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EVALUATING PERFORMANCE OF HYBRID NETWORKS BY USING LATENCY AND PDV

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Abstract- Hybrid networks are widely used in networking sector. They combine the finest features of both Wired and Wireless networks to give optimum results. Using different types of routing protocols, the capabilities of a hybrid network will be demonstrated using certain performance metrics. In this paper, we will be simulating real-time scenarios of three networks of different sizes. Each of these networks will be implemented with single routing protocol i.e. Enhanced Interior Gateway Routing Protocol (EIGRP). The networks will be simulated using Cisco Packet Tracer simulation tool. Furthermore, we have evaluated the performance of the networks by considering performance metrics like network latency and packet delay variation.

Keywords- *Hybrid networks, EIGRP, network latency, packet delay variation, OSPF, Cisco Packet Tracer, ping and congestion.*

I. INTRODUCTION

Computer networks are basically classified as Wired, Wireless and Hybrid networks. In case of wired networks, reliability of network is the key advantage but setting up the infrastructure becomes very tedious in case oflarge networks. Whereas, in wireless networks, hosts are mobile in nature but the reliability of network is poor. Hybrid networks are more reliable, scalable, flexible and effective as compared to wired and wireless network. A hybrid wired network would seem to offer the best of both worlds in terms of speed, mobility, affordability and security. If a user needs maximum Internet and file-sharing speed, then he can plug into the network with an Ethernet cable. If user needs to access a streaming video in the hallway, he can access the network wirelessly. With the right planning, an organization can save money on cable and routers by maximizing the reach of the wireless network. And with the right encryption and password management in place, the wireless portion of the network can be just as secure as the wired.

Three network topologies with 100, 300 and 500 hosts have been created using the simulation tool. A small network can have a minimum of 100 hosts and in large organizations a single network may consist of maximum 500 hosts. As these two are extreme situations, we have considered an intermediate network of 300 hosts.

Enhanced IGRP (EIGRP) is a classless, enhanced distance vector protocol that gives us a real edge over another Cisco proprietary protocol, Interior Gateway Routing Protocol (IGRP). That's basically why it's called Enhanced IGRP. Hybrid routing protocol, incorporating features of both Distance-Vector and Link-State routing protocols. Three main tables, which are stored in memory, support the EIGRP routing protocol:

(1) Neighbour Table: Information about all adjacent routers running EIGRP are stored here. This information includes sequence numbers and protocol timers.
(2) Topology Table: All destination networks that neighbour routers have reported knowing about are stored in this table. This table would include the metrics for every route reported, as some network ID may have multiple routes and the best routewould be evaluated by the cost of the metrics.
(3) Routing Table:In addition to least cost routes, EIGRP evaluates secondary routes to each network and creates a list of feasible successors that are added to the routing table. A feasible successor is a route thatwould be used if the primary route to a network fails.

The information that EIGRP receives in its updates go into these three tables.This makes EIGRP suitable for very large networks. EIGRP has a maximum hop count of 255(the default is set to100).Another thing about EIGRP is that unlike many other protocols that use a single factor to compare routes and select the best possible path, EIGRP can use a combination of Bandwidth, Delay, Load, and Reliability.

II. LITERATURE SURVEY

Performance evaluation of routing protocols is a very large topic and a lot of research work has been done in this field. However the odds of repetition in the subject of research are very less because of the vast stream of topics. The popularity of ns (network simulator) has led to a majority of the work to be

simulated using it. One such research work is the study of performance comparison of multi-hop ad hoc network routing protocols.

This paper evaluates the performance of routing protocols like AODV, DSR, and DSDV on parameters like packet delivery ratio, path optimality and routing overhead.

They have simulated each protocol in ad hoc networks of 50 mobile nodes moving about and communicating with each other, and presented the results for a range of node mobility rates and movement speeds. Another research paper includes the simulation of wireless mesh networks in ns-2.

The paper presents a variant of the AODV protocol, which makes effective use of the additional capabilities offered by the Mesh Routers. The simulation results show that under high mobility and traffic load conditions, the variant protocol provides an improvement of more than 100% in terms of packet delivery rate, latency and routing overhead over the standard AODV routing protocol.

Therefore the related work in ns-2 mainly focuses on the wireless networks with less number of hosts. In contrast, our network includes a combination of both wired and wireless with a maximum of 500 hosts. In addition, we consider congestion which affects the performance of the routing protocol and increases latency. Also there is a paper which includes configuration of EIGRP routing protocol on a network module in Cisco Packet Tracer, however it does not take account of the parameters to evaluate the protocol.

III. IMPLEMENTATION

A. Simulation Environment

Cisco Packet Tracer has been used to simulate the real–time networks. Cisco Packet Tracer is a comprehensive, networking technology teaching and learning program that offers a unique combination of realistic simulation and visualization experiences, assessment and activity authoring capabilities, and opportunities for multiuser collaboration and competition.

B. Architecture of the Network

In each of the three networks several zones are created and one zone is configured as a wireless zone. Within every single zone, there is master router and a number of slave routers. Only master routers of different zones can directly communicate with each other. So if any slave router wants to send data to a destination in another zone, it will send it via its master router.

Fig 1 shows the basic architecture of the network being simulated:

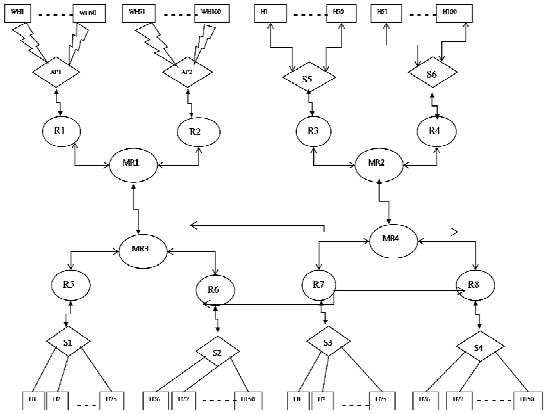

Figure 1: Architecture of the network

MR_i: Master Router
WH_i: Wireless Host
R_i : Router
S_i: Switch
H_i : Wired Host
AP_i : Access Point

C. Steps of Implementation:

1. Router Configuration

- Selecting an appropriate network module: Every router supports certain modules from which any module can be selected according to the requirements.
- Connecting cables and assigning IP to the ports: The router is physically connected to another router using serial DCE (Data Communication Equipment device) cable and with the host using copper cross-over cable. Then every serial port is interfaced by assigning it an IP address and the host is interfaced using fast Ethernet via a switch.
- Implementing a dynamic routing protocol: The routers support a number of routing protocols of which we have implemented EIGRP.

2. Host Configuration

- In case of wired network a host is connected to the router via a switch. Once it is physically connected, it can be assigned an IP address in the same network of the fast Ethernet port of the router to which it has to be interfaced. Therefore the default gateway of the host would be the fast Ethernet address of the router. IP is configured using the static method.
- A host is wirelessly connected to a router via an access point. The access point is given a unique SSID (Service Set Identification) and a WEP (Wired Equivalent Privacy) code for authentication purposes. The host searches for the network of the access point with the help of SSID and can be connected using the WEP code.

3. Testing the Connection Between the Different Components of the Network:

- PING is a computer network administration utility used to test the reachability of a host on an Internet Protocol (IP) network and to measure the round-trip time for messages sent from the originating host to a destination computer. It is used for system diagnosis. It works by sending a packet to the specified address and waiting for a reply. It is primarily used to troubleshoot internet connections.

C. Performance metrics:

1) Latency:
Network latency in a packet-switched network is measured either one-way (the time from the source sending a packet to the destination receiving it), or round-trip (the one-way latency from source to destination plus the one-way latency from thedestination back to the source). Round-trip latency is more often quoted, because it can be measured from a singlepoint. Note that round trip latencyexcludes the amount of time that a destination system spends processing the packet. Many software platforms provide a service called ping that can be used to measure round-trip latency. Ping performs no packet processing; it merely sends a response back when it receives a packet (i.e. performs a no-op), thus it is a relatively accurate way of measuring latency.

2) Packet Delay Variation (Jitter):
In computer networking, packet delay variation (PDV) is the difference in the end-to-end one-way delay between selected packets in a flow with any lost packets being ignored. The delay is specified from the start of the packet being transmitted at the source to the end of the packet being received at the destination. If the packet sizes are the same and packets always take the same time to be processed at the destination then the packet arrival time at the destination could be used instead of the time the end of the packet is received.

IV. SIMULATION RESULTS AND ANALYSIS

As mentioned earlier, we conducted simulations using Cisco Packet Tracer. Three hybrid networks of 100, 300 and 500 hosts were created and were configured with EIGRP routing protocol. To study the behaviour of the two parameters, communication between the hosts in networks is grouped into six scenarios namely:

Wired zone
Scenario I: intra zone
Scenario II: inter zone with minimum hops
Scenario III: inter zone with maximum hops
Wireless zone
Scenario IV: intra zone
Between wired and wireless zones
Scenario V: inter zone with minimum hops
Scenario VI: inter zone with maximum hops

The communication between two adjacent zones is considered to be of minimum hops and that between non-adjacent zones is considered to be of maximum hops.

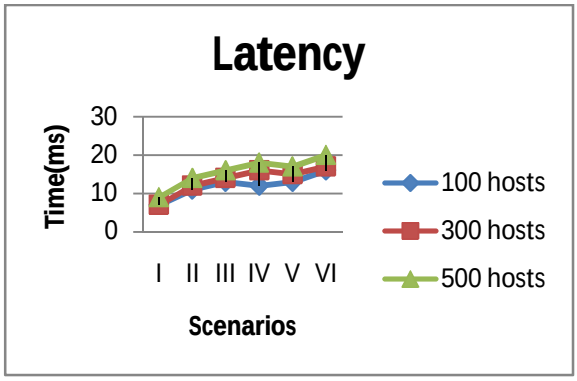

Figure 2: Comparison of latency parameter in three different networks

Fig 2 shows one-way latency in the six scenarios. In each of the networks, latency between intra wired zones is less than that between intra wireless zones. This is because the communication with wireless hosts includes broadcasting of packets which is time consuming. Hence, even in case of similar number of hops, latency between wired and wireless zones is observed to be more than that in between wired zones. Also as the number of hosts increases, latency also increases.

To calculate PDV, we have analyzed the hybrid network in three different congestion conditions denoted by C1, C2 and C3. To simulate congestion scenario, large number of packets are sent within the network at the same time. This is done to generate traffic at the routers to closely replicatethe real-time networks. The generated traffic affects packet delivery time due to queuing at the devices.

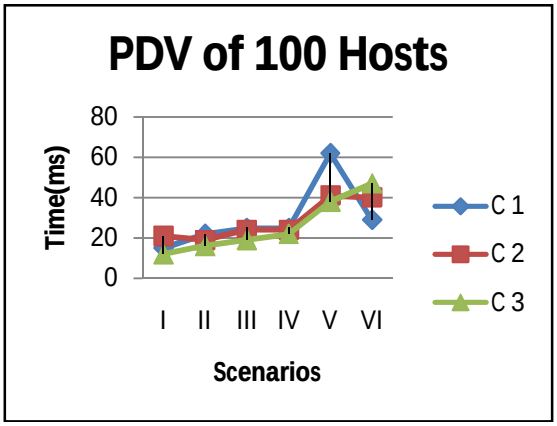

Figure. 3Comparison of PDV on different congestion scenarios on network with 100 hosts Fig. 3 shows the PDV for a network of 100 hosts wherein 16 packets are fired at the same time to generate three congestion conditions. In every condition, the packets are sent and received by hosts of every zone. For every congestion condition, the nature of the graph is same as that for latency. However the range of the packet delivery time increases for every scenario and is significantly more in case of the wireless zone. To calculate PDV for network of 300 hosts, 21 packets are fired at the same time in every congestion condition.

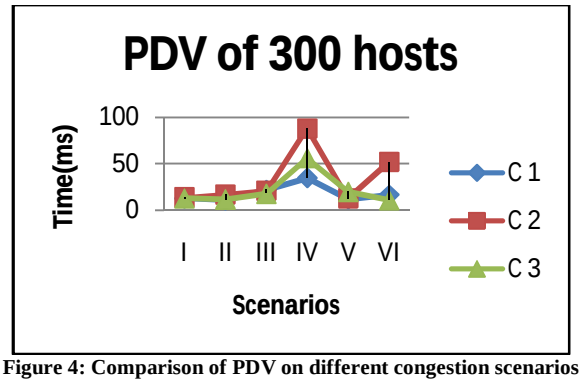

Figure 4: Comparison of PDV on different congestion scenarios on network with 300 hosts.

In network of 500 hosts, 23 packets were fired at the same time to generate congestion.

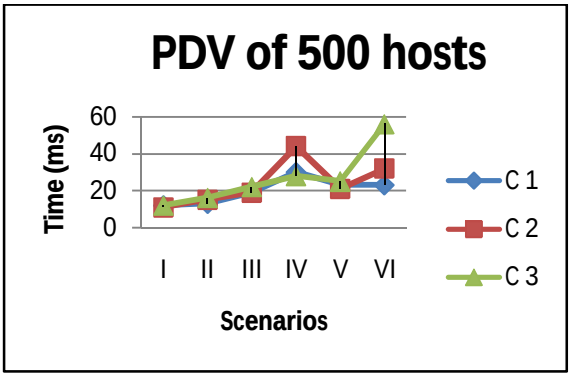

Figure 5: Comparison of PDV on different congestion scenarios on network with 500 hosts

V. CONCLUSION

The area of hybrid networking has been receiving increasing attention as it combines the best features of both wired and wireless networks. Their features can be best explored and understood using a simulation environment. Cisco Packet Tracer is one such simulator which has a user-friendly interface as well as provides realistic simulation and visualization environment. We have employed a network model of Cisco routers using packet tracer. Eventually, EIGRP a hybrid routing protocol was configured in the network as it enables the routers to quickly adapt to alternate routes. In this paper, we have graphically demonstrated the behavior of hybrid networks with respect to latency and PDV. With the increase in the number of hosts in the network, latency goes on increasing. Also with wireless hosts packet delivery time increases. The observations on PDV in different networks shows that it is a function of queuing, route changes and congestion. These observations prove the flexibility of hybrid networks wherein the user has the liberty to include wired and wireless sub networks as per the demand of the application. This decision has to be made in accordance with the acceptable range of delay variation.

VI. FUTURE WORK

We have deployed OSPF routing protocol on three networks with 100, 300 and 500 numbers of hosts. It was observed that OSPF allows for load-balancing and better bandwidth utilization. Comparison between OSPF and EIGRP shows; for EIGRP, as the number of hosts in the network increases, the latency also increases linearly. Also with wireless hosts packet delivery time increases. But with OSPF, as it works better in case of large networks, the latency goes on decreasing as the number of hosts in a network increases. The observations on PDV in different networks shows that it is a function of queuing, route changes and congestion. EIGRP shows fewer variations with respect to PDV, as compared to OSPF. These observations prove the flexibility of hybrid networks wherein the user has the liberty to include wired and wireless sub networks as per the demand of the application. This decision has to be made in accordance with the acceptable range of delay variation. Thus, EIGRP is efficient for small and medium range of network while OSPF is efficient for large networks.

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