Network Layer Routing - IV
OSPF-2

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Open Shortest Path Firts -2

OSPF-2 (RFC 2328 - http://www.ietf.org/)

- As mentioned before, there are two basic routing algorithms.
- first one, distance vector routing is in form of RIP-1, RIP-2 and RIPng.
- second one, known as Link State routing - used in OSPF.

- Basic idea
  - let each router identify all of its neighbouring routers.
  - This information is than broadcasted to every router in network.
  - Each router then compute shortest path tree keeping itself as root.
  - This tree - used to create and maintain routing tables for routing the packets.

Salient features of OSPF-2

- uses link state routing.
- RIP cannot be used for large sized networks, but OSPF can be.
- runs internal to an autonomous system. So, it is Interior Gateway Protocol.
- provide support for equal cost multipaths. This improves the routing performance.

- explicit support for CIDR (classless inter domain routing).
- authentication support for routing updates
- uses IP multicast when sending packets over broadcast networks. (These IP multicast packets are not forwarded by any router).
- protocol desing emphasize on quick response to topology changes using small amount of routing traffic.

Link state routing protocol

- Each router maintains a database describing the topology of network. (referred to as link state database).
- identical database at each router.
- local state of all the routers (usable intefaces and reachable neighbours) maintained in database.
- local states are distributed over the whole network using flooding.

- all routers run exactly same algorithm.
- from database, tree of shortest path with itself as root - computed by every router.
- this tree is used to create routing tables.
- when more than one equal cost paths exists, the traffic is divided among them.

Cost

- defined by single dimensionless meteric.
- defined for each outgoing link or interface. (interface is physical connection to broadcast network or point to point link)

Area

- to readuce the routing traffic and keep size of link state database small, set of routers and networks attached to them can be grouped together - termed as areas.

- topology of areas - hidden from rest of AS.
- routing within area determined by area's topology.
- protects area from bad routing data fromr remaining AS.
- area is generalisation of subnetted networks.

Flexible configuration of IP subnets supported.

- each route has subnetmask and destination.
- two subnetwork or same IP network can have different size subnetmasks - variable length subnetting supported.

- packet is routed to the best (longest or most specific match) network.
- host routes are treated as subnets with subnetmask 0xFFFFFFFF.

Authentication

- All OSPF exchanges are authenticated.
- various authentication mechanisms can be used.
- different subnet areas can use different authentication mechanisms.

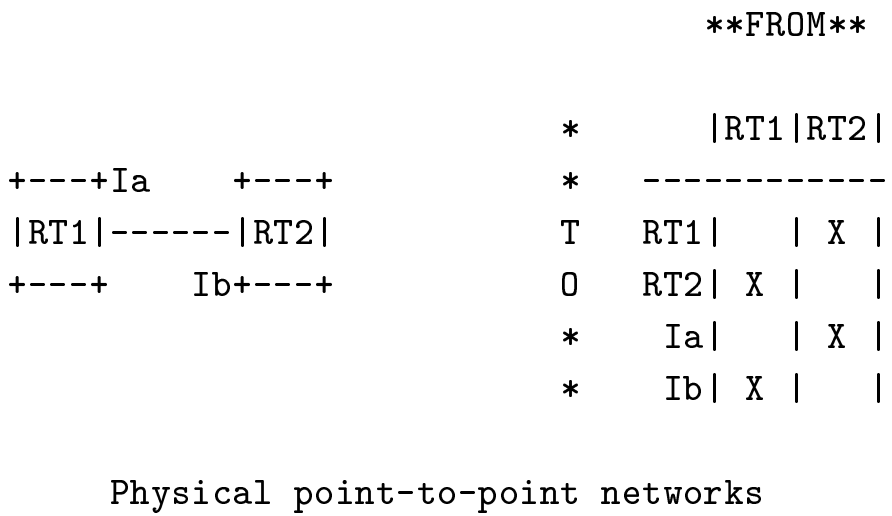
Externally derived data (routes learned through EGP)

- advertised throughout AS.
- kept separate from link state data.
- can also be tagged to pass additional information between router on boundry of AS.

Routers can be connected by three kind of networks.

- point-to-point link
- broadcast network or NBMA (nonbroadcast multiaccess)
- nonbroadcast network (point to multipoint)

OSPF is not responsible for routing of packet in these network. They are basically mechanism to connect the router to hosts or other routers.

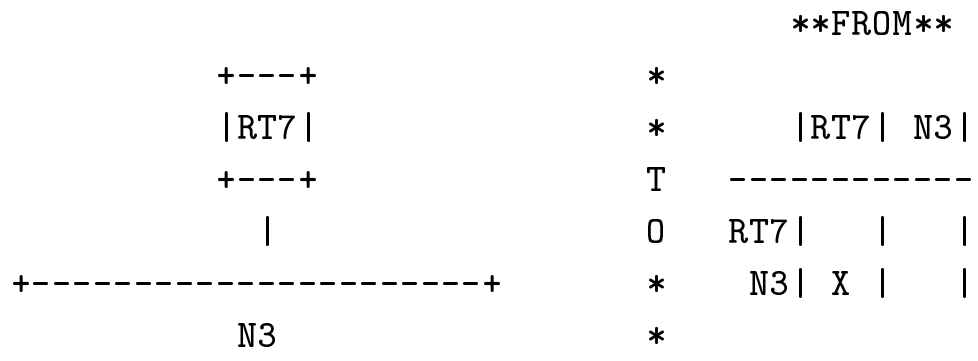


Physical point-to-point networks

When a network

- connected to a router
- all the traffic through router is either origniting or terminating in network.

The network - *stub network*

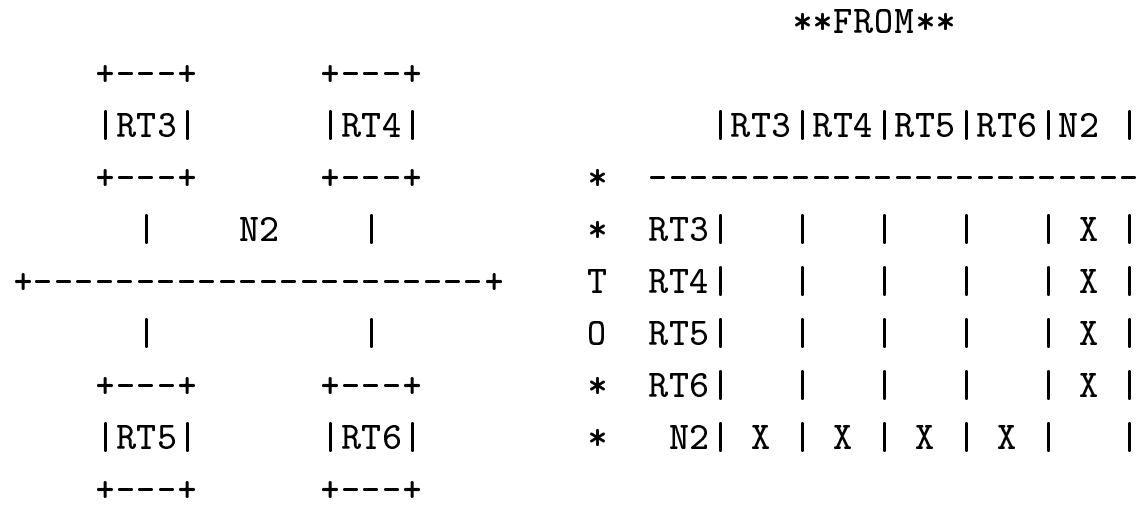


Stub networks

When a network

- connected to at least two routers.
- some traffic through router - neither originating or terminating in network present.

the network is *transit network*



Discovery of Neighbouring peers

- Hello protocol - used to discover the nieghbouring routers.
- uses broadcast on broadcast network.
- in nonbroadcast multiaccess network (NBMA) also, Hello protocol is used in broadcast mode.
- also used to select designated and secondry designated routers connected via broadcast network.

In nonbrodcast network, OSPF can run in two modes.

- NBMA (nonbroadast multiaccess) - simulated the operation of OSPF on broadcast medium.
- point-to-point to multipoint - treats non-broadcast network as collection of point-to-point links.

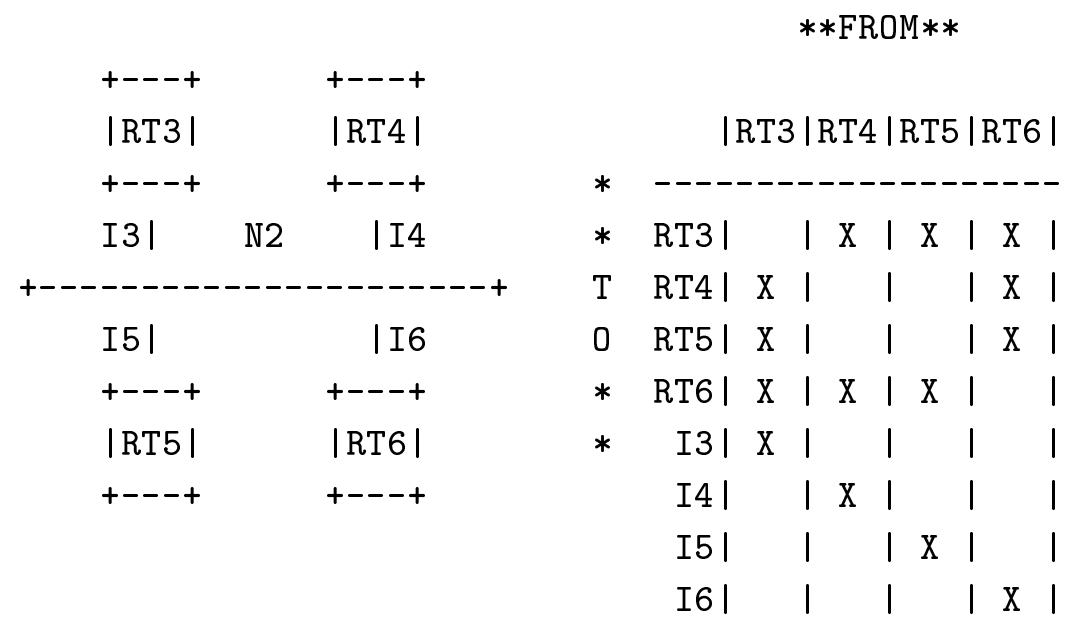
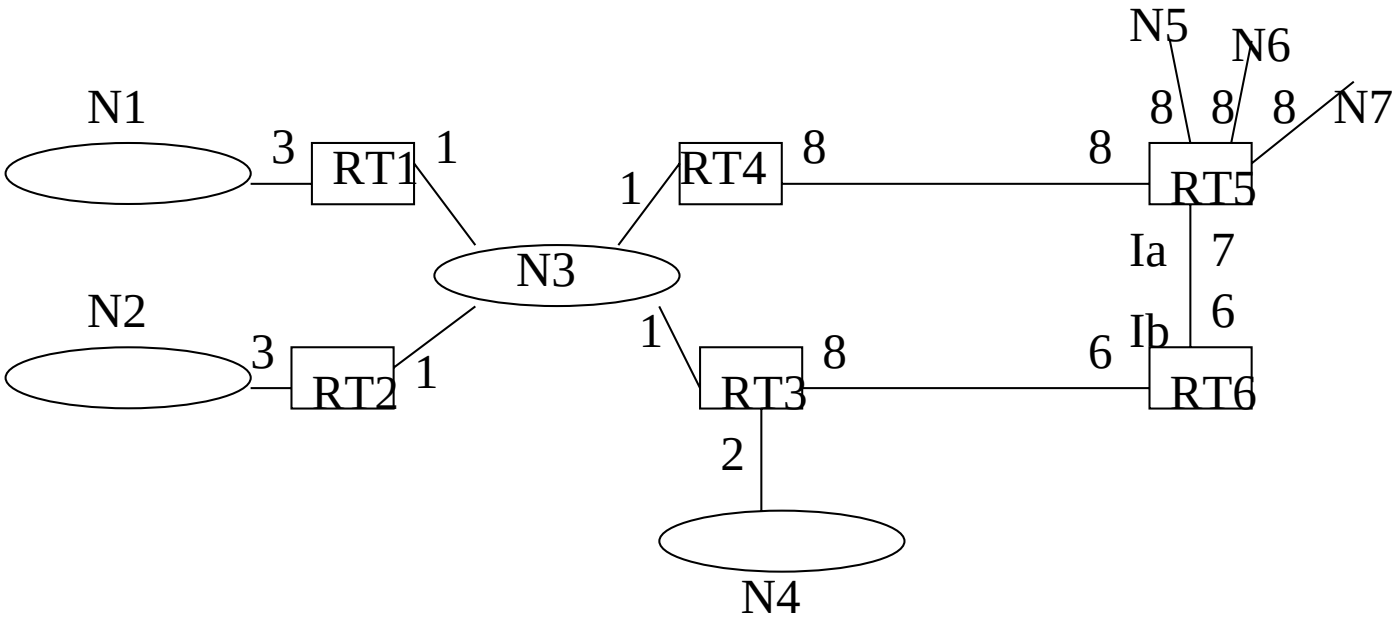


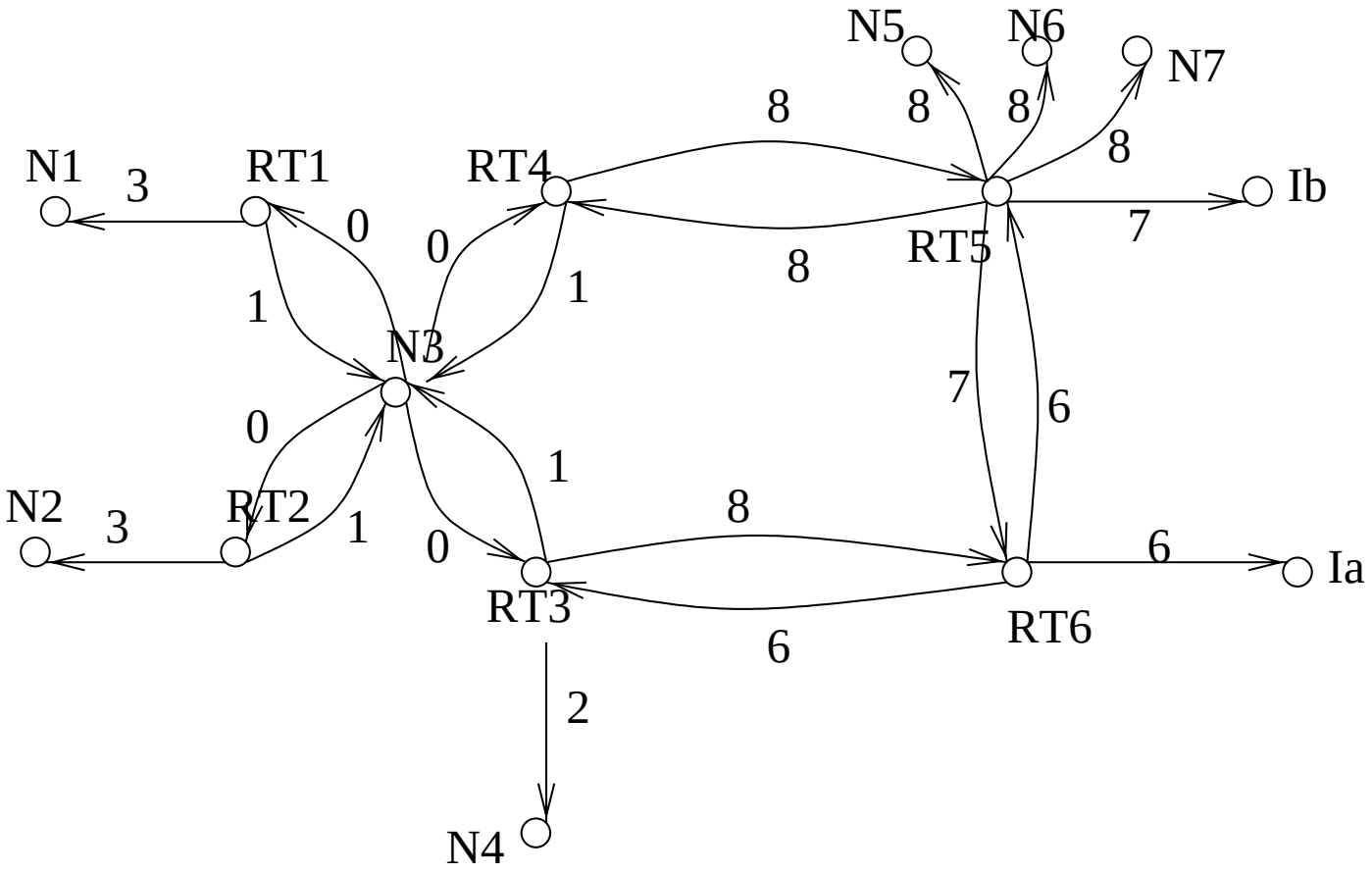
Figure 1b: Network map components
Point-to-MultiPoint networks

RT4 and RT5 cannot communicate directly

Link state database example



Link state database - represented as Directed graph



The external routes broadcasted in whole of the AS.

Two types of external routes.

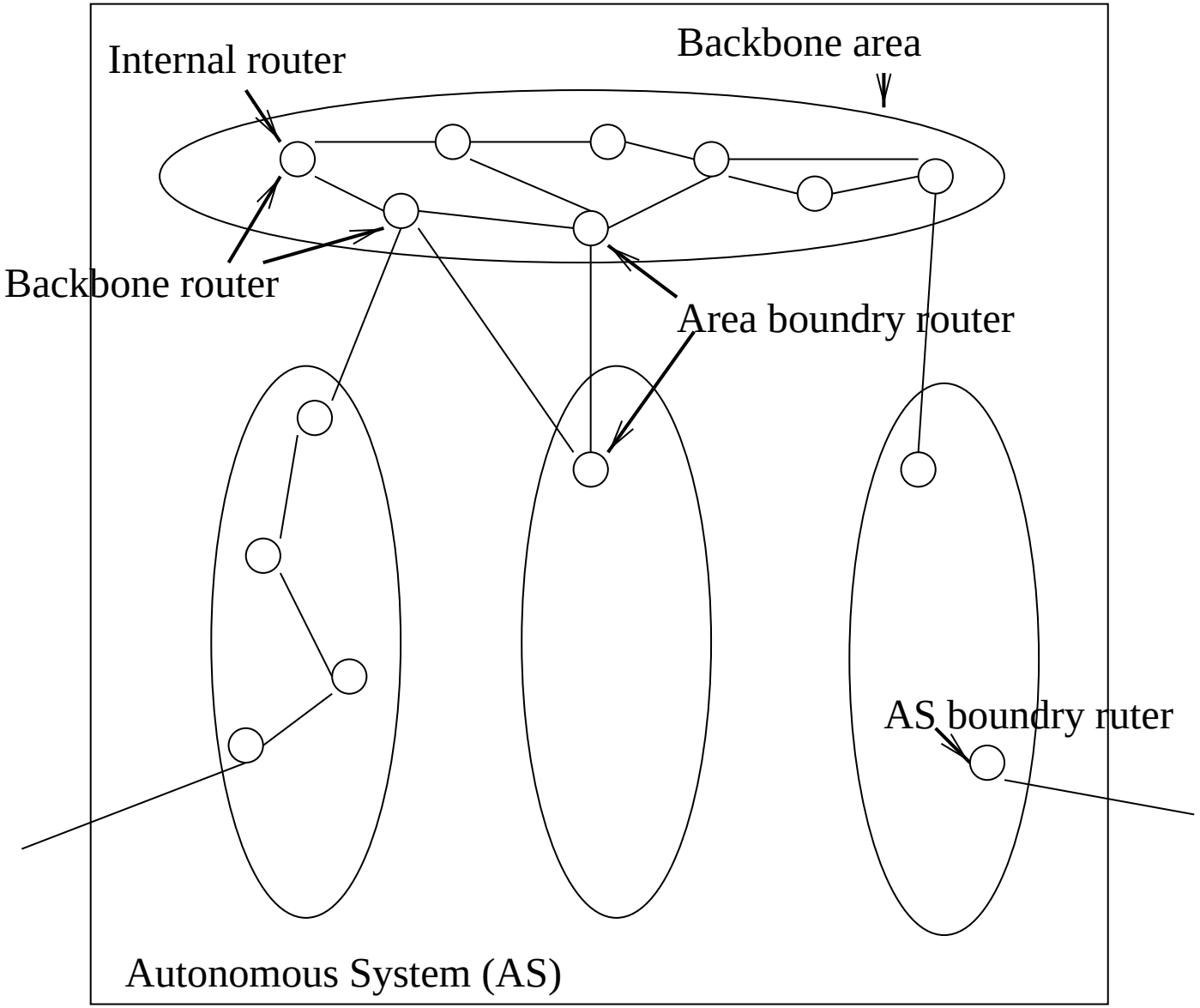
- type-I : The meteric to external destinations are considered while computing the tree in AS.
- type-II : the meteric to external destination is higher by an order. So, all distance in AS are smaller than this. choose the AS boundry router with smallest meteric to external destination.

When dividing AS in area

- always an area with id 0 (Areas id 0.0.0.0, area id is formatted as IP address) - backbone area.
- backbone should be preferably contiguous. In case it is not, it is made contiguous by using virtual link through another area.
- all areas are connected to backbone area.
- all interarea traffic will pass through backbone area.
- Intra area traffic will not pass through backbone.

Routers

- Internal router - router will all directly connected network belonging to same area. These run single copy of basic algorithm.
- Area border router - routers attached to more than one areas. There are multiple copies of basic algorithm running, one for each area.
- Backbone router - router having interface to backbone area. All area boundry routers are backbone router. But internal router (which is backbone router) in backbone ares is not area boundry router.

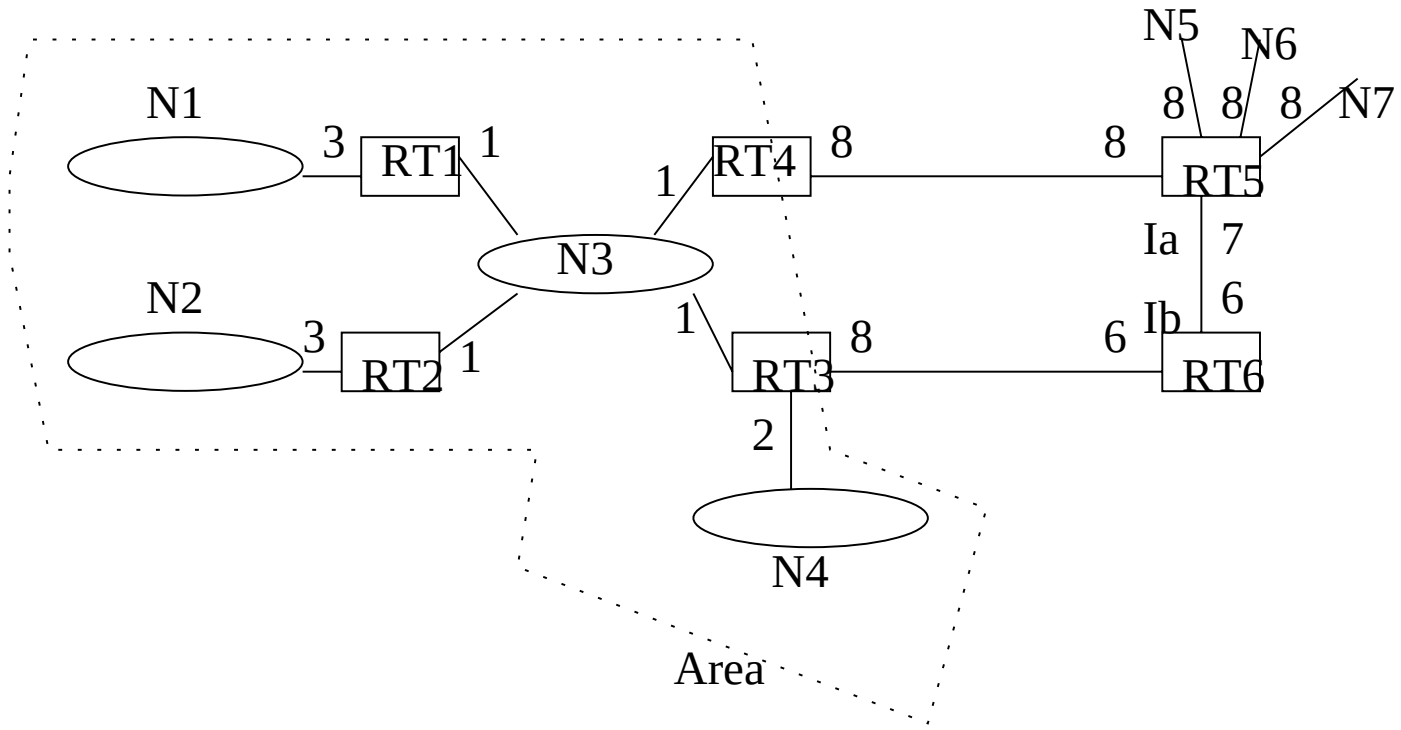

Internal router
Backbone area
Backbone router
Area boundry router
AS boundry ruter
Autonomous System (AS)

Area boundry router

- summarises the link state database in the area.
- announces the summary outside the area.
- area boundry routers can be configured to send single entry outside (instead of separate entry for each network within area).
- Advantageous to send single entry when only area boundry router is there. All packets has to be routed through this router only so having separate information for all network in stub area is useless.

Consider the network shown below.

- The dashed outline is an area.
- RT3 and RT4 are area boundry routers.



Router RT4 and RT5 will announce the following summary to outside.

	RT3	RT4
N1	4	4
N2	4	4
N3	1	1
N4	2	3

when the Area boundry router is configured to send only one entry, following summary is sent.

	RT3	RT4
N1-N4	4	4

Handling AS-external-LSAs

- external link state information - transmitted in separate link state advertisement (LSA).
- OSPF allows certain areas as stub areas.
- stub areas - have default route on per area basis.
- the AS-external-LSA not needed in these. All the packets not know will go to default area boundry routers. Thereafter backbone takes cares.
- reduces memory requirement for storing link state databases.

OSPF does not use UDP (RIP uses UDP port 520 and RIPng UDP port 521).

It runs directly over IP layer. For OSPF IP protocol no. 89 is used.

OSPF protocols packets - five types

- Hello - discover/ maintain neighbours
- Database description - summarise database contents.
- Link state request - database download
- Link state update - database update
- Link state ack - flooding acknowledgement

- Data base description and link state request are used to create adjacencies.
- Link state update - may contain LSAs of different routers.
- Each LSA - contains id of originating router and checksum of link state contents. LSAs - specifies type field also.
- All OSPF packets except Hello are sent over adjacencies only.

Five types of LSAs

- 1 : Router-LSAs : originated by all routers. describes the collected states of router's interfaces to an area. flooded throughout an area only.
- 2 : Network-LSAs : originated for broadcast and NBMA network by designated router. contains list of routers connected to the network. flooded throughout the single area only.
- 3, 4 : summary-LSAs : originated by area border router, flooded throughout the associated area. describes the routes to destination outside the area but inside the AS.

  - type 3 summary-LSAs describe route to networks.
  - type 4 summary-LSAs describe route to AS boundry routers.

- 5 : AS-external-LSAs : orginated by AS-boundry routers, flooded throughout the AS. described routes to destinations in other AS, as well as default route for AS.