Unit 8

Switching Technology

Overview

Description

Historically, switches have been considered data link layer devices. As a Layer 2 device, switches are equivalent to a multi-port bridge, with some added features that eliminate network collisions that occur in a bridged network. Layer 2 switches provide high-speed performance at relatively low cost. Unfortunately, Layer 2 switches have limitations that prevent building large networks.

Today's applications are consuming bandwidth at ever-growing rates. New applications and speedier processors are placing unprecedented demands on the network. In response manufacturers began to look for a solution.

In the 1990's, Layer 3 switches were developed that blurred the line between switching and routing. This new class of switches offers the Layer 3 forwarding historically found in routers with the ultra high-speed performance normally associated with Layer 2 switches.

This unit reviews Layer 2 switching and provides an introduction into Layer 3 switching. In-depth coverage of this increasingly important area of Unified Networking is expanded in the full NetKnowledge Course on Switching.

Unit Table of Contents

This unit contains the following lesson:

Lesson 8-1: Switching

At a Glance

Switches are designed to allow each user full access to the entire bandwidth of a network, which eliminates the problems from collisions during transmission. They build and maintain tables with the MAC address of each node in a network, to which it refers to when forwarding a packet across the network. Layer 2 switches function much the same as transparent bridges. They learn the network topology, they forward frames and conduct filtering operations. However, they go beyond the capabilities of the bridge by supporting full-duplex transmissions.

Recently, LAN switches have been developed that also operate at the network layer and handle issues usually reserved for routers. These Layer 3 switches combine the switch's Layer 2 capabilities with implementation of Layer 3 routing protocols. These multi-layer switches were developed to enhance networks based on switching technology.

What You Will Learn

After completing this lesson, you will be able to do the following:

- Identify basic characteristics of Layer 2 switching.
- Describe how Layer 3 switching combines the roles of traditional switching and routing.
- Identify the benefits of Layer 3 switching.

Tech Talk

- **Cut-through** —A switching method where the switch forwards a frame to the network without reading the entire frame and performing error checking.
- **Full-duplex Transmissions**—Communication in both directions between the sender and the receiver.
- **IP Switching**—Another name for Layer 3 switching.
- **Layer 3 Switching**—A switching scheme where the high speed switches use the network layer address to identify the best path to the destination and then forwards the frame.
- **Multi-layer Switching**—Another name for Layer 3 switching.
- **Store and Forward**—A switching method where the switch reads and stores a frame for error checking before forwarding it.

Layer 2 Switching

Switches are internetworking devices, which means they are active components of a network. They are considered active because they do more than simply pass data across a network. They make "intelligent" decisions.

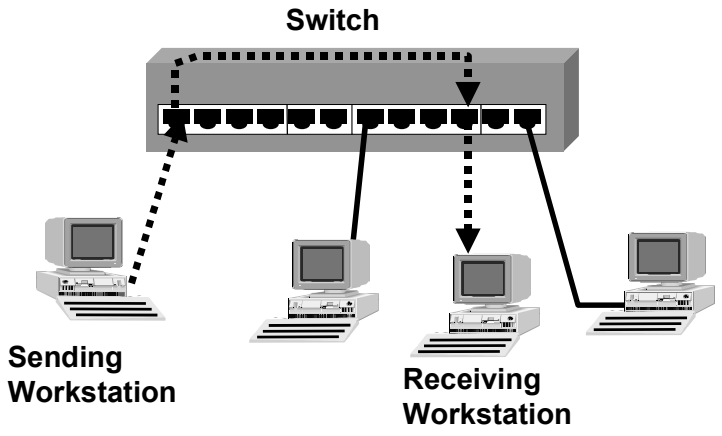
One way of relieving network congestion is to use a switch in place of either a hub or bridge. Switches allow a user full access to the entire bandwidth of the network. Switches also direct transmissions to specific workstations rather than forwarding to all workstations on the network, thus reducing network traffic.

Features

Basic features consistent for all Layer 2 switches include:

- The transmission of information over the network independent of the activities of other workstations.
- Full-duplex transmission and simultaneous transmissions.
- Dynamic learning of the network topology. Switches build MAC address tables to which they refer when forwarding packets across the network.

Layer 2 Switch



Forwarding Methods

Switches use two different methods to forward frames across a network:

- **Store and Forward**—The switch temporarily stores a frame in order to perform error-checking. At the same time, the switch discards any erroneous frames. After it has completed these operations, the switch proceeds to forward the frame on to its destination.
- **Cut-through Switching**—No error checking is performed using this method. The frame is merely inspected for the destination address and then forwarded on to its destination.

Bandwidth Distribution

Switches can also be distinguished by how they proportion bandwidth across their ports. A symmetric switch distributes bandwidth evenly amongst its ports. It can only provide services for networks with the same bandwidth, for example, 10BASE-T to 10BASE-T. Asymmetric switches distribute more bandwidth to some ports and less bandwidth to other ports. This allows the switch to connect two networks using two different bandwidths, for example, 100BASE-T to 10BASE-T.

Check Your Understanding

- Speculate what the advantages and disadvantages are for the two forwarding methods used by Layer 2 switches.

Layer 3 Switching

Traditionally, network designers have built their networks around router hops whenever possible. However, network traffic flows today are increasingly unpredictable, making it difficult to manipulate paths.

Also, since routers use software-based forwarding techniques, they have been unable to attain the high-speed performance needed to accommodate increasing network traffic.

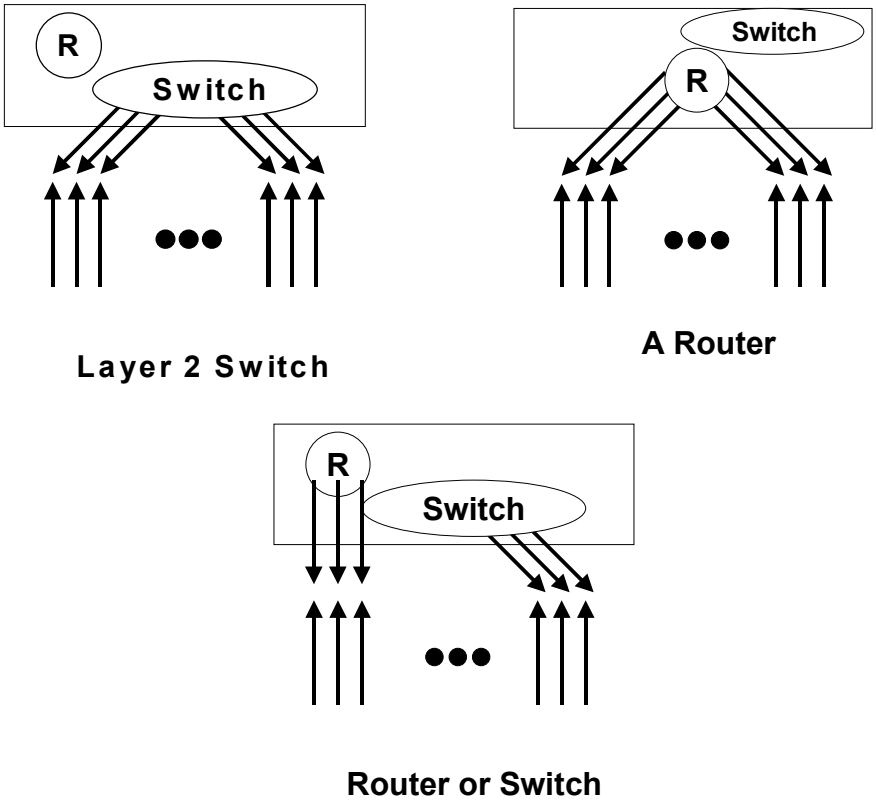
In an effort to find a solution, technology has shifted to enhancing the Layer 2 switch to also perform Layer 3 functions, while still keeping the fast and easy delivery system over the data link layer. This process has many names depending on the specific vendor. The most common names include Layer 3 switching, IP switching, and multi-layer switching.

Features

Basic features of Layer 3 switching include:

- Forwarding decisions are based on both the data link and the network layer addresses.
- Dynamic decisions are made whether to forward a frame using Layer 2 operations or a Layer 3 protocol.
- Switches located within a VLAN (Virtual LAN) operate at the data link layer and switches forwarding traffic between VLAN's operate at the network layer.
- Layer 3 switching is considerably faster than routing, because the routing functionality is hardware based rather than software based.
- Switches use routing protocols to locate the best path between the source and the destination, and then forward the packet.

Flexible Configurations of a Layer 3 Switch



Benefits

Layer 3 switching offers several benefits to the network manager.

- The network design is simplified. Often, network designers avoid router hops by adding more local servers within the same subnet group. But this practice requires the addition of another switch. With Layer 3 switches, network designers do not need to avoid the boundaries of routers.
- Layer 3 switches increase the quality of service by providing priority queuing (prioritizing of messages). This ensures bandwidth is allocated appropriately.
- Layer 3 switches implement already established protocols, that is, RIP and OSPF.
- Flexible configurations make Layer 3 switches more versatile within a variety of networks.

Nortel Networks' Accelar

As previously stated, Layer 3 switching has many names. Nortel Networks refers to this technology as router switching.

The Accelar routing switch family is Nortel Networks solution to Layer 3 switching. All the Accelar switches are true routing switches. They route and switch at the same speed. They use standard protocols like Routing Information Protocols (RIP), and Open Shortest Path First (OSPF), and they perform at speeds up to 7 Mpps (million packets per second).

The Accelar 1200 Routing Switch

Check Your Understanding

- Diagram how a Layer 3 switch operates in both workgroups and in between work groups. Explain your diagrams.

Try It Out

Collision Control

In this activity, you will be using Sniffer Basic to generate traffic first across the BayStack 153 hub and then across BayStack 350T switch (a Layer 2 switch). You will also use Sniffer Basic to track collisions that occur over both the hub and the switch.

Materials Needed:

- Nortel Netoworks' BayStack 153 Hub
- Nortel Networks' BayStack 350T Switch
- Sniffer Basic Software
- 3 Windows 95 PCs
- 3 Straight Through Ethernet Cables (Cat. 5 w/RJ-45 Connectors)
- Student Portfolio

Work in teams of three. As a team, write a summary of your experiences, including any screen shots you took during the activity.

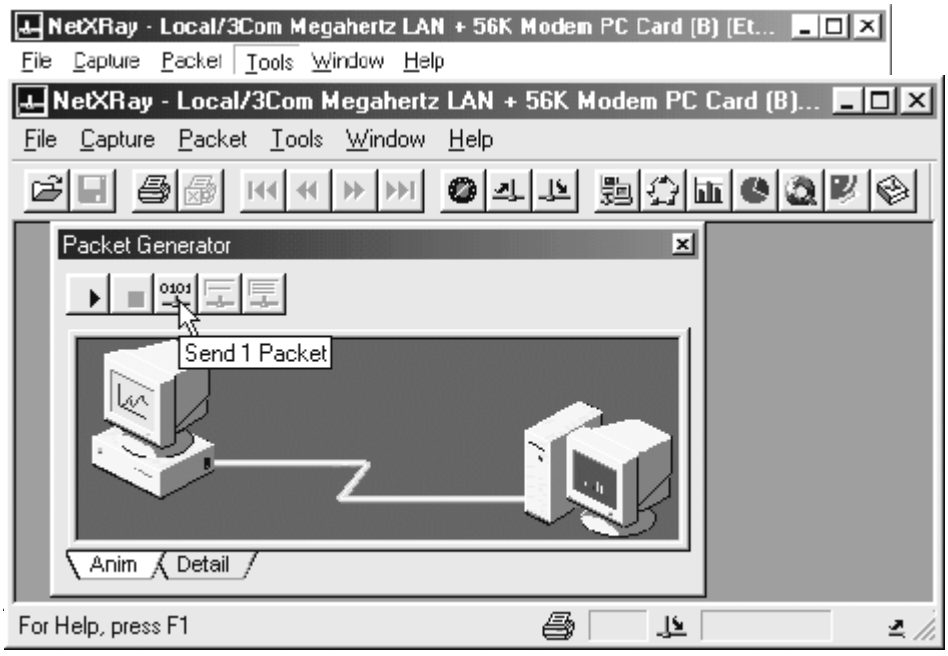
Part One: The Hub

1. Attach the three computers to the hub using straight through cables.

2. Two of the computers will generate packets across your small workgroup using Sniffer Basic's Packet Generator and the other computer will track collisions that occur using Sniffer Basic's Dashboard.

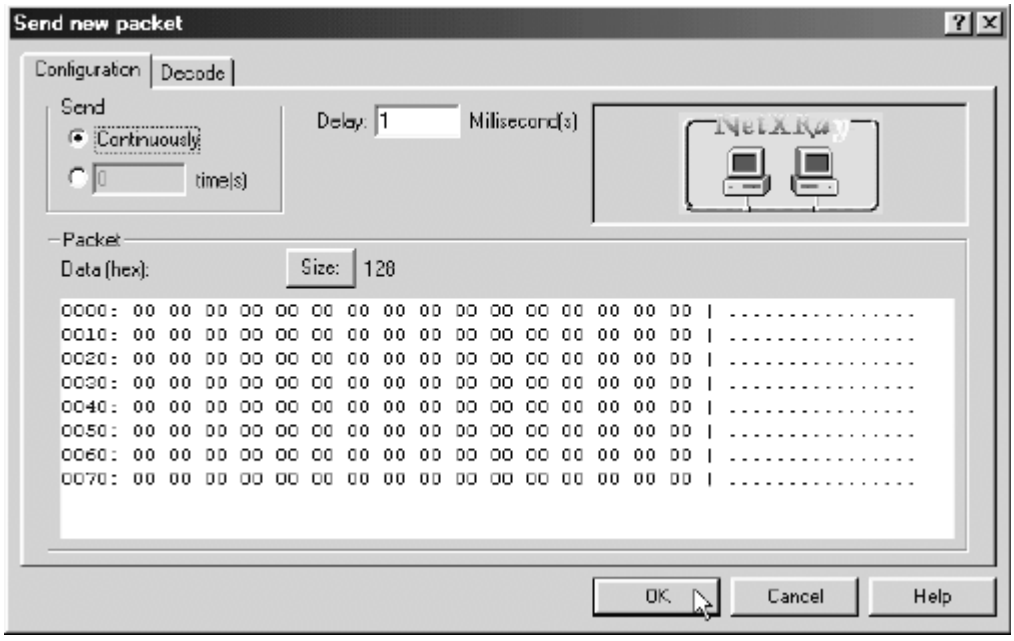
3. On the two computers designated to generating packets, open Sniffer Basic from the Start/Programs menu.

4. To generate a steady stream of packets across the network, open Packet Generator from the Tools menu.



5. The Packet Generator will open by clicking on the cable icon.

6. A configuration window will pop up where you can set the frequency of sending packets to either a set time or to continuous. You can also set the amount of delay between packets and the size of the packets.



7. In this activity, set the packet to any size. You may want to experiment to see if the size of the packet influences your results.

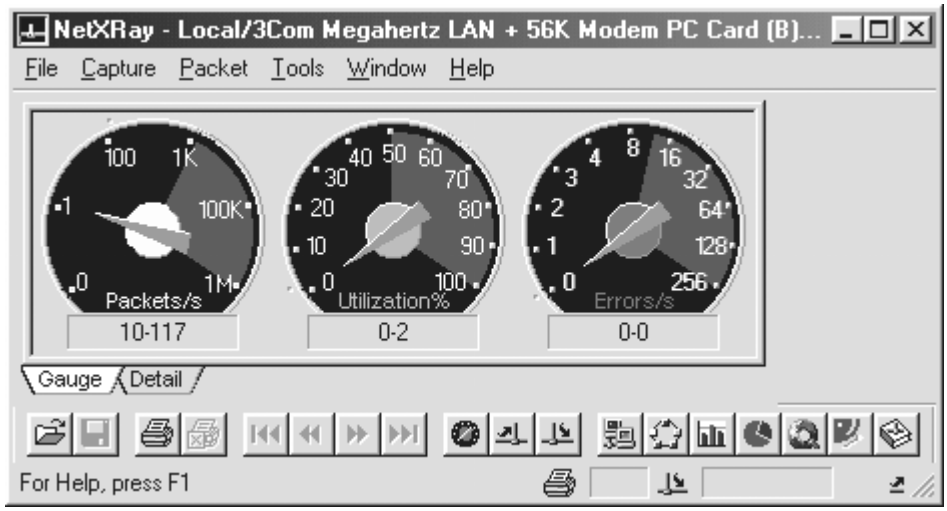
8. Set the Send configuration to Continuously.

9. Click OK to start the generator.

10. On the computer designated to view packet collisions, repeat step 3.

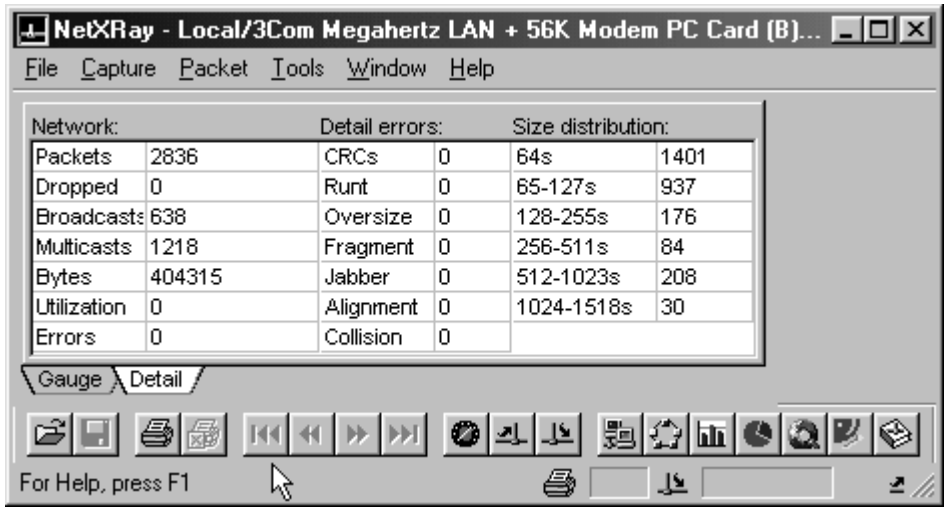
11. Click Tools.

12. Click Dashboard.



13. The Dashboard will appear with three gauges; packets, utilization, and errors. What you want to track is the errors.

14. Click Detail.



15. Notice that the display now shows the number of collisions that occur over the network. This display will update continuously. Take a screen shot (Alt+Prnt Scrn) of the display periodically to record your results and include in your portfolio.

16. For your summary of this activity, take note of the presence of errors.

17. Experiment with the Packet Generator and see if you can generate more errors.

Part Two:

1. Repeat Part One but use the switch in place of the hub.

2. Record any differences you see using the two network devices.

Rubric: Suggested Evaluation Criteria and Weightings

Criteria	%	Your Score
Enthusiastic experimentation that generates multiple results.	40	
Summary organized and in format suitable for portfolio.	40	
Cooperative group teamwork.	20	
TOTAL	**100**	

Stretch Yourself

Wading Through the Confusion

Materials Needed:

- Windows 95 PC
- Any Word Processor (e.g., MS Word)
- Pen/Pencil and Paper

In this activity you are to interpret Joseph Bardwell's poem with the knowledge you have gained from completing this course. Include in your interpretation if you agree with the poem's analogies for the various network devices and their location within the OSI model.

Write your interpretations of the poem in a short summary and justify your conclusions with information you have gained from the course.

Making the Connection

Sometimes it amazes me
that routers work at Layer 3
when switches very well could do
the job at simply Layer 2.
But switches work at Layer 3.
Oh, how confusing this can be
when bridges work at Layer 2
and routers can be bridges too!
And when you hope there'd be no more
you find a switch at Layer 4.
So Layer 4, and 2, and 3
imply OSI conformity.
But these are simply building blocks
in what we'll call an "Interconnect Box".

Rubric: Suggested Evaluation Criteria and Weightings

Criteria	%	Your Score
Analysis and synthesis of information	50	
Summary conclusions with justification	50	
TOTAL	**100**	

Network Wizards

Emerging Technologies

Materials Needed:

- Windows 95 PC
- Internet Connection (optional)
- Any Word Processor (e.g., MS Word)
- MS PowerPoint, or Transparencies, or Poster Board (optional)
- Pen/Pencil and Paper

1. One problem in the development of Layer 3 switching centers on the fact that every manufacturer is developing different technologies. Standards are still under development to ensure interoperability.
   a. Choose two switch manufacturers and research their Layer 3 switches.
   b. Compare the similarities and differences between their products.
   c. Include in your research specification sheets provided by the vendor.
   d. Once you have your vendor research complete, compare the vendor's specifications and technology to IETF's on-going work to produce international standards. A good place to start is IETF's web site on Multiprotocol Label Switching located at http://www.ietf.org/html.charters/mpls-charter.html. You may present your findings in any manner that seems appropriate; for example, written report, oral presentation, or poster presentation. Visuals should be added for clarification where necessary.

Rubric: Suggested Evaluation Criteria and Weightings

Criteria	%	Your Score
Analysis and synthesis of information	40	
Professional presentation and accompanying visuals	40	
Inclusion of specifications and resources	20	
TOTAL	**100**	

2. Layer 3 switching attempts to resolve two closely related issues: Quality of Service and Prioritization of Network Traffic. After researching these issues, create an analogy and an accompanying activity (maximum time of 45 minutes) that clearly outlines the issues for presentation to an uninformed person. Any visuals or handouts that will clarify your analogy or activity should be included.

Rubric: Suggested Evaluation Criteria and Weightings

Criteria	%	Your Score
Analysis and synthesis of information	30	
Professional presentation and accompanying visuals	40	
Activity reinforces presentation and stays within the time limit	30	
TOTAL	**100**	

Summary

In this lesson, you learned the following:

- The basic characteristics of Layer 2 switching.
- How Layer 3 switching combines the roles of traditional switching and routing.
- The benefits of Layer 3 switching.

Review Questions Name _____

Lesson 8-1: Switching

Part A

Indicate each statement as either True (T) or False (F).

1.	Layer 3 Switches are internetworking devices.
2.	Switches are passive devices that make no intelligent decisions.
3.	Cut-through switching performs error checking.
4.	Symmetric switches connect networks using the same bandwidth.
5.	Switches support full-duplex transmissions.
6.	Layer 2 switches build network layer address tables.
7.	Simultaneous transmissions are not supported by switches.
8.	Layer 2 switches refer to MAC address tables to forward packets across a network.
9.	Store and Forward switching discards erroneous frames.
10.	Asymmetric switches connect networks using different bandwidth.

Part B

1. Describe how Layer 3 switches have combined the roles of traditional switching (Layer 2) and routing.

Part C

Indicate each statement as either True (T) or False (F).

1.	Layer 3 switches simplify network design.
2.	Layer 3 increases the need to add more switches and servers to a network.
3.	Layer 3 switches are nothing more that routers.
4.	New protocols are needed to use layer 3 switches
5.	Layer 3 switches can operate either as a traditional switch or as a router.
6.	Layer 3 switches build network layer address tables.
7.	Simultaneous transmissions are not supported by layer 3 switches.
8.	Layer 3 switches refer only to MAC address tables to forward packets across a network.
9.	Layer 3 switches increase the quality of service by providing priority queuing.
10.	Layer 3 switches use both RIP and OSPF.

Scoring

Rubric: Suggested Evaluation Criteria and Weightings

Criteria	%	Your Score
Part A: Identify basic characteristics of layer 2 switching.	20	
Part B: Describe how layer 3 switching combines the roles of traditional switching and routing.	50	
Part C: Identify the benefits of layer 3 switching.	30	
TOTAL	**100**	
Try It Out:	**100**	
Stretch Yourself:	**100**	
Network Wizards:	**100**	
FINAL TOTAL	**400**	

Resources

Bay Networks, (1998). Implementing the Routing Switch: How to Route at Switch Speeds and Switch Costs. Available Online: http://www.baynetworks.com/products/Papers/2873.pdf

Sheldon, T. (1998). Encyclopedia of Networking. *Osborne/McGraw-Hill*, Berkeley, California.