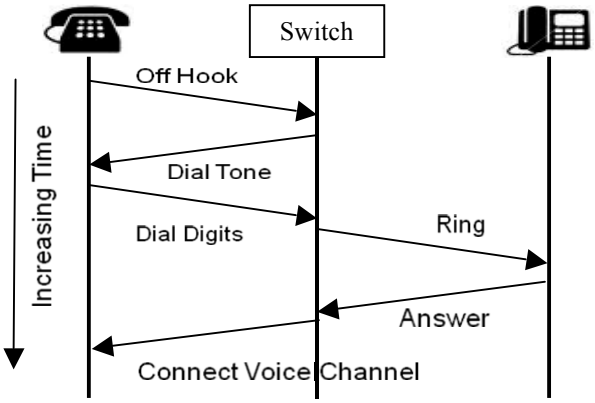

Figure 7. Part of the call processing diagram.

Only one which is shown a "successful", case event sequence is displayed and after the connection channel, not demonstrates the case event sequence. In the long distance call processing procedure, If we consider the "successful" and "unsuccessful" case event sequences, The diagram become more complicated, especially, the international long distance call processing procedure. So, it is much more understandable for students the whole procedures of the call processing if having shown with animations. The call processing procedure of Flash based animation is indicated as in Figure 8.

After animation, related objects not only displayed the dynamic images, but also they are included with different voices of signals and speeches. Therefore, the long and tedious theory can be clarified.

B. Signaling systems

The signaling system is one of the important parts in the SPCS course. The Signaling System1 (SS1) and, signaling System7 (SS7) are basic concepts for undergraduates. It plays critical role during the whole switching procedure. There are many types of signals in signaling system, such as signals in SS1, SS7 and Back ward signals. They are transformed between EOS, TS, and Distant End Office Switch (DEOS) and subscriber during the calling process. The signals are transmitted with speech signals in different channels. For example, the EOS returns a dial tone after the calling subscriber off hook immediately, indicated as Fig. 9 in Annex. If the dialed digits are non-local numbers, the EOS send Initialized Address Message (IAM) to the TS before extending the dialed digits to the distant switch. There are two signals transmitted in the preliminary steps in non-local calling procedure, in which one is dial tone sent to the calling subscriber by EOS, the other is IAM transmitted between different switches. If the whole calling process is concerned, it is need to transmit many different kinds of signals between the calling subscriber, EOS, TS, DEOS, and called subscriber, as indicated in Fig.9-10. The undergraduates often confused about this procedure and related contents.

The switching procedure between SS1and SS7, and switching of backward signals are animated with Macromedia Flash in this platform. A frame of SS1 switch to SS7 is indicated in Fig. 10 below.

In Fig. 10, there are six kinds of signals (IAM, ACM, ANC, CLF, RLG, CBK) transmitted between EOS and TS. These signals are transmitted for forwards/ backwards with different tones in the platform that it can vividly illustrate this process and improve students understanding.

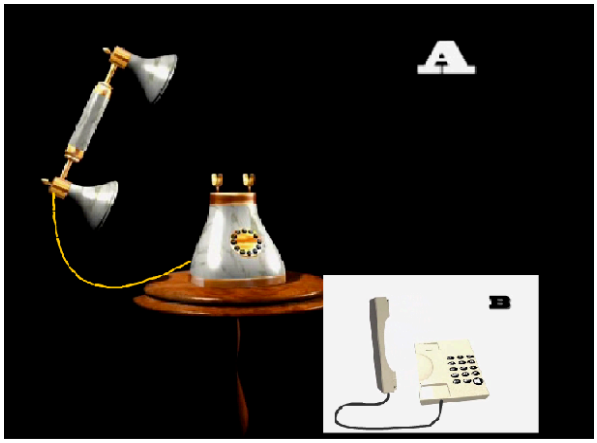

Figure.8. A frame of the call processing animation.

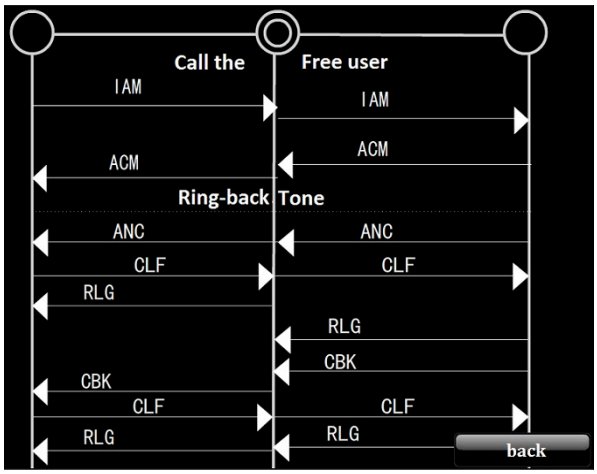

Figure 10. A frame of signals transmitted between switches in the platform

IV. CONCLUSIONS

A Macromedia Flash based platform for teaching SPCS course principles is presented in this paper. It is small sized and easy to presenting in classroom teaching. This developed platform shows great effectiveness in during the SPCS teaching that students can see the whole process of signal modulation, signaling and switching concretely, and can hear related voice signals and speeches. It played important role in improving students understanding for sophisticated SPCS theories and algorithms during the classroom teaching.

The efficiency of the Flash based platforms and animations would be further improved in our future work. Its' role in the classroom teaching would be enhanced by developing more and more SPCS animations .

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ANNEX

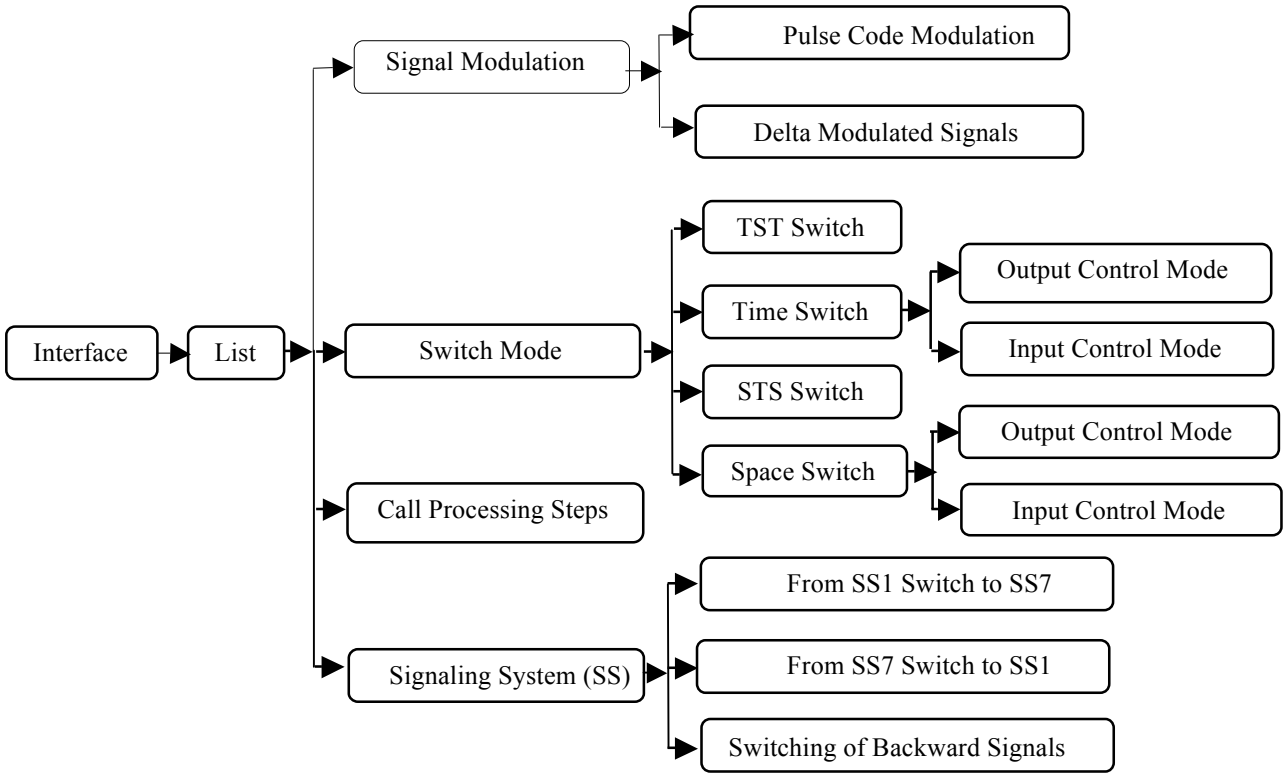

Figure 1. The structured flowchart of the platform

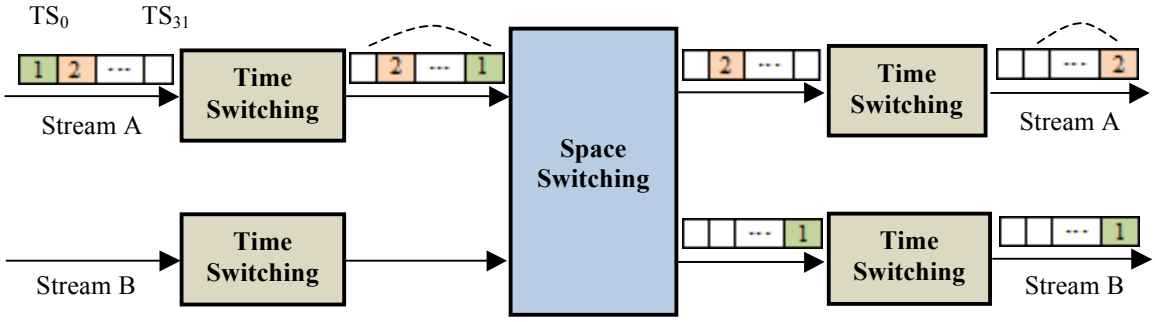

Figure 5. A time-space-time (TST) switch architecture

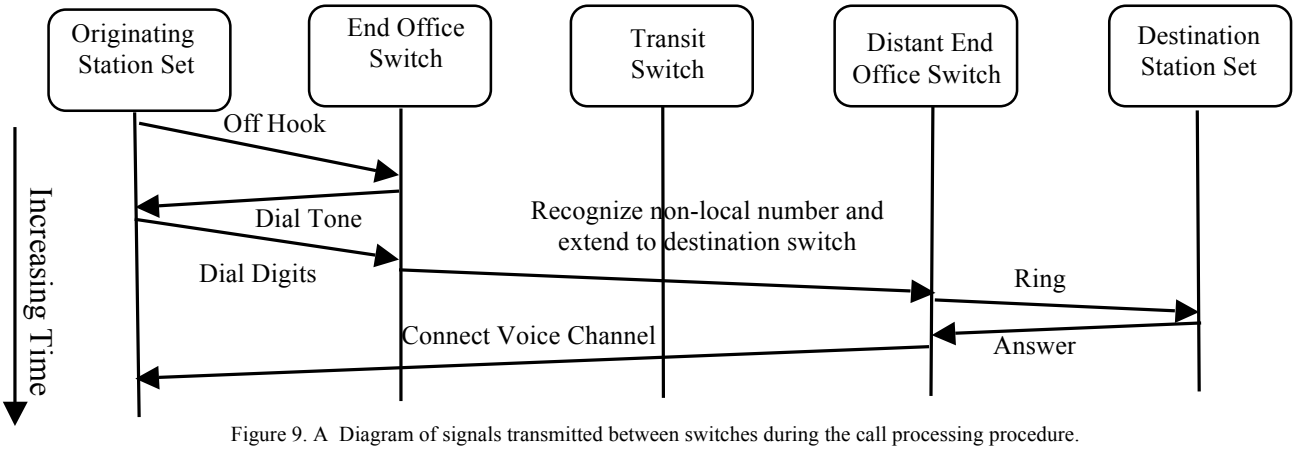

Figure 9. A Diagram of signals transmitted between switches during the call processing procedure.