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Performance Analysis of Dynamic Routing Protocols Using Packet Tracer

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Abstract- Performance of a network is based on routing protocols. RIPv1, RIPv2, EIGRP and OSPF are the dynamic routing protocols being used in the practical networks to propagate network topology information to the neighboring routers. There have been a large number of static and dynamic routing protocols available but choice of the right protocol for routing is dependent on many parameters critical being network convergence time, Ethernet delay, security and bandwidth requirement etc. In this paper, we propose the idea of routing protocols, starting with an overview of the basics of Interior Gateway Protocols (IGP). Later, we describe the idea of Link State Routing Protocols (LSRP) and Distance Vector Routing Protocols (DVRP) while making a comparison which should determine the protocol needed for each network topology. The characteristics of each routing protocol will be also discussed. According to the designed simulation experiment scenarios compare the difference between RIPv1, RIPv2, OSPF and EIGRP routing protocols.

Keywords- Interior Gateway Protocol (IGP), Border Gateway Protocol (BGP), Link State Routing Protocols (LSRP), Distance Vector Routing Protocols (DVRP), Routing Information Protocol (RIP), Enhanced Interior Gateway Routing Protocol (EIGRP), Open Shortest Path First (OPSF).

I. INTRODUCTION

A routing protocol works based on an algorithm. Routing algorithm also based on metrics to find the path to transmit data across two networks. Metrics also include cost, bandwidth, Maximum Transmit Unit, delay, number of hop count these metrics also save or store in routing table. Routing protocol has two types. First one is an interior gate way protocol and other one is an exterior gateway protocol. OSPF is also interior gate way protocol, other interior gate way Protocol are RIP, EIGRP, IGRP. BGP and BGP4 is Exterior gate way protocol.

The dynamic routing protocols keep the routing tables updated. This paper specifies the Open Shortest Path First (OSPF), Enhanced Interior Gateway Routing Protocol (EIGRP) and Routing Information Protocol (RIP) TCP/IP internet routing. The network based on TCP/IP protocol permits the efficient routing of data packets based on their IP address. Routers are used in the network to control and forward data.

In the packetized communication of information, the function of routing is moving traffic across networks and the routers should be aware of where they should forward the traffic next in order to reach the final destination. In order for routers to effectively and efficiently distribute data, the choice of the routing protocol becomes very critical factor to define the success of the network over time. Factors that differentiate one routing protocol from another include the speed that it adapts to topology changes called as convergence, the ability to choose the best route among multiple routes and the amount of network traffic that the routing protocol creates.

II. PACKET TRACER

Packet Tracer is a Cisco router simulator that can be utilized in training and education, but also in research for computer network simulations. The tool is created by Cisco Systems and provided for free distribution to faculty, students, and alumni who are all have participated in the Cisco Networking Academy. Packet Tracer supports users for creation of simulations, visualizations, and animations of networking phenomena. Like any simulation, Packet Tracer relies on a simplified model of networking devices and protocols. It provides a simulated environment where processes between various networking devices, such as routers, switches, wireless access points, computers, links and applications are visible with animations and easy explanatory descriptions. The purpose of Packet Tracer is to offer students and teachers a tool to learn the principles of networking as well as develop Cisco technology specific skills.

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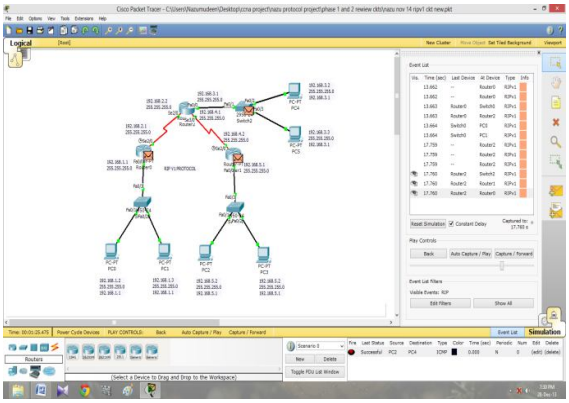

Fig.1 Packet Tracer Simulation Environment

III. Routing Protocols

Most of the routing algorithms are possible to be classified like one of two basic algorithms:

A. Distance Vector characteristics:

1. The routing by distance vector collects data of the information of the routing table of its neighbors.
2. The routing by distance vector determines the best route adding the metric value that receives as the routing information happens from router to another one.
3. With most of the protocols of routing by distance vector, the updates for the change of topology consist of periodic updates of the tables. The information happens from router to another one, giving generally like result one more a slower convergence.

RIP and EIGRP are examples of distance vector routing protocols.

B. Link state characteristics:

The link state routing obtains a great vision of the topology of complete internetwork accumulating all the necessary LSA.

1. In the link state routing, each router works independently to calculate its own shorter route towards the networks destiny.
2. With the protocols of routing of connection state, the updates are caused generally by changes in the topology.
3. The relatively small LSA that have gone to all the others routers generally give like result faster times of convergence with any change of topology of the internetwork.

OSPF is an example of link state routing protocol.

TABLE I
Difference Between DVRP and LSRP

Algorithms	DVRP	LSRP
Ease of configuration	Yes	No
Complexity	No	Yes
Bandwidth Consumption	High	Low

IV. Routing Information Protocol (RIP)

The RIP allows that routers update their routing tables at programmable intervals, generally every 30 seconds. One of the disadvantages of routers that use RIP is that constantly they are connected with routers neighboring to update his tables of routing, generating therefore a great amount of network traffic. This makes by means of a denominated concept vector-distance. A jump is entered whenever the data cross to router that is to say, happen through a new number of network, this is considered equivalent to a jump. A route that has an equal number of jumps to 4 indicates that the data which they are transported must cross 4 routers before arriving at their final destiny in the network. If there are multiple routes towards a destiny, the route with the smaller number of jumps is the route selected by router.

As the number of jumps is only metric of routing used by the RIP, not necessarily it selects the fastest route towards its destiny. A metric one is a measurement unit that allows making decisions and next will learn that other protocols of routing use other metric ones in addition to the number of jumps to find the best route of data transfer. Nevertheless, the RIP continues being very popular and it is continued implementing widely. The main reason of this is that it was one of the first protocols of routing that were developed.

A. RIP characteristics:

1. Distance vector routing protocol.
2. It metric is the number of jumps.
3. The maximum number of jumps is 15.
4. One updates every 30 seconds.

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5. Not always it selects the fastest route for the packages.
6. It generates great amount of traffic of network with updates.

There are two versions of RIP, namely RIPv1 and RIPv2. The table below summarizes the differences between these versions.

TABLE II
DIFFERENCE BETWEEN RIP TYPES

RIP Versions	RIPv1	RIPv2
Best for	Small network	Small network
Supports VLSM	No	Yes
Classes	Full	Classless

V. ENHANCED INTERIOR GATEWAY ROUTING PROTOCOL(EIGRP)

EIGRP is an enhanced version of IGRP (Interior Gateway Routing Protocol), an obsolete routing protocol that was developed by Cisco. It is an advanced distance-vector protocol that implements some characteristics similar to those of link-state protocols. Some Cisco documentation refers to EIGRP as a hybrid protocol. EIGRP advertises its routing table to its neighbors as distance-vector protocols do, however it uses the hello protocol and forms neighbor relationships similar to link-state protocols.

EIGRP sends partial updates when a metric or the topology on the network changes. It does not send full routing-table updates in periodic fashion as distance-vector protocols do. EIGRP is a classless protocol that permits the use of VLSMs (Variable Length Subnet Masks) and supports CIDR (Classless Inter-Domain Routing) for a scalable allocation of IP addresses.

EIGRP uses the metrics like bandwidth, delay, reliability, load, and MTU in making its routing decisions. The default metrics used are bandwidth and delay. For a more granular level of control, EIGRP multiplies each of the metrics by 256 before performing the calculation of the composite metric. EIGRP has been designed to make much better use of bandwidth, and to allow routers to have a much better awareness of neighboring routers. Instead of sending its entire routing table out at regular intervals, an EIGRP router sends out only partial updates, and even then, only when a route changes. This makes a better use of the available network bandwidth.

An EIGRP router also has a more complete view of the network than a typical distance vector protocol as it not only maintains its own routing table, but also keeps a copy of the routing tables of neighboring routers. When an EIGRP router cannot find a route to a network based on all the information it currently has and it sends out a query to other routers, which is propagated until a route is found.

VI. OPEN SHORTEST PATH FIRST(OSPF)

Protocol OSPF proposes the use of shorter and accessible routes by the construction of a map of the network and data base maintenance with information on local and neighboring systems, this way it is able to calculate the metric for each route, and then the shorter routing routes are chosen. In this process the metric of state of the connection and distance are calculate in the case of RIP calculates only the distance and not the link traffic, by this cause OSPF is a routing protocol designed for networks with growth constant and able to handle a distributed routing table and fast propagation, between routers. The Link State Database (LSDB) contains the link state advertisements sent around the 'Area' and each router holds an identical copy of this LSDB. The router then creates a Shortest Path First (SPF) tree using Dijkstra's algorithm on the LSDB and a routing table can be derived from the SPF tree which now contains the best route to each router

A. OSPF characteristics:

1. Fast detection of changes in the topology and very fast re-establishment of routes without loops.
2. Low overload, use updates that inform about changes on routes.
3. Division of traffic by several equivalent routes.
4. Routing according to type of service.
5. Authentication.

TABLE III
DIFFERENCE BETWEEN RIP, EIGRP AND OSPF ROUTING PROTOCOLS

Protocol	RIP	EIGRP	OSPF
suits	Small network	Large network	Large network
Convergence time	slow	fast	Fast

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Ease of configuration	Easy	easiest	Complex
100% loop free	No	yes	Yes
VLSM	Only in RIPv2	yes	Yes
Bandwidth consumption	High	low	Moderate

VII. NETWORK ANALYSIS

In order to analyse the network in terms of network convergence activity, Ethernet delay and protocol traffic sent are chosen.

A. Network Convergence: Convergence is the process of routers agreeing on optimal routes for forwarding packets and thereby completing the updating of their routing tables. Convergence occurs as a result of a change in network topology, i.e., a link becoming available or unavailable. When this occurs, each router independently runs a routing algorithm to recalculate metrics and build a new routing table based on this information. Once all the routing tables have been updated, convergence is complete.

The time required before all of the routers can reach a consensus regarding the new topology, called convergence time, depends on the number of routers in the network that use dynamic routing protocols, the distance of routers (measured in hops) from the point of change, the bandwidth and traffic load on communications links and the load on the routers. Among the ways in which convergence time can be minimized are using improved convergence algorithms and designing the network so that fewer routers need to converge and so that the load on any given router or communications link is minimized.

Convergence is necessary because routers are intelligent devices that are capable of making their own routing decisions. This distributed intelligence is usually a huge advantage, because it allows large networks to be vastly faster, more robust and more efficient than would be possible with direct human intervention. For EIGRP protocol, the network convergence time is the shortest but the OSPF network takes more time than the EIGRP Network.

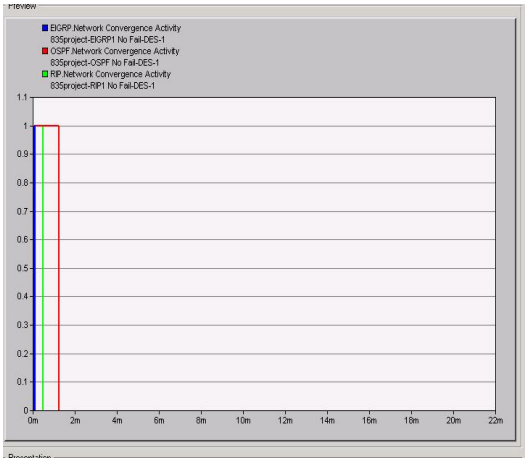

Fig. 2 Performance based on Network convergence

B. Routing Traffic: Network traffic or data traffic is data in a network. In computer networks, the data is encapsulated in network packets. Data transmitted over a network. Traffic is a very general term and typically refers to overall network usage at a given moment. However, it can refer to specific transactions, messages, records or users in any kind of data or telephone network. OSPF protocol provides higher traffic compared to EIGRP and RIP. After failure/recovery happened, OSPF protocol provides lower traffic than EIGRP.

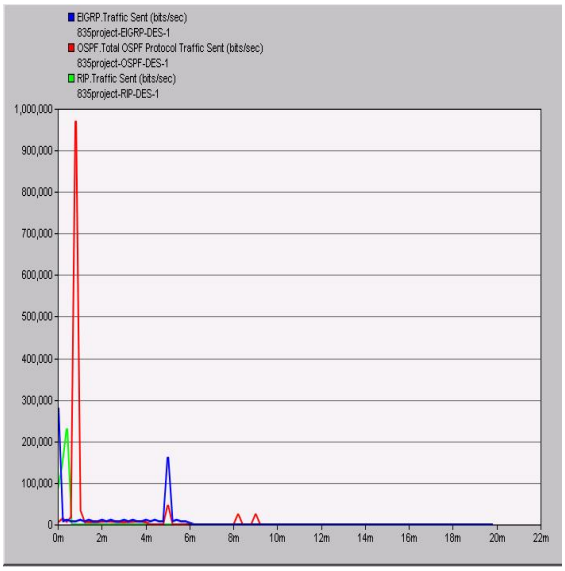

Fig. 3 Performance based on Routing Traffic

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C. Ethernet Delay: Network delay is an important design and performance characteristic of a computer network or telecommunications network. The delay of a network specifies how long it takes for a bit of data to travel across the network from one node or endpoint to another. It is typically measured in multiples or fractions of seconds. Delay may differ slightly, depending on the location of the specific pair of communicating nodes. Thus, engineers usually report both the maximum and average delay, and they divide the delay into several parts: Processing delay, Queuing delay, Transmission delay and Propagation delay.

Processing Delay- time routers take to process the packet header

Queuing Delay- time the packet sends in routing queues

Transmission Delay- time it takes to push the packet's bits on the link

Propagation Delay- time for a signal to reach its destination

There is a certain minimum level of delay that will be experienced due to the time it takes to transmit a packet serially through a link.

Onto this is added a more variable level of delay due to network congestion. IP network delays can range from just a few milliseconds to several hundred milliseconds. EIGRP provides lowest delay and RIP provides highest delay.

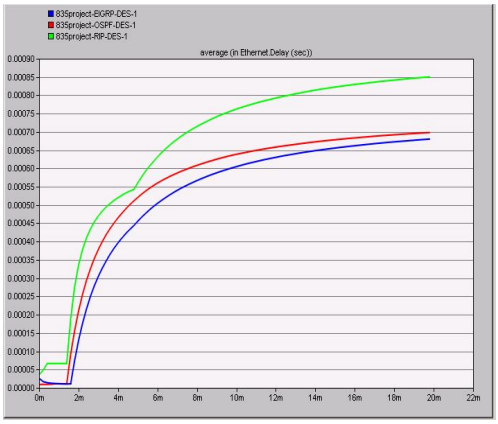

Fig. 4 Performance based on Ethernet delay

VIII. CONCLUSION

This paper demonstrated that CISCO Packet Tracer can be employed by network planners to select the most suitable routing protocol for various networks and to design an optimal routing topology. Among the IGP types the best protocol is EIGRP because it provides a better performance than RIP and OSPF, it has a good impact in the world of networking due to its fast convergence time, improved scalability and for sure the great handling of routing loops and also EIGRP has a great impact in HTTP application which gives it the power to be in the lead of routing protocols.

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