Volume 4, Issue 7, July 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Survey of Ip Routing Protocols

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Abstract - In this internet era, routing protocols play an important role in path determination to send traffic fast. There are different types of routing protocols available such as static and dynamic routing protocols. Accordingly, this paper provides depth study of various dynamic routing protocols such as RIP, EIGRP and OSPF.

Keywords- Dynamic routing protocols, RIP, EIGRP, OSPF

I. INTRODUCTION

Routing is the prime factor in this modern era of internet communication. Several routing protocols are in existence in these days. The routing of packets between IP networks is carried out by two different ways i.e. static routing & dynamic routing. In static routing "static routes are usually manually configured by network administrator by adding entries into routing table though this may not always be the case[2]. Dynamic routing is widely used for big IP networks. The most commonly used dynamic routing protocols are RIP (Routing Information Protocol), OSPF (Open Shortest Path First), IGRP (Interior Gateway Routing Protocol) and EIGRP (Enhanced Interior Gateway Routing Protocol). Communication between two routing protocols is dependent upon the routing algorithm which is purely base dependent upon the metrics to find the path to transfer the data across two networks. Routing protocols are basically divided into two types. First type is interior gateway routing protocols which is further divided into three subtypes which are distance vector, link state and hybrid routing protocols. RIP, OSPF, IGRP and EIGRP are the examples of interior gateway routing protocols. Second type is Exterior gateway routing protocols. BGP and BGP4 are the examples of exterior gateway routing protocols. The basic functionality of routing protocols is to move traffic across the networks and the routers should be aware of where they forward the data in order to reach the correct destination node. For the success of network, routing protocols play the crucial role. In this paper three routing protocols, RIP (Distance vector protocol), OSPF (Link state Protocol) and EIGRP (Hybrid Protocol) are analyzed.

II. RELATED WORK

[6]This paper settles an open question with a positive answer: Optimal traffic engineering can be realized using just link-state routing protocols with hop-by-hop forwarding. Today's typical versions of these protocols, Open Shortest Path First (OSPF) and Intermediate System-Intermediate System (ISIS), split traffic evenly over shortest paths based on link weights. However, optimizing the link weights for OSPF/ISIS to the offered traffic is a well known-hard problem and even the best setting of the weights can deviate significantly from an optimal distribution of the traffic. In this paper, they proposed a new link-state routing protocol, PEFT that split traffics over multiple paths with an exponential penalty on longer path. Unlike its predecessor, DEFT, a new protocol provably achieves optimal traffic engineering while retaining the simplicity of hop-by-hop forwarding. The new protocol also leads to a significant reduction in the time needed to the best Link weights. Both the protocol and the computational methods are developed in a conceptual framework, called Network Entropy Maximization that is used to identify the traffic distributions that are not just most select, but also achievable by link-state routing.

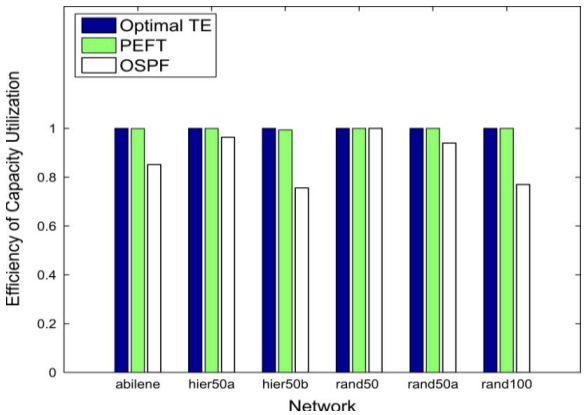

Fig 1 Efficiency of capacity utilization of optimal traffic engineering, PEFT and Local Search OSPF.

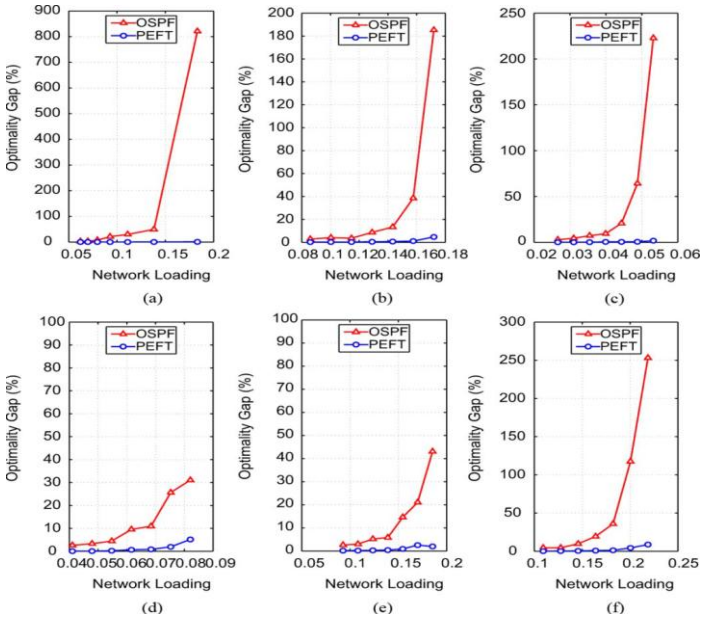

Fig 2 Comparison of PEFT and Local Search OSPF in terms of optimality gap on minimizing total link cost. (a) Abilene network. (b) Rand100 network. (c) Hier50b network. (d) Hier50a network. (e) Rand50 network. (f) Rand50anetwork.

[4]This paper presents the performance of the routing protocols it was observed that to have fastest e-mail upload response time EIGRP should be preferred for the workstations ranging from 1 to 25 but OSPF dominates in performance for 50 workstations however this difference is very small. Further to have fast HTTP page response time, again the preferred protocol is EIGRP except for the case of individual workstations giving slowest performance but as the number of workstations increases EIGRP performs well among all. Hence for the considered scenario overall best performance is delivered by EIGRP. It is considered that EIGRP is the preferred protocol for small networks but our network is a large scale network in which EIGRP performed well. Also EIGRP converges faster which means EIGRP is fast in response in comparison to OSPF, the point is again proved in the research.The results are shown below

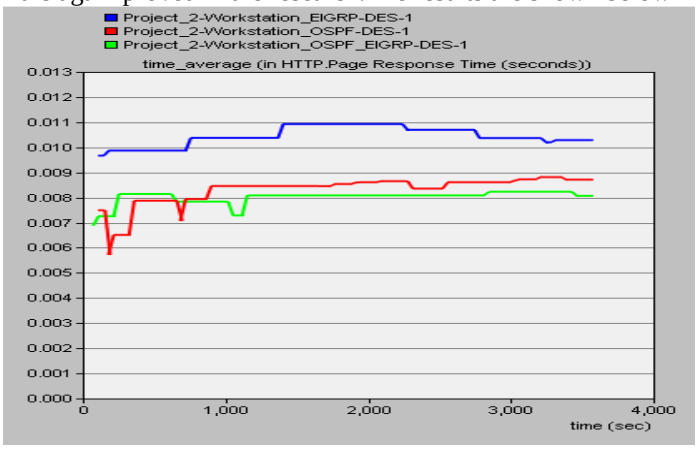

Fig 3 HTTP Page Response Time

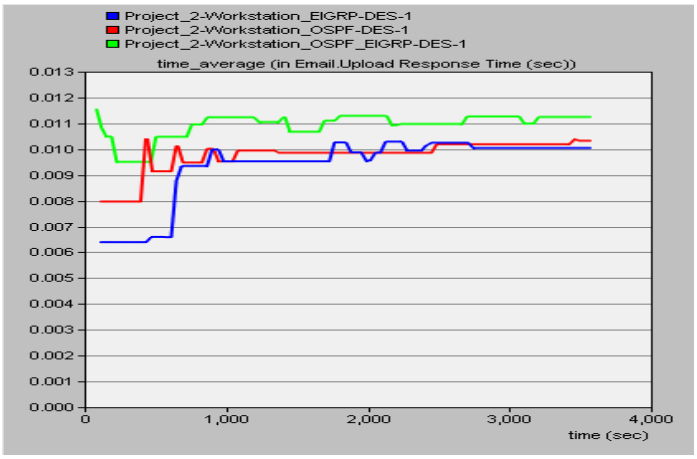

Fig 4 E-mail upload response time

[7]In this paper they analyze the challenging problem of energy saving in IP networks. A novel network-level strategy based on a modification of current link-state routing protocol, such as OSPF, is future; according to this strategy, IP routers are able to power off some network links during low traffic periods. The proposed solution is a three-phase algorithm: in the first phase some routers are elected as exporter of their own Shortest Path Trees (SPTs); in the second one the neighbors of these routers perform a modified Dijkstra algorithm to detect links to power off; in the last one new network paths on a modified network topology are computed. Performance study shows that, in an actual IP network, even more than the 60% of links can be switched off.

[8]This paper presents the implementation decisions to be made when the choice is between protocols that involve distance vector or link state or the combination of both. Here comparison is made between different parameters and detailed simulation study is performed on the network with different routing protocols and it has been shown that EIGRP provides a better network convergence time, less bandwidth requirements and better CPU and memory utilization compared to OSPF also RIP.EIGRP, OSPF also RIP are the active routing protocol 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, scalability, memory and CPU requirements, Security and bandwidth requirement etc .

III. DYNAMIC ROUTING PROTOCOLS

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

A. *Distance Vector characteristics:*

- The routing by distance vector collects data of the information of the routing table of its neighbors.
- 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.
- 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.
- In the link state routing, each router works independently to calculate its own shorter route towards the networks destiny.
- With the protocols of routing of connection state, the updates are caused generally by – in the topology.
- 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

Algorithm	**DVRP**	**LSRP**
Ease of configuration	Yes	No
Complexity	No	Yes
Bandwidth consumption	High	Low

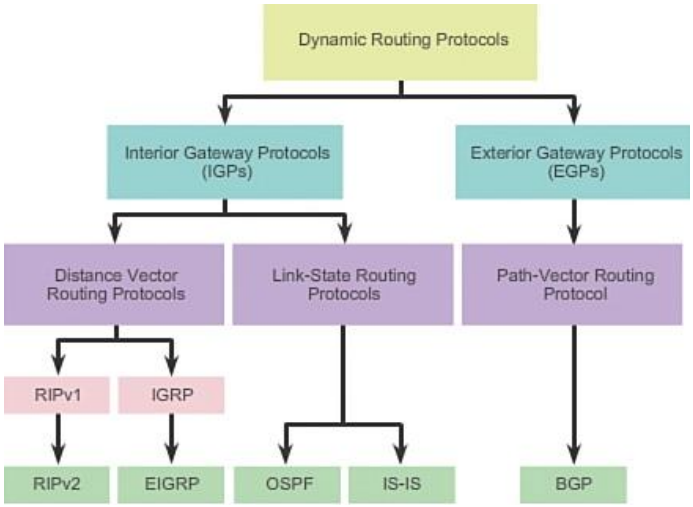

Fig 5 Dynamic Routing Protocol

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. RIP-based method is quick and accurate in a small or middle network [2].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:

- Vector routing protocol.
- It metric is the number of jumps.
- The maximum number of jumps is 15
- One updates every 30 seconds.
- Not always it selects the fastest route for the packages.
- 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	**RIP1**	**RIP2**
Best for	Small network	Small network
Supports VLSM	No	Yes
Classes	Full	Classless

V. EIGRP ROUTING PROTOCOL

EIGRP is a cisco proprietary protocol [1].It is a cross breed of distance vector protocols and link state advertisements.EIGRP uses the concept of autonomous systems to group routers which perform the same tasks. It learns about its routes from updates from other routers. But unlike other Distance vector protocols EIGRP maintains a partial topology of the network .It uses 3 tables to make routing decisions. The Routing table, the Neighbor table and the Topology table. EIGRP uses bandwidth and delay as the metrics to determine which route is the best. The protocol can also use bandwidth MTU, Reliability, load as metrics [3].

One of the major disadvantages of distance vector protocols is that they broadcast routing updates, since the updates are broadcasted they are received even by the host which is not required and hence bandwidth and system time is wasted in processing broadcast router updates that are received. EIGRP eliminates this by multicasting updates to 224.0.0.10.EIGRP also sends only triggered updates when a network is fully functional.

However it uses 1byte hello packets to verify if the neighboring router is alive or not. These hello packets are sent out every 5 seconds on LAN and multipoint connections (60 seconds in all other cases) and if the sending router doesn't receive a reply in 15 seconds (180 seconds in other cases) the router removes it from the routing table. EIGRP boasts faster convergence times, improved scalability, and superior handling of routing loops [9].

A. EIGRP metric calculation

Metric = [K1 * bandwidth + (K2 * bandwidth) / (256 - load) + K3 * delay] * [K5 / (reliability + K4)]
where K1,K3=1 and K2,K4,K5=0 [10]

B. EIGRP operation

EIGRP operation consists of 2 parts

1) Building neighbor relationships
2) Choosing routes

1) Building neighbor relations abbreviations:

For 2 routers running on EIGRP to become neighbors they must form an adjacency [4]. They can form an adjacency if and only if the autonomous system numbers and the K values on both the routers must be the same. Then the routers undergo the following steps.

- The first router generates a hello with its configuration information
- If the configuration information (Autonomous system numbers and K values) matches then the second router responds with an update message with its local topology table information (not its routing table as done by the distance vector protocols)
- The first router responds with an ACK message acknowledging the receipt of the second's Update
- The first router then sends its topology table to second router via an update message considered to be inaccessible or undesirable and is at an infinite distance.
- The second router responds with an ACK message

As for transferring of routing updates are concerned there are 3 types of messages involved [7]. They are

- UPDATE- Contains a routing update
- QUERY- Asks a neighboring router to validate routing information
- REPLY- Responds to a query message.

2) Choosing Routes:

EIGRP has the following metrics bandwidth, reliability, delay, load and MTU. However only fixed metrics such as bandwidth and delay are activated. EIGRP maintains something such as successor route and a feasible successor route in the local topology table. Successor route is the route via which the packets are forwarded and has the best metric. Feasible successor route is the route with which the router will forward packets once the successor route goes down or has the second best metric. This is the advantage of EIGRP, once a route goes down it doesn't have to send hello packets to find out another alternative route. It just brings on the feasible successor route.

VI. OPEN SHORTEST PATH FIRST (OSPF)

A Link-state routing is a concept used in routing of packet-switched networks. Link-state routing works by having the routers tell every router on the network about its closest neighbors[8].Link-state routing protocol is also known as shortest path routing protocol, as it compute the finest path in the network which is the shortest path available from the source network to the destination network. Each router joined the routing domain, will held link state databases which consist of a router list in the network. Every router has the same database. The database then is used to describe to network topology. Each router in the same domain will run the algorithm using their link-state database. Firstly, they will build a tree with each router as the root. Then, the tree consists of shortest path available to each router in that network. Other router which is joined the network will be known as leave. Linkstate advertisement (LSA) is responsible for the routing information exchange between routers. Neighbor router information can be known each time LSA is received.LSA is sent by each routing using flooding method. Each router floods its LSA to the network, and then each router will receive the LSA and processed it. Every time a network topology altered, router will send LSA to the networks. Thus the other routers will know about the network topology changes soon. Dijkstra algorithm is used to computes the shortest path from each router to other router in the same routing domain. Dijkstra algorithm used cost for each link available in the router for the computation. OSPF is a routing protocol developed by Interior Gateway Protocol (IGP) working group of the Internet Engineering Task Force (IETF) for Internet Protocol (IP) network. OSPF is a connect state routing protocol that is used to distribute routing information within a single Autonomous System (AS).

A. OSPF metric calculation

Cost = Reference / Bandwidth.

By default, Reference is 100000 [Kb/s].

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

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

The Advantage of OSPF routing protocol are:

- OSPF is not a CISCO proprietary protocol.
- OSPF always determines the loop free routes.
- If any changes occur in the network it updates fast.
- Low bandwidth utilization.
- Support multiple routes for a single destination network.
- OSPF is based on cost of the interface.
- Support Variable Length Subnet Mask (VLSM)

The disadvantages of OSPF are:

- Difficult to configure

- More memory requirements.

[1]The OSPF is an open standard protocol that is most popularly used in modern networks. It is a link state protocol. It 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 been 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 size of an area must be optimal so that this enhances the stability. Because, for some change in state of a link for a route, each router in that area needs to re-calculate its routes and this would definitely takes up a significant amount of the router's 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, only at the Area Border Routers (ABRs) and Autonomous System Boundary Routers (ASBRs).

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

OSPF uses bandwidth for metric calculation. Based upon the bandwidth of the link that is being used, a metric value is assigned. The higher the bandwidth, the lower is the metric (cost) assigned. For example, for an Ethernet link of bandwidth 10 Mbps, the cost assigned would be 10. Sum of the costs for the entire path gives the metric for a Route. Based upon the information available in the topology table, each OSPF router runs SPF (Shortest path First) algorithm and calculates the shortest path to every prefix within the same area. In case of any change in the state of a link, the OSPF router sends it in a partial update and is flooded throughout the entire network.

[2]OSPF areas and address aggregation are crucial in enabling OSPF to scale for AS domains comprising hundreds or thousands of subnets; specifically, they play an important role in optimizing router and network resource consumption, as explained below.

- ***Router Memory*:** For OSPF areas not directly connected to a router in the AS, the router's routing tables only need to contain entries corresponding to subnet aggregates rather than individual subnet addresses. In other words, a router stores individual subnet addresses in its routing table only for the OSPF areas that are directly linked to it. This observably leads to lesser routing table sizes and, thus, lowers memory requirements at routers.

- ***Router Processing Cycles*:** The link-state database maintained at each router is much smaller, since it only needs to include summary information for subnets belonging to OSPF areas not directly connected to the router. Consequently, the computational cost of the shortest-path calculation decreases substantially.

- ***Network Bandwidth*:** For subnets within each OSPF area, only aggregate address information (rather than individual subnet addresses) is flooded into the rest of the AS network. As a result, the volume of OSPF flooding traffic necessary to synchronize the link-state databases of the AS routers is significantly reduced.[10]

VII. CONCLUSION

In recent years, routing protocols has unique challenges and design issues. In this Paper; we have discussed different dynamic routing protocols and design issues with them. RIP does not work well in large scale networks because of it hop count limit to 16, .EIGRP and OSPF and RIP protocols have different features. EIGRP works well in large scale networks but it is CISCO proprietary. OSPF also works well in large scale networks but route discovery after link failure takes more time because it does not have backup route as EIGRP but OSPF is open standard and it does not trust neighbor router for the path selection.

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