



Faculty of Electrical and Computer Engineering

Dissertation for obtaining a bachelor degree
development of Network Draw Software for automatic drawing of network topology

Writer:

Ehsan Eslami

Supervisor:

Dr. Leili Mohammad Khanli

2022 spring

Abstract

In the Computer Networks world, drawing and monitoring the network topology is of particular significance for resolving the network problems. Development and expansion of Computer Networks increasingly in various scales as well as the internet development make network topologies more complicated, which this makes it difficult to draw and monitor the network. In this thesis, in addition to state the progressive challenges about the stable maintenance of the network and the reduction of network disturbances due to its precise monitoring, a detailed study of the software that smartly draws the network topology has been conducted. By connecting to the regarded computer network, this software has the ability to draw the network topology automatically for the aim of network monitoring.

Contents

chapter 1	Introduction	1
1-1	Introduction	1
1-2	Main challenges	2
chapter 2	A review on basic concepts and general idea of project	3
2-1	General idea of project	3
2-2	Telnet connection	4
2-3	CISCO routers	4
2-4	Graphical network simulator GNS3	4
2-5	Graph draw	5
2-6	Programming and software development	5
chapter 3	Different parts of project	7
3-1	Connection of software with router and extracting data	7
3-2	Analysis of data and drawing the graph	8
3-3	Algorithm optimization	11
chapter 4	Conclusion and summary	13
4-1	Summary	13
4-2	Conclusion	14
References		15

Chapter 1 Introduction

1-1- Introduction

The purpose for creating a computer network is to communicate among the computer systems, servers, and smart equipment such as mobile phones, smart TV, and etc. using the communicational equipment such as switch, router, modem, and so on. These computer networks can have different scales and sizes, from the connection of only two computers to the internal networks of a complex or even the world wide internet network, which is as wide as the entire world. Each computer network has definitely a type of topology. The network topology is a logical definition of the computer networks that includes how to connect computer systems and communicational equipment with each other. Network topology is typically the map and communication form of equipment. Network engineers and technicians who are responsible for communicating in the network and its stable maintenance, by drawing and having network topology can easily play the role in starting, developing, troubleshooting, and maintaining the network. Hence, having the topology of a network (especially networks with wide scale and dimensions) is of particular importance for network engineers. Computer networks engineers can draw and have

the topology of a network by extracting information from the network equipment such as switch or router, and analyzing this information, which this method includes various challenges that it will be pointed out in the following.

In this thesis, a software is investigated and developed, which instead of the network engineer who acted in the above method to draw the topology, the software itself automatically starts drawing the network topology by connecting to the network equipment and extracting data as well as analyzing the extracted data, and in addition to draw the topology graphically, it provides capabilities for real-time and online monitoring to the user, which typically turns this software into a network monitoring software. In this thesis, the way of operation, efficiency rate, time efficiency, and throughput of the software are examined.

1-2-Main challenges

The problems of the topology drawing by the network engineers are time-consuming and difficulty of this work for engineers. Also, since this work is done by individuals, there are the probability of error and wrong topology drawing which causes greater problems when troubleshooting.

In large-scaled networks such as Internet Service Provider or Internet self-foundation companies in a country, that the network is changing and developing permanently, there is not possible to have the momentarily network topology due to its time-consuming redrawing and being momentary, and the existence of such software can be so useful in the networks with these dimensions.

Chapter 2

A review on the basic concepts and general idea of the project

2-1- General idea of the project

General idea of this project originates from a combination of artificial intelligence and computer networks, so that if we want “to link the artificial intelligence with the world of the networked communications for setting up, developing, and maintaining the computer networks, the first way is to draw and typically understanding the map (topology) of network to artificial intelligence”.

The software that is investigated in this project is Network Draw, which is responsible for drawing the network topology. Since this software shows the network topology to the user graphically, the next idea of further development of the software can be the display of real-time network data including the routers data and the links data, to turn this software into a graphical monitoring software in addition to automatic drawing of topology.

The project of Network Draw software with the help of the network engineers can play a significant role in resolving fault quickly and developing the network. This

software is most effective in large networks, because the network permanently is changing and developing, and the network topology cannot be drawn frequently. Another strength of this software is its high promptitude, which provides topology and data of network equipment for users within several seconds, while this work takes a long time when it is done by network experts manually.

2-2 Telnet connection

In a computer network, there are different methods to access to the network equipment via the computers connected to that equipment. One of these methods is Telnet connection service, so that with this connection and giving a valid password for that router or switch, you can connect to the Console of that device and implement your desired configuration. Telnet service works by TCP protocol and port 23, and for run, it is sufficient that your connection with the desired router is established (having ping router) and Telnet setting is enabled in the router. **Network Draw** software is connected to the network equipment and extracts desired data using the Telnet service and by giving a valid password.

2-3-CISCO routers

In the network world, there are some routers with various brands that most important and best routers in the world belong to the CISCO Company. Since the way of displaying data and sending instructions of each brand is different for routers, Network Draw software has been programmed to communicate, extract data and analyze data of CISCO routers, and it can be executed on a network with a CISCO platform.

2-4-Graphic network simulator GNS3

GNS3 is a network simulator software that is used to simulate the complicated networks with the possibility to combine the virtual and real devices. Due to the fact that when configuring in GNS3, we also draw the topology practically, with regard to the performance of the software, the best way to test software is that a network is

configured in GNS3, and run the software in the same system that is connected to the network configured in GNS3 through a virtual network card, and examine the results.

2-5- Drawing graph

The topology or map of a network is typically a graph, nodes of which are the network equipment (router) and its lines are the links between these equipments.

According to the topology, the shape of this graph can have different states, which for drawing this network graph in software, the combination of multiple libraries is used that is explained in continuing this thesis.

2-6-Programming and developing software

To develop the Network Draw Software, the Python programming language is used. The libraries used in the code of this software include:

Tkinter(6) (graphical environment of software)

PIL (call the photo to software)

Re (using Regular expression)

Telnetlib(1) (using Telnet)

(extracting data from the computer network card in which the software runs)

Netifaces(1)

Numpy(5) (drawing graph)

Pandas (drawing graph)

Networkx(4) (drawing graph)

Pyvis(1)(2) (drawing graph)

The programming this software is implemented about 700 lines of codes, which finally turns into an executable file (exe.) on each system with each operating system by Pyinstaller tools. (1)(3). Considering that this software is written by Python programming language, there is no limitation for it in terms of the amount of data storage in the arrays of the code, and based on the amount of 64-bit or 32-bit processor in which the software is executed, it has the ability to store about 21000 to 56000 items in the array. As a result, in case of hardware processor support, this software has no limitation in terms of drawing a network with high numbers of the routers.

Chapter 3 Different parts of the project

3-1-Connection of software to router and extraction of data

The performance of this software can be investigated in two sections, the first section is the connection of software with router and extraction of data. The performance of Network Draw Software is that it first displays an IP which is the Default Route IP of computer to the user, that user can change it and must enter a password which is valid for all routers, then the software is connected to the first router, IP of which has been entered using the Telnet service, and by sending the instructions, it extracts data from the router for printing the desired data to the router, and by received data, it processes them and detects the IPs of neighbors Routers of the first router, and inserts them in its list respectively in order to connect to them one by one by using Telnet service and extracts the desired data. When software does not detect a new router, it stops and starts drawing the graph.

The software extracts data from all network routers only by receiving IP of one of the network routers and a password. In performing this process, the software will display the error message to the user in case of encountering each of the problems such as lack of connection, lack of Telnet communication, wrong password, input parameter of wrong IP, and greedily draws the graph or topology of the network as far as it has access.

Considering that most LAN networks (Local Area Network) are connected to their upstream network, which is often in the form of WAN (Wide Area Network), to communicate with Internet, it is natural that this software cannot connect to the router of the upstream network with the given password at the border of its own

inner network, but this software, even in drawn topology, draws the router of upstream network that is connected to the software at the border with inner network. This issue shows being greedy of the software in order to draw a more complete topology as far as possible.

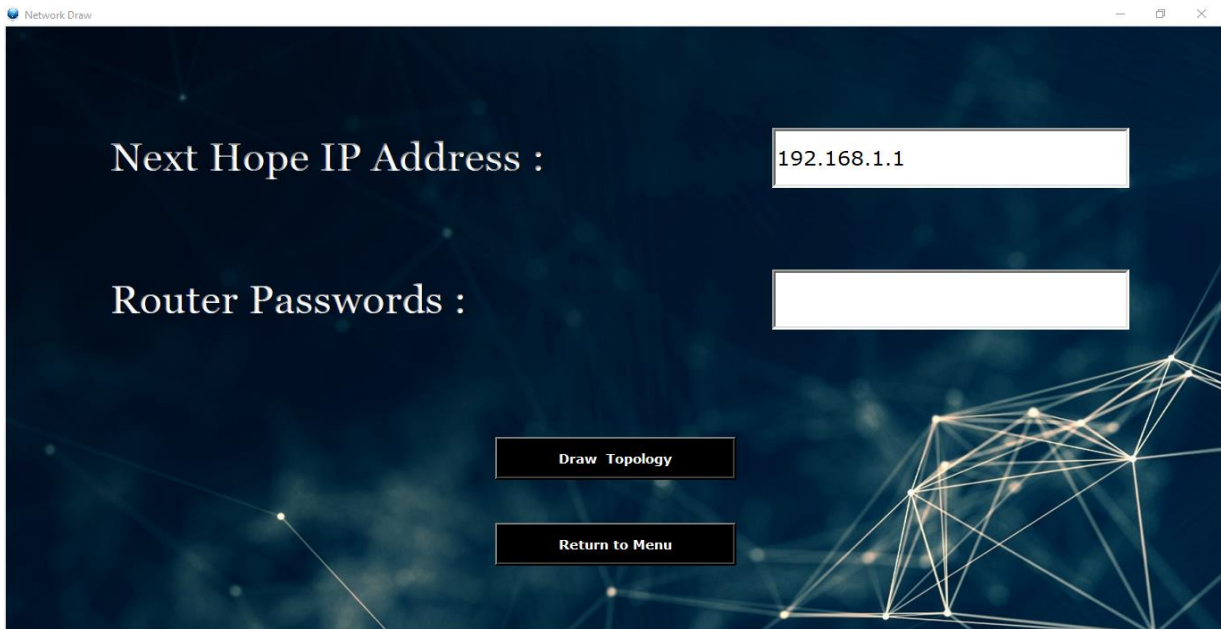


Figure 3-1: page of entering input parameters for communicating Telnet connection

3-2-Data analysis and drawing graph

After extracting data from the routers, it is time to analyze the obtained data. The data that comes from the router to the software in response to the instructions sent, is in the form of a string which by using Regular expression, it stores all data required in its memory for drawing graph and display monitoring such as IPs, router name, router type, traffic load, number and type of the links, Uptime, CPU, and so on, and then it will display when drawing the graph. After extracting the data of a router, the software analyzes and stores the data, and then it proceeds connecting to the next router. The form and shape of the printed data in response to the instructions sent in the router Console are specific to Cisco, so analyzing data is based on the type of the input responses. As a result, at present, this software is only executable with Cisco routers, but the type of router does not affect the software performance. A small part of unprocessed data and received from the router is as follows:

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/0	192.168.59.100	YES	NVRAM	up	up
FastEthernet1/0	192.168.12.1	YES	NVRAM	up	up
FastEthernet2/0	192.168.15.1	YES	NVRAM	up	up
GigabitEthernet4/0	unassigned	YES	NVRAM	administratively down	down

Cisco IOS Software, 7200 Software (C7200-ADVSECURITYK9-M), Version 15.0(1)M10, RELEASE SOFTWARE (fc1)

This product contains cryptographic features and is subject to United

--More-- \x08\x08\x08\x08\x08\x08\x08\x08 \x08\x08\x08\x08\x08\x08\x08\x08A summary of U.S. laws governing Cisco cryptographic products may be found at:

<http://www.cisco.com/wwl/export/crypto/tool/stqrg.html>

If you require further assistance please contact us by sending email to

Cisco 7206VXR (NPE400) processor (revision A) with 245760K/16384K bytes of memory.

Processor board ID 4276256513

PCI bus mb0_mb1 (Slots 0, 1, 3 and 5) has a capacity of 600 bandwidth points.

The set of PA-2FE, PA-POS-2OC3, and I/O-2FE qualify for "half

5 FastEthernet interfaces

Device ID: Router2

IP address: 192.168.12.2

Platform: Cisco 7206VXR, Capabilities: Router

Interface: FastEthernet1/0, Port ID (outgoing port): FastEthernet0/0

Cisco IOS Software, 7200 Software (C7200-ADVSECURITYK9-M), Version 15.0(1)M10, RELEASE SOFTWARE (fc1)

Technical Support: <http://www.cisco.com/techsupport>

Copyright (c) 1968-2013 by Cisco Systems, Inc.

After the software in the network did not find a new router to connect, and typically connected to all routers that could be connected, now it is time to draw a graph based on the processed data extracted from the routers and it has stored its memory.

This software makes a graph by using **networkx** library and displays a graph by using **Pyvis** library. The networkx library has ability to build a graph by giving the data of the Nodes and their connections. The Pyvis library has ability to display a graph in the graphical form with high capabilities in the form of a web page by giving the graph made by Networkx. As a result, the topology drawn by software is stored and displayed in the form of a web page. In addition to display the network topology, the software provides the exact information of routers and links for user by holding click on each router or link.

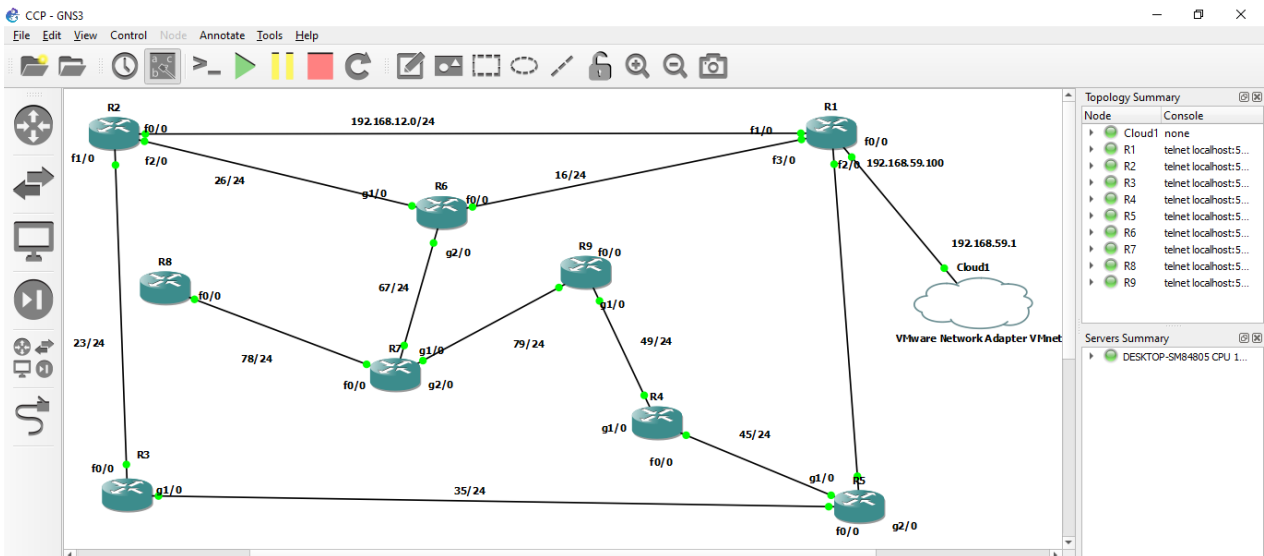


Figure 3-2: network configured in GNS3 with 9 routers

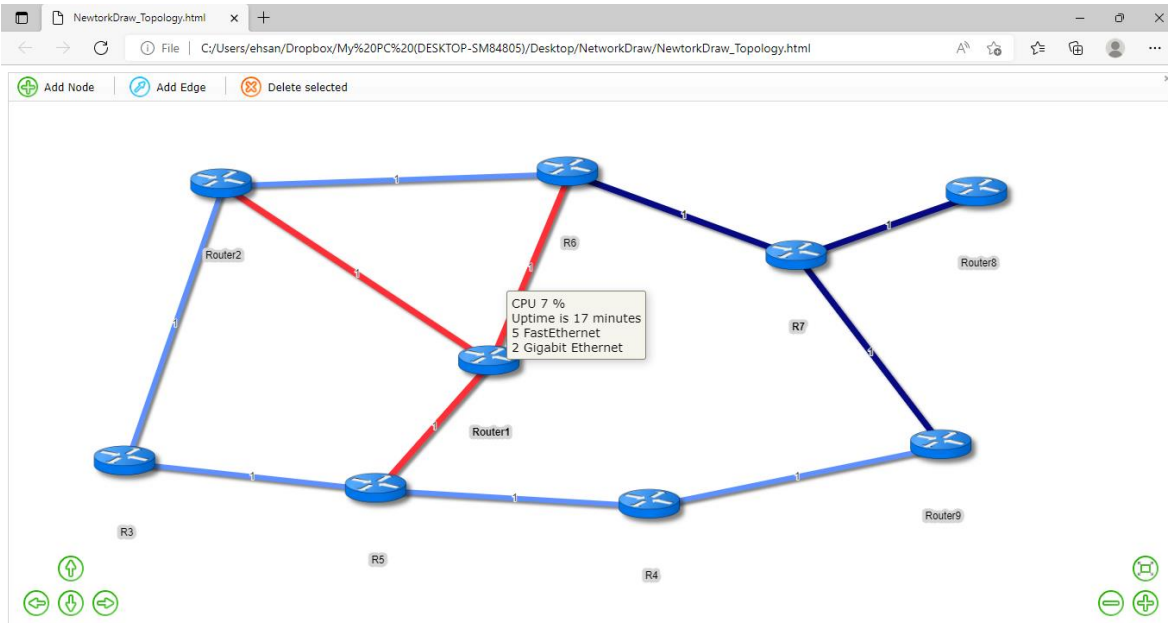


Figure 3-3: drawing the topology of network in the form of web page

3-3-Algorithm Optimization

According to the higher efficiency of the software in large-dimension networks, the promptitude of the software has been one of the considerable cases. After the correct implementation and achieving the desired result, now is the time to optimize the algorithm and reduce the time spent in software processing. Several parameters are involved about the promptitude of the software including the network connection speed, the processor of the system that executes the software, and software algorithm. Regarding the first two parameters i.e. the network connection speed and processor, no intervention can be performed to improve the promptitude, but about software algorithm, it can be improved as much as possible.

One of the tasks for optimizing the algorithm was to reduce the storage lists in order to search in each list. In fact, instead of searching in several various lists, the main data is stored in a list to find a new router in the network, and the same list is searched only once.

Another task for optimizing the algorithm that had many effects on the software promptitude, is to prevent repeated connections to routers. Considering that each

router has several links and somehow several IP, if this software is connected to one of the router IPs and extracts the data, it is not reconnected to the router with its other IPs. During the testing of the software with a network configured in GNS3 with 9 routers, the test results before and after optimization after 10 times of testing are as follows:

In the state of before optimization of algorithm, average promptitude of software is equal to: 48 seconds

In the state of after optimization of algorithm, average promptitude of software is equal to: 19 seconds

Another time, a test was implemented with 5 routers, result of which, before and after optimization after 10 times of testing are as follows:

In the state of before optimization of algorithm, average promptitude of software is equal to: 37 seconds

In the state of after optimization of algorithm, average promptitude of software is equal to: 11 seconds

It should be mentioned that since most of the processor of the software executing system is spent on the virtual network with 9 routers, consequently, the promptitude of the software will definitely be lower than the above numbers in the real mode (connected to the real network).

chapter 4

Conclusion and Summary

4-1-Summary

Network Draw Software with the exact operation and partly fast and by receiving an IP and Password can provide the data of the network routers as well as drawing the topology of the computer networks graphically for users. This software with optimized algorithm can be connected to the network routers, extract their data, analyze the data, and finally draw the network graph completely and without defect by obtained data.

4-2-Conclusion

This software has the possibility of great growth and development in terms of the ability to communicate with other methods such as SSH with routers, and the possibility to communicate with the other network equipment such as Switch or DSLAM, the possibility to communicate with other brands of the network equipment such as Mikrotik or Huawei, and the possibility to manage the network by sending the instructions for configuring network. “by increasingly growth and development of the computer networks throughout the world, the need for artificial intelligence in the network world will be felt more day by day that the steps are being taken for this purpose by developing the software such as Network Draw.

References

- <https://stackoverflow.com/questions/> (1)
- <https://pyvis.readthedocs.io/en/latest/tutorial.html> (2)
- <https://pyinstaller.org/en/stable/spec-files.html> (3)
- <https://networkx.org/> (4)
- <https://github.com/> (5)
- </library/tkinter.html>³<https://docs.python.org/> (6)

