# Top-Down Network Design

Chapter 7

Selecting Switching and Routing Protocols

# Attributes of Switching and Routing Protocols

- Network traffic characteristics.
- Bandwidth, memory, and CPU usage.
- The approximate number of peer routers or switches supported.
- The capability to quickly adapt to changes in an internetwork.
- The capability to authenticate route updates for security reasons.

# Making Decisions as Part of the Top-Down Network Design Process

- Goals must be established.
- Many options should be explored.
- The consequences of the decision should be investigated.
- Contingency plans should be made.

# Making Decisions as Part of the Top-Down Network Design Process (cont.)

- Some questions to consider after a decision has been made:
  - If this option is chosen, what could go wrong?
  - Has this option been tried before (possibly with other customers)? If so, what problems occurred?
  - How will the customer react to this decision?
  - What are the contingency plans if the customer does not approve of the decision?

# Making Decisions as Part of the Top-Down Network Design Process (cont.)

**Table 7-1** *Example Decision Table*

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

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

# Selecting Switching Protocols

- Switches Capabilities:
  - Store-and-forward processing.
  - Cut-through processing.
  - Adaptive cut-through switching.

# Switching and the OSI Layers

- Hub
- Layer 2/3 switches

# Transparent Bridging

- Switching table.

**Table 7-2** *Switching Table on a Bridge or Switch*

| MAC Address | Port |
|---|---|
| 08-00-07-06-41-B9 | 1 |
| 00-00-0C-60-7C-01 | 2 |
| 00-80-24-07-8C-02 | 3 |

# Selecting Spanning Tree Protocol Enhancements

- PortFast
- UplinkFast and BackboneFast
- Unidirectional Link Detection

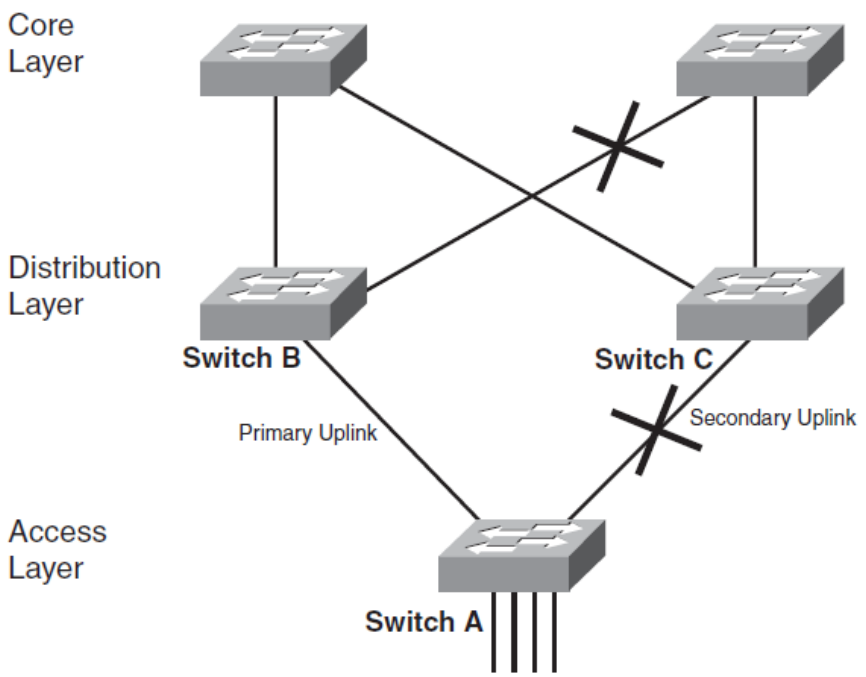


**Figure 7-1** *Access Layer Switch with Two Uplinks to Distribution Layer Switches*

# LoopGuard

- UDLD
- STP LoopGuard

# Protocols for Transporting VLAN Information

- IEEE 802.1Q
- Cisco Inter-Switch Link (ISL)
- Dynamic Trunk Protocol
- VLAN Trunking Protocol (VTP)

# Selecting Routing Protocols

- Characterizing Routing Protocols
  - Distance-Vector Routing
    - Protocols:
      - Routing Information Protocol (RIP) version 1 and 2.
      - Interior Gateway Routing Protocol (IGRP).
      - Enhanced IGRP (EIGRP) Border Gateway Protocol (BGP).
    - Features:
      - Split-Horizon, Hold-Down, and Poison-Reverse.

# Selecting Routing Protocols (cont.)

- Characterizing Routing Protocols
  - Link-State Routing
    - Protocols:
      - Open Shortest Path First (OSPF).
      - Intermediate System-to-Intermediate System (IS-IS).
      - NetWare Internetwork Packet Exchange (IPX) Link Services Protocol (NLSP).

# Selecting Routing Protocols (cont.)

- Characterizing Routing Protocols
  - Choosing Distance-Vector Protocols When:
    - The network uses a simple, flat topology and does not require a hierarchical design.
    - The network uses a simple hub-and-spoke topology.
    - The administrators do not have enough knowledge to operate and troubleshoot link state protocols.
    - Worst-case convergence times in the network are not a concern.

# Selecting Routing Protocols (cont.)

- Characterizing Routing Protocols
  - Choosing Link-State Protocols When:
    - The network design is hierarchical, which is usually the case for large networks.
    - The administrators are knowledgeable about the selected link-state protocol.
    - Fast convergence of the network is crucial.

# Selecting Routing Protocols (cont.)

- Characterizing Routing Protocols
  - Routing Protocol Metrics.
    - Hop count
    - Delay, bandwidth, reliability, and other factors.
  - Hierarchical Versus Nonhierarchical Routing Protocols.
  - Interior Versus Exterior Routing Protocols.
  - Classful Versus Classless Routing Protocols.
  - Dynamic Versus Static and Default Routing.
  - On-Demand Routing.

# Selecting Routing Protocols (cont.)

- Characterizing Routing Protocols
  - Scalability Constraints for Routing Protocols.
  - Questions:
    - Are there any limits placed on metrics?
    - How quickly can the routing protocol converge when upgrades or changes occur? Link-state protocols tend to converge more quickly than distance-vector protocols. Convergence is discussed in more detail in the next section.
    - How often are routing updates or LSAs transmitted? Is the frequency of updates a function of a timer, or are updates triggered by an event, such as a link failure?

# Selecting Routing Protocols (cont.)

- Characterizing Routing Protocols
  - Questions (cont.):
    - How much data is transmitted in a routing update? The whole table? Just changes? Is split horizon used?
    - How much bandwidth is used to send routing updates? Bandwidth utilization is particularly relevant for low-bandwidth serial links.
    - How widely are routing updates distributed? To neighbors? To a bounded area? To all routers in the AS?
    - How much CPU utilization is required to process routing updates or LSAs?
    - Are static and default routes supported?
    - Is route summarization supported?

# Selecting Routing Protocols (cont.)

- Characterizing Routing Protocols
  - Routing Protocol Convergence.

# IP Routing

- Routing Information Protocol (RIP).
  - RIP version 1, 2.
- Enhanced Interior Gateway Routing Protocol (EIGRP).
- Open Shortest Path First (OSPF).
- Intermediate System-to-Intermediate System (IS-IS).
- Border Gateway Protocol (BGP).

# Using Multiple Routing Protocols in an Internetwork

- Routing Protocols and the Hierarchical Design Model.
  - Routing Protocols for the Core Layer.
  - Routing Protocols for the Distribution Layer.
  - Routing Protocols for the Access Layer.
- Redistribution Between Routing Protocols.
  - Resolving Incompatible Metrics.
  - Administrative Distances.

# Using Multiple Routing Protocols in an Internetwork (cont.)

- Redistribution Between Routing Protocols.
  - Administrative Distances.

**Table 7-4** *Administrative Distance by Route Type*

| Route Source | Default Distance Value |
|---|---|
| Connected interface | 0 |
| Static route | 1 |
| Enhanced Interior Gateway Routing Protocol (EIGRP) summary route | 5 |
| External Border Gateway Protocol (BGP) | 20 |
| Internal EIGRP | 90 |
| IGRP | 100 |
| OSPF | 110 |
| Intermediate System-to-Intermediate System (IS-IS) | 115 |
| Routing Information Protocol (RIP) | 120 |
| Exterior Gateway Protocol (EGP) | 140 |
| On-Demand Routing (ODR) | 160 |
| External EIGRP | 170 |
| Internal BGP | 200 |
| Unknown | 255 |

# Using Multiple Routing Protocols in an Internetwork

- Integrated Routing and Bridging.

# A Summary of Routing Protocols

**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 |

# Summary

- Use a systematic, structured, top-down approach to select the right switching and routing protocols.
- Discuss bridging and switching, and routing protocols.

# Review Questions

- Compare and contrast distance-vector and link-state routing. If you were designing a new routing protocol, which would you use and why?
- Analyze the routing table on your computer. What entries are in your routing table and why are they there? Is your default route in the table and, if yes, what is it?
- Select a routing protocol that interests you, whether it's RIPv2, OSPF, EIGRP, BGP, or a different routing protocol. Research any security issues associated with this routing protocol and write two or three paragraphs about what you discovered.
- Network designers use many factors when deciding which routing protocol to use. For example, they consider whether the routing protocol converges quickly. List and briefly describe five other factors that characterize routing protocols and help a designer distinguish one protocol from another.