OSPF

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Abstract

Links state algorithms use the state of the link to calculate the routing tables, each device is notifying of the changes in the network, and only on these changes is that the algorithms are run. An advantage of this is that they can converge faster than the distance vector algorithm. One of the most used algorithm in this Link state routing field is **OSPF** *(Open Shortest Path First)* some adventages of **OSPF** are its scalability, fast convergence and efficient use of bandwidth. Here we will explain details about the inner workings of *OSPF* adventages, disadventages and state of the art.

Some definitions

1. **Shortest Path First:** Also called the Dijkstra algorithm, SPF is a routing algorithm in which a router computes the shortest path between each pair of nodes in the network.
2. **Interior Gateway Protocol:** An Interior Gateway Protocol (IGP) is a dynamic route update protocol used between routers that run on TCP/IP hosts within a single autonomous system. The routers use this protocol to exchange information about IP routes.
3. **Hello Protocol:** During initialization/activation is used for neighbor discovery as well as to agree on several parameters before two routers become neighbors, this means that using the hello protocol logical adjacencies are established. After initialization, for all network types, the hello protocol is used to keep alive connectivity, which ensures bidirectional communication between neighbors
4. **Flooding:** Is used in the routing algorithm, in which each incoming packet is sent through all outgoing links except the one that arrived.
5. **Link State Advertisement:** It communicates the local routing topology of the router to all other local routers in the same area.

OSPF

Open Shortest Path First (OSPF) is an Interior Gateway Protocol (IGP) standardized by the Internet Engineering Task Force (IETF), which is designed to efficiently scale and support large enterprise networks. OSPF is a dynamic, hierarchical, link-state routing protocol that provides fast convergence and excellent scalability. Like link-state protocols, OSPF is very efficient in its use of network bandwidth.

Also, OSPF uses the Shortest Path First (SPF) algorithm to calculate the shortest routing path, and is capable to support routing in Transport Control Protocol (TCP) / Internet Protocol (IP) networks within an area.

How OSPF works

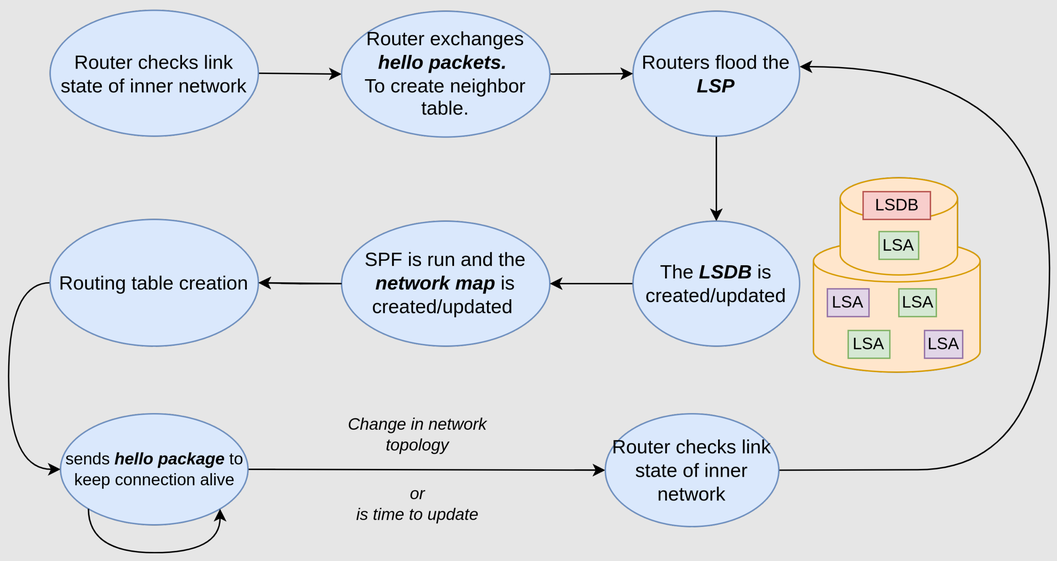

Figure 1. OSPF

OSPF is based on open standards and is often applied in corporate networks using the Link State Advertisement (LSA) routing protocol, which calculates the route based on data stored in a link state database (LSDB). In addition, it makes use of Djkstra rules to determine and choose the shortest and smartest path available to deliver packets to the best route in the network from source to destination within the LSDB to send information to its neighboring routers using the cumulative cost of the links on the route. This is because OSPF routers know their OSPF neighbors, adjacency table and topology. A step by step process would be:

1. Each router gets the information of the Link State within its own network.
2. After that each router exchanges hello packets to know who is in the network. With that a neighbor of routers table is created.
3. Then the routers create the Link State Packet (LSP) that contains information of the scanned network in item *(1)*. Once created the routers share the LSP through the flooding process.
4. After the update the LSDB *Link State Database* is created, with it Dijkstra is run, and the network map is created.
5. Given the network map the routing table can be created or updated.
6. The process is repeated starting from item *(3)* whenever the topology in the network changes.

RIP vs OSPF

The growth and expansion of current networks has led RIP to have certain limitations that can cause problems in large networks, which OSPF can handle, some of these limitations are Yau Zakariyya 2021:

- RIP has a limit of 15 hops unlike OSPF.
- RIP cannot handle Variable Length Subnet Masks (VLSM). Given the scarcity of IP addresses and the flexibility that VLSM offers in the efficient assignment of IP addresses
- Periodic broadcasts of the entire routing table consume a large amount of bandwidth.
- RIP routers go through a period of waiting and garbage collection and slowly remove information that has not been received recently. This makes RIP convergence slower than OSPF.
- RIP has no concept of network delays and link costs, so routing decisions are based on the number of hops.

Advantages of OSPF

- Compared to distance-vector addressing protocols such as the Routing Information Protocol (RIP), OSPF is more suitable for serving between large heterogeneous networks.
- OSPF can recalculate routes in a very short time when the network topology changes.
- With OSPF, an autonomous system (AS) can be divided into areas and kept separate to reduce OSPF routing traffic and the size of each area's link-state database.
- Has better convergence.
- Sends network updates using multicast. This ensures less processing on routers that are not listening to OSPF packets. Also, updates are only sent in case routing changes occur instead of periodically. This ensures a better use of bandwidth.
- OSPF allows for better load balancing.
- OSPF is an industry open standard, which means that any vendor who so desires, can incorporate OSPF into their routing devices. Liu et al. 2009

Some problems

Some of the demerits of OSPF is that:

- It requires more memory resources to hold neighbor information tables.
- Extra CPU processing to run SPF algorithm
- Difficulty to configure distance vector protocol.
- It requires more RAM to store adjacency topology, and being more complex to set up and hard to troubleshoot.

Some applications of algorithms with OSPF

- The operation of intelligent traffic forwarding in a hybrid SDN/OSPF industrial network, where they are based on a framework of Quality of Service (QoS) metrics, including packet loss rate, link utilization, and link delay, which are vitally important for QoS-aware industrial applications.
- The WAN Test Bed with a fourth subscene that allows the injection of unicast or multicast video traffic, compressed with various codecs. The generic topology used includes one computer running as a broadcast server and up to 20 desktop computers (PCs) as clients connected at the ends of a network such as outside a WAN. This network network is made up of routers and switches with different types of links interconnecting the same. For operation between routers, the OSPF V2 routing protocol was configured Facchini et al. 2017.

General OSPF examples

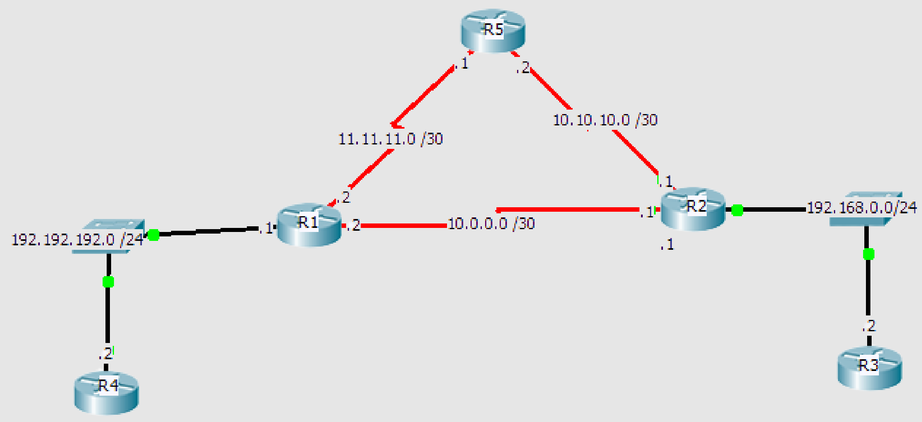

Figure 2. OSPF topology. Cisco application

Adjacent routers are routers that go beyond the simple Hello exchange and proceed into the database exchange process. The OSPF link state routing protocol uses the concept of Areas, which are sub-domains within the OSPF domain. A router within an Area maintains the complete topology information of that Area. By default, an interface can only belong to one OSPF Area. This can not only cause sub-optimal routing in the network, but it can also lead to other issues if the network is not designed correctly. Cisco 2019

References

Yau Zakariyya, A. K. (2021). "Comparative performance evaluation of RIP with OSPF routing protocol". In: *Journal of Applied Technology and Innovation* 5.10, pp. 67–71. DOI: https://dif7uuh3zqcps.cloudfront.net/wp-content/uploads/sites/11/2021/08/02195413/Volume5_Issue3_Paper12_2021.pdf.

Cisco (2019). *OSPF with Multi-Area Adjacency Configuration Example*. URL: https://www.cisco.com/c/en/us/support/docs/ip/open-shortest-path-first-ospf/118879-configure-ospf-00.html (visited on 05/10/2022).

Facchini, H., S. Perez, L. Marrone, and F. Hidalgo (2017). "Experimental Study of Multicast and Unicast Video Traffic in WAN Links". In: *IEEE Latin America Transactions* 15.10, pp. 1847–1855. DOI: 10.1109/TLA.2017.8071226.

Liu, D., B. Barber, and L. DiGrande (2009). "CHAPTER 7 - Implementing the OSPF Protocol". In: ed. by D. Liu, B. Barber, and L. DiGrande. Boston: Syngress, pp. 233–282. ISBN: 978-1-59749-306-2. DOI: https://doi.org/10.1016/B978-1-59749-306-2.00011-7. URL: https://www.sciencedirect.com/science/article/pii/B9781597493062000117.