Intradomain Routing

↳3.1 OSPF Areas

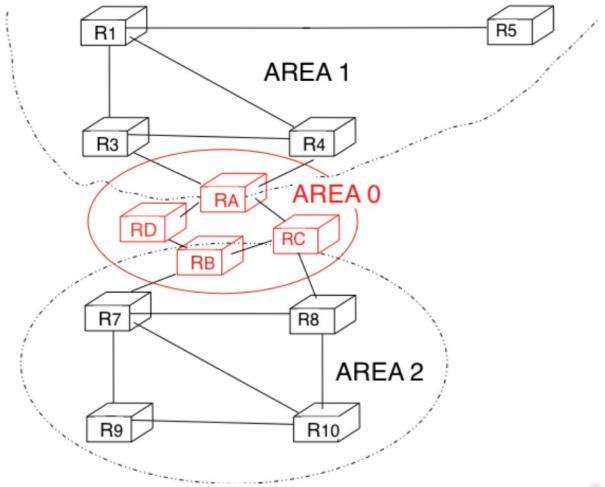
OSPF Areas

- The network administrator partitions the network in different areas
- An area is a physically contiguous part of the network, connected to some other area by a limited number of routers.
- There are two kinds of routers for OSPF:
  - Internal routers: routers that are connected only to other routers in the same area
  - Border routers: routers that belong to more than one area
- Some of the routers export a network prefix, because they are the gateways of a subnet

Backbone Area

- Area zero has a special meaning for OSPF, as it collects all the border routers, and eventually some router that do not belong to another area (like RD)
- The routers that do not belong to the backbone area can reach the other ones only passing across the backbone area.
- Every OSPF domain has an area zero, and only one.

OSPF Areas



- R1, R3, R4, R5 are internal routers in area 1
- RD is an internal router in area 0
- R7, R8, R9, R10 are internal routers in area 2
- RA, RB, RC are border routers

Link-state Behaviour

- Inside each non-backbone area, routers distribute the topology of the area by exchanging link state packets with the other routers in the area.
- The internal routers do not know the topology of other areas, but each router knows how to reach the backbone area.
- Inside an area, the routers only exchange link-state packets for all destinations that are reachable inside the area.

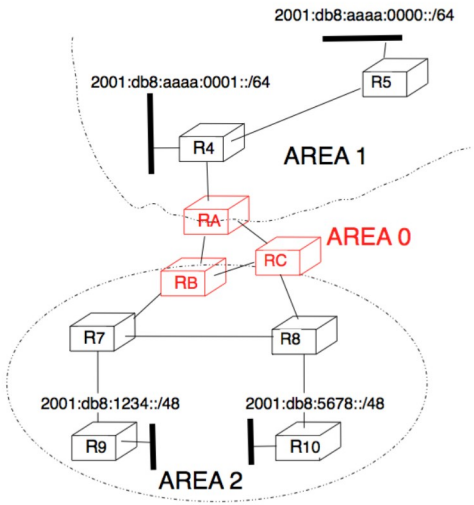
DV Behaviour

- The inter-area routing instead is done by exchanging distance vectors between border routers.
- This helps to reduce the overhead due to link-state routing control packets.

Routing Topology

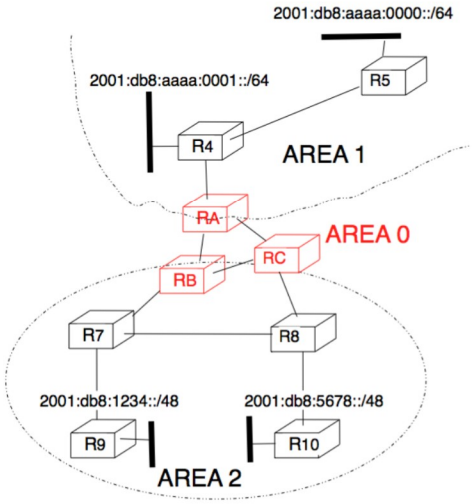
- We consider only a portion of the network, assigning IPv6 subnets to some of the routers
- In fact `OSPF` can be used with IPv6 or IPv4, and its logic does not change

Routing Topology



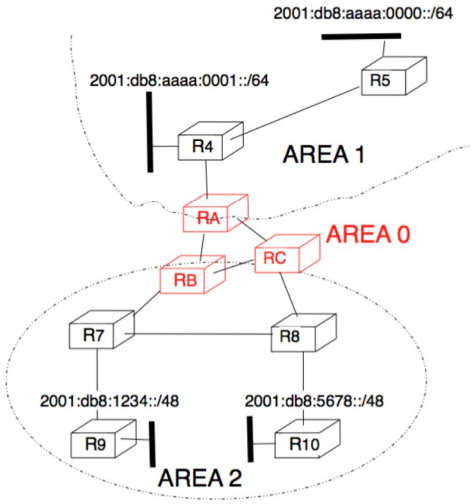
- R4 exports 2001:0db8:aaaa:0001:/64
- R5 exports 2001:0db8:aaaa:0000:/64
- R9 exports 2001:0db8:1234::/48
- R10 exports 2001:0db8:5678::/48

Routing Topology



- RB advertises 2001:0db8:1234::/48 at a distance of 2 and 2001:0db8:5678::/48 at a distance of 3
- RC advertises 2001:0db8:5678::/48 at a distance of 2 and 2001:0db8:1234::/48 at a distance of 3

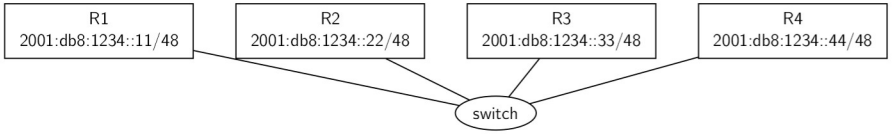
Routing Topology



- RA advertises 2001:db8:aaaa:0000::/64 at a distance of 2 and 2001:db8:aaaa:0001::/64 at a distance of 1 from RA
- Alternatively, it advertises 2001:db8:aaaa:0000::/63 at a distance of 2 from RA
- This is called network aggregation, and reduces the number of lines in the other routers' forwarding tables.

Sect. 4 OSPF Designated Routers

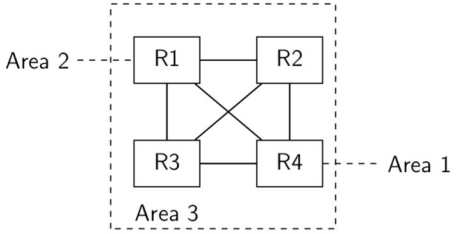
Virtual Full Mesh Networks



- In this network, all routers are connected to the same switch
- Assume they are all in Area 3 and that R1 and R4 are border routers
- OSPF will exchange link-state messages, and the logical topology that is created will be a full mesh

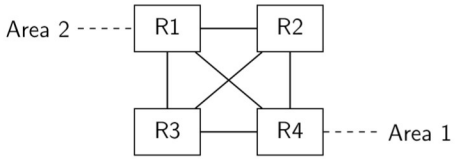
Virtual Full Mesh Networks

- OSPF will exchange link-state messages, and the logical topology that is created will be a full mesh
- This will give the false perception that there is more than one path between the two border routers
- Router R4 for instance will believe that a packet going from Area 1 to Area 2 has three possible paths: R4-R1; R4-R2-R1; R4-R3-R1



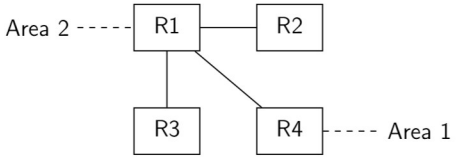
Virtual Full Mesh Networks

- Assume the switch fails.
- R4 will detect the link failure between R1 and R4.
- It will reroute traffic to R2, or R3.
- However, all links are failed. But the order in which the failures are detected is not predictable.
- So R4 may try several routes, before it concludes that all are broken and stop exporting the routes to Area 2



Designated Router

- In order to avoid this, OSPF allows to select a designated router
- All the other routers will export only the link to the designated router and not to the others



Detecting Link Failure

- A final note on how to detect link failures
- The most straightforward way is to detect the loss of HELLO messages, however, generating them with a very high frequency can induce a very high load on routers
- Ideally, the link-layer will notify the network layer if the link fails, but this is not guaranteed by all link layers
- As an alternative, some heartbeat dedicated protocol can be used to monitor each link, sending unicast messages that are way easier to generate