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GRADUATE SCHOOL OF SCIENCE AND ENGINEERING

IMPLEMENTATION OF CISCO PACKET TRACER IN ADVANCE COMPUTER NETWORK

M.Sc. THESIS

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IMPLEMENTATION OF CISCO PACKET TRACER IN ADVANCE COMPUTER NETWORK

Thesis Advisor: Asst.Prof.Dr.Sefer Kurnaz

Istanbul, 2018

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science

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Mohanad.Abdulkareem

DEDICATION

This project would not have been possible without the support of many people. Many thanks to my adviser, Asst. Prof. Dr. Sefer KURNAZ, who accept to school for graduate program and helped make some sense of the confusion. Also thanks to my committee members, who offered guidance and support. Thanks to the University of Altinbas for this possibility. And finally, thanks to my partner who endured this long process with me, always offering support and love.

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ABSTRACT

IMPLEMENTATION OF CISCO PACKET TRACER IN ADVANCE COMPUTER NETWORK

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In the process learning computer network systems, the use of virtual laboratories is very important. In this study, we also implemented Cisco Packet Tracer, which enables us to work on test scenarios without using any physical components virtually to design an advanced computer network. The Cisco Packet Tracer is used not only to simulate computer networks but also to learn computer networks.

This study consists of fifth parts. In the first chapter, we briefly introduced the Cisco Packet Tracer, the aim, the importance, the assumptions, and the limitations of the study is explained.

In the second chapter, conceptual explanations of the components necessary for designing a computer network are made. In this part, the configuration of the computer network, the types of topologies, network technologies and architecture, network cable systems and their components are described.

In the third chapter, a program system was created for an exam that measures the capacity and potential of the participants about the computer network and their information about the Cisco Packet Tracer. Also, the map and rules of the computer network structure were determined to design a computer network in a 6-storey hotel.

In the fourth chapter, in the framework of the specified network rules and map, the configurations have been made completely and the advanced computer network has been established using the Cisco Packet tracer.

Finally, in the fifth chapter, five scenarios were implemented on the network in order to prove the network in the hotel is working well. The scenarios were about transfering packet between two floors, using the command line interface(CLI) between any two devices in the network, implementation of the hotel's website, making a telephone call between phones located on

several floors of the hotel and using surveillance cameras to monitor all the hotel floors and connect these cameras to the network. The implementation of all these scenarios were showed that, the simulation network system was operated without any problem

ÖZET

Gelişmiş bilgisayar ağında cisco packet uygulaması

Bilgisayar ağ sistemlerinin öğrenilmesi aşamasında sanal laboratuarların kullanılmasının önemi büyüktür. Bu çalışmada da, ileri düzeyde bir bilgisayar ağı tasarlanması için sanal olarak hiçbir fiziksel bileşen kullanmadan test senoryaları üzerinde çalışmalar yapmamızı sağlayan Cisco Packet Tracer uygulanmıştır. Cisco Packet Tracer sadece bilgisayar ağlarını simulasyon olarak oluşturmak için değil, aynı zamanda bilgisayar ağ yapılarının öğrenilmesi amacı ile de kullanılmaktadır.

Bu çalışma beş bölümden oluşmaktadır. Birinci bölümde, kısaca Cisco Packet Tracer tanıtılmış, çalışmanın amacı, önemi, varsayımları ve sınırlamaları açıklanmıştır.

İkinci bölümde, bir bilgisayar ağının tasarlanması için gerekli olan bileşenlerin kavramsal açıklamaları yapılmıştır. Burada bilgisayar ağının konfigurasyonu, topoloji çeşitleri, ağ teknolojileri ve mimarisi, ağ kablo sistemleri ve bileşenleri anlatılmıştır.

Üçüncü bölümde, araştırmaya katılanların bilgisayar ağı konusundaki kapasite ve potensiyellerini ve Cisco Packet Tracer hakkındaki bilgilerini ölçen bir sınav için bir program sistemi oluşturulmuştur. Ayrıca, 6 katlı bir otelde bilgisayar ağ tasarlanması için bilgisayar ağ yapısının haritası ve kuralları belirlenmiştir.

Dördüncü bölümde, Cisco Packet tracer kullanılarak, bu belirlenen ağ kuralları ve haritası çerçevesinde konfigürasyonlar eksiksiz yapılmış ve ileri bilgisayar ağı oluşturulmuştur.

Son olarak, beşinci bölümde, otelin ağının iyi çalıştığını kanıtlamak için ağ üzerinde beş senaryo uygulanmıştır. Senaryolar, iki kat arasına paket aktarılması, ağdaki herhangi iki cihaz arasında komut satırı arayüzü (CLI) kullanılması, otelin web sitesinin uygulanması, otelin birkaç katında bulunan telefonlar arasında telefon görüşmesi yapılması ve tüm otel katlarını izlemek ve bu kameraları ağa bağlamak için gözetim kameraları kullanılması ile ilgilidir. Bütün bu senaryoların uygulanması, simülasyon ağı sisteminin sorunsuz çalıştığını göstermiştir.

LIST OF ABBREVIATIONS

PT	Packet Tracer
CLI	Command Line Interface
GUI	Graphical User Interface
NIC	Network Interface Card
RJ	Register Jack
CCNA	Cisco Certified Network Associate
CCNP	Cisco Certified Network Professional
ICT	Information & Communication Technology
IOS	Internetwork Operating System
RIPV1	Routing Information Protocol Version 1
RIPV2	Routing Information Protocol Version 2
EIGRP	Enhanced Interior Gateway Routing Protocol
ICMP	Internet Control Message Protocol
ARP	Address Resolution Protocol
CDP	Cisco Discovery Protocol
DHCP	Dynamic Host Configuration Protocol
NAT	Neatwork Address Translation
IP	Internet Protocol
VLAN	Virtual Lan
PPP	Point to Point Protocol
HDLC	High Level Data Link Control

CSS	Cascading Style Sheet
SQL	Structure Query Statement
VB.net	Visual Basic.Net
LAN	Local Area Network
MBPS	Mega Bit Per Second
WAN	Wide Area Network
OSI	Open System Interconnection
BNC	Bayonet Neill-Councilman
CAT-5	Category 5
UTP	Un Shielded Twisted Pair
STP	Shielded Twisted Pair
IEEE	Institute of Electrical & Electronic Engineers
CSMA	Carrier Sense Multiple Access
FDDI	Fiber Distributed Data Interface
CD	Collision Detection
MSAU	Multi Station Access Unit
ATM	Asynchronous Transfer Mode
MSE	Mobile Subscribe Equipment
TPN	Tactical Packet Network
FDDI	Fiber Distributed Data Interface
PC	Personal Computer
MAC ADDRESS	Media Access Control Address

IOT	Internet of Things
HTTP	Hyper Text Transfer Protocol
DNS	Domain Name System
WPA2	Wi Fi Protect Access2
PSK	Pre-Shared Key
Core SW	Core Switch
GNS3	Graphical Network Interface

CHAPTER ONE

Purpose: The beginning lets imagine the computer mode without networks, in this case, how we exchange the data, we will need to hundreds of soft drives to transfer information from one device to another causing agreat waste of time and effort, another example, if we have one printer and several computers. In this case, if we want to print we will stop in aqueu on the device connected to the printer, or we will transfer the printer to each user to connect it to his computer to print what he/she wants, and in both of the great touble, and here beileve that networking has evolved to meet the growing need for information and resources exchange effiectivelly.

INTRODUCTION

Today, networks can be constituted by connecting different devices such as computers, phones, printers, mobile devices, etc. wired or wirelessly. We can think of computers or computer that we use at home as part of a network. Because the internet is a network, there are only speed limits and quota. Different networks can share resources or documents with each other over the internet. Generally, it is possible to connect several computers with many cables and create a network through visual interfaces. But this will require both extra physical space and redundant cable redundancy and extra interfaces.

Switches have been produced for this purpose. With these switches, we can provide multiple computers to communicate and share with each other, with one interface. Computers are connected to the NIC (Network Interface Card) through connectors by means of the RJ-45 connectors, and there are routers called routers that allow these computers to be routed to other networks [1][2].

As seen above, computer network is so complicated that It is not enough to give the theoretical knowledge to the students in computer network education. It is necessary to learn and practice thoroughly how the systems work to build and manage these systems. The progress of technology has made both computer specialists and computer education important, especially in the computer network area [3].

In contemporary education; it is increasingly important to be able to provide learning and feedback by living in the teaching process. Simulation technology emerges as a new

development in education to be applied to network is such as simulation of network traffic and modeling of network general structure. ln the simulation environment to learn how networks work on the computer gives us both time and material advantages. Simulation approach can decrease the increasing costs in education and can raise the reducing realism environment [4], [5], [6].

Network Simulation is a network modeling on a computer and testing how the network will work without being physically installed. The vast majority of network simulator programs are programs used by companies developing network products for training and design purposes. Nowadays, CISCO Company, in the education levels of CCNA, CCNP etc. are using a simulator program developed in place of laboratory applications. Packet Tracer is a network simulation tool that enables applications of Cisco branded network devices and network design to be done without using any physical machine or vehicle. Packet Tracer, which allows network topologies and subsequent configuration of associated devices, provides a good learning environment in preparation for Cisco certification exams [7][8][9].

1.1.Background

The virtual creation of real life applications through simulations reveals the concept of a virtual laboratory "Virtual Laboratory; can be defined as a computer environment that provides an interactive real-time simulation opportunity in experiments that must be performed in order to gain practical experience in education" [1] Virtual laboratory; yet it is a computer environment that can be done in the laboratory environment or it is not possible to do it in reality, it is possible to show the applications which cannot be shown concrete but can be shown by simulation interactively with the students. Simulation; is demonstration of applications that can not actually be done or cannot be demonstrated in a computer environment; whereas the virtual laboratory is the application of the student interacting with the computer in the laboratory environment.

Computer simulation can help modeling and analyzing processes in many systems. Current areas of application include human-like systems in the fields of physics, chemistry, biology [12] and economics, finance and even social science. Simulation technology emerges as a new development to be applied to network areas such as simulation of network traffic and modeling of network overall structure. To perform network simulation, computer aided simulation tools

are used. Network simulations give more importance to the performance or validity of the distributed protocol or some specific algorithm than the visual or real-time monitoring features alone. For this reason, many different tools are being produced in parallel with the rapid development of network technologies. The importance and quality of the network simulation tools developed depends on supporting algorithms and protocols commonly used in network environments [10], [11].

1.2. Cisco Networking Academy

Growth in networks has led to a shortage in the number of people who have. The qualities to create necessary infrastructure and to design and maintain this infrastructure in order to communicate, to do business and to save lives (when critical needs are needed). This deficiency is felt all over the world where networks are being built to help economic development and growth. Similarly, people need more and better business opportunities as well as trainings that will prepare them for a global and technology-based economy. The Networking Academy is helping to meet the growing demand for information and communication technologies (ICT) specialists and to develop the career goals of these specialists all over the world [13].

With more than 10 academics in 165 countries, the Network Academy assists individuals to receive industry-wide certifications and prepare them for entry-level information and communication technology (ICT) careers in almost every sector.

Cisco Networking Academy provides students with a comprehensive 21st century learning experience that helps them develop basic ICT skills needed to design, build, and manage networks, as well as problem solving, collaboration, and critical thinking [15]. Students complete practical learning activities and network simulations to develop application skills that will help them meet the growing need for network specialists around the world [14].

In courses classroom instruction and an instructional model that combines online curriculum, interactive tools, hands-on activities, and online assessments that provide instant student feedback are used [15], [16]. Cisco Packet Tracer is one of the innovative technologies that this unified learning model benefits [15].

1.3. Packet Tracer

Network simulators are the first things that help people when they are working with network systems. Because it may not be possible to create a lab environment that can connect switches and routers immediately even if it happened, it is not always necessary. Anymore today, virtual software has been created to test it. One of them is Packet Tracer, developed by Cisco and offered free of charge to users. Packet Tracer is a powerful visualization and simulation tool that enables users to design, build, and troubleshoot network problems in a secure environment. It has an easy-to-use interface that allows you to create your topology with drag-and-drop ease [13] [14].

You can simply add and remove interfaces on the device as you want and can simply select the interfaces by selecting the devices. You do not even need to write a ping command to see if the devices are UP & Running (ie, they are running), just click on an envelope and ping it. It supports almost all networking equipment and connections that need to be tested.

The Cisco Packet Tracer program is a simulation program that enables us to perform Cisco operations or applications without using any physical machine or vehicle and provides us with a network lab environment. Most of the Lan routing applications can be done with the help of this simulation program [14].

The benefits of the Cisco Packet Tracer program include:

- It provides a comfortable and well-informed environment.
- It provides multi-user, real-time training laboratories.
- It can prepare exams for students and give points according to what they do.
- Network environment is designed, and network devices are configured using virtual equipment

The Cisco Packet Tracer is a simulator program which is used to create network topologies and configure the aforementioned devices without the need for actual Cisco Routers and Switches. With the Packet Tracer, studies can be made to prepare for the Cisco Certified Network Associate (CCNA) and (CCNA) Security exams. In these studies Cisco Routers and Switches are configured through the CLI (command line interface), and you can see all the details of a package with advanced simulation features [14].

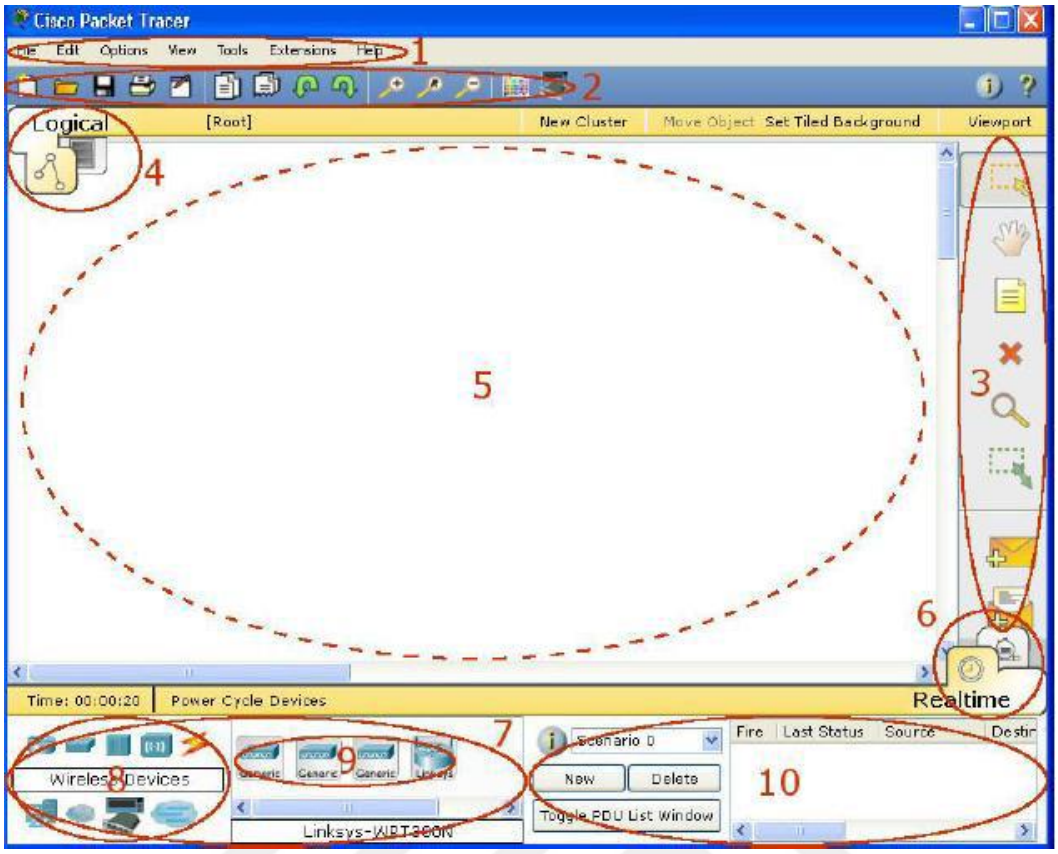

Figure 1 Component of Packet Tracers

As shown in Figure 1, [18] the components of Packet Tracers are;

1. Menu bar

2. Main toolbar

3. Common toolbar

4. Logical / Physical workspace

5. Workspace

6. Real Time / simulation working mode

7. The Network component box

8. Network device identification area

9. The network device subtype determination tool

10. Packet simulation monitoring window

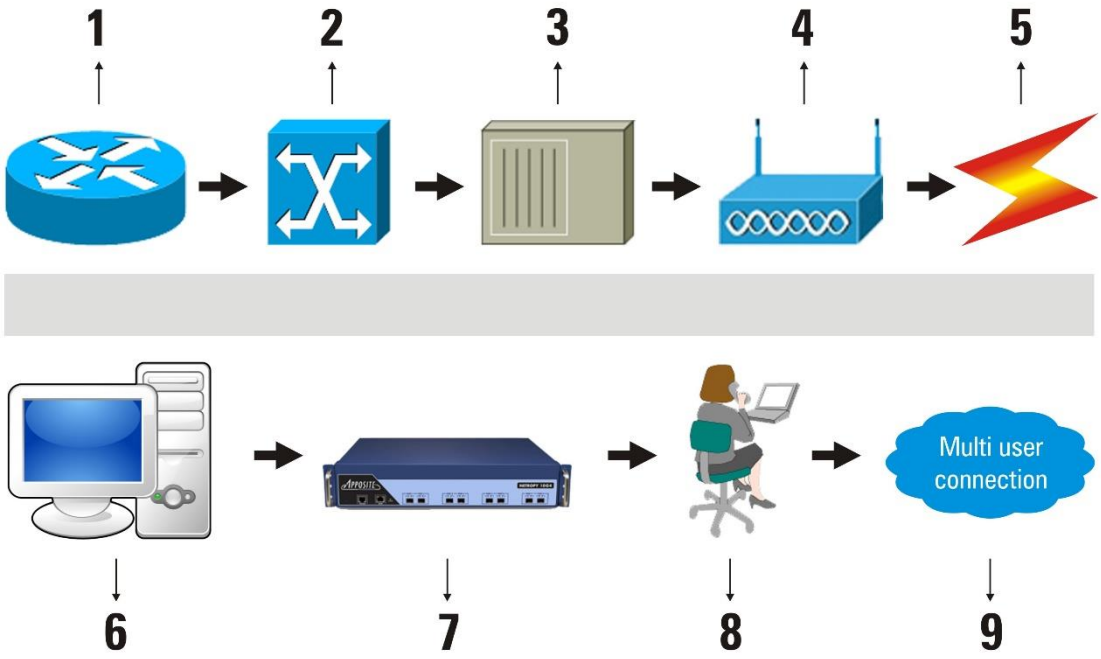

Figure 2 Network Hardware Devices

As shown in Figure 2, [18] Network hardware devices of Packet Tracer are;

1. Router

2. Switch

3. Hub

4. Access Point

5. Connections

6. End Devices

7. WAN Emulation

8. Custom Made Devices

9. Multiuser Connection

As of Packet Tracer, users in the same local network (which may be in different networks) have become multi-user, that is the possibility of cooperation, on the same topology. At the same time, the trainers can use the activity to prepare applications that will determine their competence of students [16].

At the moment, Packet Tracer is running on Windows and Linux systems. There is also a mobile version for IOS and Android.

Packet Tracer allows you to create network topologies by dragging and dropping routers, switches, and various other network devices. A physical connection between the devices is represented by a "cable" element. This tool, which allows users to obtain multiple visual representations, also carries the following features.;

- Real Time and Simulation Mode
- Logical Topology and Physical Modes
- Global Packet Sniffer called "Event Viewer"
- RIPV1(Routing Information Protocol Version1), RIPV2(Routing Information Protocol Version2, EIGRP (Enhanced Interior Getway Routing Protocol), ICMP (Internet Control Message Protocol), ARP (Address Resolution Protocol), CDP (Cisco Discovery Protocol, DHCP (Dynamic Host Configuration Protocol, NAT (Network Address Translation, IP (Internet Protocol).
- Ethernet, VLAN (Virtual Lan), 8021q, Inter
- VLAN (Virtual Lan) Routing, Frame Relay, PPP (Point to Point Protocol), HDLC (High Level Data Link Control) [19].

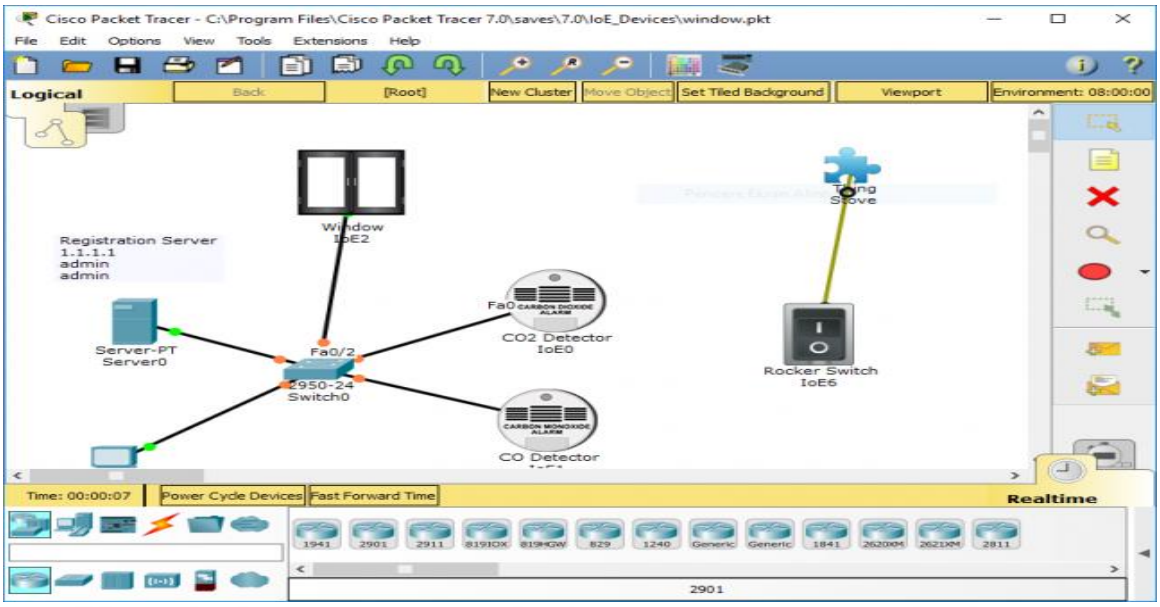

Figure 3 An example of a network design done by Packet Tracer

As of Packet Tracer, it supports a web server embedded with JavaScript and CSS support.
As a result of using the Packet Tracer, the users will have learned by applying the following;

- Identify router interfaces
- Learn IP addressing information
- Learn configuration of Ethernet and in WAN Port in routers
- Learn router methods
- Recognize the router CLI and learns some configuration commands
- They have information about routing algorithms and can observe how they work in a clear environment

1.4. Aim of Study

Virtual laboratory can be defined as a computer environment that provides an interactive real-time simulation in experiments that must be done to gain experience in practice [1]. Virtual laboratory; is the method of preparation of impossible experiments that cannot be done in a traditional laboratory environment; or simulated in the computer environment of subjects that require abstract thought. These empirical studies give practical skills to students and help them to prepare them for real life situations. Virtual laboratories are used by students to explain difficult concepts, abstract concepts by demonstration technique, simulation method. This

thesis presents the features and applications of Packet Tracer – a computer network simulator of Cisco Networking Academy- in the learning of computer network. In addition, aim to use almost devieces of the Cisco Packet Tracer to design network for building consist of six floors.

Furthermore, the flowchart of the system will be created begin to be explain in future chapters, and the program will be write by using (Visual Studio 2017 Visual Basic.NET &SQL Server 2016 Data Base) to design system that will be used to evaluate the participants after completing the training using the Cisco Packet Tracer application. So, the source code of this program will be given by other chapters. The VB.NET is currently gaining popularity, as it supports fundamental object-oriented constructs such as: abstraction, encapsulation, inheritance and polymorphism.

In this study the evaluation students by using the visual basic.net will be done by the system, when the test is ended the estimation score who will be in the screen. The system that was programmed by visual basic.net, and SQL Server 2016 Data Base will be test the users progress in the screen when the users registers a log off the result will be automatically produced in the screen if (he / she) pass or fail.

The system that will be designed program with Visual Basic .NET will show the results of the students who will perform and carry out the test through this system and the system will automatically evaluated the student's performance and when the exam is ended the result will be listed in the screen. So, the system will then determine the two groups. Having these details:

The first group of trainees; that have attained the score of (70) and above will be qualified to design the networks by working on the (Cisco Packet Tracer).

The second group of students; that will score less than (70) will need more training in the Internet in the working place they are not required to take the study in the special class and retake the required grade. We will explain the work (flowchart and source code) of this system elsewhere in this study.

1.5.Significance of The Study

The use of virtual laboratories in the field of computer networks is not yet very common. Much of this work involves the development, design and benefits of virtual laboratories, as opposed to physical and engineering models. In the literature, the work experiences obtained from virtual laboratories are not given much. Inventing something in engineering is more important than training acquired in doing it.

The effectiveness of virtual laboratories in the learning of computer networking skills is important. The reasons for these are;

1. The efficiency of using virtual laboratories as a practical technology, despite its increasing use, has not been solved and is controversial. It is hoped that this investigation, which is clearly limited to limited skill training, may be enlightening in this regard.

2. No similar research has been done on the efficiency of computer network configuration and transfer of troubleshooting skills.

3. Massive training of authorized computer network engineers in the world is needed for this respect the use of virtual laboratories is one of the solutions as it could reduce the costs of placing training programs in this profession. However, it is important that in this endeavor the effort is not undermined by providing training that may be ineffective.

1.6.Assumptions

The following assumptions were made for this study;

1. The Cisco Packet Tracer method used is the most powerful method for network teaching using virtual lab teaching.

2. The number of participants is sufficient to come to a significant result.

CHAPTER II

2. NETWORKS CONFIGURATIONS, TOPOLOGIES AND COMPONENTS

2.1. Network Configurations

2.1.1 Local Area Network

LAN (Local Area Network) is the name given to the small network system which is the result of connecting several computers close to each other as a settlement (Figure 4). It is used for scaling larger networks. It consists of personal devices such as computers, printers, mobile devices, and devices such as switches that connect them. Local networks have four different ethernet speeds: Ethernet (10 Mbps), Fast Ethernet (100 Mbps), Gigabit Ethernet and 10 Gigabit Ethernet [18].

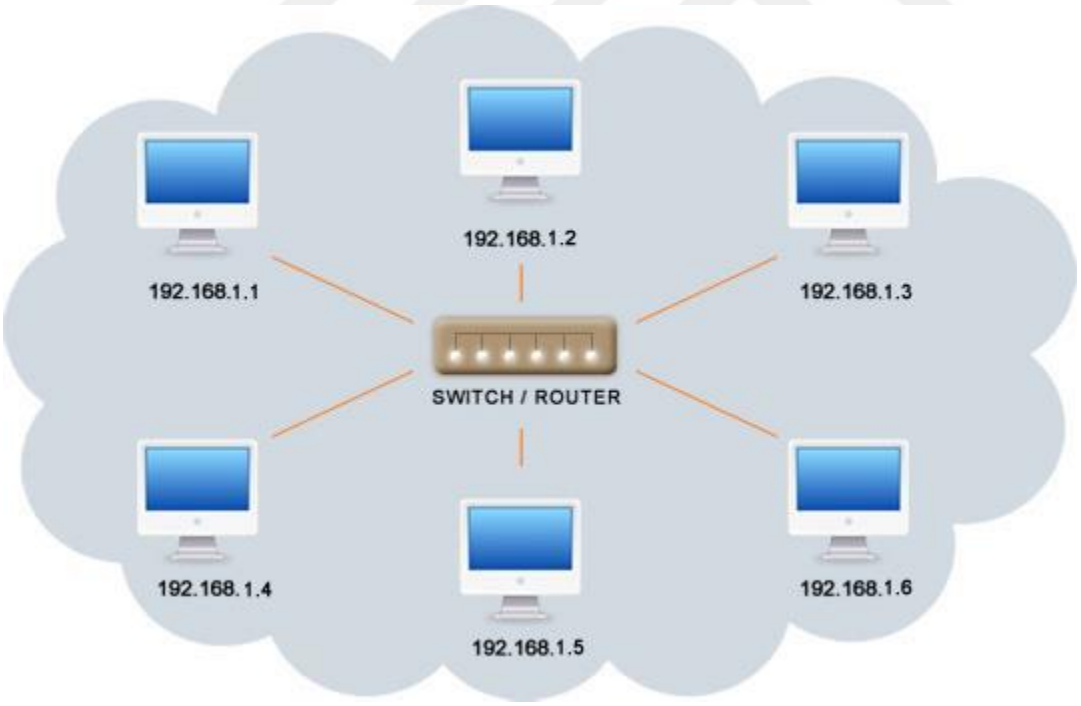

Figure 4.Local Area Network [35]

2.1.2. WideArea Network

Local area networks (LANs) communicate with each other via wide area networks (WAN) (Figure 5). The WAN also has a wide area, as evidenced by the name, and it provides the transmission environment to local area networks with the help of multiple connections. Unlike wide area network technology's local area network, it performs transmission using layer 3 (network layer) and layer 2 (data link layer) in open system interconnection (OSI). OSI is mean open system interconnection model defines a network framework for implementation of protocols in layers, where control moves from one layer to another. It is primarily used today as an education tool. It theoretically divides the computer network structure into 7 layers in logical evolution. Therefore, structuring and error handling is much more difficult than local area network (LAN) [19], [20].

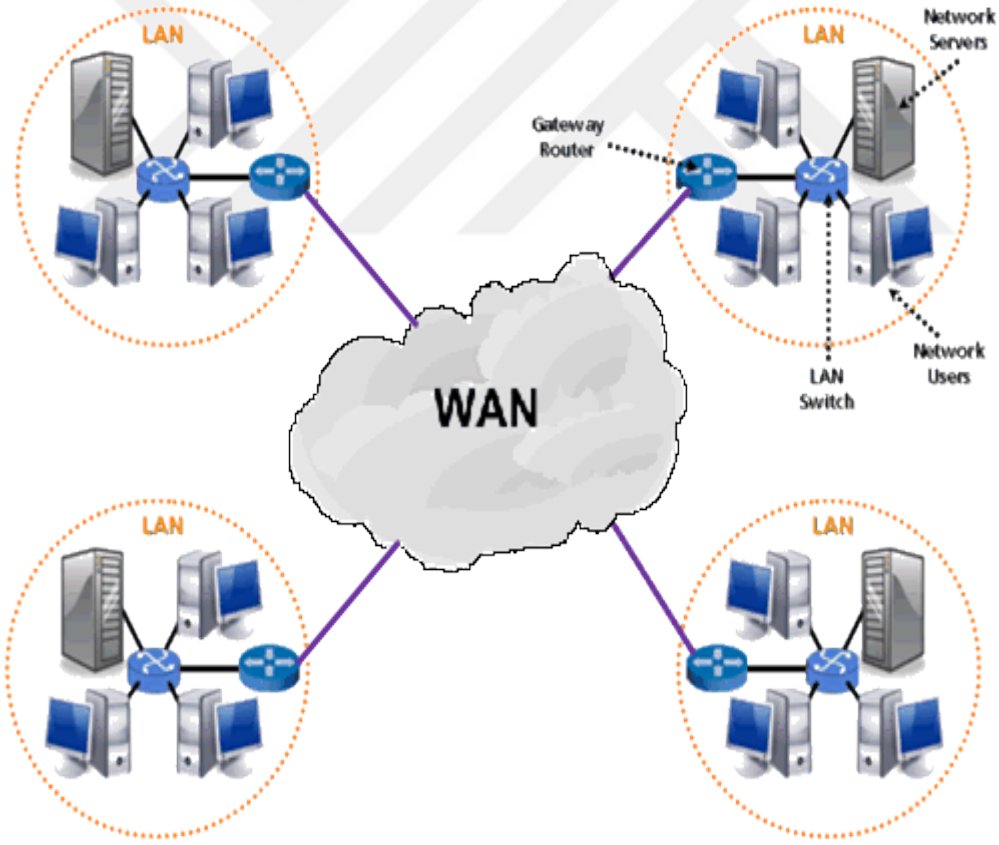

Figure 5.LAN/WAN [36]

2.1.3 Network Topologies

All computer networks need a structure that allows the data to be exchanged between networks. This structure between them is mostly provided by cables. Nowadays, wireless constructions are getting more popular. But wireless constructions are much less popular than wired constructions. Even so, the subdivisions of the wide area networks that house many local area networks are the cable type. The most important thing to do before you start to configure the network is to decide how the network will look. First, we determine the structure of the network [20].

Any network topology shows how to organize networks and systems on a network. Creating a topology is the first step in understanding the structure and working patterns of different network systems. It defines that the computer or nodes within the network are organized and interconnected. The general structure that provides how the locations of the computers on the network topology will be connected, how they will be connected, how data transmission will be done, is called topology. Some common network topologies are star, ring, mesh, linear, and tree configurations [21].

The simplest way to understand topology is to observe two distinct and unconnected pieces [22,24];

- Physical Topology: It is the visible structure when you look at a group of computers designed a network between each other. That is to say, the cables determine the visible part of the physical topology, such as how the cables have connections between the computers, and how the computers are connected to each other's.
- Logical Topology: Shows how your computer networks transmit data regardless of the way the cables are connected [29].

2.1.4. (Bus) Topology

Computers are connected to each other in a specified line direction. At the beginning and end of the main cable there are terminating connectors (Figure 7). Coaxial cable and BNC connector (Bayonet Neill-Councilman Connector) are used (Figure 6). In earlier computer networks, BNC connectors with coaxial cables were used in Ethernet networks, but Ethernet networks are now more commonly connected by RJ45(Register Jack) connectors, and CAT5(Category 5)-styles cables. The point of all connections is called the node. There is a broadcast communication between them. As a result, packets sent from a computer are transmitted to all computers connected to the network [21].

Figure 6.BNC connector (Bayonet Neill-Councilman Connector) [55]

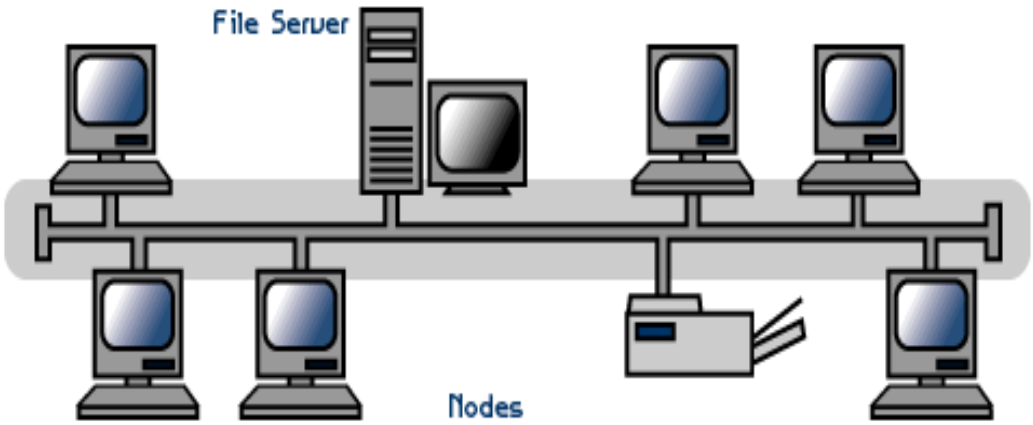

Figure 7.(Bus) Topology [37]

Advantages of Bus topology:

- Installation is safe in terms of cable structure.
- There's no need for a unit in the center.
- It is easy to add any computer to the building.
- Requires a lower cable than the star topology.
- The bus topology is work very well when the network is small.

Disadvantages:

- Up to 30 stations are connected.
- The length of the network is 185 in fine coaxial, 500 meters in thick coaxial.
- If the file server will breakdown, the entire network is disabled.
- If a main cable is also broken or disconnected, the whole network is collapse.
- At the end of the main cable, there must be a terminator connector.
- When there is a problem in the network, it takes time to find out where the problem originated.
- Usually it is not used alone as the network structure of an entire building.
- Collision is too much.

Collision: Is attempting to transfer data on the Ethernet network by two or more computers at exactly the same time and the network detects the collision of the two transmitters and discards them together. The collisions normally occur on the Ethernet network.

Collision Detect: Controls traffic on the network as soon as an Ethernet card is transmitting. If there is no data on the network cable, leave the data on the cable. If there is data on the cable, it waits until it reaches the destination. It then sends the data on it. If these are all failed, collision occurs [25].

2.1.5 Ring Topology

It is formed as a circular structure in which all the nodes are connected together (Figure 8). All the computers are connected to a loop-forming cable that forms the network. Today, UTP (Unshielded Twisted Pair Cable), and STP (Shielded Twisted Pair Cable) cables are used in ring topologies.

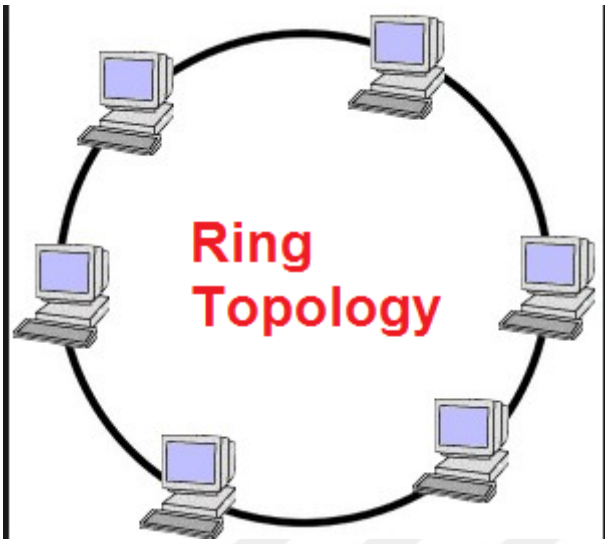

Figure 8.Ring Topology [38]

Ring Topology advantages:

- If the network is enlarged, it affects the overall system performance of the network positively.
- The whole station on the network has equal access to the network.

Disadvantages:

- The hardware needed to connect each workstation to the network is more expensive than Ethernet cards and hubs/switches.
- It has a complex structure.
- If a station fails, all stations are affected.

Ring topology usually uses twisted pair and fiber optic cable types. The most suitable protocol for this community is Token Ring [24].

2.1.6. Tree Topology

It is created by connecting networks with star topology. Nets with a star topology can be enlarged in this way (Figure 9). In the branches of the tree structure we can see the nets of the

different topologies, and the tree connects these nets in its body. Such a topology has emerged as a mixture of bus topology and star topology [21].

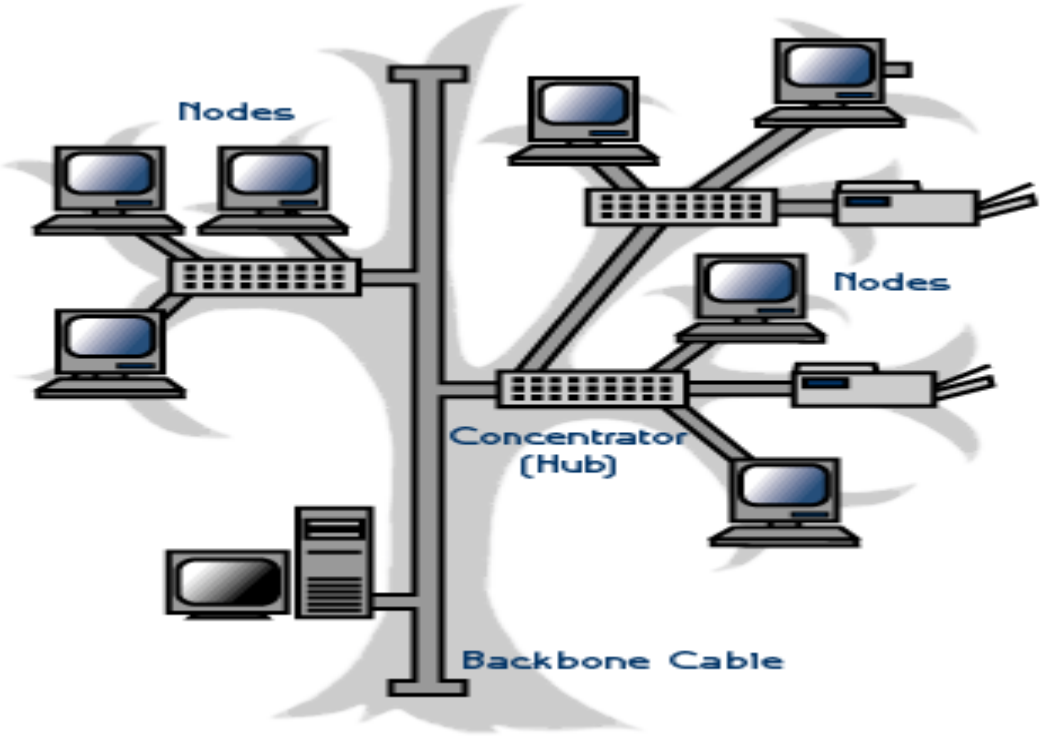

Figure 9.TreeTopology [39]

Backbone Cable : Is a larger transmision line that carries the data collected from the small lines that are interconnected with it.

a- Locally, a backbone is a line or group of lines connected by local area networks to a wide area network or with in a local network to efficently extend distances (for example, between two buildings).
b- On the Internet or other wide area network, the backbone is a set of routers that are connected by local or regional networks to long distance interconnection. Connection points are known as a network nodes. [30]

Tree Topology Advantages:

- A point to point cabling type is used for all separated parts so that if there is a break in the separated parts, the other parts are not affected.
- The products that are produced by different software and hardware manufacturers can work in this structure in harmony with each other [31]

Disadvantages:

- According to the types of cables, the average length of each separated part remains at a certain limit.
- If the backbone is interrupted, the entire network may also lose its operability.
- It is the topology with the most difficult configuration among the topologies according to the wiring types [25].
- When more nodes and sectors are added to the network for this reason, the maintenance will be difficult [31].

2.1.7. Mesh Topology

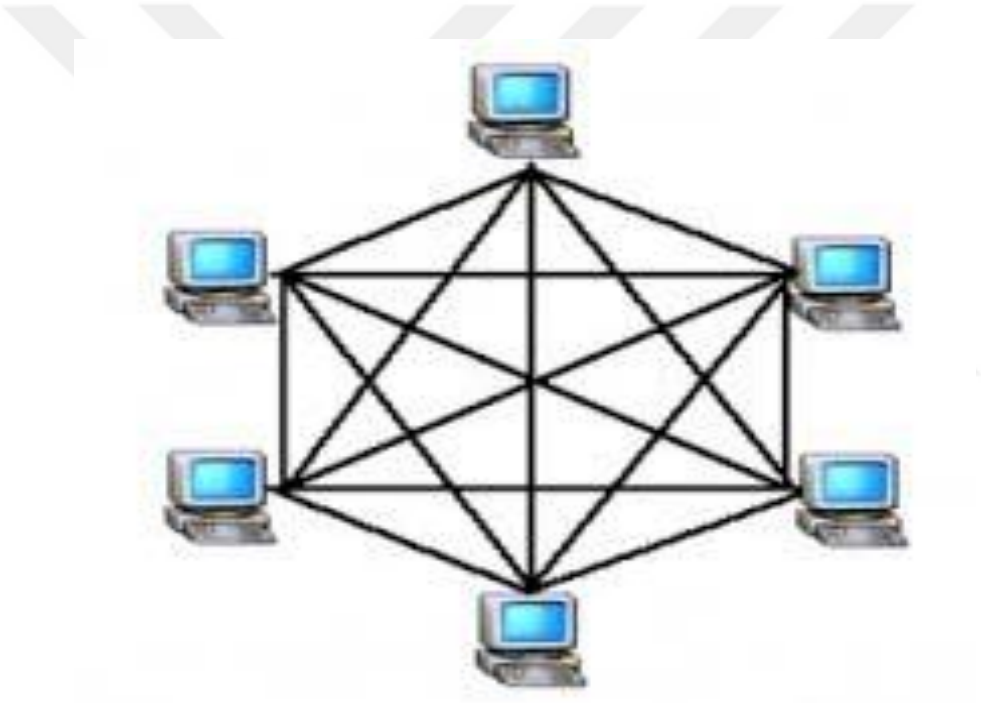

Figure 10.Mesh Topology [40]

The mesh built-in scheme, which is a very secure network structure to which all nodes are connected, is created completely or partially (Figure 10). Complex structures are not usually encountered. It is generally used in wide area networks. All the nodes are connected to each other over the network in the mesh topology. When used in local area networks, a structure connected to each other is not mandatory for all nodes [25].

There are two kinds of data transfer technologies over the mesh topology:

a) Routing: In this technique, the nodes have routing logic, according to network requirements. Such as routing logic to direct data to reach to destination using the shortest distance. Or, routing logic that contain information about broken connector, it avoids that node. We can even have routing logic, to reconfigure the failed nodes [32].
b) Floods: In this technique, the same data is transferred to all network nodes, so there is no need routing logic. The network is strong, and it is very unlikely to lose data, but it results in unwanted overhead across the network [32].

There are two kinds of mesh network topology:

a) Partial Mesh Topology: In this topology, some systems are connected in the same way as a network mesh topology, but some devices are connected only two or three devices.
b) Full Mesh Topology: In this topology, all nodes or devices are connected to each other.

Mesh Topology Advantages:

When all stations have their own point-to-point connection with other stations, multiple connections are emerged, and if one connection is lost, the other connections are used to get the signal to the destination. This is the most important advantage of this topology [33]

Mesh Topology Disadvantages:

If there is a small number of nodes in the mesh network and the size of the network environment is small, then the resulting connection amount will decrease, and the network speed will slow down [25].

2.1.8. Star Topology

The star topology is the topology that is emerged with the connection of all devices (servers, stations, and other peripherals) directly to the central connectors (switch or hub) (Figure 11). The transmitted data goes through the switch or hub in order to go to the destination address. Hub or switch can manage and control all functions of the network. In addition, a repeater / signal amplifier works similarly in a star topology network [21,24].

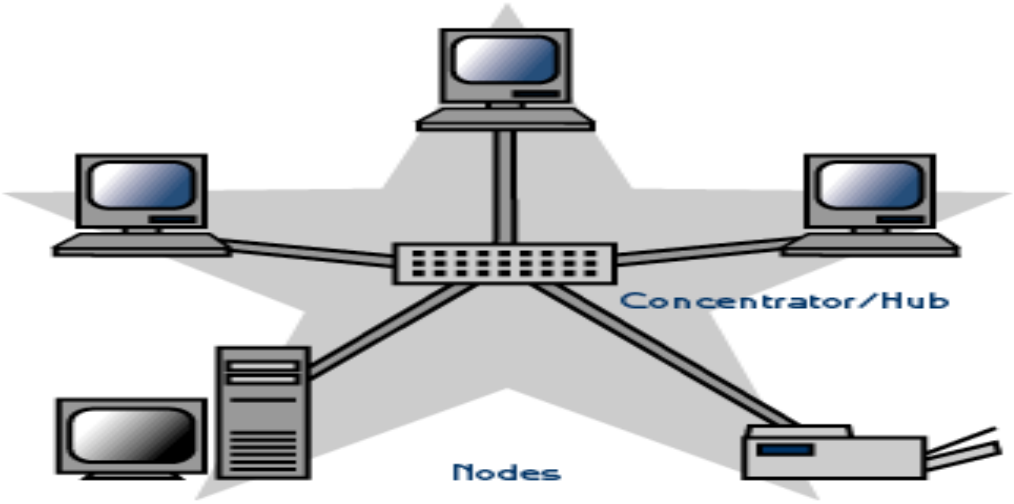

Figure 11.Star topology [41]

Star topology advantages;

- A new station can easily be added if there is space in the central device.
- Faults can be detected easily, and management is simple. Also, do not take too much time.
- Can be connected with different wiring methods.
- If a malfunction occurs in a station or a new unit is added, the whole network will not be affected.

Star topology Disadvantages;

- Compared to other topologies except mesh topology, the cable requirement is high.
- Whenever there is a problem in the hub or switch, the entire network is collapsed.
- Because hub and switch are used, the cost is higher than bus topology.

  Twisted pair and fiber optic cable types are also used widely in this topology. The widely used protocol types of this topology are Ethernet and Local talk [20]. In general, star topology is used. So, this topology will be used in this study.

2.2. Network Technologies and Architects

2.2.1. Ethernet

The Ethernet architecture is based on the IEEE 802.3 standard. This uses a network CSMA / CD (Carrier Sense Multiple Access with Collision Detection) access method.

In CSMA / CD, client computers determine the order in which the data is going to be transmitted first and then in terms of the network topology. Ethernet is also divided into classes according to communication and cable speed. Communicating at 1000 Mbps speed is gigabit Ethernet, 10 Mbps communication speed is Ethernet, 100 Mbps communication speed is called Fast Ethernet. There are two topologies that Ethernet generally uses. These are logical data path and star topology. As the network grows, it becomes hierarchical order. In general, the speed of this network is 100 Mbps. It can be increased up to 1 Gbps according to the newly introduced standard (Table 1). Computers in any network communicate with each other on a common carrier line. In a network with more than one computer, there will be no successful data transmission because transmitting data of computers at the same time can cause collision. The CSMA / CD protocol running on Layer 2 of the OSI model is used to prevent this collision. The computer that wants to start transmitting data will control the predecessor network. If the network is empty, it may send a frame. If the network is not empty, wait for the line to remain idle. If collision occurs during the frame transmission, the computer that sends the frame broadcasts a "jam" signal to other computers on the network, indicating that there is a collision in the network[26].

Carrier sense: All computers connected to the ethernet are also listening to the line and then seeing that the line is empty, then go to the package destination. But at the same time there may be even overlaps if there is more than one computer that listens to the line and at the same time sends the package.

Table 1.Ethernet Types[42]:

Ethernet type	Cable type	Data Speed	Standard Distance
1000BaseT	CAT5, CAT6	1 Gb/Second	100 m
1000BaseCX	Twin axial	1 Gb/ Second	25 m
1000BaseSX	Fiber optic	1 Gb/ Second	500 m
1000BaseLX	Fiber optic	1 Gb/ Second	5000 m

2.2.2. Token Ring

This structure uses the token passing access method and is in the IEEE 802.5 standard. These networks are configured like star topology. Computers work in a central connected to a hub. But computers provide sequential communications as if they were placed on a ring. This is logically called the ring. These ring networks are physically in the form of a star topology network. But logically it resembles a ring topology (Figure 12).

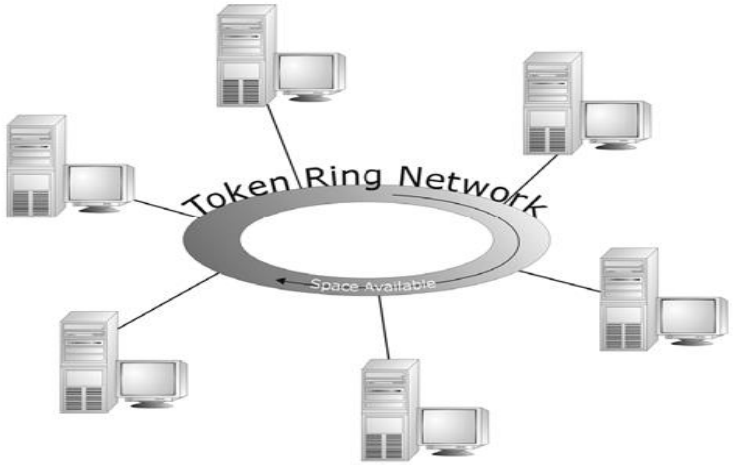

Figure 12.Token Ring Network [43]

All PCs are connected to the MSAU (Multi Station Access Unit: is often a shortcut to the Ethernet media module. MSAU is a hub or capacitor that connects a group of computers such as nodes in network terminology to local area network with a symbolic loop that mean central

hub). It provides communication by taking signals from all the stations and sending them to the next station [24,26]. The toking ring uses a ring topology in which the data is sent around the ring from one device to another and back to where it originated. Also, when the device can control the code, it uses a symbolic pass protocol that only the network can use; and this guarantees that there is no collision at any time since only one device can be used. A token ring network is a local area network (LAN) where all computers are connected to a ring or star topology, and a binary number or symbol passing scheme is used to avoid conflicts between two computers when it is desired to send a message at the same time. In local area networks after Ethernet, token ring protocol is the second most widely used protocol. In short, it works as follows;

Empty information frames are continuously routed over the ring. When a message to send a computer is found, the computer adds an icon to an empty frame (this may include only 0 to 1 in the token bit portion of the frame), and adds a message and a destination identifier to the frame. Then the frame is examined by each successive workstation. If the workstation sees that the message is a destination, copy the message framewise and change it to 0 to specify the code. Each successive workstation examines the frame. If the workstation sees that the message is a destination, copy it as framewise and to specify the code, change it to 0 [24].

On the network, just one token walks around at the same time. The token scheme can also be used with bus topology LANs. Token ring networks are now very rare because the cost and flexibility of Ethernet came to dominate the market.

Token Ring networks are originally 4 Mbps. But Token Ring networks used today are at 16 Mbps speed. The next computer that can access the network is specific on those networks. The direction of the circle will be determined by the station. There cannot be a conflict. Therefore, according to Ethernet it is a systematic network. Modern is used in Token Ring networks with STP (Shielded Twisted Pair) and UTP (Unshielded Twisted Pair) cables [24].

2.2.3. Asynchronous Transfer Mode(ATM)

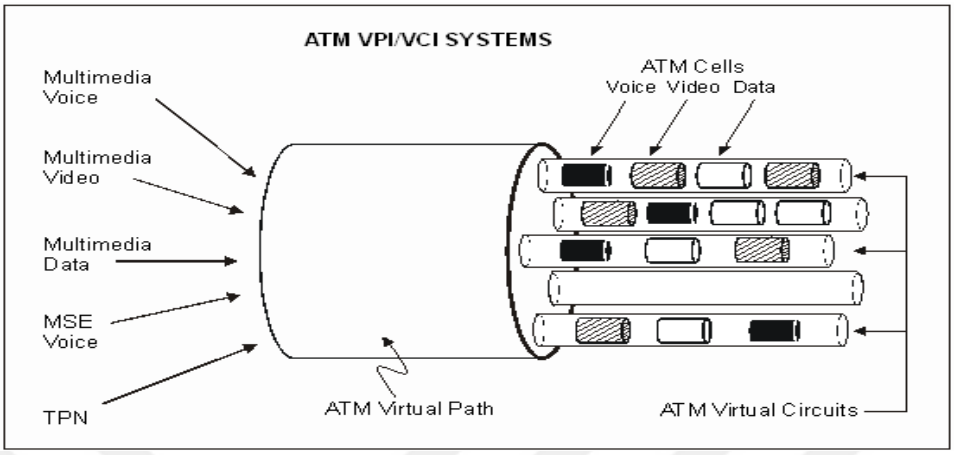

Figure 13.ATM Connection Model [44]

It is a network type that transmits data in the 53 bytes constant size cells. It is a technology that its basic is based on connection. The cell relay technique which is considered as the type of packet circuits from the advantages of circuit switching. Just as it is in the packet switch; For example, completes Frame Relay, X.25, ATM duplication, TCP / IP, and all of the switching functions, suitable for burst traffic, circuit switching is not feasible and allows devices to communicate at different speeds. However, according to packet switching, ATM is designed for high performance multimedia networks (Figure 13). Limited use in local networks commonly used to create a fast backbone structure between communication and pc networks in general [21,24,26].

MSE voice (Mobile SubscribeEquipment): Is thesystemsupplyvoiceanddataconnections on an automaticbasisusingtechniquecalledfloodsearchrouting. The system supports both mobile and wireline subscribers by means of exchanging information. This system is digital, secure, highly flexible, and has features that deal with interconnect breaks, excess traffic load and fast user traffic [34].

TPN (Tactical Packet Network): Is a part of the packet switching network. In addition, to providing data communications, the network provides interoperability with neighboring system, including commercial network [34]

Since these networks are connection-based, one of the PCs sends the necessary package for the connection setup in order to start the data communication. This package is related with the resources needed and deals with the existence of the connection to the ATM switches and the registration of the information. The virtual circuit path information of the link is also called virtual path. If the requirement on the network of the connection is not temporary, the information is kept on the continuous switching tables. Such persistent connections are called permanent virtual circuits. All links only have their own identity information. When a connection is established on both sides, it can send data immediately. This data is converted into cells of 53 bytes, i.e. 5 bytes of header and 48 bytes of information [25]. The title contains the identity of the link, for this reason these keys understand where the cells they receive will forward to them. That is why all cells go from the same path. Even if the cells follow a certain sequence, it is not generally controlled whether the cells reach their target (Figure 14).

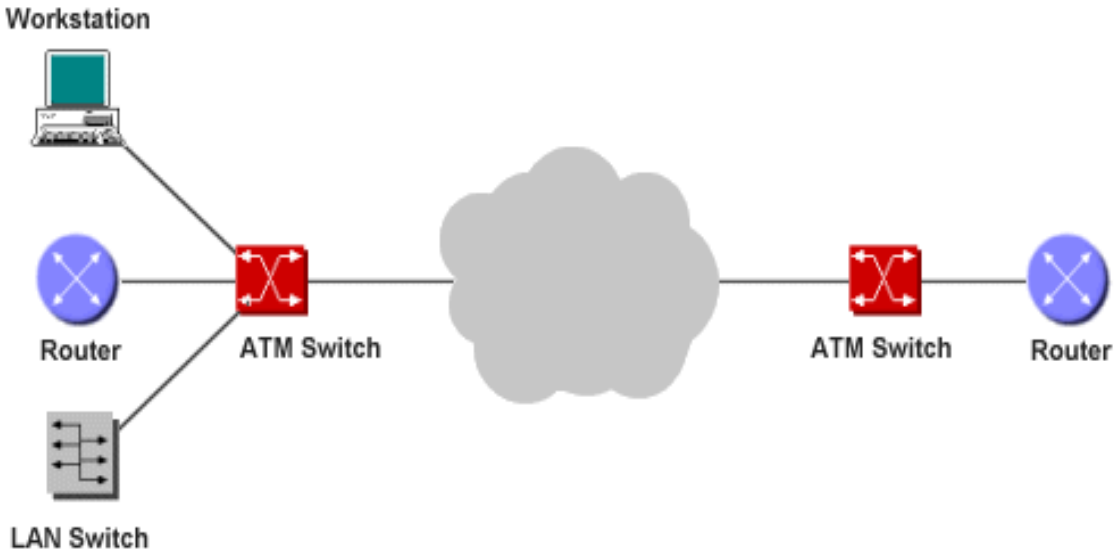

Figure 14.Architecture of Asynchronous Transfer Mode [45]

2.2.4.FDDI (Fiber Distributed Data Interface)

Todayweusetoken ring LANsthat can operate at highspeed (over 100 Mbps) throughoptical fiber cable. The double wiring technique is used in this cabling. In other words, one side transmits clockwise while the other side transmits in the opposite direction to clockwise. There are two station types as A and B class. A class station types should be connected in two fiber cables since they provide the transmission of very important data. Class B station types must be connected to one of the fiber cabling. There is a difference between IEEE 802.5 Token Ring and FDDI.A new token cannot be generated until the packet that the station sends to the destination and go back to the destination 802.5, but FDDI does not have to wait for the old token to return to generate a new token in the station [20,24] (Figure 15).

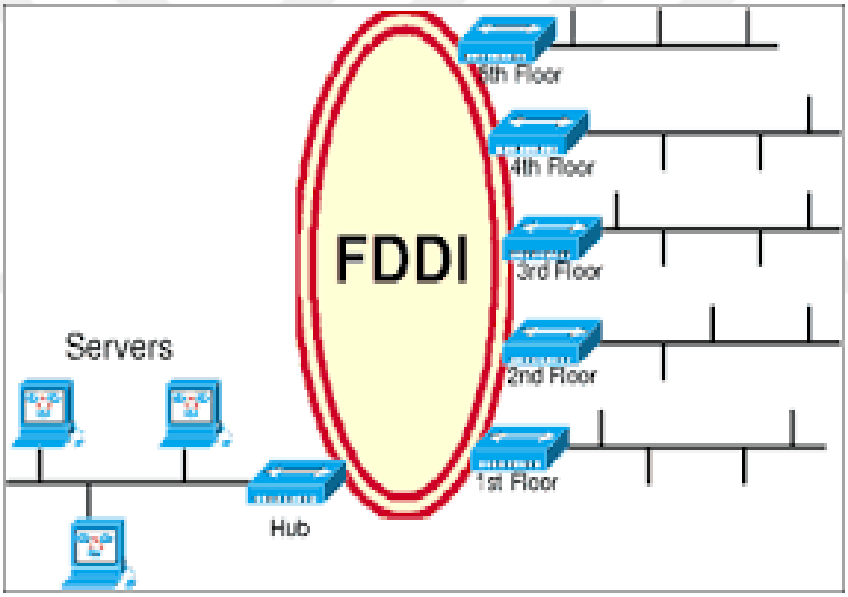

Figure 15.Fiber Distributed Data Interface [46]

2.3. Network connections

Thereare 3 types of cableused in computernetworkstoday. These; coaxialcable, twisted pair cable and fiber opticcable.

2.3.1. Coaxial cable

Coaxial cable is a type of cable developed to transmit low power signals in environments with high electro-magnetic contamination (Figure 16). This type of cable can be used in many areas. It is also used in voice and video transmission [21].

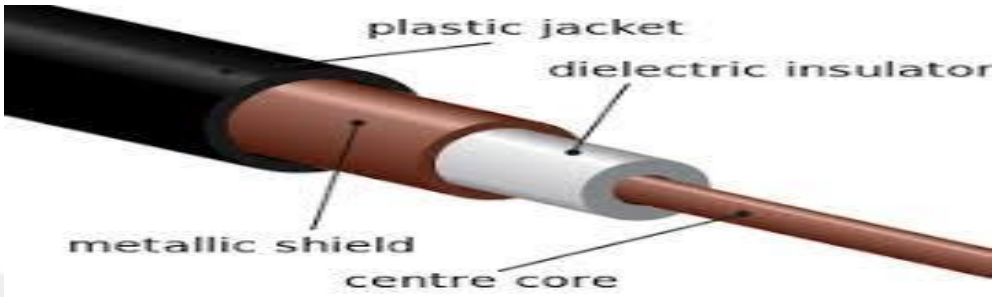

Figure 16.Coaxial cable [47]

2.3.2 Twisted-PairLines

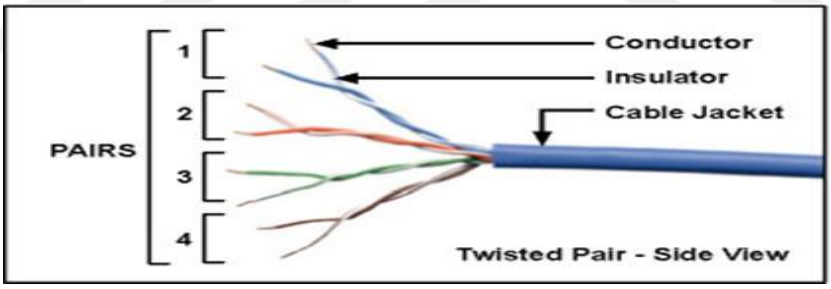

Figure 17.Twisted-Pair Lines [48]

The double-twisted cable connection is usually the most common and simplest method for a LAN.This is done by winding and twisting the pairs of wires coated with the same insulation material. The twisted wrapping of these cables leads to a reduction in noise. Such cables therefore have higher resistance to artificial noise (noise, error) signals than to two wire open lines. The accumulation of a noise signal on two lines (Figure 17), i.e. the reduction of the effect of the difference signal, is due to the proximity of the signal and ground lines. The twist of each pair in the cable is due to the cross-link reduction of several twisted pairs in the same cable [21].

2.3.3. Fiber Optical Cable

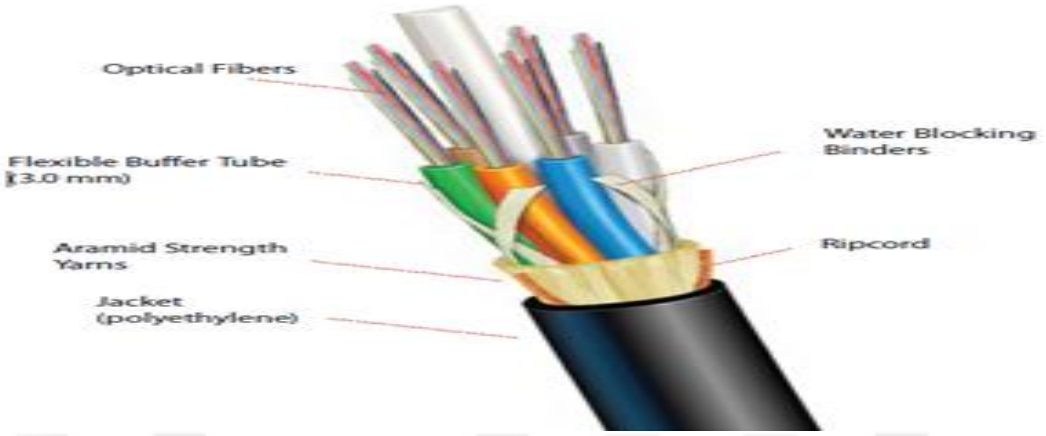

Figure 18.Fiber Optical Cable [49]

Today, the most advanced end-user technology in internet access is fiber opticcabling. We will tell in the simplest way if we say that it transmits the datum through a transparent line with the width of the light beam (Figure 18). The optical fiber technology work is the breaking the light as it passes between the different intensity environments. If the density difference between the media and the angle of the light enhancement is as high as necessary, the lower density intensity does not pass through the light environment but reflects backward. If this is done using conductive glass or a coating with a lower refractive index around the plastic fiber liner, then the light cannot come out of the interior of the fiber lane and proceeds by reflecting from the walls inside the fiber lane. The structure of these lines is the innermost part made of glass or plastic, with the radius of the transmission measured in micrometers. These parts are sufficient for transmission; but the outermost protective layer is added to protect the fiber optic cable from physical effects and to be durable. Both ends are connected to fiber optic interface inputs [21].

2.4. Network Components

Today, the purpose of network devices is to expand the network band and to allow computers to communicate with each other (Figure 19) .

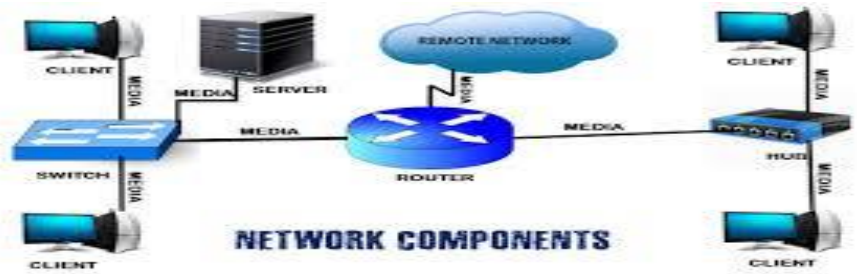

Figure 19.Network Components [54]

Basically, network devices are;

2.4.1. Hub

Figure 20.Hub [50]

It is simple network devices. It has its own power supply and works by feeding from it. In network systems, it makes the signals from the beginning and re-timing from the beginning. It gives a way they share each other to the PCs connected to this device (Figure 20). (It sends all the data to the ports.) In other words, network-connected devices that want to communicate at the same time should wait for the line to be idle. They are the devices that have Number of variable ports on numbers 8 and 24. Hubs often form a central point in networking, or they can be used for similar purposes to increase the security of that network. The OSI model is based on the fact that they are the first layer device because they operate at the bit-level. There are two types of classification for these devices; In other words, Hub devices are generally examined in a passive or active group pattern. For passive users, for multi-user environments without amplifying the incoming signal, the active ones amplify the incoming signal and split it for a very user-friendly environment. Because of this, passive hubs are not used to increase the cable length [21]

2.4.2. Repeater

Repeaters receive electrical data transmissions from any ethernet segment and translates it into binary code to transmit to the other separated fragments. The repeater therefore plays a role in both improving the electrically impaired signals and increasing the signal strength (Figure 21). Repeaters are used on many systems such as microwave, telegraph, optical communication, telephone. The reason for this is that the OSI model has 1-layer devices, which means that they operate only at the bit level, like hubs [21]

Figure 21.Repeater [51]

2.4.3. Switch

Switch provides a way to connected PCs like hubs. Providing a way with switching is different from hub devices. If 2 PCs in the network want to communicate with each other, they can communicate with other PCs because of the switching feature. Therefore, they perform better than hub devices (Figure 22). These devices have a number of ports ranging from 8 to 48 and are available in shattered models. If we are using shattered switches we can add ports if necessary. In the OSI model these devices are 2nd floor devices. They distinguish collision fields based on MAC addresses of the packets they will forward and route them according to their MAC addresses [21].

Figure 22.Switch [52]

2.4.4. Router

The router can be managed and, when required configurations are made, they can select the Best Determination Path (best path) that can be used from any number of existing paths when accessing any remote network (Figure 23). Routers connect all networks or network parts. In the OSI model they are the 3rd floor devices. However, if the required interface module is used, it connects to 2 separate network devices that can work on 2nd layer in OSI model. However, they only grant the transfer of the notification of the network address, which is reduced on the network traffic. In general, they are divided into two such as static routers and dynamic routers. In static routers, directions are hand-shaped and always use the same direction. Static routers are more secure than dynamic ones. In dynamic routers, roots are automatically configured, and the router chooses the best direction for the data. Manual shaping is done to increase security in dynamic routers [27]

Figure 23.Router [53]

CHAPTER THREE

METHODOLOGY

3.1 Introduction

In this chapter, the methodology is presented. The microsoft visual studio 2017 (Visual Basic.NET) and SQL server 2016 is used to work the system to evaluate many participants after training on Cisco Packet Tracer to implement, design, and troubleshooting for network. There are many new features in the Microsoft visual studio 2017. It has been optimized to reduce startup time and solution load time. Visual Basic.Net has some advantages like including true object-orinted inheritence, over loading, and new shared development environment. After the examination by the participants in the course and the result appear through the system. The network is designed and implemented by Cisco Packet Tracer Program. Cisco Packet Tracer is simulator program software that help people when they are working with network system. It is developed by Cisco and offered free of charge to users. It is easy to make preliminary impressions of networks that require a lot of effort in terms of cost and time to set up in real environments. Thanks to the Packet Tracer, we are able to find a trial environment for network devices that we cannot access easily in real life. In addition, the high number of users of Packet Tracer program increases the preference rate because there are many users that we can get solutions to the problems that arise while creating the simulation network simulation created with Packet Tracer is possible to be monitored in real time so that what problems will be confronted with in a real network. The difference of Packet Tracer's according to its alternatives' it has enough network devices that cannot be found in other network simulation programs and it is possible to test individual devices of network devices produced by cisco. There are also many documents from Cisco that can be exploited when creating a network simulation in the event of a problem. It is also a great advantage to have the program offered free of charge.

3.2 Flowchart of Evaluate Participants System

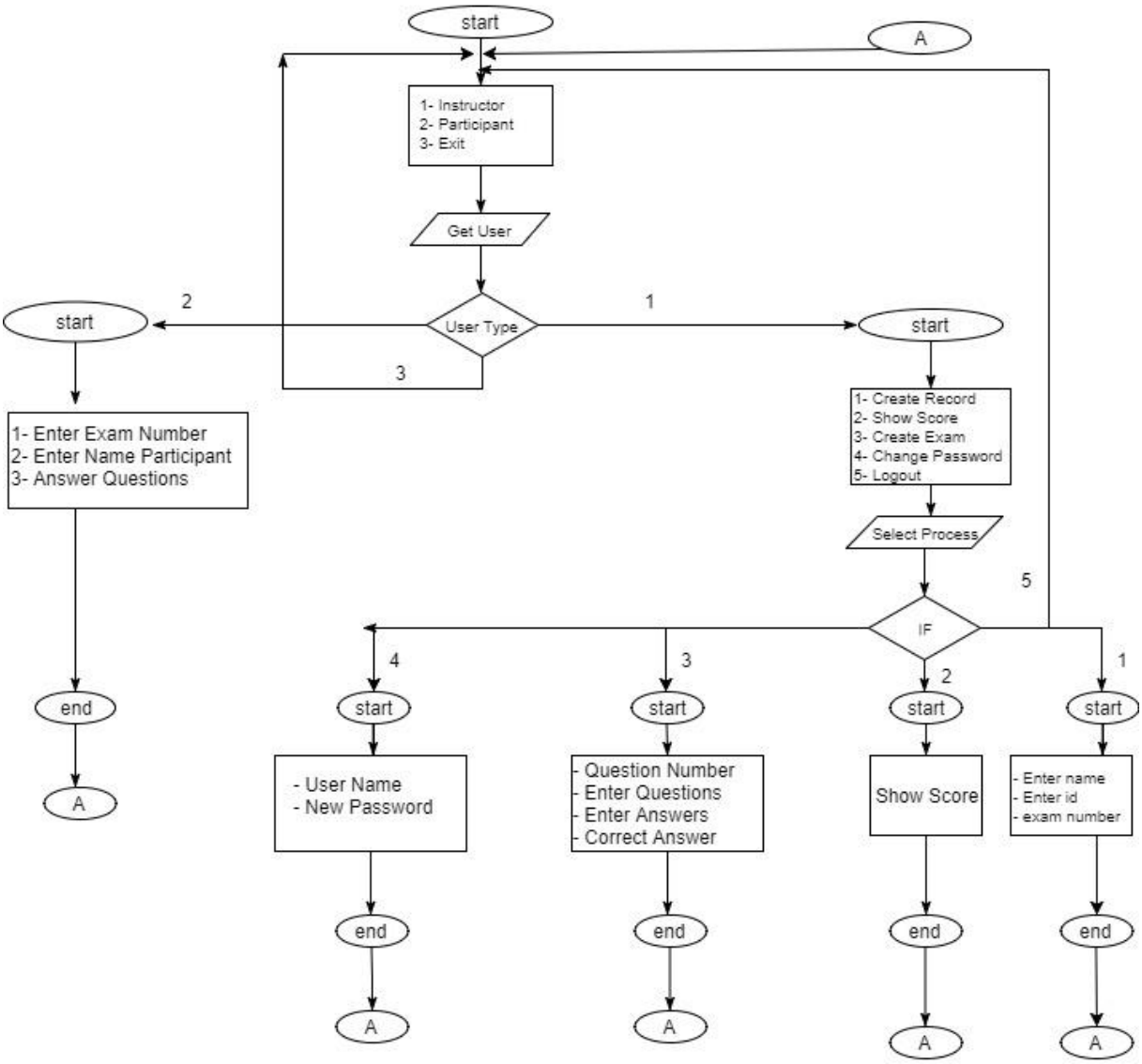

Figure 24.Flowchart of Evaluate Participants System

To examine and ascertain the capacity and potential of a participant skill to design computer networks and their knowledge of the Packet Tracer course, A programmed system has been created that will examine the participants. According to the outcome of the performance of the system, the participants will be classified and grouped into 2 categorizations:

Categorization (1):

The apprentices who have obtained a degree of (70) or higher These students will be recognized as being capable of designing, executing and preserving the computer networks by applying the Packet Tracer.

Categorization (2):

Apprentices who have received less than (70) students in the practice. These students must be trained and applied to the Packet Tracer program by applying their free time to work in the program. In addition to surfing the Internet and researching the lessons learned during the course and sending questions to professionals in the design of computer networks for technical guidance so as to be able to excel excellently without having to participate in the other training courses available.

Derived from and according to the enlisted explanation above, the participant's evaluation system has already been programmed by applying the updated Microsoft Visual Studio (2017), The Visual Basic.NET and the application of (SQL) 2016 as a database which is seen below:

1.The access to the system interface: This guides the interface to enter the system because it has the authority to enter into the system the username, user access and password are displayed through the following interface(Figure 25):

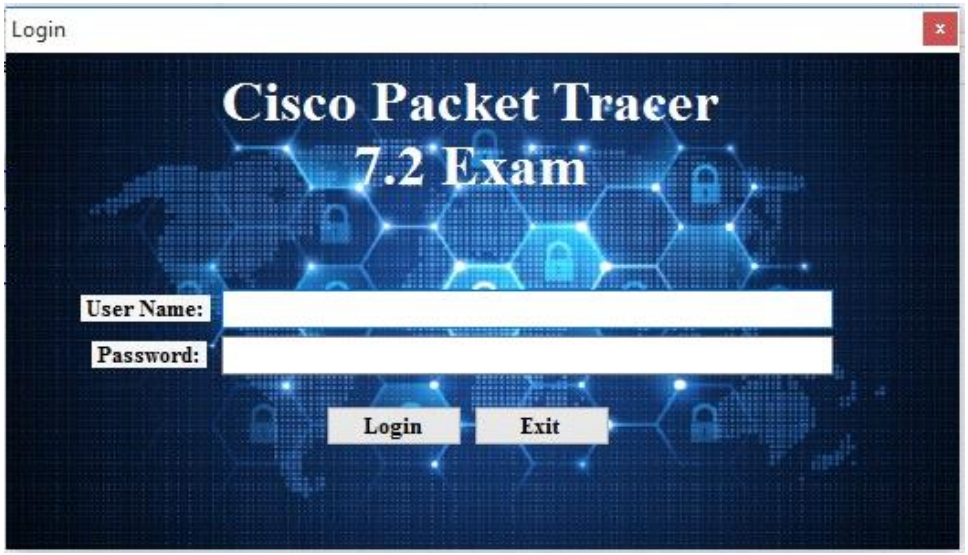

Figure 25.Login the system

2. The principal interface: The system is accessed by the teacher via the interface to access the system to present to the students the principal interface where the principal interface consists of various icons through the Guide to access it (access through the names of the students who have participated in inspection by the same teacher, after presenting their grades. Then the password is changed and the Guide before logging out of the system) Figure 26 as shown below:

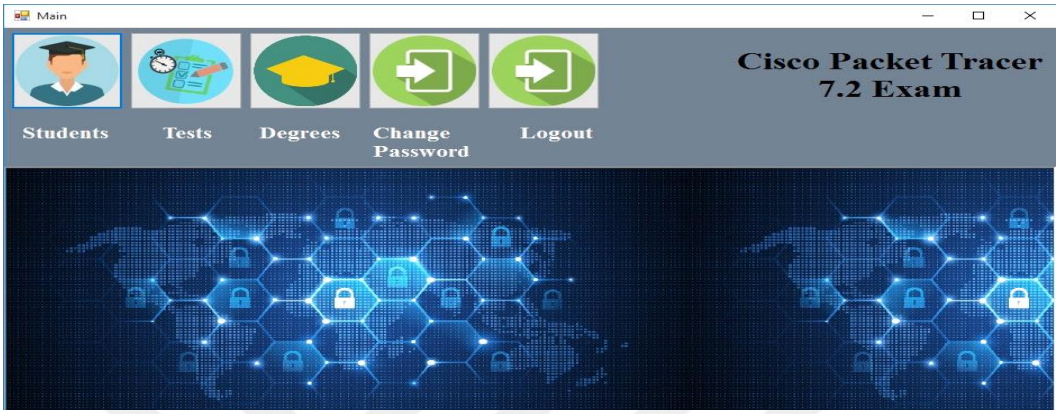

Figure 26.Principal Interface

There are many images in the main interface:

A-The icon of students: With this icon, the trainer will access the names of participants who will perform the test where the system creates a lot of test participants and random non-sequential used for the purpose of entering the exam interface. Through this interface, it is possible to delete the name of any participant that has been accessed wrongly if the examination is not performed. As shown in the following figure (Figure 27):

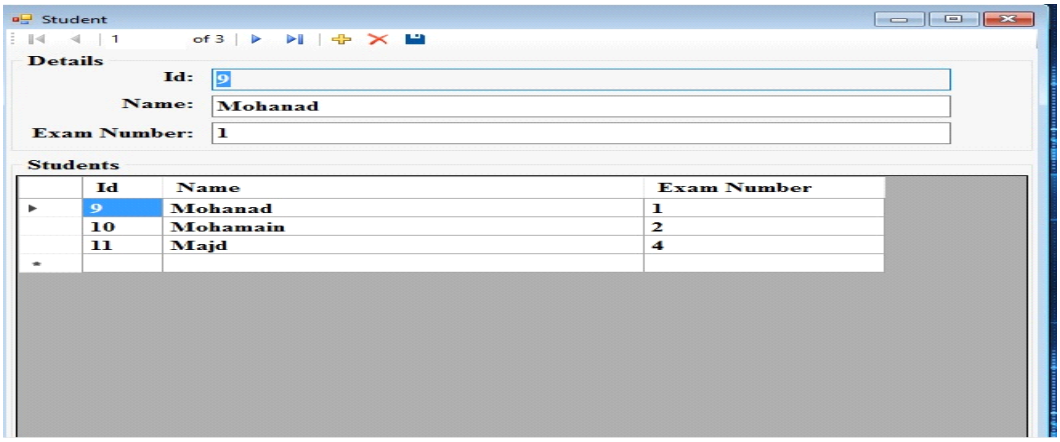

Figure 27.Name Of Participants

B - Interface Tests: Through this interface, the teacher to create the exam by entering the required information (the sequence of the test, the name of the test, the test period in minutes, and whether the test is activated or not) as shown in the figure below (Figure 28):

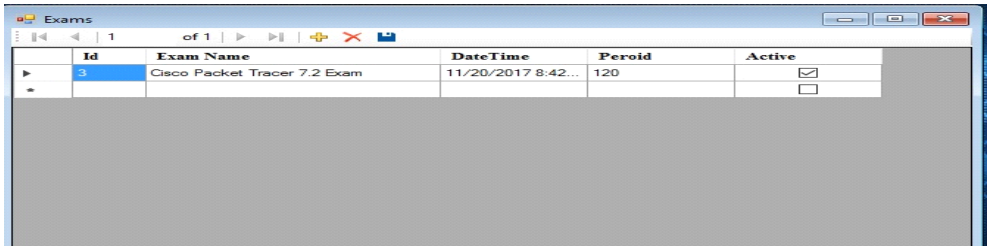

Figure 28.Interface Tests

Once the test is enabled, the system will reveal to the students the interface and how to access the test questions with the right answer. Participants would be allowed to select the right answer for these optional answers, as seen in the figure below (Figure 29):

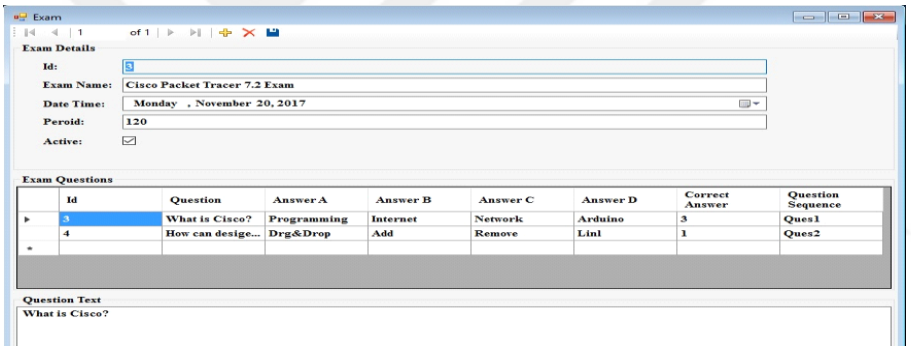

Figure 29.Create Exam

C - The Icon Levels and Points: This will be discussed extensively in the proceeding chapter of this study .

D - The Change of Passwords and access: With this icon, the instructor can decide to change the password for accessing the system as seen and presented in the figure below (Figure 30):

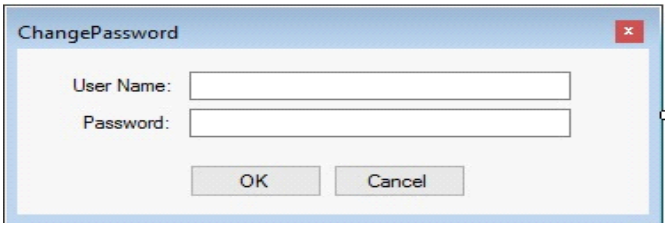

Figure 30.Change Password

E- Log Out: With this icon is possible for the instructor to exit the system permanently.

3- Login Students Interface: With this interface, students can access the system for the purpose of performing the test by logging the name of the students first and then logging in the exam number of the participant (Figure 31), which was given by the instructor. The students will then click the start button for the answer and the exam will begin. Once the examination time is over, and the questions are unanswered by the participant, the program will stop responding. Once they finish answering all the questions and pressing the end button, the system will show the outcomes of the wrong colored answers in red, as seen in the figure below (Figure 32):

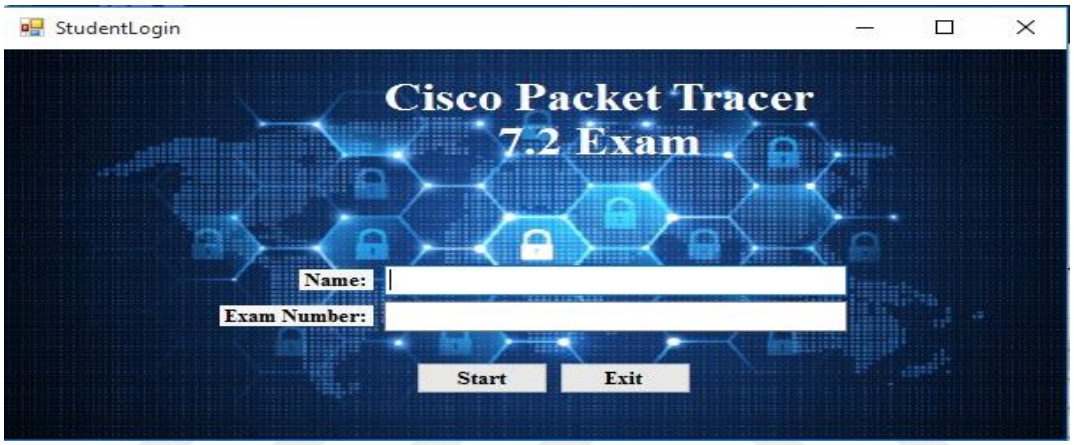

Figure 31.Login Students Interface

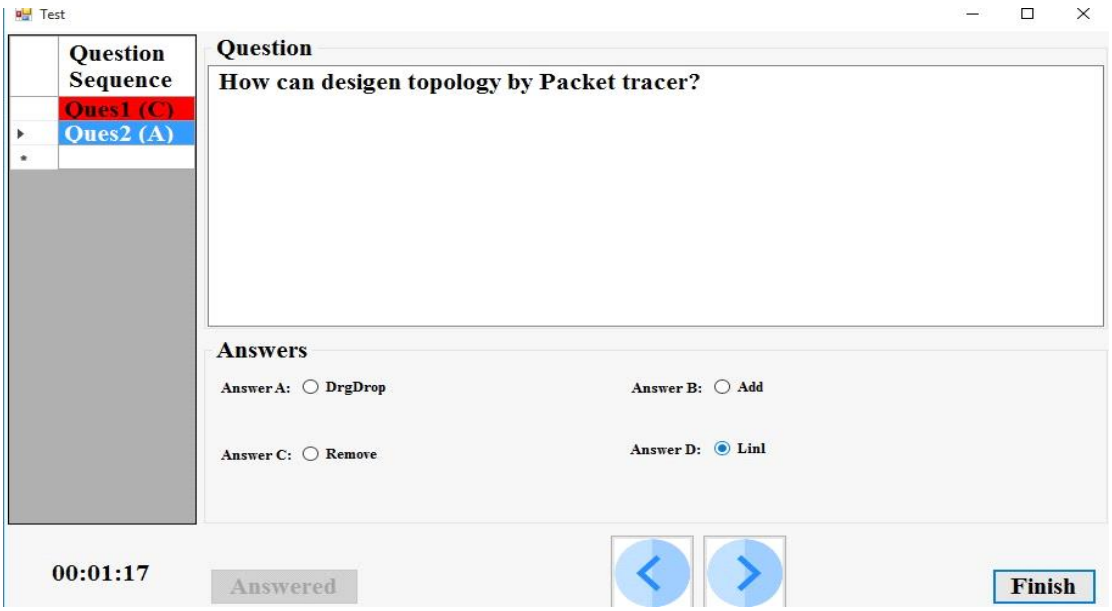

Figure 32.Wrong Answer

Right when the exam time is over and all exam takers have finished their exams and filled in their selected answers with the interface of the system. The instructors that present the exam takers with their marks by clicking on the marks icon in the principal interface. And then the system quantifies the exam taker's marks and presents it on the broad- screen with the total marks been presented for each exam taker to see. For example, the exam taker who obtained less than (70) will be regarded as haven failed in the test, on the other hand, the exam taker who obtained the mark of (70) will be regarded as haven passed the exam excellently and will be recognized and believed to able to design, execute and preserve the application of the Packet tracer as presented in the figure below(Figure 33):

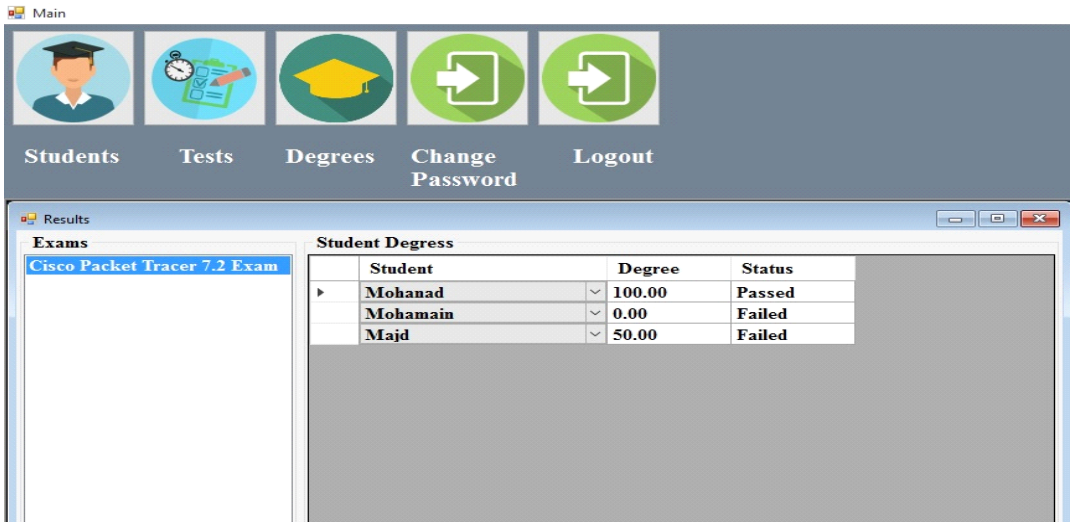

Figure 33.Students Degrees

3.3 Formation of Network Map and Determining Rules

In the process learning computer network systems, the use of virtual laboratories is very important. In this chapte, we also implemented Cisco Packet Tracer, which enables us to work on test scenarios without using any physical components virtually to design an advanced computer network. The Cisco Packet Tracer is used not only to simulate computer networks but also to learn computer networks.

The map and rules of the computer network structure were determined to design a computer network in a 6-storey hotel. In the computer network map, 9 computers, 5 laptop computers, 6 Ip phones, 14 switches, 2 routers, 4 access points, 1 security wall, 1 http server, 1 mail server, 1 IoT(Internet Of Things) server, 6 cameras, 1 tablet, 1 smartphone and 1 DHCP server were used.

A - The reason for having two routers; the first connects the telephone lines, and the second connects the switches in the normal network. These routers are located on the third floor where the server room is located.

B- The DHCP server in the server room provides automatic IP distribution to networked devices on the system. The DNS server identifies the DNS in the network and replies to the request for the website. The HTTP server is responsible for the accommodation of the hotel's website. IoTserver is involved in providing remote access to the smart devices specially cameras in this study. The server room is on the 3rd floor of the hotel.

C-Access point is used for wireless connection in floors. The switch is responsible for connecting devices that are physically connected to the network to communicate with each other. The firewall is responsible for securing the network. IP Phone performs to ensure that the Ip phones on each floor are used in communication and can used communicate with the required floors in hotel. The printer is placed in the network for use in reception.

D - IoTserver was used to create the users to connect to the camera. The purpose of using CCTV is to intervene in a short time to prevent problems that may occur in the storeys and to prevent security problems.

- The security level of the firewall specified by a reference value of 0-100, 0 being the lowest and 100 being the highest security.
- If there is a problem with the 1st floor; first of all, it must be checked whether the non-wired system on that board can be done correctly. Then switch reset is thrown. Then the switch configuration is done. After that, the devices connected to the network are provided to take IP from the DHCP.
- There is no security wall on each floor, there is one security wall, and this security wall provides protection between the outside network and the inside network.
- In case of internet interruption;
  - It must be checked if there are any problems with the cables
  - DHCP server's IP settings should be watched.
  - Whether the IP’s of the devices which are manually assigned IP in the system overlap with each other should be checked
  - It should be checked if there any changes in Switch and Router settings.

- When the camera is broken;

  - It must be checked if there is a problem with the cable of the camera.
  - It should be checked whether the camera takes the IP address correctly.
  - Make sure that the IoT server's configuration settings are correct.

The reason why the server room is on the 3rd floor can be explained as follows:

If the server room is located on the lower floors, it will be in a dangerous position against any floods and natural disasters. In the case of removal to higher floors, servers can be suffered as they are heavy and expensive devices. Considering security, it is not logical that the server room is downstairs. Considering these situations, the most suitable floor for the server room is the 3rd floor.

3.4. Network Map

First, the network map will be created and then the rules that will be on the network will be determined.

In this study, there are 9 pc, 5 laptops, 6 IP-Phone, 14 switches, 2 routers, 4 access point, 1 firewall, 1 http server, 1 IOT (Internet of Things) server, 6 cameras, 1 mail server, 1 tablet, 1 smart phone and 1 DHCP server.

3.5. Network Rules

The specified networking rules are below;

1. Switches assigned to IP telephones on each floor will be connected to the main switch.
2. Switches assigned to the normal network on each floor will be connected to the main switch.
3. The IP phones found on every floor will be connected to the designated switch for those IP phones on the floor.
4. The printer on the first floor will be connected directly to the switch on that floor.
5. Access points on the first, second, fourth and sixth floors will be encrypted with the WPA2-PSK encryption method.
6. The laptops on the second floor will be connected to that Access Point on the floor.
7. The tablet and smartphone on the fourth floor will be connected to the Access Point on the floor.

8. One laptop on the sixth floor will be connected to the Access Point on that floor.
9. Pc and laptops will take their IP from the 8th floor through the DHCP server IP pool.
10. Devices that have access to the web from networked devices will be able to access the hotel's web site.
11. The IP phones on each floor can communicate with each other.
12. The names of the computers on the first, third, fourth, fifth and sixth floors will be given according to the floor they are on; PCF1, PCF2_1, PCF2_2.
13. The IP phones on the first floor will be named according to the floors they are on, for example; IP PHONE F1, IP PHONE F2.
14. The laptops on the second and sixth floors will be named according to their floors, for example; LaptopF2, LaptopF6_1.
15. Switches designated for IP-Phones on each floor will be named according to the floors they are on, eg Phone-SW1, Phone-SW2.
16. The switches designated for the normal network on each floor will be named according to the floors, eg SW1, SW2.
17. The firewall in the system will be used as a security service for connections outside the hotel.
18. Servers located in the system room will be named according to the service they provide.
19. The cameras will be located on each floor of the hotel for the purpose of monitoring all floors and for a continuous 24 hours in day.

3.6. Network Configuration

For the Cisco network devices, the most common Packet Tracer configuration provides setup options for graphical user interface (GUI). The configuration window for cisco devices, such as DHCP server, Access Point, Router and Switch consists of four tabs important as shown below:

1- Physical: Is used to add or remove suitable units in each device that can be used in the Packet Tracer.

2- Config: Is used to prepare to configure the following (global setting, routing, V-Lan and interface setting such as fast Ethernet).

3- Desktop: Is used to select a suitable device to perform appropriate operation such as (web browser, command prompt, and terminal).

4- Command Line Interface(CLI): Command line interface on the physical device. The user can access the whole mode of the device either by using a terminal program when the computer is connected to the any device in the network. For example, router or switch using the console cable or telnet when it is connected using a crossover Ethernet cable. The Packet Tracer provide a feature to save the device that users can configure as a dedicated device with a specific set of modules.

3.6.1. Determination of IP Blocks

After the network map is created and the rules are specified, the configuration starts. It is determined from which IP block that the DHCP server will distribute the IP. For DHCP server IP adjustment explained this point in chapter four (section 4.19 step 18).

3.6.2. Implementation of Network Rules

3.6.2.1.First Rule

The names of the devices will be given as indicated in the map.

3.6.2.2. Second Rule

The settings will be made for the IP addresses of the computers and lap-tops in the system to be retrieved from the DHCP server. No IPv6 identification will be done to the computer and the lap-tops.

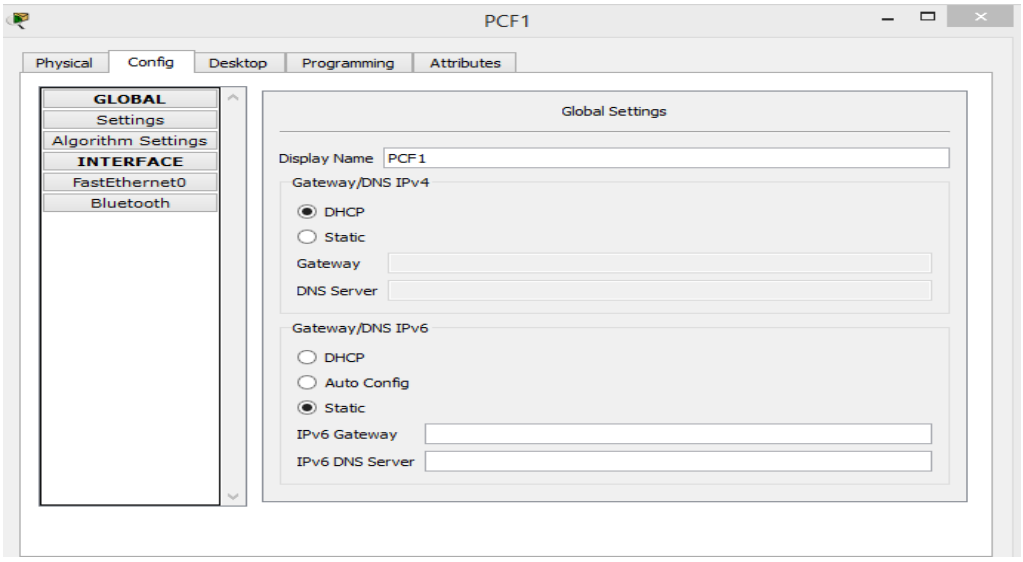

Figure 34.Second Rule(PCF-1)

3.6.2.3. Third Rule

The physical connection of the switch on that floor will be realized with the IP telephones located on each floor.

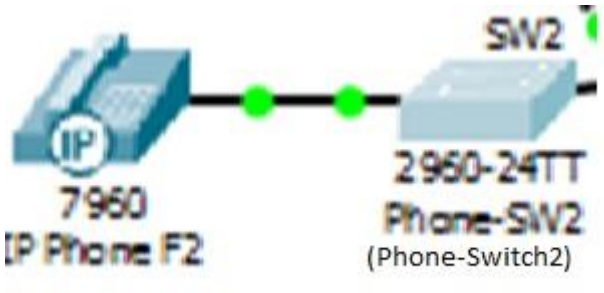

Figure 35.Third Rule (IP Telephones)

3.6.2.4. Forth Rule

Switches on each floor will also have a V-Lan structure for IP telephones and will be allowed to communicate IP telephones.

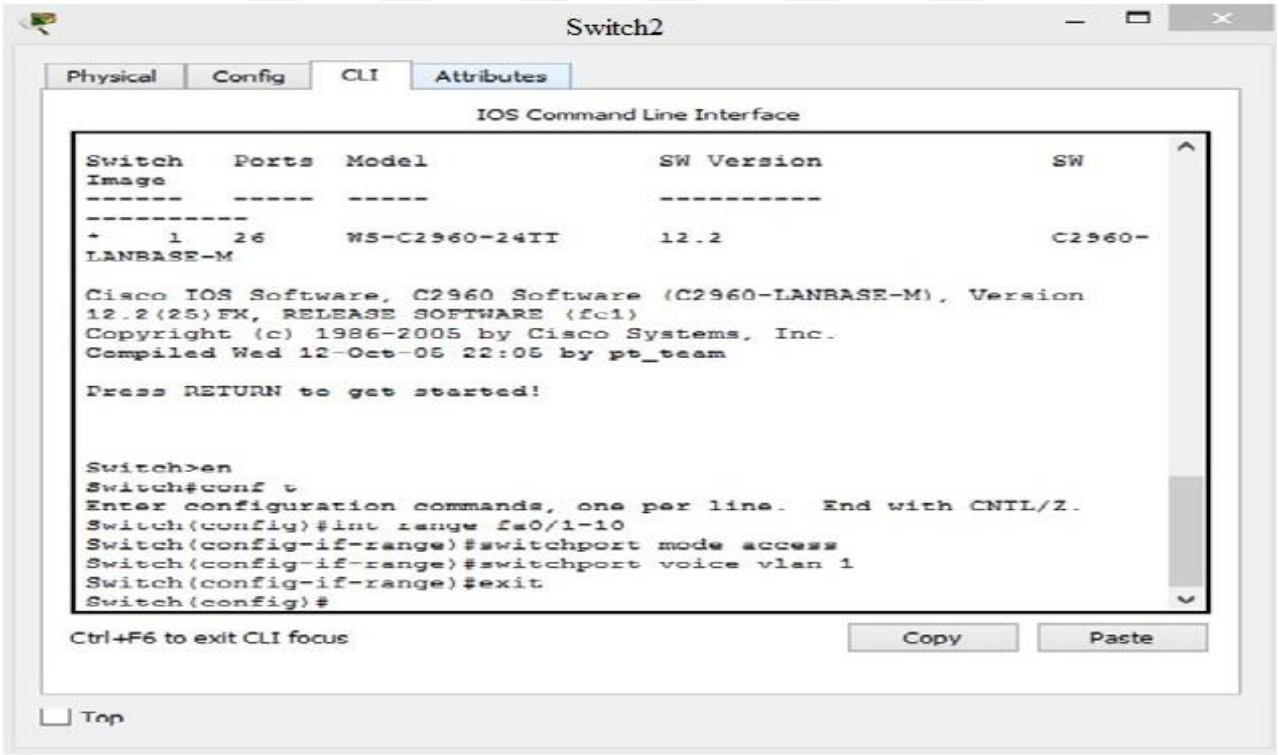

Figure 36.Forth Rule (Switch)

3.6.2.5.Fifth Rule

Router will assign numbers to IP phones. Here are the codes to use when doing these operations.

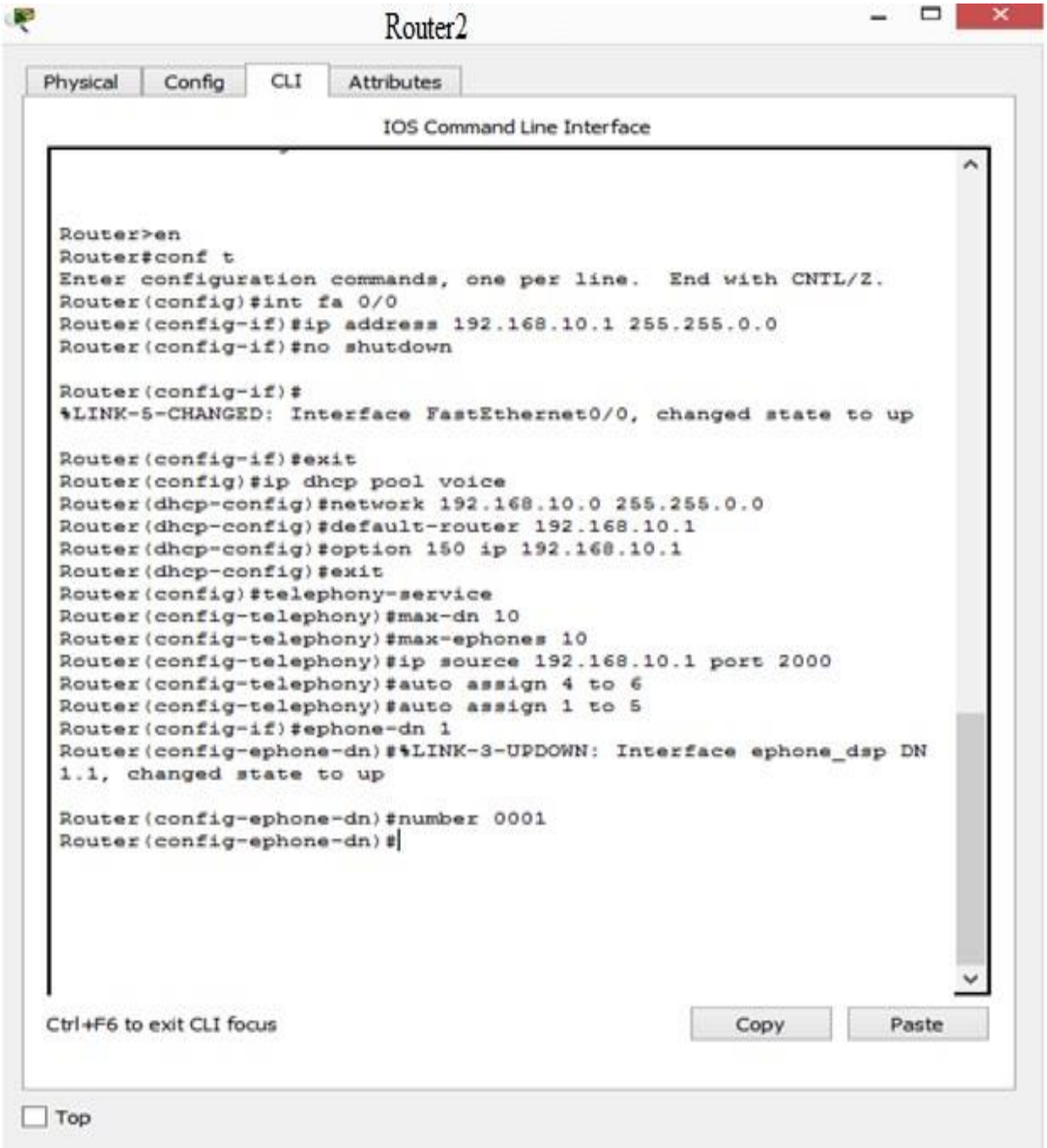

Figure 37.Fifth Rule (Router)

3.6.2.6.Sixth Rule

The Linksys-WPC300N module will be installed to operate all of the laptops with wireless.

The Linksys-WPC300N

The Linksys-WPC300N module provides one 2.4GHz wireless interface suitable for connection to wireless networks. The module supports protocols that use Ethernet for LAN access.

3.6.2.7.Seventh Rule

The printer located on the first floor of the hotel will be physically connected to the switch and set up to receive the IP address from the DHCP server.

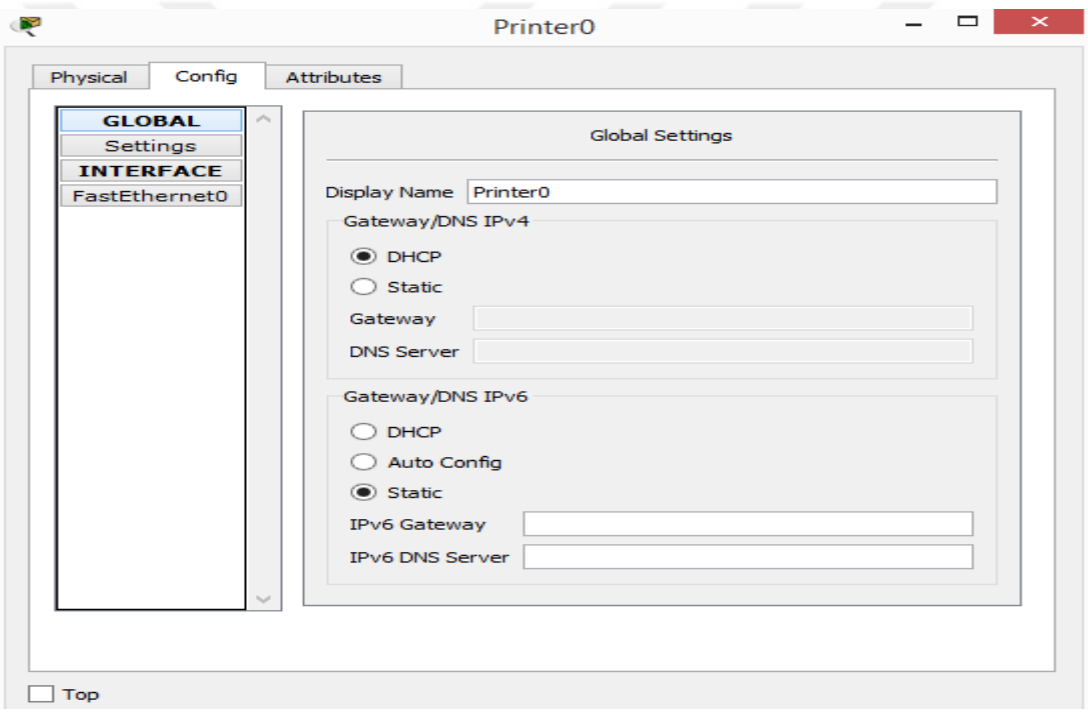

Figure 38.Seventh Rule (Printer)

3.6.2.8.Eighth Rule

Access points on the floors will determine the type of encryption by using the WPA2-PSK encryption type. The passwords will be private to each floor.

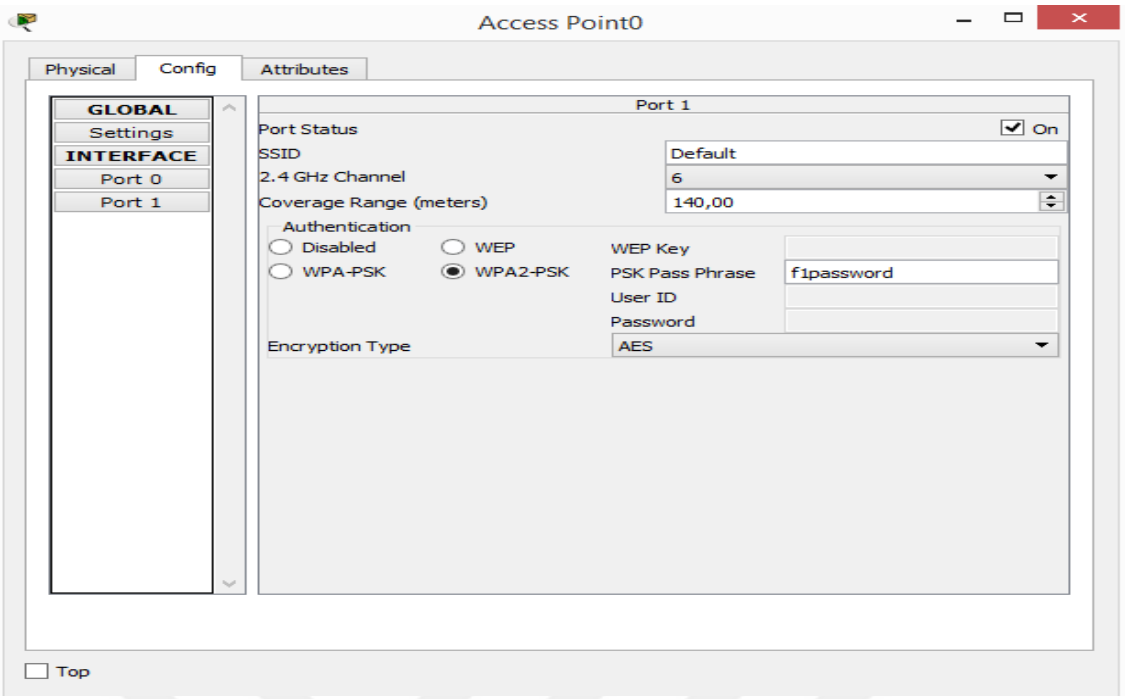

Figure 39.Eighth Rule (Access Point)

3.6.2.9.Nineth Rule

To connect the Lape-tops to the Access Point, the encrypt of the Access Point's on that floor will be entered to LapTop with the Access Point on that floor.

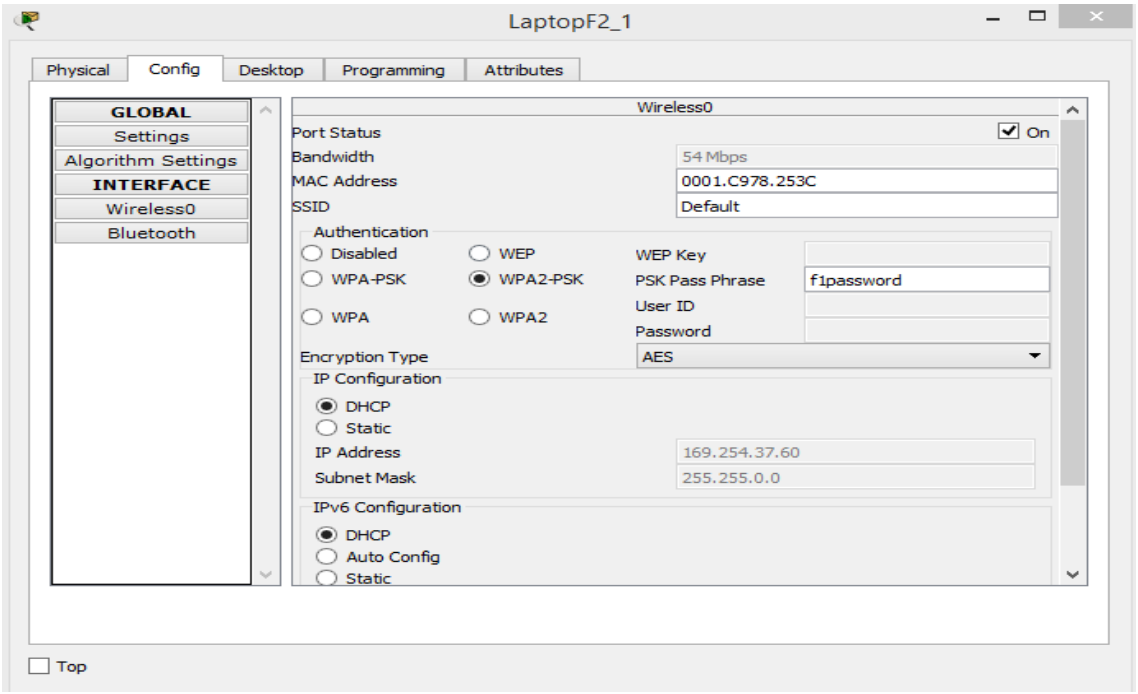

Figure 40.Nineth Rule (Laptop)

3.6.2.10.Tenth Rule

The computers in the system will be physically connected to the switch on that floor.

3.6.2.11.Eleventh Rule

The tablet, located on the fourth floor, will also be wirelessly configured to connect to the Access Pointe on that floor.

3.6.2.12.Twelfth Rule

The smartphone on the fourth floor will also be configured to wirelessly connect to Access Pointe on that floor.

3.6.2.13.Thirteen Rule

All the switches in the floors will be connected to the main switches.

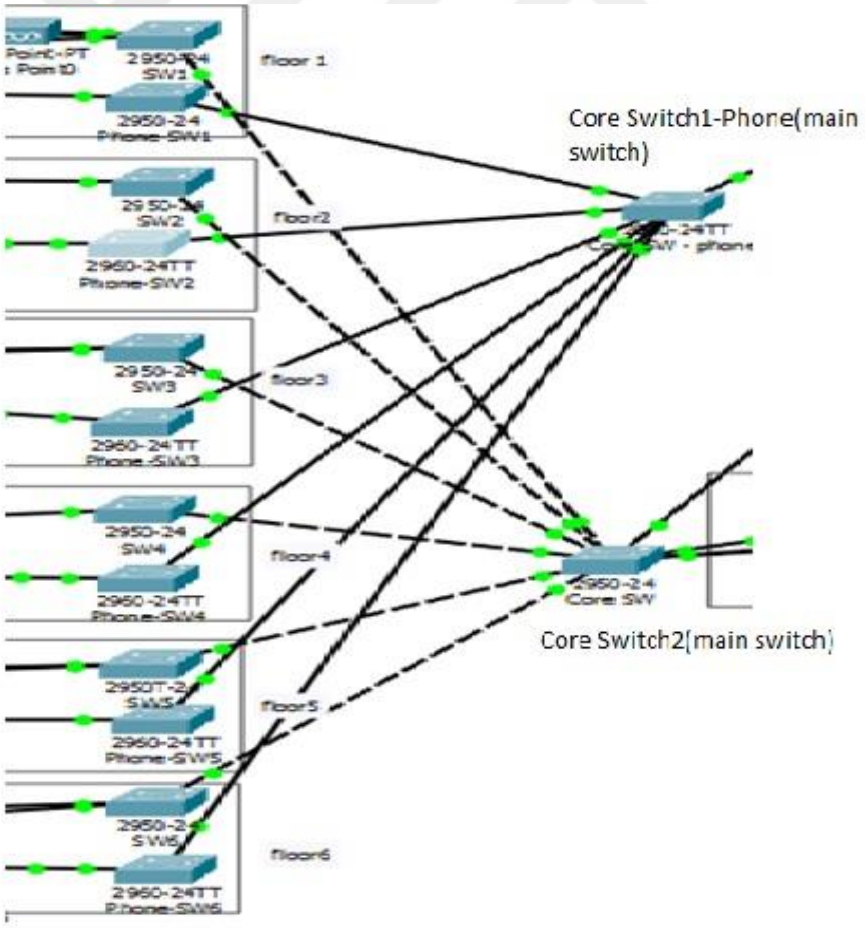

Figure 41.Thirteen Rule (Connecting Switch)

3.6.2.14.Fourteenth Rule

The main switch created for the normal network will be physically connected to the Firewall.

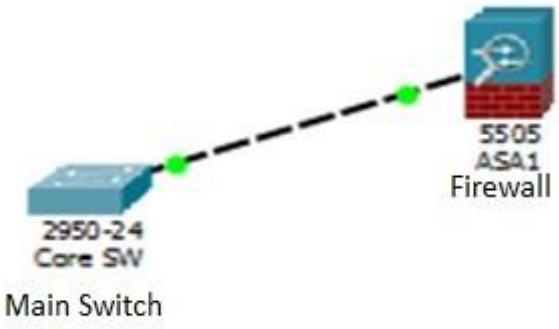

Figure 42.Fourteenth Rule

3.6.2.15.Fifteenth Rule

The physical connection between Firewall and Router will be realized.

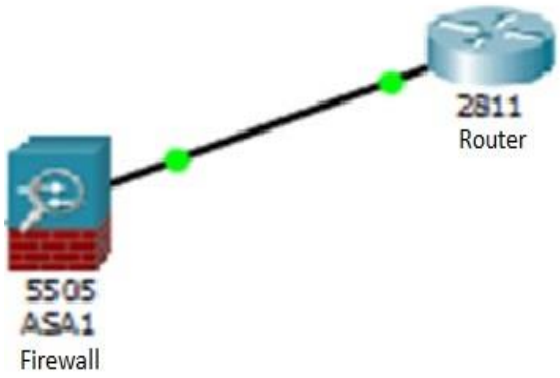

Figure 43.Fifteenth Rule (Physical Connection Firewall and Router)

3.6.2.16.Sixteenth Rule

The settings for internal network and external network security via firewall are as follows.

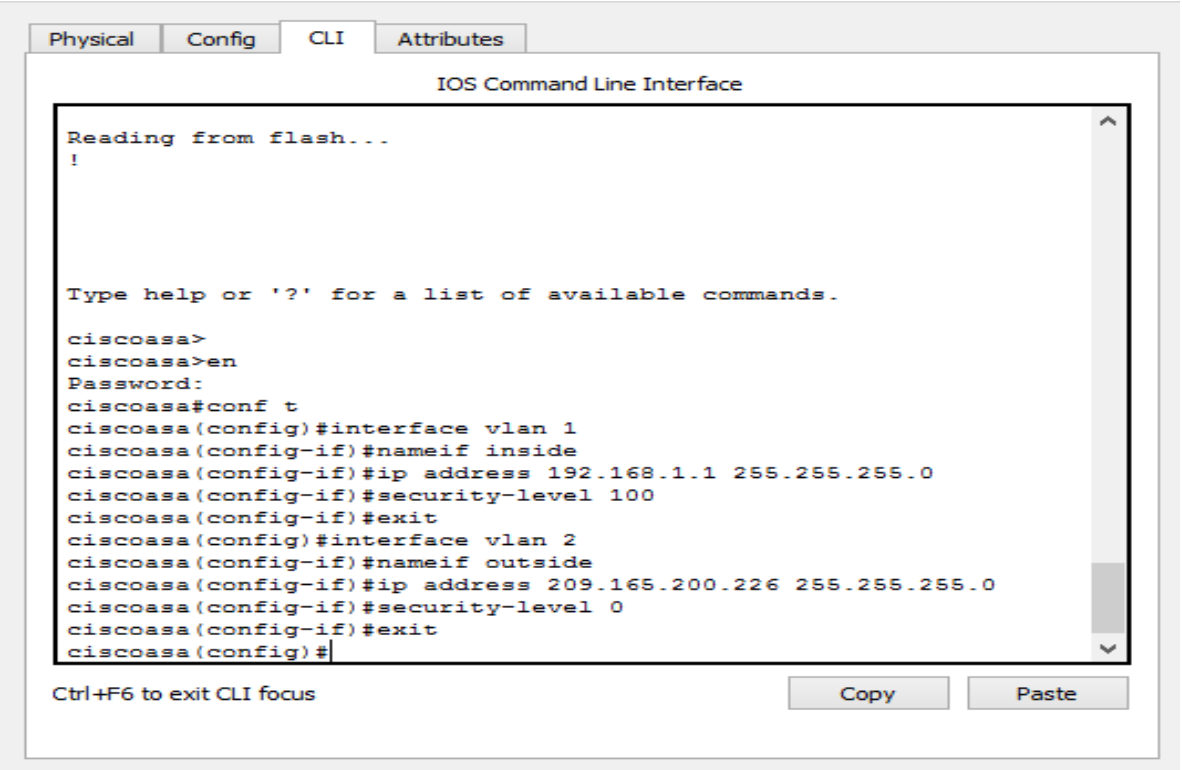

Figure 44.Sixteenth Rule (CLI)

3.6.2.17.Seventeenth Rule

Http Server will be activated and necessary corrections on index.html file will be made. The file structure of http Server will be as follows; index.html, contact.html, and aboutus.html. After making the necessary adjustments, the server will connect to the main switch.

3.6.2.18.Eighteenth Rule

DHCP Server will be activated and necessary settings will be made in Default Gateway, Start IP Address, Subnet Mask fields.

3.6.2.19.Nineteenth Rule

DNS Server will be activated. The domain name will be hotel.com.

3.7. Network Flowchart

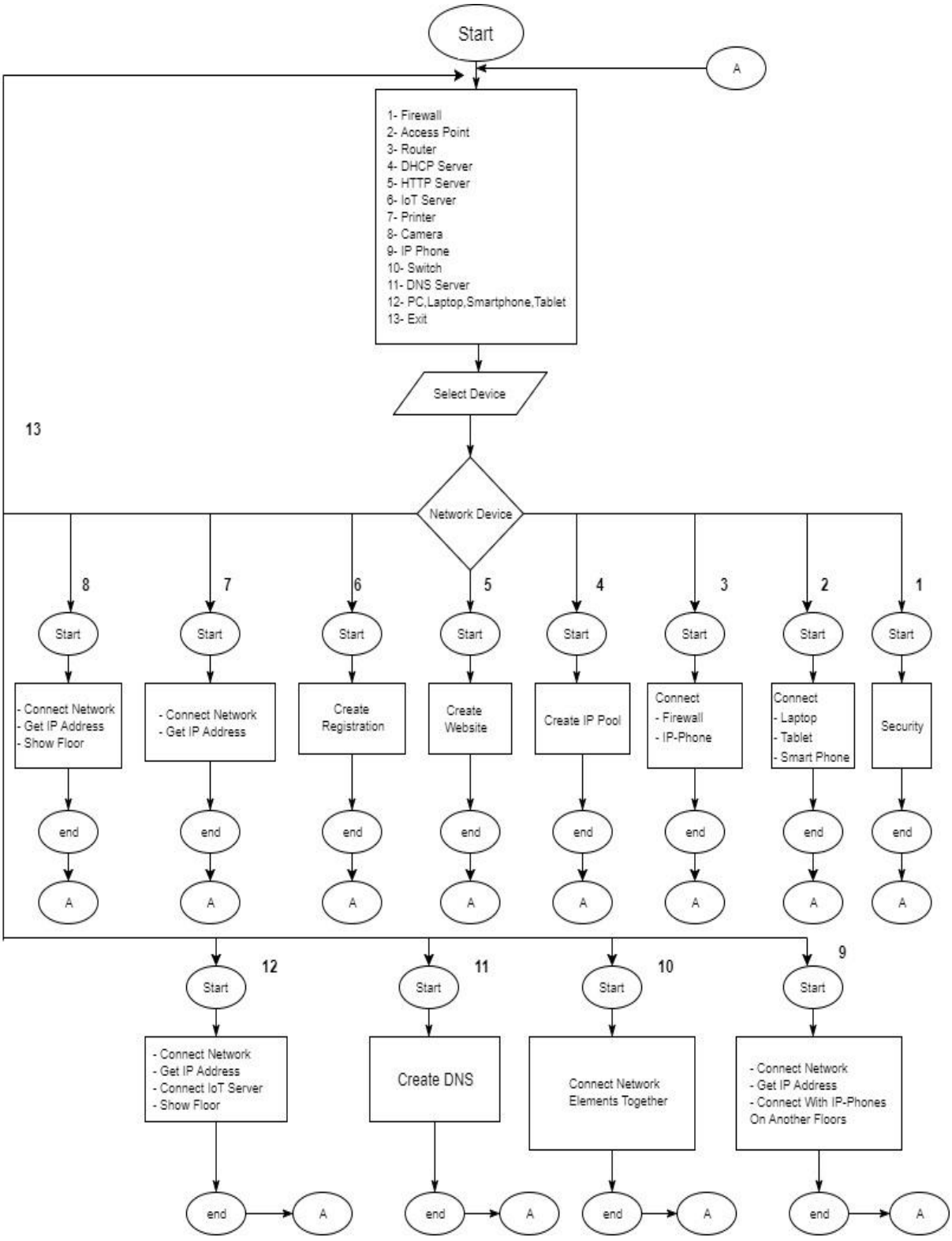

Figure 45.Network Flowchart

CHAPTER FOUR

SIMULATION

4.1.Introduction

In this chapter, the simulation is presented. The simulation is divided in many steps according to the network map as the following below.

4.2.Step 1

All of the devices were arranged according to the network map and the names of the devices were given.

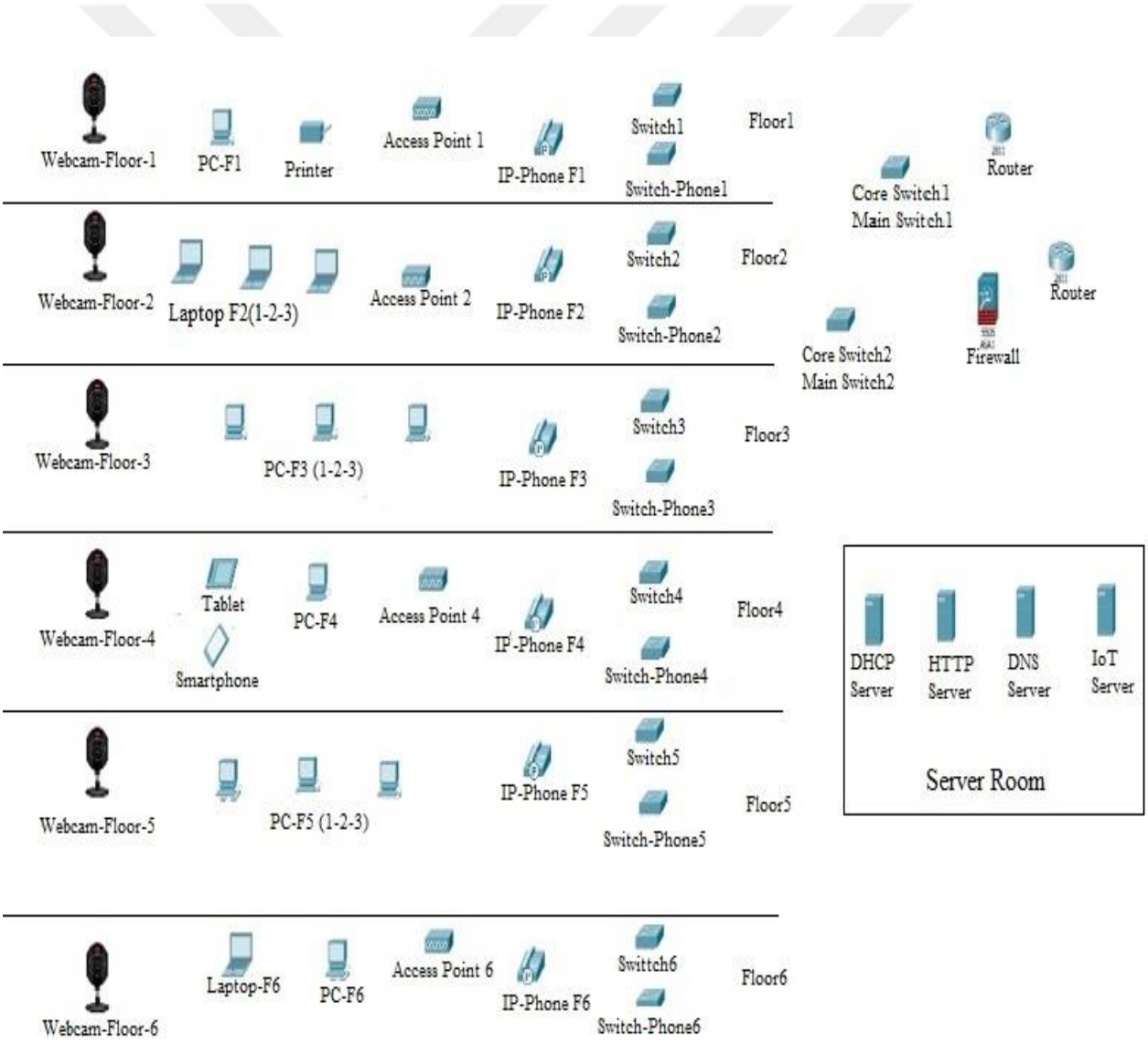

Figure 46.Network Map

4.3.Step 2

DHCP settings are enabled for computers, laptops, smart phones and tablets to take IP automatically.

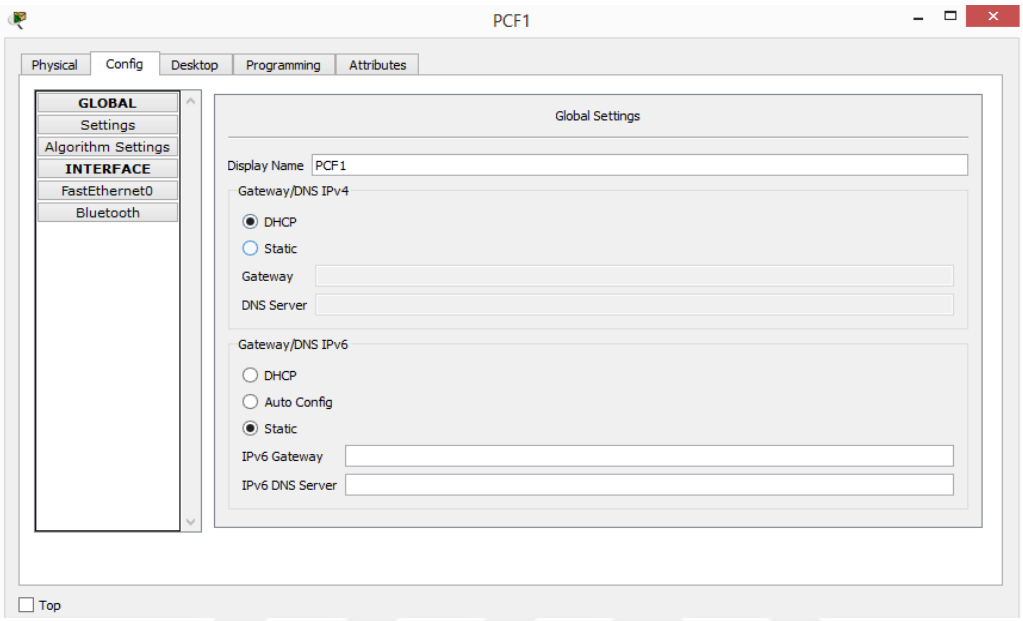

Figure 47.Activating PC DHCP

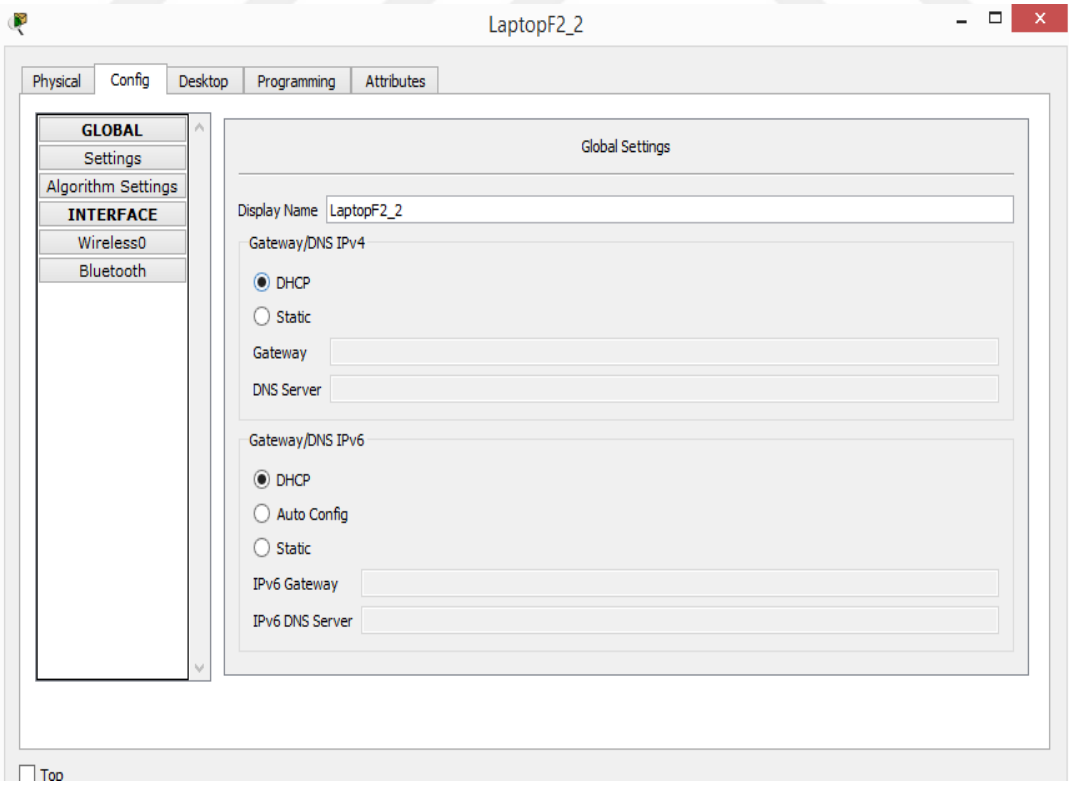

Figure 48.Activating Laptop DHCP

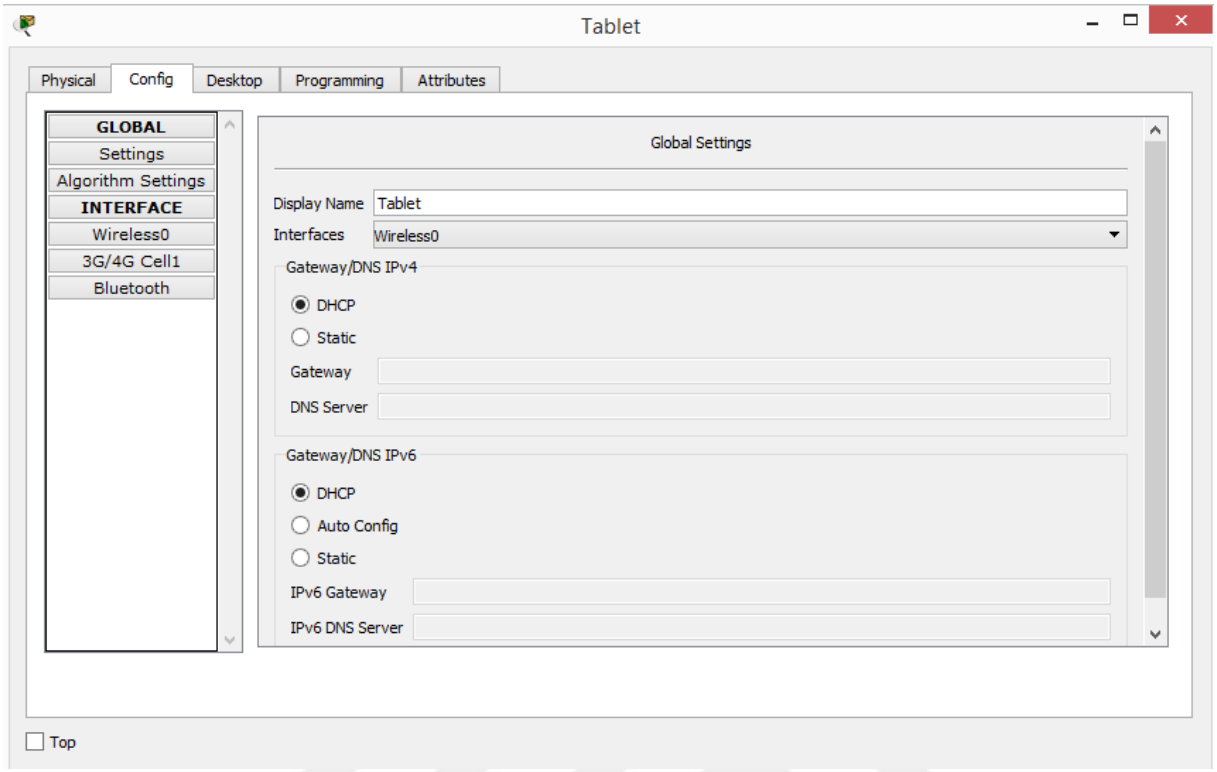

Figure 49.Activating Tablet DHCP

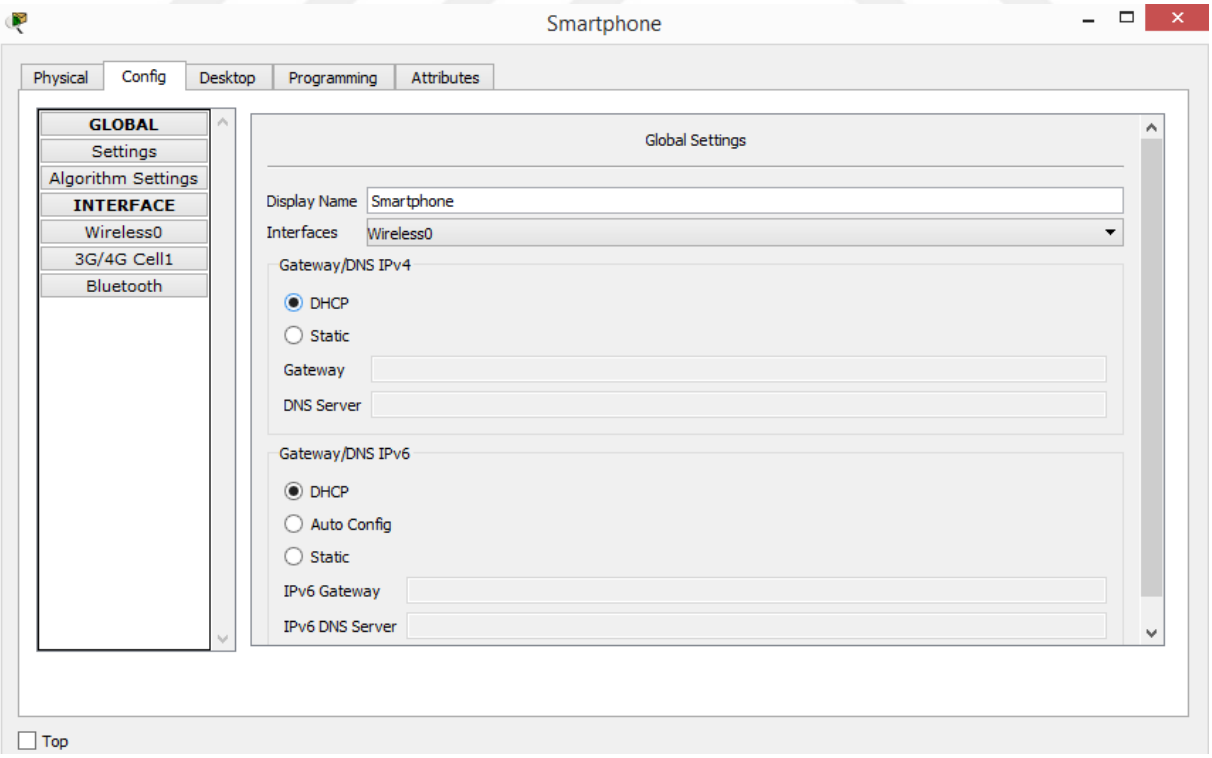

Figure 50.Activating Smaetphone DHCP

4.4.Step 3

The physical connection between the IP telephones located on each floor and the switch located on that floor was realized the connection between the IP phones and the switch was made using the Copper Straight-Through cable type, and the switch port of the IP phone was connected to the Fast Ethernet port of the switch.

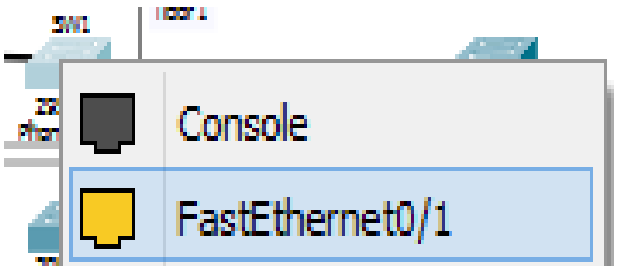

Figure 51.IP Phone Connections & Connection Ip Phone With Switch

4.5.Step 4

The necessary codes were written on the switch to communicate with each other. The codes written are as follows.

En

Conf t

İnt range fa0/1-10

Switch port mode Access

Switch port voice vlan 1

Exit

This code will connect all phones on the six floors for the purpose of securing communication between them and we will observe the results in chapter 5.

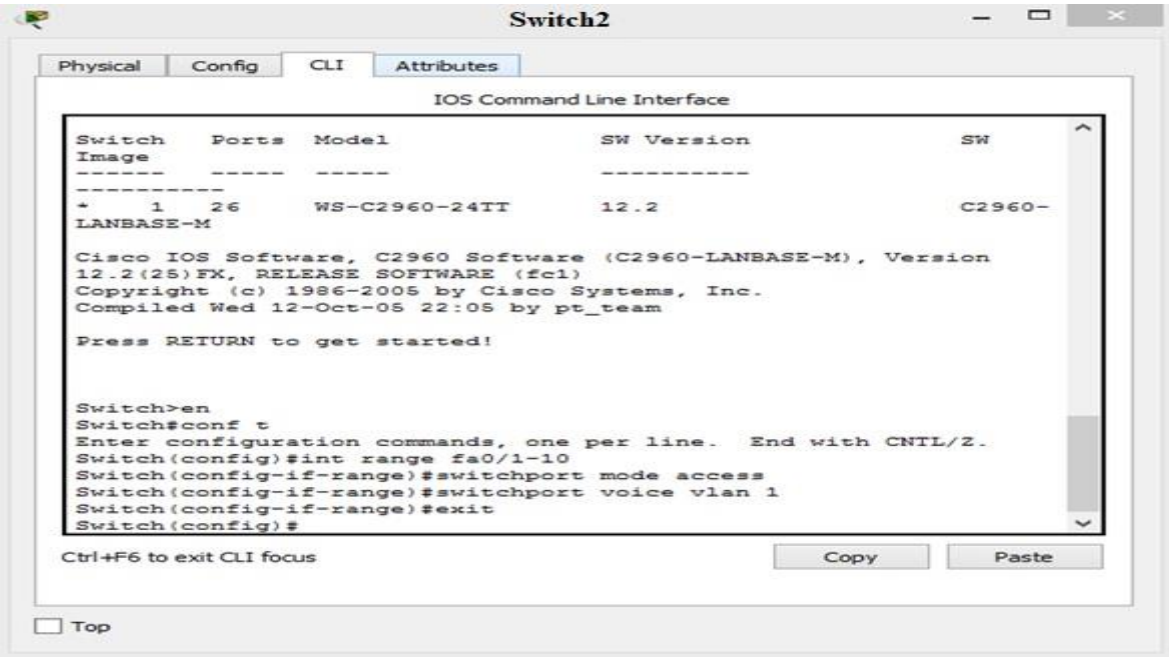

Figure 52.Switch Setting For Ip Phone

4.6.Step 5

IP phone numbers and IP settings were made over the router. Telephone numbers on the first floor was given the number 001, telephone on the second floor the number 0002, telephone on the third floor the number 0003, telephone on the fourth floor the number 0004, telephone on the fifth floor, telephone number 0005, and telephone the sixth floor was given number 0006.

Conf t

Int fa 0/0

Ip address 192.160.10.1 255.255.0.0

No shutdown

Exit

Ip dhcp pool voice

Network 192.168.10.0 255.255.0.0

Default-router 192.168.10.1

Option 150 ip 192.168.10.1

Exit

Telephony-service

Max-dn 10

Max-ephones 10

İp source 192.168.10.1 port 2000

Auto assign 4 to 6

Auto assign 1 to 5

Ephone-dn 1

Number 0001

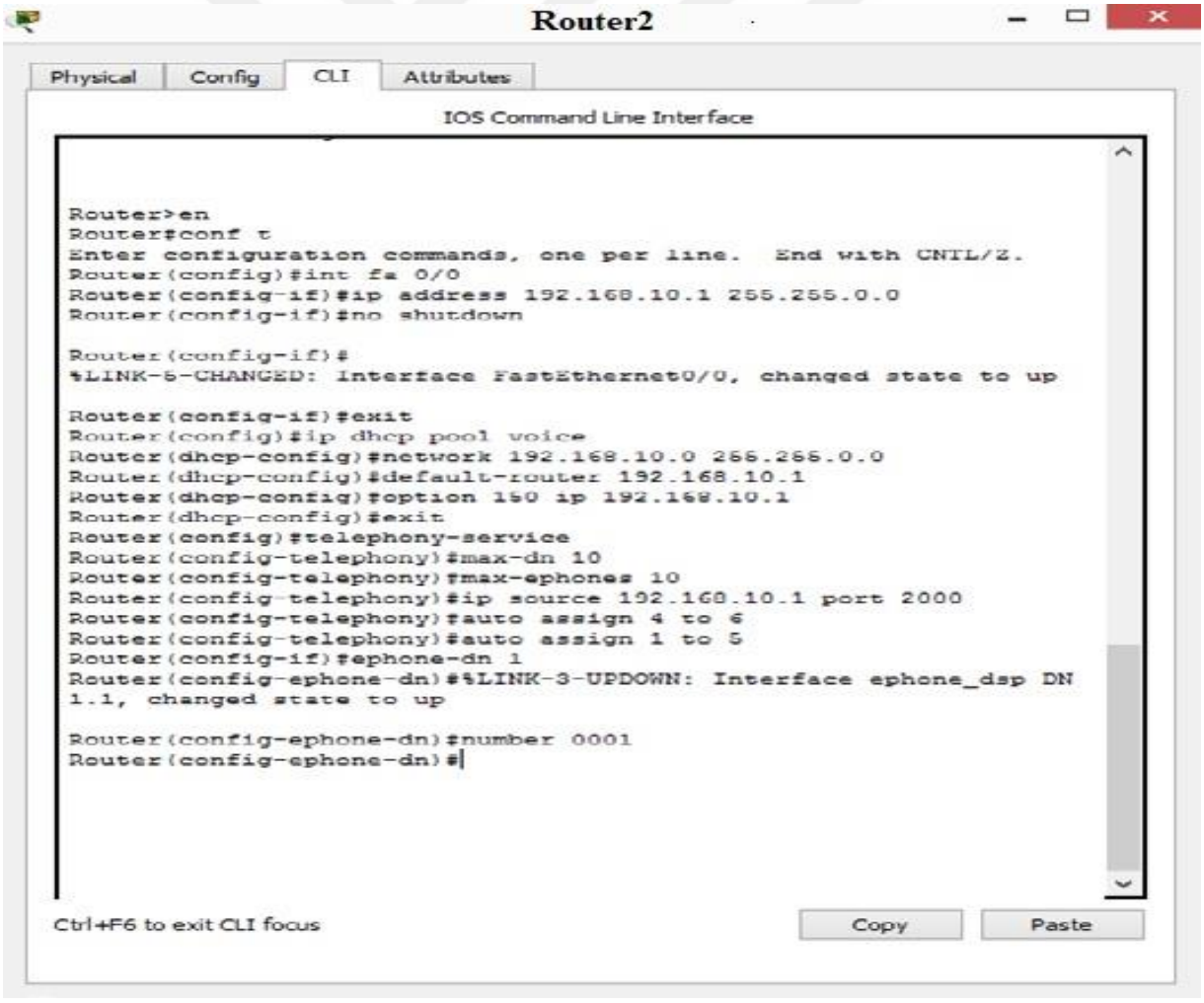

Figure 53.Router Setting IP phone

4.7.Step 6

The Linksys-WPC300N module was fitted to all Laptops to operate with wireless.

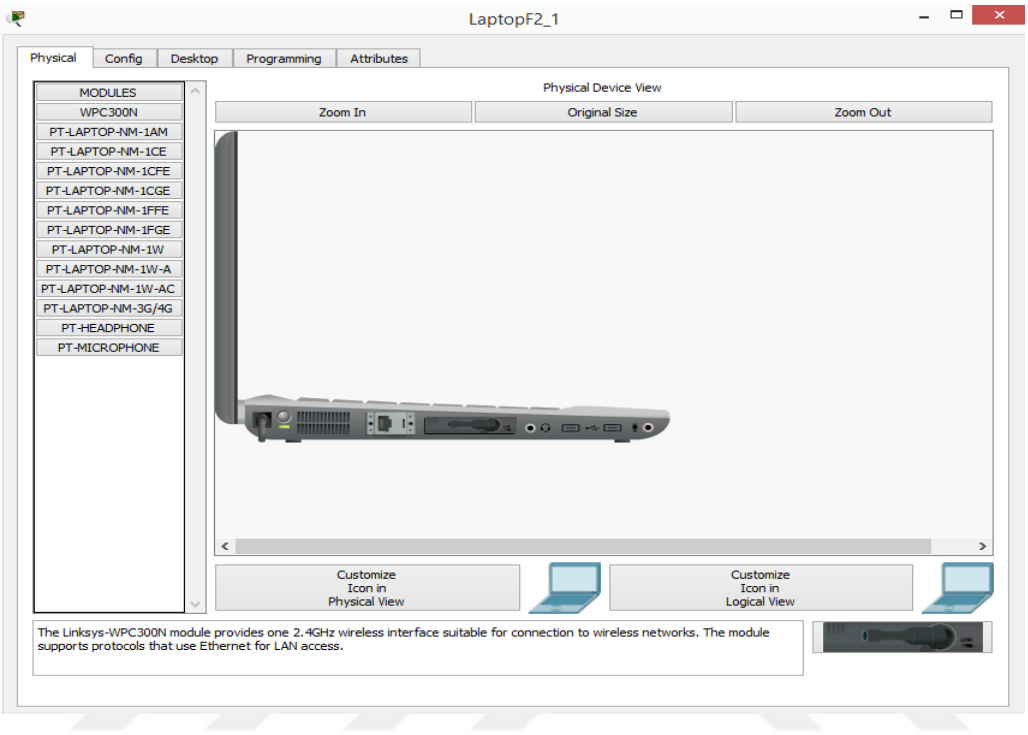

Figure 54.Laptop Wireless Module Plug-in

4.8.Step 7

The printer located on the first floor of the hotel was physically connected to the Copper Straight-Through cable and the switch was set up to receive the IP address from the DHCP server.

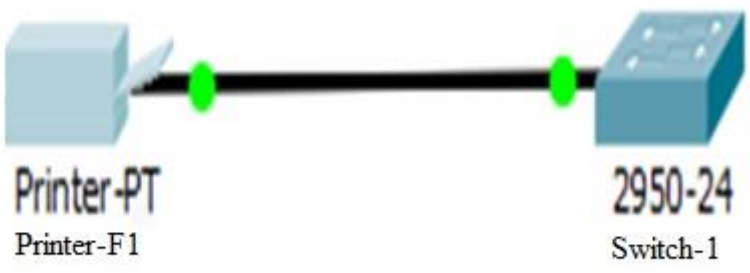

Figure 55.Physical Connection of Printer to Switch

4.9.Step 8

The access points WPA2-PSK encryption types found in the floors are used to identify each password individually.

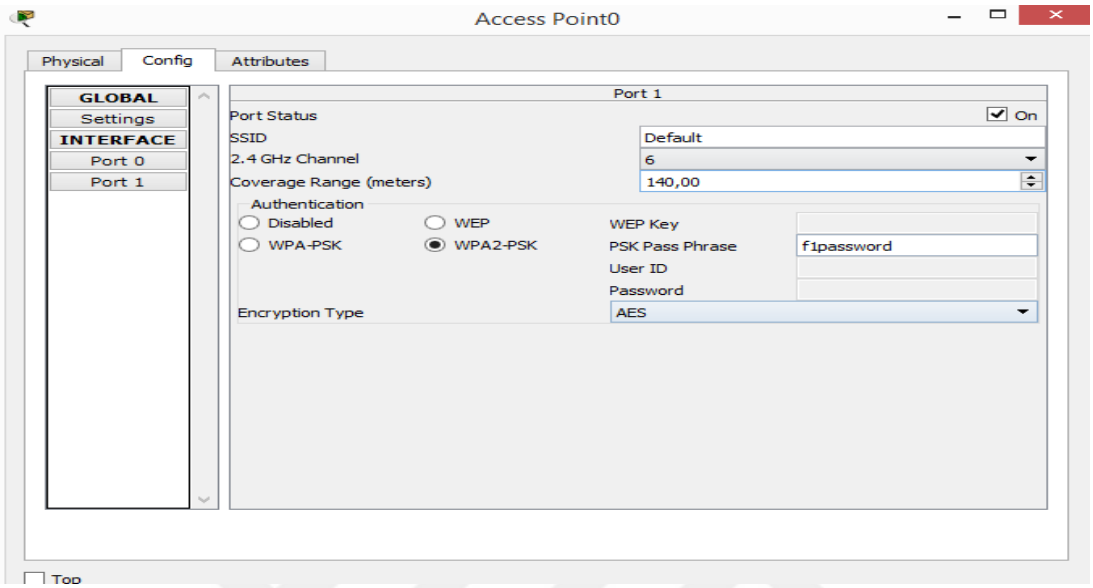

Figure 56.First Floor Access Point WPA2-PSK Password Adjustment

4.10.Step 9

For the connection of laptops to Access point, the password of access point on that floor is entered to the laptops.

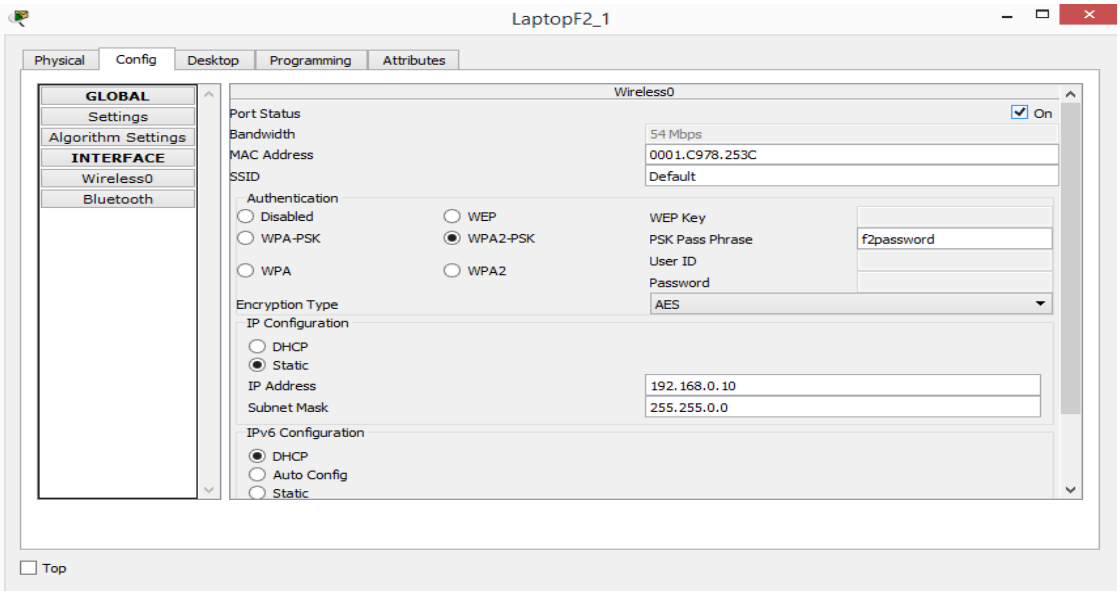

Figure 57.Entering Laptop Wireless Password

4.11.Step 10

The computers in the system are physically connected to the switch on that floor via Copper Straight-Through cable.

Figure 58.Physical Connection of Switch with PC

4.12. Step 11

Wireless adjustments were done for the connection of tablet on the fourth floor to the Access point on that floor.

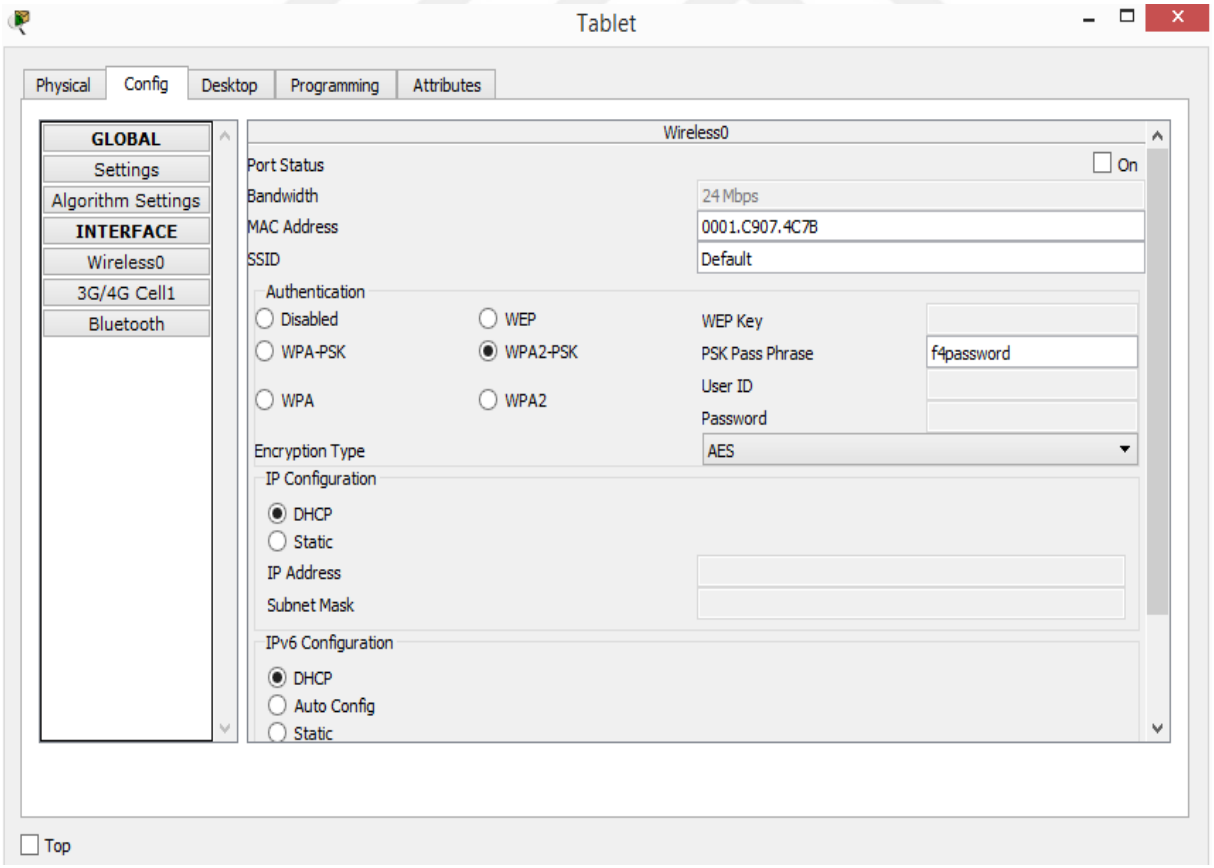

Figure 59.Entering Tablet Wireless Password

4.13.Step 12

Wireless adjustments were done for the connection of smartphone on the fourth floor to the Access point on that floor

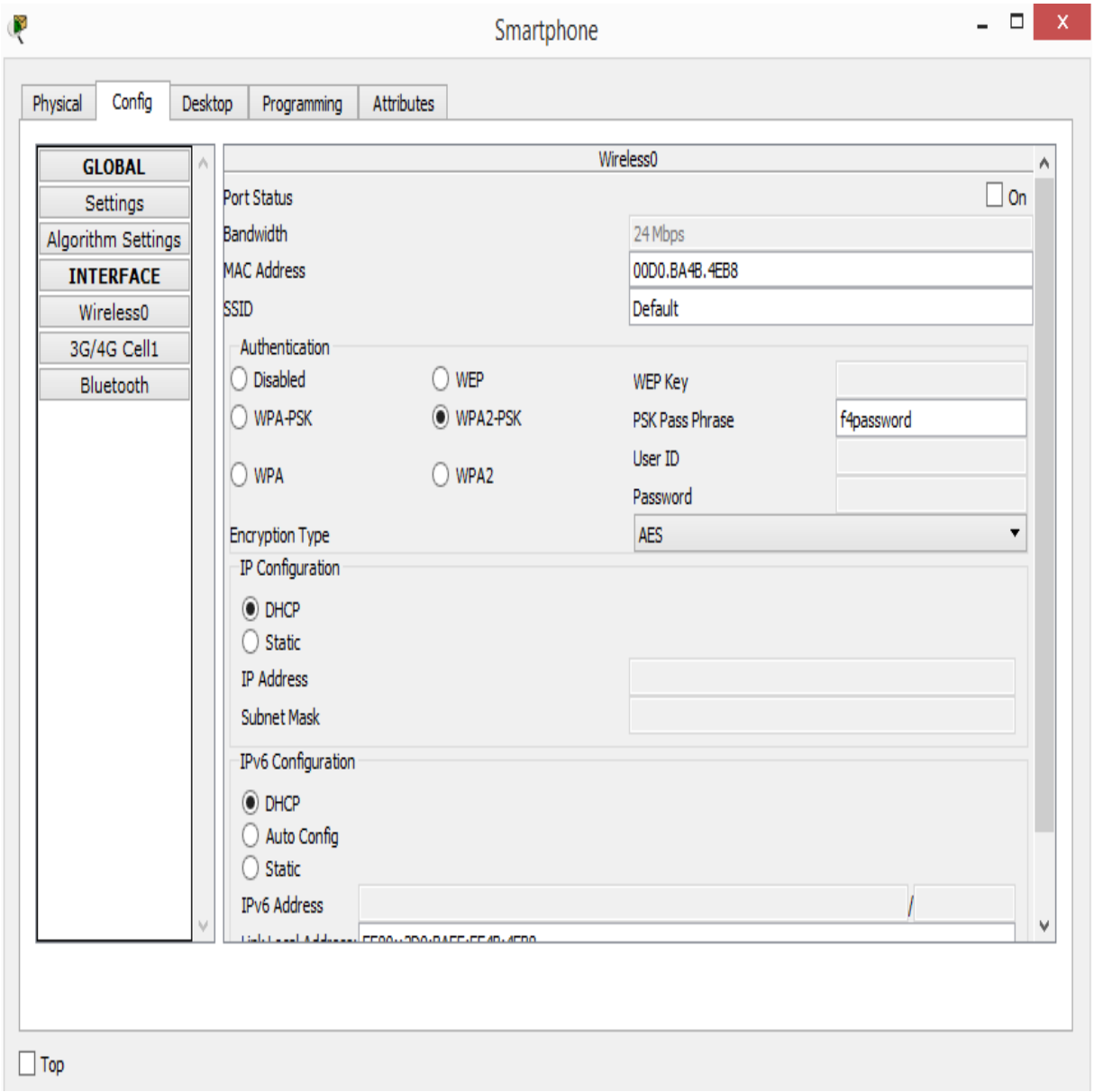

Figure 60. Entering Smart Phone Wireless Password

4.14.Step13

All the switches in the floors were physically connected to the main switches. The connection was made using copper cable-over cable type.

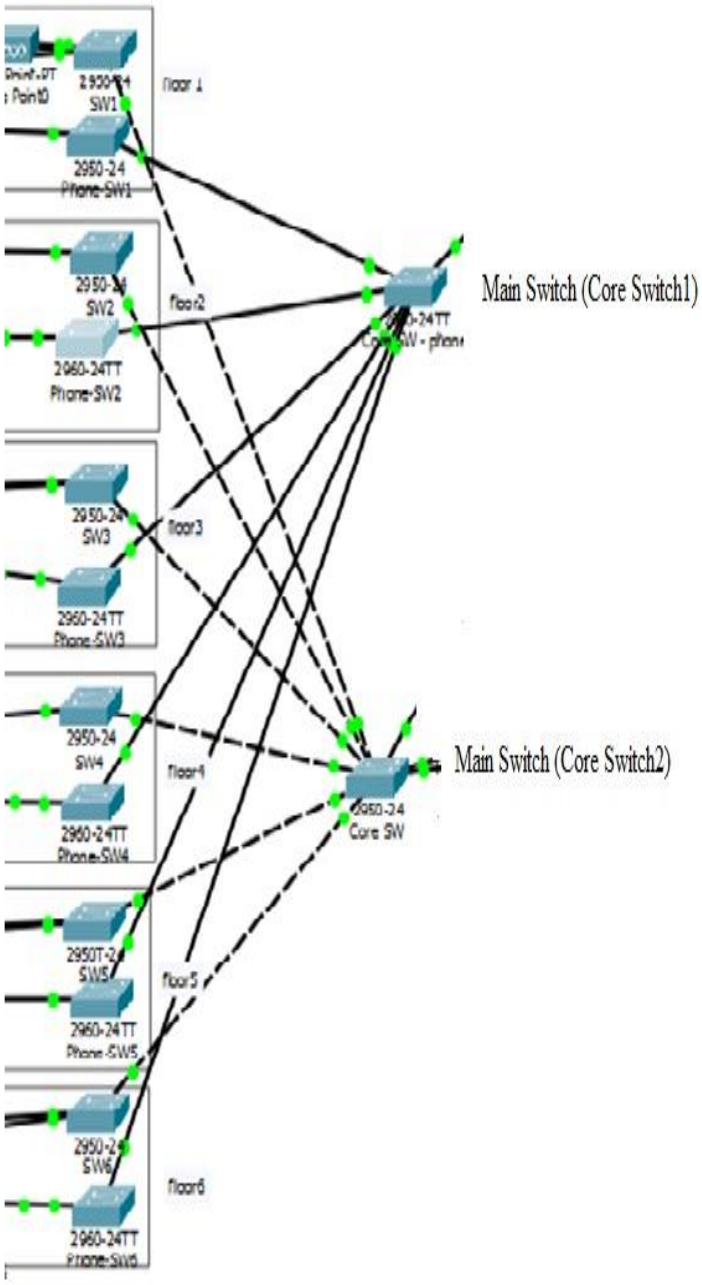

Figure 61.Physical Connectivity of Switches with Master Switches

4.15. Step 14

The main switch created for the normal network is physically connected to the Firewall. The connection was made using copper cable-over cable type.

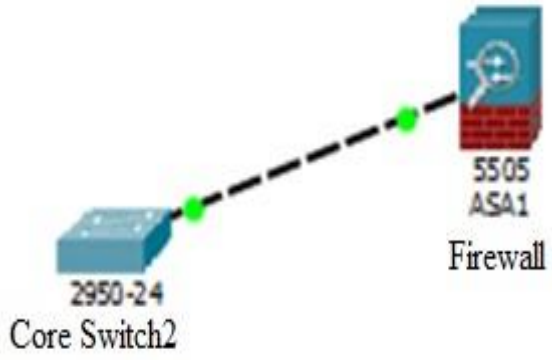

Figure 62.Firewall Physical Connection with Core Switch2

4.16.Step15

The physical connection of the Firewall to the Router was performed. The Copper Straight-Through cable type was used when the connection was made.

Figure 63.Router4 Physical Connection with Firewall

4.17.Step 16

The required settings for internal network and external network security were made through the firewall. When these settings are made, the IP address 192.168.1.1 is set for the internal network while the IP address 209.165.200.226 is set for the external network. Vlan1 was used for internal network and vlan2 for external network. The security level for the internal network was set at 100, while for the external network it was set at 0. These are the codes written over the firewall while making the adjustments;

En

Conf t

İnterface vlan 1

Name if inside

İp address 192.168.1.1 255.255.255.0

Security-level 100

Exit

İnterface vlan 2

Name if outside

İp address 209.165.200.226 255.255.255.0

Security-level 0

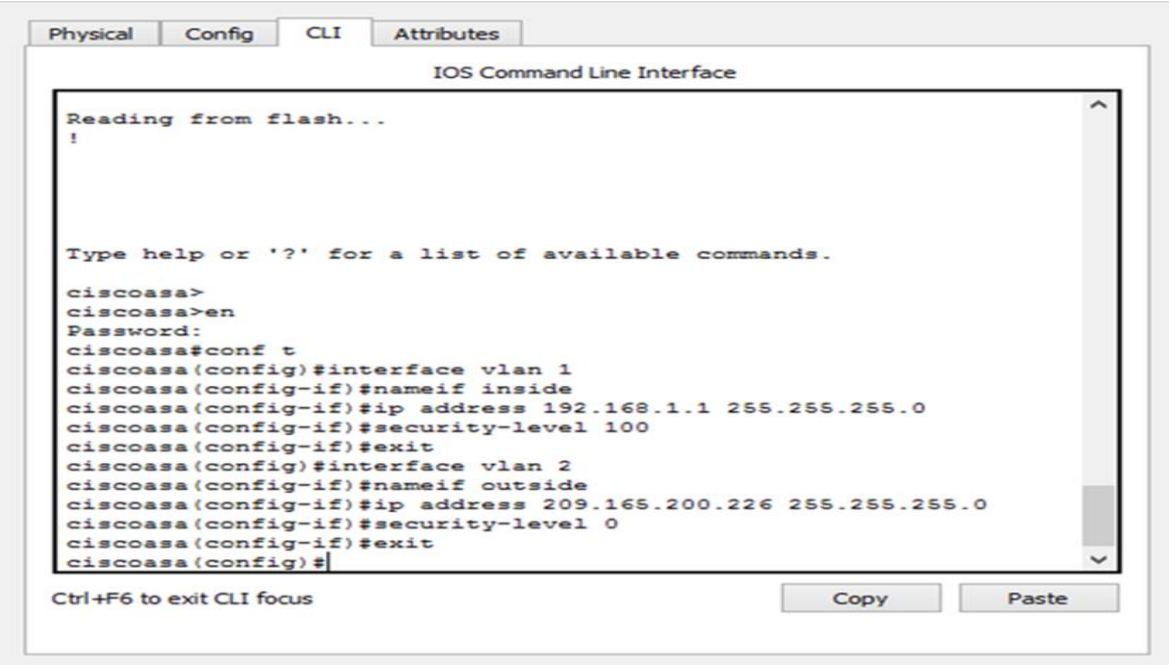

Figure 64.Firewall Adjustments

4.18.Step 17

Http Server has been activated and necessary corrections has been made on index.html file. File structure in Http Server; index.html, contact.html, and aboutus.html. The http server IP address is statically specified as 192.168.10.2. Finally, the http server was physically connected to the main switch that was created for the normal network. Copper Straight-Through cable type was used for physical connection.

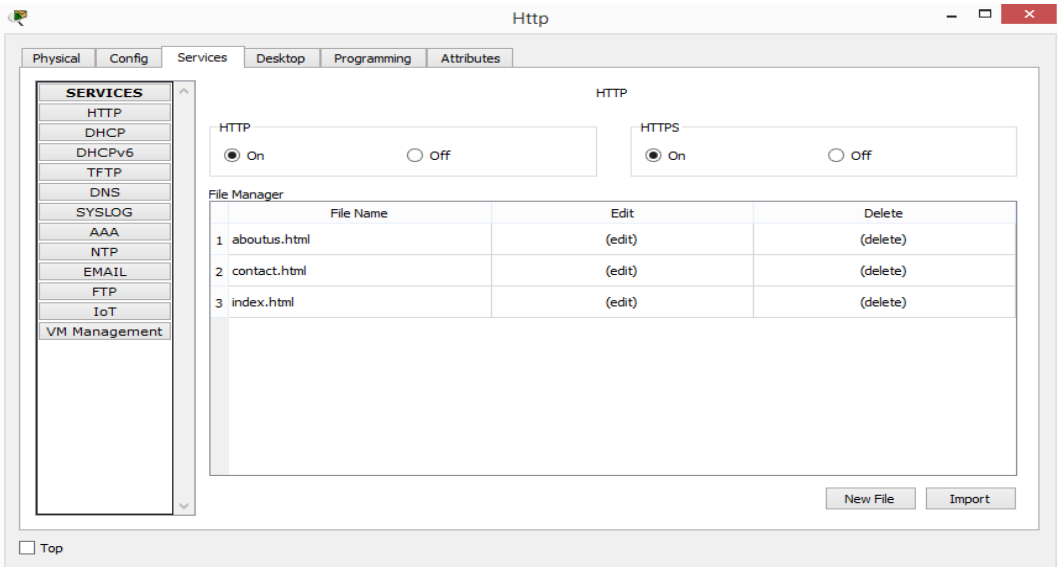

Figure 65.Http Server Activation

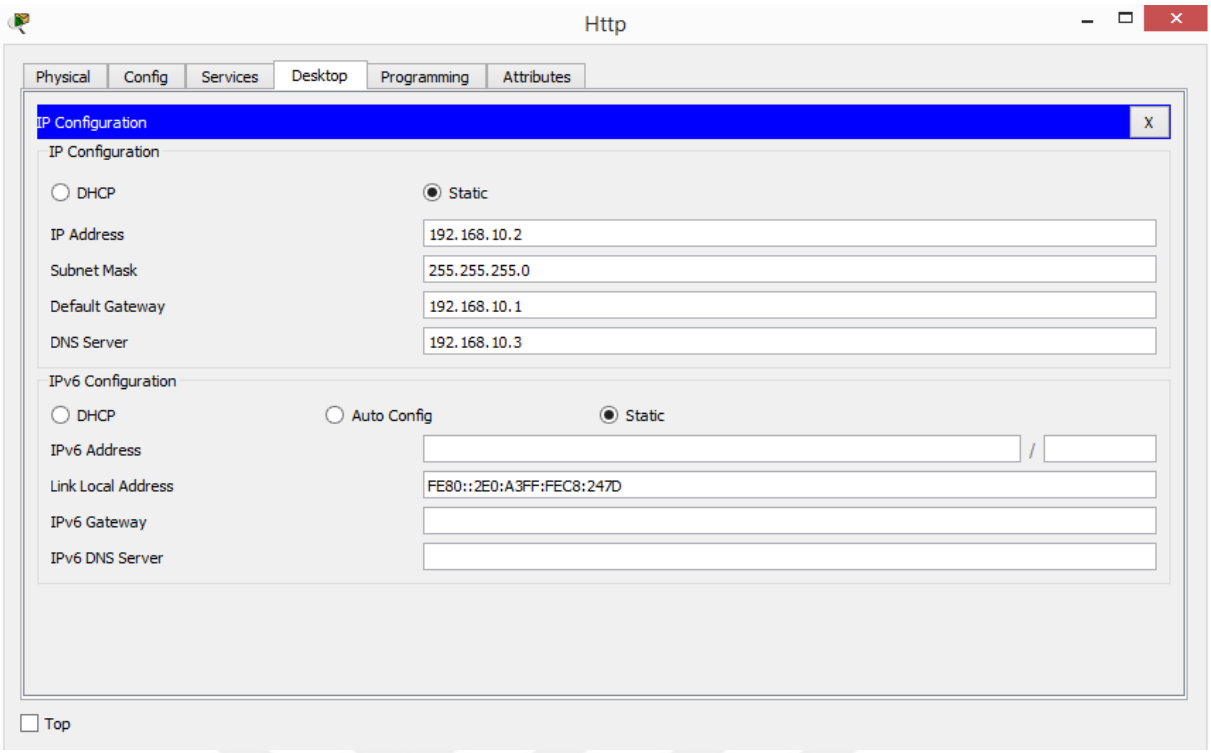

Figure 66.Http Server Ip to Adjustments

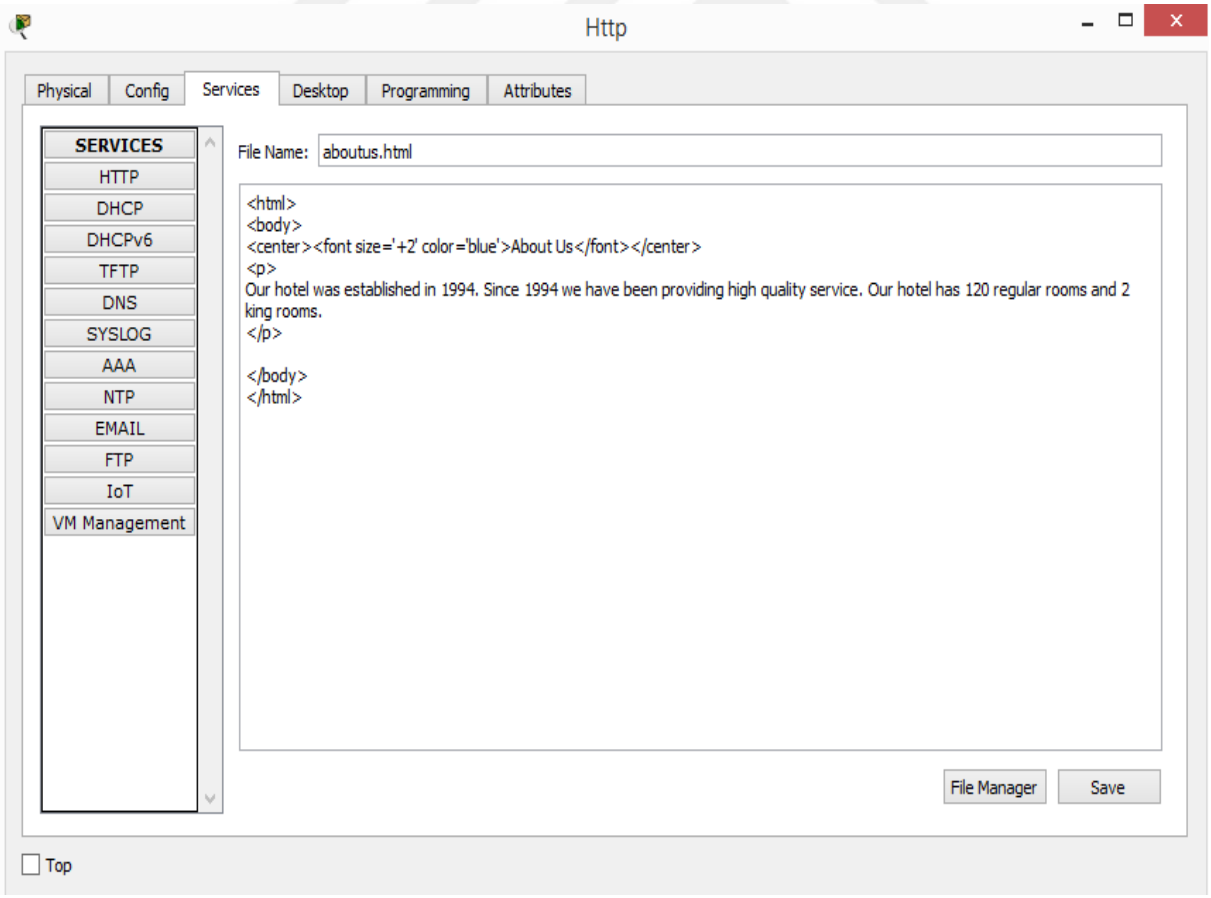

Figure 67.Http Server About Us Page Content

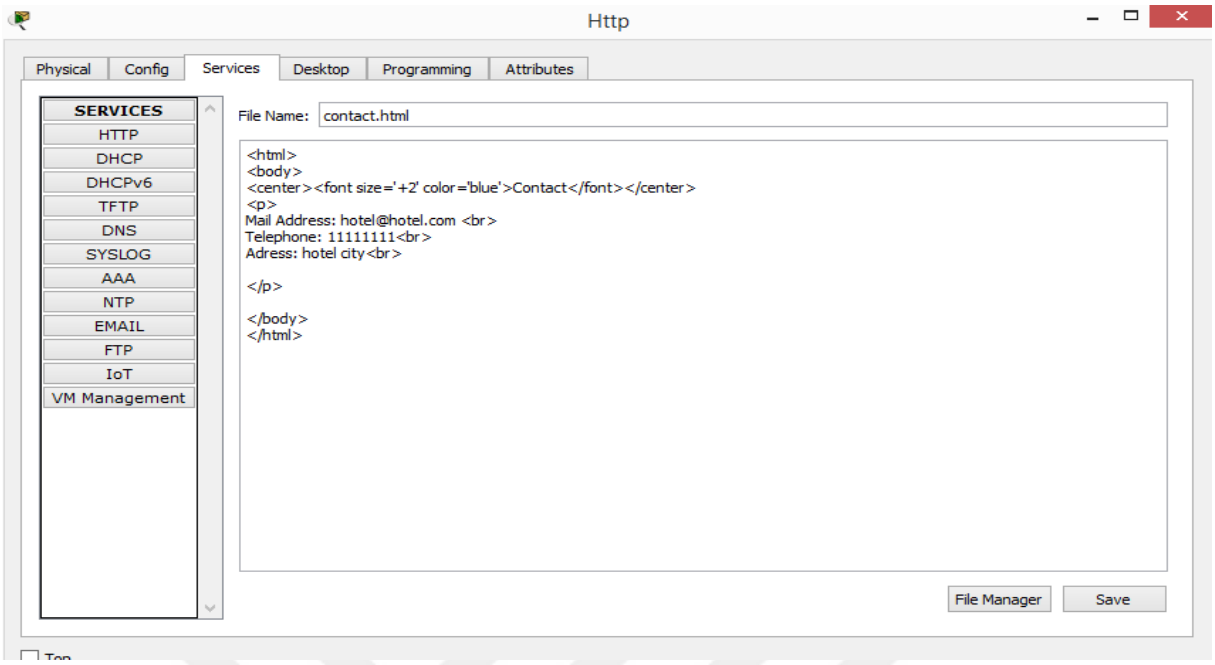

Figure 68.Http Server Contact Page Content

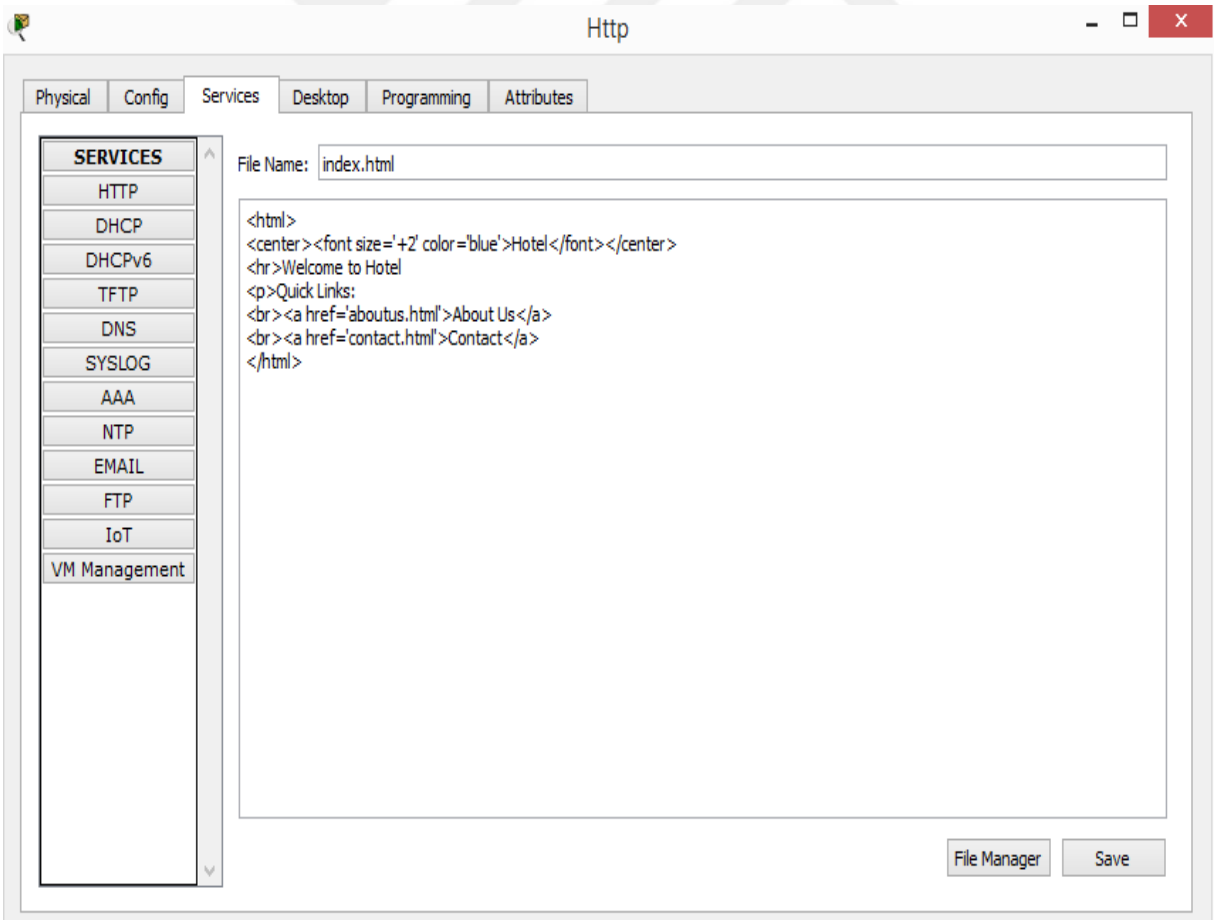

Figure 69.Http Server Index Page Content

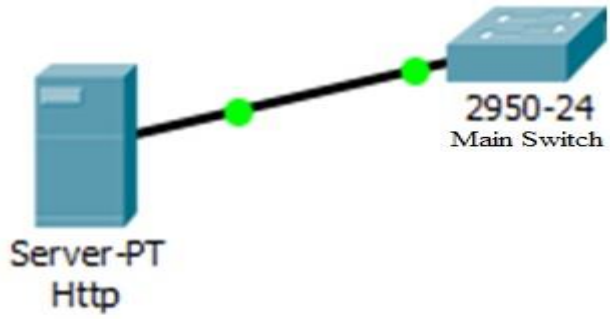

Figure 70.Main Switch Physical Connection with Http Server

4.19. Step 18

DHCP Server has been activated. Default Gateway is set to 192.168.10.1. Start Ip Address set to 192.168.10.5. The Subnet Mask is set to 255.255.255.0. DNS Server is set to 192.168.10.3. The DHCP IP number was statically entered as 192.168.10.1. Finally, the DHCP server was physically linked to the main switch created for the normal network. Copper Straight-Through cable type was used for physical connection.

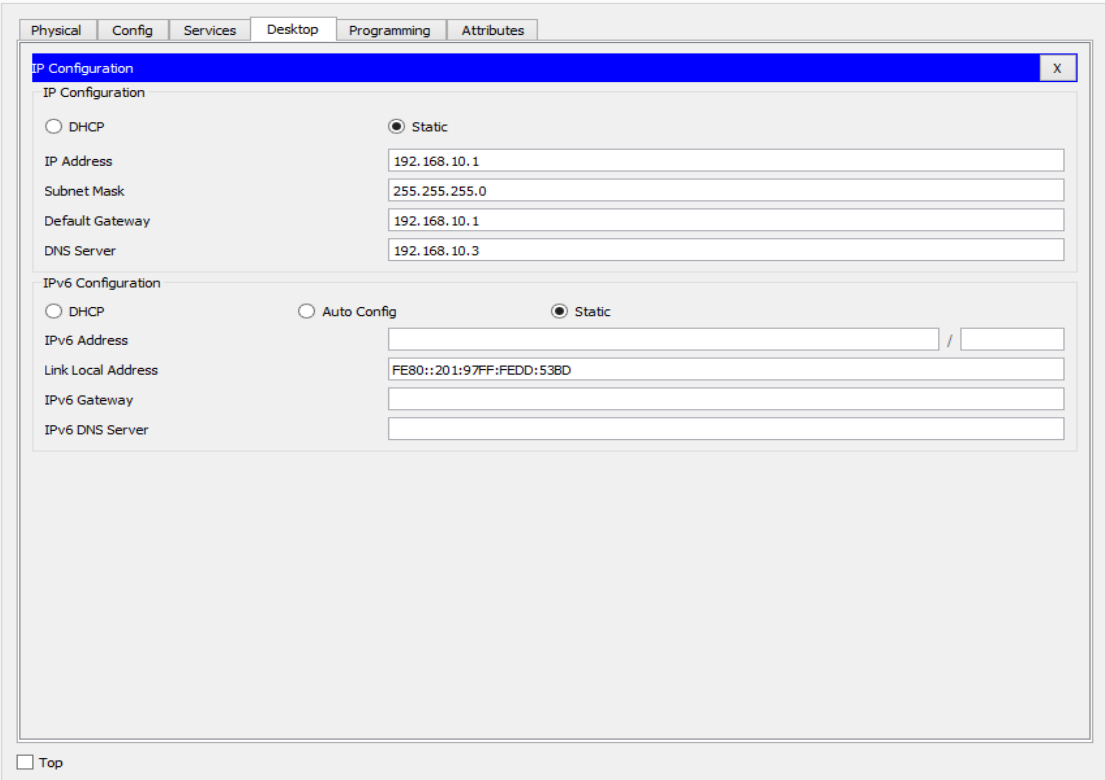

Figure 71.DHCP Server Ip Adjustment

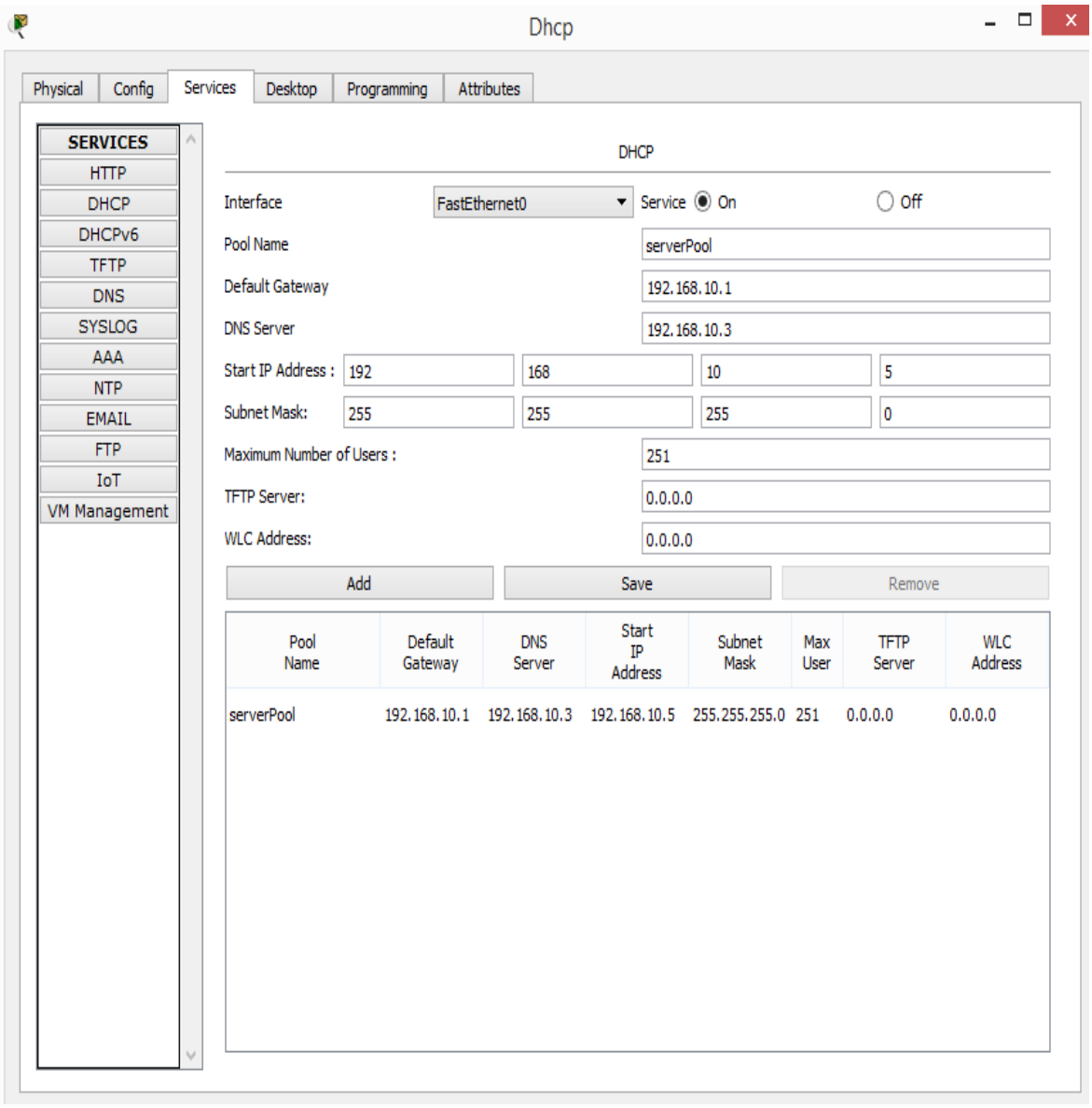

Figure 72.DHCP Server Ip Pool Creation Settings

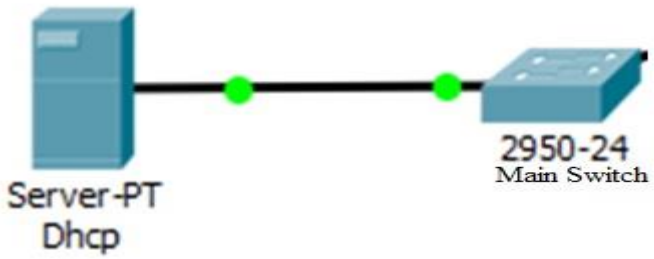

Figure 73.Main Switch Physical Connection with Dhcp Server

4.20. Step 19

DNS Server is activated. Domain name, hotel.com was specified, the address of the http server 192.168.10.2 was specified as the address. The DNS server IP address is statically specified, and the IP address is set to 192.168.10.3.

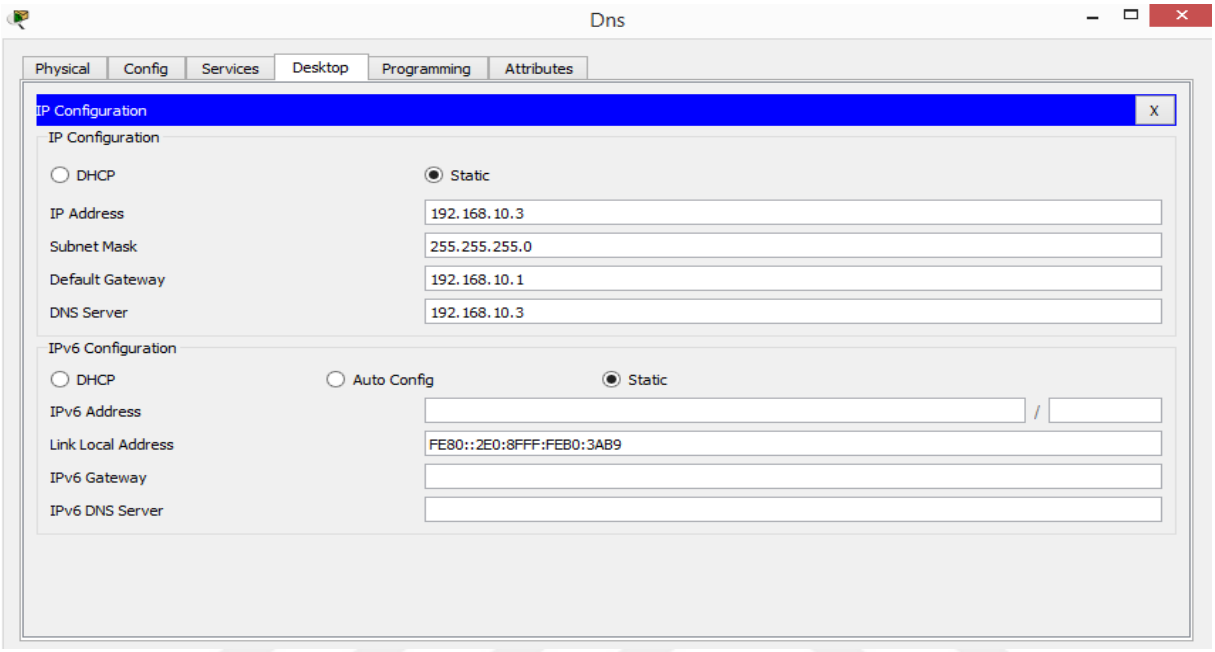

Figure 74.Dns Server Ip Adjustment

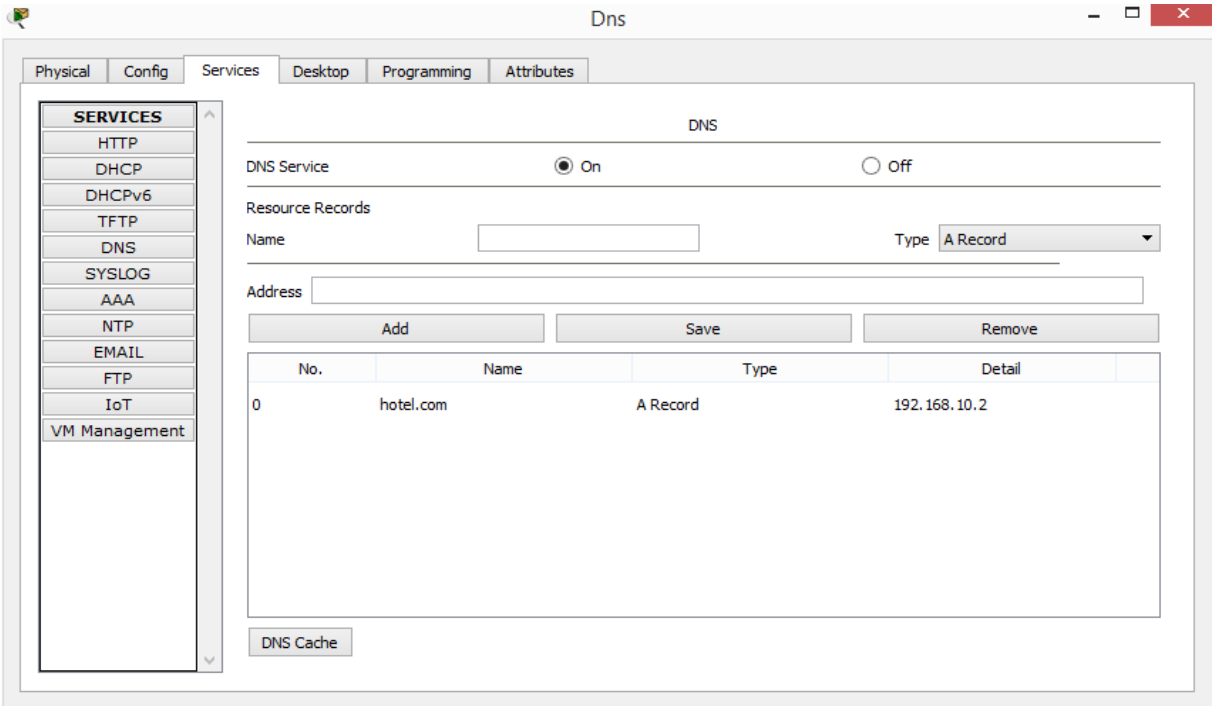

Figure 75.Dns Server Name and Address Setting

4.21. Step 20

IoT Server has been activated. Default Gateway is set to 192.168.10.1. IP Address set to 192.168.10.24. The Subnet Mask is set to 255.255.255.0. DNS is set to 192.168.10.3.

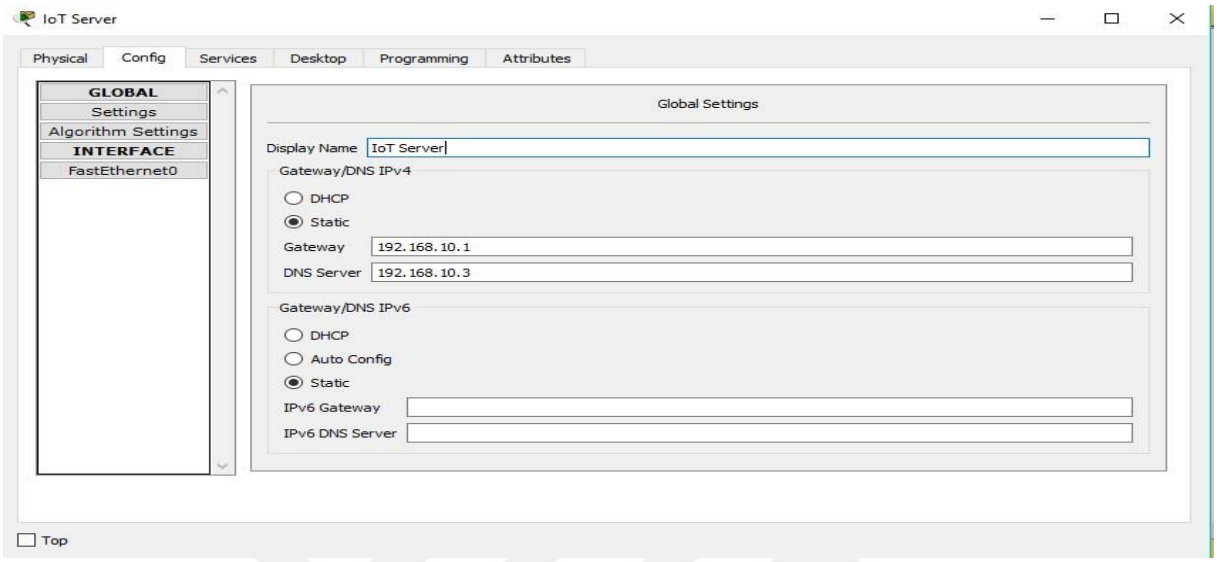

Figure 76.IoTServer Dns & Getway Adjustment

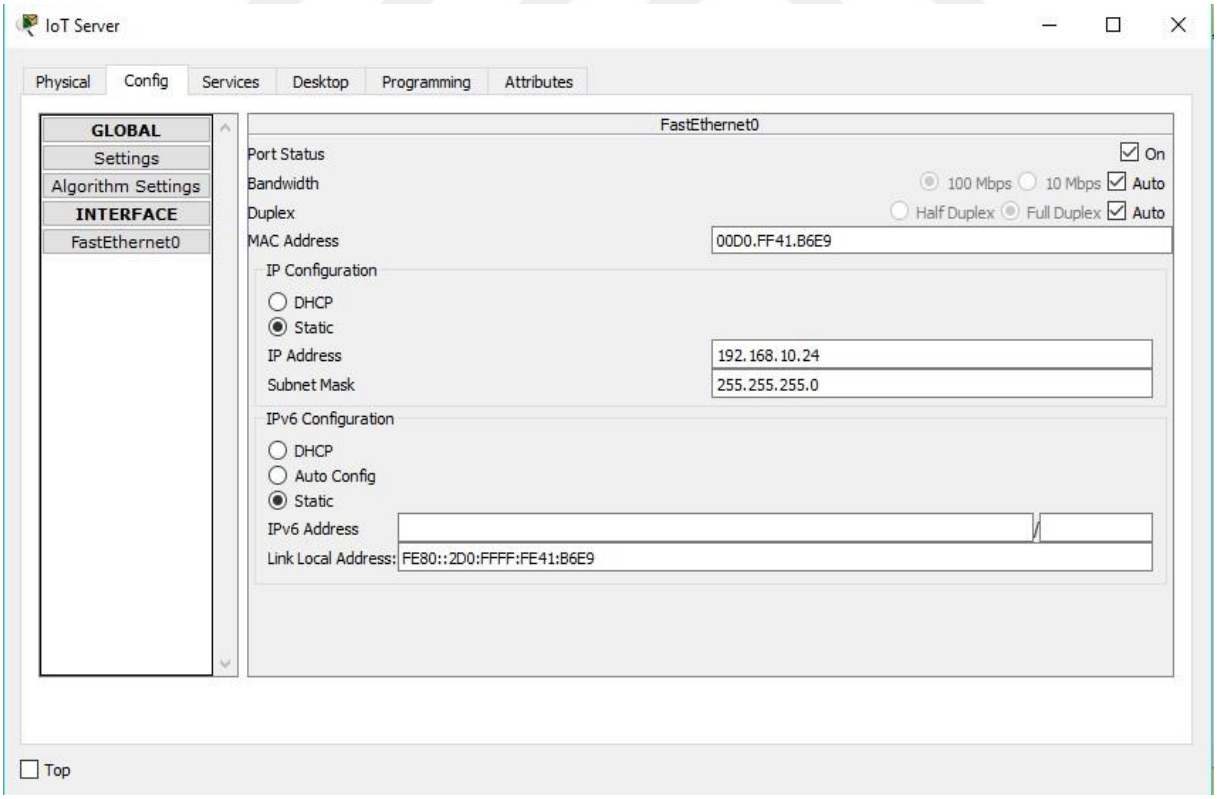

Figure 77.IoT Server IP Adjustmen

CHAPTER FIVE

RESULT AND DISCUSSION

5.1. Overview

This chapter divides to different sections, section 5.2 provides general overview on the scope of the experiments scenarios. In this chapter, the simulation results are shown. The results have been produced by the Packet Tracer for the different scenarios. In addition, the comparison is presented in this chapter.

5.2. Scnarios Scope

All scenarios produced by the Packet Tracer and in order to prove the network in the hotel is working well we have implemented five scenarios on the network. First scenario to transfer packet between two floors. Second scenario we will use the command line interface(CLI) between any two devices in the network to prove all devices connected between each other. Third scenario implementation of the hotel's website for the purpose of accessing the website pages. Forth scenario to make a telephone call between phones located on several floors of the hotel to prove that the network is also used by telephone devices as well. Moreover, the fifth scenario to prove that the security of the hotel is very important, surveillance cameras were used to monitor all the hotel floors and connect these cameras to the network.

5.2.1. Scenarios

To prove the Packet Tracer is suitable and applicable to design and implement network. In addition, the Packet Tracer is very important to use in the learning computer networks, five different scenarios have been used.

5.2.1.1 Send Packet (between two floors)Senario

In this scenario we will send a message from computer device in the first floor to another computer device in the sixth floor and we will note how the message moves step by step in order to reach the destination as shown below**:**

❖ First step, the packet was redirected to Switch1 (Figure.78).

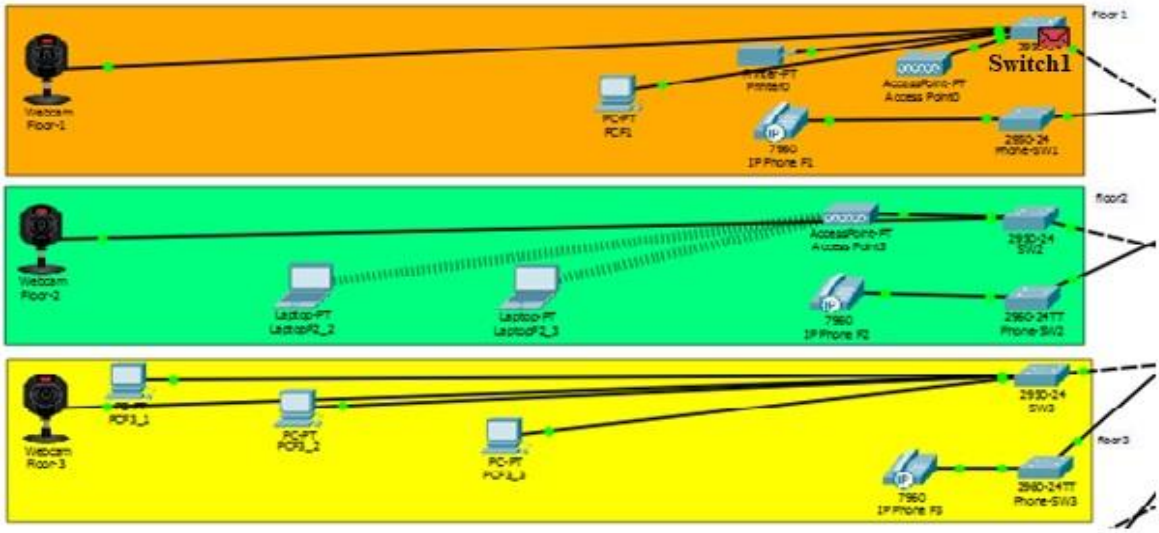

Figure 78.Send Packet Step1

❖ Second step, Switch1 redirected the package to Core Switch2 (Figure.79).

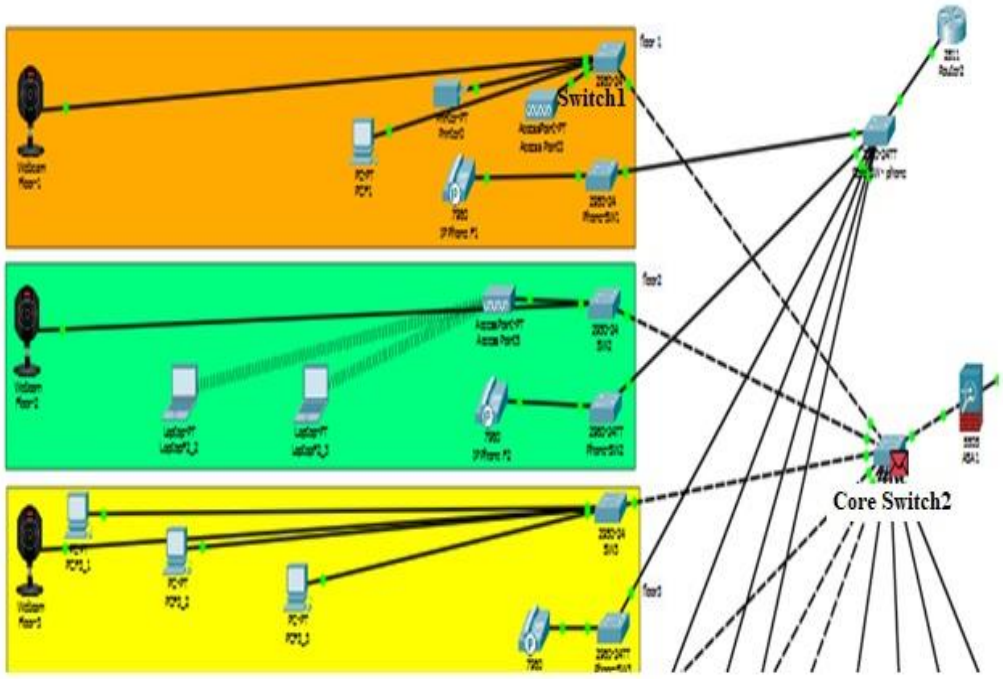

Figure 79.Send Packet Step2

❖ Third step, Core Switch2, redirected the package to Switch6 (Figure.80).

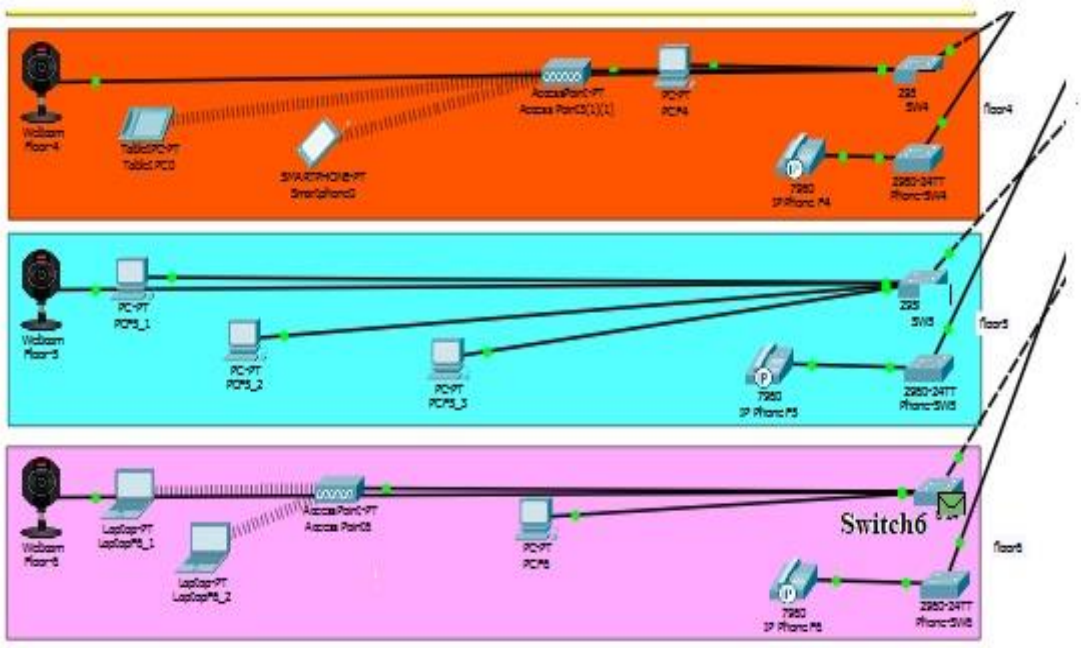

Figure 80.Send Packet Step3

❖ Forth step, Switch6, redirected the package to Access Point6 (Figure.81).

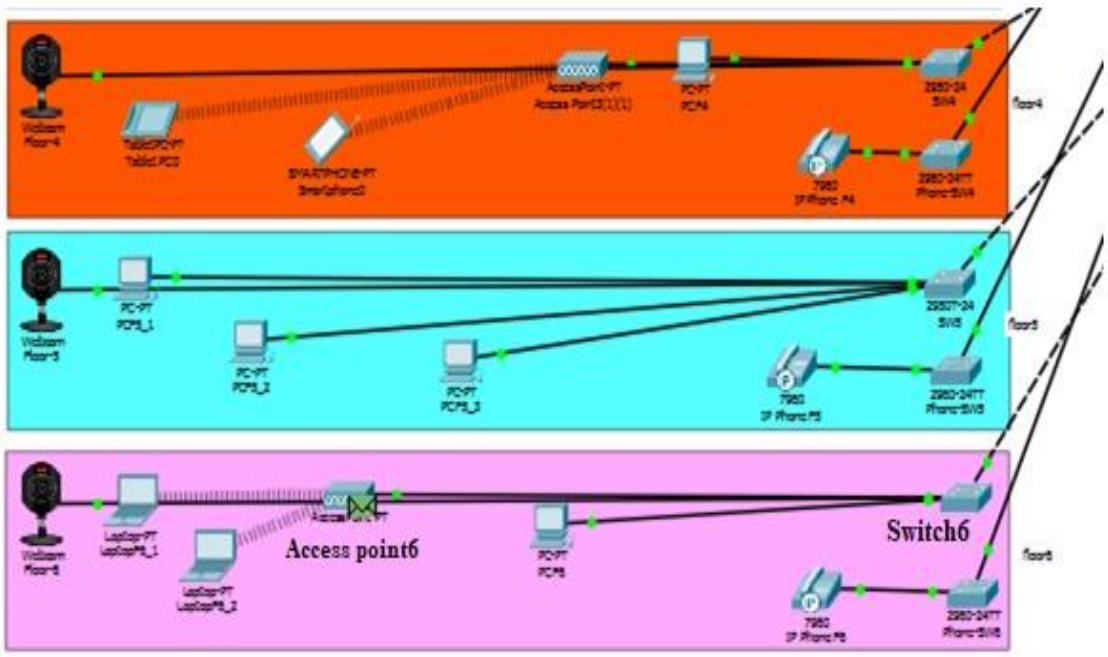

Figure 81.Send Packet Step4

- Fifth step Finally, the package was successfully sent from the Access Point 6 to the target user (Laptop1-F6) (Figure.82).

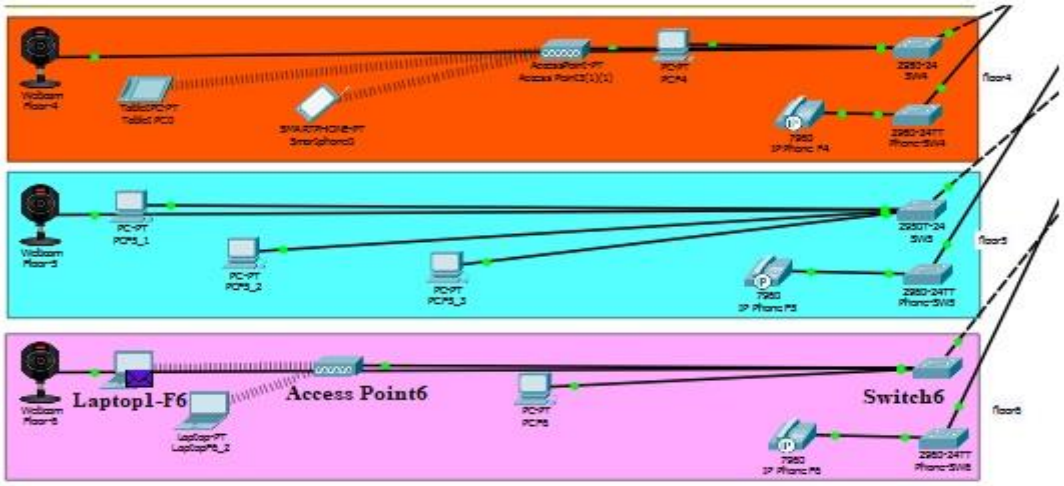

Figure 82.Send Packet Step5

5.2.1.2. Command Line Interface(CLI) Scenario

In this scenario we will use the command line interface (CLI) between any two devices in the network to prove all devices connected between each other as shown below**:**

- First step, we enter the computer device interface in any floor in the hotel and login to the Command Prompt in order to send ping between any two devices (Figure.83).

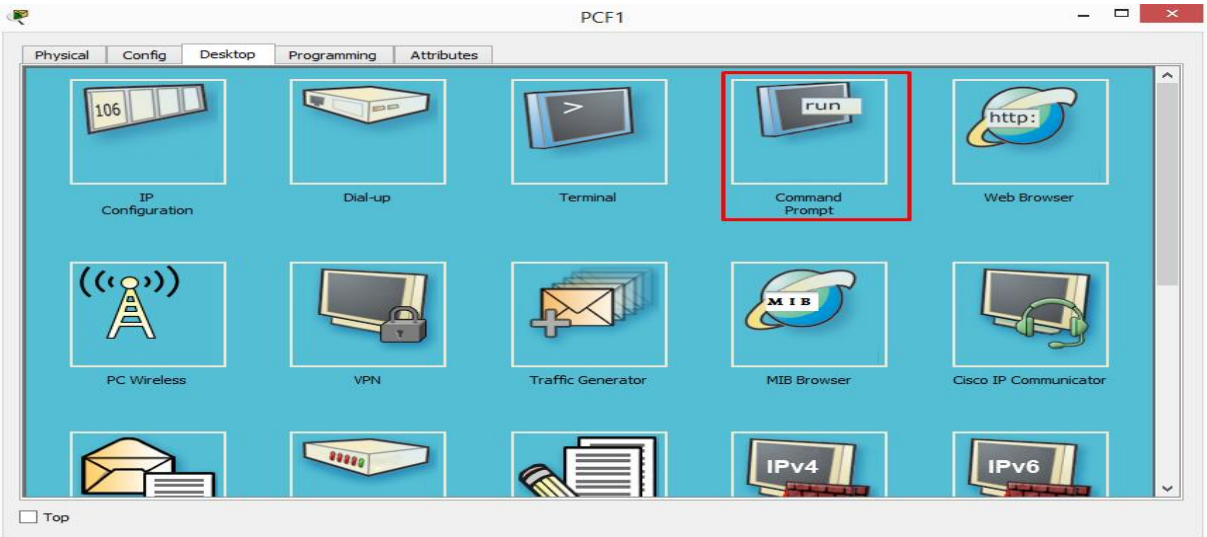

Figure 83.Command Line Interface(CLI) Step1

- Ping Command: Is one of the commands used on the command line, when it sends data over the network to another party, the other party receives that data, and then return back to the sending party. When you send data over the network, you want to be sure that the party is connected to the network, and this simple process provides additional information that makes this simple command useful, and useful to information security professional, and network workers.

❖ Second step, then we specify the target device IP address by giving the target ping command. For example, IP address (192.168.10.22) (Figure.84), (Figure.85).

Figure 84.Command Line Interface(CLI) Step2

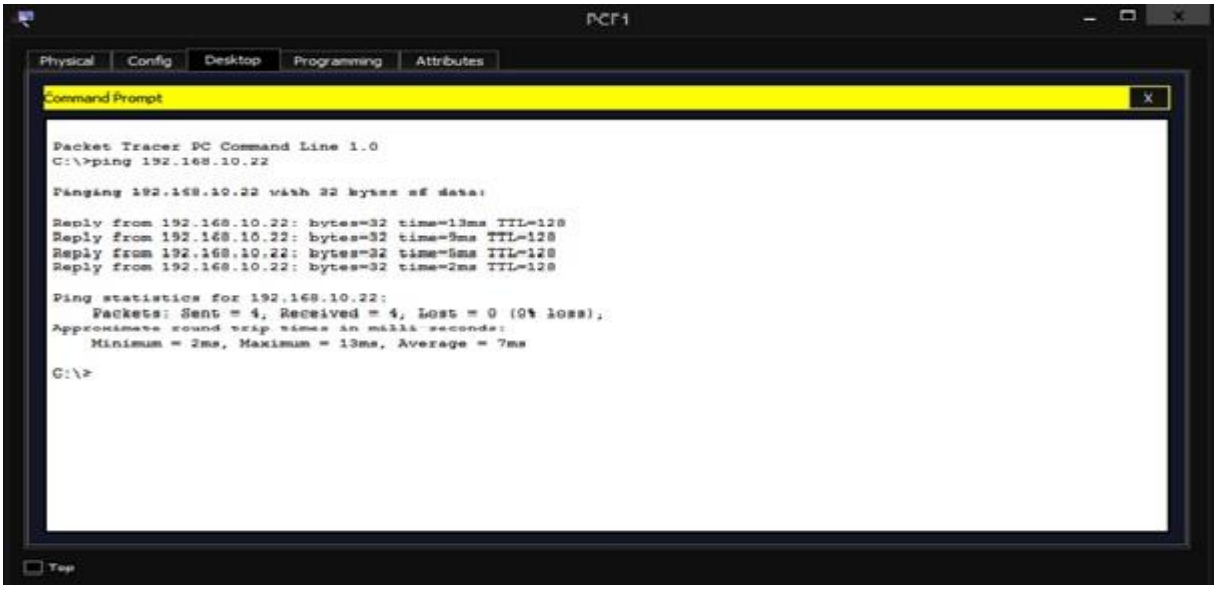

Figure 85.Command Line Interface(CLI) Step2

After implementing the ping commands the screen will appear as in (Figure 85) which contain the following information:

1- The ping address is sent to an IP address in the first line.
2- The first line indicates that the packet size is 32 bytes.
3- The (Figure.85) shows the four data packets were sent, and the result of each illustrate is in one line.
4- Each line of the result starts with a reply that comes from IP number (192.168.10.22).
5- Bytes=32 representes the size of the packet sent to the other party in this attempt.
6- TTL is the abbrevation for the (Time To Live), which represents the mixiumum time that can be deal with the before packet, and if the packet exceeds this time it is ignored.

5.2.1.3. Website Hotel Scenario

In this scenario we will implementation of the hotel's Website for the purpose of accessing the Website pages as shown below**:**

- First step, in order to login to the Website of the hotel, it is entered to the interface of any network device connected to the network and the Web Browser button is clicked (Figure.86).

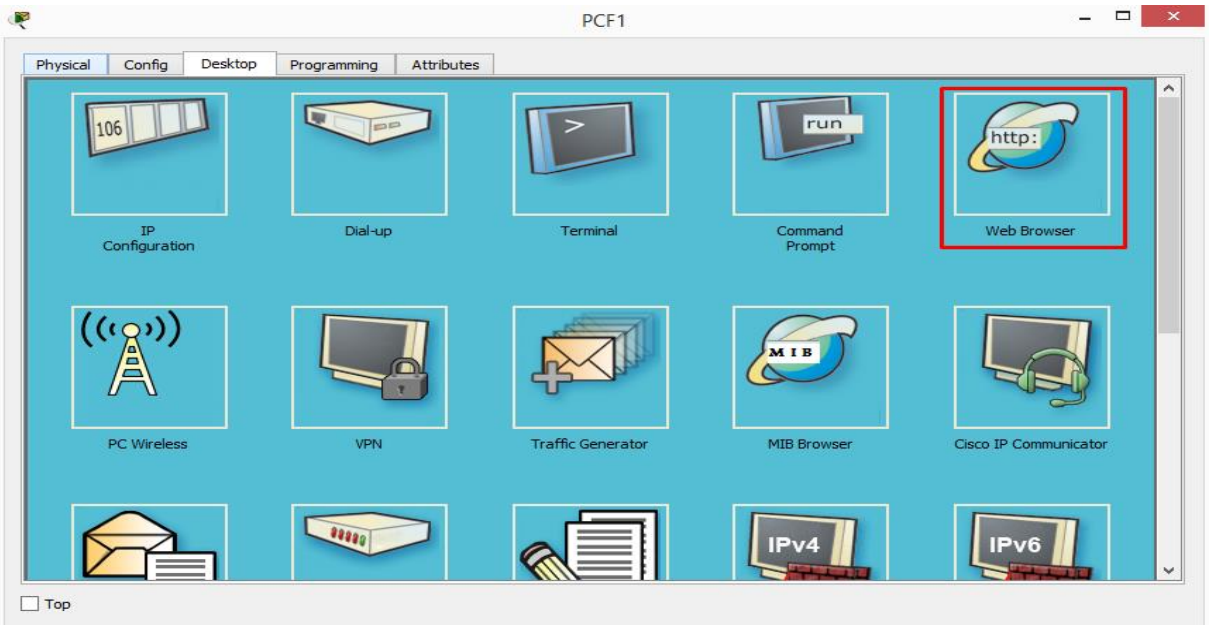

Figure 86.Web Site Hotel Step1

❖ Second step: Then http://hotel.com is written on the address line. Once this is done, the DNS server will be asked for the IP address of hotel.com. Since DNS server knows the IP address of the hotel.com domain name, it directs the user to the IP address where the HTTP server is located so that the user will be faced with the web interface (Figure.87). Then, a phrase will appear on the page (Welcome to the hotel).

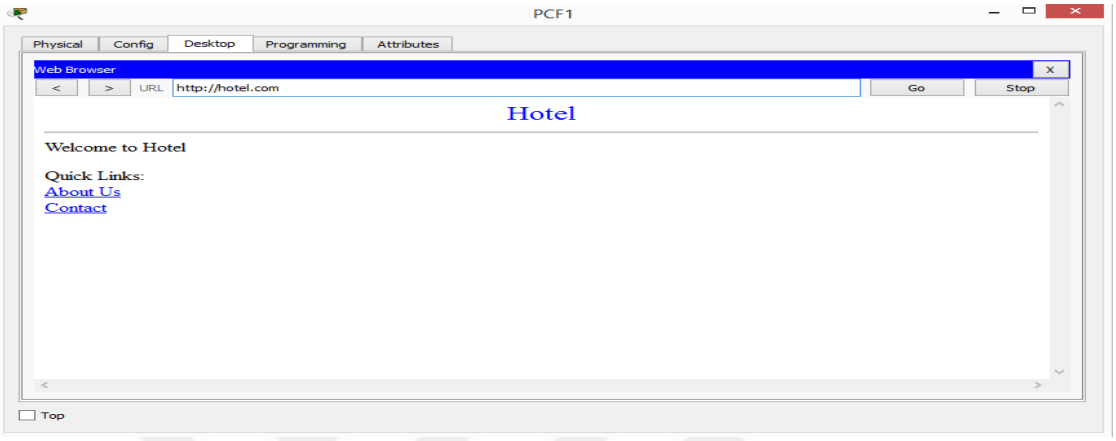

Figure 87.Web Site Hotel Step2

5.2.1.4. IP-Phone Scenario

In this scenario we will use IP-Phone device to make a telephone call between two phone devices located on second floor and sixth floor of the hotel to prove that the network is also used by telephone devices well.

❖ First step for the first time, the interface of the phone on the second floor is entered (Figure.88).

Figure 88.Make Telephone Call Step1

❖ Second step, the sixth floor telephone number is entered into the phone (0006) (Figure.89).

Figure 89.Make Telephone Call Step2

❖ Third step, the phone is opened by clicking on the phone (Figure.90).

Figure 90.Make Telephone Call Step3

❖ Forth step, the interface of the phone on the sixth floor is opened and the call is answered by clicking on the phone (Figure.91) and (Figure.92).

Figure 91.Make Telephone Call Step4

Figure 92.Make Telephone Call Step4

5.2.1.5. CCTV Scenario

In this scenario to prove that the security of the hotel is very important, surveillance cameras were used to monitor all the hotel floors and connect these cameras to the network. Moreover, Thanks to CCTV, the view from the security cameras is realized. The floors can be monitored at any time thanks to the cameras which are provided with each crawler and thus the security is ensured. To monitor security cameras, enter the interface of a device connected to the network and perform the following steps:

- First step, for the first time it is entered to the interface of the networked device and the web browser button is clicked (Figure.93).

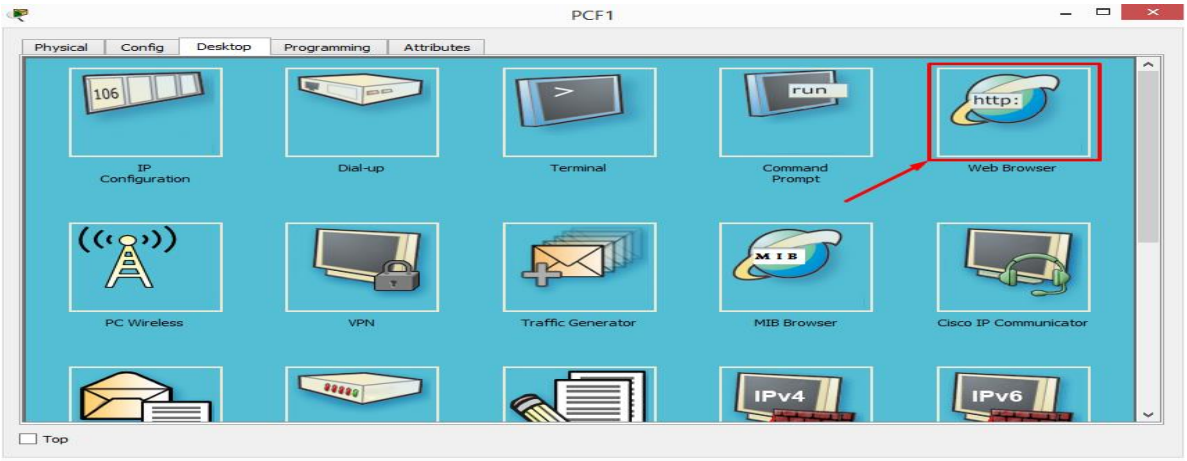

Figure 93.CCTV Step

- Second step: Then IP address IoT server, 192.168.10.24 IP address is written on the address line. Then it is logged into the system by entering the specified username and password (Figure.94).

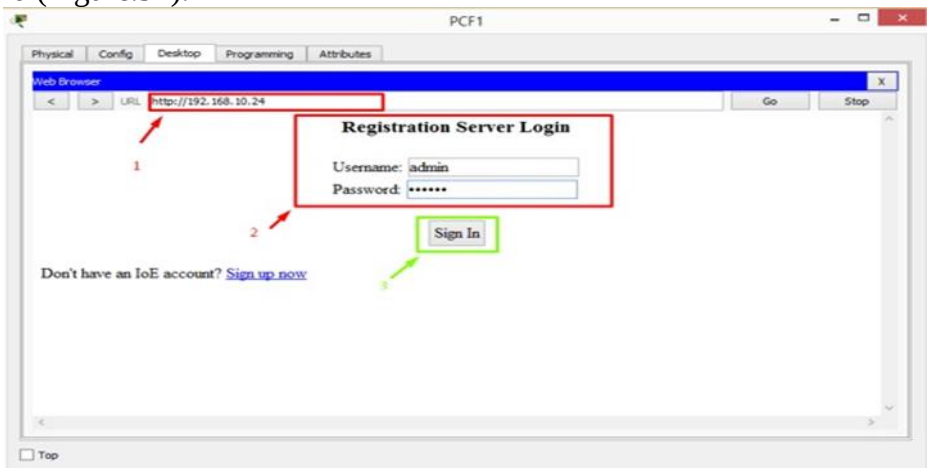

Figure 94.CCTV Step2

❖ Third step, after entering the system, the floor to be watched is selected (Figure.95).

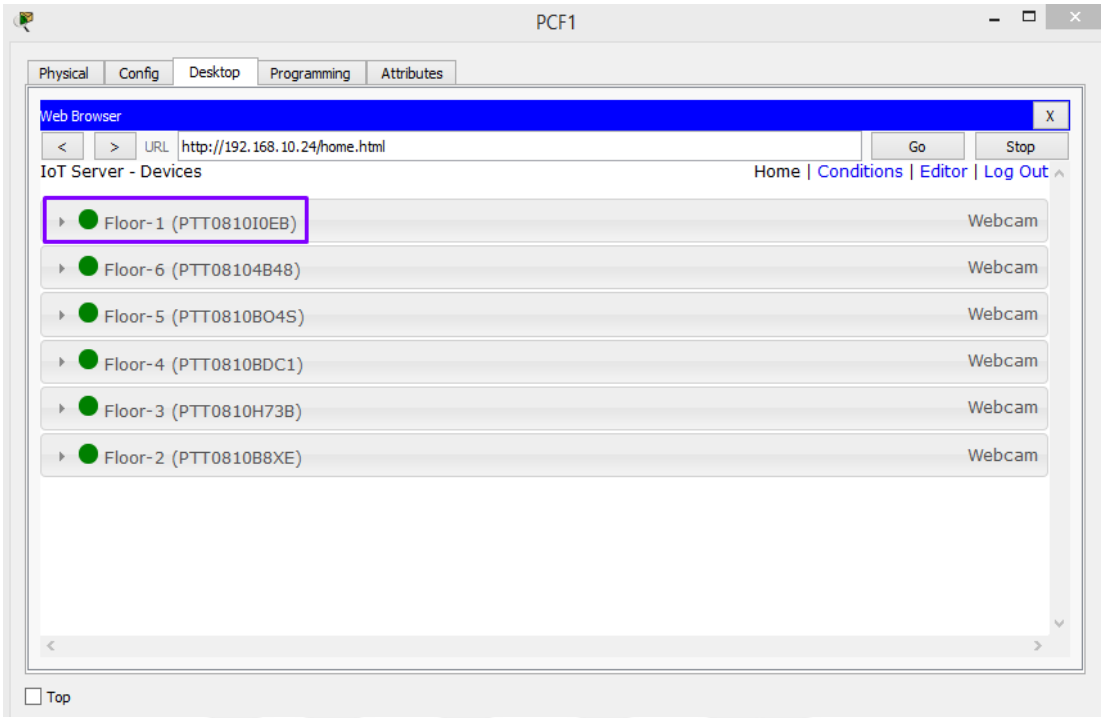

Figure 95.CCTV Step3

❖ The fourth and last step, After selecting the floor to be seen on the screen, people who enter the floor appear to us (Figure.96).

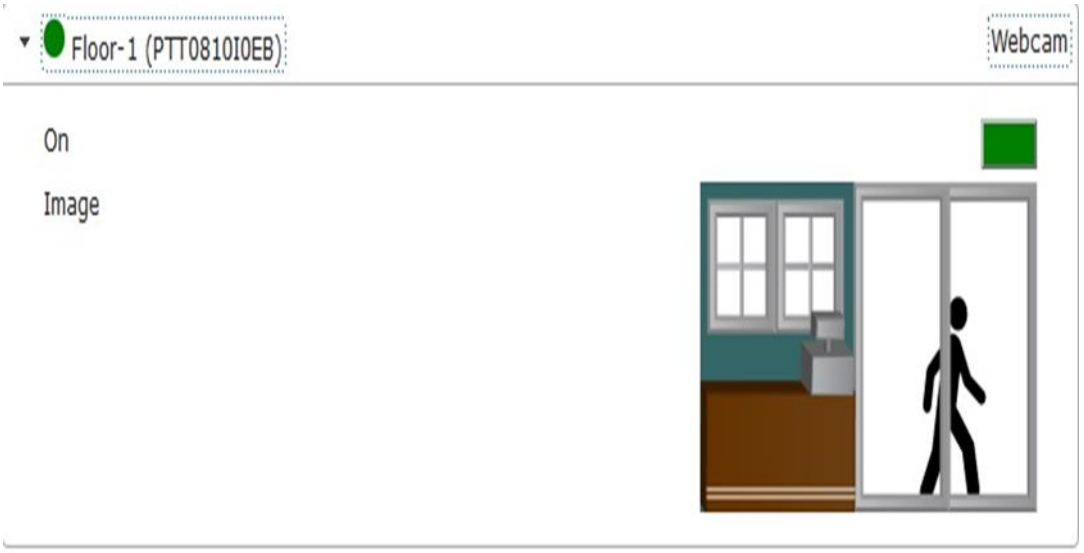

Figure 96.CCTV Step 4

5.3. Last image of the project

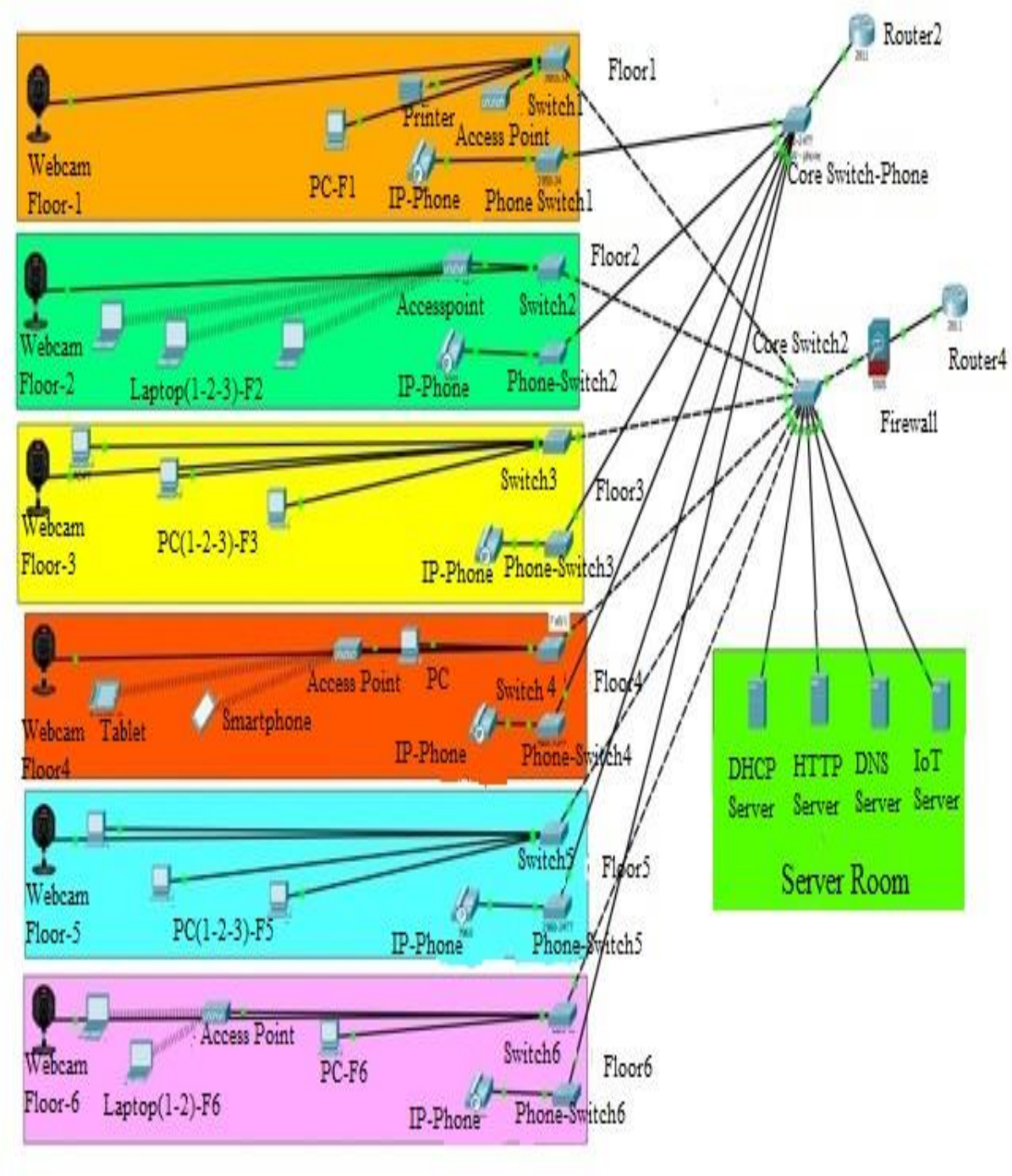

Figure 97.Last image of the project

As a result, it was seen that the network system was operated without any problem. If there will be any problem, for example interruption of internet, the cables, DHCP, IP settings and IP's of other devices, switches and routers should be checked.

5.4. Comparison Packet Tracer Vs Graphical Network Interface(GNS3)

Several studies have shown that there are two well-known network simulation and emulation tools that are widely used in teaching computer network courses. There is a Packet Tracer (PT) and Graphical Network simulation (GNS3) each with different features and for operating system both of them supported windows and linux operating system.

Packet Traer and GNS3 provide a good graphical user interface (GUI) and have been extensively used for learners to build, configure and troubleshoot network in a virtualized network environment.

GNS3 has a single working place to place a virtual network device, while the Packet Tracer interfaces provide two types of work space (logical work space and physical work space). Moreover, the Packet Tracer produce two modes of operation (real time and simulation time), on the contrary GNS3 has a real-time process only [56].

One of the major advantages of Packet Tracer is that it is a relatively small program that uses a small amount of resources, while GNS3 requirements use larger resources such as (CPU, memory and storage) [57]. That mean if used GNS3 the cost is higher than when used the Packet Tracer. Also, the packet Tracer is supported Cisco's technology very dramatically better than the GNS3 because GNS3 is not an original Cisco application [58].

For the computer system support, Packet Tracer is very easy to use, setup and dose everything it needs. It offers a much faster and easier experience for the network rather than GNS3 as it has more complex environment.

Packet Tracer in simulation mode can capture and explain the contents of the packets as the travel through from source to destination in the network. This process helps learners to understand very clearly the basic concepts of data transmission and propagation across the network, while GNS3 it self dose not have the advantage of analyzing data traffic or real-time network behavior [59].

Finally, by comparing the above we find that Packet Tracer, GNS3 are programs that have collaborative tools and Packet tracer can integrate with GNS3 for the purpose of achieving a common goal rather than competing applications. Both programs are used for learners who want to learn computer network and how to apply them [60].

CONCLUSION

In this study, Cisco Packet Tracer was used not only to simulate computer networks but also to learn computer networks. First of all, a programmed system was created in which the Microsoft visual studio 2017 (Visual Basic NET) is used to evaluate many participants after training Cisco Packet Tracer to implement, design and troubleshooting for network. In this program, participants are provided to take a Cisco Packet exam created by the teacher by entering the required information. After the test is enabled, the students are directed to select the right answer for the optional answers. When the exam is over, the system qualified participants marks and presents them on the board-screen. According to this, the participants who obtain less than 70, is regarded as haven failed in the test, on the other hand, the participants who obtain the mark of (70) is regarded as haven passed the exam excellently and is recognized and believed to able to design, execute and preserve the application of the Packet Tracer.

Also in this study, Cisco Packet Tracer was implemented to design an advanced computer network. The map and rules of the computer network structure were determined to design a computer network in a 6-storey hotel. In the computer network map, 9 computers, 5 laptop computers, 6 Ip phones, 14 switches, 2 routers, 4 access points, 1 security wall, 1 http server, 1 mail server, 1 IoT (Internet of Things) server, 6 cameras, 1 tablet, 1 smartphone and 1 DHCP server were used.

The server room was on the 3rd floor of the hotel. The two routers were located in the server room. One was used to connect the telephone lines and the other was used to connect the switches in the normal network.

The DHCP server in the server room provided automatic IP distribution to networked devices on the system. The DNS server identified the DNS in the network and replied to the request for the website. The HTTP server was responsible for the accommodation of the hotel's website. IoTserver was involved in providing remote access to the smart devices specially cameras in this study.

Access point was used for wireless connection in floors. The switch was responsible for connecting devices that were physically connected to the network to communicate with each other. The firewall was responsible for securing the network. IP Phone performed to ensure that

the Ip phones on each floor were used in communication and can used communicate with the required floors in hotel. The printer was placed in the network for use in reception.

IoTserver was used to create the users to connect to the camera. The purpose of using CCTV was to intervene in a short time to prevent problems that may occur in the storeys and to prevent security problems.

Within the framework of the specified network rules and map, the configurations were completed, and advanced network simulation was established. Shortly, first of all the necessary connections were done between ip telephones and the switches after setting of DHCP, ip phone numbers and ip settings were made over the router, necessary connections were done for the installation to operate laptops, printer, computers, tablet and smartphone, connections of all the switches in the floors to the main switch were done, and finally Http, Dhcp and DNS server was activated. As a result, it was seen that the network system was operated without any problem.

Furthermore, in order to prove the network in the hotel was working well, five experimental scenarios which were produced by Packet Tracer, were implemented.

1. First scenario: A message was sent from the computer device in the first floor to another computer device in the sixth floor and it was seen that the package was successfully reached to the target user.
2. Second scenario: The command line interface(CLI) was used between any two devices in the network and it was obversed that all devices connected between each other.
3. Third scenario: In this scenario, implementation of the hotel's website was tested successfully by accessing the website pages.
4. Forth scenario: In this scenario IP-Phone device was used to make a telephone call between two phone devices located on second floor and sixth floor of the hotel and it was seen that the network was also used by telephone devices well.
5. Fifth scenario: In this scenario, surveillance cameras were used to monitor all the hotel floors and connect these cameras to the network and it was proved that the security of the hotel was performed successfully.

Everything that can be done in Cisco trainings were applied to this network simulation system. Finally, basic devices and protocols that were supposed to be in a network were used and as a result, it was seen that the network system was operated without any problem. We developed

a visual basic.net program to run the system. Depending on request basic program can be updated to serve the requests. In this study, we show that any one who wants to establish a topology, he/she will do it using the methodology that we mentioned. He/she will study by him/her self to learn how to establish a new topology by using system via internet or in the lab. By this way, he/she will establish his/her topology without wasting any equipment as logical more than one type.

FUTURE WORK

This thesis study will be a practical guide on how to assemble, examine, and pay attention to various parameters when designing a network for researchers who want to learn or design a network.

In addition, this work can be added to wireless networks and mobile networks.

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