Network Protocols and its Implication on Connectivity and Configuration

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Abstract - Protocols play a role in network connectivity and performance. The techniques for routing packets across a network vary among protocols. In this paper, a brief review of six protocols which are employed by Cisco systems were made and they are Open Shortest Path First(OSPF), Enhanced version of Interior Gateway Protoco(EIGRP)l, Routing Information Protocol(RIP), Open System Interconnection(OSI), Spanning Tree Protocol and Transmission Control Protocol/Internet Protocol(TCP/IP) Spanning Tree Protocol is employed on switches to create broadcast domains while the others are employed in routers for routing functions. A brief comparison was made between the OSPF, RIP and EIGRP and it was discovered that EIGRP has better convergent capabilities and consumes less bandwidth.

Keywords- Enhanced interior gateway protocol, open shortest path first, routing information protocol, static routing, internet protocol

I. INTRODUCTION

Protocols are rules that govern communication of network devices in an internetwork [1]. This means it defines standards for transmission, data, mode of transmission, speed of transmission, cable types and interval[2]. Protocols contain signalling, error detection, error correction and authentication information. They can detect network errors and correct them [3]. Protocols also synchronize communication within a network. The communicating entities must agree on the protocol of choice before communication can take place. The protocols used in communication on the internet are the OSI and TCP/IP. As network characteristics changes, the router should be able to detect and update its entries to the routing table accordingly. This is called convergence [4][5] and is a important performance metric for any routing protocol. The duration is determined by how fast the routers come to an agreement on the network topology and the best path to route the packets. A routing protocol should have capacity to manage the amount of traffic available in the network. Examples of routed protocols include Internet Protocol, Telnet, Remote Procedure Call, Simple Network Management Protocol, Simple Mail Transfer Protocols, Appletalk, Novell IPX etc. Routed protocols can be divided into two broad categories; Distance vector protocols and Link state protocols. In distance vector protocol, the router uses information from other routers in the network to update its table entries and use it to determine the best route. They also send their complete routing table to other routers in the network [6]. This means router functions are dependent. Examples are RIP and EIGRP. In link state protocol, the router makes decision for routing independently and collects information from other routers in autonomous system [7]. It uses this information to calculate the best path to the network [6]. There is a greater flexibility and convergent property with this network than for distance vector protocol. This is because regular updates are sent throughout the network whenever a change is detected. Example is the Open shortest path first. There are two ways a router can get information about the best path to route packets to the destination: Static routing and dynamic routing

- **Static routing**: The network administrator configures the router and defines the routes it would take to transmit packets [6]. It is used in simple networks with limited paths to the destination. In static routing there is low overhead and less usage of computing resources
- **Dynamic routing**: Path information is obtained from information exchanged among routers. As the network change, routers update themselves about such changes [6].

II. PROTOCOLS

A. OSI(Open Systems Interconnection)

This protocol enables interoperability across several vendors of communication equipments [8]. The application layer provides the graphical user interface that will enable a user interact with the network. The

presentation layer presents the data in a format that would be understood by the user. The session layer sets up and terminates connections between communicating entities. The transport guarantees optimal transmission of data packets. The network layer defines the abstractive or logical representation of the network, routers operate in this layer. The data link layer defines communication on switches, bridges, network interface cards, MAC addresses are defined in this layer. MAC addresses are 48-bits in length with the first 24 bits called the organizational unique identifier [8]. The physical defines the physical connections. As the data moves down the OSI layer, each layer encapsulates the data from the layer above it.

B. TCP/IP(Transport Control Protocol/Internet Protocol)

This is a collection of protocols that enable independent communication between networks. It employs IP addresses for communication. Millions of computers can communicate within a network using IP addresses. The Request for Comments defines the TCP/IP standard [3]. The IP header frames contain the IP address of the sender and sink for the data packets. The Address Resolution Protocol translates IP addresses to MAC addresses for network devices to communicate. It does this by interpreting the IP address from the header and then broadcasts the message to all the nodes connected to the network and the node with the corresponding IP address responds with its MAC address. The MAC address is now passed to the data link layer and used to construct the IP datagram that is forwarded [9]. In order to reduce overhead during translation, a record of previously translated addresses is kept, so that ARP can refer to them in the future. ARP supplies the data link layer with the destination MAC address. Internet Control Message Protocol is a network layer protocol that takes care of errors and signalling messages like echo, echo reply, redirect, destination unreachable, and address mask request. A ping is a utility that makes use of ICMP packets to verify IP addresses that have been correctly assigned to a particular host. ICMP packets contain status information [9]. A gateway connects two networks with dissimilar protocols [10].

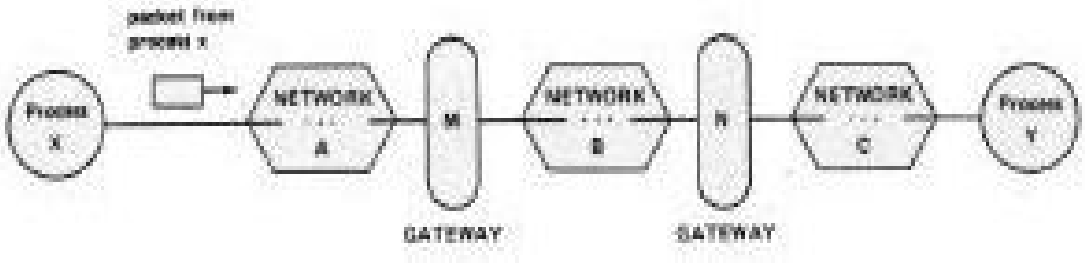

Fig1 Gateway Connecting two Networks [10]

C. Routing Information Protocol

In this protocol routing information is broadcasted to all the nodes in the network at intervals of 30 seconds [4]. This enables a router to make a choice on the best path to take when transmitting packets [7]. It is a distance vector routing protocol It uses hop count to determine the best route. Hop count is the number of routers, the packets will transverse from source to destination. The lower the hop counts the better the route. The maximum hop count is 15. Timers are also employed to mitigate incidence of collision among packets and to remove obsolete path from the routing table. The packets send and receive update to path information. It generates enormous traffic because it updates its entries by getting information from neighbouring routers. RIP does not include subnet masks when sending updates making it classful and utilizes excess bandwidth during broadcasts[11]. RIP doesn't allow networks of the same IP address class to communicate

Table2.1 Difference between RIP TYPES [19]

RIP Versions	RIPv1	RIPv2
Purpose	Small Network	Small Network
Supports VLSM	No	Yes
Classes	Classful	Classless

D. Open Shortest Path first

This is an interior gateway protocol based on Shortest Path First routing. It is a link state routing protocol and classless meaning it include variable length subnet masks in its broadcasts of Link State advertisement packets [2] [12]. Each node calculates the path from it to the next node. This information is stored in the routing table and used to create a network topology that is hierarchical in nature. This protocol is used by Cisco. This protocol divides network into areas and each area has a link state database which contains the information about the traffic through that path. The protocol employs Dijkstra's algorithm to calculate the shortest path based on link cost [13] [14]. Unlike the RIP which uses hop count to select the best route, the OSPF uses minimum delay, maximum throughput, reliability to make routing decisions. Packets are encapsulated in IP datagrams. OSPF requires high utilization of computing resources in its processing [12].

E. Enhanced Interior Gateway Routing Protocol

This protocol is an Enhanced version of Interior Gateway Routing Protocol [15]. This protocol has a maximum hop count of 255. It can used in large networks unlike the Routing Information Protocol. In this project work, the EIGRP was the protocol of choice employed in the design because of its fast convergence characteristics and better bandwidth utilization capabilities [16]. It is takes into account the dynamic nature of routing decisions and acts accordingly to synchronize communications. It employs Classless Inter-Domain routing in allocating IP addresses, this means networks host with different IP address classes can be configured to communicate. A router attached to a particular network through a fastethernet interface or serial interfaces sends test packets to that network to establish communication. These test packets will enable the router to know the status of such routers attached to that network. There are five types of test packets and they include Hello, Acknowledgements, Updates, Queries, Replies and Requests [15].

- **Hello Packet**: Employ unreliable delivery to verify the presence of neighbouring routers.
- **Acknowledgement Packet**: This indicates the reception of any packet from the neighbour and it contains no data.
- **Update Packet**: This packet contains routing information about the network topology and is propagated across the network. it propagates these packets either to neighbouring routers or 224.0.0.10[15]
- **Query Packets**: Gives information about alternative routes through a network
- **Reply Packets**: They are sent in response to query packets

The statuses of these routers are stored in a neighbour table. The Routing table combines the neighbour table and enable the router to logically design the network architecture based on the entries on the neighbour table. Destination network can either be passive or active. In the active state, destination is dynamic and the router tries to update information about the network. EIGRP uses Diffusing Update algorithm to compute the minimum bandwidth(kilobits per second) along the path, delay(microseconds), reliability, load, maximum transmission unit and hop count to make routing decisions. In order to have greater savings on bandwidth, EIGRP sends only partial updates when the logical architecture of the network changes [14].

To calculate the bandwidth, the following mathematical relationship is used[6]

$$\text{bandwidth} = (10000000/\text{bandwidth}(i)) * 256 \quad (1)$$

bandwidth(i) is the least bandwidth of the path to the destination in kilobits per second and the 256 is from the number of storage bits between Interior Gateway protocol(IGRP) and enhanced interior gatewayprotocol(EIGRP)

To calculate the delay, the following mathematical relationship is used[6]

$$\text{delay} = \text{delay}(i) * 256 \quad (2)$$

delay(i) is the total delay along the path to the destination in tens of microseconds.

Total metric is given by[6];

$$[KI * \text{bandwidth} + (K2 * \text{bandwidth})/(256 - \text{load}) + K3 * \text{delay}] * [K5/(\text{reliability} + K4)] \quad (3)$$

After analysis [12] discovered that EIGRP provided more convergence capabilities than OSPF.

F. Spanning Tree Protocol

This protocol is employed in bridges and switches for communication within LANs. It removes irrelevant connection by constantly monitoring the network. This reduces network overhead to the minimum.

Table2.2 Difference Between RIP, EIGRP and OSPF Routing Protocols[2]

Protocol	RIP	EIGRP	OSPF
Purpose	Small Network	Large Network	Large Network
Convergence	Slow	Fast	Fast
Bandwidth Consumption	High	Low	Moderate
VLSM	Supports only in Version 2	Supports	Supports
Easeof Configuration	Easy	Easiest	Complex

III. CONCLUSION

In this paper we have tried to review protocols and its application to Network configuration. We have tried to compare the Routing Information Protocol, Enhanced Interior Gateway Protocol and Open Shortest Path First using the following metrics; Application, convergence, Bandwidth consumption, Variable length Subnet masking and Ease of configuration. From observation we see that the Enhanced version of the Interior Gateway Protocol gives a better performance in all ramifications and is recommended that is employed in high service oriented networks.

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