OSPF Routing and SDN Performance Analysis on Large Scale Networks

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ABSTRACT

This study describes the implementation of OSPF and SDN routing protocols on large-scale networks by simulating using Mininet software. As well as trying to analyze which type of routing protocol has better performance by comparing the results of the QoS (Quality of Service) parameters, namely throughput, delay, jitter and packet loss. In this study, tests were carried out using 20 nodes and 20 hosts with the same network load on each routing protocol. Testing is done by getting the conclusion of the throughput parameter where OSPF routing protocol is better than SDN, as well as the delay and jitter parameters. For packet loss parameters, SDN routing protocol is better than OSPF parameters. As well as trying to analyze which type of routing protocol has better performance by comparing the results of the QoS (Quality of Service) parameters, namely throughput, delay, jitter and packet loss. In this study, tests were carried out using 20 nodes and 20 hosts with the same network load on each routing protocol. Testing is done by getting the conclusion of the throughput parameter where OSPF routing protocol is better than SDN, as well as the delay and jitter parameters. For packet loss parameters, SDN routing protocol is better than OSPF parameters. As well as trying to analyze which type of routing protocol has better performance by comparing the results of the QoS (Quality of Service) parameters, namely throughput, delay, jitter and packet loss. In this study, tests were carried out using 20 nodes and 20 hosts with the same network load on each routing protocol. Testing is done by getting the conclusion of the throughput parameter where OSPF routing protocol is better than SDN, as well as the delay and jitter parameters. For packet loss parameters, SDN routing protocol is better than OSPF parameters. In this study, tests were carried out using 20 nodes and 20 hosts with the same network load on each routing protocol. Testing is done by getting the conclusion of the throughput parameter where OSPF routing protocol is better than SDN, as well as the delay and jitter parameters. For packet loss parameters, SDN routing protocol is better than OSPF parameters. In this study, tests were carried out using 20 nodes and 20 hosts with the same network load on each routing protocol. Testing is done by getting the conclusion of the throughput parameter where OSPF routing protocol is better than SDN, as well as the delay and jitter parameters. For packet loss parameters, SDN routing protocol is better than OSPF parameters.

Keywords
SDN, OSPF, Mininet, RouteFlow, QoS

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Introduction

The development of the internet is increasing and has changed the way people live in various aspects. The internet makes it easier for people to communicate over long distances, but these developments make computer network technology more complex. Computer network technology currently uses large-scale network technology, using hundreds even thousands of nodes (routers and end host computers) [1].

Simulation is widely recognized as an important tool for analyzing networks, even when analytical methods can be used, simulations are often carried out to validate the analysis. Simulation is used for comprehend the impact of new protocol, mechanism, network service, attack, or application when it is widely used on large networks such as the internet [1].

Open Shortest Path First (OSPF) is a routing protocol specifically applied to the internal autonomous system. In conventional networks, each router maintains a database describing the network structure, and then computes the routing table by constructing the shortest path tree. Conventional network routing protocols have typical distributed routing, only link status information is sent over the link, and routing calculations are completed by each router. OSPF has strong scalability and is suitable for large scale networks. *OSPF Routing* Protocol has been developed very comprehensively, but the complex and rigid OSPF system has been difficult to adapt to the rapid development of the internet. The emergence of Software Defined Network (SDN) has brought a solution to this problem [2].

*SDN*is an innovation in terms of the network world that runs on a large scale network. The basic concept of SDN is to separate the control plane from the data plane, SDN is a routing protocol with a typical centralized routing where topology discovery and routing calculations are carried out by the SDN controller. One of the advantages of separating the data plane from the control plane is that it allows us to efficiently implement the engineering network traffic mechanism which is currently lacking due to the instability of distributed routing protocols, and high management complexity [2].

Literature Review

Software Defined Network (SDN)

Software Defined Network is a new concept in network architecture that separates the data plane from the control plane and is transferred centrally to a programmable controller. This method allows network administrators to control the operation of devices through a controller without having to configure each device individually. In the concept of a conventional network where the data plane and control plane are tightly bound to the device so that the routing protocol configuration is very inflexible, inefficient and the configuration is carried out on each device, this certainly cannot meet the current operational demands which have large networks and devices have different specifications [3].

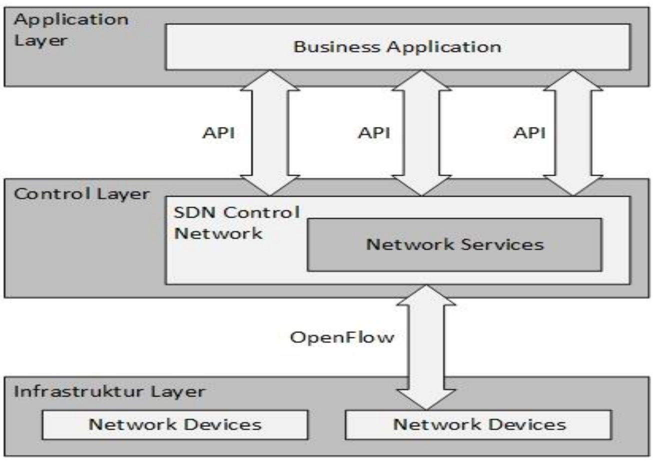

Figure 1. SDN architecture

The figure shows that most of the control and network protocols are centralized in the SDN control software. The controller manages all network devices at the base infrastructure layer which is a single virtual switch. Network operators can control the network via standard interfaces (for example, OpenFlow) independently of the network device vendor.

Network devices are only equipped with a data forwarding function which is controlled by the SDN controller. This makes network design and operation more efficient. The Application Programming Interface (API) between the application layer and the control layer can supply a virtualize network environment, so it means to implement various policies regarding routing, access control, traffic engineering, power management and others [3].

Open Shortest Path First (OSPF)

Open Shortest Path First (OSPF) is a routing protocol specifically applied to the internal autonomous system. In conventional networks, each router maintains a database describing the network structure, and then computes the routing table by constructing the shortest path tree. Conventional network routing protocols have typical distributed routing, only link status information is sent over the link, and routing calculations are completed by each router. OSPF has strong scalability and is suitable for large networks [2].

OSPF routing is an IGP (interior gateway protocol) type routing protocol that can only work within the internal network of an organization or company. Internal network means the network where the user still has the right to use, manage, and modify it, or in other words the user still has administrative rights to the network. If the user no longer has the right to use and manage it, then the network can be categorized as an external network. In addition, OSPF is also an open source routing protocol, that is, this protocol is not created by any vendor, so that anyone can use it, any device can match it, and where this routing protocol can be implemented [4].

Mininet

*Mininet*is a software emulator that allows prototyping on a wide network using only one machine. In this mininet, a network design is carried out with the desired topology. In simple terms, this mininet functions for emulation on the data path section to test the SDN network configuration. Meanwhile, to perform testing on mininet can be done with the command "sudo mn". With this command mininet will emulate an SDN network configuration consisting of 1 controller, 1 switch and 2 hosts [5].

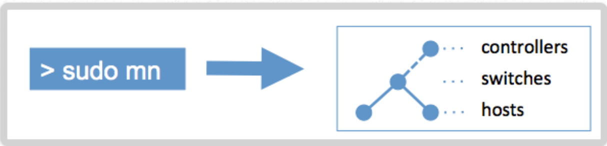

Figure 2. Single command Mininet

RouteFlow

*RouteFlow*is a framework for SDN, and developing as an open project. This work system runs on IP routing protocols (for example, BGP and OSPF) on a centralized RouteFlow server and provides a Forwarding Information Base (FIB) according to the configured routing protocols with a view to creating a hybrid network. The server collects the IP and ARP tables to be interpreted into the interactions OpenFlow rules are installed on the associated programmable switches in the network [6]. The following figure describes the architectural mechanism of RouteFlow.

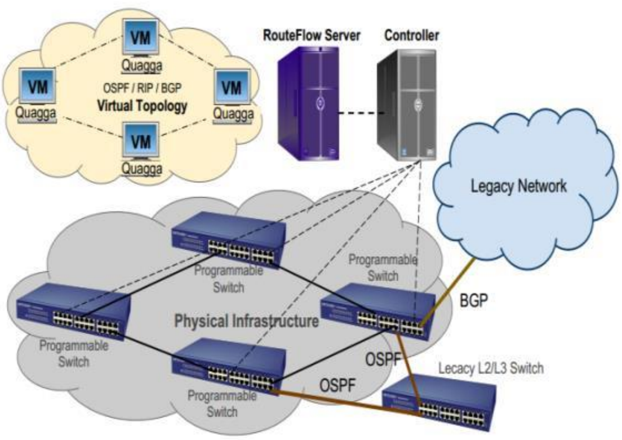

Figure 3. RouteFlow architecture

The image above illustrates the RouteFlow architecture in which the RouteFlow server is created and functions on a virtual machine (VM) in the SDN control plane. The server VM in RouteFlow maps to specific OpenFlow switches in the data forwarding field. The VM server creates a virtual topology and processes an open routing protocol, Quagga [7] [8]. The RouteFlow server sequentially looks at the status of the routing table in the VMS. If changes are obtained from the routing table, the RouteFlow server makes the same stream entries and sends them to the same fast OpenFlow Switch [6].

Quality of Service (QoS)

Quality of Service (QoS) is defined as a measure of how well the network is and aims to determine the characteristics and properties of a service. In IP based networks, IP QoS follows the performance of IP packets over one or more networks. QoS was created to help end users become more active by focusing that end users can produce performance from network-based applications [9].

The factors that affect the performance of Quality of Service in routing protocols according to some experts are as follows:

1. *Throughput*
Throughput is the effective data transfer rate, calculated in bps. Throughput is the total number of incoming packet passes that are focused during a certain time interval, divided into the distance of that time interval [10].
2. *Delay*
Delay is the time interval required by a data packet when data begins to be sent and exits the queue process until it reaches its limit. distance, physical media, jams or long processing time can affect the delay [10].
3. *Jitter*
Long queues in data processing and reassembling of data packets at the end of transmission due to previous failures causing variations in delay or also known as *jitter*. Generally, jitter is a problem on slow speed links [10].
4. *Lost Package*
A parameter that describes the condition that shows the number of packets lost or damaged during the transmission of data packets, also known as packet loss. Collisions and congestion on the network can also cause packet loss [10].

Methodology

This research was conducted in several stages, namely: needs analysis, topological design, system design, testing and data collection from simulation results. The following is a design method in the research carried out.

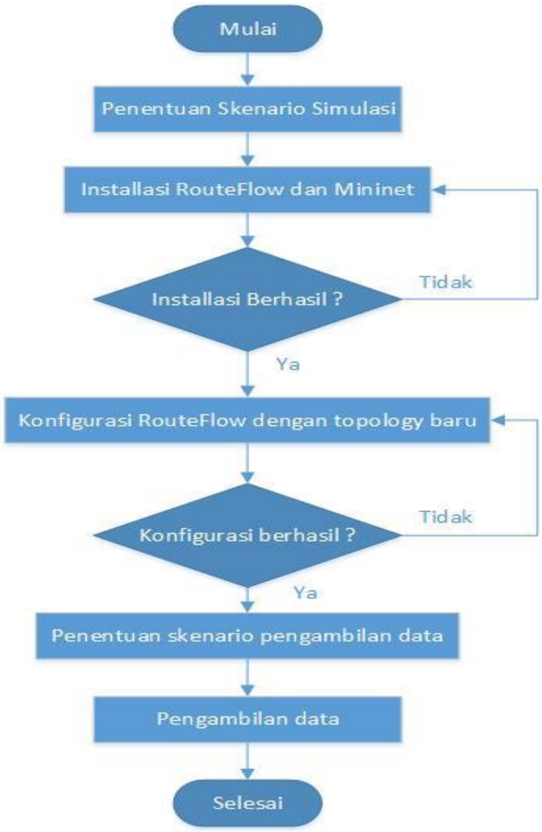

Figure 4. Simulation design

Hardware Requirements Analysis

In running the simulation hardware used in the form of a laptop with the following specifications.

Table 1. Hardware requirements

Processor	Intel (R) Core (TM) i5-2410M CPU @ 2.30GHz (4 CPUs), ~ 2.3GHz
Memory	8192 Mb
Hard Drive	500 Gb

Software Requirements Analysis

In addition to hardware, the software needed in this simulation, namely.

a. Three Virtual Machines used on laptops
b. Mininet, an emulator for running simulations
c. RouteFlow, used when running OSPF routing simulation
d. D-ITG, is used to generate traffic when collecting simulation data.

The following is an overview of installing a Virtual Machine.

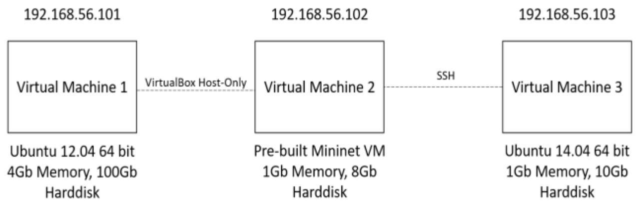

Figure 5. Virtual machine specifications

Results and Discussion

Simulation Implementation

Simulations are carried out on the same topology, namely a topology with 20 nodes, with different routing protocols, namely OSPF and SDN. From the simulations performed, the test conditions differed in the size of the bandwidth, namely 10 Mbps, 25 Mbps, and 50 Mbps. The simulation time is 15 seconds with a delay of 2 ms, packets are sent using the UDP protocol. Packets are sent to host 1, and data recipients are carried out at host 2, host 3, host 4 to host 20. The data packets sent are 20,000 data packets per second with a packet size of 512 bytes. The work rate of the routing protocol is determined by calculating and comparing the throughput, jitter, delay and packet loss values of each routing protocol in each scenario.

Throughput Results

Throughput the OSPF and SDN routing protocols are shown in the following graph:

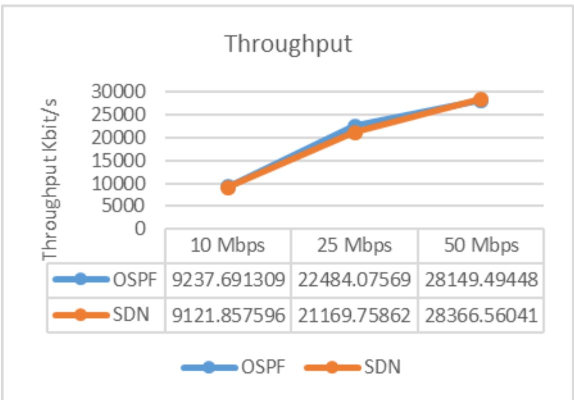

Figure 6. Throughput conclusion graph

In the graphic image, it can be seen that the overall average throughput value generated by the OSPF routing protocol is greater than the SDN throughput value at 10 Mbps and 25 Mbps bandwidth, while at 50 Mbps bandwidth, the SDN throughput value is greater than OSPF. OSPF routing protocol is more stable at 10 Mbps and 25 Mbps bandwidth, but decreases at 50 Mbps bandwidth, while SDN routing protocol is unstable at all bandwidth sizes. As the bandwidth size increases, the performance of the two routing protocols is getting better too.

Delay Results

The average delay for all nodes in the OSPF and SDN routing protocols is shown in the following graph:

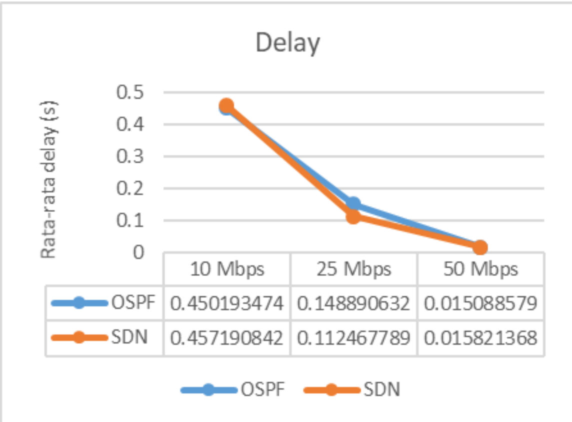

Figure 7. Delay conclusion graph

The graph shows that the average delay value generated by OSPF routing protocol is smaller than SDN routing protocol at 50 Mbps bandwidth, a large enough comparison occurs at 25 Mbps bandwidth. In the simulation with a bandwidth size of 50 Mbps, the two routing protocols began to look stable, different from the simulation with a bandwidth size of 10 Mbps and 25 Mbps. The smaller delay size makes the routing protocol's performance better.

Jitter Results

The following is the result of the conclusion of the average jitter value in the OSPF and SDN routing protocols which are described in the following graph:

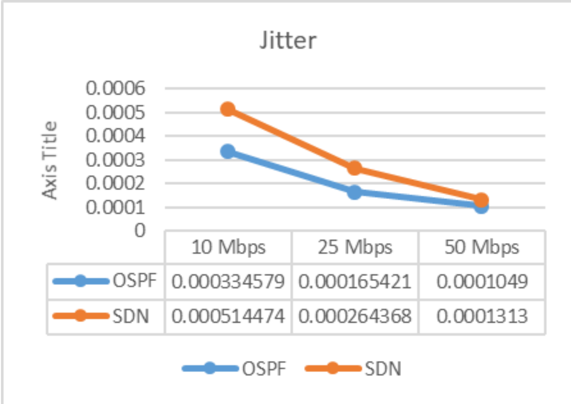

Figure 8. Jitter conclusion graph

In the graphic image, it can be seen that the overall average jitter value at all OSPF routing protocol nodes is smaller than the SDN routing protocol. The increase in bandwidth size greatly affects the performance of both routing protocols, it can be seen from the graph that shows a decrease in each bandwidth size, which means that there is an increase in performance from a bandwidth of 10 Mbps to a bandwidth of 50 Mbps.

Packet Loss Results

The following is the result of the conclusion that the average packet loss value in the OSPF and SDN routing protocols is described in the following graph:

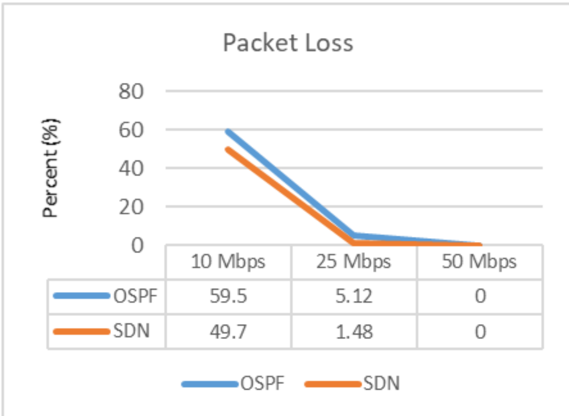

Figure 9. Packet loss conclusion graph

Conclusion

Conclusion

After simulating, testing and analyzing the performance of OSPF and SDN routing protocols on the Quality of Service given to parameter values such as throughput, delay, jitter and packet loss, it can be concluded that this study is as follows:

1. The workings of the OSPF routing protocol and SDN in the same topology can be simulated using the Mininet emulator.
2. The performance of OSPF routing protocols and SDN on large-scale networks is concluded by comparing the values obtained based on QoS parameters, namely throughput, delay, jitter and packet loss using D-ITG software. The results obtained in the throughput parameter are that the OSPF routing protocol value is better than the SDN routing protocol, but the difference in the values of the two is not too different. For the results obtained on the delay parameter also the difference in value is not that far away, OSPF routing protocol is still superior at 10 and 50 Mbps bandwidth sizes. In the OSPF routing protocol jitter parameter is better because the results obtained are relatively smaller than the SDN routing protocol. For packet loss parameters, SDN routing protocol is better than OSPF with smaller packet loss values.

Suggestions

As a suggestion for further research or development of this research, some testing or development of this final project research can be carried out, including:

1. Simulations are carried out with other protocols such as BGP or RIP.
2. Testing is done by using a larger number of nodes than the nodes used in this study.
3. The simulation is carried out with a separate device as well as an actual device.

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