**(Book 2) Chapter 10:**

Link-State Routing Protocols: (OSPF and IS-IS)

- Know the topology of the network, use it to calculate the best paths to use

- Based on Dijkstra’s shortest-path-first (SPF) algorithm

- Converges faster than distance vector routing protocols (except for EIGRP)

- Only sends messages on updates, not periodic messages

- Hierarchical design through the use of areas

- Require more memory, bandwidth and processing power than DV routing protocols

- Each router learns about its own links through directly connected networks, and sends Hello packets through LSPs out these interfaces to find neighboring routers

- Routers store all LSPs into a database, and then use this database to construct a complete map of the network topology, which is used to calculate the best path

- Link -- an interface on a router

- Link-state -- information about the state of a link

- Interface IP address and subnet mask

- Type of interface (eg: Ethernet or Serial point-to-point)

- Cost of the link

- Neighboring routers on the link

**(Book 2) Chapter 11:**

Open Shortest Path First (OSPF):

- Classless link state routing protocol that uses cost (bandwidth on IOS) for metric

- Protocol = 89 (in IP header field), multicast address 224.0.0.5 or 224.0.0.6, AD = 110

- Fast convergences and uses areas for scalability

- Uses flooding to distribute link-state packets

- Messages are called link-state packets (LSPs)

- Hello -- establish and maintain adjacency with other OSPF routers

- Database Description (DBD) -- list of router’s link-state database

- Link-State Request (LSR) -- request more info about an entry in the DBD

- Link-State Update (LSU) -- respond to LSR or announce new information

- Link-State Acknowledgement (LSAck) -- sent in response to LSU

- Hello Protocol: (message format)

- Type -- OSPF packet type (Hello, DBD, etc)

- Router ID -- ID of originating router

- Area ID -- ID of area

- Network mask, Hello interval, Router priority, DR, BDR

- List of neighbors -- list of IDs of neighboring OSPF routers

- Neighbor establishment -- router sends Hello packets on all OSPF-enabled interfaces to look for neighbors on those links

- Before establishing adjacency, all routers must agree on three values:

- Hello interval -- 10 seconds for multiaccess and point-to-point, 40 on NBMA

- Dead interval -- usually 4 times the Hello interval, so 40 and 120 seconds

- Network type

- DRs and BDRs:

- Used to reduce traffic on multiaccess OSPF networks

- DR -- updates other routers (DROther) when a change occurs in network

- BDR -- monitors DR and takes over as DR if DR fails

- OSPF builds its link-state database by collecting LSAs from other routers, and then uses Dijkstra’s algorithm to create a shortest-path-first (SPF) tree, which is then used to populate the routing table

- An area is a group of routers that share link-state information

- Router ID is determined by “router-id”, or highest IP address of all loopback interfaces

- If no loopback, then choose highest IP address of all physical interfaces

- Cost (metric) = 108 / (bandwidth in bits per second)

- Note: the 10^8 (100 Mbps) is the reference bandwidth, which can be changed

OSPF in Multiaccess Networks:

- Challenging because there are multiple pairs of routers, which can lead to many LSAs

- For N routers on a multiaccess network, there are N(N-1)/2 adjacencies

- If one router sends an LSA to all other routers, then each router that receives the LSA will re-broadcast it to its neighbors, and they will have to send back LSAcks

- To reduce the network load from LSAs, a designated router (DR) is used

- Instead of broadcasting LSAs to all routers, LSA is only sent to the DR

- DR is the only router that receives LSAs and sends to other routers

- BDR also receives LSAs, but doesn’t send unless DR goes down

- DROthers are the remaining routers that receive the LSAs sent from DR

- DROthers send LSAs to AllDRouters (DR+BDR) using 224.0.0.6

- DR sends LSA broadcasts to AllSPFRouters (DROthers) using 224.0.0.5

- In the end, only one router (the DR) ends up flooding the network

- Note that DR is only needed in multiaccess networks, and not point-to-point networks

- Choosing (electing) the DR and BDR:

- DR is the router with the highest OSPF interface priority

- BDR is the router with the second highest priority

- If priorities are equal, then the highest router ID is used to break the tie

IOS Commands:

- router ospf [PID] -- enables OSPF on the router with a 16-bit process ID

- network [IP] [WILDCARD] area [AID] -- enables OSPF for that network

- For single area OSPF, use an AID of 0

- router-id [IP] -- sets the ID of the router, which is an IP address

- show ip ospf neighbor -- used to display and troubleshoot OSPF neighbors

- show ip ospf interface [INTERFACE] -- shows OSPF information for an interface

- show ip ospf -- shows OSPF general information

- bandwidth [KBPS] -- modify bandwidth used for OSPF cost calculation

- ip ospf cost [COST] -- directly specify the cost of an OSPF interface

- ip ospf priority [0-255] -- directly specify the priority of an OSPF interface

- To update the DR, must do a “shutdown” followed by “no shutdown”

- ip ospf hello-interval [SECONDS] -- set the Dead interval

- ip ospf dead-interval [SECONDS] -- set the Hello interval

- default-information originate -- redistribute the default static route in OSPF updates

- auto-cost reference-bandwidth [MBPS] -- change ref. bandwidth for cost calculations