

# OSPF Fundamental Terminology

This explains basic concepts of OSPF including public AS number, private AS number, backbone area, ABR, IP, Link, state, LSA and LSDB in detail with examples.

OSPF stands for Open Shortest Path First. OSPF is a link state open standard based routing protocol. It was created in mid-1980. Since it is based on open standard, we can use it with any vendor's router.

## Features and advantage of OSPF

- It supports both IPv4 and IPv6 routed protocols.
- It supports load balancing with equal cost routes for same destination.
- Since it is based on open standards, it will run on most routers.
- It provides a loop free topology using SPF algorithm.
- It is a classless protocol.
- It supports VLSM and route summarization.
- It supports unlimited hop counts.
- It scales enterprise size network easily with area concept.
- It supports trigger updates for fast convergence.

Just like other routing protocols, OSPF also has its negatives.

## Disadvantage of OSPF

- It requires extra CPU process to run SPF algorithm.
- It requires more RAM to store adjacency topology.
- It is more complex to setup and hard to troubleshoot.

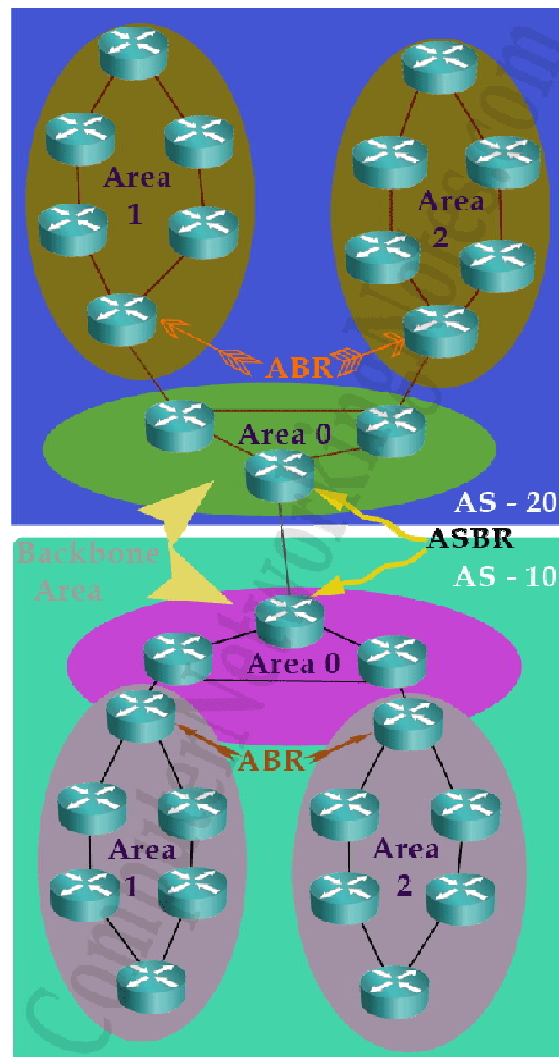
Basically OPSF was created to fulfill the requirement of enterprise size network. To scale a large size network it uses area concept. Area concept is similar to Subnetting. It allows us to separate the large internetwork into smaller networks known as areas.

Along with Area concept OSPF also supports Autonomous System (AS). Just like area, AS also divide a large network into smaller networks.

## Difference between **AS** and **Area concept**

**Area concept** is a feature of OSPF. It is limited only with OSPF. We cannot use it with other routing protocol.

**AS** is an independent concept originally defined in RFC 1771. We can use it with any routing protocols which understand its concept.



### Autonomous System

An AS is a group of networks running under a single administrative control. This could be our company or a branch of company. Just like Subnetting AS is also used to break a large network in smaller networks.

AS creates a boundary for routing protocol which allow us to control how far routing information should be propagated. Beside this we can also filter the routing information before sharing it with other AS system. These features enhance security and scalability of overall network.

Basically AS concept was developed for large networks. Routing protocols which were developed for small networks such as RIP do not understand the concept of AS systems.

There are two types of routing protocols IGP and EGP.

**IGP** (Interior Gateway Protocol) is a routing protocol that runs in a single AS such as RIP, IGRP, EIGRP, OSPF and IS-IS.

**EGP** (Exterior Gateway Protocol) is a routing protocol that performs routing between different AS systems. Nowadays only BGP (Border Gateway Protocol) is an active EGP protocol.

To keep distinguish between different autonomous systems, AS numbers are used. An AS number starts from 1 and goes up to 65535. Same as IP addresses, AS numbers are divided in two types; Private and public.

**Public AS Numbers:** - We only need to use public numbers if we are going to connect our AS with Internet backbone through the BGP routes from Internet. IANA (Numbers Authority) controls the public AS numbers.

**Private AS Numbers:** - Private AS numbers are used to break our internal network into the smaller networks. We can use any valid AS number in our network unless we connect it with public network. In above example we used two AS numbers 10 and 20 to divide our company network.

In OSPF implementation, routers which connect two different ASes are known as autonomous

Ok let's remove extra burden (ASes) from example network.



## **Area**

OSPF implements two levels hierarchy with areas: backbone and area off backbone.

### **Backbone**

Backbone is the central point of this implementation. Routers running in this area required to maintain a complete database of entire network. All areas need to connect with this area through a physical link or via a virtual link if physical link is not possible.

### **Area off backbone**

Area off backbone is the extension of backbone. Routers running in this area required to maintain an area specific database instead of complete database. This is a cool feature. It will speed-up the convergence time.

### **ABR**

Area Border Router (ABR) is a bridge between Backbone and Area off backbone. With correct IP addressing we can summarize routes information on this router.

### **IR**

IR (Internal Router) is a router running in area off backbone. IR only needs to maintain an area centric local database.

Let's put all these together in a simple example. Assume that our company has 600 hosts. It decided to use three class C subnets; 192.168.0.0/24, 192.168.1.0/24 and 192.168.2.0/24. Each subnet has 200 hosts.

For easy administration these subnets are divided in smaller networks. With VLSM default subnet /24 is subnetted in /29. When we break a default class C Subnet /24 in Subnet /29, it produces 32 networks (8 hosts in each network).

In this situation if we use a classical flat network design, routers need to learn and advertise 96 (32 + 32 + 32) networks. With hierarchy design we can reduce this number to 34 (32 + 1 + 1). Well.... how could this be possible?

Create three areas (area 0, area 1 and area 2) one for each default subnet.

In a hierarchy design we always start from area 0. No matter how many areas you create, you should always start counting from 0. Area 0 has special privilege in OSPF implementation. OSPF treats area 0 as backbone area. Assign area 0 to our first subnet 192.168.0.0/24.

Create area 1 and assign it to subnet 192.168.1.0/24. Finally create area 2 and assign it to subnet 192.168.2.0/24.

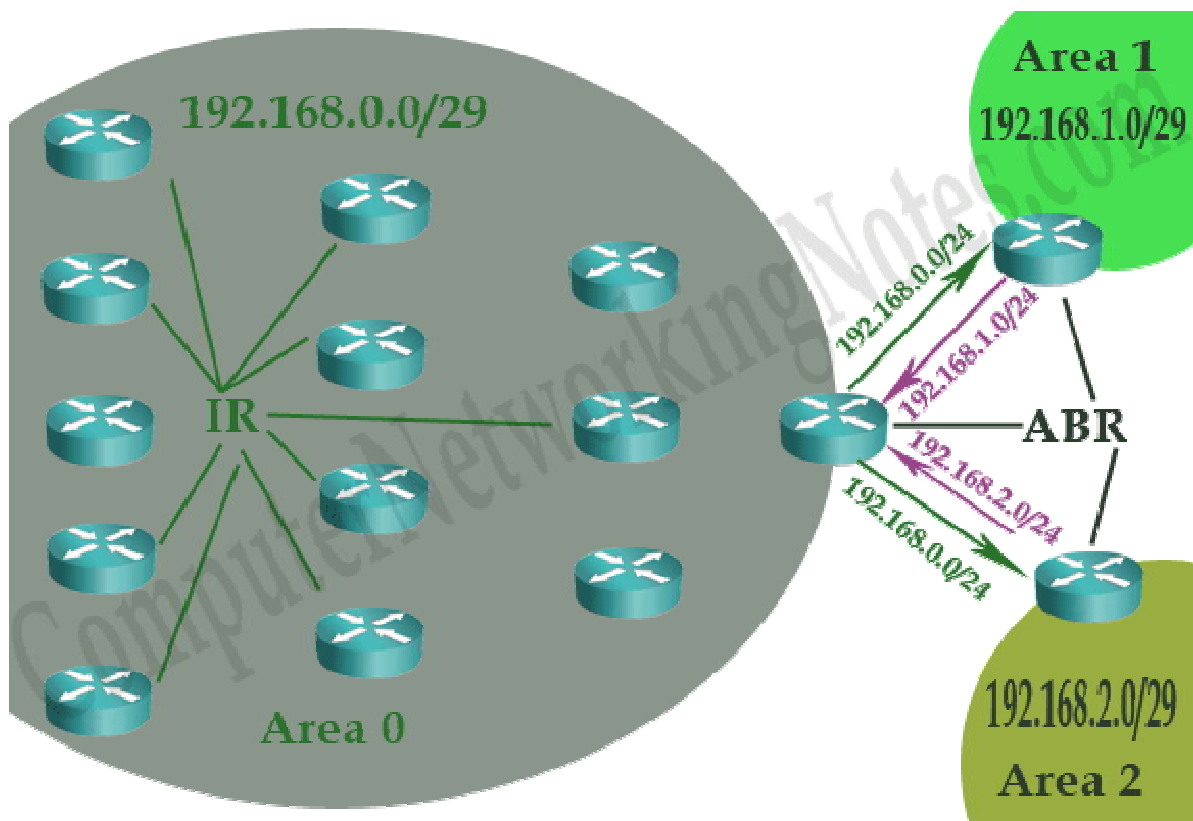
***So how this implementation reduce network broadcasts?***

There are two types of router in an area; ABR and IR.

ABR is a special router which connects two areas. In a proper implementation it should share only summarized route information with remote area.

Through routes summarization on ABR, other areas would see only summarized networks for respective areas instead of full subnets. By doing this we are reducing the amount of information that ABR need to share.

Have a look on following figure. It illustrates our implementation. Area 0 has 32 sub networks (/29) created from one default network 192.168.0.0/24. ABR of area 0 is sharing only one route 192.168.0.0/24 with area 1 and area 2 instead of all internal routes connecting 32 networks.



Hierarchy design limits network instability in a single area. It also reduces routing overhead and speed up the convergence time. If properly implemented with VLSM, it can scale an enterprise size network. Vice versa a little mistake can make it a nightmare.

I have a good news for you, Cisco tests hierarchical design in CCNP. So you can feel relax until you prepare for CCNP exam. Till associate level exam Cisco limits designing part to single area. We will use area 0 to explain the remaining article. Of-course we can use any other valid area number, but it is good practice to take correct learning path from beginning. And we know that in a hierarchy design Area 0 stands on the top.

Okay let's remove other areas from network and make it simple. Now we have only single area to study. Let's explore it step by step. You learned that OSPF is a link state protocol. What does it mean? What is link? And what is state?

### **Link**

Link is an interface running OSPF routing protocol. When we add an interface in OSPF process, it will be considered as a link.

### **State**

State is the information associated with a link (interface). A link (interface) contains several information such as IP address, up/down status, subnet mask, type of interface, type of network, bandwidth and delay. OSPF consider this information as state.

### **LSA**

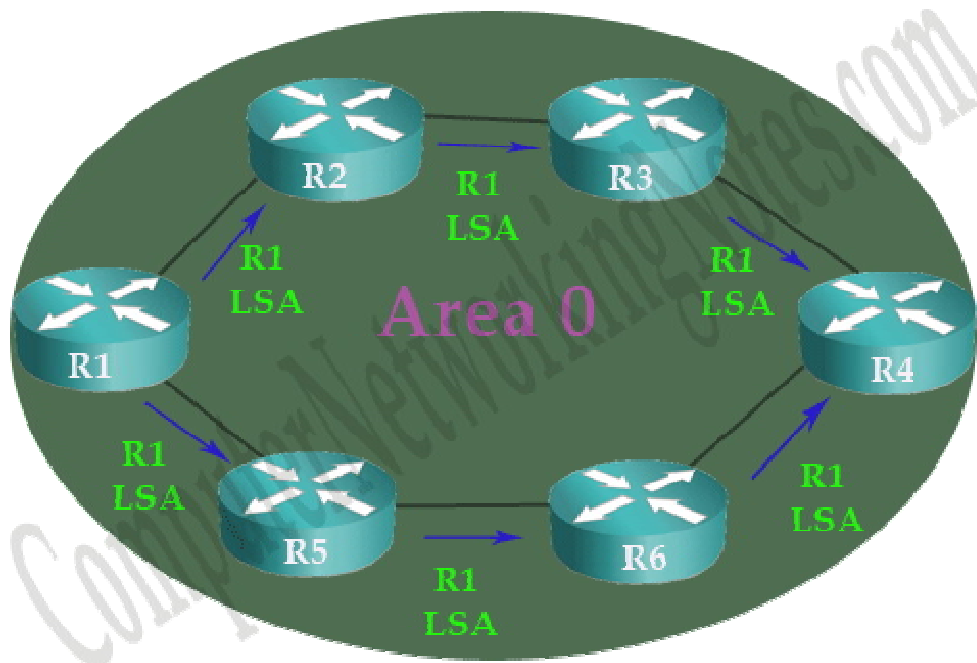
Link state advertisement (LSA) is data packet. It contains link-state and routing information. OSPF uses it to share and learn network information.

### **LSDB**

Every OSPF router maintains a Link state database (LSDB). LSDB is collection of all LSAs received by a router. Every LSA has a unique sequence number. OSPF stores LSA in LSDB with this sequence number.

Upon initialization or due to any change in network information, an OSPF speaking router generates a LSA. This LSA includes the collection of all link-states or link state updates. All routers exchange LSA by flooding. Each router that receives a LSA will store a copy of it in its LSDB then propagate the LSA to other routers.

For example figure display a basic flooding process where R1 is generating LSA and flooding it to the other routers of network.



R2 and R5 are the first clients who receive this LSA. They will update their LSDB and then forward it to R3 and R6 respectively. R3 and R6 will update their database with this LSA and then forward it to R4. From here only one router either R3 or R6 will be able to forward this LSA to R4. Why does this happen?

Because flooding process has a mechanism to prevent the loops. Before sending a LSA to neighbors, it asks them "Do you have this LSA?" If neighbor reply with yes, it will avoid flooding that LSA to this neighbor. If neighbor reply with no, it will flood that LSA to this neighbor. Thus R4 will only receive this LSA only from one neighbor; either R3 or R6.

OSPF routers share LSA only with neighbors. To become an OSPF neighbor, certain conditions need to be matched.