Advances in Computer Science and Information Technology (ACSIT)
p-ISSN: 2393-9907; e-ISSN: 2393-9915; Volume 4, Issue 4; July-September, 2017, pp. 275-279

http://www.krishisanskriti.org

Performance Analysis of Routing Protocols Implemented in a Company Network

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Abstract—*Various routing protocols like RIP, IGRP, EIGRP& OSPF are used in a network topology for forwarding the packets. Every router in a network maintains a routing table for successful delivery of packets from source to destination nodes. The information stored by router is purely dependent on the algorithm followed by it. Here in this paper the main focus is on analysing the performance of therouting protocols on the basis of the cost of delivery, no. of updated required, amount of overhead on each router, failure recovery, resultant throughput of the system& delay. This research is done to find out which protocol suits the best for the network and through a thorough analysis I have tried to find the pros and cons of each protocol.*

Index Terms: *Routing protocols, Packets, Nodes, Network*

1. INTRODUCTION

Internet protocol suite is used for communication for the internet and similar networks. [1-4] TCP/IP protocol provides end to end connectivity and also specifies how data should be formatted, addressed, transmitted, routed and received at the destination. It basically has four abstraction layers namely data link layer or link layer, internet layer, transport layer and application layers. Each layer has its own functions as Link Layer contains communication technologies for a local network; Internet Layer connects local networks and establishes internetwork communication; Transport layer handles host to host communication and Application layer contains protocols specific for data communication services on process to process level. Data is encapsulated that is enclosing of a set of data into another set of code to protect its integrity when transferring it between non-compatible systems, or to secure it from unauthorized access during transmission the figure below shows data encapsulation, it shows how the data is encapsulated from application layer to link layer via transport and internet layers. At each layer a set of header and footer are added and at the receiver side it is unwrapped that is header and footer are removed right from link layer first to application layer to get the data or message transmitted by the sender.

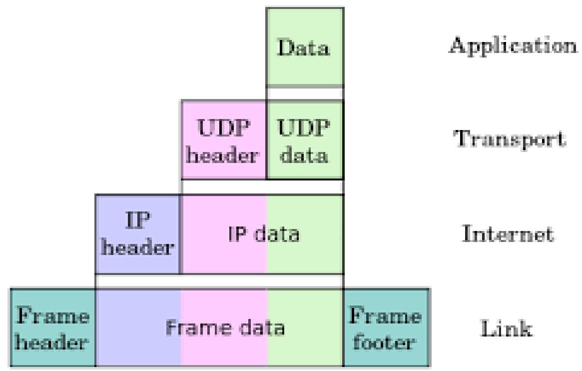

Fig. 1:Data Encapsulation in TCP/IP Suit

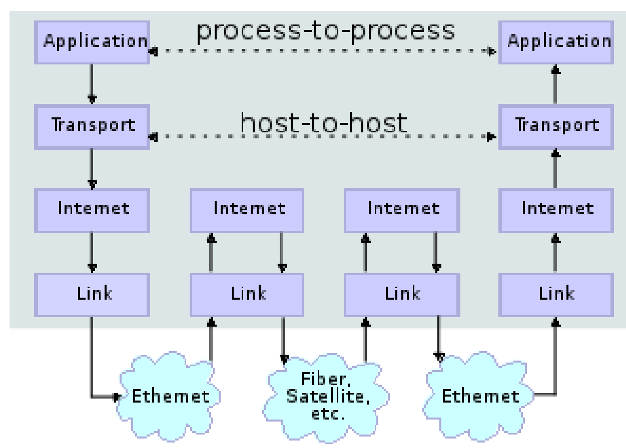

Fig. 2: Data Flow from Source to Destination

The data movement from the source to the destination via different layers and through intermediate nodes which may are generally routers in shown in Fig. 2.

The Fig. 3 below shows a simple link between sender A and receiver B via routers.

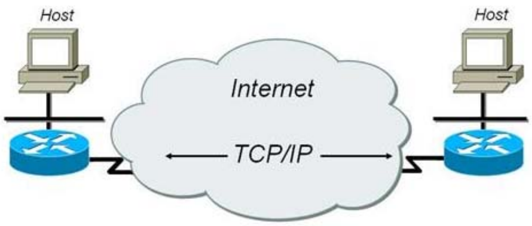

Fig. 3: Two hosts connected via routers in TCP/IP

Here in this paper I am concentrating on internetworking which is the function of the internet layer. This is enabled by router which is a device that forwards data packets between computer networks, creating an overlay internetwork. It is connected to two or more data lines from different networks. When a data packet comes in on one of the lines, the router reads the address information in the packet to determine its ultimate destination. Then, using information in its routing table or routing policy, it directs the packet to the next network on its journey. It is a data table stored in a router or a networked computer that lists the routes to particular network destinations, and in some cases, metrics (distances) associated with those routes. They contain information about the topology of the network immediately around it. The construction of routing tables is the primary goal of routing protocols. This paper comprises of five sections. The first one comprises of introduction of TCP/IP protocol and communication in a network, second one comprises of brief overview of various protocols being compared, in the third section includes the designed scenarios, fourth section consists of the results obtained and last section comprises of the conclusion drawn from the results obtained.

2. OVERVIEW

2.1 Routing Information Protocol (RIP)

The Routing Information Protocol (RIP) is one of the oldest distance-vector routing protocols which employ the hop count as a routing metric. RIP prevents routing loops by implementing a limit on the number of hops allowed in a path from source to destination. The maximum number of hops allowed for RIP is 15, which limits the size of networks that RIP can support. A hop count of 16 is considered an infinite distance and the route is considered unreachable. RIP implements the split horizon, route poisoning & hold down mechanisms to prevent incorrect routing information from being propagated.

Originally, each RIP router transmitted full updates every 30 seconds. In the early deployments, routing tables were small enough that the traffic was not significant. As networks grew in size, however, it became evident there could be a massive traffic burst every 30 seconds, even if the routers had been initialized at random times. It was thought, as a result of random initialization, the routing updates would spread out in time, but this was not true in practice. [5] Sally Floyd and Van Jacobson showed in 1994that, without slight randomization of the update timer, the timers synchronized over time.In most networking environments, RIP is not the preferred choice for routing as its time to converge and scalability are poor compared to EIGRP, OSPF, or IS-IS. However, it is easy to configure, because RIP does not require any parameters unlike other protocols. [6] RIP uses the User Datagram Protocol (UDP) as its transport protocol, and is assigned the reserved port number 520.

Features: -RIP is a distance vector routing protocol (DVR). The maximum reachable hop-count is 15 the 16 Hop is considered unreachable.In RIP metric is HOP COUNT. periodic update after every 30 seconds takes place in this protocol. It supports equal path load balancing and works at application layer.

RIP Timers: -RIP uses different kinds of timers to regulate its performance:-

Route update timer: Sets the interval (typically 30 seconds) between periodic routing updates, in which the router sends a complete copy of its routing table out to all neighbours.

Route invalid timer: Determines the length of time that must elapse (180 seconds) before a router determines that a route has become invalid. It will come to this conclusion if it hasn’t heard any updates about a particular route for that period. When that happens, the router will send out updates to all its neighbours letting them know that the route is invalid.

Hold down timer: This sets the amount of time during which routing information is suppressed. Routes will enter into the hold down state when an update packet is received that indicated the route is unreachable. This continues until either an update packet is received with a better metric or until the hold down timer expires. The default is 180 seconds.

Route flush timer: Sets the time between a route becoming invalid and its removal from the routing table (240 seconds). Before it’s removed from the table, the router notifies its neighbours of that route’s impending demise. The value of the route invalid timer must be less than that of the route flush timer. This gives the router enough time to tell its neighbours about the invalid route before the local routing table is updated.

2.2 Interior Gateway Routing Protocol (IGRP)

Interior Gateway Routing Protocol (IGRP) is a distance vector interior gateway protocol (IGP) developed by Cisco. It is used by routers to exchange routing data within an autonomous system.

IGRP is a proprietary protocol. IGRP was created in part to overcome the limitations of RIP (maximum hop count of only 15, and a single routing metric) when used within large networks. IGRP supports multiple metrics for each route, including bandwidth, delay, load, and reliability; to compare two routes these metrics are combined together into a single metric, using a formula which can be adjusted through the use of pre-set constants. By default, the IGRP composite metric is a sum of the segment delays and the lowest segment bandwidth. The maximum configurable hop count of IGRP-routed packets is 255 (default 100), and routing updates are broadcast every 90 seconds (by default). IGRP uses protocol number 9 for communication[7].

IGRP is considered a classfull routing protocol. Because the protocol has no field for a subnet mask, the router assumes that all sub network addresses within the same Class A, Class B, or Class C network have the same subnet mask as the subnet mask configured for the interfaces in question. This contrasts with classless routing protocols that can use variable length subnet masks. Classfull protocols have become less popular as they are wasteful of IP address space[8].

2.3 Enhanced Interior Gateway Routing Protocol (EIGRP)

Enhanced Interior Gateway Routing Protocol (EIGRP) is an advanced distance-vector routing protocol that is used on a computer network for automating routing decisions and configuration. The protocol was designed by Cisco Systems as a proprietary protocol, available only on Cisco routers.

EIGRP is used on a router to share routes with other routers within the same autonomous system. Unlike other well-known routing protocols, such as RIP, EIGRP only sends incremental updates, reducing the workload on the router and the amount of data that needs to be transmitted[9].

EIGRP replaced the Interior Gateway Routing Protocol (IGRP) in 1993. One of the major reasons for this was the change to classless IPv4 addresses in the Internet Protocol, which IGRP could not support.EIGRP is sometimes referred to as a hybrid routing protocol because it has characteristics of both distance-vector and link-state protocols [10].

Features of EIGRP: -EIGRP is a Hybrid protocol i.e. a mixture of both link state and distance vector routing protocol. It supports VLSM(subnets/super nets) & also integrates seamlessly with IGRP. EIGRP provides the fastest convergence and also consumes less bandwidth. EIGRP supports multiple network layer protocols.

2.4 Open Shortest Path First (OSPF)

Open Shortest Path First (OSPF) is a routing protocol for Internet Protocol (IP) networks. It uses a link state routing algorithm and falls into the group of interior gateway protocols, operating within a single autonomous system. It is defined as OSPF Version 2 in RFC 2328 (1998) for IPv4[11]. The updates for IPv6 are specified as OSPF Version 3 in RFC 5340 (2008)[12].

OSPF is perhaps the most widely used IGP in large enterprise networks. Intermediate System to Intermediate System, another link-state dynamic routing protocol, is more common in large service provider networks.

Features: -OSPF protocol is a link state routing protocol in which metric is bandwidth. Like EIGRP is supports VLSM (subnets/super nets). It supports area similar to autonomous systems. It is an Hierarchical model which supports unlimited hop counts and authentication.

Routers maintain database with link state information, weights computed using link state, IP address etc. This database in each router is updated by transmitting Link State Advertisements throughout the autonomous system. A shortest path tree is constructed by each router with itself as the root node and based on weights in the database.

3. SCENARIO DESIGNED

Suppose a network comprising of slip8_gateway connected via PPP_DS3 links. The fig. 4 shows the designed scenario where the terrain size is 16sq km , traffic is created between A-F, I-D, H-K, E-G and B-J. We have analyzed the performance of various protocols in terms of cost of packet delivery and overhead over routers. The fig. 5 shows the scenario where a router fails then we observed and analyzed the delivery of packets to destined node. The figure 6 shows the cost of each link is obtained using the formula that

Cost=(Reference bandwidth / link bandwidth)

The various protocols we analyzed are RIP, OSPF, IGRP and EIGRP respectively. Then for OSPF we have divided the network into areas. OSPF-area 1 is confined to communicate within a given area whereas in OSPF- area internetwork communication is allowed.

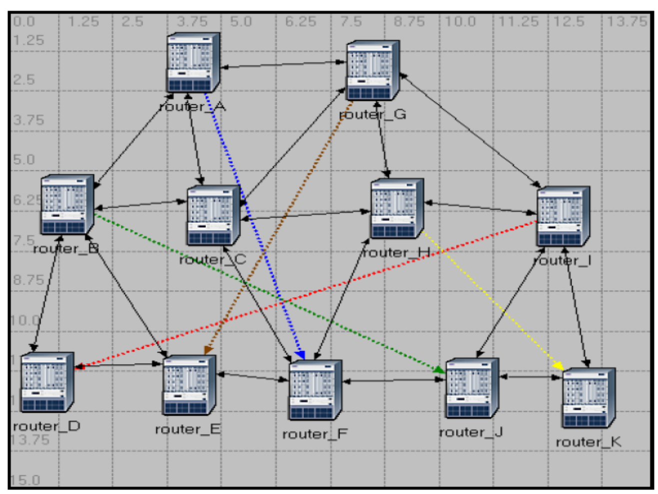

Fig. 4: Screenshot of the network designed

(Rakheja et al., 2012)

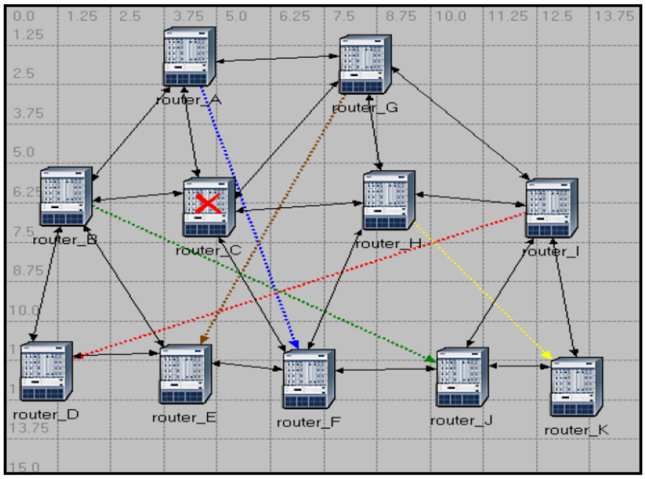

Fig. 5: Screenshot of the scenario with failed router

(Rakheja et al., 2012)

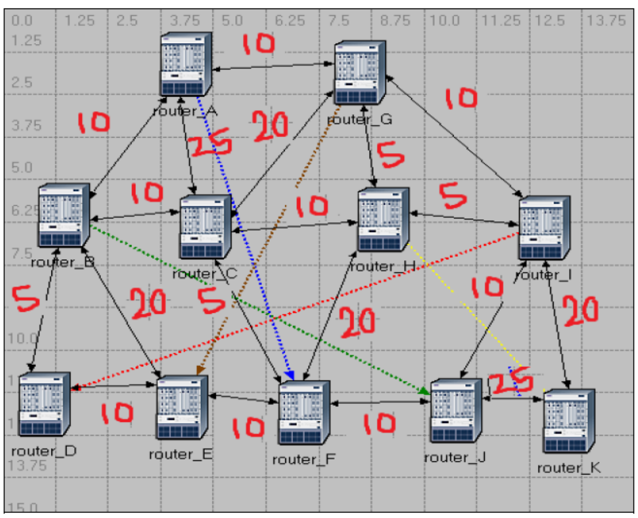

Fig. 6: Screenshot of scenario showing cost of each link

(Rakheja et al., 2012)

4. ANALYSIS

We have analyzed the performance of various routing protocols naming RIP, OSPF, IGRP and EIGRP over a scenario of size 16sq km consisting of slip8_gateway routers and on simulating the network we obtained the following results for best effort traffic which are shown below in table 1 which shows cost of transmission between two routers for different protocols. We also have analyzed overhead on routers and overall performance in terms of throughput, queuing delay and link utilization figures 7-12 show the results obtained.

TABLE 1: COMPARISON ON BASIS OF COST OF DELIVERY

Protocol	OSPF	OSPF Area 1	OSPF Area 2	RIP	IGRP	EIGRP
A-F	25	Nil	25	30	40	25
I-D	30	Nil	40	45	30	40
H-K	25	25	25	25	25	25
E-G	30	Nil	30	35	40	35
B-J	25	Nil	25	40	25	25

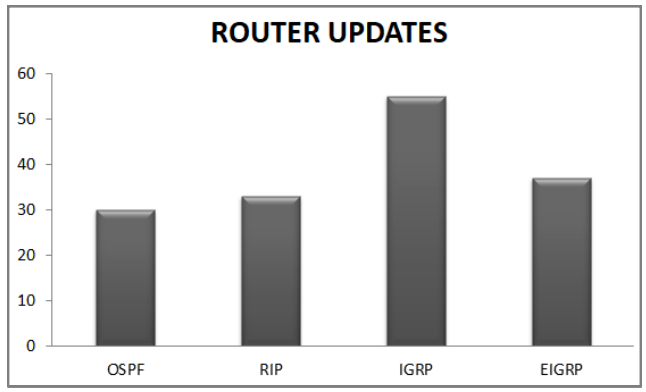

Fig. 7: Router updates comparison of various protocols

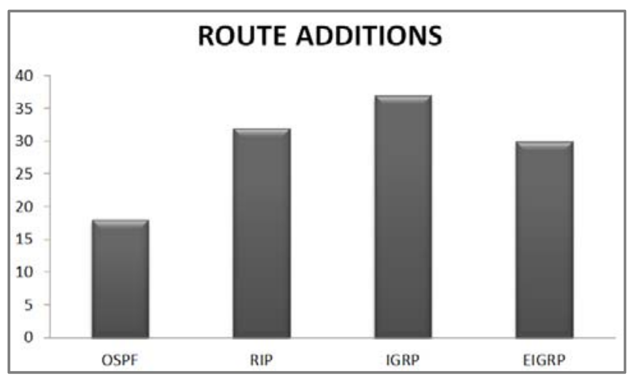

Fig. 8: Route addition comparison of various protocols

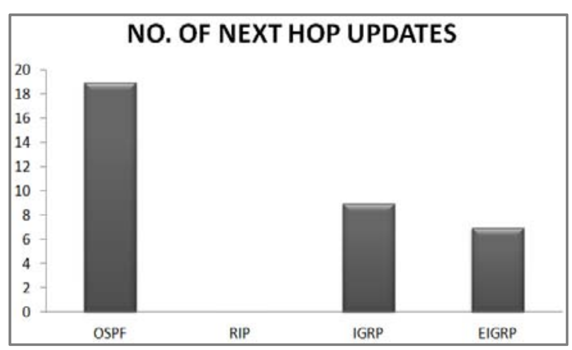

Fig. 9: Number of next hop updates of various protocols

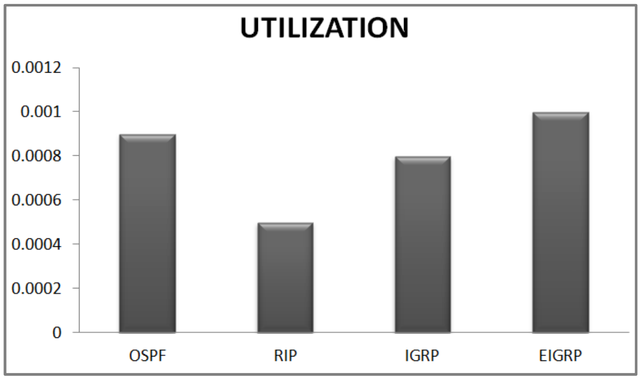

Fig. 10: Link Utilization of various protocols

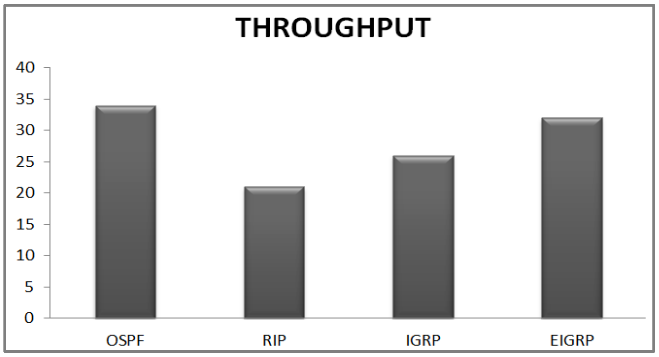

Fig. 11: Throughput of various protocols

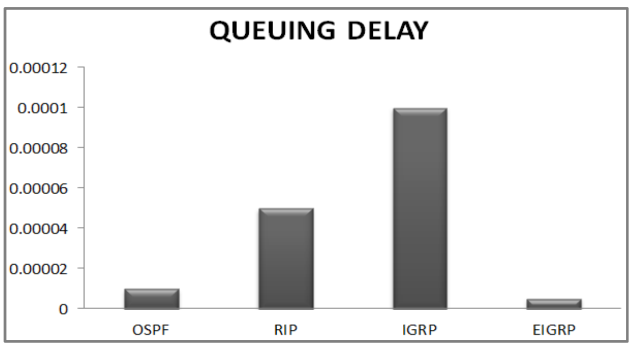

Fig. 12: Delay encountered by various protocols

As per table 1 OSPF has the least cost of transmission followed by EIGRP, IGRP and RIP. In case of router overhead shown in figure 7-9 IGRP has the maximum overhead followed by EIGRP, OSPF and RIP. And on analysing the performance parameters like throughput, utilization and delay, as per results plotted OSPF has the maximum throughput followed by EIGRP, IGRP and RIP shown in figure 10; for the case of queuing delay EIGRP has the least delay followed by OSPF, RIP and IGRP shown in figure 12 and for the case of link utilization EIGRP has the maximum link utilization followed by OSPF, IGRP and RIP as shown in figure 11.

5. CONCLUSION

On analysing the result of the performance of various routing protocols naming RIP, OSPF, IGRP and EIGRP over a scenario for cost of transmission, router overhead, throughput, link utilization and queuing delay we can say that OSPF has best performance overall as it has the least cost of transmission, lower router overhead after RIP and maximum throughput amongst all routing protocol and queuing delay of it is second lowest after EIGRP and it also has second highest link utilization after EIGRP. Then EIGRP performs good as it has cost of transmission just above OSPF and has optimum router overhead and overall performance in terms of throughput, queuing delay and link utilization. So for best effort service that is transmission of data packets OSPF performs better than other protocols for throughput, queuing delay, utilization & overhead.

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