

High speed computer networks

Interior routing protocols

Sosina M.
Addis Ababa institute of technology (AAiT)
2012 E.C.

Introduction

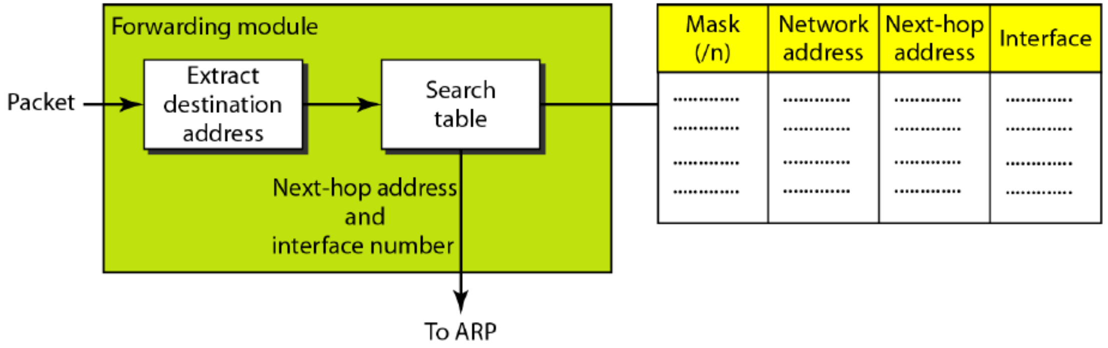
- Routers
  - responsible for receiving and forwarding packets through the interconnected set of networks

- Route decision
  - based on knowledge of the topology
  - Prevailing traffic/delay conditions of the internet

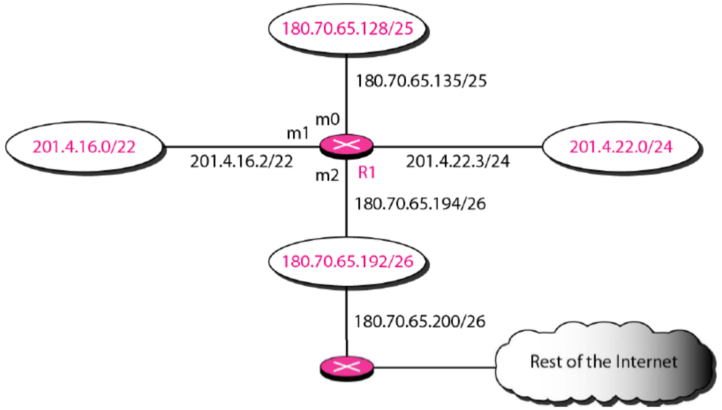
- *How routers learn about the network topology and the traffic condition?*

Routing table

❑Forwarding process



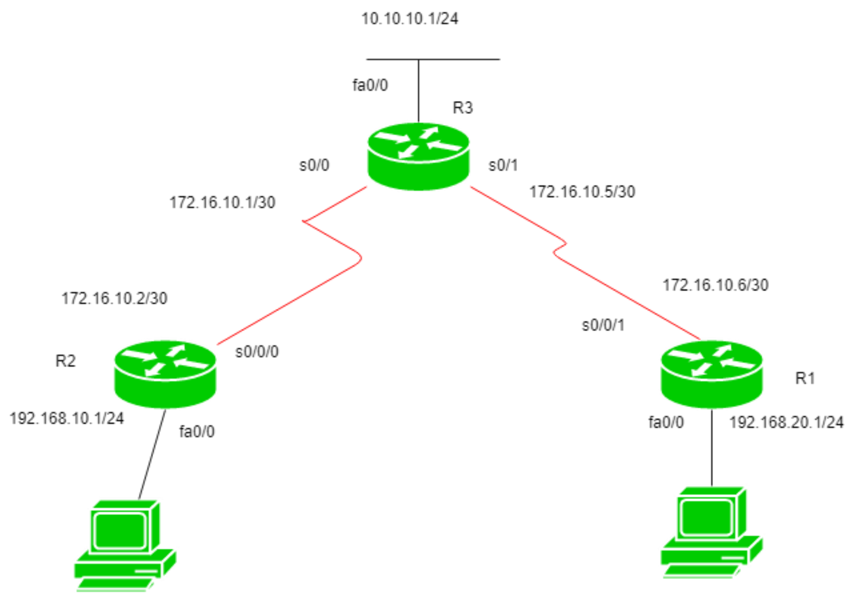
❑Routing table



Mask	*Network Address*	*Next Hop*	*Interface*
/26	180.70.65.192	—	m2
/25	180.70.65.128	—	m0
/24	201.4.22.0	—	m3
/22	201.4.16.0	....	m1
Any	Any	180.70.65.200	m2

Routing

- Fixed/static routing scheme
  - The routing information entered manually for each source-destination pair
    - ✓ But, the route may change when topology changes
  - No route advertisement – minimal overhead
    - ✓ Better security
    - ✓ requires less bandwidth than dynamic routing
  - Primary uses
    - ✓ For simple networks
    - ✓ Single default route



Dynamic routing

- In more complex internets, a degree of dynamic cooperation is needed among the routers

- The routes change when the network condition changes
  - Network failure
  - Network congestion

- To make dynamic routing decision
  - Routers exchange routing information
  - Routing algorithms are used to make a routing decision based on the routing information

Dynamic routing

- Advantages
  - Improves network performance
  - Can aid congestion control

- Disadvantages
  - Complex
  - Security
  - Consume bandwidth – route information exchange
  - Additional load

Dynamic routing

- Route decision algorithms
  - Distance vector
  - Link state
  - Path vector

- Routing information scope
  - Intra domain
  - Inter-domain

- Scheme
  - Reactive
  - Proactive

Autonomous system

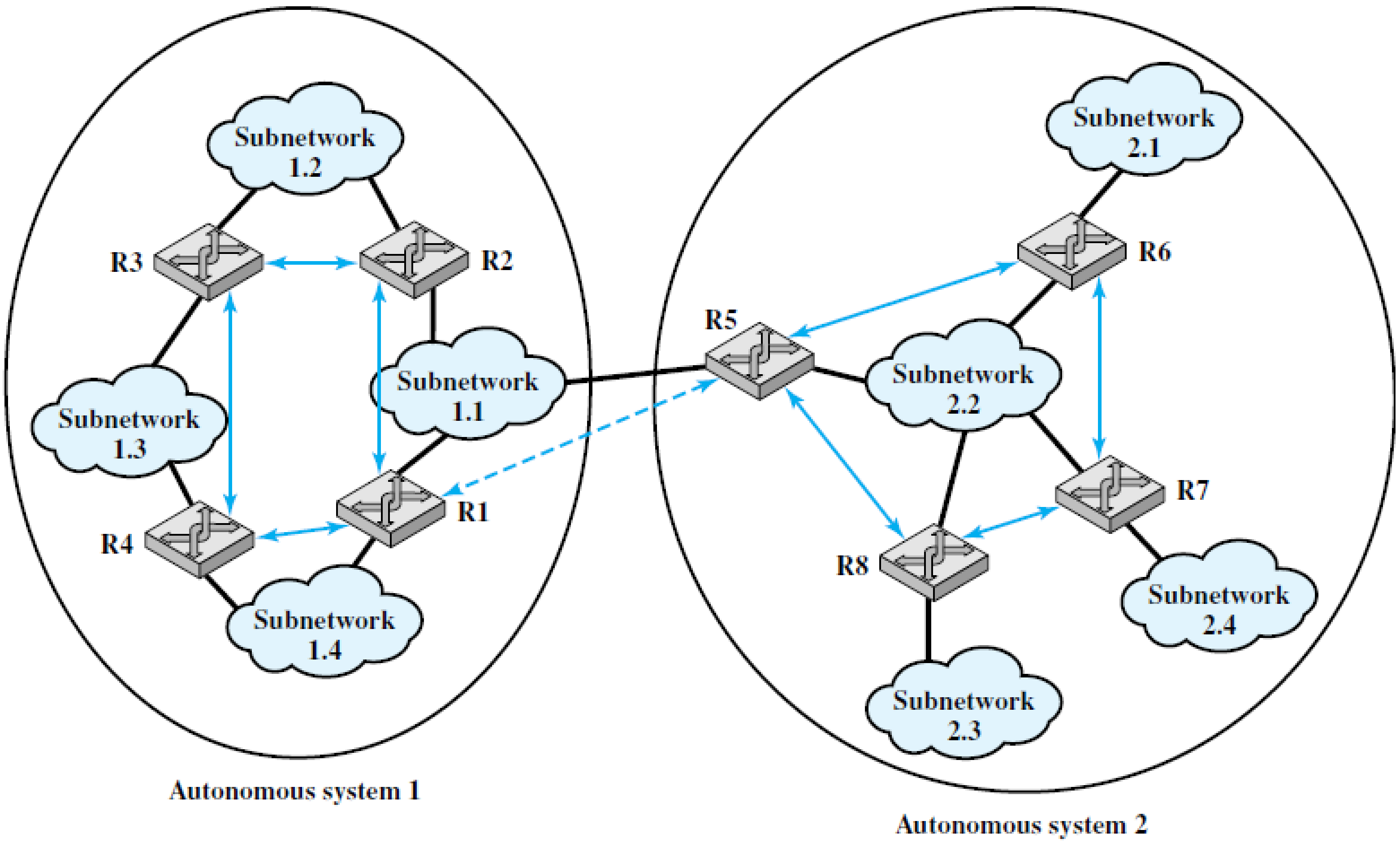
- An autonomous system (AS)
  - a set of routers and networks managed by a single organization
  - consists of a group of routers exchanging information via a common routing protocol
  - there is a path between any pair of nodes in AS

Routing protocols

- ***Interior Routing Protocol (IRP)***
  - passes routing information between routers within an AS
  - IRPs can be custom tailored to specific applications and requirements
    - ✓ i.e., routing algorithms and information in routing tables used by routers in different ASs may differ

- ***Exterior Routing Protocol (ERP)***
  - Used to pass routing information between routers in different ASs
  - The routers in one AS need at least a minimal level of information concerning networks outside the system

Application of IRP and ERP



Distance vector (DV) routing

- Each node exchanges information with its neighboring nodes
  - Neighbor nodes - directly connected to the same network
  - Information – distance vector information to all known nodes (entire routing table)

- Each node maintains
  - A vector of link costs for each directly attached network
  - distance and next-hop vectors for each destination

- Information exchange
  - Periodic update
  - Triggered update

Link state (LS) routing

- A router first determines the link cost on each of its network interface (neighbors)
- advertises this set of link costs to all other routers in the internet topology
- Each router constructs the topology of the entire configuration
- Then, computes the shortest path to each destination
  - Usually Dijkstra algorithm is used

Link state and distance vector

- LS and DV approaches can be used for interior Routing protocols
- Neither approach is effective for inter-AS routing
- DV protocol
  - assumes that all routers share a common distance metric with which to judge route preferences
    - ✓ Distance metric may be used by different ASs
  - Doesn't identify Ass
- LS protocol
  - the metrics used may vary from one AS to another
  - flooding of link state information to all routers across multiple ASs may be unmanageable

Path vector routing

- Provide information about which networks can be reached by a given router and the ASs that must be crossed to get there
  - Does not include a distance or cost estimate
  - Each block of routing information lists all of the ASs visited in order to reach the destination network
  - path information enables a router to perform policy routing

Routing information protocol (RIP)

- Applies the principle of distance vector routing
- uses the Bellman-Ford Algorithm to calculate its routes
- Distance=hop count
- Infinity=16
- Each router periodically shares its routing table to the neighboring nodes

Route update

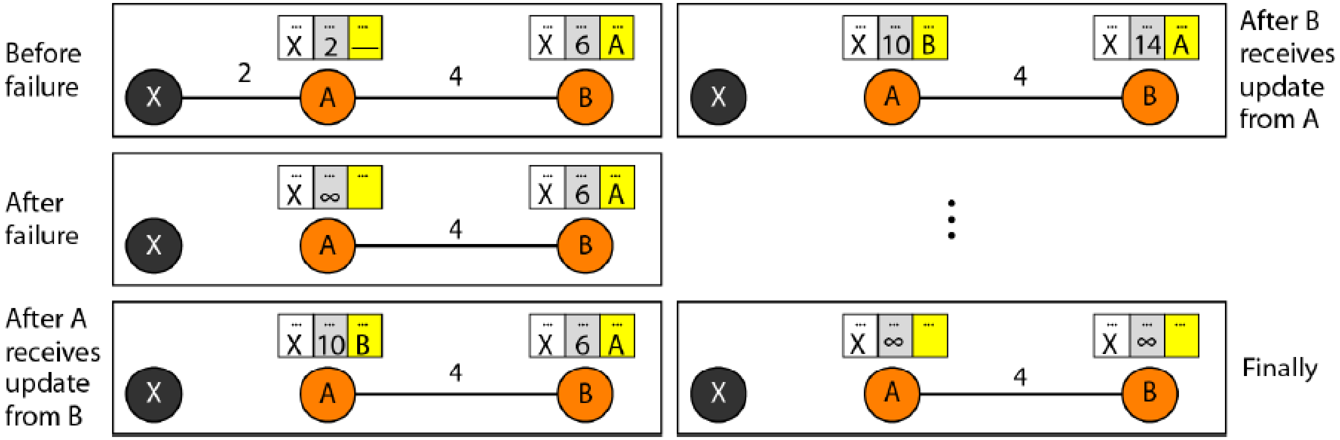
- RIP packets use UDP
- Initially each router knows only its neighbors
- After one update – neighbors at two hop distance and so on
- Upon receiving an update
  - *If the destination has no match in the routing table*
    - *Add the information to the table*
  - *Else*
    - *If the source is the same or the source is different and the cost is smaller*
      - *Replace the existing information*

Topology change

- A mechanism to detect a link failure
- Route update every 30 s
- If no updates received from a router within 180 seconds, mark route invalid
  - Assumes router crash or network connection is unstable
  - Set distance value to 16
- When a router hears from any neighbor that has a valid route to the router marked unreachable, the valid route replace the invalid one

Counting-to infinity problem

- Slow convergence to a change in topology
- Example:

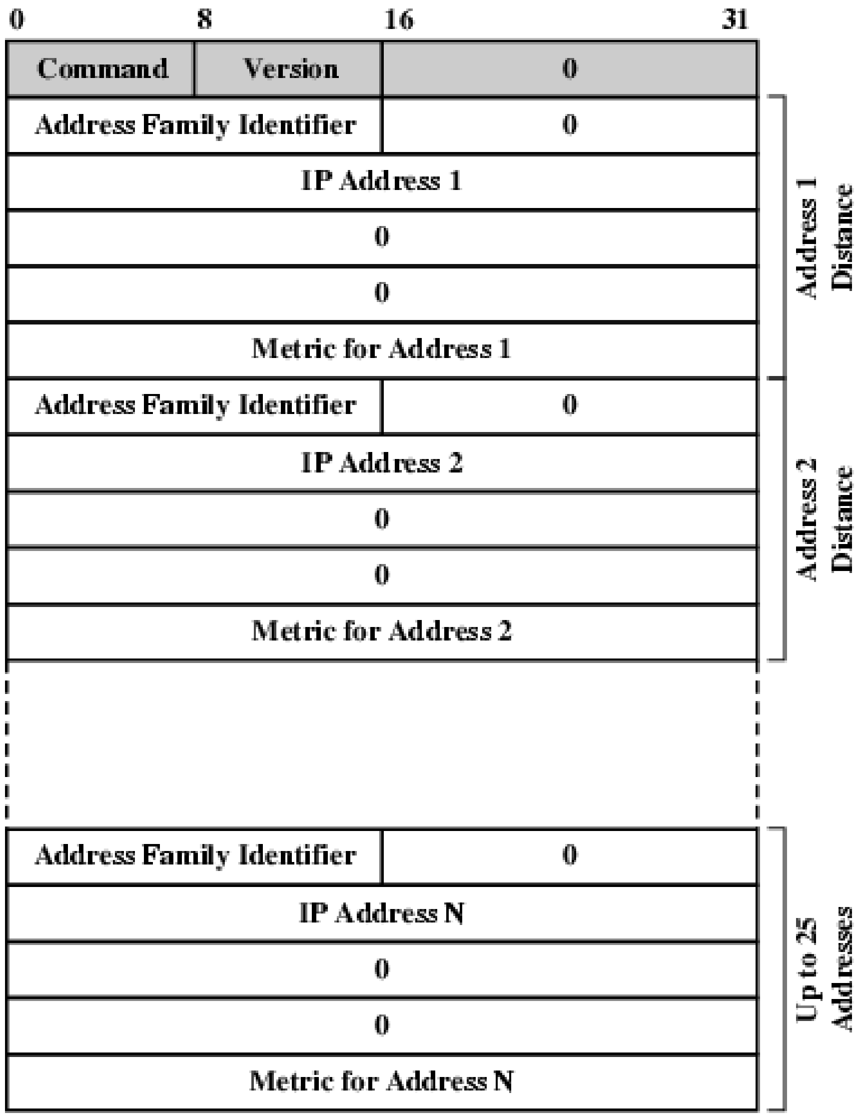


Split horizon with poisoned reverse

- ***Split horizon***
  - Each node sends only part of its table through each interface
  - If the optimum path to x is through A, the node doesn't advertise this piece of information to A
- ***Split horizon and poison reverse***
  - if there is no news about a route within a giver time, the node deletes the route
  - Node B can still advertise the value for X, but if the source of information is A, it can replace the distance with infinity

RIP packet format

- Command – request/response
- Version – RIP 1/RIP 2
- Address family identifier
  - 2 for IP
- Up to 25 route entries



RIP limitation

- Unsuitable for large configuration
  - Maximum cost =15
  - Increase the cost?
    - ✓ Convergence upon initialization or topology change can be long
- Simplistic metric leads to suboptimal routing tables
- RIP-enable devices accept RIP update from any devices

Open shortest path first (OSPF)

- Based on link state routing
- In RIP each node must send it full routing table – it may take a considerable amount of time for the information to propagate through the network

- General description
  - When initialized, router determines link cost on each interface
  - Router advertises these costs to all other routers in topology
  - Router monitors its costs
    - ✓ When changes occurs, costs are re-advertised
  - Each router constructs topology and calculates shortest path to each destination network

Flooding

- A packet is sent by source router to every neighbor
- At each router, incoming packet is retransmitted on all outgoing links except for the link on which it arrived
- When duplicate copies of the packet arrive they are discarded

- Advantage
    - Highly robust- all possible routes are tried
    - Flooding information reaches all routers quickly
- Disadvantage
    - High traffic load- proportional to the connectivity of the network

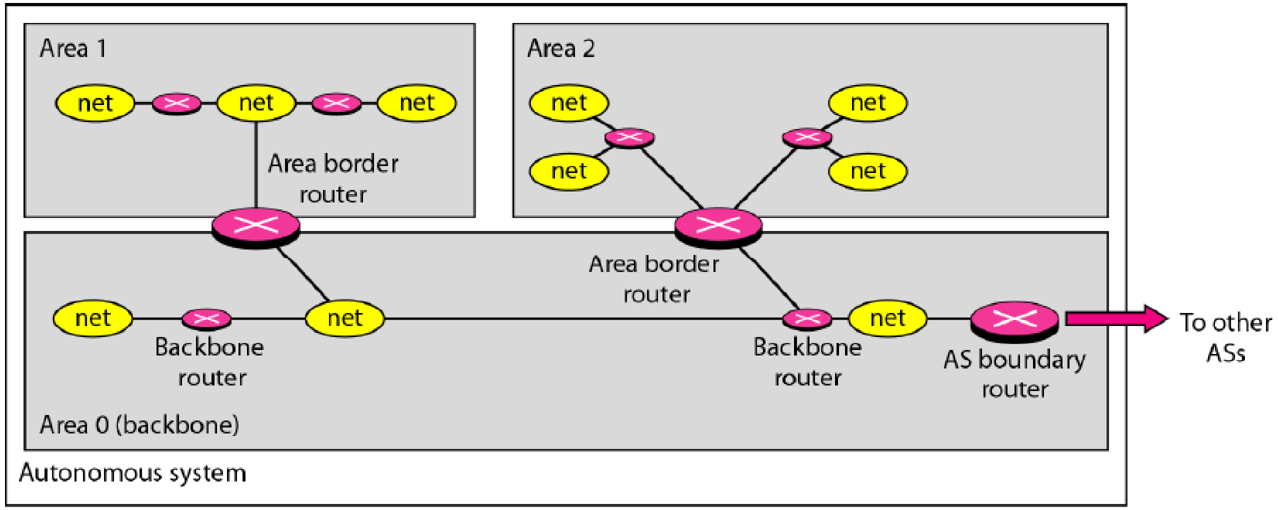
Link costs

- The costs associated with each hop, in each direction – routing metrics

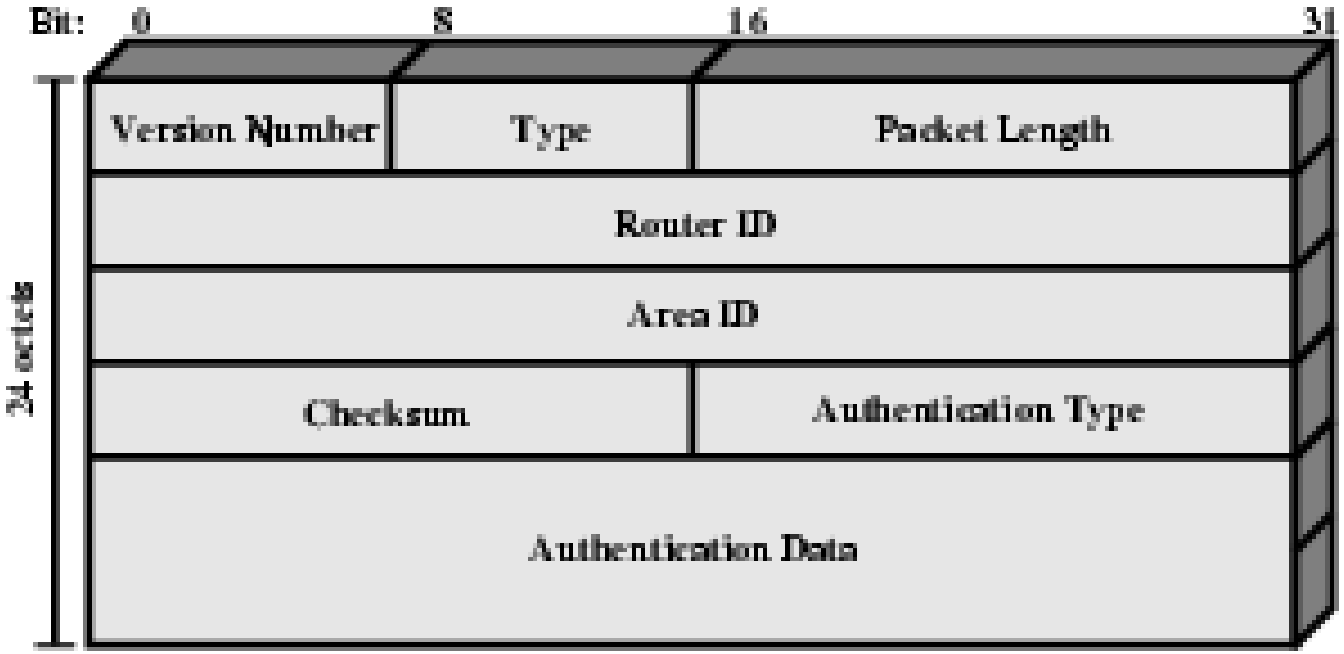
- Flexible routing metric based on the type of service (TOS)
  - Normal – e.g., hop
  - Minimize monetary cost
  - Maximize reliability – preconfigured or based on the recent outage or measured packet error
  - Maximize throughput – based on data rate of the interface
  - Minimum delay – transmit time (propagation + queueing)

Areas

- OSPF divides the autonomous system into areas to handle routing efficiently and in timely manner
  - The routing information is flooded in the area
  - At the border of an area, special routers summarize the information and sent it to other areas



OSPF packet format



Packet types

- Hello – for neighbor discovery
  - Send out periodically
- Database description – database exchange process
  - To synchronize network topology
- Link-state request
  - To request specific portions of neighboring routers link state database
- Link-state update
  - Link state advertisement to neighboring nodes
- Link state acknowledgement
  - Acknowledges a link state update