7. Selecting Switching and Routing Protocols

CHAPTER 7

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Selecting Routing Protocols

- They all have the same general goal:
  - To share network reachability information among routers
- They differ in many ways:
  - Interior versus exterior
  - Metrics supported
  - Dynamic versus static and default
  - Distance-vector versus link-sate
  - Classful versus classless
  - Scalability

Interior Versus Exterior

- Interior routing protocols such as RIP, OSPF, and EIGRP are used within an autonomous system (AS) or same enterprise.

- Exterior routing protocols such as BGP are used between multiple autonomous systems

Autonomous system (two definitions that are often used):

"A set of routers that presents a common routing policy to the internetwork"

"A network or set of networks that are under the administrative control of a single entity"

Metrics Supported

- Metric: the determining factor used by a routing algorithm to decide which route to a network is better than another
- Examples of metrics:
  - Bandwidth - capacity
  - Delay - time
  - Load - amount of network traffic
  - Reliability - error rate
  - Hop count - number of routers that a packet must travel through before reaching the destination network
  - Cost - arbitrary value defined by the protocol or administrator

Routing Algorithms

- Static routing
  - Calculated beforehand, offline
- Dynamic routing protocol
  - Distance-vector algorithms
  - Link-state algorithms
- Default routing
  - "If I don't recognize the destination, just send the packet to Router X"
- Cisco's On-Demand Routing
  - Routing for stub networks
  - Uses Cisco Discovery Protocol (CDP)

Distance-Vector Routing

- Router maintains a routing table that lists known networks, direction (vector) to each network, and the distance to each network
- Router periodically (every 30 seconds, for example) transmits the routing table via a broadcast packet that reaches all other routers on the local segments
- Router updates the routing table, if necessary, based on received broadcasts

Link-State Routing

- Routers send updates only when there's a change
- Router that detects change creates a link-state advertisement (LSA) and sends it to neighbors
- Neighbors propagate the change to their neighbors
- Routers update their topological database if necessary

Distance-Vector Vs. Link-State

- Distance-vector algorithms keep a list of networks, with next hop and distance (metric) information
- Link-state algorithms keep a database of routers and links between them
  - Link-state algorithms think of the internetwork as a graph instead of a list
  - When changes occur, link-state algorithms apply Dijkstra's shortest-path algorithm to find the shortest path between any two nodes

Distance Vector or Link-State

Choose Distance-Vector

- Simple, flat topology
- Hub-and-spoke topology
- Junior network administrators
- Convergence time is not a big concern

Choose Link-State

- Hierarchical topology
- More senior network administrators
- Fast convergence is critical

Dynamic IP Routing Protocols

Distance-Vector

- Routing Information Protocol (RIP) Version 1 and 2
- Interior Gateway Routing Protocol (IGRP)
- Enhanced IGRP
- Border Gateway Protocol (BGP)

Link-State

- Open Shortest Path First (OSPF)
- Intermediate System-to-Intermediate System (IS-IS)

Routing Information Protocol

- The first standard routing protocol developed for TCP/IP environments
  - RIP Version 1 is documented in RFC 1058 (1988)
  - RIP Version 2 is documented in RFC 2453 (1998)
- Easy to configure and troubleshoot
- Broadcasts its routing table every 30 seconds; 25 routes per packet
- Uses a single routing metric (hop count) to measure the distance to a destination network; max hop count is 15

RIP V2 Features

- Includes the subnet mask with route updates
  - Supports prefix routing (classless routing, supernetting)
  - Security.
  - Supports variable-length subnet masking (VLSM)
  - Support multicast 224.0.0.9
- Includes simple authentication to foil crackers sending routing updates

IGRP Solved RIP Problems

- 15-hop limitation in RIP
  - IGRP supports 255 hops
- Reliance on just one metric (hop count)
  - IGRP uses bandwidth, delay, reliability, load
  - By default just uses bandwidth and delay
- RIP's 30-second update timer
  - IGRP uses 90 seconds

EIGRP

- Adjusts to changes in internetwork very quickly
- Incremental updates contain only changes, not full routing table
- Updates are delivered reliably
- Router keeps track of neighbors' routing tables and uses them as feasible successor
- Same metric as IGRP (bandwidth, delay, reliability, load), but more granularity (32 bits instead of 24 bits)

Open Shortest Path First

- OSPF is an open standard, defined in RFC-2328
- Adjusts to changes quickly
- Supports very large internetworks
- Does not use a lot of bandwidth
- Authenticates protocol exchanges to meet security goals
- Uses a single dimensionless metric assigned by administrator called *cost*
- On a Cisco router, the cost of an interface defaults to 100,000,000 divided by the bandwidth

IS-IS

- Intermediate System-to-Intermediate System
- Link-state routing protocol
- Designed by the ISO for the OSI protocols
- Integrated IS-IS handles IP also

Border Gateway Protocol

- BGP allows routers in different autonomous systems to exchange routing information
  - Exterior routing protocol
  - Used on the Internet among large ISPs and major companies
- Supports route aggregation
- Main metric is the length of the list of autonomous system numbers, but BGP also supports routing based on policies

Redistribution Between Routing Protocols

- allows routers to run more than one routing protocol.
- Every routing protocol behaves differently and cannot directly exchange information.
- Redistribution can lead to routing loops if not configured carefully, and can complicate planning and troubleshooting.
- Desirable when connecting different layers of the hierarchical model. Or When migrating to a new routing protocol.
- when different departments use different protocols, or when there is a mixed-vendor environment.

Making Decisions

- Goals must be established
- Many options should be explored
- The consequences of the decision should be investigated
- Contingency (emergency) plans should be made
- A decision table can be used

Making Decisions

Routing Protocol	AD	Metric	Periodic Updates	Triggered Updates	Partial Updates	VLSM/CIDR subnet mask	Algorithm
RIP	120	Hop Count	Yes Broadcast 255.255. 255.255	Yes	No	No	Bellman - Forde
RIPv2	120	Hop Count	Yes Multicast 224.0.0.9	Yes	No	Yes	Bellman - Ford
OSPF	110	Cost - bandwidth	No	Yes	Yes	Yes	Dijkstra shortest path first
EIGRP	90	Bandwidth load delay reliability	No	Yes	Yes	Yes	DUAL
Static	1						
Connected	0						

Table 7-5 *Routing Protocol Comparisons*

	Distance Vector or Link State	Interior or Exterior	Classful or Classless	Metrics Supported	Scalability	Convergence Time	Resource Consumption	Supports Security? Authenticates Routes?	Ease of Design, Configuration, and Troubleshooting
RIPv1	Distance vector	Interior	Classful	Hop count	15 hops	Can be long (if no load balancing)	Memory: low CPU: low Bandwidth: high	No	Easy
RIPv2	Distance vector	Interior	Classless	Hop count	15 hops	Can be long (if no load balancing)	Memory: low CPU: low Bandwidth: high	Yes	Easy
IGRP	Distance vector	Interior	Classful	Bandwidth, delay, reliability, load	255 hops (default is 100)	Quick (uses triggered updates and poison reverse)	Memory: low CPU: low Bandwidth: high	No	Easy
EIGRP	Advanced distance vector	Interior	Classless	Bandwidth, delay, reliability, load	1000s of routers	Very quick (uses DUAL algorithm)	Memory: moderate CPU: low Bandwidth: low	Yes	Easy
OSPF	Link state	Interior	Classless	Cost (100 million divided by bandwidth on Cisco routers)	A few hundred routers per area, a few hundred areas	Quick (uses LSAs and Hello packets)	Memory: high CPU: high Bandwidth: low	Yes	Moderate
BGP	Path vector	Exterior	Classless	Value of path attributes and other configurable factors	1000s of routers	Quick (uses update and keepalive packets, and withdraws routes)	Memory: high CPU: high Bandwidth: low	Yes	Moderate
IS-IS	Link state	Interior	Classless	Configured path value, plus delay, expense, and errors	Hundreds of routers per area, a few hundred areas	Quick (uses LSAs)	Memory: high CPU: high Bandwidth: low	Yes	Moderate

Decision Table Example

	Goals / Options	BGP	OSPF	IS-IS	IGRP	EIGRP	RIP
Critical Goals	Adaptability - must adapt to changes in a large Internetwork within seconds	X	X	X	X	X	
	Must scale to a large size (hundreds of routers)	X	X	X	X	X	
	Must be an industry standard and compatible with existing equipment	X	X	X			X
Other Goals	Should not create a lot of traffic	8	8	8			
	Should run on inexpensive routers	7	8	6			
	Should be easy to configure and manage	7	8	6			

X = Meets critical criteria. 1 = Lowest. 10 = Highest.

Decision Table

- Decision tables may be used for both the logical and physical network design phases.
- You can use this process to help you select protocols, technologies, and devices that will meet a customer's requirements.
- You can develop similar table for switching protocols, WAN protocols, campus-design technologies, enterprise-design technologies, and so on.