SMARTICS Journal, Vol.7 No. 1 2021. p14-20
ISSN online: 2476-9754, ISSN print: 2623-0429
DOI : https://doi.org/10.21067/smartics.v7i1.5009

Configuration and Analysis Link-State Open Shortest Path First Routing Performance Multi-Area

Nur Hayati[1], Ratih Titi Komala Sari [2]
[1, 2]Department of Information and Communication Technology, University of Nasional
Jl. Sawo Manila No. 61 Pejaten Pasar Minggu, Jakarta Selatan, Jakarta, Indonesia
[1]nurh4y@gmail.com, [2]ukhuwahku01@gmail.com

***Abstract*—** *Open Shortest Path First (OSPF) is a routing protocol that uses a link-state algorithm to build and calculate the best path to all known destinations. The link-state algorithm is also known as the Dijkstra algorithm or Shortest Path First (SPF) algorithm. The Dijkstra algorithm is applied in the OSPF protocol to choose the best route that a data packet must take from an origin address to arrive at the destination address with the least cost metric. The results showed that using the OSPF routing protocol between the Head Office and Branch can communicate with each other by sending each OSPF database to each router where the maximum data transmission value is 1-millisecond sending data successfully reaches100%.*

Index Terms* — *OSPF, Routing Protocol, Link-State Algorithm, Dijkstra Algorithm.

I. INTRODUCTION

Parallel computers consist of several processes that interact with each other. Communication between processors is done through an interconnection network, while information sent between processors can be in the form of binary data sets, called packets. Routing is a mechanism to determine the route travelled by a packet originating from a source node to the network's destination node. Building a local area network from one area into several areas using multiple routers as gateways, network risk management will be even more excellent and more complicated. Network management is needed to make routing or route settings with the shortest and fastest distance in sending data packets to the destination. To get the results of a good route or path required network architecture design in the development of a multi-area network, especially determining routing protocols in network topology. The rules of the router in carrying out the routing process are known as routing protocols. Routing protocols divide into two, static routing and dynamic routing. The difference is if using static when route determination is done manually through an administrator's entry. In contrast, dynamic routing is done automatically according to the IP network information received by the router.

In communicating between data, we need to find the fastest way, which is called the best path, to make time efficient so that the data or packet sent can be received by the destination quickly. Routing protocols there are several types of different types, namely static routing and dynamic routing. There are two types of dynamic routing, namely Link State and Distance Vector. Each Link State and Distance Vector routing has its characteristics. For example, a link-state knows its neighbours while Distance Vector depends on knowing its neighbours by the router next to it. One of the Routing Link State protocols is OSPF. OSPF is an open routing that performs the fastest way to find a link-state concept that uses to forward data and control a network [3]. The experience conducts using a Cisco packet tracer simulation to find out the entire contents of the database in the OSPF Multi-area Routing Link.

II. RESEARCH METHODS

A. Analysis

Here we conduct a condition analysis of the case study organization, which has two branch offices and one head office located in different areas. A network design requires the minimum cost to optimize the interaction between branches and headquarters but produces a good network through a CISCO simulation.

B. Design

Received November 4, 2020; Revised January 28, 2021; Accepted February 16, 2021

This stage contains the form of prototype network topology that develop. It covers physical and logical network scenarios. The design of a network prototype utilizes Cisco Packet Tracer 7.0.0.0305 computer network simulation software.

C. Development

This stage is done to configure the prototype of the network topology. Configuration is performed on each device in the network prototype, including PCs, switches and routers. Configuring the OSPF routing protocol is done on the router by typing the program code in the router's CLI window. Router settings are done to produce the best path to pass data packets in the network.

D. Testing

After the network prototype has developed, each device test for connectivity.

The following are research methods

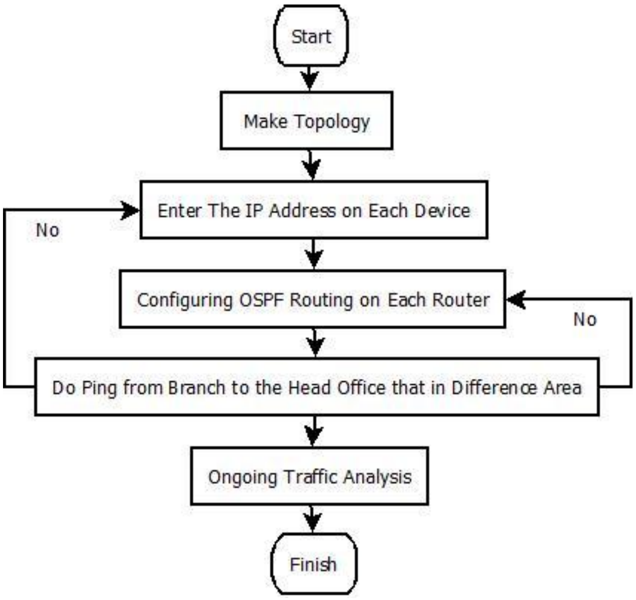

Fig. 1. Phase of Design and Analysis

The first is to determine or design the topology. When the topology has form, enter the IP address on each PC, router, switch, etc. When the PC can connect to each gateway, then the next step is to configure the OSPF Routing Protocol on each of these routers. If OSPF routing has been configured on the router but cannot ping between different areas, there is undoubtedly an incorrect OSPF configuration or the IP address on each device. If successful, an ongoing analysis process will carry out from source to destination.

III. CONFIGURATION AND ANALYSIS

A. Network Topology

The following is the topology that connects Branch and Head Office

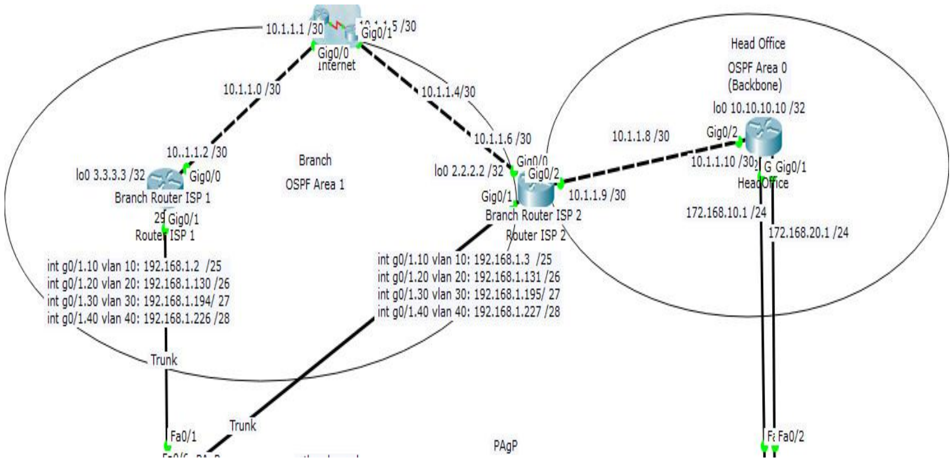

Fig 2. Network Topology

OSPF area 1 is the branch that is on the branch_router_isp-2 router (fig. 2). It becomes an ABR (Area Border Router) router near the border between one or more OSPF areas. This use to establish a connection between the backbone network and the OSPF area. Which here intend to connect between branch and head office.

B. Configuration Sub Interface and VLAN interface at Router Interface

a. Configuration sub interface router Branch_Router-ISP-1

```
Branch_Router-ISP-1(config)#interface gig 0/0
Branch_Router-ISP-1(config-if)#ip address 10.1.1.2 255.255.255.252
Branch_Router-ISP-1(config)#int gig 0/1.10
Branch_Router-ISP-1(config-subif)#encapsulation dot1Q 10
Branch_Router-ISP-1(config-subif)#ip add 192.168.1.2 255.255.255.128
Branch_Router-ISP-1(config)#int gig 0/1.20
Branch_Router-ISP-1(config-subif)#encapsulation dot1Q 20
Branch_Router-ISP-1(config-subif)#ip add 192.168.1.130 255.255.255.192
Branch_Router-ISP-1(config)#int gig 0/1.30
Branch_Router-ISP-1(config-subif)#encapsulation dot1Q 30
Branch_Router-ISP-1(config-subif)#ip add 192.168.1.194 255.255.255.224
Branch_Router-ISP-1(config)#int gig 0/1.40
Branch_Router-ISP-1(config-subif)#encapsulation dot1Q 40
Branch_Router-ISP-1(config-subif)#ip add 192.168.1.226 255.255.255.240
Branch_Router-ISP-1(config)#interface loopback 0
Branch_Router-ISP-1(config-if)#ip address 3.3.3.3 255.255.255.255
```

b. Configuration sub interface router Branch_Router-ISP-2

```
Branch_Router-ISP-2(config)#interface gig 0/0
Branch_Router-ISP-2(config-if)#ip address 10.1.1.6 255.255.255.252
Branch_Router-ISP-2(config)#int gig 0/1.10
Branch_Router-ISP-2(config-subif)#encapsulation dot1Q 10
Branch_Router-ISP-2(config-subif)#ip add 192.168.1.3 255.255.255.128
Branch_Router-ISP-2(config)#int gig 0/1.20
Branch_Router-ISP-2(config-subif)#encapsulation dot1Q 20
Branch_Router-ISP-2(config-subif)#ip add 192.168.1.131 255.255.255.192
Branch_Router-ISP-2(config)#int gig 0/1.30
Branch_Router-ISP-2(config-subif)#encapsulation dot1Q 30
Branch_Router-ISP-2(config-subif)#ip add 192.168.1.195 255.255.255.224
Branch_Router-ISP-2(config)#int gig 0/1.40
Branch_Router-ISP-2(config-subif)#encapsulation dot1Q 40
Branch_Router-ISP-2(config-subif)#ip add 192.168.1.227 255.255.255.240
Branch_Router-ISP-2(config)#interface loopback 0
Branch_Router-ISP-2(config-if)#ip address 2.2.2.2 255.255.255.255
```

c. Configuration sub interface router HO
HO(config)#interface g0/0
HO(config-if)#ip add 172.168.10.1 255.255.255.0
HO(config)#interface g0/1
HO(config-if)#ip add 172.168.20.1 255.255.255.0
HO(config)#interface g0/2
HO(config-if)#ip add 10.1.1.10 255.255.255.252
HO(config)#interface loopback 0
HO(config-if)#ip add 10.10.10.10 255.255.255.255

C. Configuration OSPF *Multi-Area*

a. Configuration OSPF Branch_Router-ISP-1 at *Branch*
Branch_Router-ISP-1>en
Branch_Router-ISP-1#conf t
Branch_Router-ISP-1(config)#router ospf 1
Branch_Router-ISP-1(config-router)#router-id 1.1.1.1
Branch_Router-ISP-1(config-router)#network 192.168.1.0 0.0.0.127 area 1
Branch_Router-ISP-1(config-router)#network 192.168.1.128 0.0.0.63 ar 1
Branch_Router-ISP-1(config-router)#network 192.168.1.192 0.0.0.31 ar 1
Branch_Router-ISP-1(config-router)#network 192.168.1.224 0.0.0.15 ar1
Branch_Router-ISP-1(config-router)#network 10.1.1.0 0.0.0.3 area 1
Branch_Router-ISP-1(config-router)#network 3.3.3.3 0.0.0.0 area 1

b. Configuration OSPF Branch_Router-ISP-2 at *Branch*
Branch_Router-ISP-2>enable
Branch_Router-ISP-2#configure terminal
Branch_Router-ISP-2(config)#router ospf 1
Branch_Router-ISP-2(config-router)#router-id 3.3.3.3
Branch_Router-ISP-2(config-router)#network 10.1.1.8 0.0.0.3 area 0
Branch_Router-ISP-2(config-router)#network 10.1.1.4 0.0.0.3 area 1
Branch_Router-ISP-2(config-router)#network 2.2.2.2 0.0.0.0 area 1
Branch_Router-ISP-2(config-router)#network 192.168.1.0 0.0.0.127 area 1
Branch_Router-ISP-2(config-router)#network 192.168.1.128 0.0.0.63 ar 1
Branch_Router-ISP-2(config-router)#network 192.168.1.192 0.0.0.31 ar 1
Branch_Router-ISP-2(config-router)#network 192.168.1.224 0.0.0.15 ar 1

c. Configuration OSPF HO pada *HeadOffice*
HO>enable
HO#configure terminal
HO(config)#router ospf 1
HO(config-router)#router-id 10.10.10.10
HO(config-router)#network 10.10.10.10 0.0.0.0 area 0
HO(config-router)#network 10.1.1.8 0.0.0.3 area 0
HO(config-router)#network 172.168.10.0 0.0.0.255 area 0
HO(config-router)#network 172.168.20.0 0.0.0.255 area 0

D. Verification on Each Router

a. Router ABR

```
Branch_Router-ISP-2#show ip ospf
 Routing Process "ospf 1" with ID 3.3.3.3
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 It is an area border router
```

As seen from the verification results above with the command "show ip ospf" in Branch_Router-ISP-2, Branch_Router-ISP-2 acts as an ABR in "output it is an area border router".

b. Type of LSA at OSPF
The following is type of LSA at OSPF,

```
Branch_Router-ISP-2#show ip ospf database
            OSPF Router with ID (3.3.3.3) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
3.3.3.3         3.3.3.3         267         0x80000003 0x00c747 1
10.10.10.10     10.10.10.10     269         0x80000006 0x001a95 4

                Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
10.1.1.10       10.10.10.10     269         0x80000002 0x0032d3

                Summary Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
192.168.1.0     3.3.3.3         265         0x8000000a 0x006df0
192.168.1.128   3.3.3.3         265         0x8000000b 0x00e7b4
192.168.1.192   3.3.3.3         265         0x8000000c 0x002417
192.168.1.224   3.3.3.3         265         0x8000000d 0x0041c8
10.1.1.4        3.3.3.3         265         0x8000000e 0x004bec
10.1.1.0        3.3.3.3         265         0x8000000f 0x007bbe
2.2.2.2         3.3.3.3         265         0x80000010 0x00be7c
3.3.3.3         3.3.3.3         265         0x80000011 0x00989c
1.1.1.1         3.3.3.3         265         0x80000012 0x00f249

                Router Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum Link count
3.3.3.3         3.3.3.3         274         0x8000000d 0x00996a 6
1.1.1.1         1.1.1.1         803         0x80000010 0x00d940 6
8.8.8.8         8.8.8.8         799         0x80000006 0x001a94 3

                Net Link States (Area 1)
Link ID         ADV Router      Age         Seq#       Checksum
192.168.1.3     3.3.3.3         828         0x80000005 0x003848
192.168.1.131   3.3.3.3         822         0x80000006 0x00d379
192.168.1.195   3.3.3.3         816         0x80000007 0x0010a4
192.168.1.227   3.3.3.3         810         0x80000008 0x00cab1
10.1.1.1        8.8.8.8         861         0x80000003 0x008733
10.1.1.5        8.8.8.8         799         0x80000004 0x000fda

                Summary Net Link States (Area 1)
Link ID         ADV Router      Age         Seq#       Checksum
10.1.1.8        3.3.3.3         265         0x80000005 0x003508
10.10.10.10     3.3.3.3         260         0x80000006 0x006bb8
172.168.10.0    3.3.3.3         260         0x80000007 0x001ccf
172.168.20.0    3.3.3.3         260         0x80000008 0x00ab35
Branch_Router-ISP-2#
```

Fig 3 Type LSA at *Routing* OSPF

Seen there are 3 LSA types in both areas, so there are 6 LSA, including:

1. Router Link States (Area 0)
2. Net Link States (Area 0)
3. Net Link States Summary (Area 0)
4. Router Link States (Area 1)
5. Net Link States (Area 1)
6. Summary Net Link States (Area 1)

In numbers 1-3 for area 0 & numbers 4-6 area 1, here is an explanation of each LSA.

1. Router Link States
   Included in LSA type 1 that generate by each router for each area, in the routing tab, the IP prefix indicated by the code "O".
2. Net Link States
   Included in LSA type 2 generated by routers that have broadcast-type links, in the routing tab, the IP prefix indicated by the code "O".
3. Summary Net Link States
   Included in LSA Type 3 generated by ABR which contains information from both areas, in the routing tab the IP prefix is indicated by the code "O IA".

Now we see the OSPF routing table at HO.

```
HO#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/3] via 10.1.1.9, 00:57:35, GigabitEthernet0/2
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/2] via 10.1.1.9, 00:57:35, GigabitEthernet0/2
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/3] via 10.1.1.9, 00:57:35, GigabitEthernet0/2
     10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
O IA    10.1.1.0 [110/3] via 10.1.1.9, 00:57:35, GigabitEthernet0/2
O IA    10.1.1.4 [110/2] via 10.1.1.9, 00:57:35, GigabitEthernet0/2
     192.168.1.0/24 is variably subnetted, 4 subnets, 4 masks
O IA    192.168.1.0 [110/2] via 10.1.1.9, 00:57:35, GigabitEthernet0/2
O IA    192.168.1.128 [110/2] via 10.1.1.9, 00:57:35, GigabitEthernet0/2
O IA    192.168.1.192 [110/2] via 10.1.1.9, 00:57:35, GigabitEthernet0/2
O IA    192.168.1.224 [110/2] via 10.1.1.9, 00:57:35, GigabitEthernet0/2

HO#
```

Fig 4. ***Routing Table*** **at HO** ***Router***

Seen in the OSPF routing table there is the code "O IA" which means that the IP can be obtained from other areas.

c. Look at the Neighbor Router

```
Branch_Router-ISP-2#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
10.10.10.10       1   FULL/DR         00:00:39    10.1.1.10       GigabitEthernet0/
8.8.8.8           1   FULL/DR         00:00:39    10.1.1.5        GigabitEthernet0/
1.1.1.1           1   FULL/BDR        00:00:39    192.168.1.2     GigabitEthernet0/
1.1.1.1           1   FULL/BDR        00:00:38    192.168.1.130   GigabitEthernet0/
1.1.1.1           1   FULL/BDR        00:00:38    192.168.1.194   GigabitEthernet0/
1.1.1.1           1   FULL/BDR        00:00:38    192.168.1.226   GigabitEthernet0/
Branch_Router-ISP-2#
```

Fig 5. Look at ***Neighbor*** **at Each Router**

Using the command "show ip ospf neighbour" can see all neighbours in one area. For ABR, routers have two areas; the router can see the neighbours of those two areas. It is different from an internal router that only can see one neighbouring in the same area and cannot see neighbours who have different areas.

E. Test ping from Branch *to* Head Office

```
HO#ping 3.3.3.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/1 ms

HO#
```

Fig 6. Do Ping from ***Branch*** **to** ***Head Office***

The results of the ping successfully passed through different areas, which means, Branch can connect to the Head Office.

IV. CONCLUSIONS

The simulation shows by using the OSPF routing protocol. The Head Office and Branch can communicate with each other even though they are in different areas by sending each OSPF database to each router. The maximum data transmission value is one millisecond when sending data successfully reaches100%.

REFERENCES

[1] Achmad. "Implementation of Open Shortest Path First (OSPF) Routing Protocol in The Ring Topology Model". Journal of Faktor Exacta 8(2) : 92-99, University of Indraprasta PGRI, Jakarta 2015. ISSN: 1979 - 276X

[2] Rahmdhani Syahputra, Linna Oktaviana, Ery Safrianti "Comparative Analysis of RIPV1 EIGRP and OSPF Routing Performance at PT. Chevron Pacific Indonesia". JOM FTEKNIK Vol. 2, No. 1 Feb 2015, University of Riau, Riau. ISSN : 2355 - 6870

[3] Danu Wiyoto "CCNA v127.1.1.3 Workbook" Best Path Training Center, Tangerang, 2017.

[4] Iwan Sofana "Cisco CCNA Network and Computer" Publisher Informatics, Bandung, 2009.

[5] Iwan Sofana "Cisco CCNP Network and Computer" Informatics Publisher, Bandung, 2009.

[6] Hari Antoni Mursil "Appliacation of OSPF to Determine The Best Path in Network". Journal of Elektro and Telekomunikasi Terapan (JETT), Vol. 4 No. 1, July 2017, Telkom University, Bandung.
[7] Jing Yang, Yilong Yang "Design and Implementation of a Distributed Crawler Multi-Area Based on Skipnet-YL Network", Third Pacific-Asia Conference on Circuits, Communications and System (PACCS), 2011, Huiyang, Wuhan, China (2011).
[8] Guntro Barovih "Comparison of Router Software Performance on Multi Area OSPF Routing Simulation". IT Journal, Vol. 4 No.2 Oct 2017, University of Potensi Utama, Medan. ISSN : 2252 – 746X.

Nur Hayati, Obtained a bachelor's degree (S.Si) from the University of Nasional in 2006. Then earned a Master's degree (M.T.I) from the University of Indonesia in 2011. Currently, the author is a lecturer in the Informatics study program at the University of National.

Ratih Titi Komala Sari, Obtained a bachelor's degree (S.T) from the University of Gunadarma in 2004. Then earned a Master's degree (M.M.S.I) from the University of Gunadarma in 2014. Currently, the author is a lecturer in the Informatics study program at the University of National.