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Performance Evaluation of Routing Protocol OSPF with GNS3

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Abstract: With the time duration Networking progress played a main role in communication and the progress shows better results with Networking Protocols. Because they offer a standardized means for moving data across various devices and networks, networking protocols are crucial in the computer industry. They provide correct and effective data transmission as well as the comprehension and processing of data by network devices. It would be challenging for various networks and devices to connect and share information without these protocols. By giving networks and devices a way to authenticate and encrypt their interactions, networking protocols also play a significant part in computer networks. Open Shortest Path First (OSPF) on simulators Opnet and packet tracer. Performance evaluation of OSPF protocol enhances the functionality and is more effective for transmission among OSPF performed in networks. These ratings were organized by a search of 50 articles from IEEE, ScienceDirect, Semantic Scholar, and Microsoft Academic databases. The evaluation is around convergence, delay time, and analyze the performance of the protocol.

Keywords: Networking Protocols, GNS3, OSPF, OPNET.

1. Introduction

The Open Shortest Path First (OSPF) routing protocol is used to distribute routing data across a single autonomous system (AS) in a network. It is a link-state routing (LSR) protocol, which means that it creates a view of all networks by figuring out the links' states (i.e., the connections between two systems) and then utilizing data to determine the optimum route for data transmission. OSPF is a classless routing protocol, which enables it to accommodate varied network topologies inside a single OSPF area and variable-length subnet masks (VLSMs)[1]. Hierarchical routing is also supported, allowing for better scalability and the more effective use of network components. The usage of a hierarchical network that is separated into zones is one of OSPF's distinguishing characteristics. An area ID, a 32-bit number that is specific to each area, is given to it. All other areas in the OSPF domain are connected to the core network, sometimes referred to as area 0, at this point. An area border router connects every other area to the core network[2]. Each broadcast and non-broadcast multi-access network uses a designated router and a backup designated

router in OSPF. The network's OSPF routers elect the Designated Router and Backup-Designated Router, which charge to overseeing router-to-router communication[3].

In this study, networking protocols Enhance the performance of protocols in the network time efficiency which is an important thing for networking performance, and protocols Save packets and transfer information which is highly beneficial for networking. The fact that OSPF can accept variable-length subnet masks is one of its key advantages[4]. As a result, subnets of various sizes can be created, allowing for more effective use of IP address space. This is especially beneficial for large networks because using a single subnet mask would waste a lot of IP address space. Multiple pathways to a destination can be supported by OSPF, which is an additional advantage. Equal-cost multipath routing is used in this situation. As a result, traffic can be dispersed across numerous paths rather than being restricted to one, allowing for more effective use of network resources[5]. As traffic can be redirected in the event of a failure on one of the paths, this can help improve network resilience. Virtual links can also be used, according to OSPF. This makes it possible to connect two locations logically even if they aren't physically connected. The OSPF (LSDB) is what is used for this. The condition of each connection and the cost of each path are two details regarding the state of the network that may be found in the Link State Database[6].

Enabling quick network convergence shortens the time it requires for the network to resume regular functioning following a failure. OSPF can be used at the industrial level to link together several sites or factories. This enables the establishment of a single, cohesive network, which can be helpful for businesses that run several sites. OSPF can also be used to link several industrial control systems together, Supervisory control and data acquisition systems, as well as programmable logic controllers, are examples of such systems. As a result, it is possible to share data and develop a single, integrated control system.

The main goals of doing this research are:

- To work configure and ping all PCs in topology.
- To evaluate the analysis of OSPF simulation use for better connectivity of protocols and delay time and recovery between sender and receiver router.
- To take appropriate results in a graphical view of protocols using GNS3 simulation.
- Networking protocol OSPF protocol convergence, throughput, delay time, protocol performance analyses in simulator GNS3.

OSPF can be used in industrial networks to link together various industrial devices. As a result, it is possible to share data and develop a single, integrated control system. Additionally, OSPF can be used to link several industrial systems together, including systems integration and office communication networks. This enables the establishment of a single, coherent network, which might be advantageous for businesses that manage a different industrial network. OSPF can also be used to link several industrial networks together, including systems integration and office communication networks. Companies that run various industrial operations may find this handy.

This work is organized as follows: Section 2 contains the literature review. Section 3 presents the methodology of the study. Section 4 discusses the results. In last, the conclusion and future work is described in section 5.

2. Literature Review

In networking, network protocols constitute an important structure. The router uses IP messages (internet protocol packets) to help with network conversion. A router is a device that transmits data from a sender to a receiver, and dynamic protocols such as OSPF operate in networks as open-source protocols. The routing information protocol is a dynamic protocol, not a fast one[7]. Typically used in a network for

tiny systems. In the network, it assists with OSPF. It is mostly used for large-scale systems in networks and supports an unlimited number of routers. In the routing table, "O" denotes the OSPF protocol[8]. The ideal way for simulator performance is to give the simulator time to follow the parameters, which produces the best results. For (IP) networks, the OSPF routing protocol is employed. Since it offers variable-length subnet masks, that enable highly effective use of Internet Protocol address space, it is regarded as a classless routing protocol. Both service provider networks and enterprise networks use OSPF extensively[9].

The fact that OSPF can accept variable-length subnet masks is one of its key advantages. As a result, subnets of various sizes can be created, allowing for more effective use of IP address space. This is especially beneficial for large networks because using a single subnet mask might waste a lot of IP address space[10]. The result is A routing protocol called Open Shortest Path First (OSPF) is used to disseminate routing data within one autonomous system (AS) in a network. It is a link-state routing protocol, that indicates that creates a map of the whole network by figuring out the connections' states (i.e., the connectivity of two devices) and then uses that data to determine the optimum route for data transmission[11]. The attempt given forward by Opnet was used to assess network performance using three protocols: "RIP", "OSPF", and EIGRP, as well as performance measures for revised routing protocols such as "EIGRP", "RIP", and "OSPF". Emulation-specific "EIGRP" is the best option for any network topologies that require fast link and bandwidth management[12].

To select the most effective path for transmitting packets, OSPF enables routers to interact with one another and exchange details about the network's locations. In comparison to static routing, which employs predefined pathways that cannot react to network changes, this offers routing that is more flexible and scalable. In a performance network, the properties of major routing protocols require assistance from any router in the network[13]. Interior Gateway Routing Protocol (IGRP), Open Shortest Path First (OSPF), and other delayed routing technologies are used in networks, Routing Information Protocol (RIP), and Enhanced Interior Gateway Routing Protocol (EIGRP)[14].

The network at the resourceful office demonstrates that EIGRP network convergence is more intense than OSPF network convergence. The development of an IP routing table is identical to that of another routing table at the network layer with the addition of a layer of labeling in this approach. As a result, traffic that is not delivered via IP can be separated without the need for VPNs on specific systems[15].

IGP protocols like RIP, OSPF, and EIGRP are put into practice and examined in the specified topology. RIP configuration is simpler than EIGRP and OSPF configuration[16]. The point-to-point protocol is used to establish authentication between each router to protect information between the networks. Each router has a username and password, and interaction between two devices only happens if they match. In the same network, throughput, end-to-end delay, and convergence time are all examined. Convergence time, which is a key component of routing protocols, has a direct impact on throughput and end-to-end delays. Following further investigation, it was determined that EIGRP's convergence time is quicker than that of RIP and OSPF. In comparison to RIP, OSPF and EIGRP have reduced latency[17].

The simulation environment used wired network connections. These variables were all combined at once to test how well IPV4 and IPV6 performed[13]. It is evident from the findings that IPV6 with all these parameters outperforms IPV4 in every way. The amount of time a package needs to travel can be influenced by its size. If a packet's size in IPV4's RIP protocol is small, the packet will travel slowly. When using another routing protocol, on the other hand, a packet's short size will slow it down. Future wired and wireless network connections will support more routing protocols, as well as additional test data formats available in addition to text files[18].

3. Materials and Methods

This research was carried out by the principles of applied research, such as solving a real-world networking issue while providing an alternative, more advantageous answer based on theories and solutions to issues that have already occurred. This systematic study draws on four databases: Microsoft Academic, Semantic Scholar, ScienceDirect, and the IEEE Digital Library. Systematically, articles searched on these databases contain the performance of the protocol, Routing impact, impact of protocols and analysis of RIP, EIGRP, and OSPF protocols. Desire articles were given published last 10 years even so some articles from the past 1year have been added in this systematic review there about accessibility and range of the research studies article searched had it accomplished on different keywords which contain "network protocol" "gns3, OSPF networking protocol" "OSPF performance" and also use keyword simulator GNS3. During article searching accord different other related and similar articles were evaluated. The same articles eliminate between all of the articles. Explore 29 articles from IEEE, 12 articles explore from ScienceDirect, 164 articles explore from Semantic Scholar and also search 12 articles from Microsoft Academic. For the final review abstract and content choose 100 articles and the final 50 papers for systematic review. Totals analyze articles 217, and after removing the identical duplicate remaining articles 182, the next step eliminates articles and chooses on a title basis 134.

3.1. Data Collection

Table I show a database in which explore 29 articles from IEEE, 12 articles explore from ScienceDirect, 164 articles explore from Semantic Scholar and also search 12 articles from Microsoft Academic. Totals analyse 217 publications, and after eliminating the same duplicate articles that remained at 182, the next step removes articles and chooses 134 based on the title. Finally, in the examination of the abstract and content, 100 articles are selected, and the remaining 50 papers are for a systematic review.

Table 1. Database search

Data Bases	Search Strings
IEEE Xplore	("All Metadata": OSPF PROTOCOL) AND ("All Metadata": ROUTING PROTOCOL) AND ("All Metadata": OSPF)
ScienceDirect	OSPF, networking protocol OSPF, GNS3
Semantic Scholar	"OSPF networking protocols" + filters
Microsoft Academic	Performance of networking protocols, analyze OSPF protocol, OSPF networking protocols

3.2 Population of Sampling

Desire articles were given published last 10 years even so some articles from the past 1 year have been added in this systematic review there about accessibility and range of the research studies article searched had it accomplished on different keywords which contain "network protocol" "GNS3, OSPF networking protocol" "OSPF performance" and also use keyword simulator GNS3. Table 2 shows the population of sampling data which is gotten from a different publisher.

Table 2. The population of Sampling Data

Process	Selection Criteria	IEEE Xplore	ScienceDirect	Semantic Scholar	Microsoft Academic	Total
Screening	Keyword	29	12	164	12	217
Screening	Duplicate	25	09	138	10	182
Screening	Title	20	07	99	08	134

Further Screening	Abstract & Conclusion	18	05	70	07	100
Evaluation	Final Articles	15	04	25	06	50

4. Results and Discussions

GNS3 is used to generate a proper device scenario and use OSPF routing techniques for a particular device scenario while designing a network system. To evaluate the algorithm's efficiency, packets are examined. Here is a topology with two routers, the routers connect to share routing details and choose the most efficient path for data transfer. If a router is added or removed from OSPF, or a route is altered due to a connection being down or up, just the new information not the entire routing dataset is sent. The first target is the connectivity of router switch and pcs in the virtual lab which is created in GNS3. Figure 1 shows topology off-scenario this is how OSPF functions in GNS3 with a topology of two routers: R1 and R2 connect with a switch with fast Ethernet line R1 fastEthernet0/0 Ip-address 192.168.10.0 and f1/0 which connect with pc1 and Ip address is 192.168.25.0 similarly R2 F0/0 connect with switch Ip address 192.168.15.0 and the other side f1/0 Ip Address 192.168.20.0 connected with pc2. Windows operating systems are compatible with the graphical user interface (GUI) of GNS3. In general, GNS3 offers a thorough and intuitive solution for network simulation on the Windows operating system.

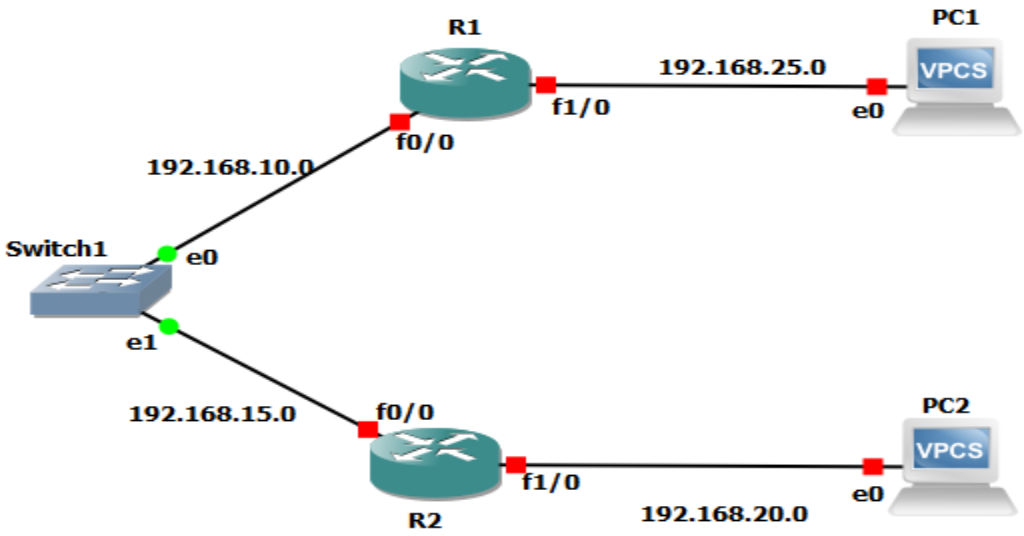

Figure 1. Topology Off-Scenario

Both routers relate to a switch and a single pc separately. The routers also will communicate regarding their routers, creating a comprehensive representation of the structure of the system. To identify which routes are the most effective, the routers will compare their routing databases. Figure 2 This is an on-scenario OSPF function in GNS3 with a topology of two routers: R1 and R2 connect with a switch with fast Ethernet line R1 fastEthernet0/0 Ip-address 192.168.10.0 and f1/0 which connect with pc1 and Ip address is 192.168.25.0 similarly R2 F0/0 connect with switch Ip address 192.168.15.0 and the other side f1/0 Ip Address 192.168.20.0 connected with pc2.

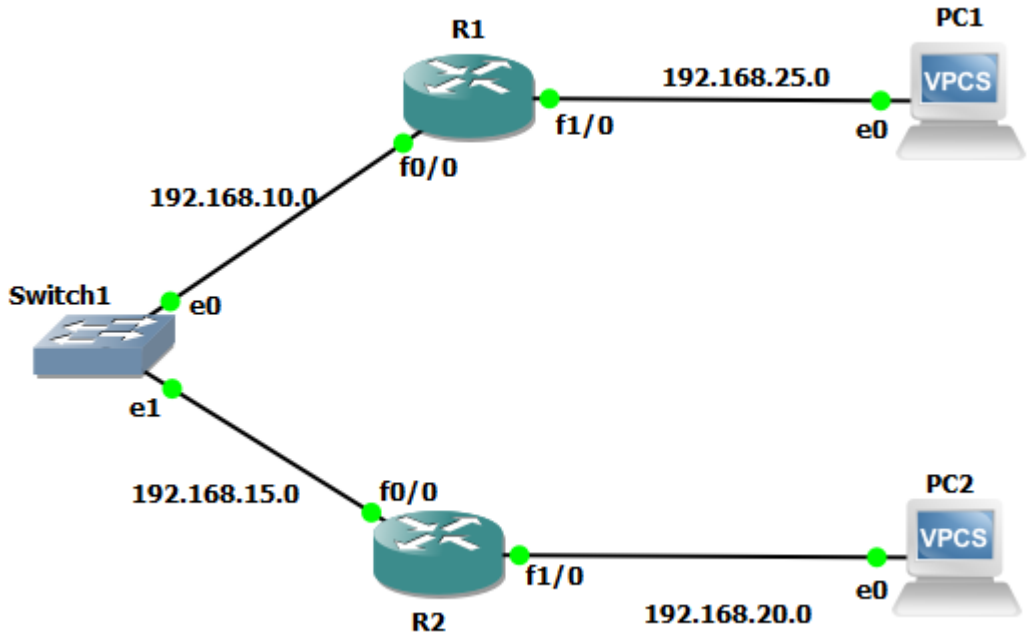

Figure 2. Working Scenario.

4.1 SPF Method

The routers employ the SPF technique to determine the optimum path for information transfer after updating the link status databases. The routing table is then updated with this data. Figure 3 shows the topology of the web-User Interface of topology and its summary details.

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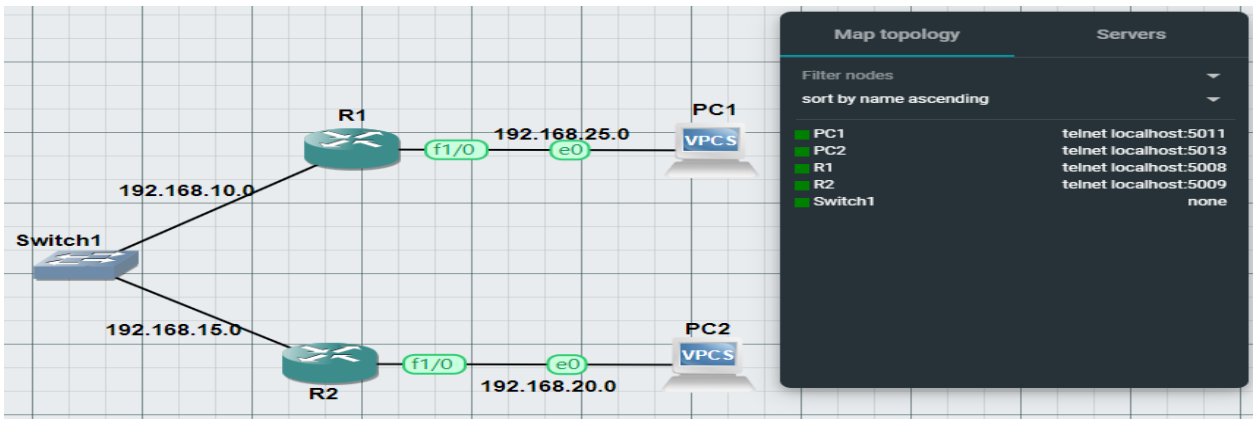

Figure 3. Topology Web-UI.

4.2 Appling component of GNS3 of the network (VM) virtual machine

Virtual machines (VMs) based on Linux, Windows and Unix are among the supported platforms for GNS3 Appling component of GNS3 of the network (VM) virtual machine or Graphical user interface (GUI) in this implementation.

This is a very important question and step of my research because my all work and implementations depend on this step and how and when is beneficiary for a user to use GNS3 use in the graphical user interface (GUI) or virtual machine (VM) is helpful or best workplace or not so the elaboration first about (GUI) here graphical user interface means devices, routers and pcs are represented in graphical view and virtually connected which easy to crat any network and all result which needed and follow in the table and represent in graph form and is an easy way to understand the results. GUI results analyze on window (64-

bit) for initialization and check the router connectivity and performance. In Windows hardware compatibility must be able to run properly GNS-3 simulation tool. Advanced and updated hardware be able to process the simulation tool. These factors must affect the needed results.

The other way (VM) virtual machine which gives the workplace to create a separate workstation, a server that creates any large and specific network which configures different routers and contains huge traffics. VM performs best pest performance on Linux, Ubuntu operating systems, and workstation work, and creating any workstation VM is important. Hardware compatibility also must be able to run properly the GNS-3 simulation tool in the VM phase. Advanced and updated hardware can process the simulation tool these factors must be affected by the needed results that are shown in Table 3.

Table 3. Results

Measurements	OSPF
Throughput (kbps)	620
Delay Time (ms)	41
Convergence time (ms)	9
Drop packet's	4
Secure packet's	490

GNS3 Graphical User Interface (GUI) to build and maintain virtual networks. It offers a simple user interface for establishing, managing, and watching virtual systems and networks. The topology model, device frameworks, device logos, device characteristics, and system information are just a few of the elements included in GNS3's GUI. Additionally, it has functions such as real-time network visualization, adjustable programming improvement, and drag-and-drop functionality. The GNS3 GUI makes it simpler to create and manage virtual networks and makes it simpler for users to comprehend and manage their network setups.

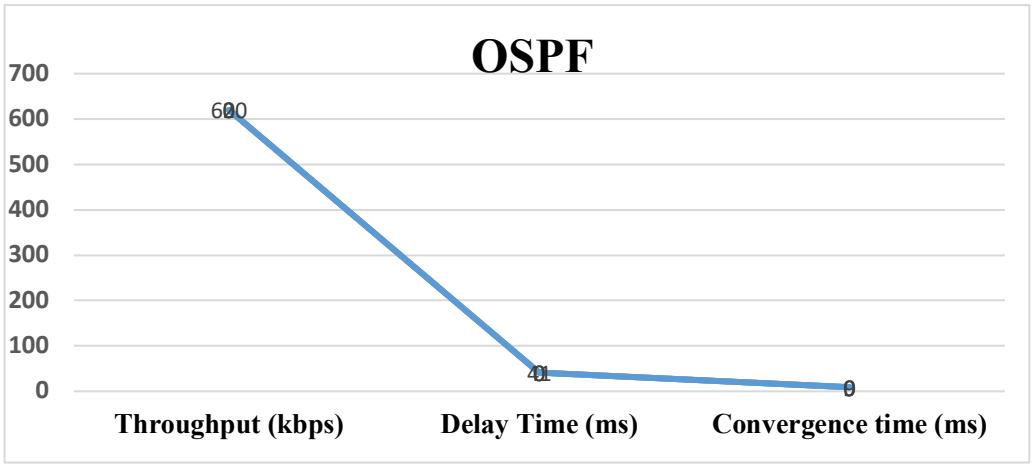

Figure 4. Result Graph

Based on sample size analyses the performance of protocols and create topologies with different networks. (Figure 4) shows a Comparative analysis of OSPF, and simulators use for better connectivity of protocol and link failure and recovery between sender and receiver router. Based on simulation findings, it can be said that OSPF gave a clear overview of the OSPF routing algorithm, its distinguishing features, and Cisco's summary of the open requirements update. The sections that followed described the network topology that was employed during testing. The router devices must be connected to the fast Ethernet line to execute these simple solutions. Thus, Windows (64 bits) may test and deploy this suggested setup and

network. the OSPF settings. To access control between the routers, the point-to-point protocol is used to establish identification between each router. Each router has a username and password, and interaction between two devices only happens if they match. Topology deducts and sends queries quickly to near neighbours to control and manage given updates to each router. Comparison of all sample sizes their implementations and results about router OSPF work bitterly and OSPF generates huge traffic.

5. Conclusion and Future Work

According to the simulation outcomes, it can be said that OSPF gave a clear overview of the OSPF protocol routing algorithm, its distinguishing features, and Cisco's summary of the release of the open specification. The sections that followed showed the network topology that was employed during testing. The router devices must be connected to the f0/0 (fastEthernet) line to execute these simple solutions. Thus, Windows (64 bits) may test and deploy this suggested setup and network. the OSPF settings. To access control between the routers, the point-to-point protocol is used to enable authentication between each router. Each router has an identity detail, and interaction between two devices just happens if they match. In the same network, throughput, end-to-end latency, and convergence time are all examined. Convergence time, which is a key component of routing protocols, has a direct impact on throughput and end-to-end delays. These variables can be optimized to get the optimum router convergence, delay time, and throughput outcomes in the GNS3 simulation tool OSPF: Routing device configuration Check that all routers have the proper OSPF settings, such as durations, priority, and access network.

Network Architecture makes sure the network topology is effectively built to cut down on the number of hops and avoid overload. Bandwidth Increasing the connections' bandwidth will shorten the latency period and boost throughput. The performance of the routers verifies that they have the high processing power to process OSPF protocol routing traffic. Load balancing to ease traffic congestion and boost performance, establish reliability and scalability to divide traffic across many pathways. Link Cost Calculation to make sure that the optimal pathways are used for packet forward, and establish the OSPF bridge cost calculation technique. The GNS3 simulation tool OSPF routers' convergence, latency time, and throughput may be optimized to get the optimum performance.

GNS3 is used to generate a proper device scenario and use OSPF routing techniques for a particular device scenario while designing a network system. To evaluate the algorithm's efficiency, packets are examined. Create a topology with two routers, the routers connect to share routing details and choose the most efficient path for data transfer. GNS3 with a topology of two routers OSPF protocol enable: R1 and R2 connect with a switch with fastEthernet line R1 fastEthernet0/0 Ip-address 192.168.10.0 and f1/0 which connect with pc1 and Ip address is 192.168.25.0 similarly R2 F0/0 connect with switch Ip address 192.168.15.0 and the other side f1/0 Ip Address 192.168.20.0 connected with pc2.

If a router is added or removed from OSPF, or a route is altered due to a connection being down or up, just the new information not the entire routing dataset is sent. The first point is the connectivity of router switch and pcs in the virtual lab which is created in GNS3. (IP) networks, the Open Shortest Path First routing algorithm is employed. Since it allows variable-length subnet masks, that enable more effective use of IP address space, it is regarded as a classless routing protocol both service provider networks and business networks utilize OSPF extensively. The fact that OSPF can accept variable-length subnet masks is one of its key advantages. As a result, subnets of various sizes may be created, allowing for more effective use of IP address space. This is especially beneficial for big networks because using a single subnet mask may waste a lot of IP address space. To evaluate and install this suggested setup (GNS3) and network into VM workstations. OSPF compares with other advanced dynamic protocols like IS-IS.

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