INTERNATIONAL JOURNAL OF
RESEARCH IN COMPUTER
APPLICATIONS AND ROBOTICS
ISSN 2320-7345

RIP, OSPF, EIGRP ROUTING PROTOCOLS

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ABSTRACT: - In a computer network, the transmission of data is based on the routing protocol which selects the best routes between any two nodes. Different types of routing protocols are applied to specific network environment. Three typical types of routing protocol are chosen as the simulation samples: RIP, OSPF and EIGRP. RIP (Routing Information Protocol) is one of the oldest routing protocols still in service. Hop count is the metric that RIP uses and the hop limit limits the network size that RIP can support. OSPF (Open Shortest Path First) is the most widely used IGP (Interior Gateway Protocol) large enterprise networks. OSPF is based on the Shortest Path First (SPF) algorithm which is used to calculate the shortest path to each node. EIGRP Enhanced Interior Gateway Routing Protocol) is Cisco's proprietary routing protocol based on Diffusing Update Algorithm. EIGRP has the fastest router convergence among the three protocols we are testing. More detailed description of these three routing protocols is included. We aim to analyze the performance of the three protocols in this paper

Keywords: RIP, OSPF, EIGRP, IGP, Shortest Path First (SPF).

I. INTRODUCTION

As long as a number of IP addresses can be used, the routing configuration is required so that these 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 worst problem that can happen is the loss of important information that is sent. This disorder can occur because the improper configuration of routing tables on the routers, the router device is down, or loss connections between routers. There are two different way to configure routing tables in the router. The routing tables on the routers can be configured by using static routing or active routing. Used for a Computer network that is not too large, it is advantageous to using static routing. In addition to save router resources, the configuration is not too difficult. When the computer network is larger, the use of static routing will be harder for administrators who are responsible to manage the routing tables. The number of entries in the routing table and also the accuracy of each entry is a key factor for the performance of the computer network. If there are changes that occur in the topology, routing tables must be updated soon. So the packet sent on the network is not discarded because of an error in the routing table.

The classification of routing protocol:

The classification of routing protocol is depicted in below. Where there are some dynamic routing protocol can be used to configuring routing tables in the router. There is Interior Gateway Protocol (IGP) than should be used for the routers in same domain network such as Routing Information Protocol (RIP), Enhanced Interior Gateway

Routing Protocol (EIGRP), Open Shortest Path First (OSPF) and ISIS (Intermediate System – Intermediate System). And for the routers in different domain network, Exterior Gateway Protocol (EGP) can be used such as Border Gateway Protocol (BGP). For the router in the same domain network, there are two types of dynamic routing protocols that can be used on computer networks, namely distance vector and link-state routing protocols.

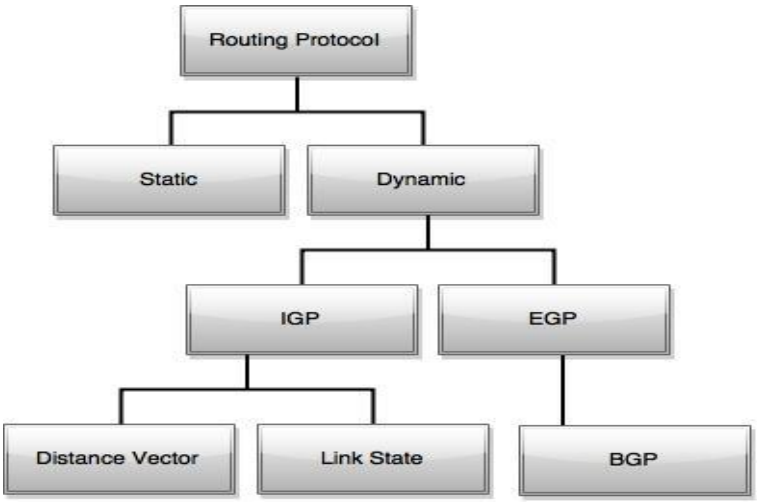

Fig 1: Routing protocol classification

Both types of routing protocols have advantage and disadvantages. For the distance vector type, EIGRP (Enhanced Interior Gateway Routing Protocol) will be used. And for the link-state type, OSPF (Open Shortest Path First) will be used. Both of these dynamic routing protocols can be used in both IPv4 and IPv6 networks.

II. OPEN SHORTEST PATH FIRST (OSPF)

OSPF, a link - state routing protocol, is used in large organizations for their Autonomous System (AS) networks. OSPF gathers link state information from available routers and determines the routing table information to forward packets to based on the destination IP address. This occurs by creating a topology map for the network. Any change in the link is immediately detected and the information is forwarded to all other routers, meaning they also have the same routing table information. Unlike RIP, OSPF only multicasts routing information when there's a change in the network. OSPF is used in complex networks that are subdivided to ease network administration and optimize traffic. It quickly calculates the shortest path if topology changes, using minimum network traffic.

OSPF allows network admin to assign cost metrics for a particular router so that some paths are given higher preference. OSPF also provides an additional level of routing protection capability and ensures that all routing protocol exchanges are authenticated.

<table>
<tr><td colspan="2">Version #</td><td colspan="2">Type</td><td colspan="2">Packet Length</td></tr>
<tr><td colspan="6">Router ID</td></tr>
<tr><td colspan="6">Area ID</td></tr>
<tr><td colspan="3">Check Sum</td><td colspan="3">Authentication Type</td></tr>
<tr><td colspan="6">Authentication</td></tr>
<tr><td colspan="6">Authentication</td></tr>
</table>

OSPF Message Types

OSPF doesn't send information using UDP. Instead, it builds IP datagram's directly, packaging them using protocol number 89 for the IP protocol field. Different message types of OSPF include:

- **Hello Packet** – Sent by routers to set up relationships with neighbors and communicate frequently to keep the connection alive. Hello Packet shares key parameters on how OSPF is to be used within the network.
- **Database Description** – The description of the link state database for autonomous systems are transmitted from one router to another.
- **Link State Request** – This is requested when a portion of the network needs to be updated with current information. The message specifies exactly which links are requested by the device that wants more current information.
- **Link State Update** – This contains the updated information for the requested links. It's sent in response to the LS request.
- **Link State Acknowledgement** – This acknowledges the link-state exchange process for link state update message.

OSPF – Pros and Cons

OSPF routing protocol has a complete knowledge of network topology allowing routers to calculate routes based on incoming requests. Additionally, OSPF has no limitations in hop count, it converges faster than RIP, and has better load balancing. A downside with OSPF is that it doesn't scale when there are more routers added to the network. This is because it maintains multiple copies of routing information. An OSPF network with intermittent links can increase traffic every time a router sends information. This lack of scalability in OSPF makes it unsuitable for routing across the Internet.

III. ROUTING INFORMATION PROTOCOL (RIP)

Routing Information Protocol (RIP), is one of the most commonly used routing protocols for small homogeneous networks. As a distance-vector routing protocol, RIP is used by routers to exchange topology information periodically by sending out routing table details to neighboring routers every 30 seconds. These neighboring routers in turn forward the information to other routers until they reach network convergence. RIP uses the hop count metric with the maximum limit of 15 hops, anything beyond that is unreachable. Because of this, RIP is not suitable for large, complex networks.

RIPv1 vs. RIPv2

There are two versions of RIP. RIP version 1 uses classful routing and does not include subnet information while sending out periodic routing table updates. RIPv2 is classless and includes the subnet information supporting Classless-Inter Domain Routing (CIDR).

<table>
<tr><td colspan="2">Command</td><td colspan="2">Version</td><td colspan="2">Must be Zero (Unused)</td></tr>
<tr><td colspan="3">Address Family Identifier</td><td colspan="3">Route Tag</td></tr>
<tr><td colspan="6">IP Address</td></tr>
<tr><td colspan="6">Subnet Mask</td></tr>
<tr><td colspan="6">Next Hop</td></tr>
<tr><td colspan="6">Metric</td></tr>
</table>

Unlike RIP version 1, version 2 multicasts the routing updates to the adjacent routers using the address 224.0.0.9. Network convergence happens much faster in RIPv2.

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RIP – Advantages and Disadvantages

Routing Information Protocol has its own advantages in small networks. It's easy to understand, configure, widely used, and is supported by almost all routers. Since its limited to 15 hops, any router beyond that distance is considered as infinity, and hence unreachable. If implemented in a large network, RIP can create a traffic bottleneck by multicasting all the routing tables every 30 seconds, which is bandwidth intensive. RIP has very slow network convergence in large networks. The routing updates take up significant bandwidth leaving behind very limited resources for critical IT processes. RIP doesn't support multiple paths on the same route and is likely to have more routing loops resulting in a loss of transferred data. RIP uses fixed hop count metrics to compare available routes, which cannot be used when routes are selected based on real-time data. This results in an increased delay in delivering packets and overloads network operations due to repeated processes.

IV. ENHANCED INTERIOR GATEWAY ROUTING PROTOCOL (EIGRP)

EIGRP, a distance vector routing protocol, exchanges routing table information with neighboring routers in an autonomous system. Unlike RIP, EIGRP shares routing table information that is not available in the neighboring routers, thereby reducing unwanted traffic transmitted through routers. EIGRP is an enhanced version of IGRP and uses Diffusing Update Algorithm (DUAL), which reduces the time taken for network convergence and improves operational efficiency. EIGRP was a proprietary protocol from Cisco®, which was later made an Open Standard in 2013.

<table>
<tr><td>Version</td><td>OPCode</td><td>CheckSum</td></tr>
<tr><td colspan="3">Flag</td></tr>
<tr><td colspan="3">Sequence Number</td></tr>
<tr><td colspan="3">Acknowledgement Number</td></tr>
<tr><td colspan="3">Autonomous System (AS) Number</td></tr>
<tr><td colspan="3">Type/Length/Value</td></tr>
</table>

EIGRP Packet Types

Different message types in EIGRP include:

- Hello Packet – The first message type sent when EIGRP process is initiated on the router. Hello packet identifies neighbors and forms adjacencies while being multicast every 5 seconds by default (60 seconds on low bandwidth network).
- Update Packet – Contains route information that is only forwarded when there is a change. They are only sent to the routes that have partial updates. If there's a new neighbor discovered, the packet is then sent to the router as a unicast.
- Acknowledgement – This is unicast as a response to Update packet by acknowledging when they receive an update.
- Query – This packet is sent to query routes from neighbors. When a router loses a route while sending the multicast, Query packet is sent to all neighboring routers to find alternate paths for the router.
- Reply – These are unicast by routers that know alternate routes for the neighboring routers queried on a network.

EIGRP – Pros and Cons

Speedy network convergence, low CPU utilization, and ease of configuration are some of the advantages of EIGRP. The EIGRP routers store everything as routing table information so they can quickly adapt to alternate routes. The variable length subnet mask reduces time to network convergence and increases scalability. EIGRP also includes MD5 route authentication. Compared to RIP and OSPF, EIGRP has more adaptability and versatility in complex networks. EIGRP combines many features of both link-state and distance-vector. Since EIGRP is mostly deployed in large networks, routers tend to delay sending information during allotted time, which can cause neighboring routers to query the information again, thus increasing traffic.

V. SCENARIO DESIGNED

The various protocols we analyzed are RIP, OSPF, IGRP and EIGRP respectively.

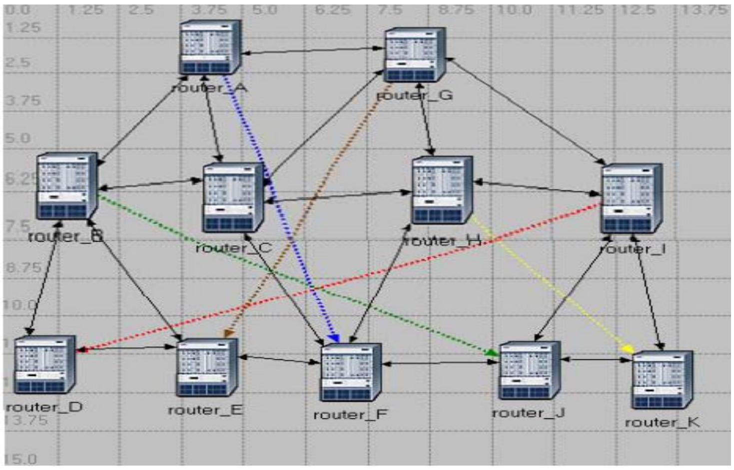

Fig 2: The network designed

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 inters network communication is allowed.

VI. ANALYSIS

We have analyzed the performance of various routing protocols naming RIP, OSPF, IGRP and EIGRP over a scenario of size 15 sq 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 4-8 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 3: Router updates comparison of various protocols

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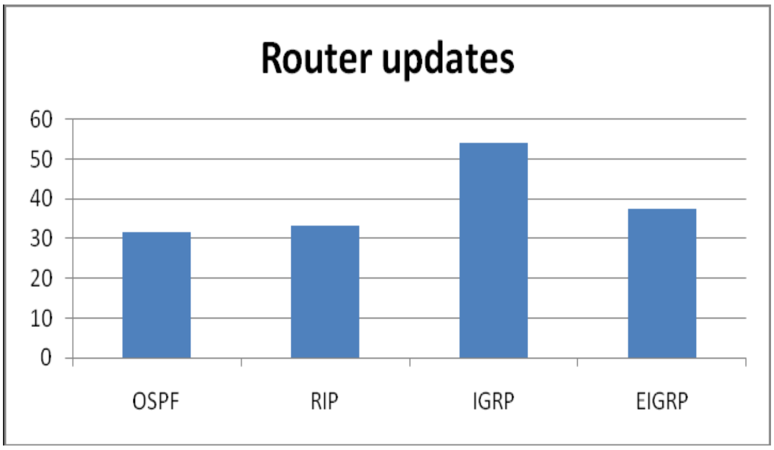


Fig 4: Number of next hops updates of various protocols

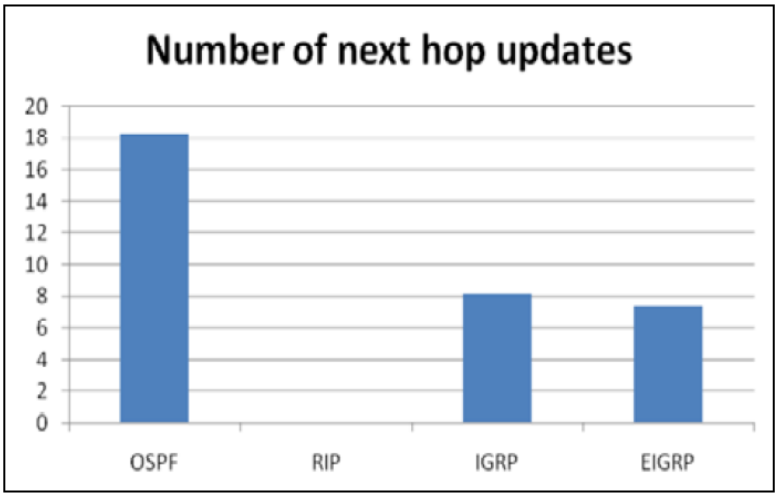


Fig 5: Link utilization of various protocols

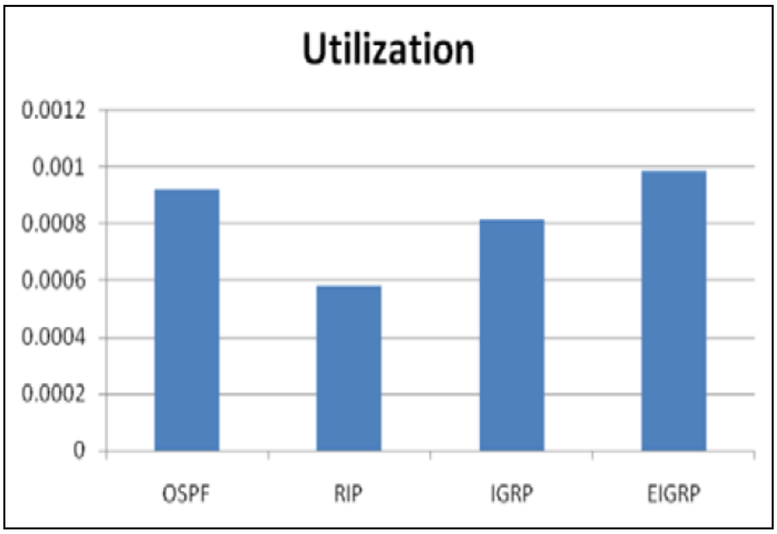


Fig 6: Throughput of various protocols

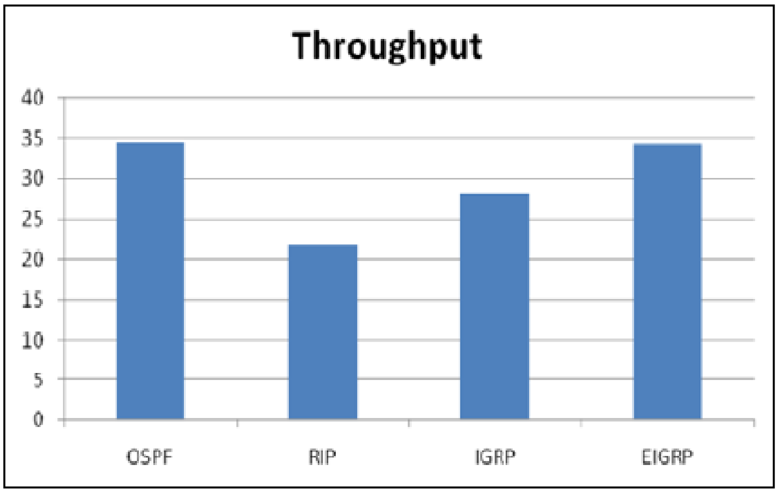
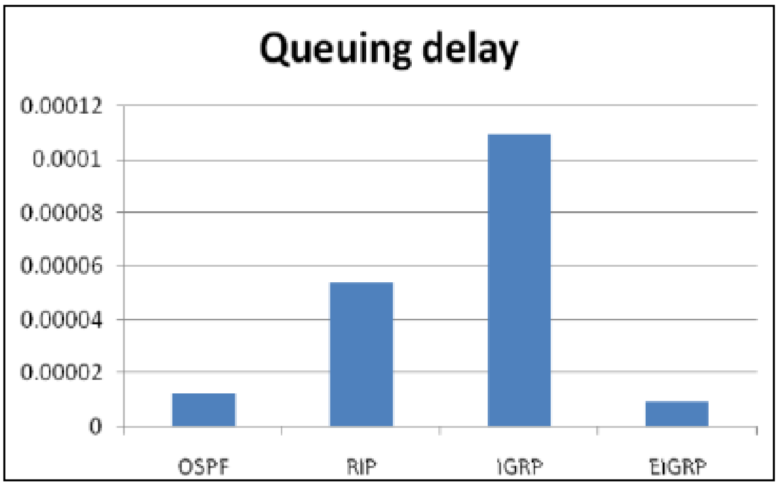


Fig 7: Delay encountered by various protocols



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 3-4 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 5; for the case of queuing delay EIGRP has the least delay followed by OSPF, RIP and IGRP shown in figure 7 and for the case of link utilization EIGRP has the maximum link utilization followed by OSPF, IGRP and RIP as shown in figure 6.

VII. CONCLUSION

This article concludes by presenting a comprehensive survey of current research on routing protocols from various experimental results evaluating the performance of RIP, OSPF, IGRP and EIGRP. All the protocols studied are all successful in improving the link utilization in a relatively static environment with long-lived flows. And many of them showed poor responsiveness to changing network conditions. Though there are various schemas and mechanisms proposed, there is no single mechanism that can overcome the unreliable nature of network in a reliable way.

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