Introduction to OSPF

Network Infrastructure Workshop

Last updated October 2019

OSPF

- Open Shortest Path First
- Open:
  - Meaning an Open Standard
  - Developed by IETF (OSPF Working Group) for IP – RFC1247
  - Current standard is OSPFv2 (RFC2328)
- Shortest Path First:
  - Edsger Dijkstra's algorithm for producing shortest path tree through a graph
    - Dijkstra, E. W. (1959). "A note on two problems in connexion with graphs". Numerische Mathematik 1: 269–271

OSPF

- Known as a Link State Routing Protocol
  - The other link state routing protocol is IS-IS
  - Each node in the network computes the map of connectivity through the network
- The other type of Routing Protocol is Distance Vector
  - Like EIGRP or RIP
  - Each node shares its view of the routing table with other nodes

OSPF

- Routers with OSPF enabled on them look for neighbouring routers also running OSPF
  - Using the “Hello” protocol
  - The “Hello” packet includes the subnet mask, list of known neighbours, and details such as “hello interval” and “router dead interval”
    - Hello interval – how often the router will send Hellos
    - Router dead interval – how long to wait before deciding router has disappeared
    - The values of “hello interval”, “router dead interval” and subnet mask must match on both neighbours
  - When a neighbouring router responds with matching details, a neighbour relationship is formed

OSPF Neighbour Relationships

- A relationship is formed between selected neighbouring routers for the purpose of exchanging routing information
  - This is called an ADJACENCY
- Not every pair of neighbouring routers become adjacent
  - On multi-access networks (e.g. ethernet), only selected routers form adjacencies

OSPF Adjacencies

- Once an adjacency is formed, neighbours share their link state information
  - Information goes in a Link State Packet (LSP)
  - LSPs sent to a neighbour are known as Link State Announcements (LSA)
- New information received from neighbours is used to compute a new view of the network
- On a link failure
  - New LSPs are flooded
  - The routers recompute the routing table

OSPF across a network

- All routers across the network form neighbour relationships with their directly attached neighbours
- Each router computes the routing table
- Once each router has the same view of the network, the network has converged
- The IGP design for a network is crucially important to ensure scalability and rapid convergence
- Generally: the fewer the prefixes, the faster the convergence

OSPF Areas

- OSPF has the concept of areas
  - All networks must have an area 0, the “default” area
  - Areas are used to scale OSPF for large networks
  - There are many types of areas, to suit many different types of infrastructure and topologies
  - Most small to medium networks (up to ~300 routers) can happily use a single area

OSPF

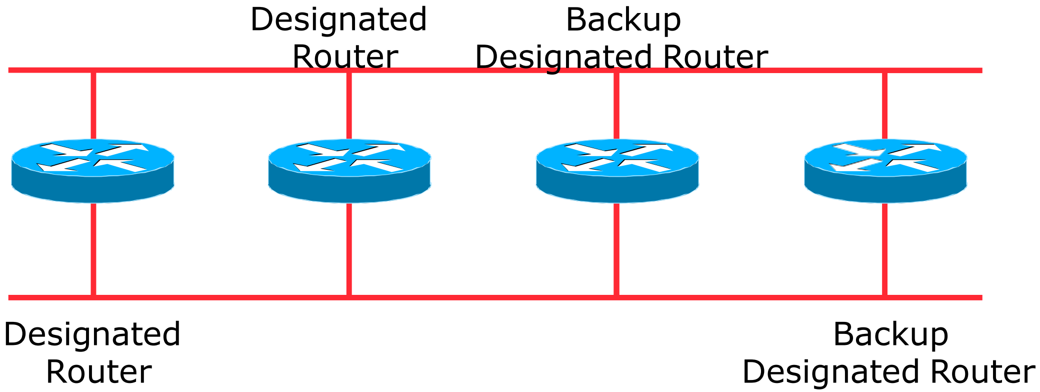
- OSPFv2 is for IPv4
  - For carrying IPv4 prefixes only
- OSPFv3 is for IPv6
  - For carrying IPv6 prefixes only
  - Based on OSPFv2 but is specifically for IPv6
  - Documented in RFC5340
  - Is totally independent of OSPFv2
- Configuration concepts and syntax are very similar
  - (There are subtle differences/improvements)

Links in OSPF

- Two types of links in OSPF:
  - Point-to-point link
    - Only one other router on the link, forming a point-to-point adjacency
  - Multi-access network (e.g. ethernet)
    - Potential for many other routers on the network, with several other adjacencies
- OSPF in multi-access networks has optimisations to aid scaling
  - Two routers are elected to originate the LSAs for the whole multi-access network
  - Called "Designated Router" and "Backup Designated Router"
  - Other routers on the multi-access network form adjacencies with the DR and BDR

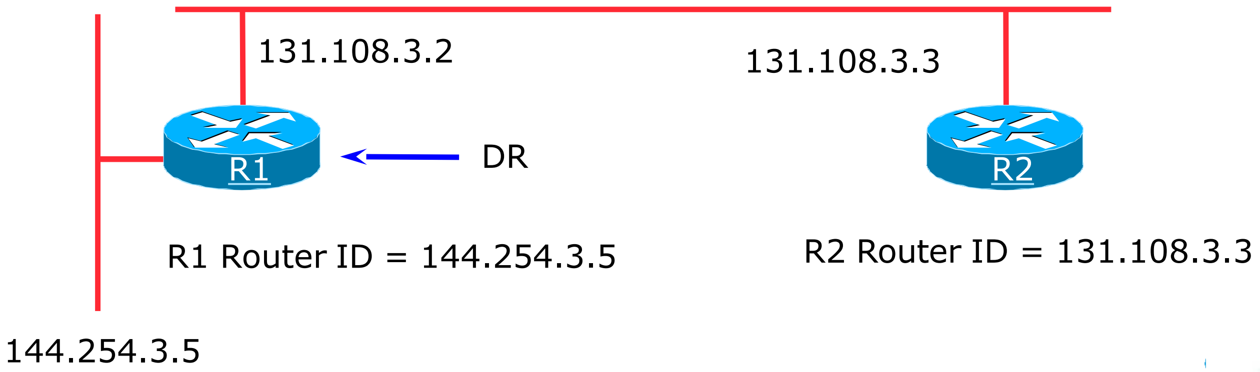
Designated Router

- There is ONE designated router per multi-access network
  - Generates network link advertisements
  - Assists in database synchronization
  - Scales OSPF for multi-access (ethernet) networks



Selecting the Designated Router

- Configured priority (per interface)
  - Configure high priority on the routers to be the DR/BDR
- Else priority determined by highest router ID
  - Router ID is 32 bit integer
  - Set manually, otherwise derived from the loopback interface IPv4 address, otherwise the highest IPv4 address on the router



Adjacencies: Examples

- To find adjacency state, use:

```
show ip[v6] ospf neighbor
```

- Point-to-Point link

```
Neighbor ID     Pri State           Dead Time   Address         Interface
10.10.15.236      0 FULL/  -        00:00:35    10.10.15.16     Serial1/0
```

- F

```
Neighbor ID     Pri State           Dead Time   Address         Interface
10.10.15.225      1 FULL/BDR        00:00:35    10.10.15.2      FastEth0/0
10.10.15.226      1 FULL/DR         00:00:35    10.10.15.3      FastEth0/0
```

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OSPF on Cisco IOS

- Starting OSPFv2 (IPv4) in Cisco's IOS

```
router ospf 42
```

  - Where "42" is the process ID

- Starting OSPFv3 (IPv6) in Cisco's IOS

```
ipv6 router ospf 42
```

  - Where "42" is the process ID

- OSPF process ID is unique to the router
  - Gives possibility of running multiple instances of OSPF on one router
  - Process ID is not passed between routers in an AS
  - Some ISPs configure the process ID to be the same as their BGP Autonomous System Number

OSPF on Cisco IOS

- Forming neighbour relationships
  - OSPF needs to be activated on the interface the neighbour relationship is desired on:

```
interface POS 4/0
 ip address 192.168.1.1 255.255.255.252
 ip ospf 42 area 0
!
router ospf 42
 passive-interface  default
 no passive-interface POS 4/0
!
```

OSPF interface costs

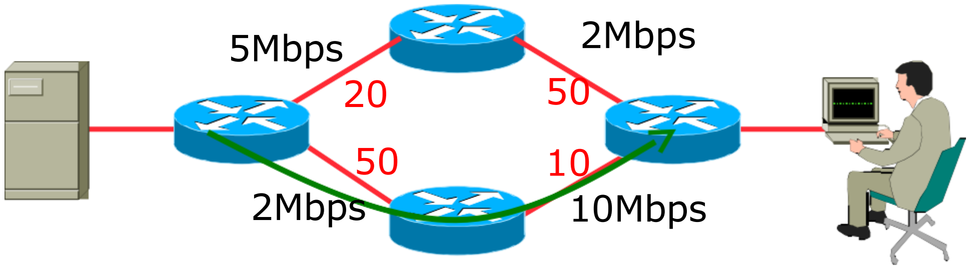
- Cisco IOS sets the interface cost automatically
  - Formula used: cost = 10^8/interface bandwidth
    - Which is fine for interfaces up to 100Mbps
- Many operators develop their own interface cost strategy

```
ip ospf cost 100
```

  - Sets interface cost to 100
  - Care needed as the sum of costs determines the best path through the network
- OSPF chooses lowest cost path through a network
- OSPF will load balance over paths with equal cost to the same destination

OSPF Metric Calculation

- Best path/lowest cost = 60



OSPF Metric Calculation

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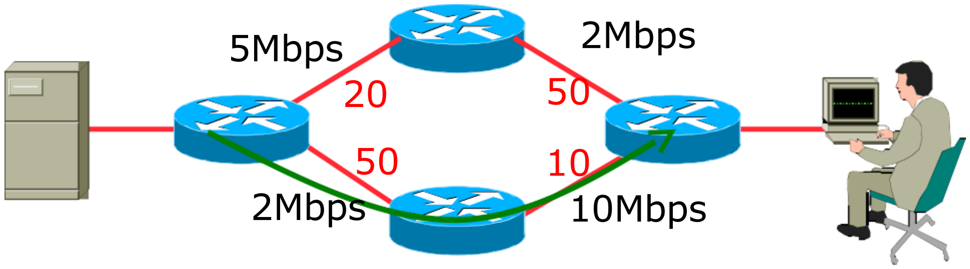
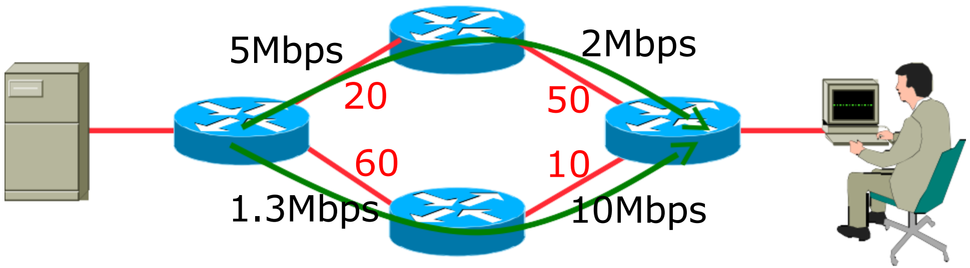


- Equal cost paths = 70



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21 - 26 October 2023

Conclusion

- OSPF is a Link State Routing Protocol
- Quick and simple to get started
  - But has a myriad of options and features to cover almost all types of network topology
  - ISPs keep their OSPF design SIMPLE
  - ~300 routers in a single area is entirely feasible

Questions?