SUDAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

& COLLEGE OF COMPUTER SCIENCE INFORMATION TECHNOLOGY

COMPUTER SYSTEMS AND NETWORK DEPARTMENT

Network Backbone Devices Management

A PROJECT SUBMITTED AS ONE OF THE REQUIREMENTS FOR OBTAINING A BACHELOR OF HONOR IN COMPUTER SYSTEMS AND NETWORKS

OCTOBER 2016

بسم الله الرحمن الرحيم

SUDAN UNIVERSITY OF SCIENCE AND TECHNOLOGY
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OCTOBER 2016

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الآيـــــــة

: قال تعالى

{وَ قُلْ رَبِّ زِدْنِي عِلْماً}

صدق الله العظيم

[سورة طه] 114

الحمدلله

الحمد لله اللهم ربنا لك الحمد بما خل قتنا ورز قتنا وهديتنا وعلمتنا وأذ قذتنا وفرجت عنا
لك الحمد بالإيمان ولك الحمد بالإسلام ولك الحمد بال قرآن ولك الحمد بالأهل والمال والمعافاة
كبت عدونا وبسطت رز قنا وأظهرت أمننا وجمعت فر قتنا وأحسنت معافاتنا
ومن كل ما سألناك ربنا أعطيتنا
فلك الحمد على ذلك حمدا كثيرا
لك الحمد بكل نعمة أنعمت بها علينا في قديم أو حديث أو سر أو علانية أو خاصة أو عامة
أو حياً أو ميت أو شاهد أو غائب
لك الحمد حتى ترضى ولك الحمد إذا رضيت ولك الحمد بعد الرضى
وصلى اللهم وسلم على سيدنا محمد وسلم تسليما كثيرا

الشكر والعرفان

لابد لنا ونحن نخطو خطواتنا الأخيرة في الحياة الجامعية من و قفة نعود إلى أعوام قضيناها في رحاب الجامعة مع اساتذتنا الكرام الذين قدمو لنا الكثير باذلين بذلك جهودا كبيرة في بناء جيل الغد لتبعث

.. الأمه من جديد
و قبل أن نمضي ت قدم آسمى آيات الشكر والامتنان والت قدير والمحبة الى الذين حملو أ قدس رساله في
.. الحياة
.. إلى الذين مهدو لنا طريق العلم والمعرفة
.. إلى جميع أساتذتنا الأفاضل
كن عالما.. فإن لم تستطع فكن متعلما.. فإن لم تستطع فأحب العلماء.. فإن لمن تستطع"
"فلاتبغضهم
..ونخص بالشكر والت قدير مشرفتنا الغالية
أ/ رهام لطفي
والتي لايسعنا الإ أن ن قول لها
"إن الحوت في البحر , والطير في السماء, ليصلون على معلم الناس الخير"
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.. كل الشكر , ونخص
(عائلاتنا الكريمة)
و
نهى عطا المنان - ت قى يوسف - رزان عبدالحميد - محاسن أسامة - ربا عبود - م قداد جمال الدين
م/ وليد هاشم د/ نعمة عز الدين
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الإهداء

ها تلك أيام العناء والشـ قاء تنتهي وها اليوم والحمد لله صفحات سهر الليالي تنطوي..
أيامها سنين ..بشهورها.. وأيامها.. وساعاتها.. تت قضي
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إلى من كللهم الله بالهيبة والو قار..
..إلى من نحمل اسمهم بكل افتخار
الى من لم يبخلو بشيء من أجل دفعنا لطريق النجاح،
إلى من كلّت أناملهم ليقدمو لنا لحظة سعادة
إلى من علمونا صعود درجات الفلاح درجة.. درجة
(والدينا الأعزاء)

الى ملاكنا في الحياة..
إلى من بها نكبر وعليها نعتمد..
إلى شمعة متقدة تنير ظلمة حياتنا..
إلى من بوجودها نكتسب قوة ومحبة لا حدود لها..
إلى من سهرت الليالي معنا لكي ترانا يوم نحمل شهادتنا..
إلى من كان دعائها سر نجاحنا وحنانها بلسم جراحنا إلى أغلى الحبايب
(أمهاتنا الحنونات)

إلى أصحاب القلب الطيب والنوايا الصادقة
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الى من شاركونا حضن الام وبهم نستمد عزتنا واصرارنا
(أخواننا وأخواتنا)

إلى من انسونا في دراستنا وشاركونا همومنا
إلى الأخوان والأخوات الذين لم تلدهن أمهاتنا إلى من تحلو بالايخاء وتميزو بالوفاء والعطاء إلى
ينابيع الصدق الصافي إلى من معهم سعدنا وبرفقتهم في دروب الحياة الحلوة والحزينة سرنا
إلى من كانو معنا على طريق النجاح والخير
إلى من عرفنا كيف نجدهم وعلمونا ان لا نضيعهم
(أصدقاؤونا)

إلى هذه الصرح العلمي الفتي الجبار
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(كلية علوم الحاسوب وتقانة المعلومات)

ABSTRACT

Computer networks became a necessary and important aspect of any organization to provide connectivity among its devices and to reach the internet. Building such network needs certain devices and configurations which require effort from network administrators to configure, control and manage those devices to keep the network working properly according to the organization policies.

That is why we found it more suitable to build an application that helps the administrator perform those tasks through a clear graphical user interface with additional features help in configuring and managing the network (e.g. tasks scheduling, backup and restore configuration, mobile notifications and remote management).

This application gives administrators flexibility, time and effort efficiency to manage organization network devices.

المستخلص

اصبحت الحوجة إلي وجود شبكة أمر ضروري وأساسي لأي مؤسسة ليتم ربط أجزاء المؤسسة مع بعضها وربط المخدمات داخلها بشبكة الإنترنت, ولبناء هذه الشبكة يتطلب ذلك توفر اجهزة ذات مواصفات خاصة منها الأجهزة الرئيسة لربط الشبكة.

هذه الاجهزة تتطلب مجهود من مسؤولي الشبكة في عملية ضبطها والتحكم فيها وإدارتها لذلك وجدنا من ومرا قبتها وذلك في سبيل إستمرار عملها على أكمل وجه وحسب سياسات المؤسسة, المناسب إنشاء برنامج يد قوم بهذه المهام من خلال واجهات رسومية واضحة لضبط أجهزة الشبكة مع توفير العديد من المزايا الادارية منها: جدولة المهام, النسخ الاحتياطي واسترجاع الضبط إضافة إلى نظام الإشعار من الهاتف الجوال والتحكم في الاجهزة عن بعد.

مع وجود هذا البرنامج في المؤسسة اصبحت مهمة مسؤولي الشبكة أكثر مرونة وفعالية مع توفير الو قت والجهد المبذول في ضبط الأجهزة .

LIST OF TERMS

Term	Description
CLI	Command Line Interface
VPN	Virtual Private Network
NAT	Network Address Translation
DHCP	Dynamic Host Configuration Protocol
QoS	Quality of Service
OSPF	Open Shortest Path First
ACL	Access Control List
RIP	Routing Information Protocol
EIGRP	Enhanced Interior Gateway Routing Protocol
OSI	Open System Interconnection

Local Area Network	LAN
Wide Area Networks	WAN
Metropolitan Area Network	MAN
Internet Protocol	IP
Media Access Control	MAC
Personal Computer	PC
Dynamic Name Service	DNS
Interior Gateway Routing Protocol	IGRP
Variable Length Subnet Mask	VLSM
Simple Network Management Protocol	SNMP
Graphical User Interface	GUI
Internetwork Operating System	IOS
Extensible Markup Language	XML
Remote Method Invocation	RMI
Structured Query Language	SQL
Graphical Network Simulator	GNS3
Secure Shell	SSH
Transfer Control Protocol	TCP
File Transfer Protocol	FTP
Trivial File Transfer Protocol	TFTP
User Datagram Protocol	UDP

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CHAPTER ONE

INTRODUCTION

OVERVIEW 1.1

In any institution that use a large and complex network, network administrators are facing set of difficulties and complexities in managing devices of the network and detecting problems that occur; specially problems that need a quick response.

Therefore, providing a mechanism that helps with the management process of the rapid change in the configuration that an administrator needs in some cases, and provide portability which makes the work easy is an important need.

PROBLEM STATEMENT 1.2

Large institutions deal with the following problems:

- Managing and detect problems when increasing the number of devices in the network, which slow process of diagnosis.
- Need of reconfiguration when changing router to a different vendor.
- Any failure of a router or link needs a quick reaction to provide availability.
- Command line needs special skills from the administrator to remember many configurations.

SCOPE OF RESEARCH 1.3

In this research, the focus is on the network devices routers from two vendors Cisco and Huawei, provide ability to create network with basic configuration, including routing protocols and certain special configurations such as (VPNs, NAT and DHCP), monitoring of devices behavior and network traffic accounting, scheduling configurations, and adding Access Lists rules.

The most important point in this research is translating the basic configurations .such as (OSPF and ACL) between different vendors

At lasts a mobile application that includes two main features: nonfictions and .change state of the ports to up or down

OBJECTIVES OF RESEARCH 1.4

This research aims to establish in integrated software, which contains a series of features to help in the process of network devices managing and control network devices through a Simple, fast and easy graphical interface, offers mobility/portability feature to alert administrator about network problems

PROPOSED SOLUTION 1.5

Software that access all devices in the network that basically configured, managing process and detect problems, alert administrator when critical problems happen, and provide access to the network even from a remote location

This makes the management process and detects problems in the network faster and easier.

STATE OF THE ART 1.6

“RCM: A User Friendly Router Configuration Machine” [1] a research produced by Samreen Amir that aim to communicate with the router with the same CLI commands, but invisible to the user, provide widely used Configuration such as RIP V1, RIP V2, EIGRP and OSPF.

“Mobile Application for Network Monitoring Software Using Android Operating System” [2] a research produced by Sudan University of Science and Technology aim to facilitate the monitoring process recognize the state of the network, and View details for a specific device if connected to the network.

“Graphical Network Interface Configuration Network Services (Click Administrator)” [3] a research produced by Sudan University of Science and Technology aim to reduce the complexity and amount of administrative work when administrator wants to configure and mange network service, intend by creating graphical network interface to makes network administration easier and less prone to error.

THESIS LAYOUT 1.7

This research has the following Thesis Layout: -

Chapter 2 Explore the theoretical background of the network, open system interconnection (OSI) model and some of network devices. It also introduces similar researches with common points.

Chapter 3 discusses the techniques and tools that will be used to achieve the research objective.

Chapter 4 contains system description and analysis using standard unified modeling language.

Chapter 5 discusses the steps we took to implement the system.

Chapter 6 displays the results, conclusion and recommendations.

At the last there are preferences and appendix.

CHAPTER TWO

BACKGROUND OF THE NETWORK AND PREVIOUS STUDIES

INTRODUCTION .1

This chapter will touch two major parts; the general description of network devices and monitoring process to introduce the area of the research and the related studies to this research to be aware of the state of the art so far.

BACKGROUND OF THE NETWORK .2

Network management 2.2.1

The process of controlling a complex data network to maximize its efficiency and productivity.

Computer Network 2.2.2

A set of computers connected together to communicate and share resources via network device by using Ethernet cable, wireless or through radio waves.

Internet 2.2.3

Are a million of connected computing devices (hosts, end-system).

Network Topology 2.2.4

It is the schematic description of a network arrangement, connecting various nodes through lines of connection.

- **Bus Topology**: All nodes connected to a direct link cable which acts as a backbone for the network.

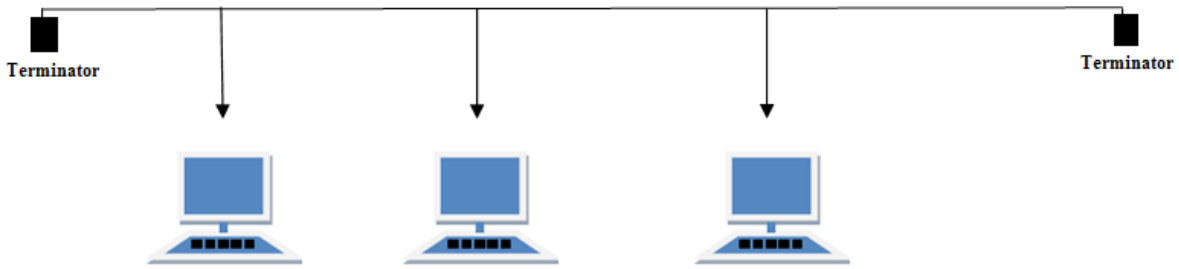


Figure (2.1) Bus Topology

- **Star Topology**: All computers connected to central device that manage .the connection between computers

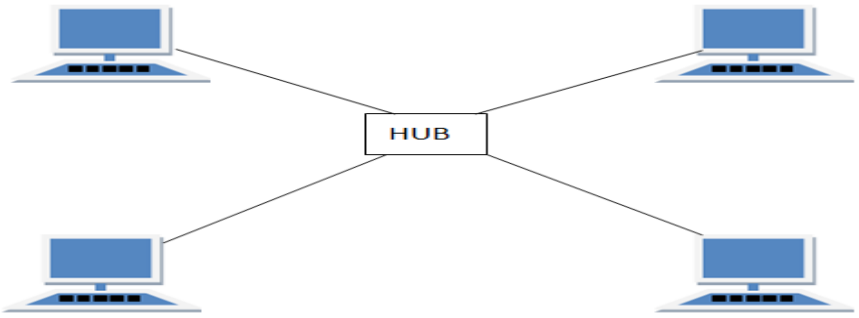


Figure (2.2) Star Topology

- **Ring Topology**: Each computer connected to the next computer directly .to be one like a ring

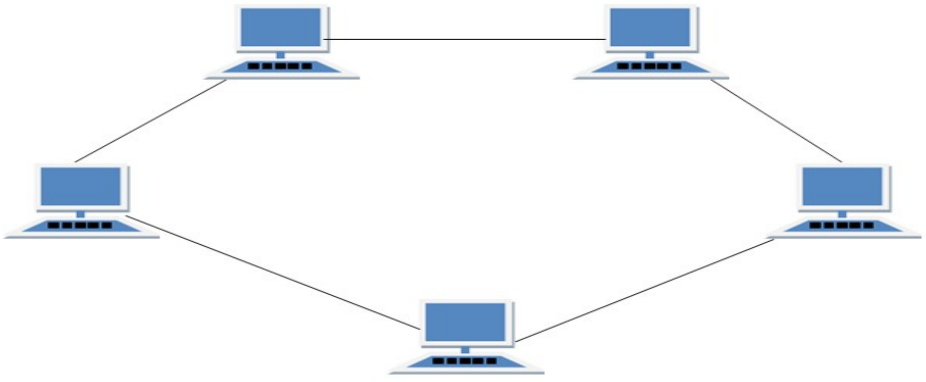


Figure (2.3) Ring Topology

- .**Mesh Topology**: Each computer connects directly to other computers

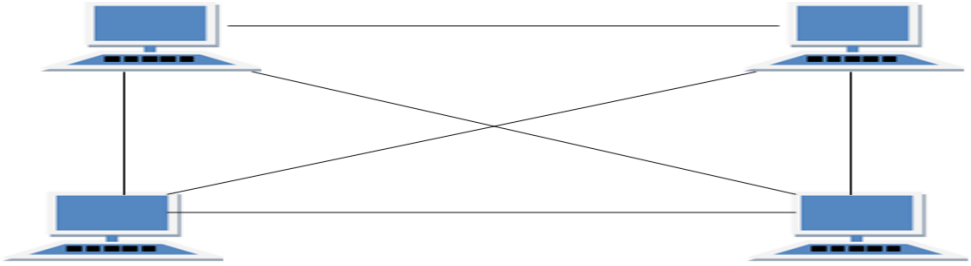


Figure (2.4) Mesh Topology

Network Type Based on Size 2.2.5

- **LAN (Local Area Network):** is a network with simple, short distance and limited by number of computers such as in room, a floor and building.
- **WAN (Wide Area Networks):** connects multiple LANs to one another over great geographic distances such as towns, states, and countries.
- **MAN (Metropolitan Area Network):** connect multiple geographically nearby LANs to one another such as a city.[4]

Open Systems Interconnection Model 2.2.6

The OSI reference model architecture divides the network communication into seven layers. Each layer covers different network activities, equipment, and protocols. The model defines how each layer communicates and works with the layers directly above and below it.

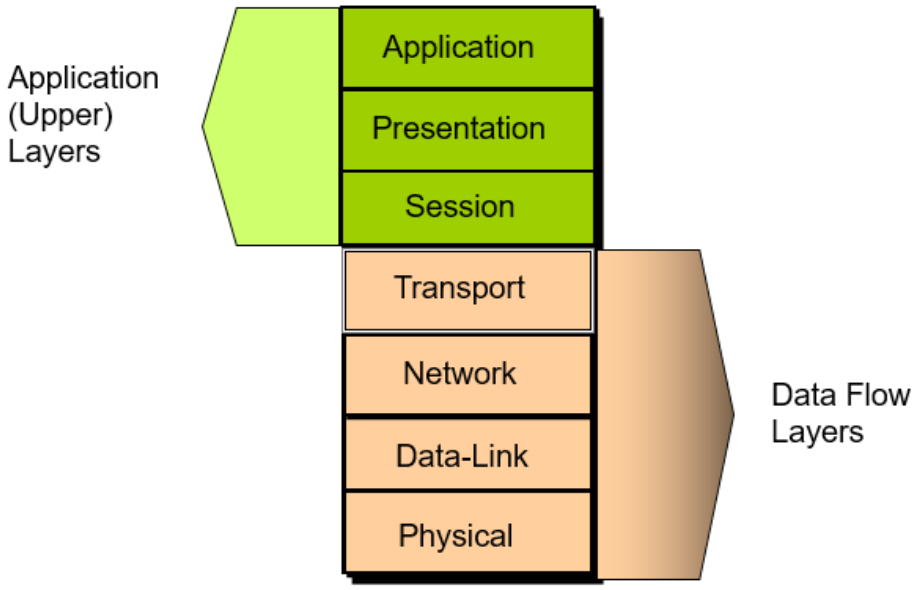


Figure (2.5) OSI Model

Application Layer 2.2.6.1

This layer relates to the services that directly support user applications, such as software for file transfers, database access, and e-mail.

Presentation Layer 2.2.6.2

Defines the format used to exchange data among networked computers.

Session Layer 2.2.6.3

It allows two applications on different computers to open, use, close and manage a connection called a session (A session is a highly structured dialog between two workstations).

Transport Layer 2.2.6.4

This layer provides an additional connection level beneath the session layer. The transport layer ensures that packets are delivered error free, in sequence, fragment .and reassembling packets without any losses or duplications

Network Layer 2.2.6.5

It is responsible for addressing messages and data link. This layer also determines the route from the source to the destination computer. It determines which path the data should take based on network conditions, priority of service, and other factors. It also manages traffic problems on the network, such as switching and routing .of packets and controlling the congestion of data

Data-Link Layer 2.2.6.6

This layer sends data frames from the network layer to the physical layer. It controls the electrical impulses that enter and leave the network cable. On the receiving end, the data-link layer packages raw bits from the physical layer into data .frames

Physical Layer 2.2.6.7

This layer transmits the unstructured, raw bit stream over a physical medium .(such as the network cable

The physical layer is totally hardware-oriented and deals with all aspects of .establishing and maintaining a physical link between communicating computers

Networking Devices 2.2.7

Equipment that connects directly to a network segment is referred to as a .device

These devices are broken up into two classifications

- **End-User Devices:** include computers, printer, scanners, and other devices that provide services directly to the user.

- **Network Devices:** include all the devices that connect end-user devices together to allow them communicate.

Network Devices 2.2.8

A special device used in computer networking and it is responsible of communication between computers**.**

Type of Network Devices 2.2.8.1

Hub: A central point device connects group of hosts receives incoming packets, possibly amplifies the electrical signal, and broadcasts these packets out to all devices on the network.

Switch: A switch is a multi-port bridge and it operates at OSI data link layer 2. It stores MAC addresses in an internal lookup table so temporary switched paths are created between the frame's source and destination. Some Switches have limited layer 3 IP routing capabilities.

Router: Is an OSI network layer 3 devices that forwards data packets between computer networks, this device examines incoming packets to determine the destination address of the data, then examines its internal routing table to choose the best path for the packet through the network, and switches them to the proper outgoing port.

Firewall: is a device designed to control the flow of traffic into and out of a network by examining them against its inner rules. In general, firewalls are installed to prevent attacks.

Network Address Mechanism 2.2.9

- **Internet Protocol address (IP):** Is the logical hierarchical address that is used mainly in computer networks addressing, and it is used by layer 3 devices to determine the exit interface.
- **Media Access Control Address (MAC):** Is the physical flat address that is used mainly by switches to determine the exit interface.
- **Name:** Is the address that mainly used by human to easily remember the websites; however the PCs use the Domain Name Service (DNS) server to translate the name into IP address.

Routing 2.2.10

The process of transferring packet of data from source to destination, by selecting the minimum cost, distance, and/or time path from several alternatives.

Figure (2.6) Routing process

Routing Types 2.2.10.1

- **Static routing:** Network administrator configures information about remote networks manually.
- **Dynamic routing:** Information is learned from other routers, and routing protocols adjust routes automatically.
- **Default routing:** Accessing to a network that doesn't know you and not exist in your network address when you want to connect to the Internet.[5]

Routing Protocols 2.2.10.2

Specifies how routers communicate with each other, disseminating information
.that enables them to select routes between any two nodes on a computer network

Types of Routing Protocols 2.2.10.3

.1 .Distance Vectors: RIP v1, IGRP and RIP v2

.2 .Link state: OSPF

.3 .Hybrid: EIGRP

Table (2.1) Distance Vectors vs. Link state

Distance Vectors	Link state
Each router is aware only of its immediate neighbors.	Each router is aware all of other routers in the area.
Best for: simple, flat design and non-hierarchical.	.Best for: large and hierarchical networks
.Convergence time is not an issue	.Convergence time is crucial
Send periodic updates of entire routing table.	Send triggered partial update
Does not understand the topology of the network.	Has detailed knowledge of distant networks and routers.

2.2.10.3.1 Routing Information Protocol (RIP)

It only uses hop count to determine the best way to remote network, it sends the complete routing table out to all active interfaces every 30 seconds and it has maximum allowable hop count of 15 and administrative distance is 120. RIP version 1 uses only classful routing, but RIP version 2 uses classless routing.

Classful routing	Classless routing
Routes are exchanged between foreign networks.	Include subnet mask with route advertisement, support VLSM and subnetting.
RIP v1 and IGRP.	RIP v2, OSPF, EIGRP and IS-IS.

Table (2.2) classful and classless routing

2.2.10.3.2 Interior Gateway Routing Protocol (IGRP)

All routers must use the same number in order to share routing table information, can use bandwidth, load, delay and reliability to create a composite metric, routing updates that are broadcasted every 90 seconds.

2.2.10.3.3 Open Shortest Path First (OSPF)

Open standards routing protocol used to find the best path for packets as they pass through a set of connected networks and works by using Dijkstra algorithm. It is protocols aimed at traffic moving around within a larger autonomous system network like a single enterprise's network.

A pair of routers using OSPF can authenticate each message, it is optimized by supporting multi-access networks by designating a single router to broadcast on the network, also it allows scalability, unlimited hop count and supports CIDR (Class-less Inter Domain Routing)[6].

2.2.10.3.4 Enhanced Interior Gateway Routing Protocol (EIGRP)

Enhanced to IGRP, it is probably one of the two most popular routing protocols in use today. It offers multiprotocol support, communication via (RTP) Reliable

Transport Protocol, best path selection via (DUAL) Diffusing Update Algorithm and reduce network overhead.

Compared to IGRP, EGRP boasts faster convergence time, improve scalability, and superior handling of routing loops. EIGRP routers that belong to different autonomous system (ASes) do not automatically share routing information and they do not become neighbors [7].

Network Address Translation 2.2.11

It translates between local address to a public address; its function was developed to address the limited amount of IPv4 routable addresses that could be used or assigned to companies or individuals.

There are different types of NAT that can be used, which are:

- **Static NAT** Mapping an unregistered IP address to a registered IP address on a one to one basis. Particularly useful when a device need to be accessible from outside the network.
- **Dynamic NAT** Mapping an unregistered IP address to a registered IP address from a group of registered IP addresses.
- **Overloading NAT with PAT (NAPT)** a form of dynamic NAT that maps multiple unregistered IP address to a single registered IP address by using different ports. That is known also as a PAT (Port Address Translation), single address NAT or port level multiplexed NAT [8].

Access List 2.2.12

perform packet filtering to control the movement of packets through a network.

Packet filtering provides security by limiting the access of traffic into a network, restricting user and device access to a network. IP access lists reduce the chance of spoofing and denial-of-service attacks, and allow dynamic, temporary user-access through a firewall. [9].

There are two types of access lists:-

- Standard Access Lists

Filter network traffic based on the source IP address only [10].

- Extended Access Lists

IP access lists that filter traffic by Source IP address, Destination IP address, Protocol type and Port number [10].

Network Monitoring 2.2.13

Describes the use of a system by constantly monitor a computer network for slow or failure components and notifies the network administrator (via email, pager or other alarms) in case of outages [11].

SNMP 2.2.14

SNMP is a protocol that allows remote and local management of items on the network including servers, workstations, routers, switches and other managed devices [11].

SNMP divide in to tow part:

- **Manager -or NMS (Network Management Station)** usually a host, that controls and monitors a set of agents [12].

Agent - or server usually routers [12]

PREVIOUS STUDIES 2.3

RCM: A user friendly Router Configuration 2.3.1 Machine

This paper presents a graphical user interface configuration for Cisco routers by Using Visual C # .NET as a language of programming to create the applications that .communicates with the Cisco Internetwork Operating System to configure the router The Communication between Application and Cisco Router is performed using router console port and then the application sends the CLI commands to the IOS using graphical interfaces part; the interface is created for all various types of protocols and .features that are supported

This study has provision flexible, easy to use, easy to implement and secure solution to the conventional Command Line Interface (CLI) method and as well as to the complex GUI architecture of Cisco Configuration Professional. It further makes it important that RCM communicates with the router done with the same CLI commands .but invisible to the user

RCM configures the most widely used configuration commands and the interior routing protocols such as RIP V1, RIP V2, EIGRP and OSPF. It also provides protocol .authentication for interior routing protocols

Mobile Application for Network Monitoring 2.3.2 :Software Using Android Operating System

This study aims to facilitate the monitoring process; there is too much delay between the moment of the fall of the device or server and the moment the message arrival to the Administrator or by email.

So this research designs a Monitoring Application that works in an effective and strong way on the mobile smart phone, This application allows mobility property; So that the network administrator know what is happening in the network from anywhere by opening the application only, It is also expected to solve the problem of delays by sending a notification in real time of failure in a particular device.

This study has recognized the state of the network, by knowing the network connected-devices and devices that are not connect also View details of a specific device if connected to the network, also showing services associated with each device, and view details on the status of each service in the devices.

Graphical Network Interface 2.3.3 Configuration Network Services (Click :(Administrator

This research aims to reduce the complexity and amount of administrative work when administrator wants to configure and mange network service, intend by creating graphical network interface to makes network administration easier and less prone to error.

Running services (DHCP, DNS, Proxy, NSF AND FTP) using Ubuntu server11.04, programing language C++, testing software in

a LAN consist of 20 devices, there portioning system is Windows and Ubuntu.

CAPTER THREE

TOOLS AND TECHNIQUE

OVERVIEW 3.1

This chapter describes the tools and techniques that will be used; to achieve the objectives of the project.

TOOLS AND TECHNIQUE 3.2

Operating System 3.2.1

An OS is a program that controls the execution of application programs and acts as an interface between applications and the computer hardware.

Windows 3.2.1.1

An operating system and Graphical User Interface (GUI) created by Microsoft, allows easy “point and click” operations to provide a user friendly environment.

Windows begins with Microsoft developed the first IBM personal computer and referred to as MS-DOS. The initial version, MS-DOS 1.0, was released in August 1981; by 1990 Microsoft create a successful Graphical User Interface (GUI) operating system called windows 3.0 which implemented as a layer on top of MS-DOS.

Over the years Windows is developed to reach multiple versions with the same fundamentals.[13]

Linux 3.2.1.2

An open source operating system began in 1991 with the commencement of a personal project by Finnish student Linus Torvalds to create a new free operating system kernel. Since then, the resulting kernel has been marked by constant growth throughout its history; it has grown from a small number of C files under a license

prohibiting commercial distribution to more than 18 million lines of source code under .[the GNU General Public License v2 [14]

Android 3.2.1.3

Android is an open source mobile operating system based on Linux kernel and currently developed by Google. With a user interface designed primarily for .[touchscreen mobile devices such as smartphones and tablet computers [15]

Advantages to developing for the Android platform

- Zero startup costs to begin development: The development tools for the platform are free to download
- Freedom to innovate in Android OS due to its open-source platform
- Open distribution model: developers are free to distribute their applications through other distribution channels as well.
- Multi-platform support: There are a wide variety of hardware devices powered by the Android OS, including many different phones and tablet computers. Development for the platform can occur on Windows, Mac OS or Linux.

(Internetwork operating system (IOS 3.2.1.4

Cisco IOS (Internetwork Operating System) is a proprietary operating system that runs on most Cisco Systems routers and switches.

The core function of Cisco IOS is to enable data communications between network nodes. In addition to routing and switching, Cisco IOS offers dozens of additional services that an administrator can use to improve the performance and security of network traffic. Such services include encryption, authentication,

firewall capabilities, policy enforcement, deep packet inspection, Quality of Service, intelligent routing and proxy capability [16].

JAVA 3.2.2

A very popular programming language developed by Sun Microsystems; it is the global standard for developing mobile applications, games, Web-based content, and enterprise software, Java is a C-language derivative; so its syntax rules look much like C's [17].

Some of the Java's important features:

- Easy to learn and understand [18].
- Designed to be platform-independent and secure, using virtual machines [18].
- Object-oriented (It is close to the reality perceived in dealing with things) [18].

(Unified Modeling Language (UML 3.2.3

UML first appeared in the 1990's as an effort to select the best elements of many modeling systems proposed at the time, and to combine them into a single coherent notation. It has since become the industry standard for software modeling and design, as well as the modeling of other processes in the scientific and business worlds. The UML is a tool for specifying software systems. Standardized diagram types to help you describe and visually map a software system's design and structure. Using UML it is possible to model just about any kind of application, both specifically and independently of a target platform. The use of UML as a tool for defining the structure of a system is a very useful way to manage large, complex systems. Having a clearly visible structure makes it easy to introduce new people to an existing project.

:**Some UML features**

- UML breaks the complex system into discrete pieces that can be understood easily.
- Hand over the system to new team becomes easier.
- Complex system can be understood by the disparate developers who are working on different platforms.
- UML model is not a system or platform specific. It unifies all disparate developers under one roof.

UML Diagrams 3.2.3.1

Use Case Diagram 3.2.3.1.1

Use case diagram at its simplest is a representation of a user's interaction with the system that shows the relationship between the user and the different use cases in which the user is involved. A use case diagram can identify the different types of users of a system and the different use cases.

Sequence diagram 3.2.3.1.2

Sequence diagram is an interaction diagram that shows how processes operate with one another and in what order. A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the Logical View of the system under development. Sequence diagrams are sometimes called event diagrams or event scenarios.

Deployment diagram 3.2.3.1.3

Deployment diagram depicts a static view of the run-time configuration of processing nodes and the components that run on those nodes. In other words, deployment diagrams show the hardware for your system, the software that is installed on that hardware, and the middleware used to connect the disparate machines to one another.

Enterprise Architect 3.2.3.2

Is a program that is used to design and manage the schemes UML, this program is fast and easy to use, and it features reduce the costs spent on the follow-up course of the project under development.[20]

(Extensible Markup Language (XML 3.2.4

An extensible Markup Language, which is a language that can be used to describe data in a meaningful way. Virtually anywhere there is a need to store data, especially where it may need to be consumed by more than one application

It defines a set of rules for encoding documents in a format, which is both human readable and machine-readable; one of the aims of XML is to implement a clear separation between data and presentation. It is defined by the W3C's XML 1.0 Specification and by several other related specifications, all of which are free open standards.[21]

(Java Remote Method Invocation (RMI 3.2.5

An API that provides a mechanism to create distributed application in java that allows an object to invoke methods on an object running in another JVM. The RMI provides remote communication between the applications using two objects stub and skeleton.[22]

XML Remote Procedure Call 3.2.6

The XML-RPC protocol was created in 1998 by Dave Winer of User Land Software and Microsoft which uses XML to encode its calls and HTTP as a transport mechanism [23].

:Compression between above software's 3.2.7

Next Table shows the comparison between java RMI and XML RPC that can used to create connection between server and client.

Technology	Advantages	Disadvantages

Java Remote Method (Invocation (RMI	- Simple and clean to implement that leads to more robust, maintainable and flexible applications. - No client installation is needed except java capable browsers. - At the time of changing the database, only the server objects are to be recompiled but not the server interface and the client remain the same.	- Can use only the java supported platforms. - Limited functionality because of security restrictions. - No support for legacy systems.
XML RPC	- Designed to be as simple as possible. - Simple mechanism to call remote procedures on a machine with a different OS. - XML-RPC is language and platform independent. -XMLRPC libraries are available in Java and other languages (e.g: .Net).	- Limited choice of data types. - No type checking of array values; mixed type not forbidden. - No check that a struct has no duplicate names. - Strings allow only ascii.

:Determining the best choice

In these research XML-RPC open source software is selected to building the

:Connection between the server and client

- the architecture is simple compared with java RMI
- Support for many programming language
- Simple user interface

Eclipse 3.2.8

A general purpose open platform that facilitates and encourages the development of third party plug-ins. It is known as IDE, provides tools for coding, building, running and debugging applications. Originally designed for Java, now supports many other languages [24].

Advantages [24]

- Faster code/compile/run cycles (real time).
- Open source (free).
- Extensible (plug-in).

Disadvantages [24]

- Pretty heavyweight.
- Requires JRE.
- Difficult to Learn

Android Studio 3.2.9

Official IDE for Android platform development, was announced on May 16, 2013 at the Google I/O conference, it is available for download on Windows and Linux.[25]

Android Studio features

- Gradle-based build support.
- Android-specific refactoring and quick fixes.
- ProGuard integration and app-signing capabilities.
- Template-based wizards to create common Android designs and components.
- A rich layout editor that allows users to drag-and-drop UI components, option to preview layouts on multiple screen configurations.[12]
- Built-in support for Google Cloud Platform, enabling integration with Google Cloud Messaging and App Engine.

(Structured Query Language (SQL 3.2.10

A standard language used to access and manipulate databases in: MySQL, SQL Server, Access, Oracle and other database systems.

SQL consists of a data definition language, data manipulation language, and a data control language. The scope of SQL includes data insert, select, update and delete, schema creation and modification, and data access control.

Some of the SQL important features:

- Portable: Databases using SQL can be moved from device to another without any problems.

- Easy to learn and understand
- Integrates with Java: by using an API known as JDBC (Java Database Connectivity).

GNS3 3.2.11

A Graphical Network Simulator program developed primarily by Jeremy Grossman. It allows emulation of complex networks and running operating systems such as Windows XP Professional or Ubuntu Linux in a virtual environment on the computer, also it allows the same type of emulation using Cisco Internetwork Operating Systems [26].

Advantages

- GNS3 is an open source, free program offers an easy way to design and build networks of any size, pre-deployment testing without the need for network hardware.
- Test more than 20 different network vendors in risk-free virtual environment.
- Create dynamic network maps for troubleshooting and proof of concept (POC) testing.
- Connect virtual network to any real network.

Disadvantages

- Slower throughput than real equipment
- The switching functionality is very limited.
- Only a few older Cisco router platforms supported.
- High CPU utilization
- It can’t take the place of a real router.

(Secure Shell (SSHv2 3.2.12

An application protocol and software suite that allows secure network services over an insecure network such as the public Internet. It replaces other, insecure protocols and services, including Telnet and FTP. It can be used for remote terminal connections, remote file copying, and forwarding X11 sessions (on UNIX) as well as arbitrary TCP ports through a secure tunnel. It is based on strong encryption and authentication [27].

TFTP Protocol 3.2.13

TFTP is an acronym for Trivial File Transfer Protocol and is a forerunner protocol of FTP. The TFTP protocol is basically used for information transfer from a server to a client or vice versa. TFTP is intended to be used when bootstrapping disk less systems are used. This is also used by memory less devices like routers, switches to get their bootstrap information from their servers.

TFTP protocol uses UDP for transferring files between server and the client on port "69", by default. When TFTP is used, the file that is getting transferred is split up into packets each containing 512 bytes of data. The completion of the transfer is informed to the receiver by sending a packet that has 0-511 bytes [28].

System log server 3.2.14

Syslog is a way for network devices to send event messages to a logging server usually known as a Syslog server. The Syslog protocol is supported by a wide range of devices and can be used to log different types of events. For example, a router might send messages about users logging on to console sessions, while a web-server might log access-denied events.

Most network equipment, like routers and switches, can send Syslog messages, as do most firewalls [29].

By using this tools and techniques the research achieved its objectives.

CHAPTER FOUR

SYSTEM DESCRIPTION AND ANALYSIS

INTRODUCTION 4.1

This chapter addresses the system functions and its general description, clarifies the system components, and also deals with the detailed analysis of the operations of .the system using the UML schemes

SYSTEM DESCRIPTION 4.2

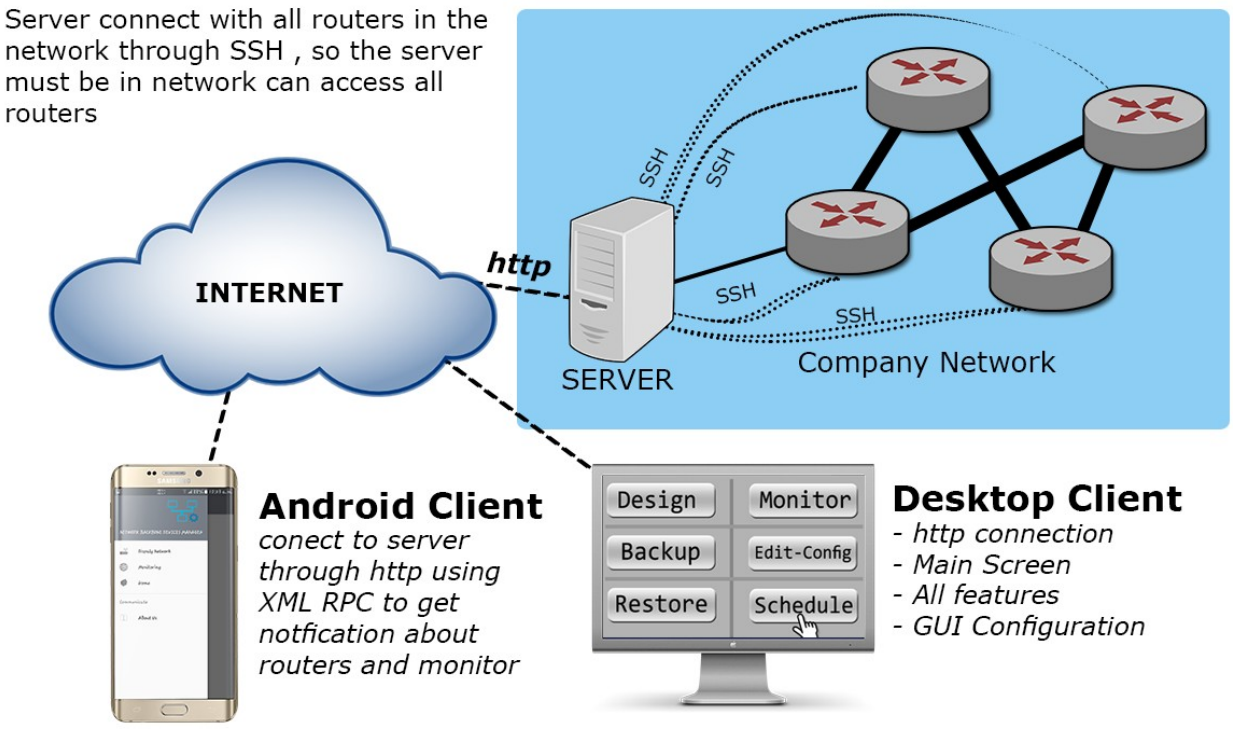
The system provides to the administrator the ability to manage and control the network devices followed by the basic stage of doing preparation configurations for routers and firewall. The first function of the system is to help creating simplified network design and put the basic configurations, through using an effective graphical .user interface GUI

The second stage is connecting devices with the server software using the console port, and applied all configurations to the device by desktop software after that placed devices on the operating environment. That was the second most important function for this system which is connecting the software server with network which .gives important features for management

The last function is to access the network through a mobile application when .the administrator is away from the work place

SYSTEM ENVIRONMENT 4.3

The system consists of a desktop application, smart phone client and server. The server connects to all routers through SSH.



.Figure (4.1): system environment

SYSTEM FUNCTIONALITY 4.4

System functions are divided into two main categories, functions provided to the root administrator and functions provided to the administrator.

Root Administrator Functions 4.4.1

- **(Add A New User(Administrator**

Allows the root administrator to add a new user by identifying the basic .(.information (name, privilege, phone number, registration date …etc

- **(Delete (Administrator**

.Allow the root administrator to delete specific administrator

- **Preparation Configurations**

It allows the administrator to prepare basics configuration including routing protocols and certain special configurations such as (VPNs), (NAT), .((DHCP) and (QoS

- **Monitoring**

Allows to monitor devices behavior and network traffic accounting, gives statistical performance of devices and overview of the flow in the .network

- **Edit Configurations**

This feature allows editing many Configuration such as (VPNs), (NAT), .((DHCP) and (QoS

- **Backup**

.Allows saving all configurations of specified routers in database

- **Restore**

It allows the administrator to restore all Configurations in old (Cisco) routers to the new one even the routers that are from different vendors such as .(Huawei) the system translates and reconfigure the new device

- **Scheduling**

Allows defining a set of configurations that are automatically executing .in a given time

- **Notifications**

.Alert the administrator when there are critical problems

Administrator Functions 4.4.2

The administrator has the same functions as the root administrator except that it cannot add or delete an administrator because this operation is limited only to the root .administrator

ANALYSIS USING UML SCHEMES 4.5

:To analyze this system using UML diagrams three schemes were adopted

Use Case Diagram 4.5.1

This scheme is used to describe of the behavior of the system, identify the administrator and represent their interaction with the system and help understanding the requirements

Figure (4.2): illustrates the use case diagram of the network administrator and .processes that can be made

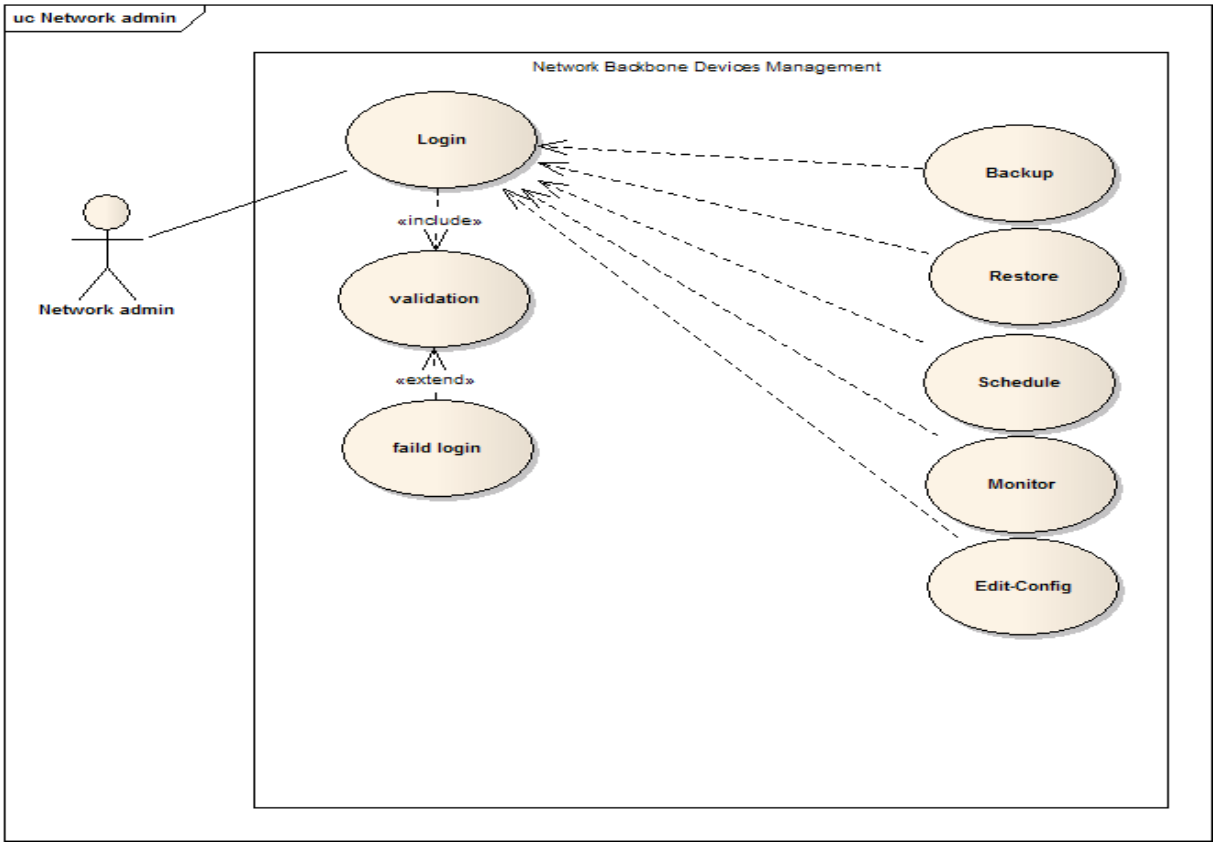


Figure (4.2): use case diagram for network administrator

Figure (4.3): illustrates the use case diagram of the smart phone and processes .that can be made

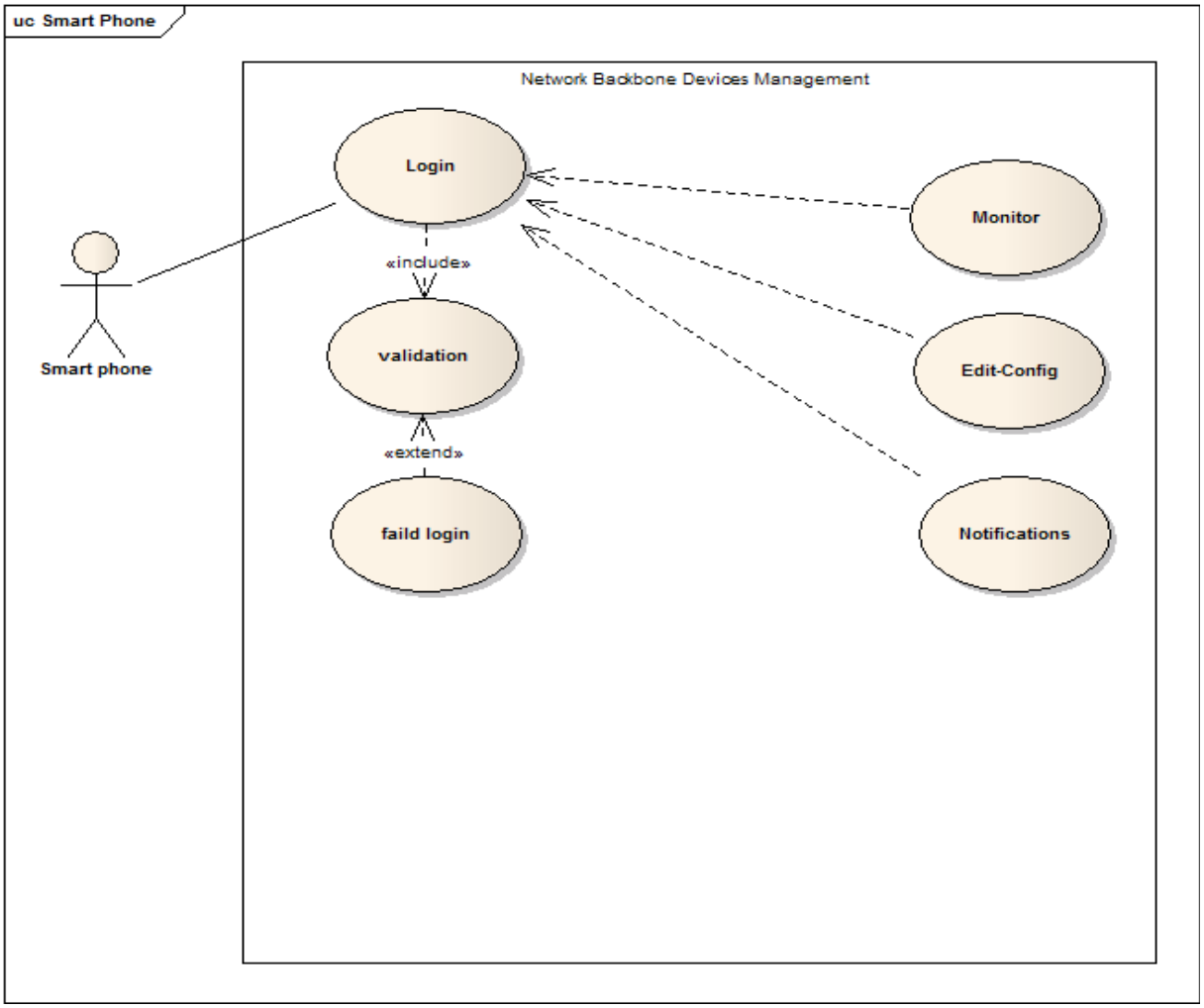


Figure (4.3): use case diagram for smart phone

Sequence Diagram 4.5.2

This scheme is used to show how processes operate with one another and in which order they operate, used to show the flow of data and messages between the various system components and it’s an essential component used in processes related .to analysis, design and documentation

The research contains seven sequence diagrams for the system each of them illustrates a function provided by the system whether to the administrator or .smartphone

Login Process 4.5.2.1

The system requires the user to enter username and password to login to the system as shown in the table (4.1) and figure (4.4).

Table (4.1): Login process

Use Case Name	Login	
Actor	Administrator	
Preconditions	No	
Main Flow of Events	The system asks the administrator .to enter username and password	.1
	The administrator enters .username and password	.2
	The desktop interface asks the .system to join	.3
	The system returns ID to network administrator	.4
	The system checks the validity of .the input information	.5
	If input valid the system returns ”“login successful	.6
	”else “login failed	

.It is logged on the system .7

Post Conditions	The system displays a graphical interface containing all the basic operations that can be performed by the system user.

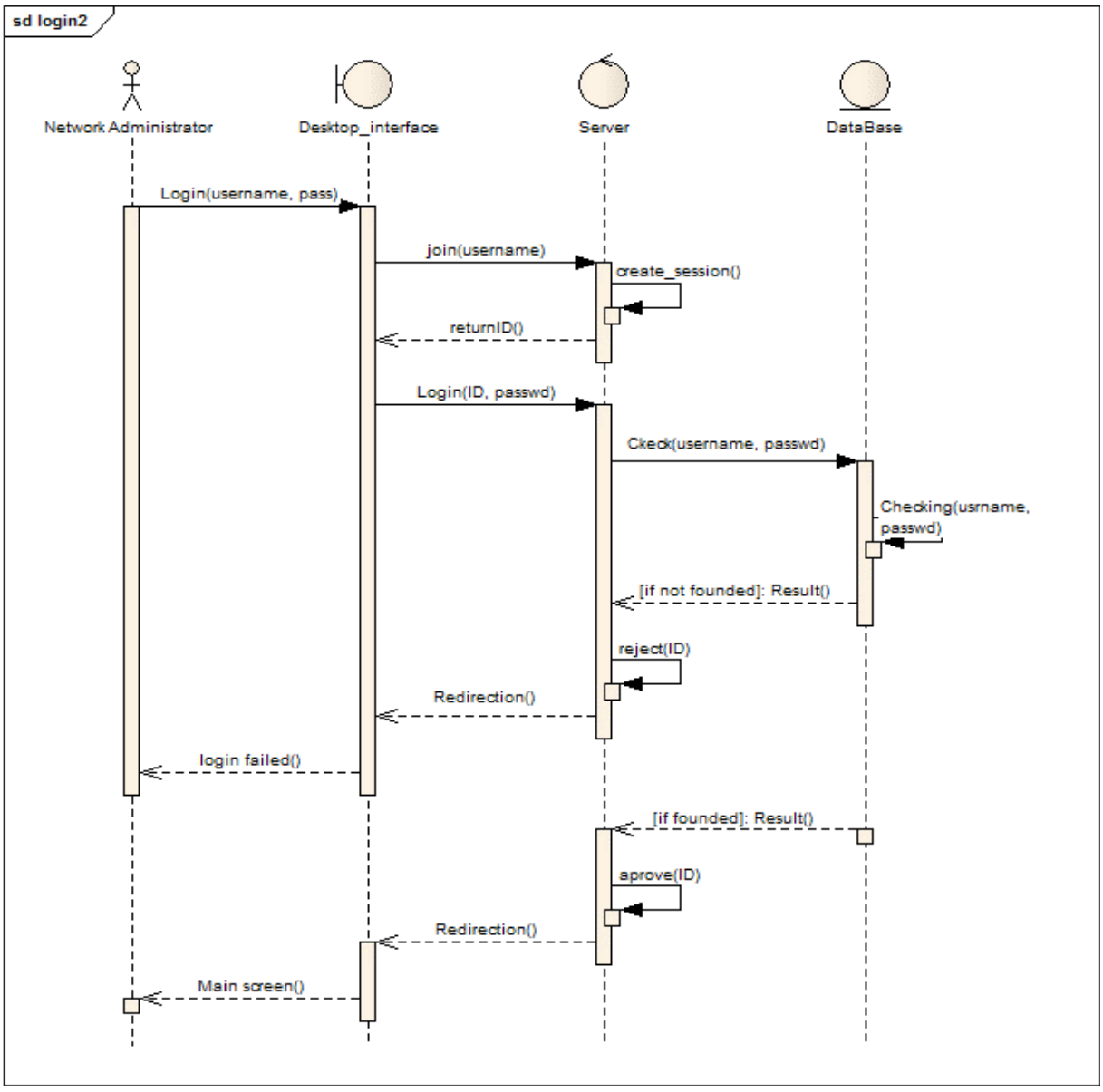


Figure (4.4): sequence diagram for login process

Monitor Process 4.5.2.2

After the administrator successfully login, the system allows administrator to (monitor the devices as shown in the table (4.2) and figure (4.5

Table (4.2): Monitor process

Use Case Name	Monitor
Actor	Administrator
Preconditions	Successfully login
Main Flow of Events	.1 The administrator determines the device and asks the system show the status of a device.
	.2 The system gets information related to the device of its own file.
	.3 The systems display the status of the required device.
Post Conditions	The system displays a graphical interface containing status and details of the device.

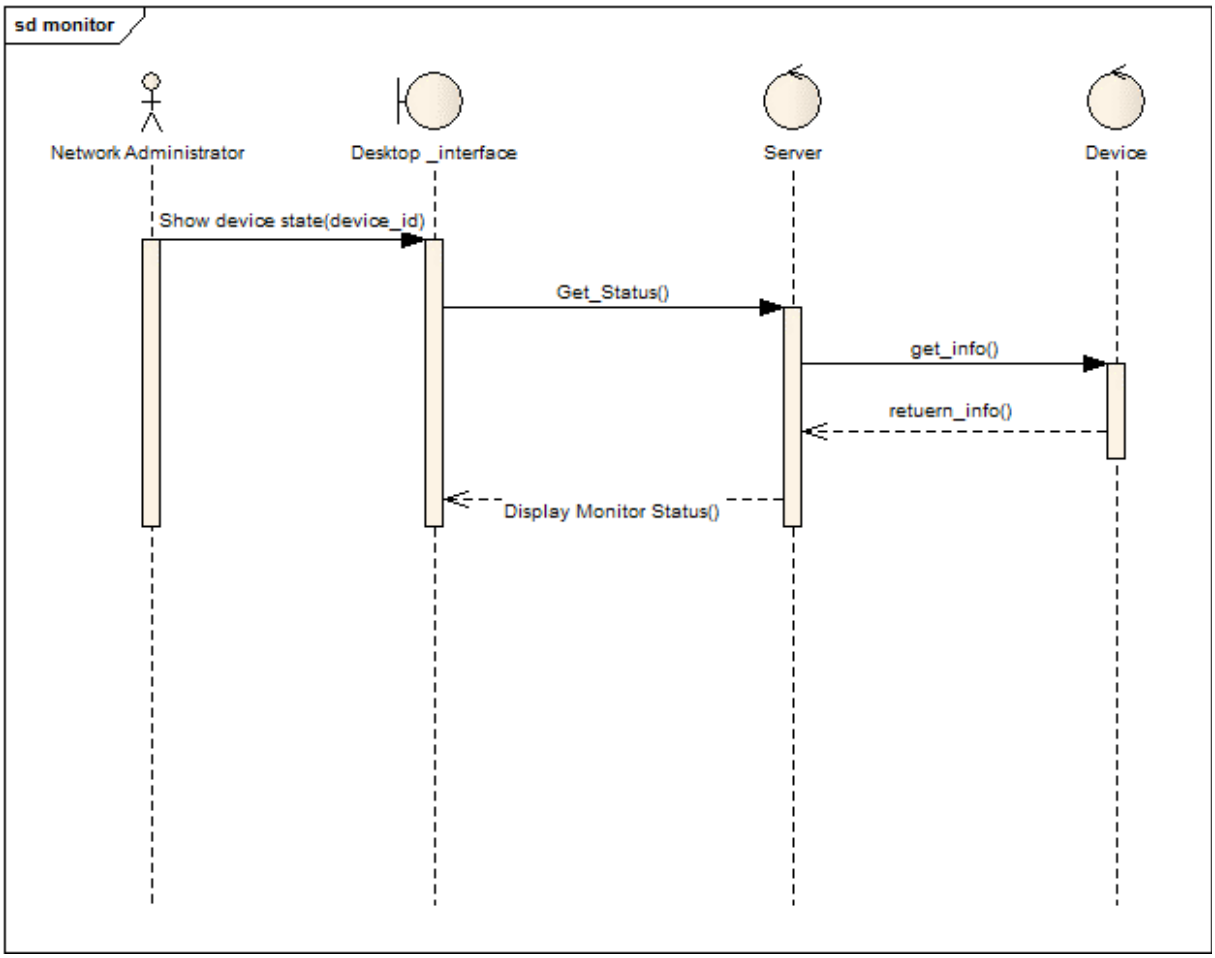

sd monitor
Network Administrator
Desktop _interface
Server
Device
Show device state(device_id)
Get_Status()
get_info()
retuern_info()
Display Monitor Status()

Figure (4.5): sequence diagram for monitor process

Edit Configuration Process 4.5.2.3

After the administrator successfully login, the system allows to the system (administrator to edit configuration as shown in the table (4.3) and figure (4.6.

Table (4.3): Edit Configuration process

Use Case Name	Edit Configuration
Actor	Administrator
Preconditions	Successfully login
Main Flow of Events	1. The administrators enter the new Configuration.
	2. The system checks the Configuration.
	3. Generate the new configuration command.
	4. After that notify the user the change is made.

Post Conditions	The system displays message illustrate that the edit completed successfully.

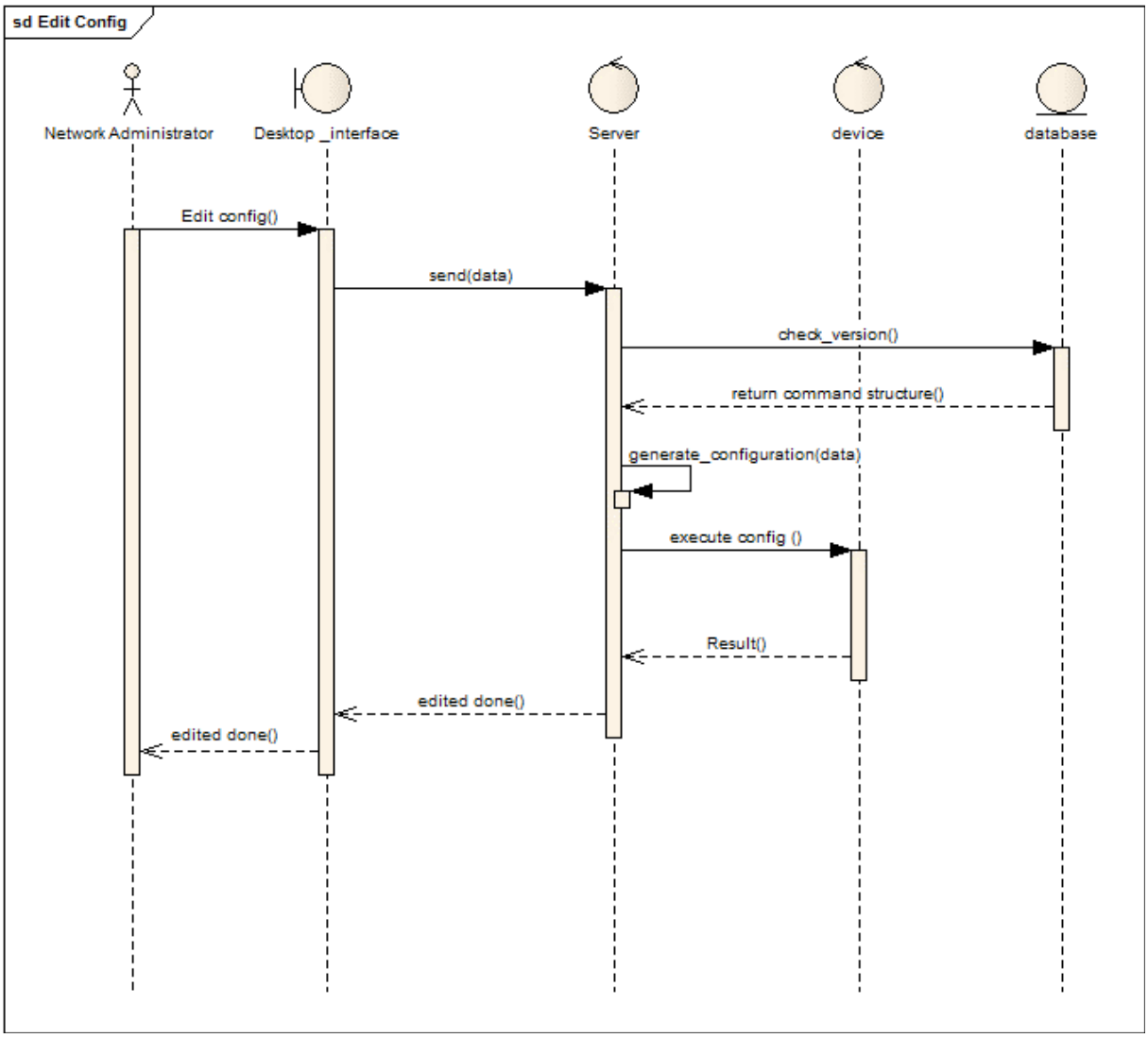


Figure (4.6): sequence diagram for edit Configuration process

Backup Process 4.5.2.4

After the administrator successfully login, the system allows the administrator to backup all the configuration as shown in the table (4.4) and figure (4.7).

Table (4.4): Backup process

Use Case Name	Backup
Actor	Administrator
Preconditions	Successfully login
Main Flow of Events	1. The administrator determines the device and asks the system to make backup.
	2. The system copy running configurations and store them in the database.
Post Conditions	The system displays message illustrate that the backup completed successfully.

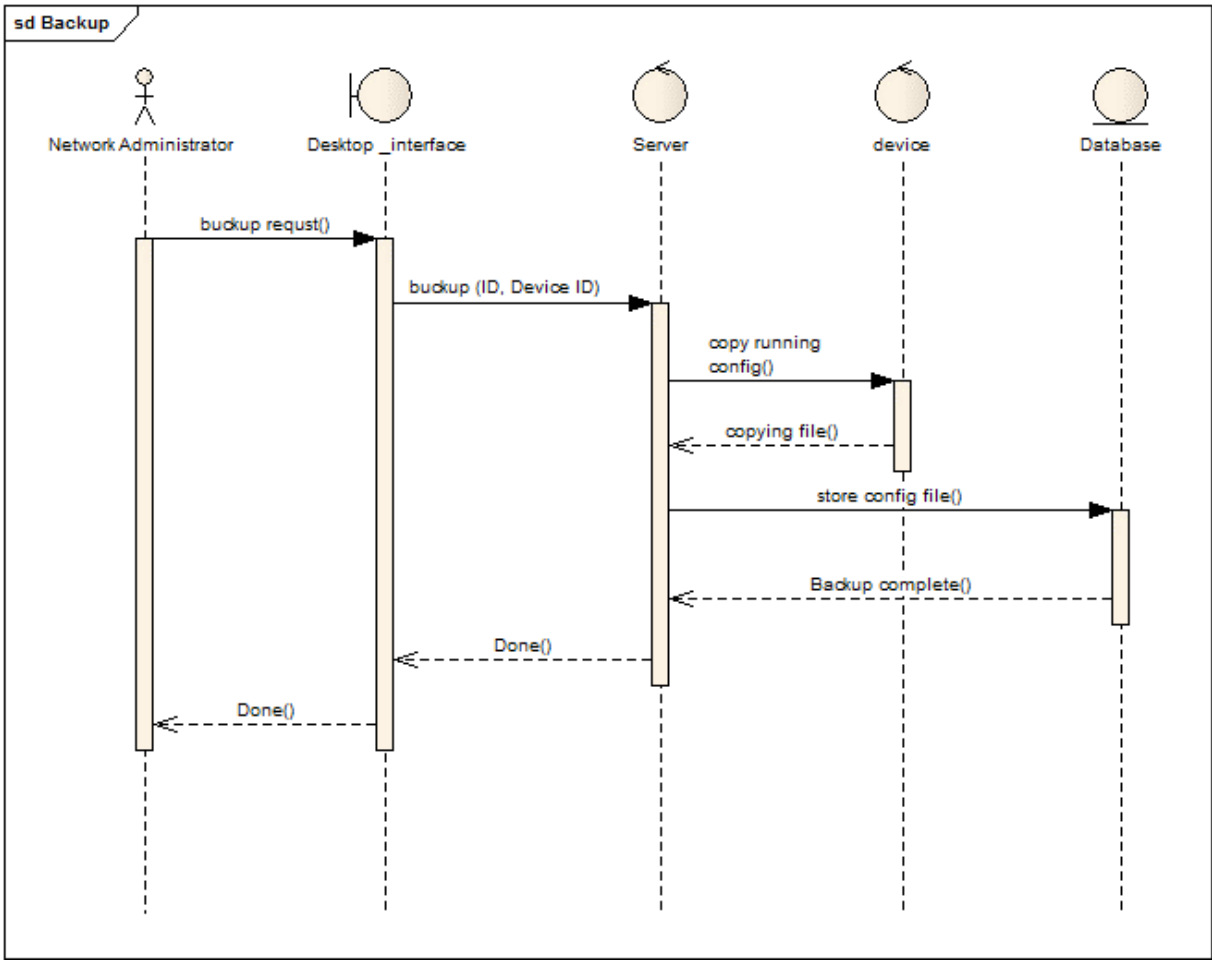

sd Backup
Network Administrator
Desktop _interface
Server
device
Database
buckup requst()
buckup (ID, Device ID)
copy running config()
copying file()
store config file()
Backup complete()
Done()
Done()

Figure (4.7): sequence diagram for backup process

Restore Process 4.5.2.5

After the administrator successfully login, the system allows administrator to .(restore the device that is already exists as shown in the table (4.5) and figure (4.8

Table (4.3): Edit Configuration process

Use Case Name		Restore
Actor		Administrator
Preconditions		Successfully login
Main Flow of Events	.1	.The administrators choose the device
	.2	The system checks devices and making .restore
	.3	The system translator and reconfigurations .even the devises from differently vendors

.4	.It restores the devices
Post Conditions	The system displays message illustrate that the operation completed successfully.

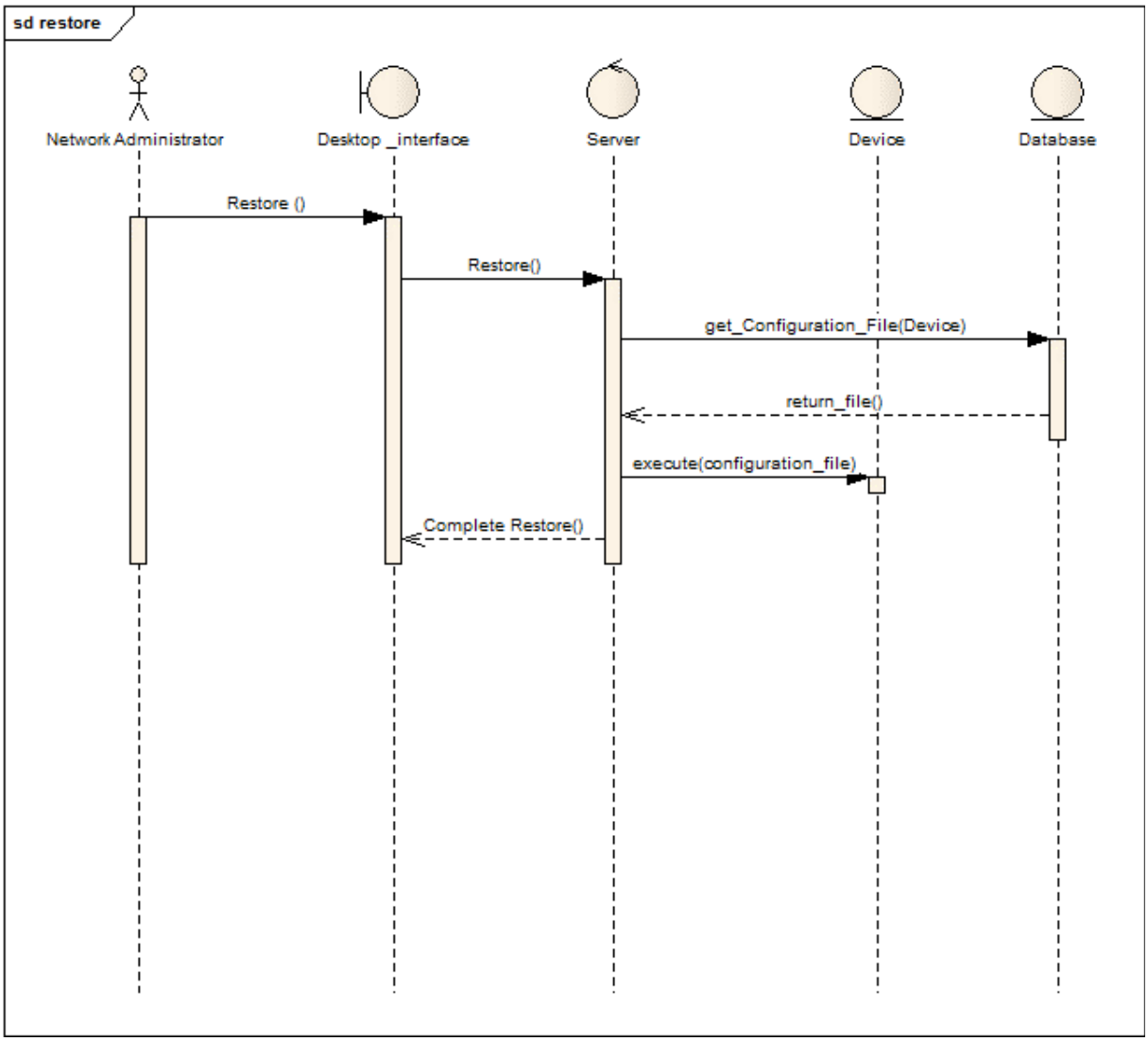


Figure (4.8): sequence diagram for restore process

Schedule Process 4.5.2.6

After the administrator successfully login the system allows administrator to (schedule as shown in the table (4.6) and figure (4.9

Table (4.6): Schedule process

Schedule		Use Case Name
Administrator		Actor
Successfully login		Preconditions
The administrators enter time and services to be deny.	.1	Main Flow Of Events
The system checks the data and time to deny the services.	.2	
The system displays message illustrate that the operation completed successfully.		Post Conditions

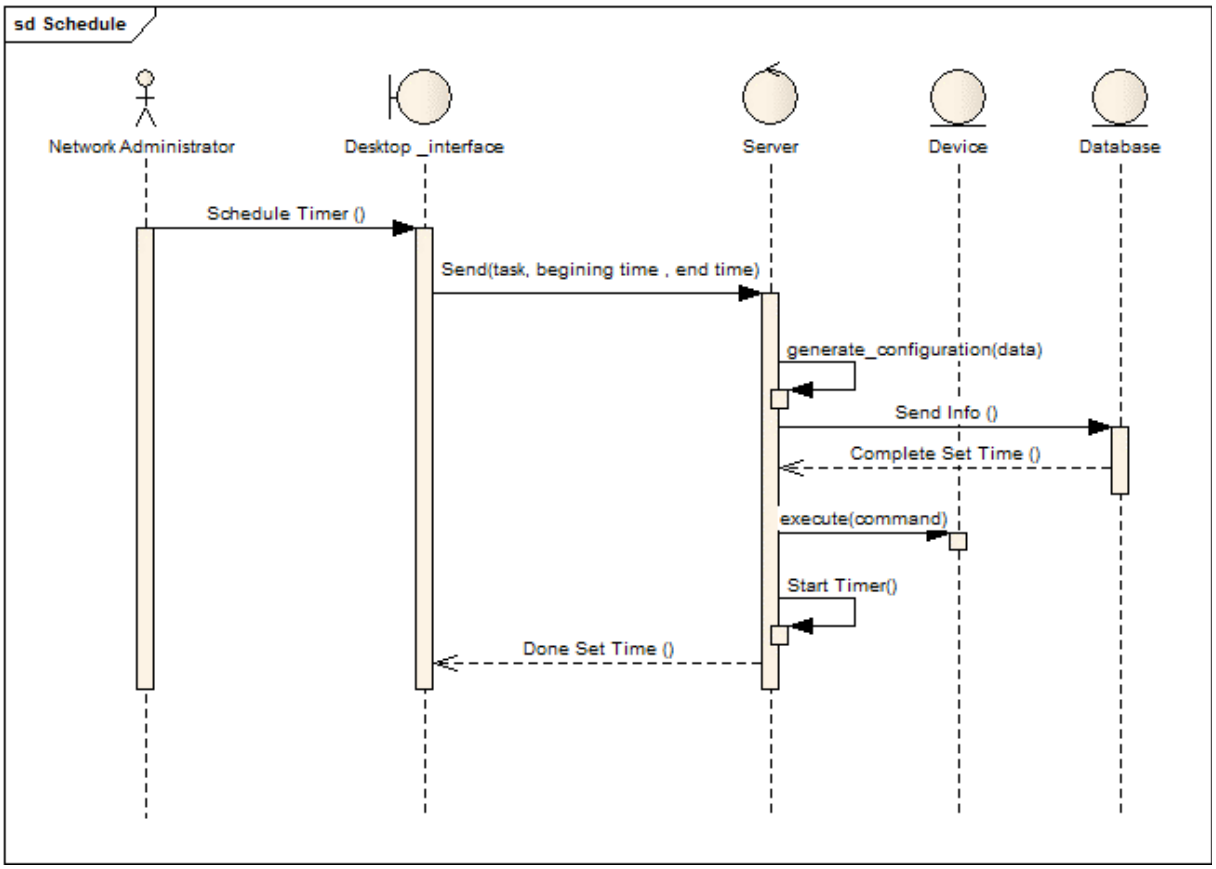


Figure (4.9): sequence diagram for schedule process

Notifications Process 4.5.2.7

After the administrator successfully login the system allows administrator to get (notifications as shown in the table (4.7) and figure (4.10

Notifications		Use Case Name
Administrator		Actor
Successfully login		Preconditions
The system alerts the administrator when critical problem occurs.	.1	Main Flow Of Events
The administrator displays the notifications and provide access remotely to network.	.2	
The system display the notified device.		Post Conditions

Table (4.7): notifications process

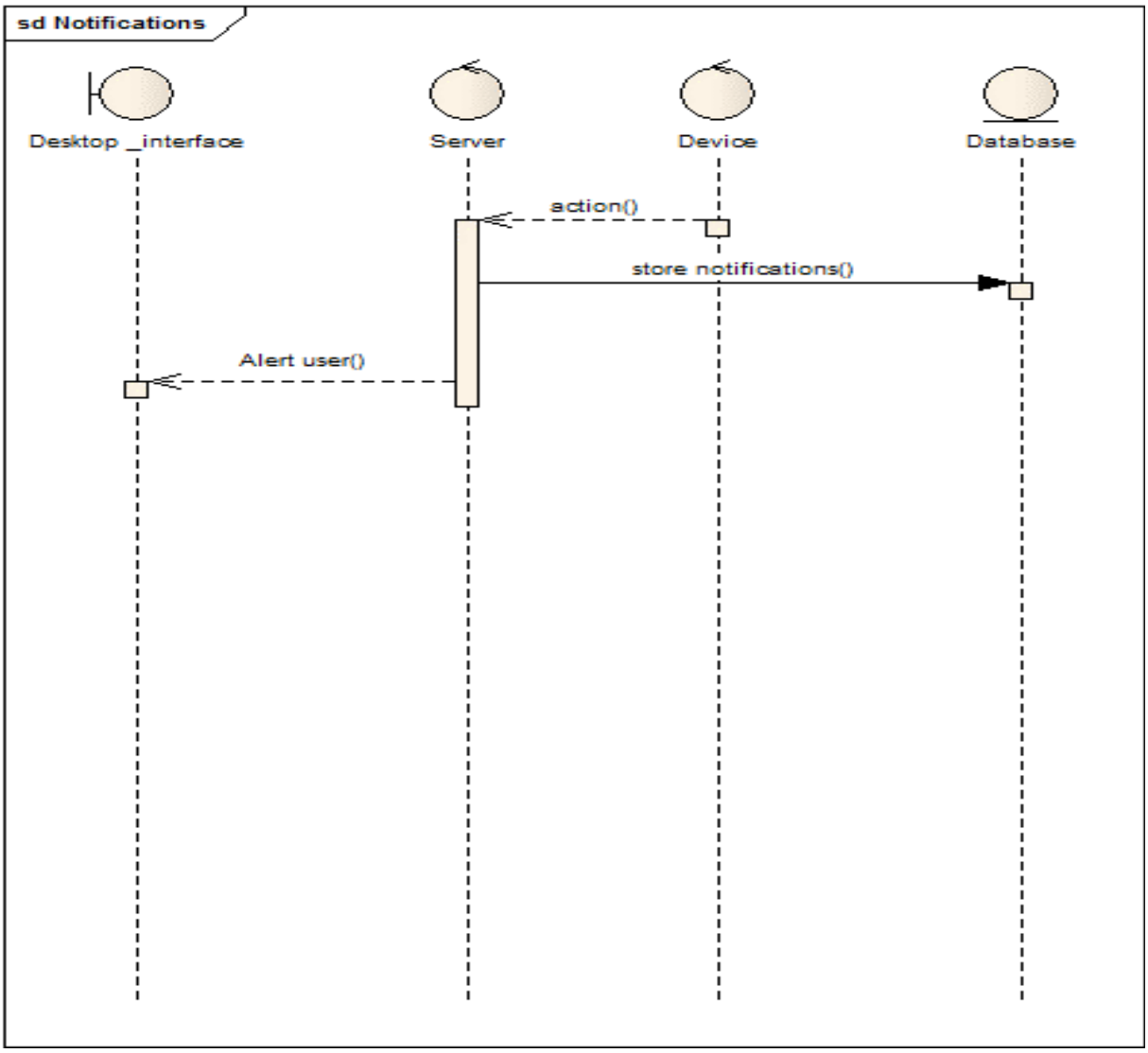


Figure (4.10): sequence diagram for notifications process

Deployment Diagram 4.5.3

Deployment diagram illustrates hardware and software used in the system and .how these components interact with each other

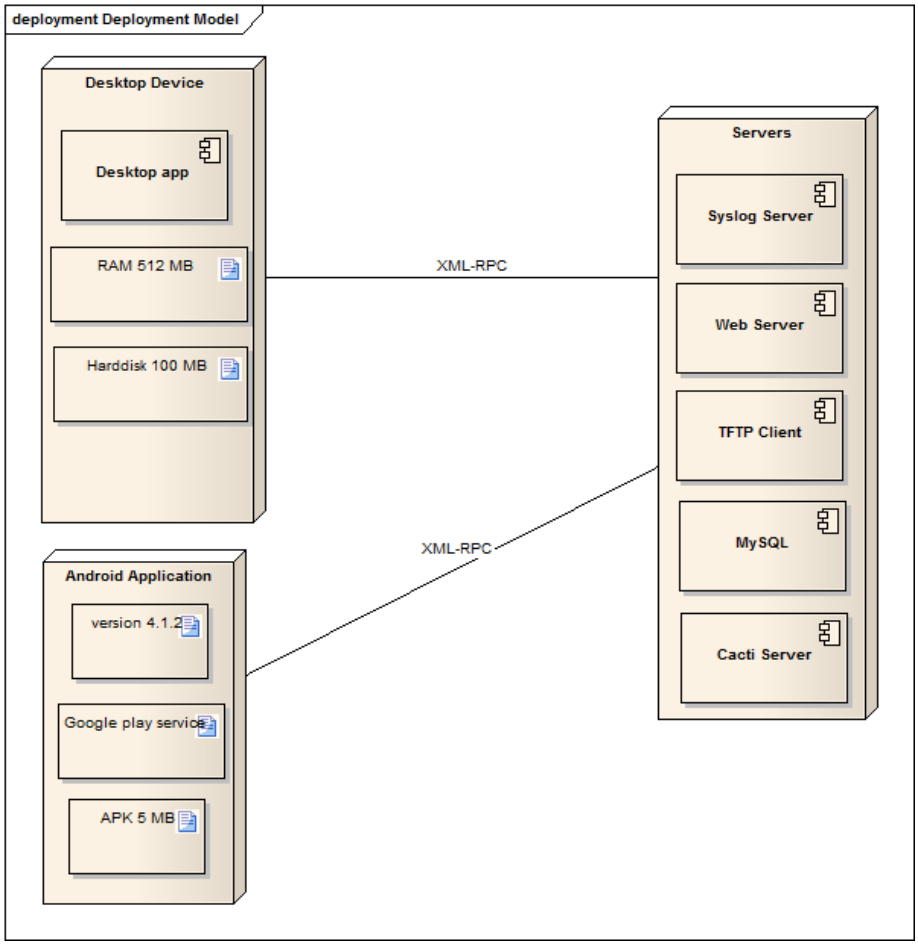


Figure (4.11): Deployment Diagram

CONCLUSION 4.6

This chapter addressed the description of the proposed system and its functions.

On the other hand, it takes this section to analyze the operations of the system using .UML diagrams

CAPTER FIVE

IMPLEMENTATION

INTRODUCTION 5.1

This chapter deals with the graphical interfaces for (desktop application, Android Application); explain the components and how it works.

This chapter discusses the implementation of the system and how the server and clients will communicate with devices, as we shown in (figure 4.1) the server works as an intermediate between clients and the devices that constitute organization network.

NETWORKING ENVIRONMENT 5.2

A network scenario has been created using GNS-due to cost limitations of using real routers.

This scenario contains of many routers connected to each other based on the topology defined by network administrator. Any device in this network configured to be reachable from any connected node, so static route configured or routing protocol has been enabled in each device

Finally, confirmed the SSHv2 activated in all routers in addition to a local username and password created in all Routers.

SERVER SIDE 5.3

When server starts a connection to database establish and set of operations and verification processes will execute.

Loading Devices 5.3.1

The server fetches all information about devices from database, and based on it server establish SSHv2 connection with each device and save them as objects to make server execute configurations on specific router during the runtime.

TFTP Server verification 5.3.2

TFTP Server has several operations likes (putFile, getFile… etc.),
so the main server checks TFTP server and it root Directory to ensure
it connectivity for future exchange of configuration files between
.server and router

Starting Syslog Server 5.3.3

The server start listening for syslog client which will be a router
and waiting for an event of arrival logs to store them in the database

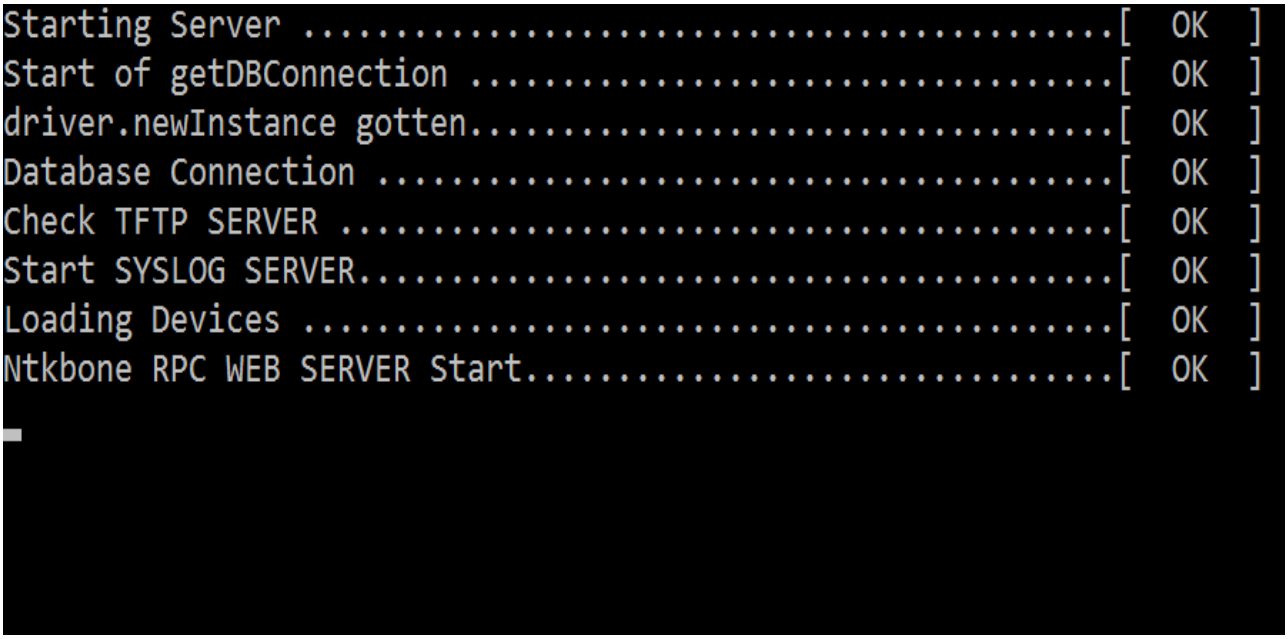


Figure (5.1): server first screen

DESKTOP APPLICATION 5.4

Login screen 5.4.1

The next screen used for login to the system

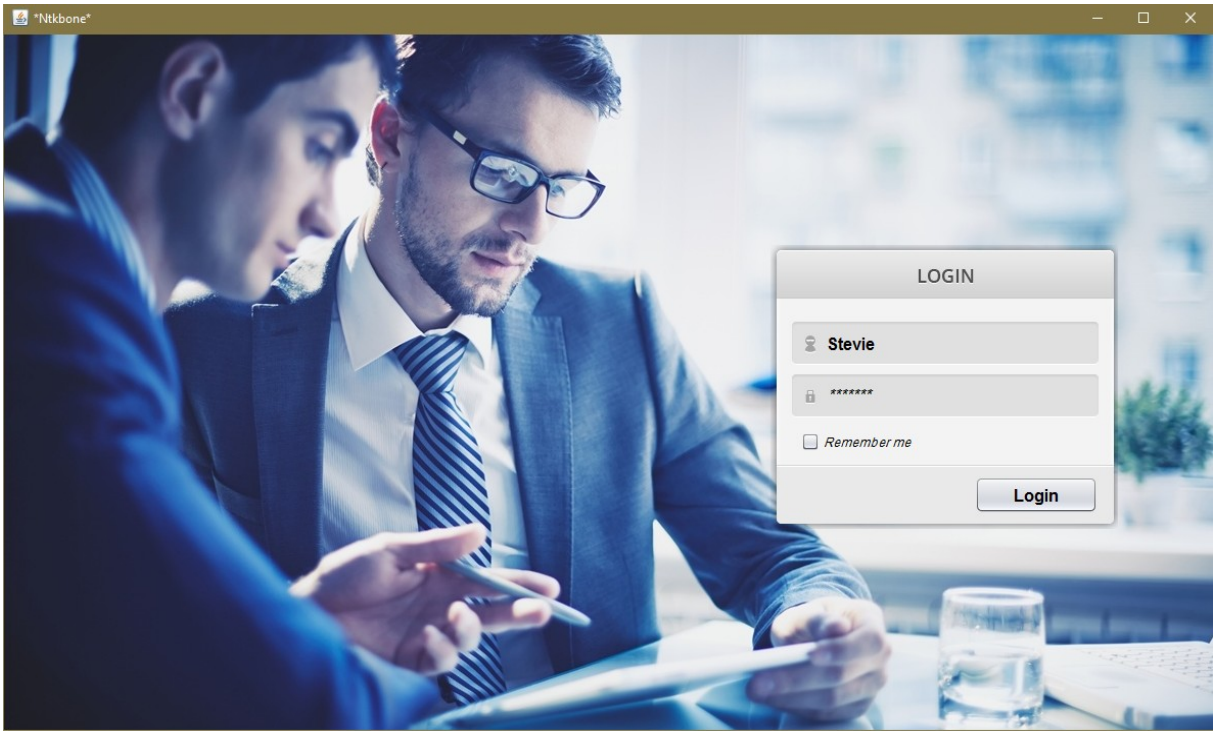


Figure (5.2): Login screen

Main screen 5.4.2

The next screen show the main functions of desktop application such as backup, monitoring, restore, add or delete user, notifications .and configure new device

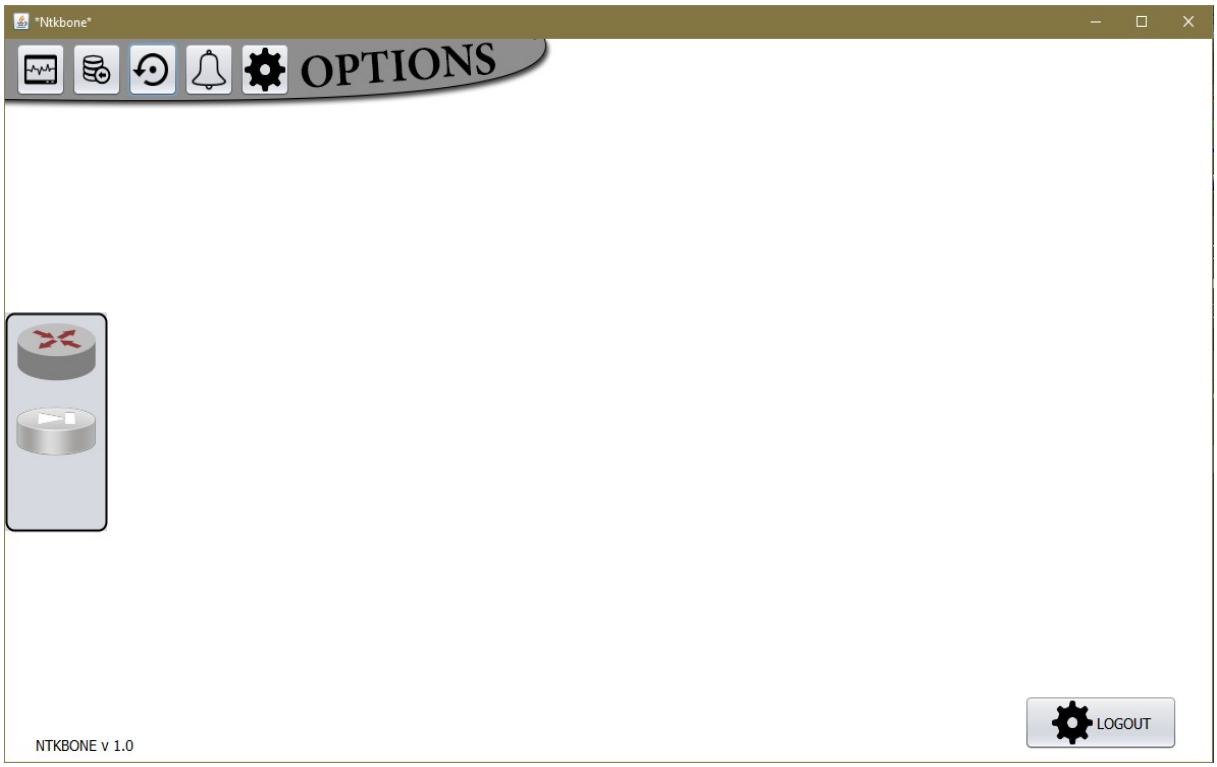


Figure (5.3): Main screen

Add Device 5.4.3

The next screen show addition of new router and its basic configuration

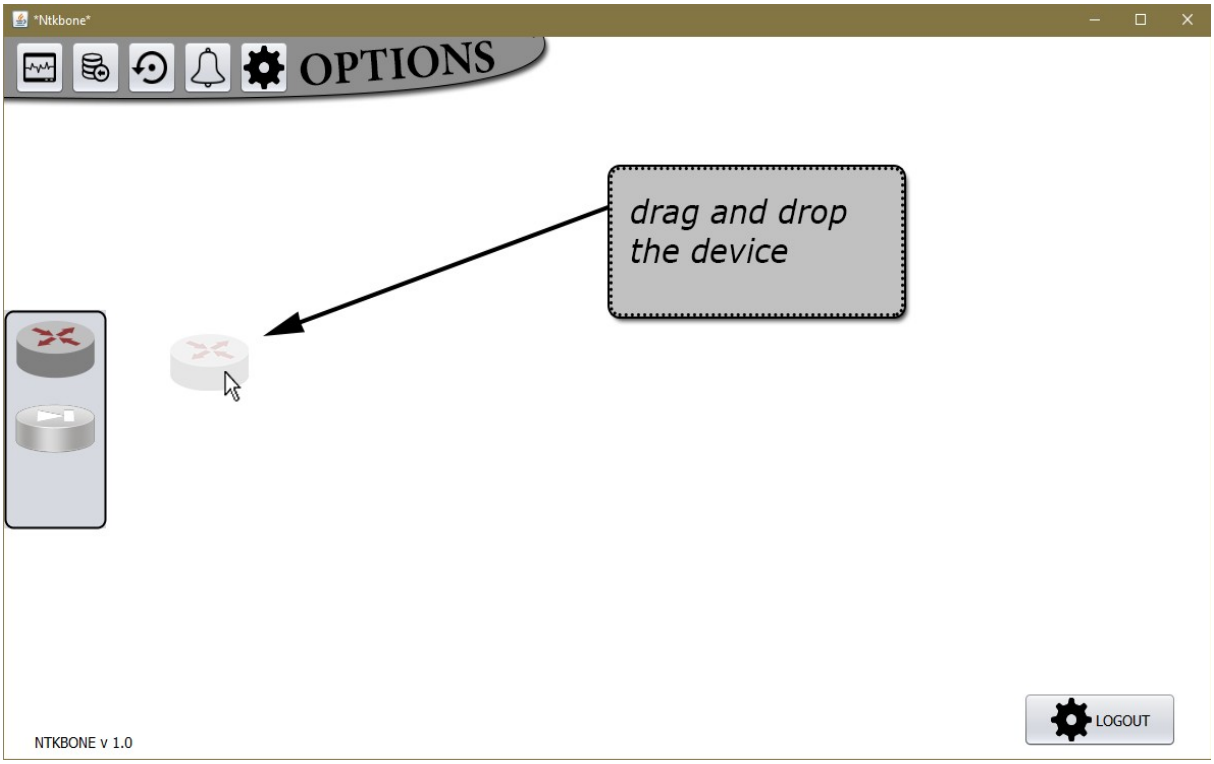


Figure (5.4): Add router screen

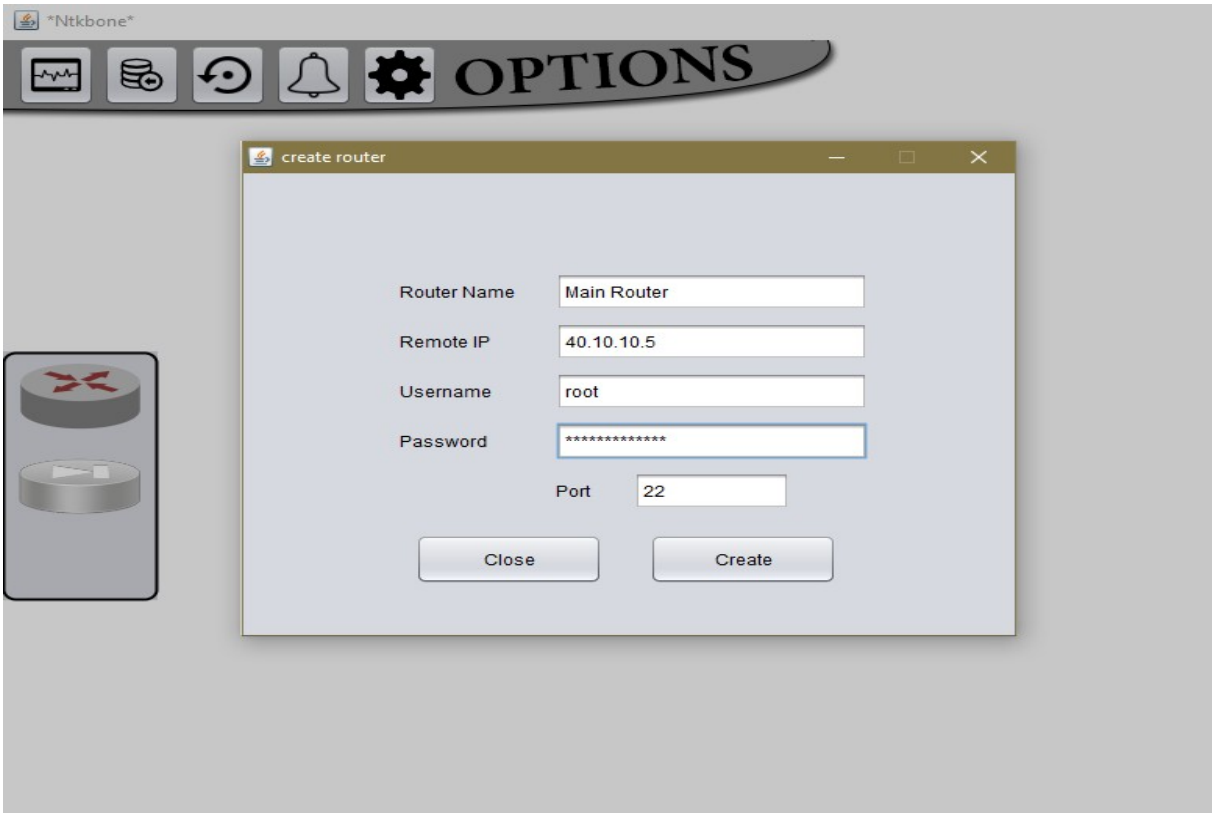


Figure (5.5): Configure router screen

Interfaces configuration and status 5.4.4

The next screen show how router interfaces accessed to apply new ACL group, shut down the interface, configure DHCP and show interface state.

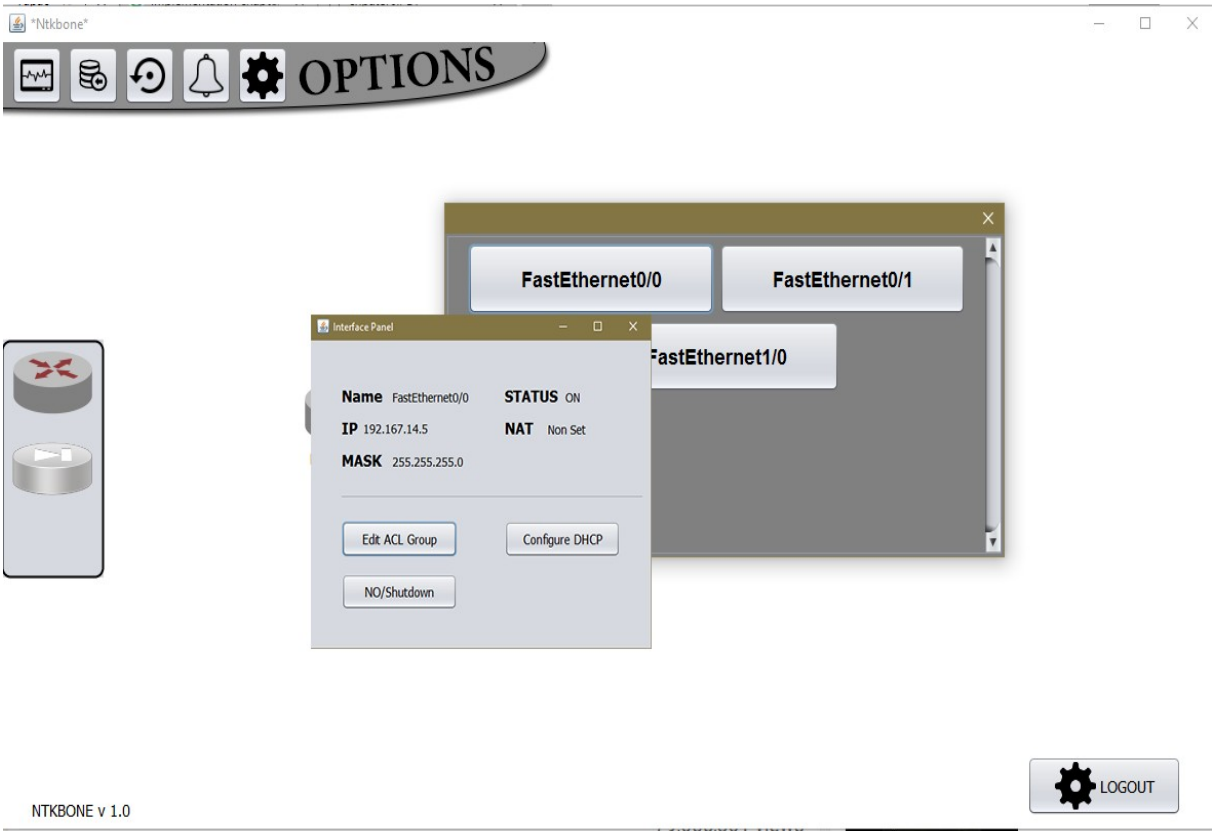


Figure (5.6): router interface screen

Access List Screen 5.4.5

The next screen show how to add, edit or delete access list ((standard or extended

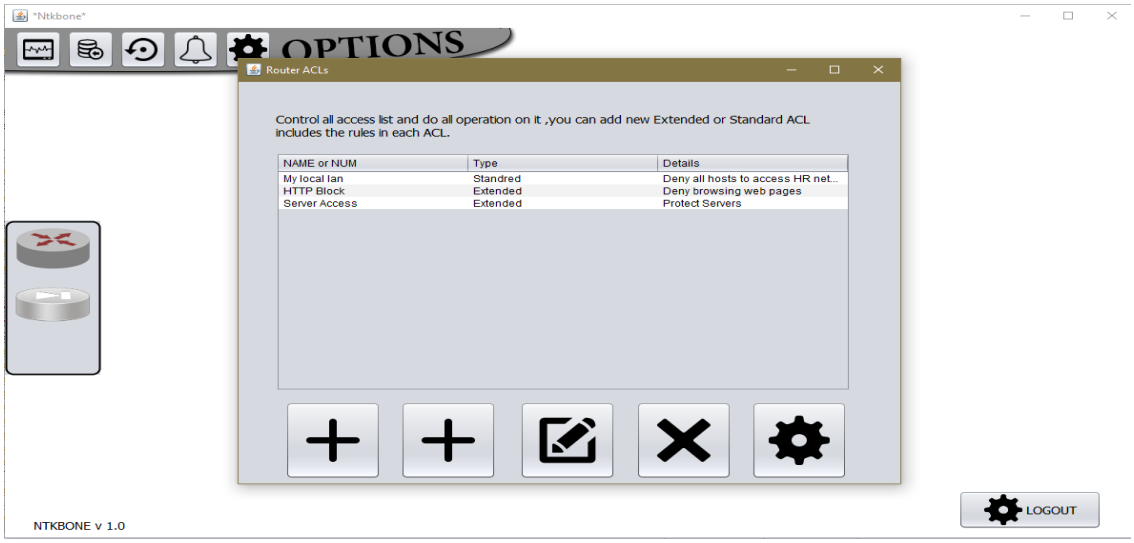


Figure (5.7): Access List screen

Many network administrators find themselves in trouble when they Telnet into a router and begin applying an access list and the most problem of writing an access list

is the sequential nature of it which make administrator cannot remove a line from an access list or swap rules. This software solved this problem by the next interface with flexible handling of rules with the availability of delete, edit or swap rules which are .not available before in the use of command line

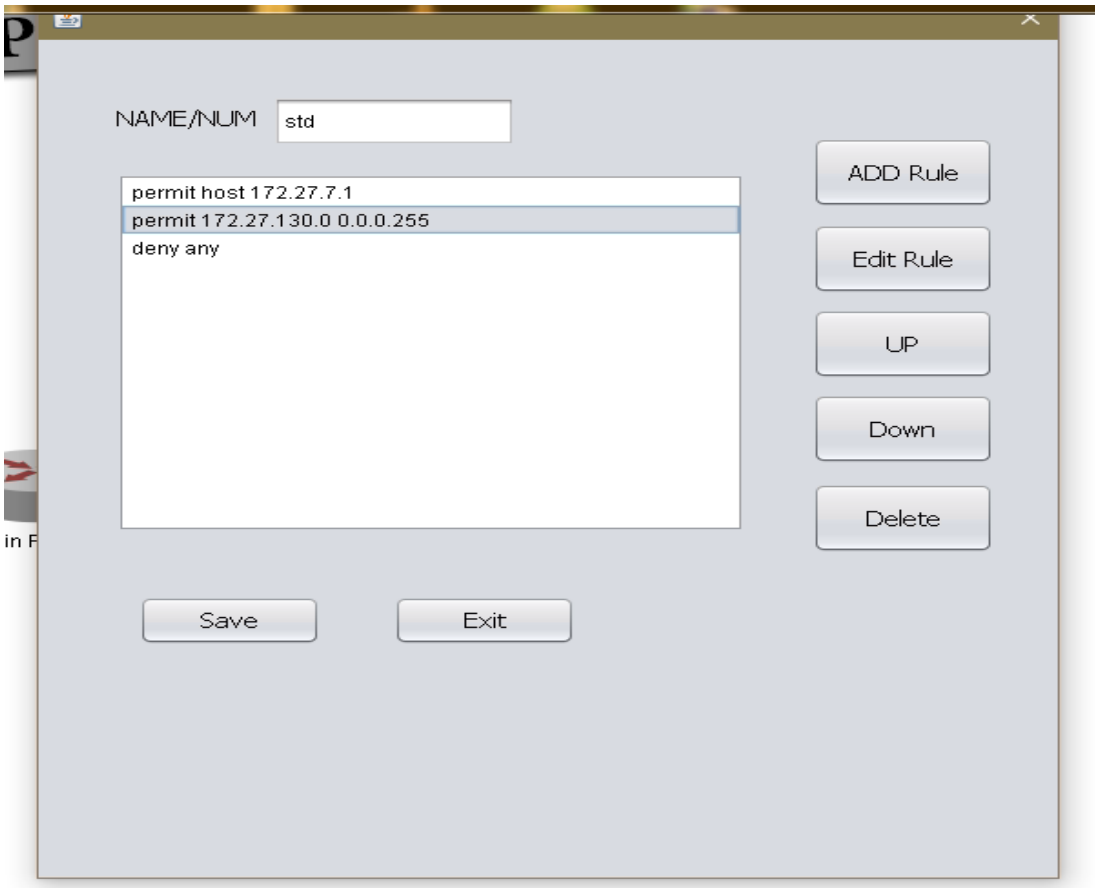


Figure (5.8): Access List Setting

ANDROID APPLICATION 5.5

Main screen 5.5.1

The next screen show system logo

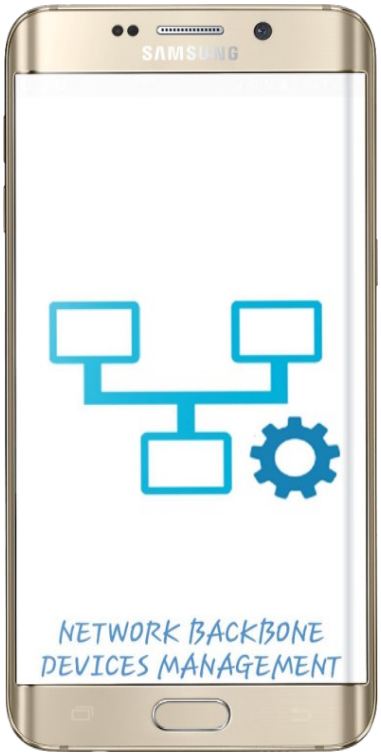


Figure (5.9): system Logo

Login 5.5.2

The next screen show that administrator must enter username ,password and press login button to be able using the system

Figure (5.10): administor login

Home Interface 5.5.3

The next screen show that after logging to the system and verify the username and password, moves to administrator home

interface which contains the operations of the system administrator ((Display Network

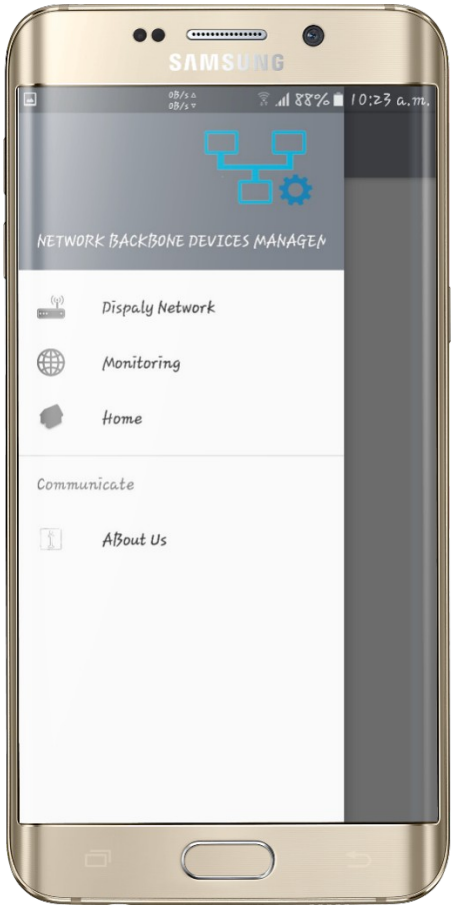


Figure (5.11): Home interface

Display Network 5.5.4

The next screen show that when administrator pressed on (Display Network), moves to display list of routers in network with ID and IP for each router by pressing on the router show more details

Figure (5.12): list of routers in network

Router Interface 5.5.5

The next screen show router interface state wither its up or down

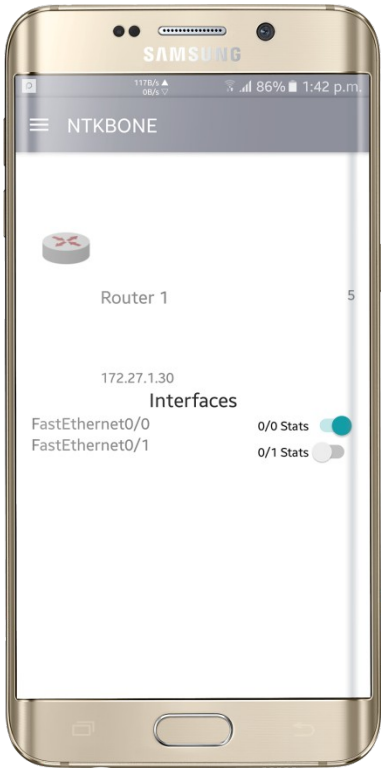


Figure (5.13): router interface

Notification 5.5.6

The next screen show that the system notify the administrator and provide access remotely to network

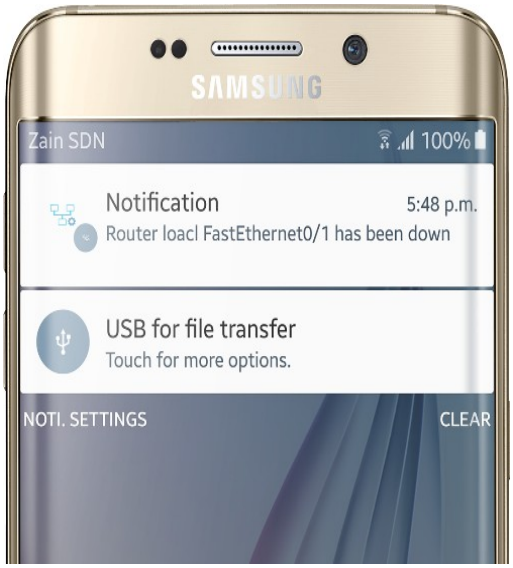


Figure (5.14): Notification

CHAPTER SIX

RESULTS, CONCLUSION AND RECOMMENDATION

INTRODUCTION 6.1

This chapter display research results that have been accessible after implementing the system and recommendations for future research and studies.

CONCLUSION 6.2

System software has been established and implemented to provide help to network administrators in managing the backbone devices in the network of institution by using graphical interfaces for only one vendor (Cisco) and no special configurations are made except the NAT.

As the software aims to be addition to the administrator it provides simple tool to control and maintain the work of network devices, add access list rules on the routers and notify administrator about network problems.

RESULTS 6.3

The application was tested in android smart phone and desktop application and achieved the goals of the research successfully by:

- Create Graphical Interfaces to configure devices.
- Provide simple way for administrator to access backbone devices of institution network from any location.
- Sends alerts to network administration when critical problems happen and provide access to the network, even from a remote location.
- Backup and restore network devices configuration
- Apply scheduler of specific configurations that performs for a fixed period of time

RECOMMENDATIONS 6.4

After the completion of this project and applied it, we recommend the following to improve the system:

- More development of the system to make it work on other operating system for smart phones (e.g. IOS, Windows Phone) to keep up with technological evolution.
- Applying IPV6.
- Include switching
- Apply BGP commands.
- Include all Huawei and Juniper commands.
- Do some special GUI for firewall.
- Does some security link such as (finger point, and encryptions).

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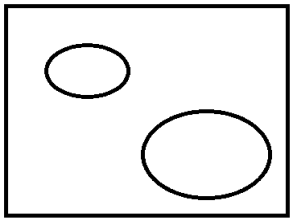
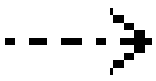
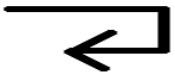
APPENDIXS

Appendix (I) explain the symbols used in the modeling and analysis system using UML diagrams

Shape Description	Shape name	Shape
He is system's user he could be a person, machine or even another .system or part of system	Actor	
Describes and shows the interaction over time with a single meaning for the end user of the system to perform a specific job. Used to enhance the functional requirements and details of the implementation of the system	Use Case	
Is a workbook that contains a collection of the use cases that are applied inside	Boundary	
It is identify the single instance and all of the data .of this instance	Data base	
Results of procedure calls	Massage response	

General type of relationship between the elements. May bear the name at each end of the role of the item in the end, may also bear the multiplicity and the direction and limitations. Used to convey an inheritance	Associate	
Refers to the flow of information or control is transferred between the elements. Used in all schemes of interaction	Message	
Reflect or suggest anew process known as the life line's operation	Self-Message	
A control is a class that represents a controlling entity or manager	Program logic	
A boundary is a class that represent, typically a user interface screen	User GUI	
A component is a replaceable part of a system that conforms to and provides the realization of a set of .interfaces	Component	

A node is a physical element that exists at run time and represents a computational resource, generally having at least some memory and, often, processing capability	Node