Routing

Topics for discussion

- Basic routing concept
- Router and what does it do?
- Build Routing table
- Route Selection process
- Routing protocols
- OSPF

Basic routing concept

Routing is the process of moving data packets between different networks

Routing is done on Layer 3(Network Layer) in OSI Model

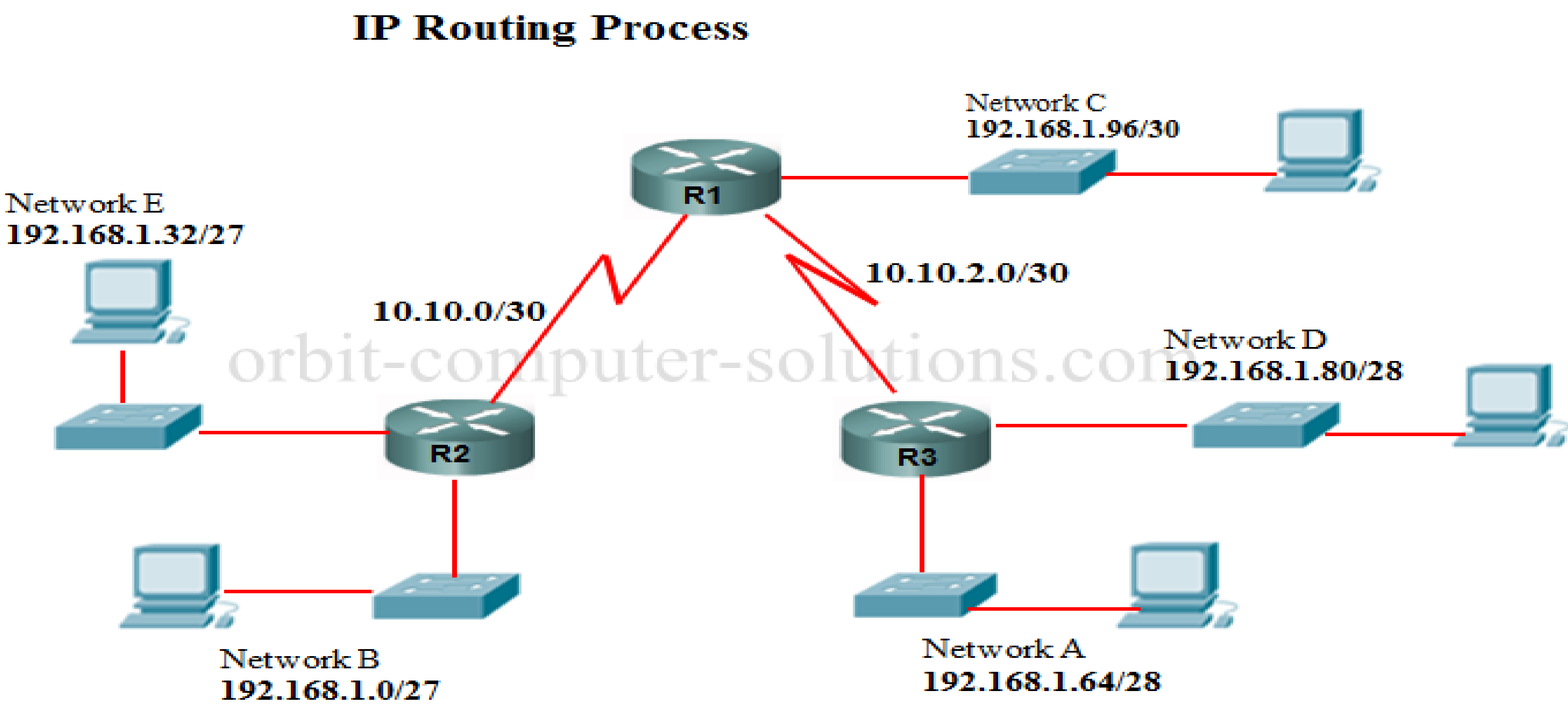
Basic routing concept

Routing, in essence, is the act of finding a path from one place to another on which a packet can travel. They will generally be distributed among many routers, allowing them to jointly share information.

Routing is said to contain three elements:

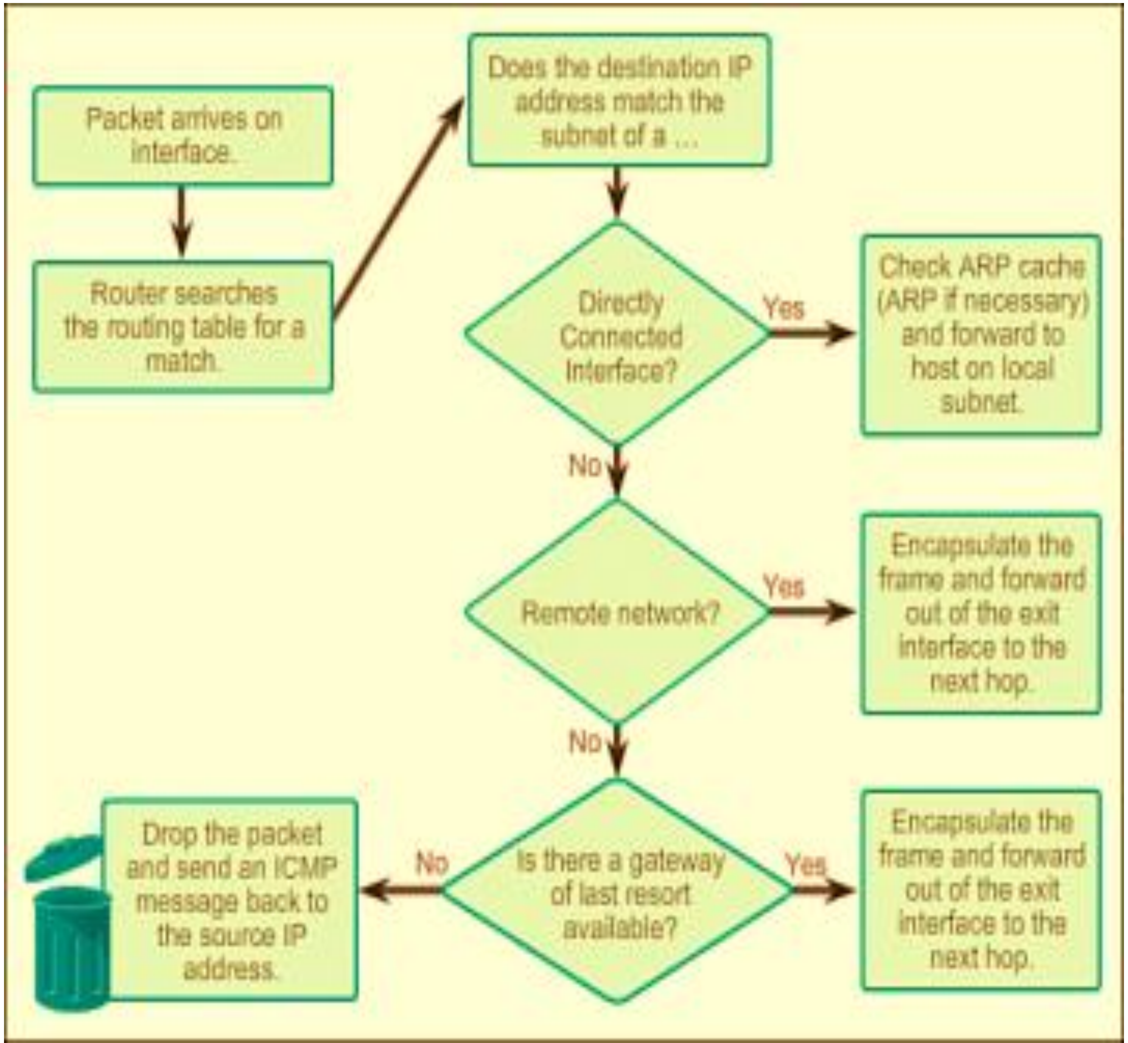
- **Routing protocols, the things that allow information to be gathered and distributed.**
- **Routing algorithms, to determine paths .**
- **Routing databases to store information that the algorithm has discovered.**

Basic routing concept



Basic routing concept

Algorithms



Basic routing concept

Routing Database

```
R1#show ip rip database
172.31.0.0/16    auto-summary
172.31.1.0/24    directly connected, Loopback1
172.31.2.0/24
    [1] via 172.31.123.2, 00:00:05, FastEthernet1/0
172.31.14.0/24    directly connected, Serial0/2
172.31.15.0/24    directly connected, Serial0/0
172.31.24.0/24
    [1] via 172.31.14.4, 00:00:07, Serial0/2
    [1] via 172.31.123.2, 00:00:05, FastEthernet1/0
172.31.25.0/24
    [1] via 172.31.15.5, 00:00:06, Serial0/0
    [1] via 172.31.123.2, 00:00:05, FastEthernet1/0
172.31.123.0/24    directly connected, FastEthernet1/0
192.168.4.0/24    auto-summary
192.168.4.0/24
    [1] via 172.31.14.4, 00:00:07, Serial0/2
192.168.5.0/24    auto-summary
192.168.5.0/24
    [1] via 172.31.15.5, 00:00:06, Serial0/0
R1#
```

Basic routing concept

Routed Protocols vs Routing Protocols

Routed protocol is a protocol that can be routed through Routers.

Routed protocols are the actual data that is transferred from router to router .

ie.IP ,telnet, SNMP.

A routing protocol is a protocol that tells other routers about routes to other routers...

Ie. EIGRP, OSPF, RIP etc...

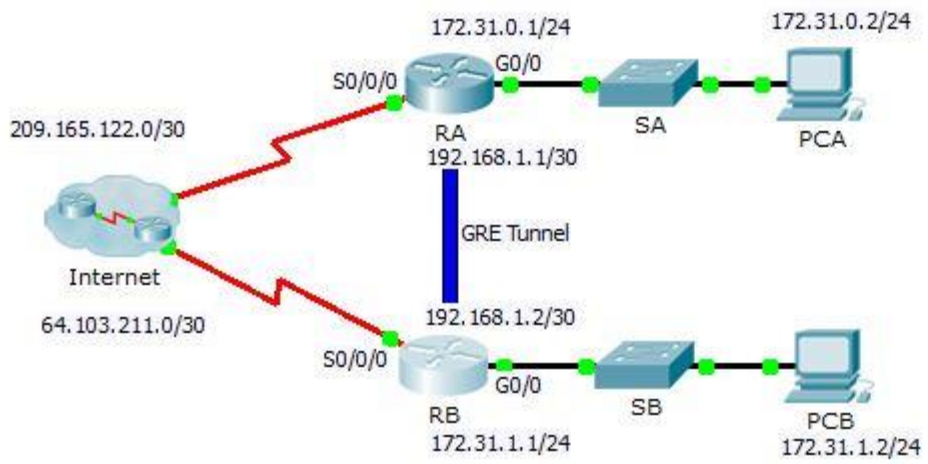
Routing protocols tell the data where to go.

Routed protocols are what pass through the routes.

understand people like data. bus like routed protocol & signals on road like routing protocol

Router and what does it do?

A **router** is an **Intermediate** System (IS) which operates at the network layer of the OSI reference model. **Routers** may be used to connect two or more IP networks, or an IP network to an internet connection.



Router and what does it do?

Some common function of router

- Routers Allow computers share a common Internet resource.
- Routers support NAT.
- The presence of a router, improves security.
- Some routers support advanced security such as VPN
- Some routers have firewalls providing considerable protection against hacking into your network.
- Routers monitor network usage, and can send email alarms when abnormal things happen.
- Routers have Parental Controls.
- Traffic control.

Build Routing table

To go remote or unknown destination , router need to build routing table .

There are two basic methods of building a routing table.

1.Static Routing

2.Dynamic Routing

Build Routing table

Static Routing : **A Static route is a route that is manually entered by a network administrator to routing table to reach a specific destination.**

This is simple to design and easy to implement

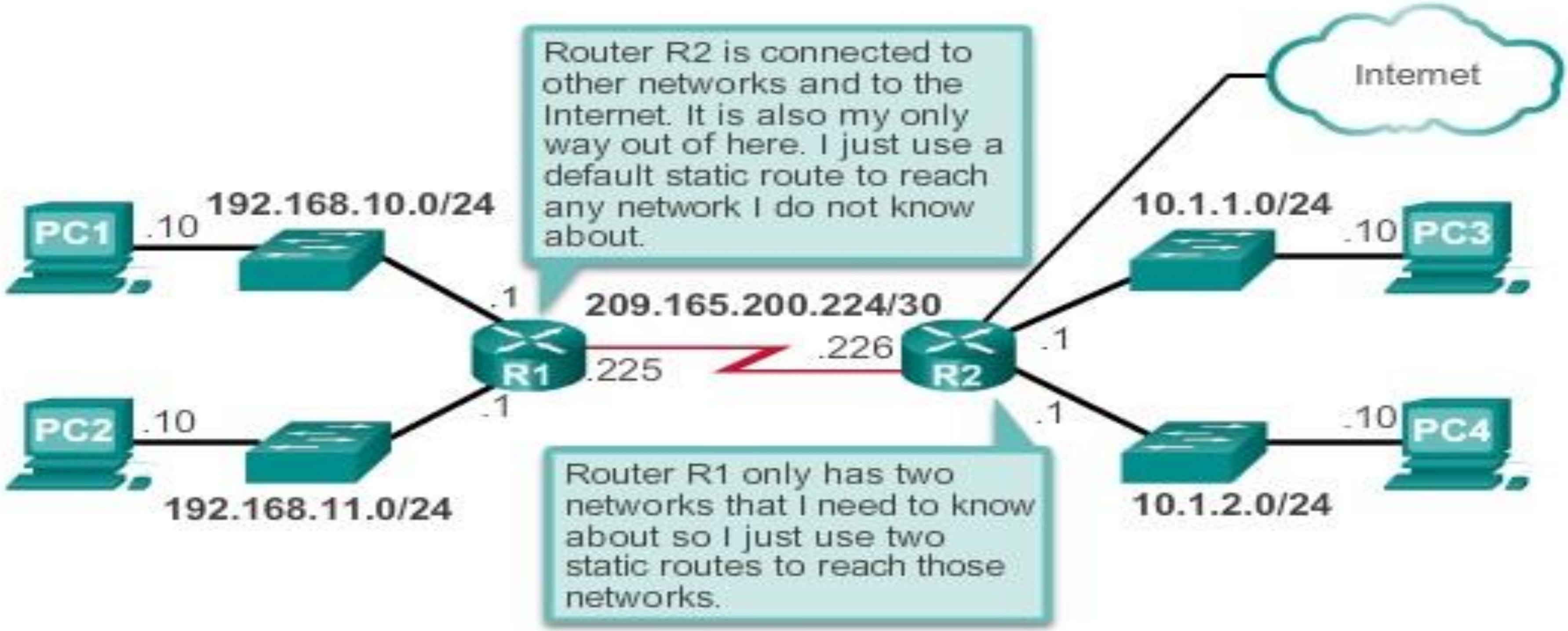
We need the following information to configure static Route in most of the router

Configuration Parameter

- **Destination Network like 10.10.10.0**
- **Destination Subnet Mask 255.255.255.0**
- **Exit interface or through which interface packet will go to Destination.**
- **Next hop or Gateway to reach Destination**

Build Routing table

Static Routing Scenario



Build Routing table

Advantages and Disadvantages Static Routing

Advantages:

- Easily implemented in a small network.
- No overheads are produced on router CPU.
- Secure because the routes are managed statically.
- It is predictable as the route to the destination is fixed.
- Extra resources (such as CPU and memory) are not required as update mechanisms are not needed.
- Bandwidth usage is not required between routers.

Disadvantages :

- Unsuitable for complex topologies and large networks.
- Large networks increase configuration complexity and time consumption.
- Link failure can hinder traffic rerouting.

Build Routing table

Dynamic Routing

imagine that your network consists of 100 routers and you have to add only 2 new different subnets to the network.

You would need to add 200 static routing entries

Build Routing table

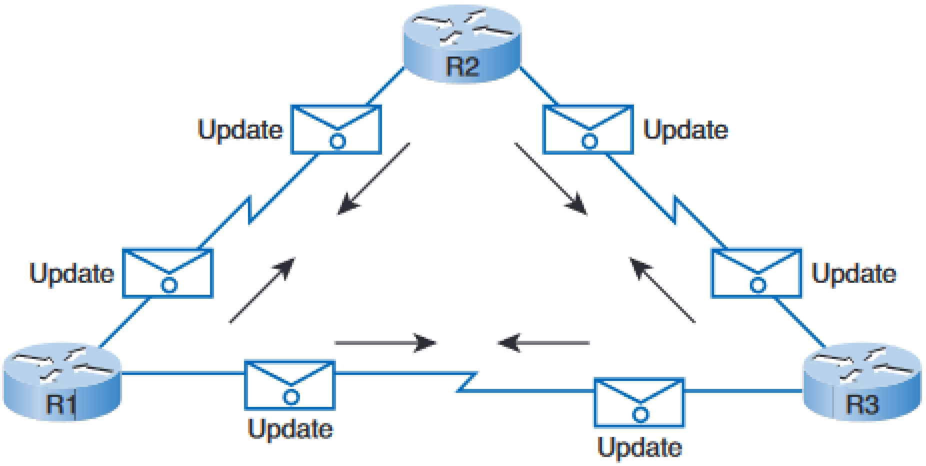
Dynamic Routing:

Dynamic routing is a networking technique that provides optimal data routing. Unlike static routing, dynamic routing enables routers to select paths according to real-time logical network layout changes

Dynamic routing uses multiple algorithms and protocols.

Dynamic routing protocols are supported by software applications running on the routing device (the router) which dynamically learn network destinations and how to get to them and also advertise those destinations to other routers. This advertisement function allows all the routers to learn about all the destination networks that exist and how to those networks.

Build Routing table



A dynamic routing table is created, maintained, and updated by a routing protocol running on the router

Example : RIP (V1 &V2),OSPF,EIGRP,BGP,IS-IS

Build routing table

Purpose of Dynamic Routing Protocols

- Discovering remote networks.
- Maintaining up-to-date routing information.
- Choosing the best path to destination networks.
- Having the ability to find a new best path if the current path is no longer available.

The components of a routing protocol are as follows:

- Data structures .
- Algorithm.
- Routing protocol messages.

Advantages and Disadvantages Dynamic Routing

Advantages :

- It is suitable for all type of networks.
- Simpler to configure on larger networks
- Automatically build routing tables.
- Will dynamically choose a different (or better) route if a link goes down
- Ability to load balance between multiple links

Disadvantages:

- It is hard to implement.
- It is less secure, since it shares routing updates with other routers.
- It puts additional overhead on resources such as CPU, memory and link bandwidth.

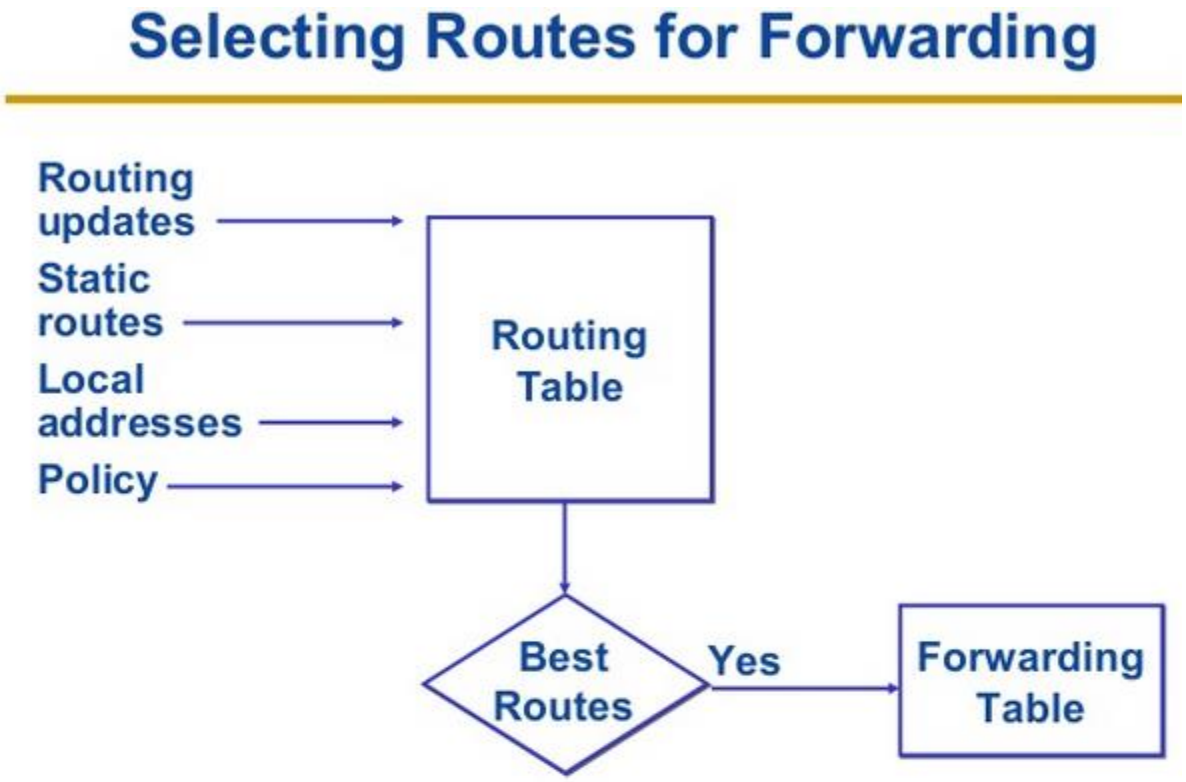
Build routing table

Comparison Chart

BASIS FOR COMPARISON	STATIC ROUTING	DYNAMIC ROUTING
Configuration	Manual	Automatic
Routing table building	Routing locations are hand-typed	Locations are dynamically filled in the table.
Routes	User defined	Routes are updated according to change in topology.
Routing algorithms	Doesn't employ complex routing algorithms.	Uses complex routing algorithms to perform routing operations.
Implemented in	Small networks	Large networks
Link failure	Link failure obstructs the rerouting.	Link failure doesn't affect the rerouting.
Security	Provides high security.	Less secure due to sending broadcasts and multicasts.
Routing protocols	No routing protocols are indulged in the process.	Routing protocols such as RIP, EIGRP, etc are involved in the routing process.
Additional resources	Not required	Needs additional resources to store the information.

Route Selection process

Routing Selection



Route Selection process

Routing Selection

- Route selection Base on :
  - **Longest, or more specific, match**
  - **Preferences, for difficult protocols**
  - **Routing metrics, for same protocol**

- Given multiple routes to a destination , the router must select The best routing path

- Load balancing may be considered

Route Selection process

Routing Selection

- Most specific address is matched :
  - **Host route**
  - **Subnet**
  - **Summary route, or group of subnet**
  - **Major network number**
  - **Supernet , or group of major networks**
  - **Defaults address**

Route Selection process

Routing Selection (Longest match)

IP Packet Destination	172.16.0.10	10101100.00010000.00000000.00001010
Route 1	172.16.0.0/12	10101100.0001000.00000000.00000000
Route 2	172.16.0.0/18	10101100.0001000.00000000.00000000
Route 3	172.16.0.0/26	10101100.0001000.00000000.00000000
Route 4	0.0.0.0/0	00000000.00000000.00000000.00000000

Route Selection process

Preferences

- Route selection processes calculate the active route from all routers In the routing table
- Preferences routes are placed in the forwarding table
- The active route is the route with the lower preference value
  - **Preference is a value in the range of 0 to 255**
  - **Preference is used to rank routes received from different protocol, Interface , or remote systems**
- Identifies the believability of a source in determining best route

Route Selection process

Preferences

Administrative Distance: Administrative distance is the feature that routers use in order to select the best path when there are two or more different routes to the same destination from two different routing protocols. Administrative distance defines the reliability of a routing protocol. Each routing protocol is prioritized in order of most to least reliable (believable) with the help of an administrative distance value.

Administrative distance (AD) AD is a numeric value from 0 to 255. If one update has lower AD value than other, then the route with the lowest AD will be placed in the routing table

Route Selection process

Administrative Distance

Route Source	Default Distance	Routing Table Entry
Connected interface	0	C
Static route out an interface	0	S
Static route to a next-hop address	1	S
EIGRP summary route	5	D
External BGP	20	B
Internal EIGRP	90	D
IGRP	100	I
OSPF	110	O
IS-IS	115	i
RIPv1, RIPv2	120	R
Exterior Gateway Protocol (EGP)	140	E
ODR	160	O
External EIGRP	170	D EX
Internal BGP	200	B
Unknown	255	

Route Selection process

Routing Metrics

Metric: If two routing updates for same network have same AD value then metric will use to choose the best path. Metric is a measurement to calculate best path. Route with the lowest metric will be chosen. Different routing protocols use different metrics. It may use single metric or multiple metrics. For example EIGRP uses bandwidth, delay, load, MTU and reliability while RIP only uses hop count as metric.

Route Selection process

Routing Metrics

- Routing Metrics are generally a measurement of cost or overhead
- Metrics are protocol-specific
  - Used to determine the best route for single protocol
  - Don’t compare metrics from different routing protocols

Route Selection process

Routing Metrics

- **Possible routing metrics include :**
  - **Hop count**
  - **Composite index/metrics**
    - **Bandwidth : Amount of data that can be transmitted in a fixed amount of time**
    - **Delay : Transit latency of path**
- **Common practice is to link bandwidth as a measure of cost , like a toll for the router .**
- **Path metrics are calculated by adding the interface metrics along the path**

Route Selection process

Routing Metrics

Routing Protocol	Metric	Description
EIGRP	Bandwidth	Capacity of link in Kbps
EIGRP	Delay	Time to reach in destination
EIGRP	Load	Path that is least utilize
EIGRP	MTU	Path that support largest frame size
EIGRP	Reliability	Path that have least down time
OSPF	Cost	Inverse of bandwidth links
RIP	Hop count	Hops (Routers) in the way of destination

Dynamic Routing protocol

Classifying Dynamic Routing Protocols

Routing protocols can be classified into different groups according to their characteristics:

- **IGP or EGP**
- **Distance vector or link state**
- **Classful or classless**

Dynamic Routing protocol

IGP and EGP

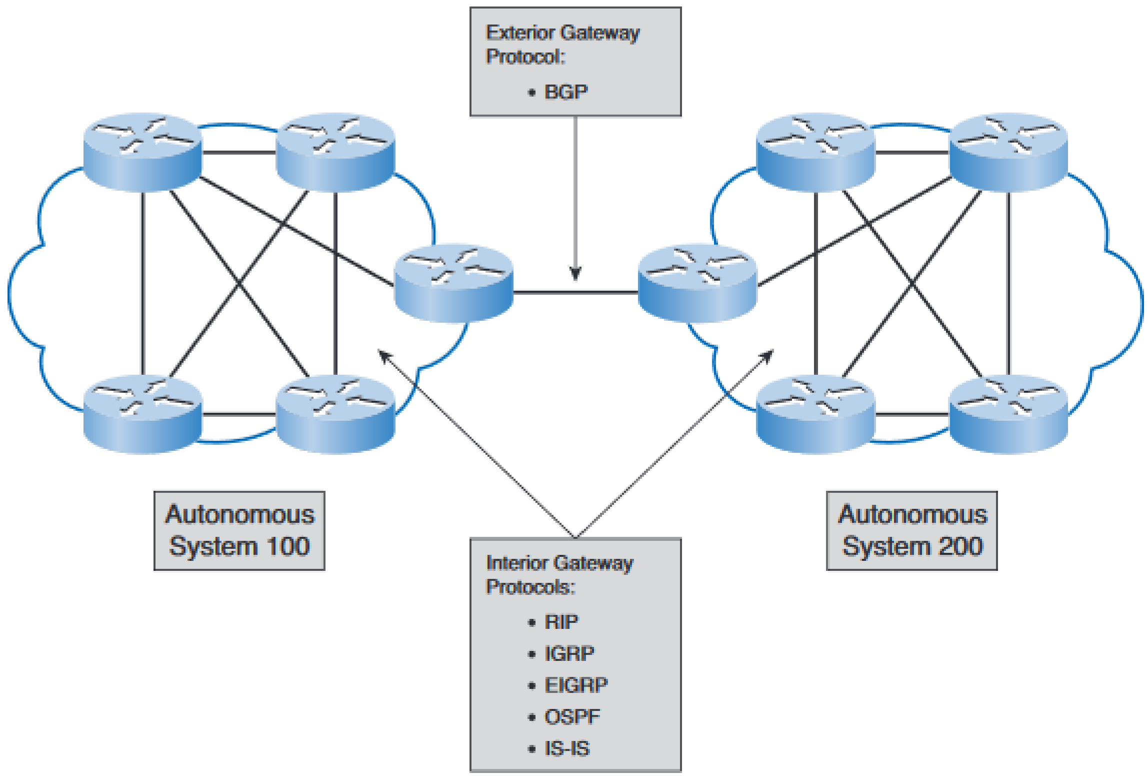
An autonomous system(AS)—otherwise known as a routing domain is a collection of routers under a common administration. Typical examples are a company's internal network and an ISP's network.

Two types of routing protocols are:

- **Interior gateway protocols (IGP):Used for intra-autonomous system routing, that is routing inside an autonomous system.**
- **Exterior gateway protocols (EGP):Used for inter-autonomous system routing, that is, routing between autonomous systems.**

Dynamic Routing protocol

IGP and EGP



Dynamic Routing protocol

Interior gateway protocols (IGP) can be classified as two types:

- Distance vector routing protocols
- Link-state routing protocols

Distance vector routing protocols:

Distance vector means that routes are advertised as vectors of distance and direction. Distance is defined in terms of a metric such as hop count, and direction is simply the next-hop router or exit interface. Distance vector protocols typically use the Bellman-Ford algorithm

for the best-path route determination.

Dynamic Routing protocol

Distance vector protocols work best in situations where:

- The network is simple and flat and does not require a hierarchical design.
- The administrators do not have enough knowledge to configure and troubleshoot link-state protocols.
- Specific types of networks, such as hub-and-spoke networks, are being implemented.
- Worst-case convergence times in a network are not a concern

Dynamic Routing protocol

Link-state routing protocols : A link-state routing protocols uses the link-state information to create a topology map and to select the best path to all destination networks in the topology.

In contrast to distance vector routing protocol operation, a router configured with a link-state routing protocol can create a “complete view,” or topology, of the network by gathering information from all the other routers.

With some distance vector routing protocols, routers send periodic updates of their routing information to their neighbors. Link-state routing protocols do not use periodic updates.

After the network has converged, a link-state update is only sent when there is a change in the topology.

Dynamic Routing protocol

Link-state protocols work best in situations where:

- **The network design is hierarchical, usually occurring in large networks.**
- **The administrators have a good knowledge of the implemented link-state routing protocol.**
- **Fast convergence of the network is crucial.**

Dynamic Routing protocol

All routing protocols can also be classified as either :

- Classful routing protocols
- Classless routing protocols

Classful routing protocols: Do not send subnet mask information in routing updates

This was at a time when network addresses were allocated based on classes: Class A, B, or C. A routing protocol did not need to include the subnet mask in the routing update because the network mask could be determined based on the first octet of the network address.

Classless routing protocols: include the subnet mask with the network address in routing updates. Today's networks are no longer allocated based on classes,

Dynamic Routing protocol

The most commonly used routing protocols are as follows:

- **RIP:A distance vector interior routing protocol**
- **IGRP: The distance vector interior routing protocol developed by Cisco**
- **OSPF: A link-state interior routing protocol**
- **IS-IS: A link-state interior routing protocol**
- **EIGRP: The advanced distance vector interior routing protocol**
- **BGP: A path vector exterior routing protocol**

OSPF

Open Shortest Path First (OSPF) was designed as an interior gateway protocol, for use in an autonomous system base on the shortest path first(SPF) algorithm also known as a the dikktra algorithm.

Why is OSPF needed ?

- Open Standard
- Link state protocol
- Scalability
- Fast convergence
- Support authentication /Security
- Support VLSM
- Support IPv6(OSPFv3)
- Support load balancing
- Use a hierarchical structure

OSPF

Link State characteristics of OSPF:

- **OSPF employs a hierarchical network design using Areas.**
- **OSPF will form neighbor relationships with adjacent routers in the same Area.**
- **Instead of advertising the distance to connected networks, OSPF advertises the status of directly connected links using Link-State Advertisements (LSAs).**
- **OSPF sends updates (LSAs) when there is a change to one of its links, and will only send the change in the update. LSAs are additionally refreshed every 30 minutes.**
- **OSPF traffic is multicast either to address 224.0.0.5 (all OSPF routers) or 224.0.0.6 (all Designated Routers)**
- **OSPF is a classless protocol, and thus supports VLSMs**

Other characteristics of OSPF include:

- **OSPF supports only IP routing**
- **OSPF routes have an administrative distance is 110**
- **OSPF uses cost as its metric, which is computed based on th bandwidth of the link. OSPF has no hop-count limit.**

OSPF Terminology

- OSPF databases / tables:
  - OSPF adjacency database = Neighbor table
  - OSPF link-state database = Topology table
  - OSPF forwarding database = Routing table
- Link-state advertisements (LSAs)
- Link-State Database (LSDB)
- Shortest-Path First (SPF) Routing Algorithm
  - Dijkstra algorithm
- SPF Tree
- OSPF Areas
  - Backbone (transit) and standard areas.
- Types of OSPF routers:
  - Internal router, backbone router, Area Border Router (ABR), Autonomous System Boundary Router (ASBR)
  - Designated Router (DR) and Backup Designated Router (BDR)

OSPF

The OSPF process builds and maintains three separate tables:

- A neighbor table – contains a list of all neighboring routers.
- A topology table – contains a list of all possible routes to all known networks within an area.
- A routing table – contains the best route for each known network.

OSPF

OSPF Neighbors

OSPF forms neighbor relationships, called adjacencies, with other routers in the same Area by exchanging Hello packets to multicast address 224.0.0.5. Only after an adjacency is formed can routers share routing information.

Each OSPF router is identified by a unique Router ID. The Router ID can be determined in one of three ways:

- The Router ID can be manually specified.
- If not manually specified, the highest IP address configured on any Loopback interface on the router will become the Router ID.
- If no loopback interface exists, the highest IP address configured on any Physical interface will become the Router ID

OSPF

OSPF Neighbors :

By default, Hello packets are sent out OSPF-enabled interfaces every 10 seconds

for broadcast and point-to-point interfaces, and 30 seconds for non-broadcast and point-to-multipoint interfaces. OSPF also has a Dead Interval, which indicates how long a router will wait without hearing any hellos before announcing a neighbor as "down." Default for the Dead Interval is 40 seconds for broadcast and point-to-point interfaces, and 120

seconds for non-broadcast and point-to-multipoint interfaces. Notice that, by default, the dead interval timer is four times the Hello interval. These timers can be adjusted on a per interface basis

OSPF

OSPF Neighbors :

OSPF routers will only become neighbors if the following parameters within a Hello packet are identical on each router:

- **Area ID**
- **Area Type (stub, NSSA, etc.)**
- **Prefix**
- **Subnet Mask**
- **Hello Interval**
- **Dead Interval**
- **Network Type (broadcast, point-to-point, etc.)**
- **Authentication**

The Hello packets also serve as keepalives to allow routers to quickly discover if a neighbor is down. Hello packets also contain a neighbor field that lists the Router IDs of all neighbors the router is connected to.

OSPF

OSPF Neighbors :

A neighbor table is constructed from the OSPF Hello packets, which includes the following information:

- **The Router ID of each neighboring router**
- **The current “state” of each neighboring router**
- **The interface directly connecting to each neighbor**
- **The IP address of the remote interface of each neighbor**

OSPF

DR and BDR: OSPF routers in a network which need DR (Designated router) and BDR (Backup designated router) do not share routing information directly with all each other's. To minimize the routing information exchange, they select one router as designated router (DR) and one other router as backup designated router (BDR). Remaining routers are known as DROTHERs.

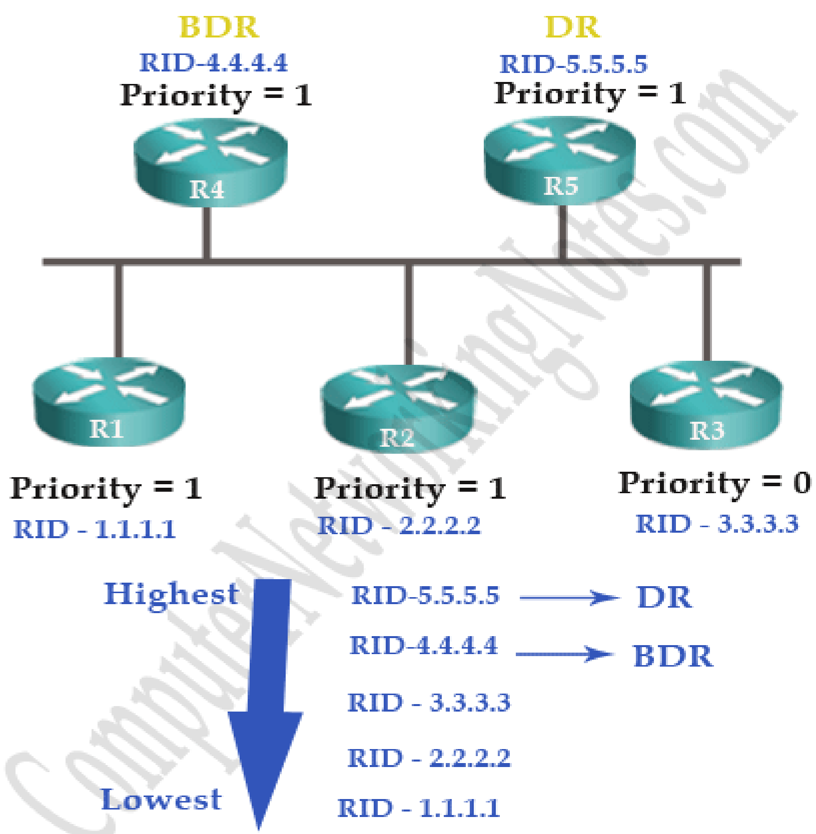
All DROTHERs share routing information with DR. DR will share this information back to all DROTHERs. BDR is a backup router. In case DR is down, BDR will immediately take place the DR and would elect new BDR for itself

OSPF

DR and BDR Election process:

Condition 1:- *Use the highest priority value*

Condition 2:- *If there is a tie use the highest RID*



OSPF

OSPF Neighbor States:

Neighbor adjacencies will progress through several states, including:

Down – indicates that no Hellos have been heard from the neighboring router

Init – indicates a Hello packet has been heard from the neighbor, but two-way communication has not yet been initialized

2-Way – indicates that bidirectional communication has been established.

ExStart– indicates that the routers are preparing to share link state information.

Exchange – indicates that the routers are exchanging Database Descriptors

Loading –indicates the routers are finally exchanging Link State Advertisements containing information about all links connected to each router.

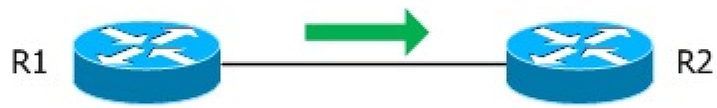
Full – indicates that the routers are fully synchronized

- **Full/DR – indicating that the neighbor is a Designated Router (DR)**
- **Full/BDR – indicating that the neighbor is a Backup Designated Router (BDR)**
- **Full/DROther – indicating that the neighbor is neither the DR or BDR**

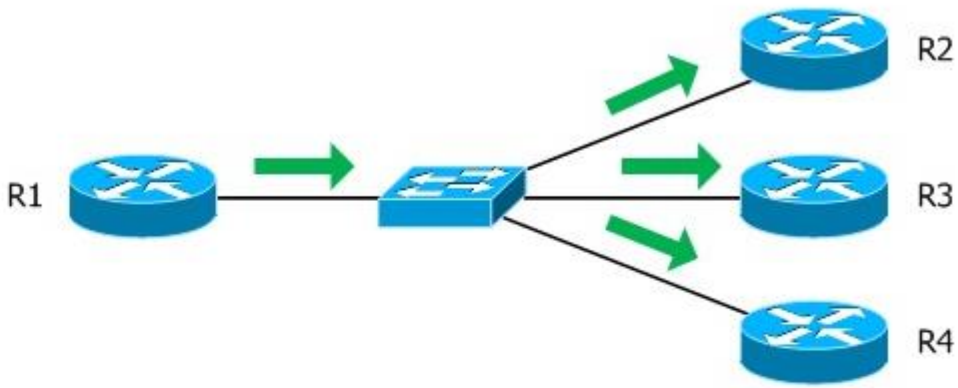
OSPF Network Types:

OSPF uses different types of exchange process for different types of network.

- **Point to point network**



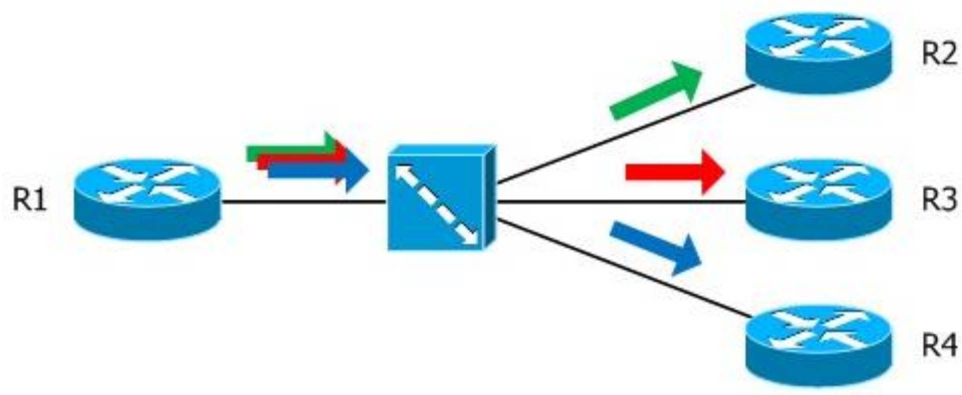
- **Broadcast Networks**



OSPF

OSPF Network Types:

- **NMBA**



- **Point to multipoint**

OSPF

OSPF area Types:

Area are logical groupings of host and networks , including their **routers having Interface connected to any of included network .**

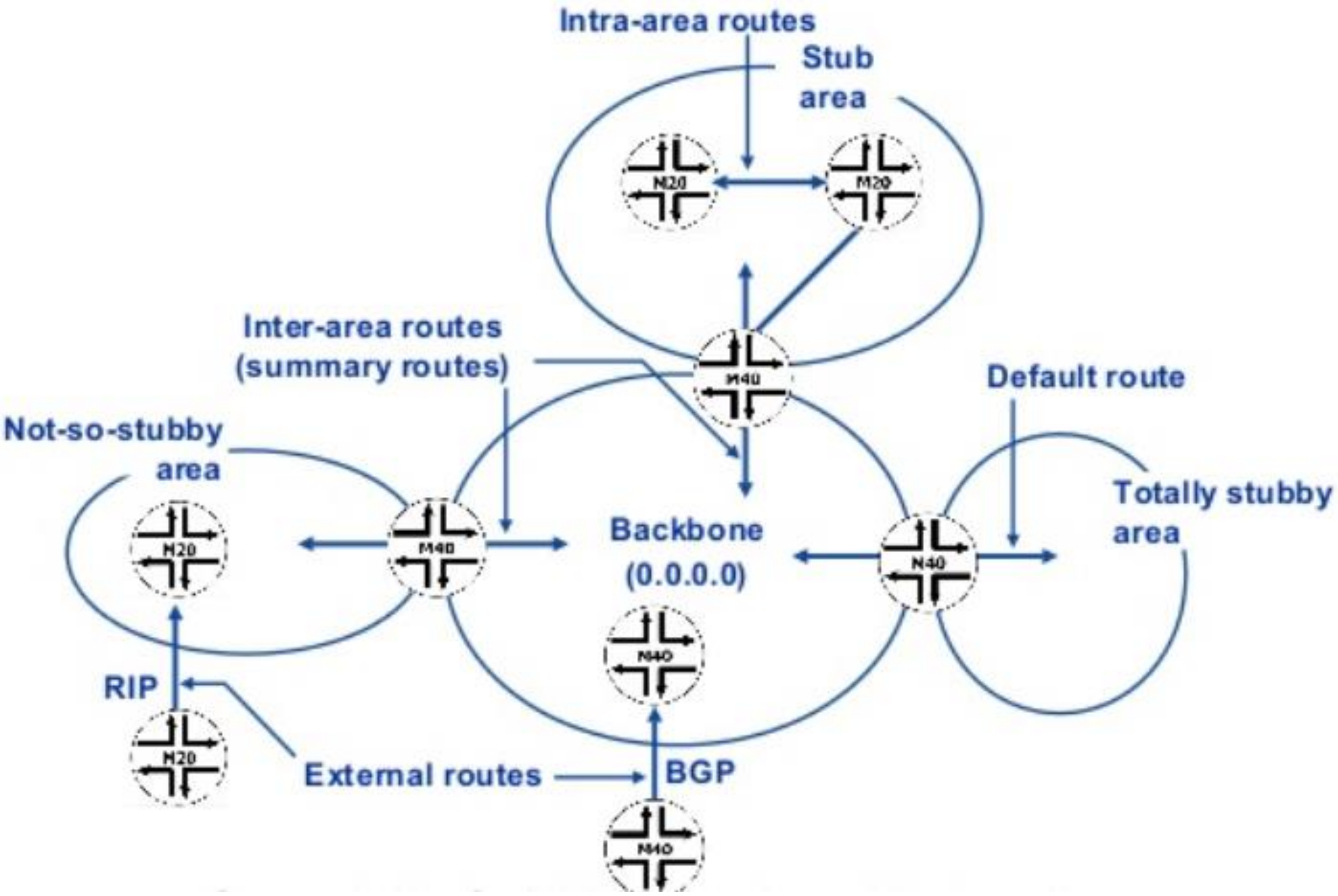
- **OSPF backbone(area 0) distributes routing information between areas**
  - **Contains all area border routers and backbone routers**
  - **All traffic between areas goes through the backbone**
- **Backbone itself an OSPF area**
- **If backbone is configured as not contiguous , must configure virtual link**
  - **Between any backbone routers that share a link to a nonbackbone area or transit area**
  - **Function as a direct link**

OSPF Stub areas:

- **Stub areas**
  - Do not carry external routes
  - Virtual links cannot be configured across
  - Cannot contains ASBR
- **Totally stub area**
  - Stub are that not only receive the defaults route from backbone
- **Not so Stubby are**
  - Allow limited importing of external routes
- **Transit area**
  - Used to pass traffic from one adjacent area to backbone , or to another are if the backbone is more then two hops away from an area

OSPF

OSPF area types:



OSPF

OSPF router: Four different types of routers designate the hierarchical routing structure used by OSPF. Each router has a unique role and set of defining characteristics within the hierarchy.

Internal Routers

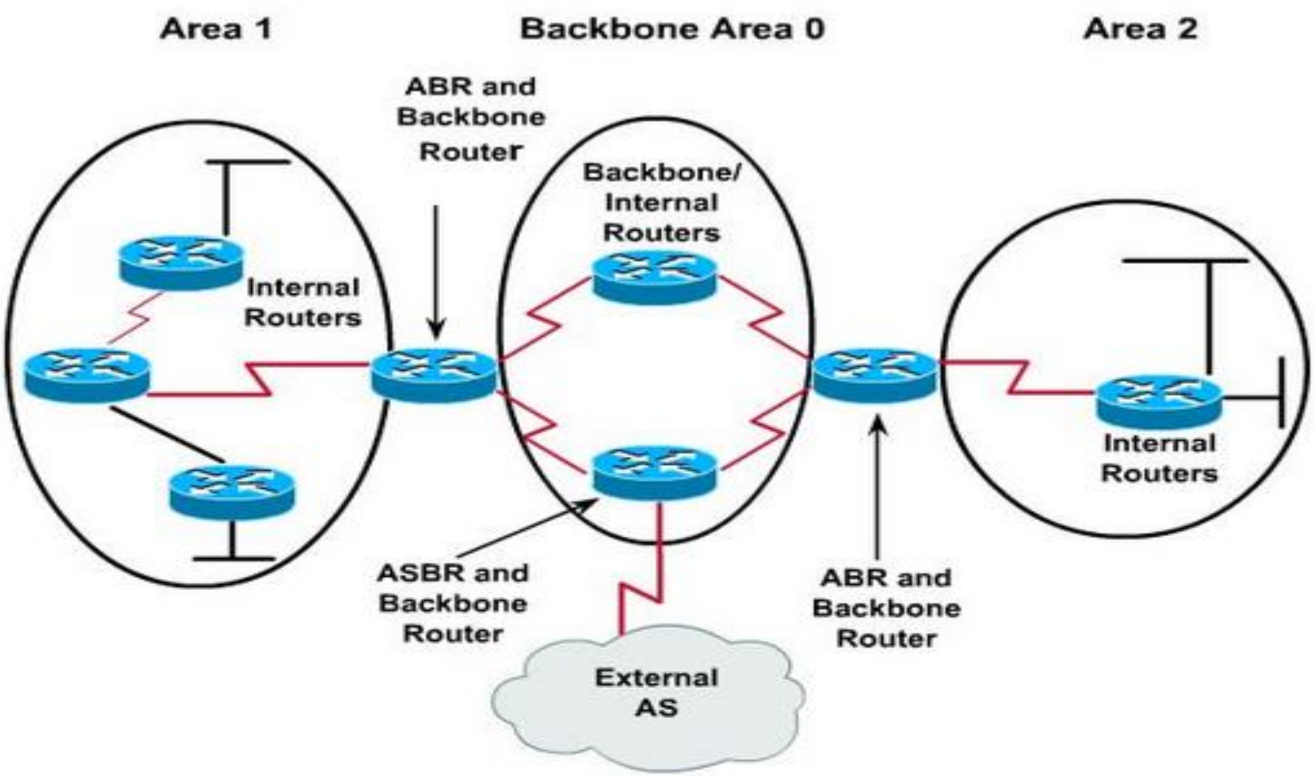
Area Border Routers

Autonomous System Boundary Routers

Backbone Routers

OSPF

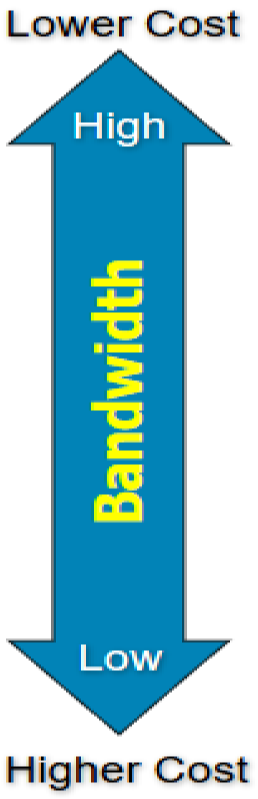
OSPF router:



OSPF

OSPF Metric Calculation

- The OSPF metric calculation is based on cost.
- Cost is an indication of the overhead required to send packets across a certain interface.
- The cost of an interface is inversely proportional to the bandwidth of that interface.
  - A higher bandwidth is attributed a lower cost.
  - A lower bandwidth is attributed a higher cost.



OSPF

Link-state Advertisement (LSAs)

- When a change occur in the network topology , the router experience the change creates a link-state advertisement(LSA) concerning that link

  LSAs also called link-state protocol data unit(PDUs).
- The LSA is multicasted to all neighboring device using either 224.0.0.5 or224.0.0.6 .
- Routers receiving the LSA immediately forward it to all neighboring routers

OSPF

Link-state Database(LSDB)

- Routers receiving add the LSA to their link-state database(LSBD)
- The LSBD is used to calculate the best path through the network
- OSPF best route calculation is based on Edsger Dijkstra's shortest path First (SPF) algorithm

SPF routing algorithm :

  - The SPF algorithm accumulates cost along each path ,from source to destination
  - The accumulated costs is then used by router to build a topology table

OSPF

SPF tree and routing table

- The topology table is essentially an SPF tree which contains
  A listing of all OSPF networks and the cost to reach them

- The resulting best routes are then considered to be added
  to routing table

OSPF Packet

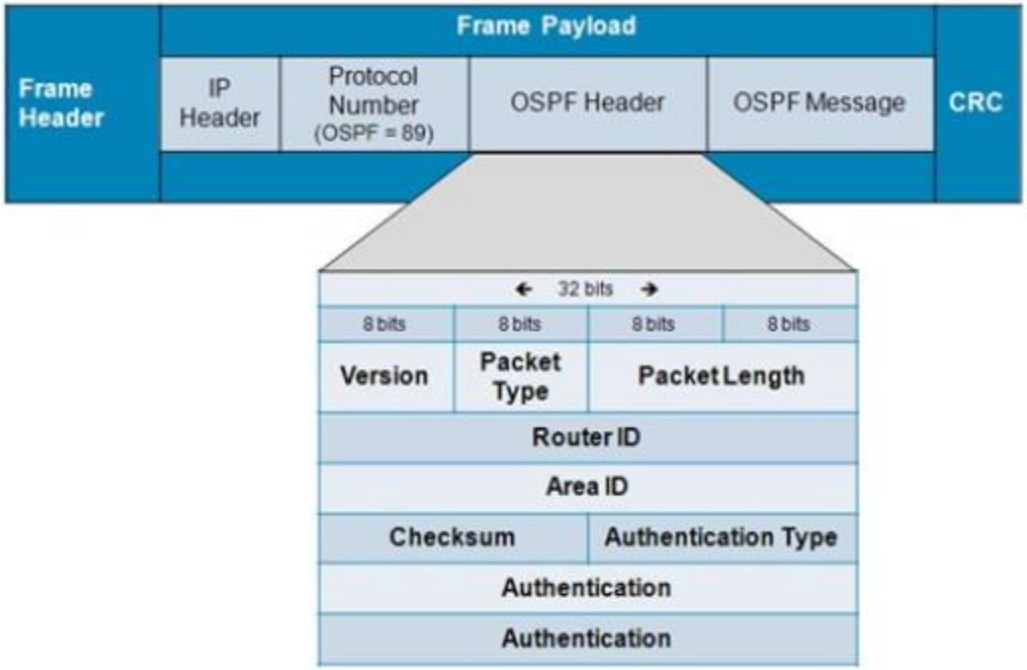
- OSPF packets are used to perform several functions, including:
  - Neighbor discovery, to form adjacencies.
  - Flooding link-state information, to facilitate LSDBs being built in each router.
  - Running SPF to calculate the shortest path to all known destinations.
  - Populating the routing table with the best routes to all known destinations.

OSPF Packet

Frame Header	Frame Payload				CRC
	IP Header	Protocol Number (OSPF = 89)	OSPF Header	OSPF Message	

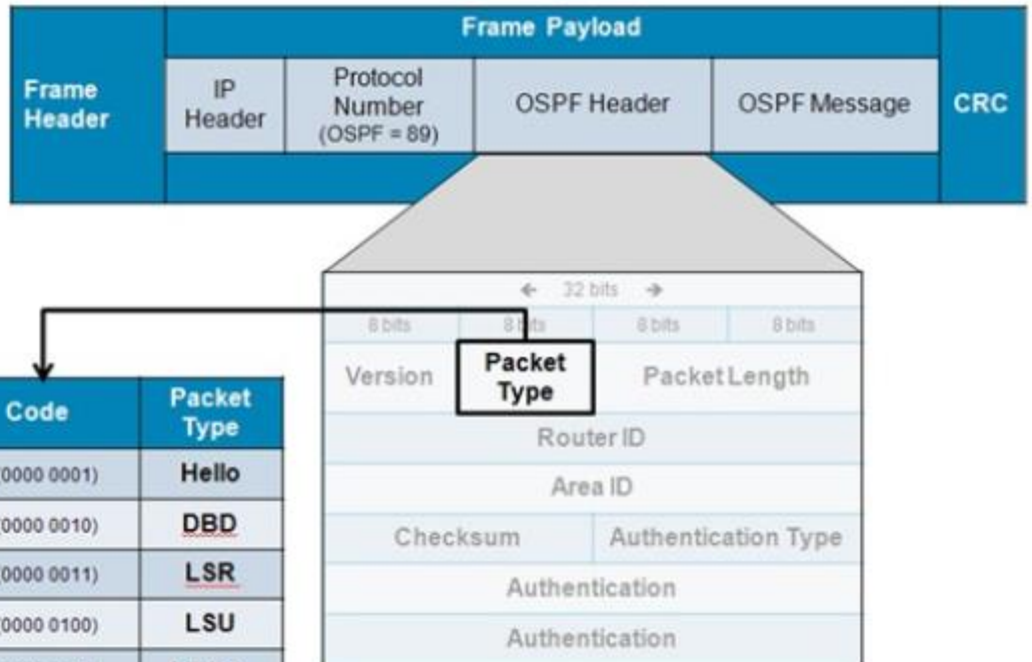
On a LAN, the OSPF packet is encapsulated in an Ethernet frame with a destination multicast MAC address of either: • **01-00-5E-00-00-05** • **01-00-5E-00-00-06**	The destination multicast IP address is set to either: • **224.0.0.5** (All OSPF routers listen to this address.) • **224.0.0.6** (All DR and BDR routers listen to this address. The OSPF protocol field is **89**.	The OSPF header identifies the type of OSPF packet, the router ID and the area number.	The OSPF message contains the packet type specific message information.

OSPF Header


Frame Payload
Frame Header
IP Header
Protocol Number (OSPF = 89)
OSPF Header
OSPF Message
CRC
32 bits
8 bits
8 bits
8 bits
8 bits
Version
Packet Type
Packet Length
Router ID
Area ID
Checksum
Authentication Type
Authentication
Authentication

OSPF

OSPF Packet Types



Code	Packet Type
1 (0000 0001)	Hello
2 (0000 0010)	DBD
3 (0000 0011)	LSR
4 (0000 0100)	LSU
5 (0000 0101)	LSAck

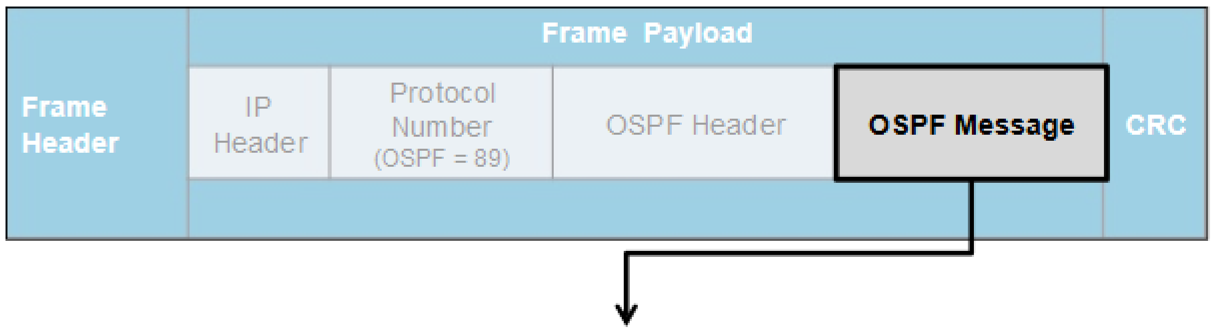
OSPF Packet Types

- Five packet types make OSPF capable of sophisticated and complex communications.

Type	Packet Name	Description
1	Hello	Discovers neighbors and builds adjacencies between them.
2	DBD	Database description Checks for database synchronization between routers.
3	LSR	Link-state request Requests specific link-state records from another router.
4	LSU	Link-state update Sends specifically requested link-state records.
5	LSAck	Link-State Acknowledgment Acknowledges the other packet types.

OSPF

OSPF Message



The OSPF message contains different information, depending on the packet type:

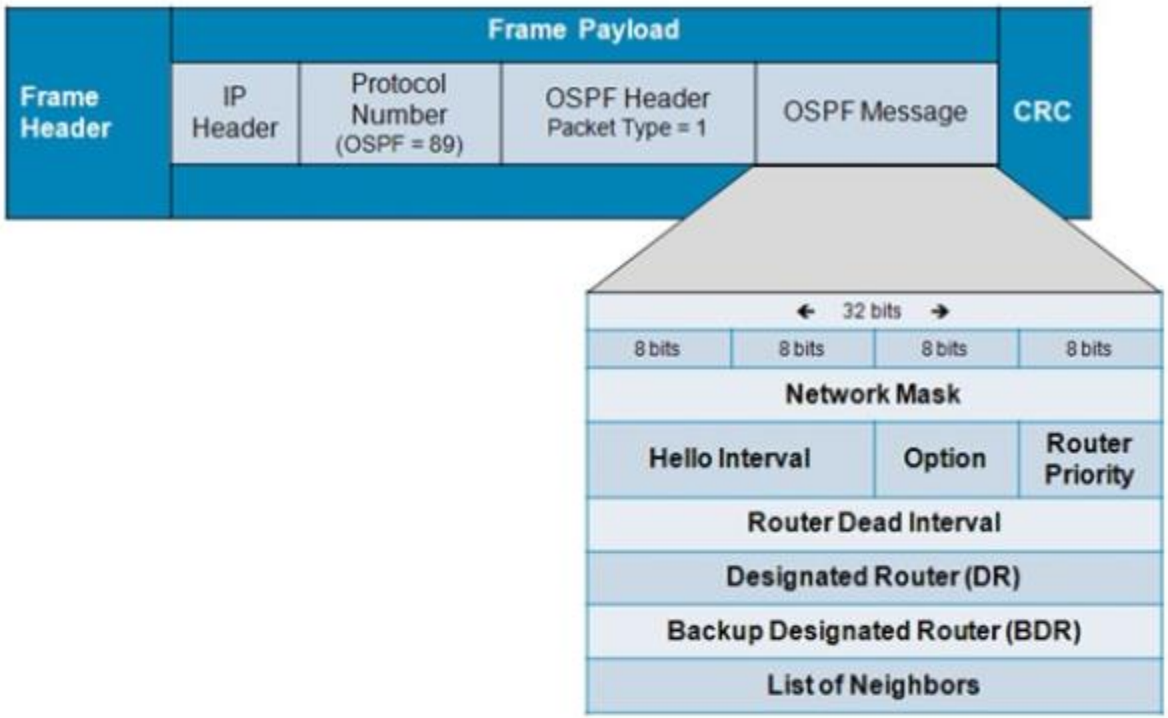
Packet Type	Contains
Type 1 - Hello	Contains a list of known neighbors.
Type 2 - DBD	Contains a summary of the LSDB, which includes all known router IDs and their last sequence number, among a number of other fields.
Type 3 - LSR	Contains the type of LSU needed and the router ID of the router that has the needed LSU.
Type 4 - LSU	Contains the full LSA entries. Multiple LSA entries can fit in one OSPF update packet.
Type 5 - LSAck	Data field is empty.

Type 1 - OSPF Hello Packet

- Hello packets are used to:
  - Discover directly connected OSPF neighbors.
  - Establish and maintain neighbor adjacencies with these directly connected neighbors.
  - Advertise parameters on which two routers must agree to become neighbors.
  - Elect the Designated Router (DR) and Backup Designated Router (BDR) on multi-access networks like Ethernet and Frame Relay.

OSPF

Type 1 - OSPF Hello Packet



Type 1 - OSPF Hello Packet

- Hello packet fields must match on neighboring routers for them to establish an adjacency:
  - Hello interval
  - Dead interval
  - Network type.
  - Area id
  - Authentication password
  - Stub area flag
- Two routers may not form an OSPF adjacency if:
  - The subnet masks do not match, causing the routers to be on separate networks.
  - OSPF Hello or Dead Timers do not match.
  - OSPF Network Types do not match.
  - There is a missing or incorrect OSPF `network` command.

OSPF

Type 1 - OSPF Hello Packet

- By default, OSPF Hello packets are transmitted to 224.0.0.5 (all OSPF routers) every:
  - **10 seconds** (Default on multiaccess and point-to-point networks).
  - **30 seconds** (Default on NBMA networks – Frame Relay).
- The Dead interval is the period, expressed in seconds, that the router will wait to receive a Hello packet before declaring the neighbor "down."
  - If the Dead interval expires before the routers receive a Hello packet, OSPF will remove that neighbor from its link-state database.
  - The router floods the link-state information about the "down" neighbor out all OSPF enabled interfaces.
- Cisco uses a default of 4 times the Hello interval.
  - **40 seconds** (Default on multiaccess and point-to-point networks).
  - **120 seconds** (Default on NBMA networks – Frame Relay).

OSPF

Type 2 - OSPF DBD Packet

- The Database Description (DBD) packets contain an abbreviated list of the sending router's link-state database and is used by receiving routers to check against the local link-state database.
- The link-state database must be identical on all link-state routers within an area to construct an accurate SPF tree.

Type 3 - OSPF LSR Packet

- The Link State Request (LSR) packet is used by the receiving routers to request more information about any entry in the DBD.

Type 4 - OSPF LSU Packet

- The Link-State Update (LSU) packets are used for OSPF routing updates.
  - They reply to LSRs as well as to announce new information.
- LSUs contain seven different types of Link-State Advertisements (LSAs).
- LSUs contains the full LSA entries.
  - Multiple LSA entries can fit in one OSPF update packet.

OSPF

Type 5 - OSPF LSAck Packet

- LSAck - Link-State Acknowledgement Packet:
  - When an LSU is received, the router sends a LSAck to confirm receipt of the LSU.
  - The LSAck data field is empty.

OSPF

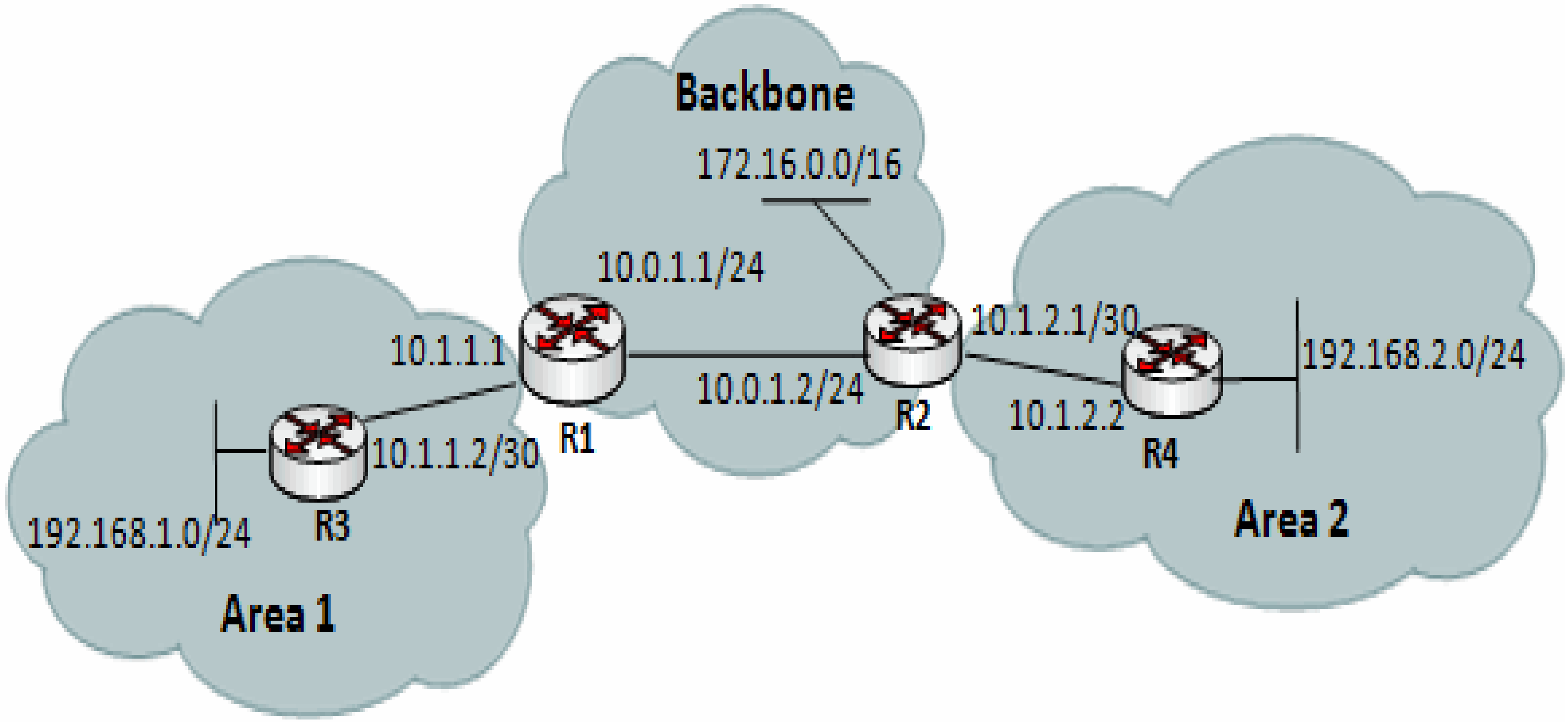


Figure 6.7. Example of multi- area OSPF network

OSPF

Basic Configuration OSPF:

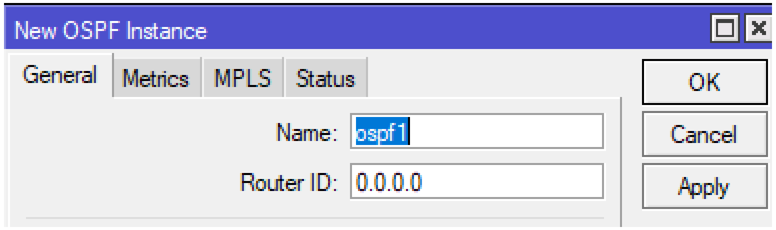
There are three basic elements of OSPF configuration:

- ❑ Enable OSPF instance
- ❑ OSPF area configuration
- ❑ OSPF network configuration

OSPF

Basic Configuration OSPF:

Routing>OSPF>instances: A routing instance is a collection of routing tables, interfaces, and routing protocol parameters



Router ID : Can be use Loopback or if not specified use lowest IP address on active interface

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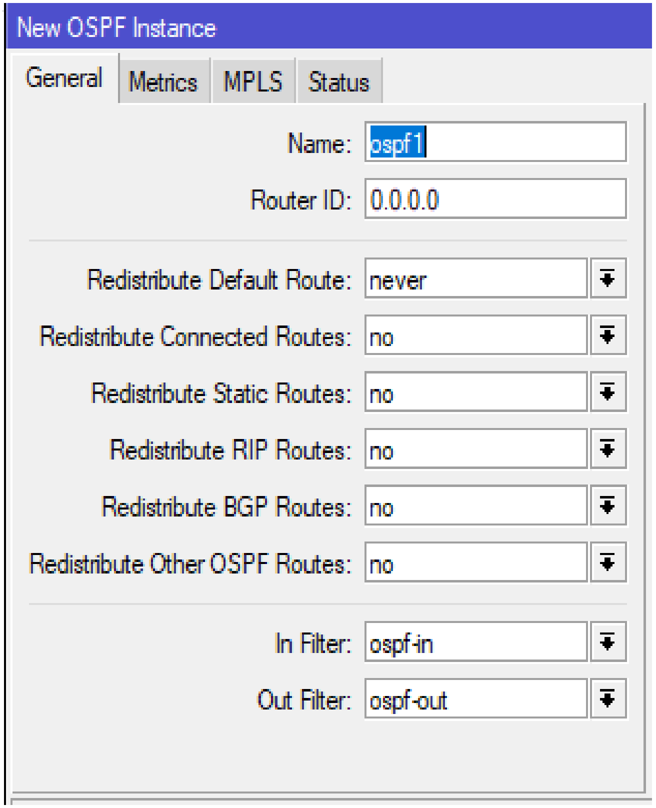
Basic Configuration OSPF:

Routing>OSPF>instances>redistribution route



OSPF

Basic Configuration OSPF:

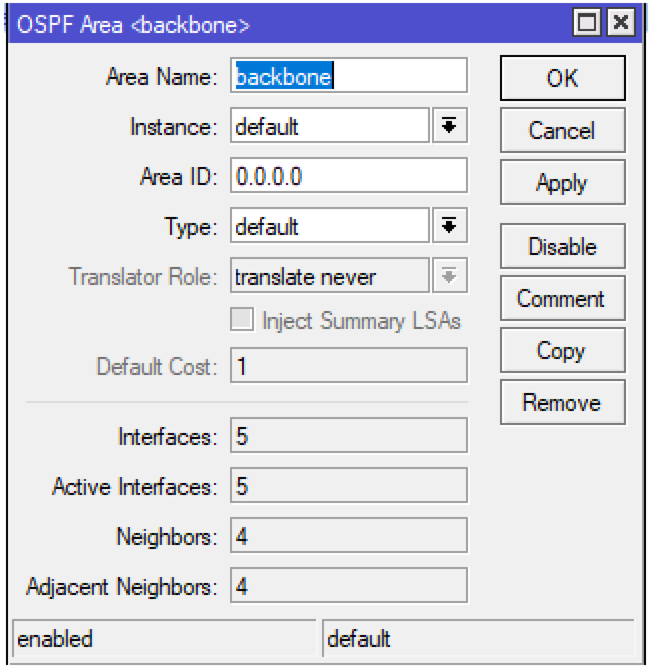
Routing>OSPF>areas

Area name : the name of the area

Instance: default

Area ID : 0.0.0.0 (Backbone area) OSPF area identifier

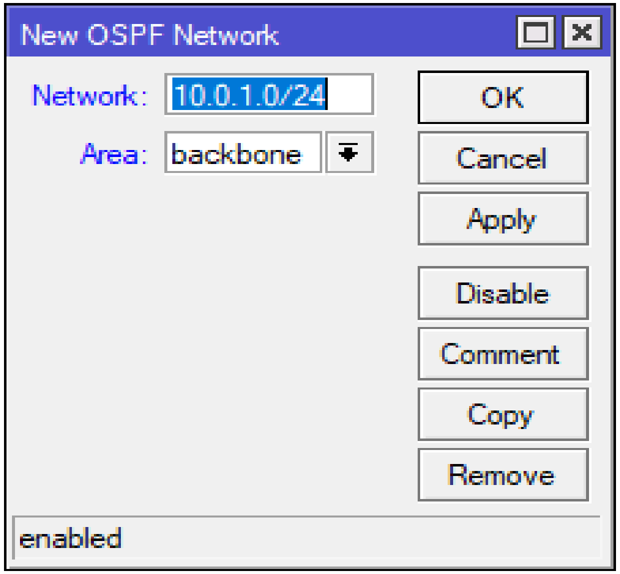
Type: Default , NSSA,Stub



OSPF

Basic Configuration OSPF:

Routing>OSPF>network



OSPF

Basic Configuration OSPF:

Routing>OSPF>Interface

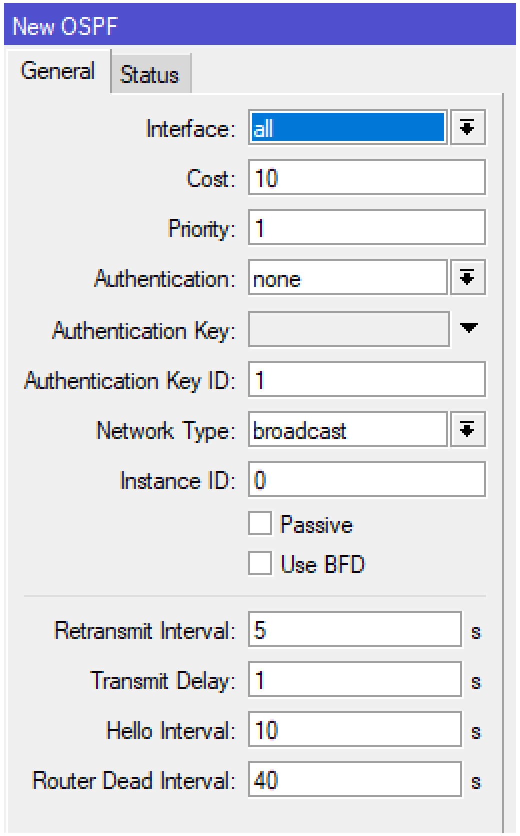
Interface : Connected interface send

receive OSPF massage

Cost : expressed as link state metric

Authentication : authentication method

Network type: OSPF network type on this interface



OSPF

#Hands on Lab#