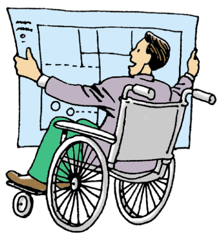
Lesson 1: Switching Concepts

At a Glance



All switches do at least these things:

- They receive data at their input ports.
- They determine where the data needs to go.
- They move the data to the correct output port (also called forwarding).
- They send the data out.

Some switches store the data (store-and-forward) while they decide where it should go. Other switches are fast enough to make the decision on the fly (cut-through).

This lesson will cover the internal workings of a switch. It describes what happens to data frames from the time they arrive at the switch's input port until the time that they leave through the output port.

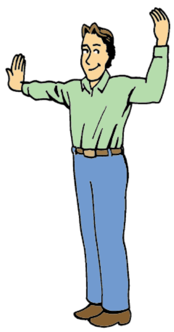
What You Will Learn

After completing this lesson, you will be able to:

- Describe several switching architectures
- Explain the difference between store-and-forward and cut-through switching technology
- Define half duplex and full duplex and explain the advantages and disadvantages of each
- Describe several methods of flow control and explain why it is needed

Student Notes:

Tech Talk



- **ASIC**—Application Specific Integrated Circuit - A microprocessor with instructions for a specific type of processing built in.
- **Backplane—**The modular plug-in device, which functions like a computer motherboard, found in many switches.
- **Blocking—**Switches can be classified as blocking or non-blocking based on whether they can run all their ports at wire speed simultaneously. In a blocking switch, not all ports can run at full wire speed without loss of packets or cells.
- **Cut-Through—**A switching architecture in which the switch begins forwarding a frame as soon as the destination MAC address of that frame has been received.
- **Flow Control—**A term used to describe the control of the flow of data on networks in order to prevent congestion and packet dropping.
- **Full Duplex—**Mode of data transfer in which data can be transmitted in both directions simultaneously. A telephone conversation is an example of full duplex.
- **Half Duplex—**A mode of data transfer in which data can be transmitted in only one direction at a time. One device must wait for the other device to stop transmitting before it can begin. A conversation over a CB radio is an example of half duplex.
- **RISC**—Reduced Instruction Set Circuit - A microprocessor that uses a smaller set of instructions to process data and therefore can process faster.
- **Store-and-Forward**—A switching architecture in which the switch waits to receive an entire frame before forwarding it.

Switching Architecture

Engineers are constantly trying to improve the speed of the hardware inside a switch (and inside any computer). Switches, or more specifically, the integrated circuits inside switches, make use of two strategies for improving hardware speed:

- **RISC**—Reduced Instruction Set Circuit
- **ASIC**—Application Specific Integrated Circuit

RISC

A computer contains programs that tell it what to do with data. Each program is a list of instructions. Each instruction is a list of steps the computer must follow. Instructions can be simple or complex. For example, if your teacher gave you the instruction "get ready to take a quiz," you might break down that instruction into its individual steps such as get out a piece of paper, get out a pen, write your name on the paper. The more complicated the instruction, the more thinking you have to do to break it down into steps you can actually follow. On the other hand, if your teacher gives you the instruction "get out a piece of paper" and then gives you the instruction "get out a pen" and then the instruction "write your name on the paper," you don't have to do much thinking at all. The simpler the instructions, the less thinking you have to do, but the more your teacher has to tell you.

This is the logic behind a RISC chip. Inside the computer is a microprocessor that contains its own programs telling it what to do with data. The microprocessor's programs are also a list of instructions. An IBM computer scientist, John Cocke, discovered that the computer performed a small subset (20 percent) of the instructions far more often than the other instructions. This research resulted in the development of a smaller set of processing instructions, the "reduced instruction set." A RISC processor is a microprocessor chip that contains this reduced set of instructions and has programs made up of a smaller number of simpler instructions. This makes the processor work faster because it has to "think" less, that is, it keeps fewer instructions in its memory and can retrieve them faster. Of course this also makes more work for the programmer (like the teacher) to write more code to tell the microprocessor what to do.

ASIC

A further step to reducing the number of instructions a processor must know, in addition to making them part of the hardware, is to make the instructions specific to an application. This is the concept behind the Application Specific Integrated Circuit (ASIC). An ASIC for switching is a microprocessor with switching instructions programmed into it. The microprocessors in a switch perform very limited functions, unlike the processor in your desktop computer that must do many things. The inclusion of ASIC hardware into a switch makes it faster and more capable than a bridge that is software driven. These integrated circuits make up what is called the “switch fabric.” The switch fabric performs protocol functions such as spanning tree, RIP and OSPF.

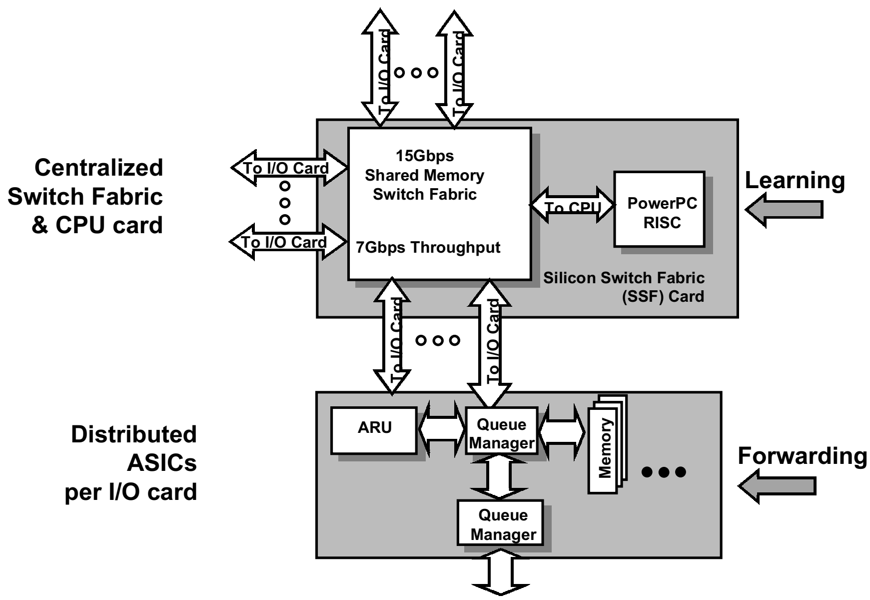
Check Yourself

- What does RISC mean?
- Why was RISC developed and who developed it?
- What observations did John Cocke make about computer instructions and why was this important?
- How does RISC increase the speed of devices?
- What is ASIC?

Switch Fabric

The term switch fabric refers to the electronic pathways that carry the data between the input ports and the output ports. As the demand for transmission speed increases, engineers try to design switching fabrics that operate faster.

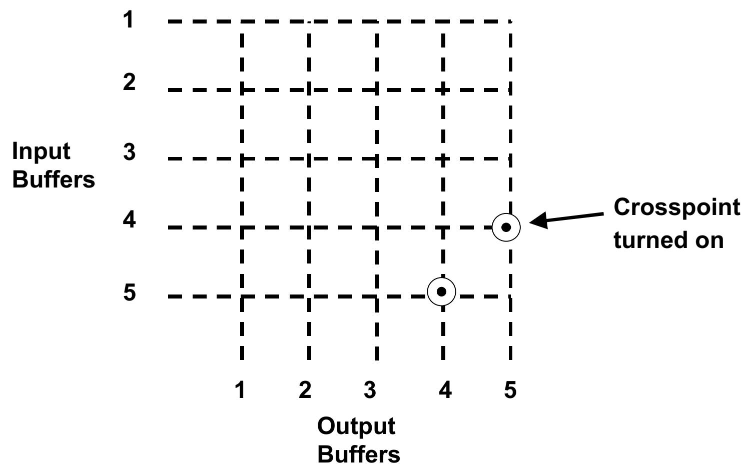
Layer 3 Switch Fabric



Crossbar Switch

The simplest type of switch uses a crossbar design. Every input port is connected to every output port. A grid can represent this.

Crossbar Switch Diagram



When data enters an input port, an integrated circuit microprocessor turns on the crosspoint of both input and output ports and turns off all other crosspoints for those ports. The only way for the data to travel is to be transmitted through the crosspoint to the correct destination.

Crossbar switch architecture can achieve very high bandwidth because many pairs of ports can connect simultaneously across the switching fabric.

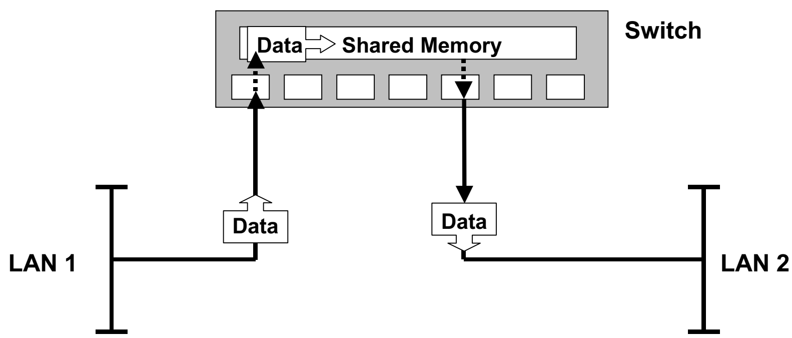
Crossbar switch architecture does not scale well. Each new port added to the switch requires new connections to every other port. This increases the complexity, speed, and cost of the switch. The integrated circuit that controls the crosspoints is also a potential bottleneck.

If the output port is in use, the data is kept in the buffer of the input port.

Shared-Memory Switch

In a shared memory switch, data that enters an input port goes directly into a shared memory area. From the memory area, data is switched to the correct output port. Even if the output port is available, the data always goes into the shared memory area first. This can slow things down. If large amounts of data enter the switch, the shared memory area must have enough memory to hold the incoming data. If there is insufficient memory, the data will be dropped.

Shared-Memory Switch



High-Speed Bus Switch

Later models of switches use a bus. Data enters an input port and moves onto a high-speed data bus. Data moves across the bus to the output port. The bus uses time division multiplexing (TDM), which makes it fast enough to accept data from all the input ports at once. The high-speed bus switch is the most commonly used. A typical high speed bus switch design looks like this:

- Inside the switch is a backplane, a modular plug-in device that works like the motherboard. The most important component on the backplane is the bus. All of the ports are connected to the bus.
- Each port has its own buffer and ASIC. The buffer holds data until it can be transferred onto the bus. The ASIC controls the buffer, input and output.
- Another ASIC is connected to all the ports and controls when the ports can transmit data to the bus.

The bus constantly transfers data from the input ports to the output ports. Each input port transfers its data into a specific "seat on the bus," called a slot. The order in which data comes off the bus is the order in which it goes to the output ports. The slot changer on the bus reorders the slots so that they match up with the correct output port. For example, suppose the switch is designed so that there are 8 slots on the bus picking up data from input ports 1 through 8 and carrying the data to output ports 1 through 8. When data comes into input port 1, it moves into slot 1 on the bus. If data from input port 1 is intended for output port 1, the slot changer leaves the slots in the same order, slot 1 comes first, slot 8 last. Output port 1 takes its data out of the first slot. If data from input port 3 is intended for output port 5, the slot changer moves output port 5 into the output port 3 position.

Parallel Switching

The next generation of switches, parallel switching, is now being used for Asynchronous Transfer Mode (ATM), which you will study in Lesson 3-2. ATM is an extremely fast data transmission technology, operating in the range of 25 Mbps to 2.4 Gbps. ATM employs cell switching. It converts data into small equal-sized cells and switches those cells at high speed. To handle these transmission rates, new switch architecture called parallel or "busless" switching has been developed. In a bus-based switch, all data must travel over the bus from the input port to the output port. This means that data transmission is limited to the capacity of the bus. In a parallel switch, many "switching elements" do the work of the bus. Just as a switch cuts down on the number of devices contending to transmit their data on the network, a parallel switch cuts down on the number of ports contending to transmit their data on the bus. The same logic that works on the large scale of the network applies to the small scale inside the switch.

Check Your Understanding

- In a simple crossbar switch with 10 input ports and 10 output ports, how many crosspoints are there? If you add one input port and one output port, how many crosspoints will there be? How many crosspoints need to be set for a message to move from an input port to an output port?

  Answer: There are 100 crosspoints. If you add one input and one

- Why might data be slowed down when using a shared-memory switch?
- What can a network manager do to improve a shared-memory switch network that has slowed due to increased traffic?
- Describe the switching fabric of a high-speed switch.

- Describe parallel switching.
- How is parallel switching able to improve high-speed switching?
- Does data on a 10 Mbps LAN travel at 10 Mpbs? Why/why not?

Switching Techniques

Switches can be grouped into types according to how they process incoming packets. The two basic switch technologies are:

- Cut-Through
- Store-and-Forward

Cut-Through Switching

When a cut-through switch receives a packet, it finds the destination address and then begins to forward the packet to its destination. As soon as the destination address is received, the cut-through switch makes the link between the receiving port and the destination port. By not waiting to receive the entire frame, a cut-through switch can forward frames very quickly. However, since it doesn't check for errors, a cut-through switch will forward corrupted frames. The advantage of a cut-through switch is low latency; however, because cut-through switches do not check the entire frame before sending it through the out port, bad and/or corrupt packets can get sent out.

Store-and-Forward Switching

A store-and-forward switch waits to receive an entire frame before analyzing it and forwarding it. It takes more time to examine the entire frame. This adds to network latency, but examining the complete frame allows the switch to check for errors and drop bad frames. A store-and-forward switch can make more involved routing decisions and can also filter out bad packets and protect destination LANs from corrupt frames.

Because store-and-forward switches can now perform their tasks so quickly, there is no significant difference in speed between store-and-forward switches and cut-through switches.

There are now hybrid switches available that mix both cut-through and store-and-forward architectures. For example, a switch might normally operate in cut-through mode, but if it detects a high number of errors going out, it can change to store-and-forward mode.

Flow Control Methods

If a switch receives data faster than it can process that data, it will temporarily hold the incoming data in a buffer until it can get to it. Ideally, a switch won't have to use its buffers because it will be fast enough to handle all the data it receives. If a switch is really overwhelmed, its buffers might fill up. If a frame or packet arrives at a switch when the switch is busy, and there's no room in the buffer, the frame will be dropped.

To prevent buffers from filling up, switches employ *flow control*. The sending machine must send its packets at the speed the receiving machine (and the network) can handle. If it sends too slowly, it wastes time. If it sends too fast, it could fill up the buffer of the receiving machine.

There are several methods of flow control, depending on the type of network. In a 10 Mbps Ethernet LAN, CSMA/CD provides flow control. Devices stop sending when their frames collide with others. After a collision, each device sends a broadcast announcing that there has been a collision. Each device then waits a certain amount of time and tries again. This method of flow control actually adds traffic because of the broadcast message and the retry.

On a Fast Ethernet LAN, each receiving device can transmit a "pause" frame to tell the sending device to slow down. This kind of flow control tries to control the amount of data *before* there are collisions and frames must be resent.

Gigabit Ethernet gives the responsibility for flow control to the switch. The switch can determine where the data is coming from and tell that specific device to slow down. This reduces the amount of additional traffic created by collisions or "pause" frames.

Flow control is another reason it is important to design carefully when designing a network with switches. The fastest switches, such as those running Gigabit Ethernet, should be in the part of the network (sometimes called the core) that receives the most traffic. This is where flow control will most likely be needed and faster switches will do a better job.

Half Duplex and Full Duplex Connections

A half duplex connection allows data to travel from sender to receiver; while one device sends, the other receives. A device with a half duplex connection either sends or receives, but it cannot do both since it only has one channel.

A full duplex connection allows both devices at either end of a link to send data at the same time. A full duplex device can send and receive data simultaneously. While a device is sending data, the data it is receiving goes into a buffer. When it is finished sending, the received data moves from the buffer onto the bus.

Think of the difference between half duplex and full duplex as the difference between juggling with one hand and juggling with two. When you juggle with one hand, you must wait until you've thrown the ball you're holding before you can catch another ball. When you juggle with two hands, one hand catches while the other throws. The catching hand acts as the buffer. A juggler using two hands can keep many more balls in the air than a juggler using only one. This is the same advantage that full duplex has over half duplex. Now consider what would happen if the two-handed juggler tried to pass balls back and forth with a one-handed juggler. In order to have a full duplex connection, *both* devices, the switch and the server connected to it, must be capable of full duplex.

Check Your Understanding

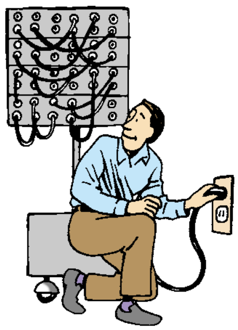
- Name and describe two switching techniques.
- Why do you think hybrid switches are made?
- What is flow control?

- Why is flow control important?
- Explain how Ethernet CSMA/CD controls the flow of data.
- What is one problem with this type of flow control?
- What is the difference between half duplex and full duplex and why is this important?
- What are the advantages and disadvantages for the two forwarding methods used by Layer 2 switches?

Try It Out

Materials Needed:

- BayStack 350T Switch and owners manual
- Windows 95 PC
- HyperTerminal software



Configuring Port Speed and Half Duplex and Full Duplex Modes

Connect your workstation to the 350T Switch for this activity. Keep a log of your activities during this lab. When you complete the activity, write a one-page report that discusses how a network manager might utilize these features of the switch. Include the report in your portfolio.

1. Start HyperTerminal and go to the Technician Interface and select Switch Configuration. Select Port Configuration.
   - ♦ What do you notice about the link state for the various ports?
   - ♦ What is the Speed and Duplex mode for each of the Up links?
2. You can enable and disable ports by changing the status field of the corresponding port.
3. All ports are configured for auto-negotiation of the speed and half and full duplex modes. The auto-negotiation field is set to enabled. To change the speed and mode setting for a port, you must disable autonegotiation first.
4. Observe the LEDs on the switch when you change the status and autonegotiation parameters.
5. For a port that is not used, move the cursor to the Autonegotiation field. Disable and press Enter.
   - ♦ What are the values that appear in the Speed and Duplex Fields for that port?
6. Change the Speed to 100 Mbps and Duplex to Full. Observe the LEDs.
   - ♦ What do you observe?

Rubric: Suggested Evaluation Criteria and Weightings:

Criteria	%	Your Score
Participation and completion of lab activity	20	
One-page report about the features of speed and duplex mode that indicates a thorough understanding of the concepts covered in the lab.	60	
Portfolio entries complete	20	
Other		
TOTAL	**100**	

Stretch Yourself

Materials Needed:

- Classroom Network
- Optivity software

Exploring Optivity Management Software

Electronic data collection provides you with detailed information about network topology, component configuration, and performance. You can use software network management tools, such as Optivity and HP OpenView, to collect data over extended periods of time. Using these tools will provide you with logs and current protocol statistics to establish baseline performance about the network. If there are network problems, you can also use these tools to attempt to reproduce the problems so that you can troubleshoot solutions.

In this lab, you will practice the skills required to monitor, baseline, and optimize the performance of an Ethernet network. You will use Optivity Campus applications and its options to monitor network activity and create a performance baseline.

Directions: Work in groups of no more than three. Keep a record of experiences, problems, troubleshooting, results, and any other details you deem pertinent. This one-page summary is to be incorporated into your portfolio.

Part 1

Monitor network activity for a segment or ring with Optivity Campus and an RMON probe.

1. Open the Optivity 7.0.1 application and type **manager** for User Name and do not include a Password.

2. Under Applications, select Campus Command Center.

3. In the CCC Folders panel, select the Probes or Hubs folder.

4. In the Contents panel, select an RMON–capable agent. In the Attributes panel, click the RMON tab.

5. In the RMON panel, click the RMON Summary button.

   If the selected hub icon contains multiple DCEs, the RMON Probe List is displayed. In this case, select the interface that you want to monitor, then click the Select button.

   The statistics that are displayed show traffic monitored by the RMON agent (probe) for the entire segment or ring. These statistics will be the same wherever the probe is located, whether in a router, hub, or on a standalone station.

   - What percentage of packets shown in the Statistics panel are broadcast?
   - What packet size is most often used?

6 On the RMON Summary view toolbar or pull–down RMON menu, click the Hosts button.

   - What is the MAC address of the device with the most packets in?

7. On the RMON Host toolbar or on the pull–down RMON menu, click the History button.

   - What type of information is provided in the graph?
   - What is the length of time the history information reflects?

8. On the RMON History toolbar or pull–down RMON menu, click the Layer 2 Traffic Matrix button

   The Layer 2 Traffic Matrix window opens. This defines the top talkers on the segment by MAC address at Layer 2. You may sort the information in either descending or ascending order by right clicking on the field headers i.e.: packets.

- What is the source address of the top conversation?

9. Right-click on the top talker then click on conversations. A graphical view of the traffic between the top talker and the other devices on the network appears. You can display the devices by either their MAC or Network addresses by right clicking ion the field headers, i.e., source

   - What are the IP and MAC addresses of the most active devices?

10. Close all the RMON windows.

Part 2

Monitor network activity for router ports.

1. In the CCC Resources panel, click on the Routers folder.
2. In the Contents panel, click on a router.
3. In the CCC toolbar, click the Monitor button.

   The RouterMan window opens.

   You can also click the right mouse button on the router icon and choose RouterMan from the menu that is displayed.
4. Click the right mouse button on the Performance button in the Router section, select Performance by Interface, drag right, and select Packets.

   The Performance–By–Interface window opens.
5. Note the interface transmitting the most packets on the line below:

   - Is this the same interface as the one transmitting the most bytes?

     A larger number of bytes per packet indicate a more efficient use of the network bandwidth.
6. Click the right mouse button on the Performance button in the Router section, select Performance by Interface, drag right, and select Bytes.

7. Click the right mouse button on the Ethernet Performance button in the Interface section and select Statistics.

   The Performance Statistics window opens.

8. Note the number of non–unicast (multicast and broadcast) output frames and the unicast (single destination) output frames.

   A large number of multicasts may indicate a need to reconfigure the network.

9. Close the RouterMan window.

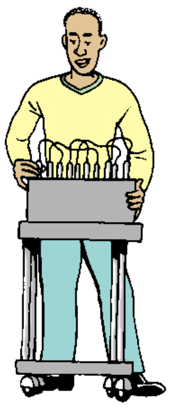
Rubric: Suggested Evaluation Criteria and Weightings:

Criteria	**%**	**Your Score**
Successful completion of activity	15	
Complete, accurate responses to lab activity questions	15	
Complete summary of experiences and an insightful analysis of how a network manager might use this software to help improve network performance.	20	
Summary included in portfolio	15	
Participation and cooperative teamwork during activity	20	
Other		
TOTAL	**100**	

Network Wizards

Materials Needed:

- Classroom Network
- Optivity software



Using Report Manager

In this lab, you will use Report Manager to capture network performance statistics and to generate a report. This report will be used to create network activity for you to measure and observe.

Work in groups of no more than three. It will take at least one week to compile the data for this activity. Be sure to keep an accurate log of records. Your instructor will provide you with the values you need to configure the data collection window.

Upon completion of this activity, prepare a summary of the activity that takes place across your network.

1. Open Report Manager.
2. In the **CCC Folders** panel, lick the LANs folder.
3. Select your team's segment and choose Report Manager from the Applications menu on the CCC menu bar. The Report Manager List window for the selected LAN opens.
4. Configure the Data Collection window. Use the values provided by your instructor for this step.
5. Click the Create New button on the toolbar or choose this option from the pull–down Report menu. The Data Collection window will open.
6. Type or select the following information in the **General** tab window:
   a. Enter your team name in the Description field.
   b. Type the address of your workstation.
7. In the Collection Target field, select segment from the pull–down selection list.
8. From the pull down list, select Minutes for the Polling Interval unit.
9. In the Polling Interval field, set the length of the polling interval to 1 minute.
10. In the Collection Duration field, set the length of the duration to 20 minutes. (Check with your instructor about the 20-minute time requirement.)

11. Click the Device Details tab.
    a. Enter the following data to collect data for specific parts of the hub:
       – Port Index—Port number
12. Click the Database Log tab and note the position of the sliders for the following parameters: [Check with your instructor about these times.]
    – 1 Hour Later
    – 1 Day Later
    – 1 Week Later

    These separate parameters allow you to collect fewer data points (and use less disk space) as the length of the data collection increases. For the classroom exercise, these values will not matter because the length of data collection will be quite short.
13. Click the File Export tab and type a file name containing your team number (such as team 1.tab) in the file name field. What is the directory path for the file to be saved?
14. Leave the export file type as Tabbed Files.

    The other options allow you to export the file in different versions of Hypertext Markup Language (HTML) for viewing with a World Wide Web browser.
15. From the Automatic Export pull–down list, select Once At End of Collection.
16. Leave the Export on Day, Export at Time, and Export Value options at the default values, unless your instructor gives you specific values for your collection.
17. Change the Export Value to Absolute.
18. Click OK.

    A new entry is displayed in the Report Manager List window and the data collection runs for the time that you selected in the Collection Duration field.

    While waiting for collection of data, look at the buttons on the Report Manager toolbar by pointing the mouse at each button. No click is necessary.
19. View the collected data.

    Wait ten minutes for the data collection to complete:

20. In the Report Manager List, click on a row.
21. Click the Display Report button on the toolbar or choose this option from the pull–down Report menu. The Report window will open showing the data collected.
22. Click the Create Table Group button, immediately to the left of the group selection list on the toolbar. The Create Table Group window will open.
23. View the contents of the different predefined groups.
    - Group 1: Collision Rate %, Error Rate %, and Utilization %
    - Group 2: Octets
    - Group 3: Broadcast Packets, Multicast Packets, and Pkts. (Packets)
    - Group 4: Align Collision, Dropped, Fragments, Oversize, and Undersize
    - Group 5: Jabber
24. In the Add Group field, enter a name containing your team's number.
25. In the Group Names list, click on the group containing the data you want to display:
    - Click Group 1 for **Utilization**, Group 2 for **Octets**, Group 3 for **Broadcasts**, and Group 4 for **Collisions and Errors**, and Group 5 for **Jabbers**.
26. For each data item you wish to choose, click the item in the All Items list and then click the Add button to add the item to the Selected Items list.
27. Click OK.
28. Derive some baseline numbers for the classroom network.
29. Scan the Report Manager report to obtain the highest level of utilization. Record this value in the following blank: ________________

    Scan the report to obtain the highest number of collisions. Record this value in the following blank:

    ____

    ____

30. Pull down the arrow by the group display on the toolbar of the report. Select each group to view the details of your network collection Record this value in the following blank:___________________________________

    ____.

Rubric: Suggested Evaluation Criteria and Weightings:

Criteria	**%**	**Your Score**
Successful completion of activity	25	
Summary of lab activity that indicates a thorough understanding of concepts covered in this lab.	40	
Summary included in portfolio	10	
Participation and cooperative teamwork during activity	25	
Other		
TOTAL	**100**	

Summary

Lesson 1: Switching Concepts

In this lesson, you learned to do the following:

- Describe several switching architectures
- Explain the difference between store-and-forward and cut-through switching technology
- Define half duplex and full duplex and explain the advantages and disadvantages of each
- Describe several methods of flow control and explain why it is needed

Name ____________________

Review Questions Name ______________________

Lesson 1: Switching Concepts

Multiple Choice: Directions: Select the best answer.

1. Integrated circuits inside switches use RISC and ASIC to improve speed. Which of the following is true?
   a. ASIC is more of a hardware solution to speeding up the switches than RISC.
   b. RISC is more of a hardware solution to speeding up the switches than ASIC.
2. Which of the following statements about RISC is false?
   a. RISC strategy places a small set of frequently used instructions in the switch
   b. RISC uses simple instructions.
   c. RISC makes creating code easier for programmers.
3. RISC is an abbreviation for:
   a. Relevant Instruction Set Computer
   b. Reduced Instruction Set Computer
   c. Relevant Instruction Series Computer
4. Which of the follow statements about ASIC is false?
   a. ASIC stands for application-specific integrated circuit.
   b. ASIC's instructions are hard-coded into the switch.
   c. ASIC puts data into memory.

5. Which is the fastest switching fabric?
    a. Crossbar
    b. Shared-Memory
    c. High-Speed Bus
6. Which of the following switching fabrics slows down the network with heavy use?
    a. Crossbar
    b. Shared-Memory
    c. High-Speed Bus
7. Which of the following switching fabrics is most similar to High-Speed Bus?
    a. Crossbar
    b. Shared-Memory
8. With crossbar fabric switching, where is data stored when an output port is busy?
    a. Buffer in the input port
    b. Buffer in the output port
9. Which of the following statements is false?
    a. Crossbar switch architecture does not scale well.
    b. With crossbar strategy, each new port increases the complexity, speed and cost of switch.
    c. With high-speed bus architecture, the bus uses time division multiplexing (TDM) to make it fast enough to accept data from all ports at once.
    d. TDM is used in both crossbar and high-speed bus switches.

Name ____________________

10. Which statement below about High-Speed Bus strategy is false?

    a. Inside the switch is a backplane, similar to a high-end motherboard.

    b. Each port has its own buffer and ASIC.

    c. An ASIC is connected to all ports and controls when ports can transmit data to the bus.

    d. None of the above.

11. Which of the following statements is false

    a. ATM, an extremely fast form of data transmission, uses parallel switching.

    b. Parallel switching converts data into small equal-sized cells.

    c. In parallel switching data transmission is limited to the capacity of the bus.

    d. Switches are non-blocking if all ports can run at full wire speed without loss of packets or cells.

12. What statements about cut-through switches are false?

    a. As soon as the destination address is received, the switch makes a link between the receiving and destination port.

    b. A cut-through switch checks for errors.

    c. A cut-through switch can forward frames very quickly.

    d. There is less chance of network latency with cut-through switches than store-an-forward switches.

13. Which of the statements about store-and-forward switches is false?
    a. Store-and-forward switches wait until the entire frame is received before analyzing and forwarding it.
    b. There is less chance of network latency with store-an-forward switches than with cut-through switches.
    c. The store-and-forward switches check for errors.
    d. There is no significant difference in speed between store-and-forward and cut-through switches
14. Which of the following statements about CSMA/CD flow control is false?
    a. Devices stop sending when their frames collide with others' frames.
    b. After a collision, each device involved sends a broadcast announcing a collision.
    c. On a fast Ethernet LAN, each receiving machine sends a "pause" to the sending machine after a collision.
    d. In gigabit machines the switch determines where the data came from and tells that device to slow down.
15. Which of the following statements is false?
    a. Half duplex allows data to travel from sender to receiver.
    b. Full duplex allows a device to send and receive data at the same time.
    c. Full duplex and half duplex devices can talk to each other.

Scoring

Criteria	Points	Your Score
Check Your Understanding		
Describe several switching architectures	25	
Explain the difference between store-and-forward and cut-through switching technology	25	
Define half duplex and full duplex and explain the advantages and disadvantages of each	25	
Describe several methods of flow control and explain why it is needed	25	
Total	**100**	
Try It Out: Configuring Port Speed and Half Duplex Modes	**100**	
Stretch Yourself: Monitoring Network Operations	**100**	
Network Wizards: Using Report Manager	**100**	
Lesson Review	**100**	
TOTAL	**500**	

Resources:

BayNetworks (1998). *Using the BayStack 350 Series 10/100 Autosense Switch.* BayNetworks, Inc., Billerica, Massachusetts.

Black, Darryl P. (1999). *Building Switched Networks: Multilayer Switching, QoS, IP Multicast, Network Policy, and Service Level Agreements.* Addison-Wesley, Reading, Massachusetts.

Ciampa, Robert (1999). *Layer 3 Switching A guide for Professionals.* Prentice Hall PTR, Upper Saddle River, New Jersey.

Craft, Melissa, Poplar, Mark A., Watts, David V., Willis, Will (1999). *Network +.* The Coriolis Group, LLC, Scottsdale, Arizona.

Groth, David. Bergersen, Ben. Catura-Houser, Tim (1999). *Network+ Study Guide.* Sybex Inc., Alameda, California.

Groth, David. Bergersen, Ben. Catura-Houser, Tim (1999). *Network+ Study Guide.* Sybex Inc., Alameda, California.

http://www.lantronix.com/technology/tutorials/switching.html)

Keshav, S. (1997). *Switching: An Engineering Approach to Computer Networking: ATM Networks, the Internet, and the Telephone Network.* Addison-Wesley Publishing Company, Reading, Massachusetts.

http://www.cs.cornell.edu/home/skeshav/book/slides/switching/ppframe.htm

http://www.3com.com/technology/tech_net/white_papers/500660.html#A

Metzler, J., DeNoia, L. (1999) *Layer 3 Switching: A Guide for IT Professionals*. Prentice Hall PTR, Upper Saddle River, New Jersey.

Nortel Networks (1999). *NetKnowledge: Routing.* Nortel Networks, Billerica, Massachusetts.

Nortel Networks (1995). *Introduction to Internetworking.* BayNetworks, Inc., Billerica, Massachusetts.

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