Open Shortest Path First (OSPF) Routing Protocol and the Use of Virtual-Links

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Abstract: Open Shortest Path First (OSPF) routing protocol is a dynamic routing protocol which employs link-state routing and Dijkstra's shortest path algorithm. Using LSA's (Link State Advertisements) the router's local routing topology is advertised to all other routers in the same OSPF area. OSPF employs a hierarchical network design using Areas. Area 0 is called the backbone and other areas are connected to the backbone area or area 0 using virtual-Links. Hierarchical network architecture has two major advantages. Firstly, the router does not have detailed information about network topology outside of its area, which Thereby reduces the size of its database and helps in fast convergence. Secondly, there is systematic grouping and communication when the network is subdivided into areas, which is a logical collection of OSPF network, routers and links that have the same area identification. Troubleshooting is made easier. In this paper we explain in detail, the connection of other OSPF areas to the backbone area or area 0 using virtual-Links. We connect area 10 to area 0 via virtual-link. Also, a virtual-Link can be used to connect to the backbone through non-backbone area. The area through which a virtual-link is configured is known as the transit area (which will never be a stub area) and it consists of full routing information (should and must).

Keywords: Open Shortest Path First (OSPF) routing protocol, link-state routing, Dijkstra's shortest path algorithm, LSA's, OSPF area, virtual-Link and transit area.

I. INTRODUCTION

A router is a Layer 3 device [1] which selects a path between networks securely forward data packets across that path towards the intended destination. Routers area configured with routing protocols to do so. There are 2 types of routing

- Static routing- It is used to manually set up the optimal path between the source and the destination. In many cases, static routes are manually configured. When there is a change in the network or failure occurs between two statically defined devices, traffic will not be re-routed. This requires manual reconfiguration by an admin. Static routing is the simplest way of routing the data packets from a source to a destination. It is suitable for very small networks and its configuration is very time consuming.

- Dynamic routing- unlike static routing, dynamic routing protocols use complex dynamic routing algorithms to update the routing table and to find the optimal path. The dynamic routers are based on various routing algorithms like OSPF (Open Shortest Path First), RIP (version 1 and 2), EIGRP and IS-IS, which constitute the IGP (Interior Gateway Protocol) and the Border Gateway Protocol (BGP), which is an Exterior Gateway Protocol (EGP). If a router on the route goes down, the destination is unreachable. In this case, static routing is useless. Dynamic routing eliminates the faulty router and finds out another possible optimal path from source to destination in the same network.

II. CONCEPT OF HIERARCHICAL NETWORK AND VIRTUAL LINKS

OSPF follows hierarchical network structure [2]. It consists of many areas, which are a logical connection of OSPF networks, routers and links that have the same area identification. Area 0 is called the backbone area [3] of that network and all other areas must be connected to the backbone. Hierarchical network design involves dividing the network into logical areas and each area, or tier in the hierarchy provides specific functions that define its role within the overall network. Figure 1 shows area 0 (backbone area) and other areas. In figure 1 we can observe the hierarchal design of an OSPF network.

Any area n, where n=1, 2, 3, 4….. and n!= 0 is connected to its backbone area, area 0 via virtual-links [4]. A virtual-link connects other areas to area 0. Also, other areas can be connected to the backbone area through a non-backbone area (area n, n! =0). Figure 2 shows the use of virtual-link to connect area 2 to area 0. Figure 3 shows the use of virtual-links to connect other areas to area 0 via a non-backbone area. Here area 20 is acting as a virtual-link to connect area 30 to area 0. Also, area 10 is the virtual-link to connect area 20 to area 0.
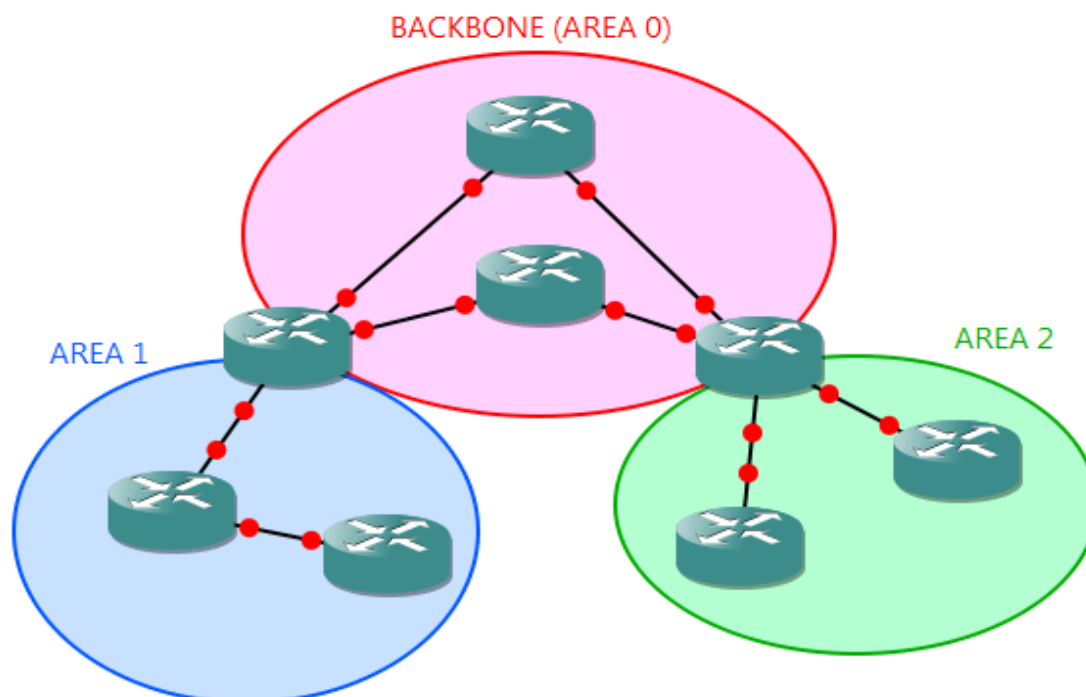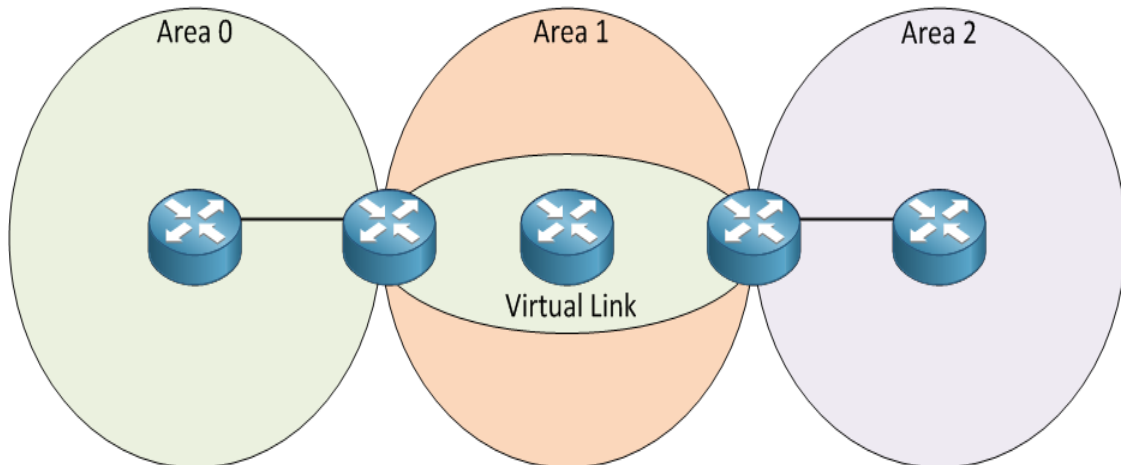
Figure 1 shows area 0 (backbone area) and other areas.

III. NETWORK

Figure 4 shows the network topology of a chosen problem and to be solved and simulated using Network Simulator tool [5]. Area 0 is the backbone area. R1 and R6 are the Border Routers (BR) of area 0. Area 10 consists of two BRs R2 and R7. A virtual link is established between area 0 and area 10. Area 10 is further connected to other areas through virtual-links and further connecting those to the backbone area or area 0. We are following hierarchical network topology because

- Dividing a network into areas can improve/ help the network engineer or admin in trouble shooting.
- Provides systematic analysis of the network, as the network these days includes millions of connections and links.
- Every area is connected to the backbone or area 0 via virtual-links.
- The router does not have detailed information about network topology outside its area, which thereby reduces the size of its database and helps in fast convergence.

Figure 5 shows the configuration of OSPF on R1 and a virtual-link between area 0 and area 10 using interface loopback. Figure 6 shows the configuration of OSPF on R2 and virtual-link between area 0 and area 10 using interface loopback. After these commands, area 10 is connected to area 0 and communication is established.

IV. NEXT PROJECT- BORDER GATEWAY PROTOCOL

In this paper we have configured OSPF on routers inside an AS. OSPF is an Internal Gateway Protocol and is always configured on routers within an AS. BGP is an Exterior Gateway Protocol (EGP) used to connect two different Autonomous Systems. Table 1 shows the difference between IGP and EGP. In the next paper we will be configuring BGP- both EBGP (External BGP) and IBGP (Internal BGP).

Table1

Sl.no	IGP	EGP
1	Interior Gateway Protocol	Exterior Gateway Protocol
2	Used/ configured within an AS	Used or configured between different AS
3	Routing takes place within the boundary of the AS	Routing takes place between different AS with different AS number
4	RIP, OSPF, IS-IS and EIGRP area the IGPs	BGP is an EGP

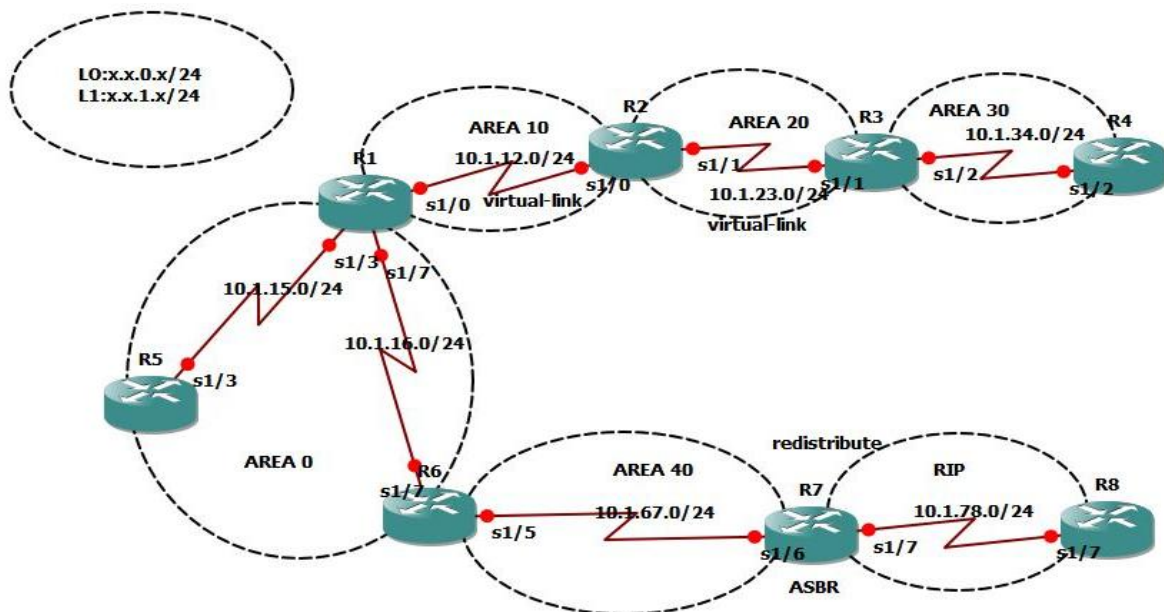Figure 2 shows the use of virtual-link to connect area 2 to area 0.

Figure 3 shows the use of virtual-links to connect other areas to area 0 via a non-backbone area.

Figure 5 shows the configuration of OSPF on R1 and a virtual-link between area 0 and area 10 using interface loopback.

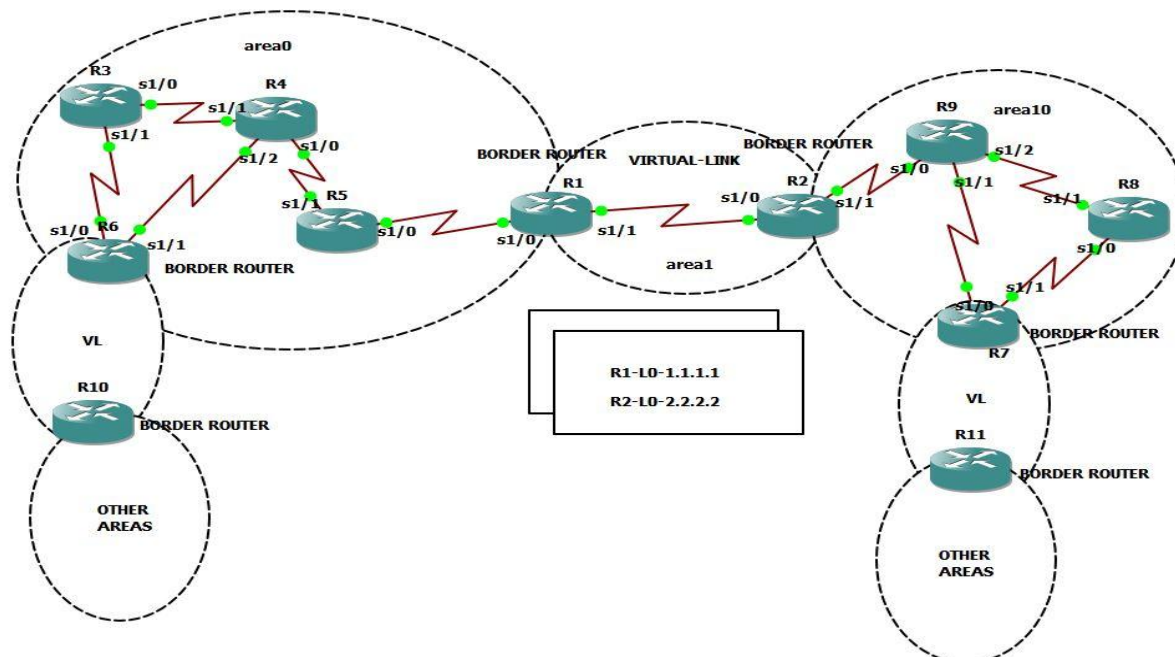Figure 4 shows the network topology of a chosen problem and to be solved and simulated using Network Simulator tool.

Figure 6 shows the configuration of OSPF on R2 and virtual-link between area 0 and area 10 using interface loopback.

V. CONCLUSIONS

OSPF routing protocol provides a window for logical division of a complex network of routers, switches, links etc. into area. Each area is connected to a backbone area, called area 0, thereby enabling hierarchical routing. Hierarchical routing and division of the existing complex network into its logical subunits in the form of areas ensures systematic network analysis and trouble shooting. It als0 enables autonomous routing within these logically configured areas. Also communication between these areas is possible using a virtual-link.

REFERENCES

[1] Route Redistribution-A Case Study - ijarcce- www.ijarcce.com/upload/2017/june-17/IJARCCE%2042.pdf
[2] Open Shortest Path First - Router Alley- www.routeralley.com/guides/ospf.pdF
[3] Open Shortest Path First- A Case Study - ijarcce- www.ijarcce.com/upload/2017/june-17/IJARCCE%2096.pdF
[4] OSPF Virtual Link - Cisco- www.cisco.com/c/en/us/support/docs/ip/open-shortest...ospf/47866-ospfdb7.html
[5] GNS3 | The software that empowers network professionals- https://www.gns3.com/