

# Open Shortest Path First (OSPF)

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### 1. Introduction

Network routing requires switches and routers to be aware of the other devices in the network to know where to send packets. The only way this is possible is if each router shares its knowledge about the network with the other devices. All routers then have a basic understanding of the network and know how to forward packets. In order to exchange information between routers a special protocol is required.

### 2. OSPF

Open Shortest Path First (OSPF), which was created to replace RIP (Routing Information Protocol), is a routing protocol designed for larger or more complex networks than those normally supported by RIP. OSPF standards are covered in RFC 1245 and RFC 1583.

OSPF is a link state protocol. In link state algorithms a router determines the state of, or status of, its links. Each router constructs a link state advertisement (LSA) with the status of its links and transmits this to its neighbors. The routers build a complete list of all routes to all destinations based on compiling the LSAs from each router. Each router identifies which routers and subnets are directly connected to it. Then, it distributes this information to all other routers. OSPF routers use this information and build a table of what the network looks like. Using this table, each router can identify where sub-networks are located, what routers are in direct connection, and how to get to any specific router.

OSPF is also an interior gateway protocol that distributes routing information between routers in a single autonomous system. Once all routers have constructed their databases based on the LSA information, they run the shortest path first algorithm. This results in a tree structure with each router at the "root" of its own tree and the shortest path to all other destinations mapped out. The selection of the path to these destinations is based on metrics, which may be based on hop count, bandwidth, load, cost, reliability, delay, or controlled statically by the user. This provides the network manager greater control over how routing occurs in the network.

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### 3. OSPF Packets

This diagram shows the basic format of the OSPF packet. The fields are as follows:

Version Numbr	Type Field	Packet Length
Router ID		
Area ID		
Checksum	Authentication Type	
Authentication		
Authentication		
Data		

The first field, **version number**, identifies the OSPF version used.

Next is the **type field**, which identifies the OSPF packet type. This field will either contain a "hello" message or a database description. Hello messages are used to establish and maintain neighbor relationships. The database description describes the contents of the router's topological database.

There are three types of messages that can reside in the database description type field:

- **Link-state request**, which is used to request pieces of the topological database from a neighbor router
- **Link-state update**, which is a response to a link-state request packet
- **Link-state acknowledgment**, which acknowledges the receipt of a link-state update packet

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The **packet length field** specifies the size of the total packet.

The **router ID field** identifies the source of the packet.

The **area ID** identifies the OSPF area to which the packet belongs.

The **checksum field** provides a way to check the entire packet's content for any damage suffered in transit.

The **authentication type field** contains the authentication type. OSPF protocol exchanges can be authenticated and are configurable. The authentication field contains information that will identify the sender as a valid entity on the network.

Lastly, the **data field** contains the information being exchanged.

### 4. OSPF Operation

Let's use an example to illustrate OSPF operation. Imagine that there are four interconnected switches and each switch is connected to a central network – this is the OSPF backbone area. When everything is first turned on, OSPF routers detect which networks are directly accessible. They also try to determine who their neighboring routers are. Routers identify neighboring routers by transmitting "hello" packets on all their ports. In these packets, each router identifies itself.

Authentication can be used to validate the communication between routers, but this is optional since an explicit trust relationship can be setup between routers so they "trust" one another.

When a router receives a "hello" packet from a neighbor a "relationship" is established and information is exchanged. When it is determined that more than one router is present within an area, a primary (designated) router is selected as well as a backup designated router.

Once the designated router is selected, all other routers establish a relationship with it to exchange database information. The database exchange process uses OSPF request and response messages to exchange data. Once the databases are fully exchanged and synchronized, the routers are said to be in a **full state**.

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After they are synchronized, the routers run the shortest path algorithm. Each router constructs a tree structure from itself to all known destinations. By building this structure, the routers are able to determine how to best forward a packet to any destination across the network.

A similar database relationship is also established with the backup router; however, this is only used in case of the designated router's failure.

Once the network is up and running, the routers periodically send "hello" packets on their interfaces. This is done to verify that all links are still active and also to make sure of the neighboring routers' status.

If a link failure or loss of communication between neighboring devices occurs, the router or routers that detect the change advertise this information to other routers, so they can update their databases. This guarantees that all routers are updated with the most current network topology information as quickly as possible.

To summarize, OSPF separates networks into areas and each area has a designated router. All routers in an area send database updates about attached networks and stations to the designated router, and the designated router sends that information to all other routers in the area. Using the database information, routers construct tree structures using the shortest path first algorithm, allowing them to forward packets efficiently.

### 5. Advantages and Disadvantages of OSPF

OSPF is able to quickly update all routers on large, complex networks. It is able to forward traffic across multiple paths to a single destination (equal cost, multi-path capability).

OSPF also uses metrics to determine the best path to a destination – it does not just depend on hop count as RIP does. Unfortunately, because of OSPF's ability to handle large complex networks it is also more complex for the network manager to configure and set up, and it requires greater computing power within the router. The manager must manually understand, calculate, and factor in path costs that the routers will use during router-to-router exchanges.

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### Appendix A: Glossary

**Designated router** – OSPF separates the network into regions called areas. Within each area, there is a router identified as the designated router. This router is responsible for the distribution of all intra- and inter-area routing information.

**Link state advertisement (LSA)** – The LSA is similar to a RIP update. The LSA is used by routers to exchange information about the status of their connections to neighbors.

**Hello messages** – These are messages generated by each router to identify its neighboring routers and to verify their status. If a router does not reply to a hello message, that indicates the loss of a connection and results in the generation of an updated LSA.

**Backbone** – OSPF separates the network into OSPF areas. All OSPF areas must connect directly to a special area called the backbone area. This area is used to exchange routing information between all other areas.

### Appendix B: Sources for additional information

[IETF OSPF Working Group](http://www.ietf.org/html.charters/ospf-charter.html)

<http://www.ietf.org/html.charters/ospf-charter.html>

[OSPF Overview](http://www2.rad.com/networks/1995/ospf/ospf.htm)

<http://www2.rad.com/networks/1995/ospf/ospf.htm>

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