The objective of the lab was to simulate an Ethernet Local Access Network (LAN) using OpNet ITGuru. The simulation was of a 10BaseT Ethernet LAN (connected using standard Cat5 cable). There were two different configurations of the LAN, one with a single hub and one with two hubs connected by a switch. The next two sections present the results of each simulation and include an analysis of the network operating under different load conditions. The final section presents conclusions.

Configuration

The first simulation scenario was of 16 workstations connected to a 10BaseT Ethernet LAN with a single hub. Fig. 1 shows the topology of the scenario. The network was configured using the *ethernet_station* node model, an *ethernet16_hub*, and the *10BaseT* link model.

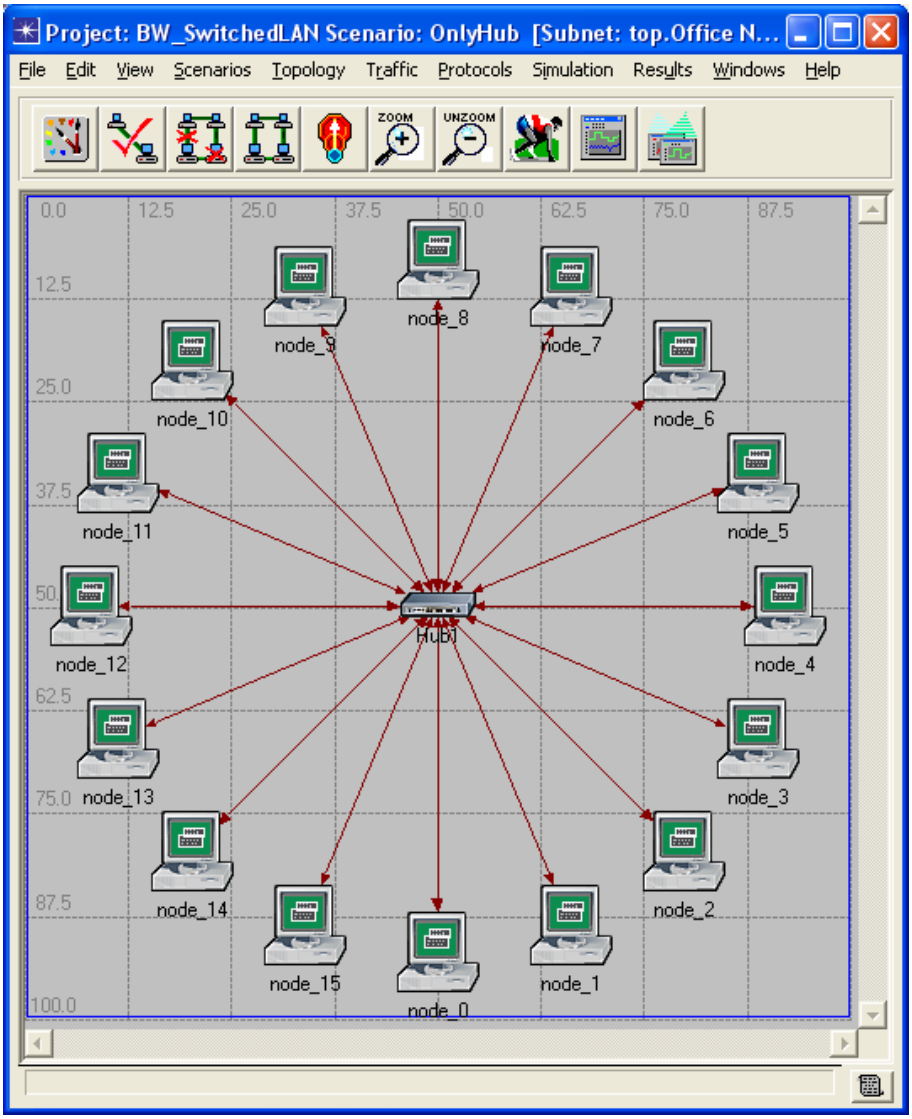

Figure 1 – HubOnly Scenario Topology

The second scenario included the same 16 workstations, but added a second hub and connected the two hubs using an *ethernet16_switch*. Fig. 2 shows the topology of the second scenario.

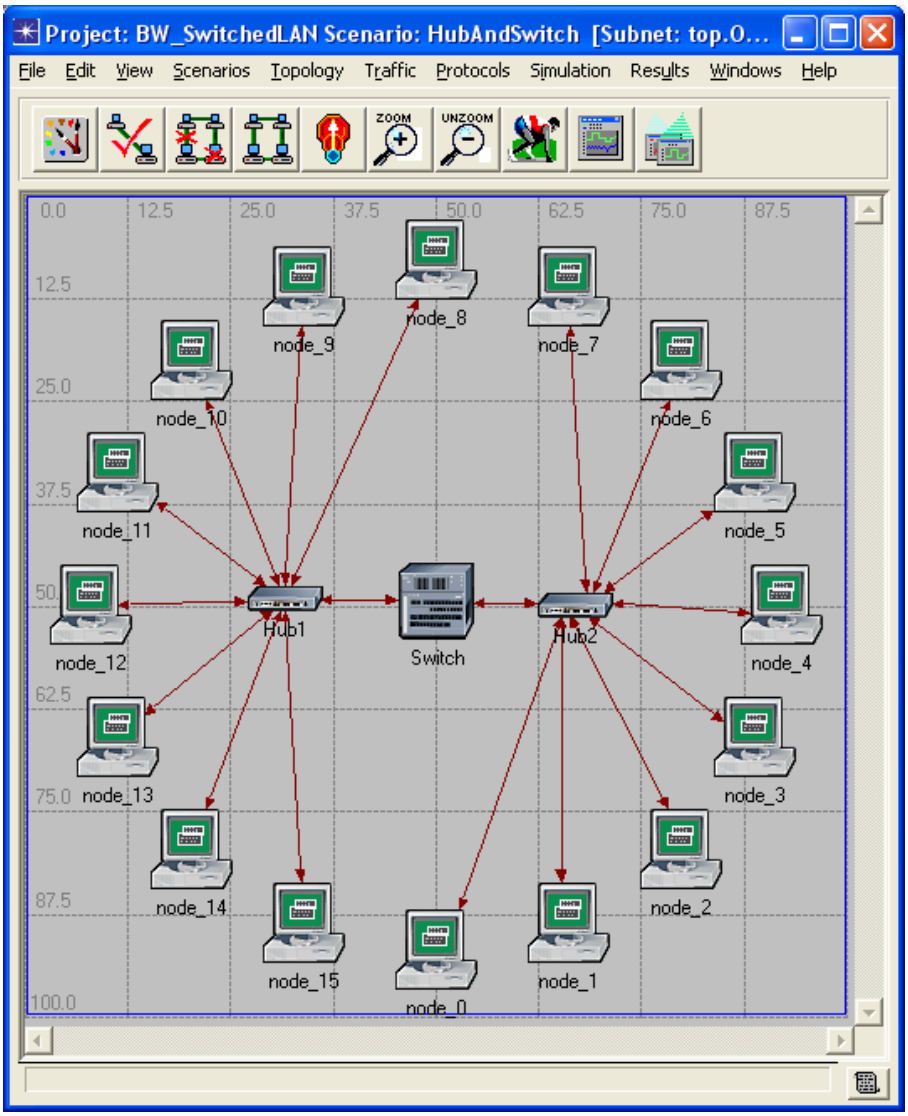

Figure 2 - HubAndSwitch Scenario Topology

All 16 workstations were configured identically. Each was assigned an *On State Time* (time in which it was allowed to send packets) of **exponential(100)**, and an *Off State Time* (dead time between packet transmissions) of **exponential(0)**. The *packet size* was set to **constant(1500)**, and the *interarrival time* (time distribution for generation of packets to send) was set to **exponential(0.02)**.

The simulation was set to capture the network-wide *delay (sec)*, *packets received / sec*, *packets sent / sec*, and *collision count* for each scenario.

Running the Simulation

The simulation was executed for two minutes for each scenario. After the simulation was completed, a graph was generated comparing the rate of packets sent for each scenario; Fig. 3 shows the graph that was generated (this is the time-average value over the simulation).

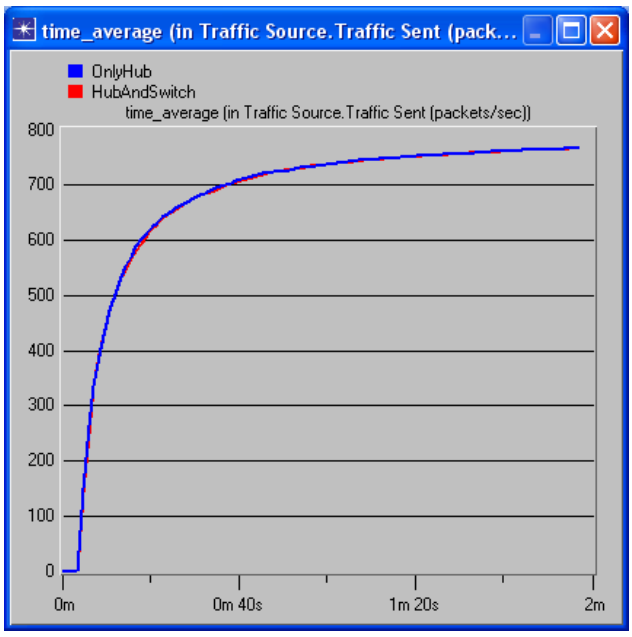

Figure 3 – Time-Average Packets Sent

As expected, since the nodes were configured identically for both scenarios, they generated the same traffic into the network. However, Fig. 4 shows the traffic received for each scenario (also time-average):

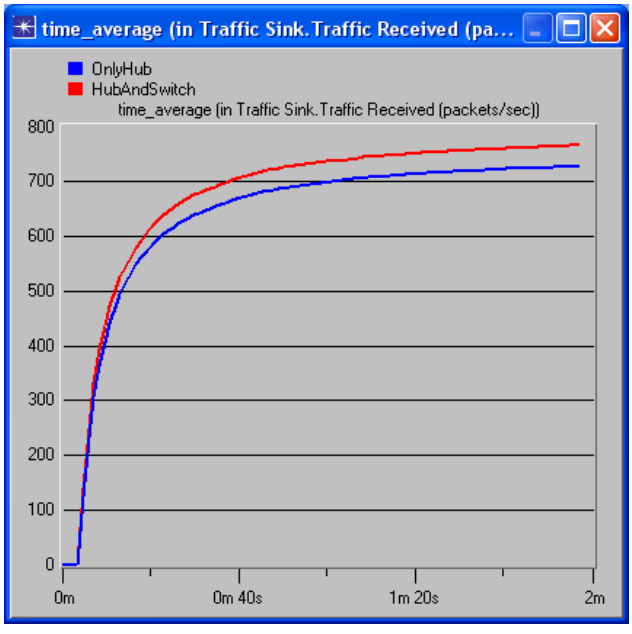

Figure 4 – Time-Average Packets Received

Fig. 4 shows that the overall throughput of the network in the *HubAndSwitch* scenario was somewhat higher. Fig. 5 shows the comparison of the time average delay between the two scenarios, and Fig. 6 shows the comparison of collision counts for each of the hubs.

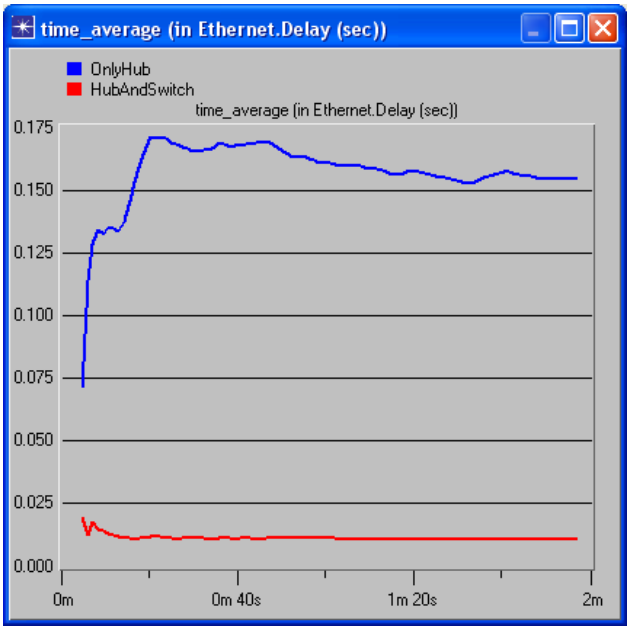

Figure 5 - Time-Average Network Delay

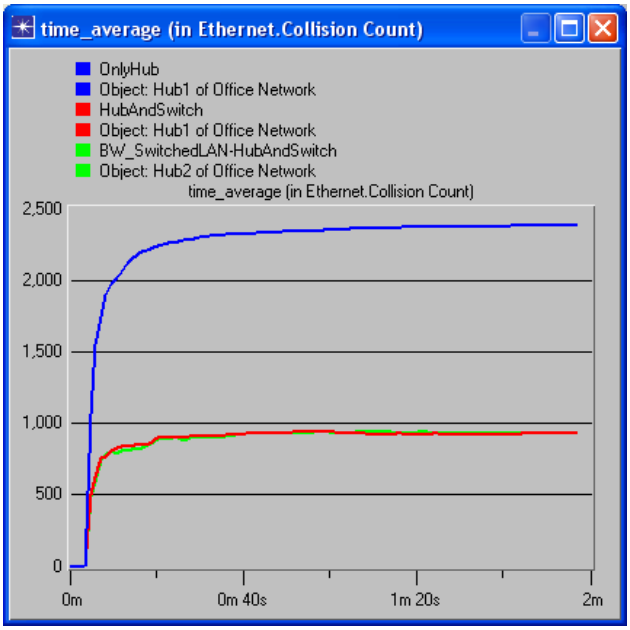

Figure 6 - Time-Average Collision Count for Hubs

The increase in throughput and decrease in delay are due to the reduction in collisions. The network was essentially split into two smaller networks, which were then bridged using the switch. This effectively reduced the traffic on each individual network, reducing collisions. The switch allows nodes to communicate between the two networks without adding collisions.

Note that it is not possible to analyze a collision count for the switch – because the switch buffers packets received on each of its ports and sends them when the destination port is available, it does not introduce collisions.

Additional Scenarios

Two additional simulation scenarios were created; each of the three had the same 16 nodes, but the first, *SwitchOnly*, replaced the hub from the *HubOnly* scenario with an *ethernet16_switch.* The second scenario, *Switches*, replaced the two hubs in the *HubAndSwitch* scenario with *ethernet16_switch*es, and connected them directly together (removing the middle switch). The configuration of the nodes was identical to the first two scenarios. Fig. 7 shows the two new topologies.

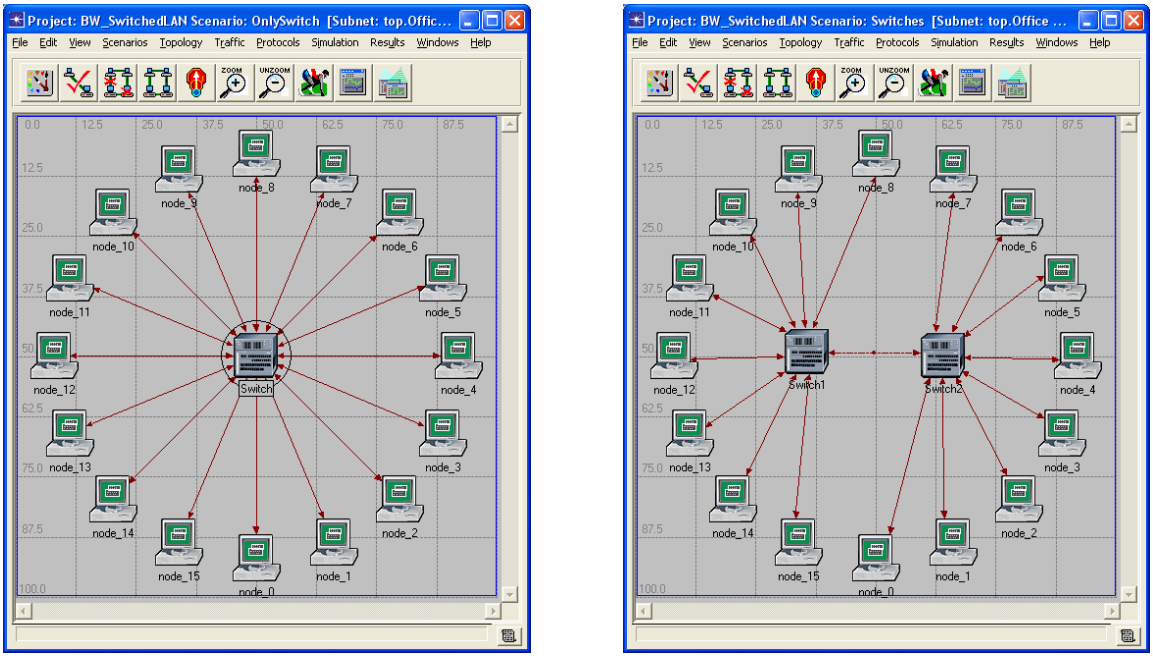

Figure 7 - SwitchOnly and Switches Scenario Topologies

These scenarios were also run for two minutes and compared to the original scenario results, in terms of packets received, delay, and collision count. Fig. 8 shows the time-average throughput (packets received per sec); the two new scenarios were essentially indistinguishable from the *HubAndSwitch* scenario, indicating that even though that network was using hubs, the traffic through each hub was low enough that it didn't cause a significant decrease in throughput. Fig. 9 shows the time-average delay (sec); the two new scenarios were nearly identical, and as expected, they were even better than the *HubAndSwitch* scenario, due to the complete absence of collisions.

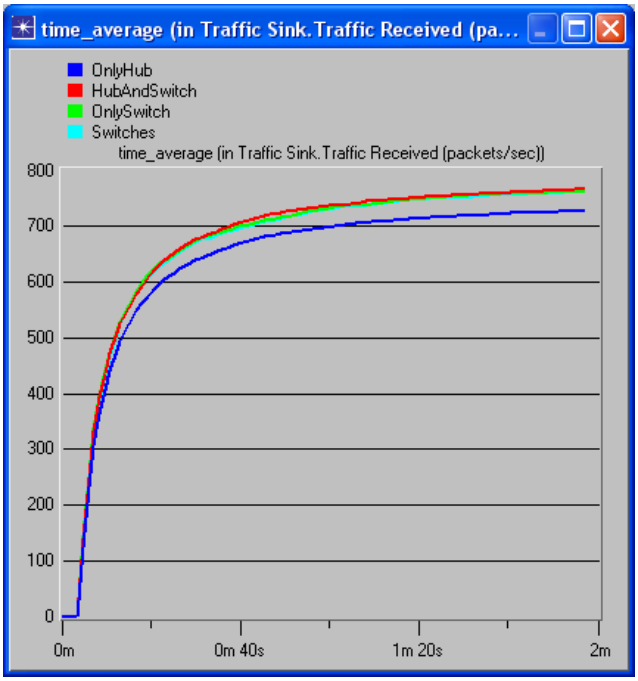

Figure 8 - Time-Average Throughput for All Four Scenarios

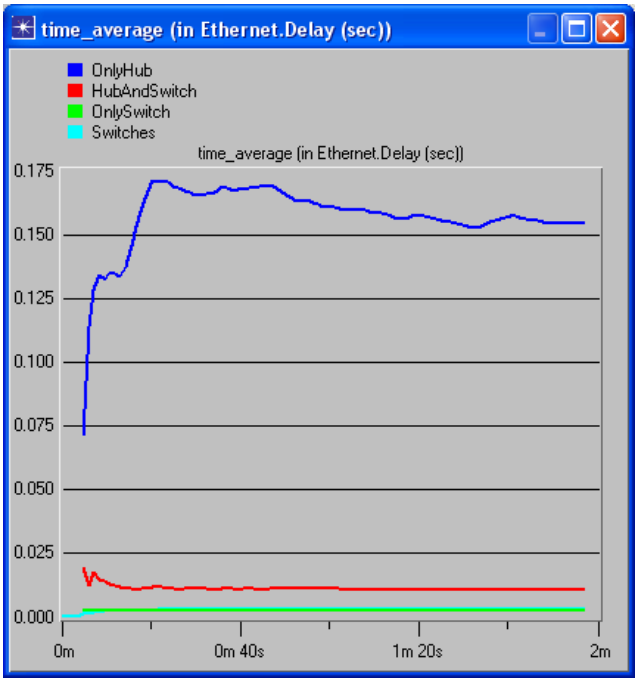

Figure 9 - Delay for All Four Scenarios

Conclusions

The simulation scenarios helped to clearly demonstrate the differences between hubs and switches in a network. However, the results of the last two scenarios compared to the hub and switch scenario indicated that it is possible to use hubs (which tend to be lower cost than switches), as long as the attached nodes offer a volume of traffic limited sufficiently to maintain performance on that segment of the LAN.

One problem was encountered with the OpNet simulator during this experiment; when the *HubOnly* scenario was copied to the *SwitchOnly* scenario, the parameters of the Ethernet stations did not copy over, and they were set to their default values instead. When that scenario was run, this caused it to have almost no network throughput, because the default was to generate packets very infrequently. Aside from this, everything functioned as expected.