Lab# 1

Ethernet

A Direct Link Network with Media Access Control

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1. Objective

This lab is designed to demonstrate the operation of the Ethernet network. The simulation in this lab will help you examine the performance of the Ethernet network under different scenarios.

2. Overview

The Ethernet is a working example of the more general Carrier Sense, Multiple Access with Collision Detect (CSMA/CD) local area network technology. The Ethernet is a multiple-access network, meaning that a set of nodes sends and receives frames over a shared link.

In this lab you will set up an Ethernet with 30 nodes connected via a coaxial link in a bus topology. The coaxial link is operating at a data rate of 10 Mbps. You will study how the throughput of the network is affected by the network load as well as the size of the packets.

3. Procedure

3.1 Create a New Project

3.2 Create the Network

3.3 Configure the Network Nodes

3.4 Configure the Simulation

3.5 Choose the Statistics

3.6 Run the Simulation

3.7 View the Results

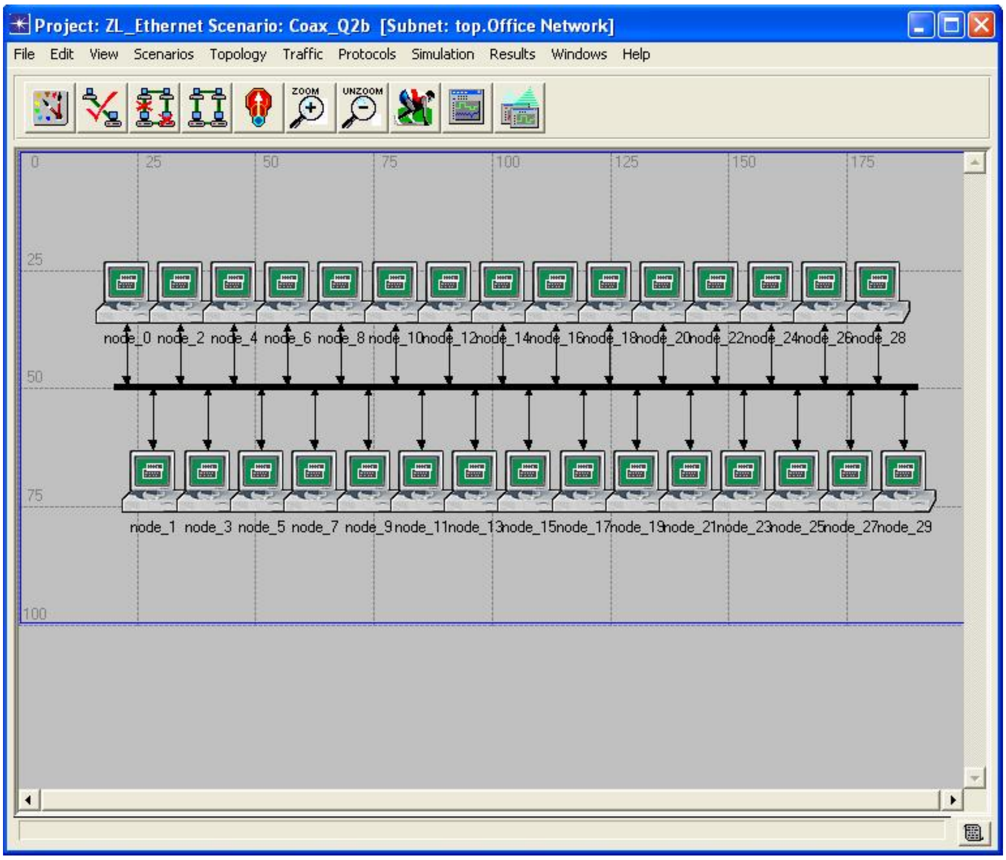

Figure 1 Topology of an Ethernet network

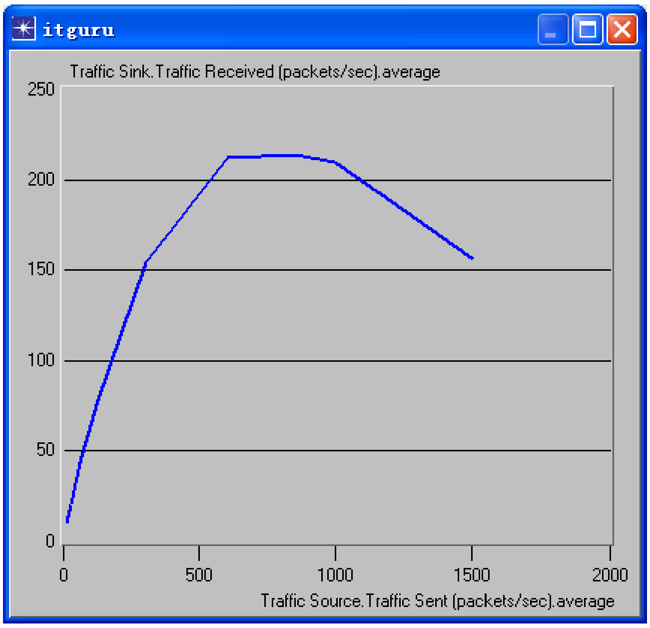

Figure 2 Simulation Result

4. Further Readings

4.1 Background / Operational Description

Ethernet is a bus-based local area network (LAN) technology commonly used in the technical and business communities. Detailed information about the Ethernet protocol is in the IEEE 802.3 Standard.

4.2 Model Scope and Limitations

The Ethernet MAC model provided with OPNET implements the carrier sensing, collision detection, and retransmission mechanisms specified in the IEEE 802.3, IEEE 8-2.3u, and IEEE 802.3z Standard. Explicit modeling is performed for all features other than serialization of bit transfers to and from the physical layer. The following list itemizes the features provided in this model:

- FIFO processing of Transmission Requests
- Propagation Delay based on Distance Between Individual Stations
- Carrier Sensing from Physical Layer
- Collision Detection from Physical Layer
- Truncated Binary Exponential Backoff
- Transmission Attempt Limit of 16
- Interframe Gap Timing for Deference
- Jam Sequence Transmission after Collisions
- 802.3 Minimum and Maximum Frame Sizes
- Frame Bursting (1000BaseX Ethernet operating in half-duplex only)
- Full- and half-duplex transmissions

You can configure port-based VLANs on all generic bridge and switch models, and on any vendor-specific models that support this technology. Ethernet link models allow you to simulate point-to-point trunk links; a single trunk link can carry traffic for multiple VLANs as specified by IEEE 802.1q. To configure a VLAN, set the VLAN Scheme attribute to “Port-based VLAN” on the bridge or switch supporting the VLAN. You can assign VLAN identifiers to specific port numbers in the VLAN Port Configuration Table. (To find a link’s port numbers, use Link Interfaces on the Edit Attributes (Advanced) dialog box.) Note that you can assign only one VLAN identifier to a specific port. However, multiple ports can belong to the same VLAN. Model Descriptions Reference Manual 8 Ethernet Model Description MD-8-2 IT Guru/Release 9.1 The Ethernet models also support Fast EtherChannel technology. This allows multiple Ethernet point-to-point links to be bundled into one logical full-duplex channel of up to 800 Mbps (for Fast Ethernet) or 8000 Mbps (for Gigabit Ethernet). You can use a Fast EtherChannel or Gigabit EtherChannel link in place of any regular Ethernet link (10BaseT, 100BaseT, or 1000BaseX). EtherChannel links support flow-based balancing of traffic, and are useful for upgrading bottleneck links in Ethernet LAN networks. Note—You can only use EtherChannel links when Ethernet is running in full-duplex mode. The Ethernet models can be deployed either in a bus (10Base2) or a hub (10BaseT, 100BaseT or fast ethernet, and 1000BaseX or gigabit ethernet) configuration. The following list itemizes the main differences between these two configurations:

- Connections from the MAC processes to the hub are via duplex point-to-point links, as opposed to a bus medium.
- Collision Detection in the hub configuration is handled by the hub, rather than

individual MAC processes.

• Deference mechanism is handled by the hub, rather than a separate deference process.

• Ethernet hubs cannot be directly connected to one another. Instead, a bridge must be used to link two or more hubs together.

5. Questions

5.1 Explain the graph we received in the simulation that shows the relationship between the received (throughput) and sent (load) packets. Why does the throughput drop when the load is either very low or very high?

When the received packets are less than 600, the received packets and the sent packets are positive related, the sent packets will increase according to the sent packets. And then this relation will become less. When number of the sent packets is between 600-1100, number of the received packets will keep unchanged. When it is over 1100, number of the received packets will decrease when the sent packets keep increasing.

5.2 Create three duplicates of the simulation scenario implemented in this lab. Name these scenarios Coax_Q2a, Coax_Q2b, and Coax_Q2c. Set the Interarrival Time attribute of the *Packet Generation Arguments* for all nodes (make sure to check Apply Changes to Selected Objects while editing the attribute) in the new scenarios as follows:

- Coax_Q2a scenario: exponential(0.1)

- Coax_Q2b scenario: exponential(0.05)

- Coax_Q2c scenario: exponential(0.025)

In all the above new scenarios, open the *Configure Simulation* dialog box and from the *Object Attributes* delete the multiple-value attribute (the only attribute shown in the list). Choose the following statistic for node 0: Ethcoax → Collision Count. Make sure that the following global statistic is chosen: Global Statistics→Traffic Sink→Traffic Received (packet/sec). (Refer to the *Choose the Statistics* section in the lab.)

Run the simulation for all three new scenarios. Get two graphs: one to compare node 0's collision counts in these three scenarios and the other graph to compare the received traffic from the three scenarios. Explain the graphs and comment on the results. (*Note:* To compare results you need to select Compare Results from the Results menu after the simulation run is done.)

See Figure 3, it shows the conditions of the smaller number of exponential with the larger number of collision count. As the exponential is smaller, the times of sending packets are larger than before. At the same time, numerous other machines try to send their own packets, as a result, more conflicts happens.

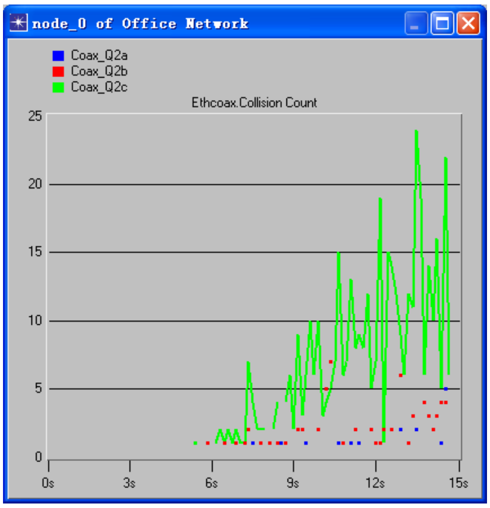

Figure 3 Collision Count

See Figure 4, it shows that at the beginning, CoaxQ2a with exponential = 0.1 has the lowest traffic received speed. However, when the load becomes heavier, the speed goes up. And the highest point of curve Coax_2c is at the beginning. But the speed drops a little as the traffic load becomes heavier. The curve of Coax_Q2b with the value of exponential = 0.05 keeps rising all the time, and it reaches its highest point at the time when the traffic load is heavy.

These three curves show that different exponential will affect the efficiency of the networks. In another word, an appropriate value of exponential is required.

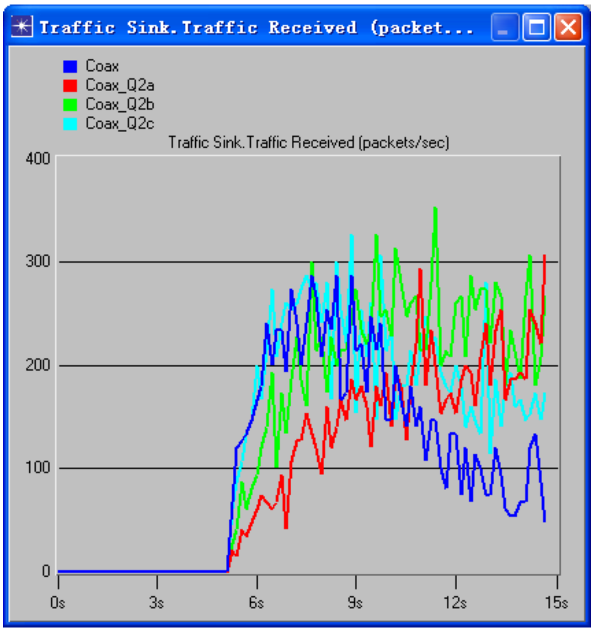

Figure 4 Traffic Received (packets per sec)

Coax_Q2a scenario: exponential (0.1)

Coax_Q2b scenario: exponential (0.05)

Coax_Q2c scenario: exponential (0.025)

5.3 To study the effect of the number of stations on Ethernet segment performance, create a duplicate of the Coax_Q2c scenario, which you created in Question 2. Name the new scenario Coax_Q3. In the new scenario, remove the oddnumbered nodes, a total of 15 nodes (node 1, node 3, , and node 29). Run the simulation for the new scenario. Create a graph that compares node 0's collision counts in scenarios Coax_Q2c and Coax_Q3. Explain the graph and comment on the results.

Figure 5 shows the net structure.

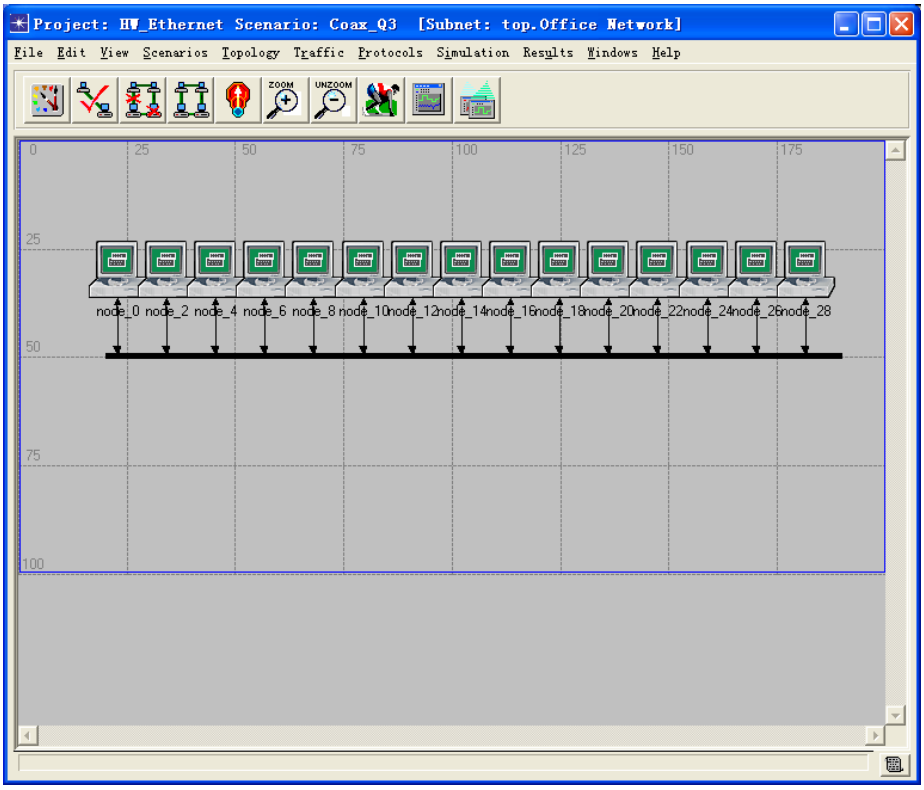

Figure 5 Net structure of Coax_03

The number of Coax_Q3 nodes is half of Coax_Q2c. As fewer computers will make fewer collisions, so we can see in Figure 6, that the Collision Count with more nodes is larger.

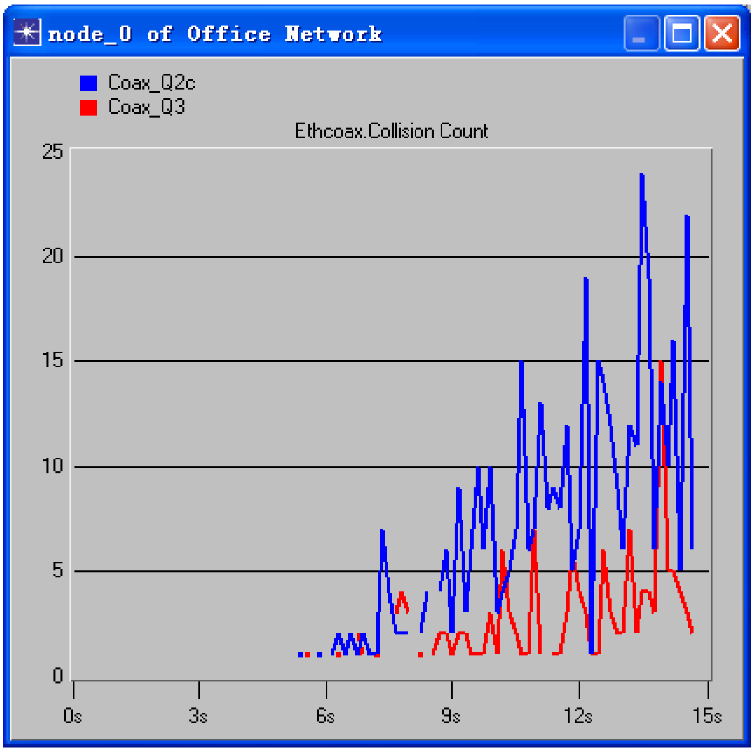

Figure 6 Ethcoax Collision Count

5.4 In the simulation a packet size of 1024 bytes is used (*Note:* Each Ethernet packet can contain up to 1500 bytes of data). To study the effect of the packet size on the throughput of the created Ethernet network, create a duplicate of the Coax_Q2c scenario, which you created in Question 2. Name the new scenario Coax_Q4. In the new scenario use a packet size of 512 bytes (for all nodes). For both Coax_Q2c and Coax_Q4 scenarios, choose the following global statistic: Global Statistics→Traffic Sink→Traffic Received (bits/sec). Rerun the simulation of Coax_Q2c and Coax_Q4 scenarios. Create a graph that compares the throughput as packets/sec and another graph that compares the throughput as bits/sec in Coax_Q2c and Coax_Q4 scenarios.

Explain the graphs and comment on the results.

Figure 7 shows the traffic received speed. The network with smaller packets (constant 512bytes) has smaller speed at the beginning. However, with the time goes by, the speed maintains a certain value, which is bigger than the network (Coax_Q2c) with larger packets. This is because of the difference of the packet number. With more packets to be sent, the time efficiency becomes worse. So it is smaller when the load of network is light. As the network load is rising, the network with more sending packets will be more efficient. It is because the smaller size packet will make the collision count drop.

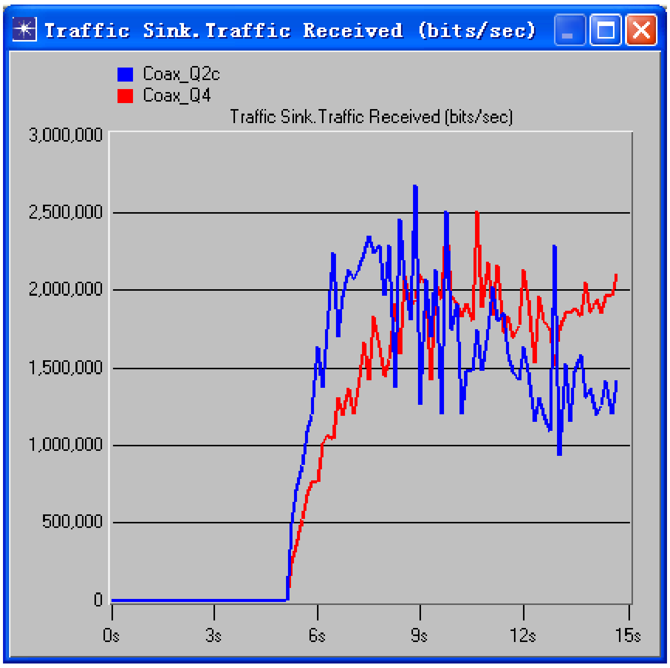

Figure 7 Traffic Received (bits/sec)