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A Review on the Dynamic Routing Protocols in TCP/IP

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Abstract:
In this modern internet generation, routing protocols play a crucial role. It dispose how the communication is done in router. An internet is a combination of networks connected by routers. When a packet goes from a source to a destination, it will perhaps pass through many routers until it reaches the router attached to the destination network. Routing protocols is a combination of rules and procedures that lets routers communicate each other of changes also include procedures for combining information received from other routers. From source to destination in this paper, we surveyed the performance evaluation of various routing protocols with certain criteria's like Router updates, Link utilization, end to end delay etc.

Key words*: Routing Protocols; Communication; routers*

1. Introduction

As the number of ip addresses can be used the routing along network play a vital role. There are many optimum techniques for router to choose the optimum pathway one approach is using a cost a metric other protocols allow the administrator to assign a cost for passing through a network and some define the metric in a different way like in Border Gateway Protocol(BGP) , the criterion is the rule, which can be set by the administrator . A routing table can be either static one with manual entries or dynamic one that is updated automatically when there is change somewhere in the internet. Routing protocols have been created in response to the demand for dynamic routing tables. Optimum pathway is required so that the computers can communicate with each other even in different network. Misconfiguration of the routing table can cause problems that can interface the data transmissions such as packet loss and delay. The serious problem that happen is the loss of packets containing important information that should be sent across the networks. This irregularity can occur because the improper configuration of routing tables on the routers, the router agent may be down or of loss connections between the router devices. There are two different ways of configuring routing tables in routers. The routing tables on the router devices can be configured by using static routing or active routing. The static routing is advantageous to computer networks that is not too huge. In extension to recover the router resources, the configuration is not too crucial. When the computer network is huge, the use of the static routing will be harder for administrators to administer the routing tables who are engaged in it. The number of entries in the routing table and also the accuracy of each entry is a key factor for the carrying out of the computer networks. If there occur any changes in the topology, routing tables must be updates soon. So the packet sent on the network is not discarded because of an error in the routing table.

The categorizing of the routing protocol is classified below. Where there are some dynamic routing protocol can be used to configure routing tables in the router devices. There is Interior Gateway Protocol(IGP) that should be used for the routers across the same domain network such as Routing Information Protocol (RIP), Enhanced Interior Gateway Routing Protocol(EIGRP), IS-IS(Intermediate System – Intermediate System) and Open Shortest Path First (OSPF).For the routers across different domain network, Exterior Gateway Protocol(EGP) can be used as such as Border Gateway Protocol(BGP).There are two types of dynamic routing protocols for the router in the same domain network that can be used on computer networks, the most popular ones are distance vector and link state routing protocols. Both have their own advantages and disadvantages. Enhanced Interior Gateway Routing Protocol(EIGRP) is the implementation of the distance vector protocol. Open Shortest Path First(OSPF) is the implementation of the link state protocol. These dynamic routing protocols can be implemented in both IPv4 and IPv6 networks.

The Classification of routing protocol

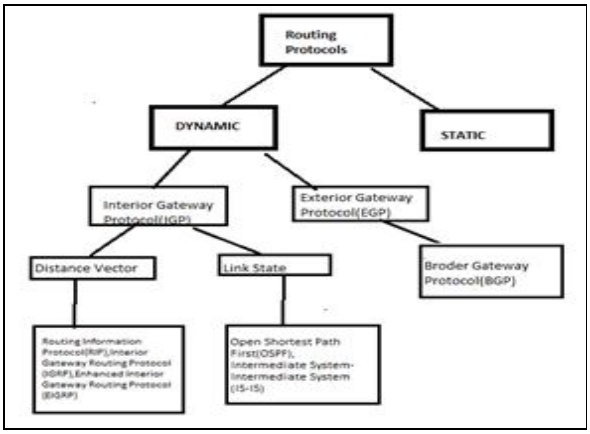


Figure 1: Popular Routing Protocols

2. Previous Works

Today internet is so large that one routing protocol cannot handle the task of updating the routing tables of all routers. So network is divided into Autonomous System(AS).OSPF and EIGRP will share the routing information between routers in the same autonomous system. This research will shows that EIGRP are much better than OSPF in many different topologies.

This work include an approach for tuning dynamic routing protocols using link state as metrics and focusing on the EIGRP dynamic routing protocol in order to get consistent and expected failover of dynamically routed links in complex networks . Evaluation of Enhanced Interior Gateway Routing Protocol(EIGRP) via packets simulation. EIGRP, an intra-domain routing protocols developed by Cisco is mainly based on the Diffusing Update Algorithm(DUAL) which determine the best path among all Feasible paths. DUAL also helps ensure a loop-free routing environment. Each autonomous system can choose one or more intra-domain routing protocols to handle routing inside the autonomous system. Earlier studies shows EIGRP's ability to adapt quickly to routing changes in medium- scale networks. The extension made to evaluate EIGRP performance under a very dynamic network.

The decisions of choice is between the protocols that involve distance vector or link state union of both. In comparison with different parameters and a simulation study on the network with distinct routing protocols it is shown that EIGRP provides a better network convergence time, better CPU and memory utilization , less bandwidth requirements in comparison to OSPF and RIP . There have been large number of static and dynamic routing protocols choice is made for routing across the network is dependent on many factors critically network convergence time , scalability, memory and CPU utilization, security and bandwidth constraint etc. EIGRP uses bandwidth and delay of the line by default to calculate its distance metric.

This paper settles an open question with a positive answer :Optimal Traffic engineering can be realized with link-state routing protocols with hop by hop forwarding. Link-state routing protocols, Open Shortest Path First(OSPF) and Intermediate System-Intermediate System(IS-IS), separates traffic equally over shortest paths based on link weights However optimizing the link weights for OSPF/IS-IS is a well-known-hard problem and even the setting of link weights can deviate significantly over an optimal distribution of the traffic. So here comes the proposal of a new link-state routing protocol, PEFT that splits traffics over multiple paths with an exponential penalty on longer path.

This paper discuss about the link-state failures causes like convergence delay in both EIGRP and OSPF. And present a method of transmitting routing updates in IPv6 .Updates are sent when a change occurs, and include only the change. Some of the routing protocols use a separate packet to send/receive routing updates are subjected to instability in a limited bandwidth . We evaluate our technique by OSPF and EIGRP stabilizes extra quickly.

In this paper we analyze the challenging problem of energy saving in IP networks. A novel network-level strategy as modification to the current link-state routing protocol, such as OSPF are able to switch off some network links during low traffic periods. Here we use the Dijkstra algorithm to detect links to power off .Performance study shows that , in an IP network more than the 58% of links can be switched off.

We also examine the network performance while using three dynamic routing protocols RIP,OSPF and EIGRP. Video ,HTTP and Voice application where configured for net move . We as well examine the behavior when using link failure / recovery controller between network nodes. The performance and effectiveness are analyzed between these protocols and implemented in network.

3. Brief on Dynamic Routing Protocols

3.1. Routing Information Protocol (RIP)

The Routing Information Protocol (RIP) is a standardized distance-vector routing protocol that uses UDP port 520 for message encapsulation.RIP supports IP and IPX routing. It consists of two message types.

- A request message is used to ask neighboring routers to send an update.
- A response message carries the update.

When RIP is configured on a router, it sends Broadcast packets containing the request message out the entire RIP enabled interfaces and then listens for response messages. Routers receiving the request message respond to it by sending their routing tables in the response message as packet . And this process continues until the network is converged. A RIP router sends out its full routing table in its update once in 30 seconds. If any new entry is found in an update , the RIP router enters it into the routing table along with the sending router's address. It uses the hop count as a metric for determining best paths. The maximum hop count is 15 thereby preventing routing loops in the network. If the hop count of an incoming route is 16, it is considered to be inaccessible or undesirable and is at an infinite distance. RIP prevents inappropriate information from propagating throughout the network, by the use of its features like split horizon with poison reverse method to prevent the count to infinity problem. RIP can perform load balancing for up to six equal-cost links.

3.1.1. Versions

- **RIPv1:**RIPv1 supports Class full routing; so variable length subnet masks(VLSM) cannot be implemented. It also uses Broadcast mechanism there is also no authentication mechanism .
- **RIPv2:** RIPv2 supports Class less Inter-Domain Routing (CIDR) and thus does include the subnet mask with its routing table updates. .RIPv2 uses multi-cast instead of broadcast.. There is also authentication mechanism.

In modern IP-based networks can transmit information using different ways of addressing and delivery:
delivery of a particular specified device(unicast) ,multicast delivery(multicast) and broadcast delivery(broadcast).All these types of information delivery imply the use of routing protocols. There is also multipath routing involves optimization. In many works dealing with routing protocols we need to provide a description of them, or the advantages and disadvantages. There is therefore a need for a qualitative comparison ,so making recommendations for the use of protocols, which lend a idea of the possibilities for their use

3.1.2. Unicast Protocols

Unicast is a one-to one connection between the client and the server. Unicast is the term used to describe communication where a piece of information is sent from one point to another point. Unicast uses IP based delivery methods ,which are session-based protocols such as Transmission Control Protocol(TCP) and User Datagram Protocol(UDP). In the model network consisting of Windows Media Player client wants to connect to a Windows Media Server using unicast, that client set up direct association to the server. Each unicast Windows Media client that connects to the Windows Media Server takes up additional bandwidth. For instance, if we have only on client streaming 100kbps , only 100kbps is being used. If we have 10 clients all streaming 100-kilobits per second(kbps) streams, those clients as a cluster are taking up 1000 Kbps.

3.1.3. Multicast Protocols

In the model network created in the software package Network Simulator consists of two hundred routers with varying number of users in the group. Here a concept of value is introduced in network resources in the group transfer, measured in the number of transmitted packets per second. By value here means the total amount of load generated useful and official traffic and the traffic that arises when connected (disconnected) users. In particular ,assess of the performance of protocols are the cost of communication versus the number of network nodes, the recipients in a group capacity.

3.1.4. Multipath Routing

Multipath routing involves optimizing the use of network resources in term of distribution network load and to prevent overloads as well as increases fault tolerance. To solve this problem Heuristic algorithms and approximation algorithms with polynomial and pseudo polynomial time computations are often used .In addition they help to solve the problem only in special cases(For example, two constraints without optimization ,one constraint with optimization ,etc)

3.1.5. Router-protocol based methods

Router -protocol based topology discovery methods are the methods that establish the topology of the network from the information got from routers in the network. As the RIP protocol and OSPF protocol are the main router protocols used in the network, topology discovery methods based on these protocols are mainly discussed.

- **RIP-based method:** It is a protocol in which each router shares at regular intervals , its knowledge about the entire AS with its neighbors. It is classified as an interior gateway protocol(IGP) and it used the distance -vector routing algorithm. It broadcast its route information by UDP. The message is sent every 30 seconds, so it can adapt with network changes. The RIP employs hop count as a routing metric. so we can deduce the connections between routers through the hop counts . Thus, RIP can be used for topology discovery. RIP-based method is quick and accurate in a small or middle network. As RIP uses UDP to broadcast its route messages, the messages are not reliable and may lost in the network . So it is unsafe to broadcast messages in a large scale net.
- **OSPF-based method:** It is a dynamic routing protocol used in Internet Protocol networks. It uses the link-state routing protocol and belongs to the group of interior gateway protocols. It constructs a topology map of the network. and this topology determines the routing table delivered to the Internet Layer and routing decisions are made to the destination IP address found in IP datagram. It figure out the shortest path using Dijkstra's Algorithm, a shortest path first algorithm. OSPF supports models like Variable -length subnet masking(VLSM) or Classless Inter-Domain Routing (CIDR) addressing.

3.1.6. RIP Internet Protocol Failure Analysis and Research

RIP routing table is updated periodically in order to maintain the table entries correct and effective, updated routing table is send to adjacent routers. Here each entry in table has a timer which when not updated periodically the route to measure the value is set to infinity and marked for deletion, when another 60 seconds to removal from the local routing table of route the router exchange routing information with other routers, other routers know that the route has been ineffective.

Even though the RIP algorithm is rather simple and easy to implement, but there are some drawbacks.

- In a small network .RIP has very little overhead in terms of bandwidth, memory consumption, processor load etc.,
- RIP subnet address is not the concept. If a C class address in the last 8 bits of host number is 0, then the RIP cannot distinguish between non-zero parts is a subnet or a host address.
- supports only equal-cost load balancing pinhole congestion can be a problem.
- RIP router in the routing table provides the maximum hop count is 15, when the source host to a number of hops between the destinations hosts more than 1, the router that is unreachable.
- slow convergence may cause serious problem.

3.2. Open Shortest Path First(OSPF)

Link-state routing protocol is also known as shortest path routing protocol, as it compute the finest shortest path available from source to the destination network. Each router in the same domain will run the algorithm using their link-state data base. The database then is used to describe the network topology. Firstly they will build a tree with each router as the root and then the tree consists of shortest path available to each router in the network .Other remaining routers joined the network will be known as leaf. Link state advertisement(LSA) is responsible for the routing information exchange between routers and LSA is sent by each routing using flooding method. Every time a network topology altered, router will send LSA to the network routers so other routers will know about the network topology changes soon. Dijkstra algorithm used cost for each link available in the router for the computation of shortest path. OSPF routing protocol developed by Interior Gateway Protocol (IGP) and rigorously tested by working teams of the Internet Engineering Task Force(IETF) for Internet Protocol(IP) network.

OSPF has five different packet types. Each packet has a specific purpose in OSPF route. Lower OSPF packets .

- Hello Packet.
- Database description.
- Link state request packet.
- Link state update.
- Link state acknowledgement packet.

The Advantage of OSPF dynamic routing protocol are:

- OSPF is more appropriate for serving large heterogeneous inter networks
- OSPF for all time determines the loop free routes.
- Changes in OSPF networks are propagated quickly
- Low bandwidth utilization
- Maintain multiple routes for a single destination network.
- OSPF is cost based for their interfaces.
- Uses Variable Length Subnet Mask(VLSM)

The disadvantages of OSPF are:

- Difficult to configure.
- More memory requirements.

OSPF features the concept of areas to provide scalability. The key factor in designing an OSPF network is the assignment of router and its links to an area(s), which is whether it has to be put in Area 0 (Backbone) or any other non-backbone area. We take many factors into account while making this design.

For choosing an area ,the most significant factors that are to be considered are stableness and redundancy. The range of an area must be optimal so that this enhances the stability. Each router in that area needs to re-calculate its routes and it takes significant amount of CPU resources.

When there exist multiple equal cost paths to the same destination, OSPF performs load sharing across all the links. OSPF supports only manual summarization and that too around the Area Border Routers(ABRs) and Autonomous System Boundary Routers(ASBR s). If we have a high capacity link and if the count of prefixes is small, then the new routers can be added. Each OSPF router sends Link-State Advertisements(LSA) over all its adjacencies. Based upon the way the routing has to happen, areas are classified into five types.

- Backbone(area 0)
  Allows Router LSA, Network LSA ,Network Summary LSA,ASBR Summary LSA and AS External LSA
- Non-backbone,non-stub
  Allows Router LSA ,Network LSA, Network Summary LSA,ASBR Summary LSA and AS External LSA
- Stub
  Allows Router LSA ,Network LSA ,Network Summary LSA
- Totally Stub
  Allows Router LSA and Network LSA

- 5.Not-so-stubby
  Allows Router LSA, Network LSA ,Network Summary LSA,ASBR Summary LSA and NSSA External LSA.

OSPF areas allows the Autonomous Systems to be broken up into regions call areas comprising hundreds or thousands of subnets; especially they play vital role in optimization of routers and network resource consumption, as explained below.

- Link bandwidth: In OSPF, a reliable flooding mechanism is used to ensure that router link state databases are remained synchronized. The refreshing of Individual components of the link state databases(the LSAs) are done infrequently(every 30 minutes),at least when the topological changes occurs. Still , the amount of link bandwidth used by the flooding procedure increases with the increase in the volume of the database.
- Router Memory: The volume of an OSPF link state database can get pretty large, particularly in the existence of many external LSAs. This observably leads to requirements on the amount of router memory available.
- CPU usage: In OSPF, this is dominated by the length of time it takes to run the shortest path calculation(Dijkstra procedure). This is a function of the number of routers in the OSPF system.

3.3. Enhanced Interior Gateway Routing Protocol(EIGRP)

It is one of the distance vector routing protocol .The distance vector consists of destination ID, shortest distance and after that hop. Now every node passes a distance vector to its neighbor and informs about the shortest paths. The routers are responsible for exchanging the distance vector. When a router in the network receives the advertisement of the lowest cost from its neighbors, it followed by add this admission to the routing table. In distance vector routing protocol, the router do not know the information of the entire path . The router knows only the information about the direction and the distance interface packet will be forwarded . EIGRP is a CISCO owned private routing protocol, which is an updated and improvised version of the interior gateway routing protocol(IGRP). Figure depicts the structure of EIGRP packet

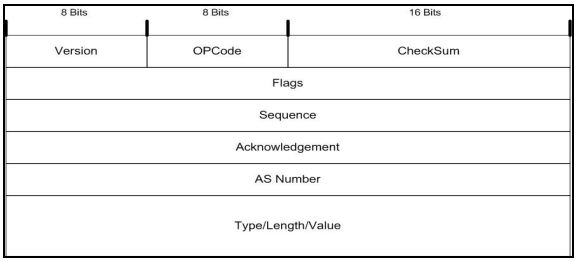


Figure 2: Structure of EIGRP packet

The advantages of using EIGRP are as follows:

- Easy to configure.
- Loop free routes.
- Maintains backup paths to the destination network.
- Very fast rapid convergence times for changes in the network topology and bandwidth utilization.
- Uses Variable Length Subnet Mask(VLSM) and Classless Inter Domain Routing(CIDR).
- Supports authentication.

The disadvantage of using EIGRP are as follows:

- Considered as protocol came up with by CISCO, it is a private protocol, not a open standard.
- Routers from other vendor are not supported by EIGRP.

EIGRP, implements the features of both distance vector protocols and link state protocols hence it is considered as hybrid protocol. EIGRP is relying on the diffused update algorithm(DUAL) to calculate the shortest path to a destination within a network. EIGRP also has a great quality of being very easy on CPU utilization for devices. It is scalable; it does accommodate very large networks. EIGRP features a very simple configuration. Automatic summarization is enabled by default; so EIGRP acts in a class full manners and automatically summarizes prefixes. It also supports routing for multiple network protocols like IPX, AppleTalk and IP through the concept of Protocol Dependent Modules(PDM), by which EIGRP process uses a different route table for each network layer protocol.

Five possible components that used for metric calculation of EIGRP:

- Bandwidth: Weakest link bandwidth from the total path
- Delay: Sum of the delays occurred for the entire path
- Reliability
- Load
- MTU

If we pick up reliability and load for metric calculation, the metrics would be changing way too often and this will cause instabilities and problems in CPU utilization. So it was decided to use only bandwidth and delay.MTU is not involved in metric formula at all and it is just a potential tie-breaker. These components have corresponding Values. And the metric can be manipulated accordingly ,changing these K values. For two EIGRP routers to be neighbors, these values must match.

3.3.1. EIGRP Metrics

- Feasible Distance(FD) is purely the cost between the local router and the destination prefix.

- Advertised Distance(AD) is the cost from next hop to the destination prefix. Also called Reported Distance(RD)
- Successor is the finest(lowest cost)route to the destination.
- Feasible Successor is the next best route to the destination. The advantage with DUAL is that when a successor fails, it is immediately replaced by a feasible successor into the routing table. While choosing a feasible successor, it has to satisfy the feasibility condition -Next hop must have AD less than current FD of the current successor.
- Reply-generating a reply to a query

EIGRP also builds three separate tables similar to OSPF

- Neighbor table – list of all neighboring network routers. These routers must belong to the same Autonomous System
- Topology table – list of all routes in the Autonomous System
- Routing table – contains the best route for each known network

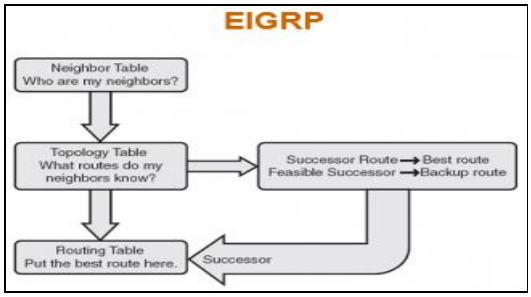


Figure 3: EIGRP Tables

4. Scenario Designed

The various routing protocols analyzed and performance are examined RIP,OSPF 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 2 inters network communication is carried out.

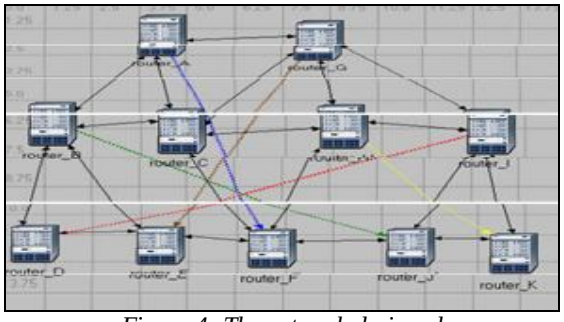


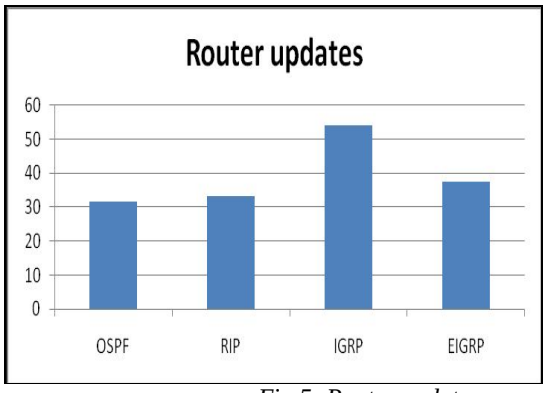
Figure 4: The network designed

5. Analysis

We here analyzed the performance of various routing protocols naming RIP,OSPF and EIGRP over a scenario of size 15sq km consisting of gateway routers and on simulating the network we obtained the following results for best effort traffic which are shown below in table 1which 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 4-8 show the results obtained.

Protocol	OSPF	OSPF-area1	OSPF-area2	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

Table 1: Comparison On Basis Of Cost Of Delivery



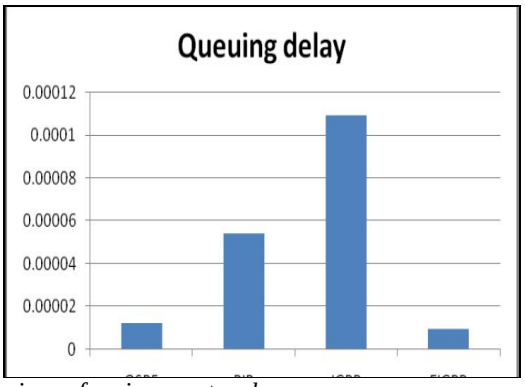
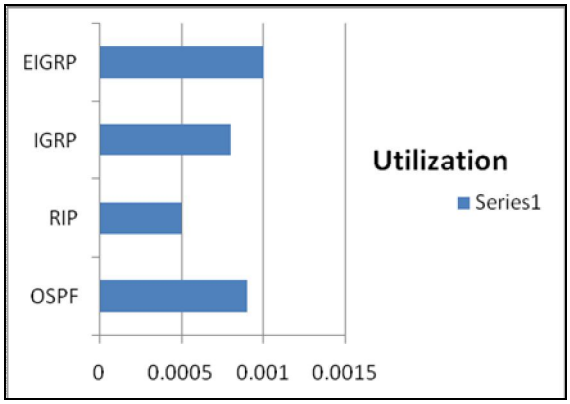


Fig 5: Router updates comparison of various protocols
Fig 6: Delay encountered by various protocols



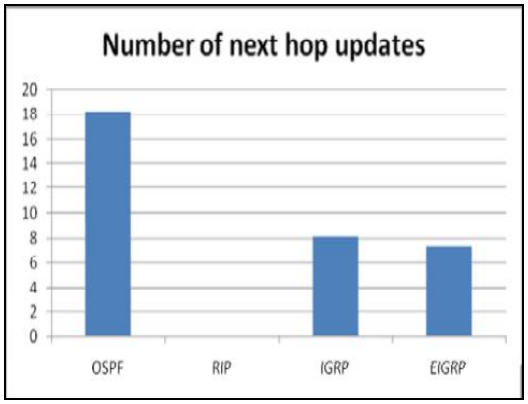


Fig 7: Link utilization of various protocols
Fig 8: Number of next hops updates of various protocols

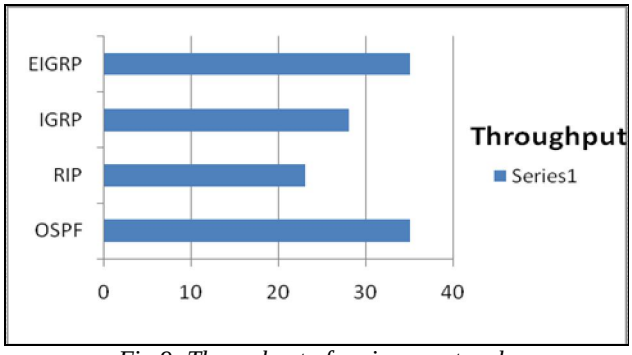


Fig 9: Throughput of various protocols

As per table 1 OSPF has the least cost of transmission followed by EIGRP, IGRP and RIP. In case of router overhead IGRP has the maximum overhead followed by EIGRP, OSPF and RIP .And on analyzing 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 ; for the case of queuing delay EIGRP has the least delay followed by OSPF, RIP and IGRP shown in figure and for the case of link utilization EIGRP has the maximum link utilization followed by OSPF, IGRP and RIP as shown in figure.

6. Conclusion

On comparing the results of the simulation of different protocols namely RIP,OSPF and EIGRP for convergence, throughput, link utilization and queuing delay, we can consider the performance of EIGRP to be the best among all. The second to EIGRP comes OSPF, which has the second highest link utilization and throughput after EIGRP. The choice between the two protocols i.e. OSPF and EIGRP can be difficult. Thus we may conclude that when we consider the above scenarios, EIGRP performs better but when the other criterion like least cost of transmission and lower router overhead are taken into consideration OSPF can be an alternate choice.

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