

# Analysis of IP Routing Protocol

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**Abstract**— In the sector of computer networking, a routing Protocol specifies how routers communicate to pick the foremost effective route for information or data transfer between computer nodes. This paper discusses the routing process and appears at a generic classification of routing protocols. It also summarizes the features of variety of the foremost significant protocols like RIP, OSPF, IS-IS, IGRP, EIGRP and BGP, while comparing their individual functioning.

**Index Terms**—Routing protocol, networking, QoS, performance analysis, optimal routing protocol selection CISCO, RIP, EIGRP, OSPF, BGP, RR.

## I. INTRODUCTION

Data Routing refers to the tactic of determining the only Route for the transmission of data packets from source to destination and it's based upon routing protocols. Routing protocols are a gaggle of rules which a communication network follows when computers plan to communicate with each other across networks. A routing protocol could also be a protocol that specifies how routers communicate with each other, disseminating information that allows them to select routes between any two nodes on a network [1]. Routing Algorithms are liable for selecting the simplest path for the communication. A routing protocol is therefore the language a router speaks with other routers so as to share information about the reachability and standing of the network [2].

Networks using OSPF Protocol”, International Journal of Scientific and Research Publications, ISSN 2250-315, vol. 3, no. 4, (2016). [20] A. Kudtarkarl, R. Sonkusare and A, Ambawade, “Performance Analysis of Routing Protocols for Real Time Application”, IJARCC, vol. 3, January 2014.

## II. CLASSIFICATION AND PREDICTION

Routing is established by the configuration of routing tables within the routers. There are two alternative ways to configure routing tables in router- static routing and dynamic routing. Static routing is that the process of manually entering routes into the routing table of a tool using its configuration file that's loaded when the routing device starts up. In static routing, all the changes within the logical network layout need to be manually done by the supervisor. However, dynamic routing allows routers to select the only path when there is a true time logical network layout change. Static routing is straightforward to implement in small networks. [3] These networks are very safe and predictable because the route to the destination always remains an equivalent and doesn't require any routing algorithm or update mechanisms. But

dynamic routing protocols work well and are suitable altogether topologies where multiple routers are required. they're scalable and automatically determine Better routes if there's a change within the topology. Their Ability to scale and get over internetwork faults makes Dynamic routing protocols a far better choice for medium, Large, and really large networks. Figure 1 depicts the Classification of dynamic routing protocols.

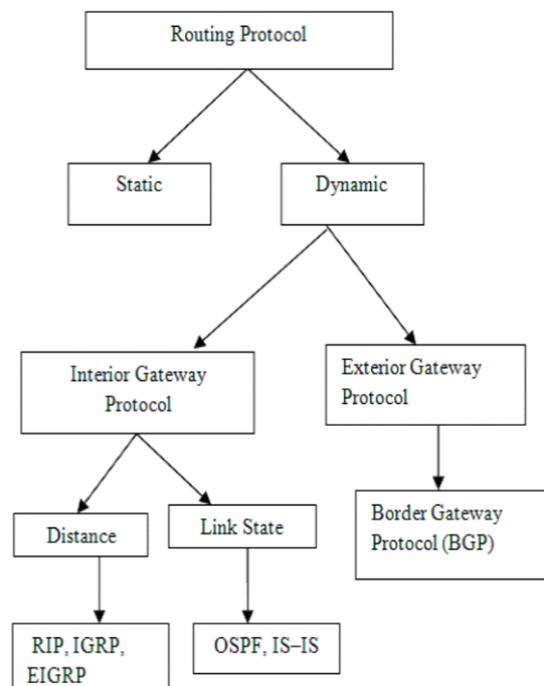


Figure 1. Forms of Routing Protocols

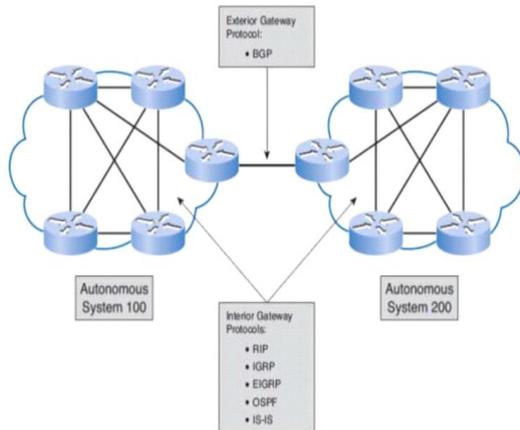
Dynamic routing protocols are classified into EGP and IGP, which is further classified into distance vector routing protocol and link state routing protocol. Distance vector protocol uses simple algorithms to calculate cumulative distance value between routers supported hop count. Link state protocols use sophisticated algorithms that maintain complex database of internetwork topology.

A. IGP and EGP An Autonomous System &#40;AS&#41; may be a collection of routers under a standard administration like a corporation or a corporation. An AS is additionally mentioned as a routing domain. Typical samples of an AS are a company's internal network and an ISP's network. the web is based on the AS concept; therefore, two kinds of routing protocols are required:

·Interior Gateway Protocols (IGP): Used for routing within an AS. it's also mentioned as intra-AS routing. use an IGP on their internal networks [4]. IGP's include RIP, EIGRP, OSPF,

and IS-IS. Companies, organizations, and even service providers

·Exterior Gateway Protocols (EGP): Used for routing between autonomous systems. it's also mentioned as inter-AS routing. Service providers and enormous companies may interconnect using an EGP. The Border Gateway Protocol (BGP) is that the sole currently viable EGP and is that the official routing protocol employed by the online.



**Figure 2.** Shows the position of employment of the aforementioned protocols in a networking domain. (Position of various protocols in a network infrastructure)

### III. ROUTING INFORMATION PROTOCOL (RIP)

How RIP works is an initial router will send a replica of its entire routing table to all or any of its neighboring routers every 30 seconds plus a little random number to avoid all of the routers updating their tables at an equivalent time. Those routers will then update their tables thereupon information, keeping only the simplest routes in their

Routing tables, then send their entire routing table to their neighbors. This cycle will continue until all of the routers within the network have exchanged information about one another. The knowledge being passed is that the number of hops a given node is away. A hop meaning subsequent step within the network. This is often referred to as distance vectoring. The protocol avoids indefinite routing loops by limiting what percentage hops away a destination are often. If a destination is quite 15 hops away, RIP marks it as unreachable. This has the advantage of avoiding loops and therefore the disadvantage of limiting the dimensions of a network to fifteen hops. § RIPv1: RIPv1 supports Classful routing; therefore variable length subnet masks (VLSM) can't be used. There's also no authentication mechanism.

RIPv2: RIPv2 supports Classless Inter-Domain Routing (CIDR). It uses MD5 mechanism for Authentication. Precondition of this method is that the routers within the network use RIP protocol because the tool of the route information exchanges [7]. RIP-based method is quick and accurate during a little or medium sized network. However, it's going to cause serious problems during a large scale network. As RIP uses UDP to broadcast its route messages, the messages aren't reliable and should be lost within the network. Also, it's unsafe to broadcast messages during a large scale network. When many broadcast messages are sent, it's going

to cause broadcast storm, which may cause the network to Breakdown. Besides, RIP protocol defines count of 16 as the state of unreachable. Hence, RIP-based protocol is out there for little or medium networks. So on form sure the routing table entries are correct, RIP routing table is updated periodically, and sends the updated routing table to adjacent routers [8]. Additionally, the routing table related to each entry features a Timer. When running RIP within the router where a route isn't Updated within the time prescribed, the route to live the Values is on the brink of infinity and marked for deletion. Thus, when The router exchanges routing information with other routers, Other routers know that the route has been ineffective.

#### Drawbacks

Although the RIP algorithm is comparatively simple, there are some drawbacks.

1. RIP subnet address isn't an idea. If a C class address within the last 8 bits of host number is 0, then the RIP cannot distinguish whether the non-zero parts are a subnet or variety address.
2. RIP router within the routing table provides the utmost hop count as 15. When the number of hops to the destination host is kind of 15, that router is unreachable.
3. RIP route selection is just a measure of the number of hops; it can't be combined with other network routing performance considerations.
4. When the network fails, it needs an extended time to transfer this information to all or any or any or any routers. This process is comparatively slow and slow convergence may cause problems. So it is not suitable for frequent changes in routing as within the case of a large-scale Internet environment.

### IV. INTERIOR GATEWAY ROUTING PROTOCOL (IGRP)

IGRP stands for Interior Gateway Routing protocol which uses distance vector protocol to exchange data within a system [9]. IGRP could even be a proprietary protocol that was created partially to beat the restrictions of RIP which had a maximum hop count of only 15, and one routing metric when used within large networks. It supports multiple metrics for every node which incorporates delay, load and bandwidth, so on match the two routes which are combined into single metrics. The utmost 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.

The IGRP protocol allows kind of gateways to coordinate their routing [10]. Its goals are the following:

- Stable routing even in very large or complex networks. No routing loops should occur, whilst transients.
- Fast response to changes in topology.
- Low overhead. That is, IGRP itself shouldn't use more bandwidth than what's actually needed for its task.
- Splitting traffic among several parallel routes once they're of roughly equal desirability.
- Taking under consideration error rates and level of traffic on different paths.

#### A. Operation

The path for routing packets from source to destination is calculated within the network. supported the metric information, one composite metric is calculated for the trail . The composite metric combines the effect of the various metric components into one number representing the goodness of that path. it's the composite metric that's actually want to choose the sole path. Periodically each gateway broadcasts its entire routing table to all or any or any or any adjacent gateways. When a gateway gets this broadcast from another gateway, it compares the table with its existing table. Any new destinations and paths are added to the gateway's routing table. Paths within the printed are compared with existing paths. If a replacement path is best, it's going to replace the prevailing one. Information within the printed is additionally want to update channel occupancy and other information about existing paths. This general procedure is analogous thereto employed by all distance vector protocols. it's mentioned within the mathematical literature because the Bellman-Ford algorithm. In IGRP, the overall Bellman-Ford algorithm is modified in three critical aspects. First, rather than an easy metric, a vector of metrics is employed to characterize paths.

Second, rather than picking one path with the tiniest metric, traffic is split among several paths, whose metrics fall under a specified range. Third, several features are introduced to supply stability in situations where the topology is changing. IGRP provides a system for interconnecting computer networks which may stably handle a general graph topology including loops. The system maintains full path metric information, i.e., it knows the trail parameters to all or any or any or the opposite networks to which any gateway is connected. Traffic are often distributed over parallel paths and multiple path parameters are often simultaneously computed over the whole network.

## V. ENHANCED INTERIOR GATEWAY ROUTING PROTOCOL (EIGRP)

Enhanced IGRP (EIGRP) could even be a classless, enhanced distance vector protocol. Like IGRP, EIGRP uses the concept of an autonomous system. EIGRP is usually mentioned as a hybrid routing protocol because it's characteristics of both distance-vector and link state protocols. as an example, EIGRP doesn't send link-state packets as OSPF does; instead, it sends traditional distance vector updates containing information about networks plus the price of reaching them from the attitude of the advertising router [11]. EIGRP has link-state characteristics as well: it synchronizes routing tables between neighbours at start-up then sends specific updates only topology changes occur. This makes EIGRP suitable for very large networks. EIGRP features a maximum hop count of 255 (the default is on the brink of 100).

Unlike many other protocols that use one factor to match routes and choose the sole possible path, EIGRP can use a mixture of subsequent factors:

- 1) Bandwidth: Weakest link bandwidth within the whole path
- 2) Delay: Sum of the delays for the whole path
- 3) Reliability
- 4) Load
- 5) MTU

Like IGRP, EIGRP uses only bandwidth and delay of the road to work out the sole path to a faraway network by default.

### A. Operation

Before EIGRP routers exchange routes with one another ,they must become neighbors. There are three conditions that possess to be met for adjacency establishment:

1. Hello or ACK received
2. AS numbers match
3. Identical metrics (K values)

Link-state protocols tend to use Hello messages to Establish adjacency because they normally do not send out Periodic route updates and there has to be some mechanism to help neighbors realize when a new peer has moved in or an old one has left or gone down. To maintain the Neighbor-relationship, EIGRP routers must also continue Receiving hellos from their neighbors. As long as Hello Packets are received, a router can determine that a neighbor is alive and functioning [12]. Once this is Determined, the neighboring routers can exchange routing Information.

### B. Salient Features

The salient features of EIGRP are as follows:

1. Support for IP and IPv6 (and some other routed protocols) via protocol dependent modules.
2. Considered classless (same as RIPv2 and OSPF).
3. Support for VLSM/CIDR.
4. Support for summaries and noncontiguous networks.
5. Efficient neighbor discovery.
6. Communication via Reliable Transport Protocol (RTP).
7. Best path selection via Diffusing Update Algorithm (DUAL).

### C. Diffusing Update Algorithm (DUAL)

The basis of Enhanced Interior Gateway Routing Protocol's operation is the Diffusing Update Algorithm (DUAL) [13], which is used to compute shortest paths without ever creating routing-table loops or incurring counting-to-infinity behavior. DUAL has been shown to be free of routing-table loops at every instant, regardless of the type or number of changes in the network, and to converge to correct routing-table values within a finite time after the occurrence of an arbitrary sequence of link-cost or topological changes [14]. Because DUAL is loop-free at every instant, it does not have any hop-count limitation, which is a necessity in case of RIP.

The distance information, known as a metric, is used by DUAL to select minimum cost loop free paths. DUAL selects routes to be inserted into a routing table based on feasible successors. A successor is a neighboring router used for packet forwarding that has a least cost path to a destination that is guaranteed not to be part of a routing loop. When there are no feasible successors but there are neighbors advertising the destination, a recomputation must occur. This is the process where a new successor is determined. The amount of time it takes to recompute the route affects the convergence time. Even though the recomputation is not processor intensive, it is advantageous to avoid recomputation if it is not necessary. When a topology change occurs, DUAL will test for feasible successors. If there are feasible successors, it will use any one that it finds in order to avoid any unnecessary recomputation.

Thus, EIGRP is the first internet routing protocol that provides loop-freedom at every instant and convergence

times comparable to those obtained with standard link-state protocols. Furthermore, EIGRP provides multiple paths to every destination that may have different weights.

#### D. Advantages of EIGRP

1. Easy to configure.
2. Loop free routes.
3. Keeps backup path to the destination network.
4. Convergence time is low and bandwidth utilization.
5. Support Variable Length Subnet Mask (VLSM) and Classless Inter Domain Routing (CIDR).
6. Supports authentication.

#### E. Disadvantages of EIGRP

1. Considered as Cisco proprietary routing protocol.
2. Routers from other vendors are not able to utilize EIGRP.

### V. OPEN SHORTEST PATH FIRST (OSPF)

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 link state protocol which maintains the routing table for all connections in the network. OSPF runs on top of IP, i.e., an OSPF packet is transmitted with IP data packet header. The concept of OSPF routing is based on creating, maintaining and distributing a link state database, which describes a collection of routers and their operational interfaces, how they are interconnected and cost to use the interfaces. Cost is a metrics used to describe the relative efficiency of various routes to the destination [15]. Each router in a particular domain runs the algorithm using their link-state database. Each router in the routing domain is responsible for the creation of its local piece of topology by link state advertisements (LSA). LSAs contain information describing routers, networks, reachable routes, route prefixes and metrics. The LSAs are then reliably distributed to all other routers in a process called flooding, which allows OSPF routers to synchronize their topology databases. Most of the OSPF operations are dedicated to keeping the link-state database synchronized among OSPF routers. As long as every OSPF router has an identical link state database, every router can calculate the shortest paths to the advertised destination using Dijkstra Shortest Path First algorithm [16]. Dijkstra algorithm uses the cost to each link available in the router network for computation. OSPF has five different packet types, where each packet in the route has a specific purpose. The following types of packets are sent within these networks:

- a. Hello packet
- b. Database description
- c. Link state request packet
- d. Link state update
- e. Link state acknowledgement packet

#### OSPF Area Design

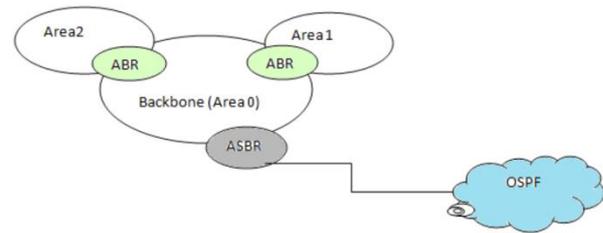


Figure 3. Area Design of OSPF Routing Protocol.

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.

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.

**1. 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.

**2. 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 shortest-path calculation decreases substantially.

**3. 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.

#### A. Advantages of OSPF

1. OSPF is not a Cisco proprietary protocol
2. OSPF always determines loop free routes
3. If any changes occur in the network, it updates its database quickly
4. Low bandwidth utilization
5. Supports multiple routes for a single destination network
6. OSPF is based on cost of the interface
7. Supports Variable Length Subnet Mask (VLSM)

#### B. Disadvantages of OSPF

1. Difficult to configure
2. More memory requirements

## VII. INTERMEDIATE-SYSTEM TO INTERMEDIATESYSTEM (IS-IS)

IS-IS stands for Intermediate - System to Intermediate -System which uses link-state routing algorithm for high speed data transmission. The protocol was defined in ISO/IEC 10589:2002 as an international standard within the Open Systems Interconnection (OSI) reference design [17].

Intermediate System-Intermediate System (IS-IS) is a Shortest Path First (SPF) protocol which is one of the most commonly used intra-domain internet routing protocols. It is similar to the OSPF protocol, which is also a link state protocol. The traffic is routed along shortest path to the destination. The weights of the links, and thereby the shortest path routes, can be changed by the network operator. A simple default weight setting suggested by Cisco is to make the weight of a link inversely proportional to its capacity. The general objective in setting weights is to route demands through an OSPF/IS-IS based network so as to avoid congestion in terms of link loads exceeding capacities with resulting packet loss and back-off in TCP [18].

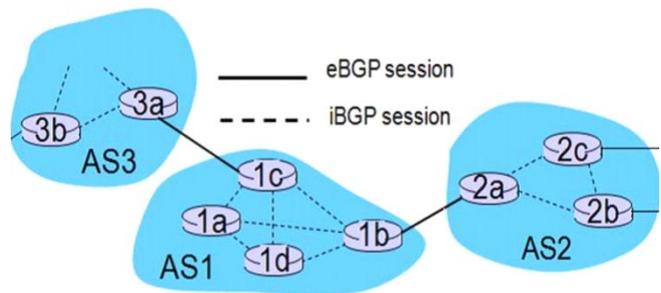
IS-IS does not use IP to carry routing information messages. IS-IS is neutral regarding the type of network addresses for which it can route. OSPF version 2 on the other hand, was designed for IPv4. This allowed IS-IS to be easily used to support IPv6. To operate with IPv6 networks, the OSPF protocol was rewritten in OSPF v3 [17]. IS-IS routers are designated as being: Level 1 (intra-area); Level 2 (inter area); or Level 1-2 (both). Level 2 routers are interarea routers that can only form relationships with other Level 2 routers. Routing information is exchanged between Level 1 routers and other Level 1 routers, and Level 2 routers only exchange information with other Level 2 routers. Level 1-2 routers exchange information with both levels and are used to connect the inter area routers with the intra area routers. IS-IS uses Dijkstra's algorithm in which independent database is built by each IS-IS router for computing the best path for transmission in a network [5].

## VIII. BORDER GATEWAY PROTOCOL (BGP)

This protocol differs significantly from the other that were discussed in its purpose. BGP is used to exchange routing information between the nodes/routers that connect a network of autonomous systems. It is often used in the routers that connect ASs to the internet. There are two versions that should be mentioned, Internal BGP (IBGP) and External BGP (EBGP). EBGP is used to for updating routing information between two or more Internet Service Providers. Within a service provider the routers will exchange routing information using IBGP.

**Internal BGP (iBGP):** When BGP runs between two peers in the same autonomous system, it is referred to as Internal BGP (iBGP). This BGP provides each AS a means to propagate reachability information to all As internal routers.

**External BGP (eBGP):** When BGP runs between different autonomous systems, it is called External BGP (eBGP). This BGP provides each AS a means to obtain subnet reachability information from neighboring autonomous systems. Figure 4 depicts the area of operation of eBGP and iBGP



### B. Operation

A router may learn about more than one route to the destination AS. In such a case, it selects the route based on:

1. Local preference value attribute: policy decision
2. Shortest AS-Path
3. Closest Next-Hop router: hot potato routing
4. Additional criteria

The BGP messages exchanged between peers over TCP connection could be any of the following:

- a. **Open:** Opens TCP connection to peer and Authenticates sender
- b. **Update:** Advertises new path (or withdraws old)
- c. **Keepalive:** Keeps connection alive in absence of Updates; also acknowledges Open request
- d. **Notification:** Reports errors in previous message; also used to close connection

BGP sessions are established between border routers that reside at the edges of an AS and border routers in neighbouring autonomous systems. These sessions are used to exchange routes between neighbouring autonomous systems. Border routers then distribute routes learned on these sessions to non border (internal) routers as well as other border routers in the same AS using internal-BGP (iBGP). In addition, the routers in an AS usually run an Interior Gateway Protocol (IGP) to learn the internal network topology and compute paths from one router to another. Each router combines the BGP and IGP information to construct a forwarding table that maps each destination prefix to one or more outgoing links along shortest paths through the network to the chosen border router.

### C. Salient Features

Thus, BGP is a relatively simple protocol with the following salient features.

1. BGP is an incremental protocol, where after a complete routing table is exchanged between neighbors, only changes to that information are exchanged. These changes may be new route advertisements, route withdrawals, or changes to route attributes.
2. BGP is a path-vector protocol where advertisements contain a list of autonomous systems used to reach the destination. Routes are advertised at the prefix level, so an AS would send a separate update for each of its reachable prefixes.
3. BGP update messages may contain several fields, including a list of prefixes being advertised, a list of prefixes being withdrawn, and a list of route attributes that describe various characteristics of each advertised route.

## IX. CONCLUSION

This paper thus presented a detailed analysis of various routing protocols. RIP had been in use for a long time, relative to IP, and has done well. With the increased demand on all networks, especially IP, there needs to be improvement in performance, and that is where OSPF comes in, making a protocol that is more flexible and always creates an optimal path between a source and destination node. One point that is worth pointing out again is the effort the designers of OSPF have made, so the transition to the new protocol is easier, by building into the protocol the backward compatibility for RIP. So if one router is "speaking" RIP to a router that understands OSPF the system will not fail. The third internal protocol, EIGRP seems to be another improvement with every advantage of both, with the exception that it may not be as widely used as RIP. Notice that all of the articles that this paper looks at for further research are in the area of wireless networking, that was intentional because the trend in networking is going towards wireless. This opens up new areas of research, one of them being the design of new routing protocols.

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