

A Comparative Study of Routing Protocols

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Abstract— A reliable, secure and scalable communication platform relies on correct combination of protocols. This paper is all about routing protocols. Basically routing is useful for communication and disseminating information among the routers. Routing protocols are used for selecting best path for transferring data in a network. Here different types routing are presented and a comparative study has been done regarding the characteristic of each routing protocols. This to find out best protocols combination for any complex network for achieving fast and reliable communication.

Keywords— Static Routing, Dynamic routing, and Comparative study among all dynamic routing protocols.

I. INTRODUCTION

The primary purpose of routing protocols is to deliver packets from source to destination. To quickly adapt changes which occur in network the routing protocol uses various algorithm, process and message. The characteristic of routing protocols are:

Correctness: The routing should be done properly and correctly so that the packets may reach their proper destination.

Simplicity: The routing should be done in a simple manner so that the overhead is as low as possible. With increasing complexity of the routing algorithms the overhead also increases.

Robustness: Once a major network becomes operative, it may be expected to run continuously for years without any failures. The algorithms designed for routing should be robust enough to handle hardware and software failures and should be able to cope with changes in the topology and traffic without requiring all jobs in all hosts to be aborted and the network rebooted every time some router goes down.

Stability: The routing algorithms should be stable under all possible circumstances.

Fairness: Every node connected to the network should get a fair chance of transmitting their packets. This is generally done on a first come first serve basis.

Optimality: The routing algorithms should be optimal in terms of throughput and minimizing mean packet delays. Here there is a trade-off and one has to choose depending on his suitability.

Static Routing: In static routing network is fixed. Because fixed routing provides quick and reliable services and it does not work with complex algorithm and mechanism. Static routers are manually configured by network administrators. No extra node can be added or deleted after creating such network. It is basically used for building small network where the requirement of routes is less.

II. STATIC ROUTING ADVANTAGES AND DISADVANTAGES

Static routing advantages are as follows:

- **Minimal CPU processing:** Processors do not require a steady stream of information to function at a certain speed.
- **No overhead on network.** Overhead is any combination of memory, bandwidth, or other resources that are required to attain a particular goal.

Static Routing Disadvantages are as Follows:

- Configuration and maintenance are time-consuming.
- Manually update required when topology changes.
- Configuration is error-prone, especially in large networks.
- Administrator intervention is required to maintain changing route information.
- Does not scale well with growing networks;
- Maintenance becomes cumbersome.
- Requires complete knowledge of the entire network for proper implementation.

III. DYNAMIC ROUTING

- Dynamic routing, also called adaptive routing, describes the capability of a system, through which routes are characterized by their destination, to alter the path that the route takes.
- Classification of dynamic routing:
- According to the characteristic of routing protocols, the protocols are classified into various groups.

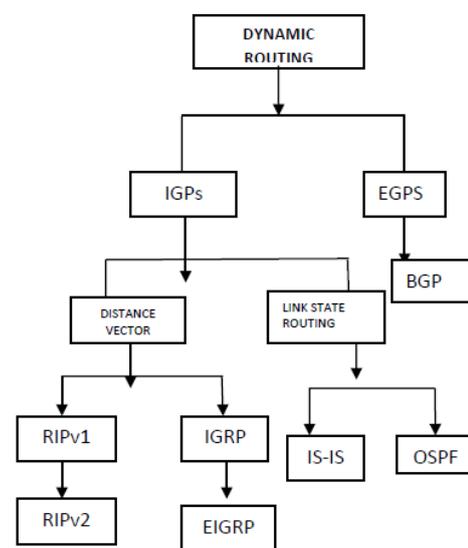


Fig. 1. Dynamic routing protocols.

IV. IGP

Interior Gateway Protocol (IGP) is a distance vector routing protocol used to communicate routing information

within a host network. It was invented by Cisco. IGP manages the flow of routing information within connected routers in the host network or autonomous system. The protocol ensures that every router has routing tables updated with the best available path. IGP also avoids routing loops by updating itself with the changes occurring over the network and by error management.

The Purpose of IGP:

Communicate routing information to all connected routers within its boundary or autonomous system. Continue updating whenever there is a topological, network or path change that occurs.

V. DISTANCE VECTOR ROUTING

Distance-vector protocols are based on calculating the direction and distance to any link in a network. "Direction" usually means the next hop address and the exit interface. "Distance" is a measure of the cost to reach a certain node. The least cost route between any two nodes is the route with minimum distance. Each node maintains a vector (table) of minimum distance to every node. The cost of reaching a destination is calculated using various route metrics. RIP uses the hop count of the destination whereas IGRP takes into account other information such as node delay and available bandwidth.

VI. LINK STATE ROUTING

Link-state routing protocols are one of the two main classes of routing protocols used in packet switching networks for computer communications, the other being distance-vector routing protocols. Examples of link-state routing protocols include Open Shortest Path First (OSPF) and intermediate system to intermediate system (IS-IS).

The link-state protocol is performed by every switching node in the network (i.e., nodes that are prepared to forward packets; in the Internet, these are called routers). The basic concept of link-state routing is that every node constructs a map of the connectivity to the network, in the form of a graph, showing which nodes are connected to which other nodes. Each node then independently calculates the next best logical path from it to every possible destination in the network. The collection of best paths will then form the node's routing table.

VII. RIP: (ROUTING INFORMATION PROTOCOLS)

The Routing Information Protocol (RIP), which is a distance-vector based algorithm, is one of the first routing protocols implemented on TCP/IP. Information is sent through the network using UDP. Each router that uses this protocol has limited knowledge of the network around it. This simple protocol uses a hop count mechanism to find an optimal path for packet routing. A Maximum number of 16 hops are employed to avoid routing loops. However, this parameter limits the size of the networks that this protocol can support. The popularity of this protocol is largely due to its simplicity and its easy configurability. However, its disadvantages include slow convergence times, and its scalability limitations. Therefore, this protocol works best for small-scaled networks.

Characteristic:

- First routing protocols implemented on TCP/IP.
- Distance-vector algorithm is used.
- Uses a hop count mechanism to find an optimal path for packet routing.
- Max hop count (16 hops) used to prevent infinite loops.
- It is used in Small networks.

Advantage:

- Simple protocol and easy to implement.

Disadvantage:

- Network size limitation.
- Slow convergence times, and its scalability limitations.

VIII. IGRP—INTERIOR GATEWAY ROUTING PROTOCOL

Characteristic:

- advanced distance vector protocol
- Increased scalability.
- Multiple path support.

Advantage:

- Easy to configure and use.
- Uses the delay, bandwidth, reliability, and load of a link as it's metric. This makes it very accurate in selecting the proper route.

Disadvantage:

- Not an Internet standard; all routers must be from Cisco Systems
- Converges slowly; slower than RIP
- Doesn't support VLSM
- Prone to routing loops

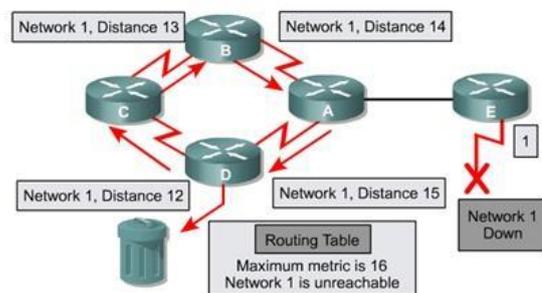


Fig. 2. Count to infinity that limits RIP network diameter of 15 or fewer hops.

IX. EIGRP: (ENHANCED INTERIOR GATEWAY ROUTING PROTOCOLS)

EIGRP is a Cisco-developed advanced distance-vector routing protocol. Routers using this protocol automatically distribute route information to all neighbours. The Diffusing Update Algorithm (DUA) is used for routing optimization, fast convergence, as well as to avoid routing loops. Full routing information is only exchanged once upon neighbour establishment, after which only partial updates are sent. When a router is unable to find a path through the network, it sends out a query to its neighbours, which propagates until a suitable

route is found. This need-based update is an advantage over other protocols as it reduces traffic between routers and therefore saves bandwidth. The metric that is used to find an optimal path is calculated with variables bandwidth, load, delay and reliability. By incorporating many such variables, the protocol ensures that the best path is found. Also, compared to other distance-vector algorithms, EIGRP has a larger maximum hop limitation, which makes it compatible with large networks. The disadvantage of EIGRP is that it is a Cisco proprietary protocol, meaning it is only compatible with Cisco technology.

Characteristic:

- Advanced distance-vector algorithm.
- Full routing information only exchanged once upon neighbour establishment, after which only partial updates are sent.

Advantage:

- Requires less CPU than OSPF.
- Requires little bandwidth for routing updates.
- Supports VLSM or CIDR.
- Uses the delay, bandwidth, reliability, and load of a link as its metric; this makes it very accurate in selecting the proper route.
- Offers backward compatibility with IGRP.

Disadvantage:

- Not an Internet standard, all routers must be from Cisco Systems.

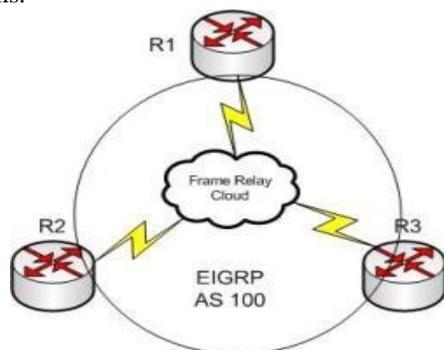


Fig. 3. EIGRP protocols.

X. OPEN SHORTEST PATH FIRST (OSPF)

Open Shortest Path First (OSPF) is a very widely used link-state interior gateway protocols (IGP). This protocol routes Internet Protocol (IP) packets by gathering link-state information from neighboring routers and constructing a map of the network. OSPF routers send many message types including hello messages, link state requests and updates and database descriptions. Djisktra’s algorithm is then used to find the shortest path to the destination. Shortest Path First (SPF) calculations are computed either periodically or upon a received Link State Advertisement (LSA), depending on the protocol implementation. Topology changes are detected very quickly using this protocol. Another advantage of OSPF is that

its many configurable parameters make it a very flexible and robust protocol

Characteristic:

- Converges quickly, compared to a distance vector protocol
- Routing update packets are small, as the entire routing table is not sent
- Not prone to routing loops
- Scales very well to large networks
- Recognizes the bandwidth of a link, taking this into account in link selection
- Supports VLSM or CIDR
- Supports a long list of optional features that many of the other protocols do not

Advantage:

- Fast detection of topology changes, flexibility in modifying parameters.

Disadvantage:

- Most complex routing protocol.

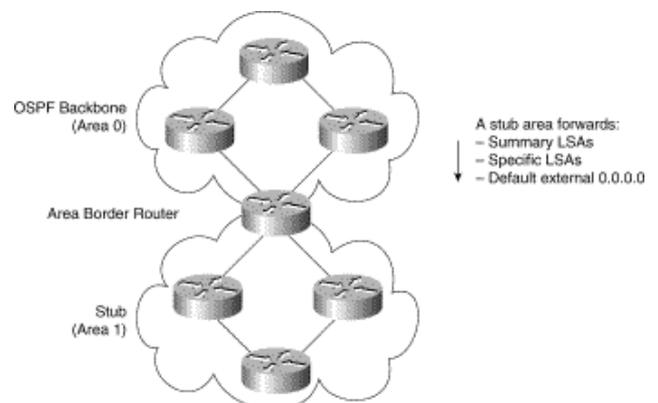


Fig. 4. OSPF hierarchical topology.

XI. IS-IS (INTERMEDIATE SYSTEM TO INTERMEDIATE SYSTEM)

In recent years, the IS-IS routing protocol has become increasingly popular, with widespread usage among Service Providers. It is a link state protocol, which enables very fast convergence with large scalability. It is also a very flexible protocol and has been extended to incorporate leading edge features such as MPLS Traffic Engineering. The IS-IS routing protocol is a link-state protocol, as opposed to distance-vector protocols such as Interior Gateway Routing Protocol (IGRP) and Routing Information Protocol (RIP). Link-state offers several advantages over distance-vector protocols. It is faster converging, supports much larger internetworks, and is less susceptible to routing loops.

Characteristic:

- Hierarchical routing.
- Classless behavior.
- Rapid flooding of new information.
- Fast Convergence.
- Very scalable.

- Flexible timer tuning.
- Link State
- Routes IP, CLNS
- Routing Advertisements: Partial When Routing Changes Occur
- Metric: Variable Cost (default cost 10 assigned to each interface)
- Hop Count: None (limited by network)

XII. EGP (EXTERIOR GATEWAY PROTOCOLS)

The Exterior Gateway Protocol (EGP) is an inter domain reach ability protocol used in the Internet a large, international network connecting research institutions, government agencies, universities, and private commercial businesses. EGP is documented in Request for Comments (RFC) 904, published in April 1984.

As the first exterior gateway protocol to gain widespread acceptance in the Internet, EGP served a valuable purpose. Unfortunately, the weaknesses of EGP have become more apparent as the Internet has grown and matured. Because of these weaknesses, EGP is currently being phased out of the Internet, and is being replaced by other exterior gateway protocols such as the Border Gateway Protocol (BGP) and the Inter domain Routing Protocol (IDRP).

XIII. BGP (BORDER GATEWAY PROTOCOL)

Border Gateway Protocol (BGP) are the core routing protocol of the internet and responsible to maintain a table of Internet protocol networks which authorize network reaching capability between AS. The Border Gateway Protocol (BGP) expressed as path vector protocol. It doesn't employ conventional IGP metrics but making routing judgment based on path, network policies. It is created to replace the Exterior

Gateway Protocol (EGP) routing protocol to permit completely decentralized routing in order to permit the removal of the NSF Net which consent to internet to turn into a truly decentralized system. The fourth version of Border Gateway Protocol (BGP) has been in use since 1994 and 4th version from 2006. The 4 version RFC 4271 has many features such as it correct a lots of previous errors, illuminating vagueness and brought the RFC much nearer to industry practice.

Characteristic:

- Path Vector.
- Routes IP.
- Routing Advertisements: Partial When Route Changes Occur.
- Metrics: Weight, Local Preference, Local Originated, As Path, Origin Type.
- Hop Count: 255
- Variable Length Subnet Masks
- Keep alive Timer: 60 seconds
- Hold down Timer: 180 seconds

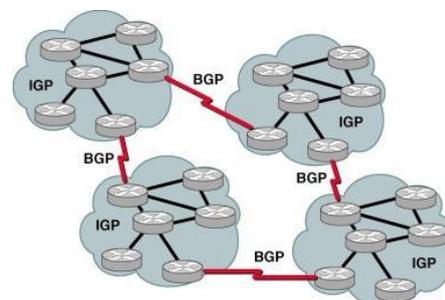


Fig. 5. Border gateway protocol.

TABLE I. Comparative study among RIPv1, RIPv2, OSPF, EIGRP, IGRP, IS-IS, BGP.

Features	RIPv1	RIPv2	OSPF	EIGRP	IGRP	IS-IS	BGP
Algorithms	Distance Vector.	Distance Vector.	Link state.	Both distance vector & link State.	Distance vector.	Link state	Best path Algorithm.
Metric	Hop count	Hop count	Cost, bandwidth	Delay, bandwidth, reliability, and load.	Delay, bandwidth, reliability, and load.	Variable Cost	Hop count
Maximum no of hops	15	15	Autonomous system is Treated as single Subsystem.	Maximum 255	Maximum 255 (default 100)	None	255
Subsystem segmentation	Autonomous system is treated as single Subsystem.	Autonomous system is treated as single Subsystem.	Breaks the Autonomous system in areas.	System is not divided in Areas.	No segmentation of AS.	Rapid flooding of new information.	Partial When Route Changes Occur.
Integrity	No authentication In RIP-1.	Authentication is added to RIP-2	Supports authentication	Supports authentication	No authentication	Supports authentication	Supports authentication
Complexity	Simple	Simple	Relatively complex	Highly complex	More complex than RIP	complex	complex
Protocols/port	UDP 520	UDP 520	IP 89	IP 88	IP 9.	IP124	TCP 179
Convergence	Slow convergence	Slow convergence	Generally faster than RIP	Fast convergence	Slow convergence	Fast convergence	Average

Administrative Distance	120	120	110	90	100	115	200
Update	Periodical Updates.	Periodical Updates.	Multicasts whenever changes are Made.	DUAL Multicast Incremental update.	Change with updating.	Change with updating	Change with updating.
Load balancing	Only supported on equal-cost Paths.	Only supported on equal-cost paths	Supports 6 equal-cost paths, but difficult to Implement.	Supports 6 unequal paths, but commonly ignored due to its complexity And instability.	Support unequal cost path load balancing.	IS-IS supports load balancing over and up to six equal-cost paths.	Unequal Bandwidth Allocated to the Paths
Scale	Small network.	Small network.	Enterprise network	Medium network.	Small to large network	large	Connect to different AS
Routing	Classful Routing loop counter mechanism	Classless	Classless	Classless 100% loop free.	Classful	Classless	Classless

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