Comparison of Distance Vector and Link State Routing Algorithms

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ABSTRACT

The paper will elaborate the comparison of various routing algorithms and protocols based on certain important features. The main stress will be on comparison of distance vector routing algorithm and Link State routing algorithm. The Paper will conclude that Link state routing algorithm/protocol (OSPF) is better as compared to distance vector routing algorithm /protocol (RIP, IGRP, EIGRP) based on certain features like scalability, hierarchical nature and convergence time, support of VLSM technology.

Introduction

The main function of networking layer is routing. Routing mainly concerned with path determination and data transportation. For path determination there are certain routing algorithms and protocols which are used. It is very important to decide the path, which is based on the algorithms and protocols used. Better the algorithm and protocol, better the path is selected and more conveniently data is transported.

Routing algorithm

The method in which the routing tables are created and updated is called the routing algorithm.

Routing Protocol - The software implementation of routing algorithm is called the routing Protocol. Routing protocol exist and operate only in routing devices, whereas network protocols such as IP (Internet Protocol), NetWare or DEC net, which are routable through routers are called routed protocols. Routing Protocols [1] are used by intermediate systems to build tables used in determining paths for data transportation. Examples of Routing Protocols are RIP, IGRP, EIGRP, OSPF, and BGP. Section 1.0 gives the background of different routing algorithms. Section 2.0 discusses the comparison of dynamic routing algorithms. Section 3.0 discusses the technical review of dynamic routing protocols and their comparisons along with advantages and disadvantages. Section 4.0 gives the conclusion of the paper and Section 5.0 gives the references.

1.0 Background :

Routing algorithms [1] can be further divided into the following types-

1. Static versus dynamic
2. Single Path versus Multi path
3. Flat versus hierarchical
4. Host Intelligent versus Router-Intelligent
5. Intra-domain versus Inter-domain
6. Link-State versus Distance-vector

Nowadays the research work is in progress on many of above routing algorithms. But more research emphasis is on Link-State routing algorithm and Distance-vector Routing algorithms. Different algorithms are required in different situations depending upon the requirement of the particular condition Because single routing algorithm or protocol is not sufficient in every situation at all times. Single routing protocol may be sufficient for small network, but many different routing protocols are used in large networks. The Internet, e.g., is divided into collection of autonomous systems (Ass), each of which is normally administrated by a single entity. Research work is going on two dynamic routing algorithm i.e. Link-State & distance vector routing algorithms. But Link-State routing algorithm is having better research prospectus being open system Interconnection algorithms e.g. OSPF.

2.0 Comparison of Dynamic Routing algorithms :

Here we emphasis on two types of routing algorithms specially Link-State versus Distance-vector routing algorithms. In decentralized routing algorithms [2] each router has information about the routers it is directly connected to. It doesn't know 'about every router in the network. These algorithms are known as DV (distance Vector) algorithms. In global routing algorithms, every router has complete information about all other routers on the network and the traffic status of the network. These algorithms are known as LS (Link-State) algorithms.Examples of Distance vector routing Protocols are RIP, IGRP, EIGRP.

Examples of Link-State routing Protocols are OSPF and IS-IS

3.0 Technical Review of Routing Protocols & their Comparison

Routing protocol does the following things: -

1) To reduce the administrative efforts by dynamically filling the routing table with routes to all networks.
2) When more than one route to a given network is available, either
   a) To place the best route in the table.
   b) Or To place the multiple routes in the table and load balance across the routes.
3) To automatically remove invalid routes from the table when a failure (Direct or Indirect) occurs.
4) If a better route is heard, to add that route to a table.
5) To eliminate routing loops as quickly as possible.

3.1 Routing Information Protocol:

Routing Information protocol is easy to understand and configure. Almost guaranteed to be supported by all routers. Support load balancing. Generally loop free. RIP's metric is hop count. Max. hop Count is 15. A metric of 16 is considered as infinite. After so many advantages it is also having some disadvantages.

1) Inefficient (bandwidth intensive)
2) Slow Convergence in larger networks.
3) Supports only equal cost load balancing.
4) Pinhole congestion can be a problem.
5) Limited scalability
6) Does not support VLSM (Variable length subnet masking)
7) Broadcasted updates can cause wide spread based of CPU cycles on hosts.

Due to the problems in RIP. Some improvements were made in RIP and it was named as RIP version-2 without drastically changing the protocol. Some useful improvements version-2 are as under

1) VLSM support – subnet masks are transmitted with RIP 2 updates.
2) Multicasted updates – updates are multicasted rather than broadcasted reducing CPU cycle wastage for Non-RIP hosts.
3) Authentication support – Clear text authentication is supported for RFC compliant routers.

3.2 Interior Gateway Routing Protocol:

It is a CISCO proprietary routing protocol that was designed to solve some of the scalability problems with RIP in larger, more complex networks. As such, it includes improvements on most of RIPs shortcoming timers and metrices. IGRP is a distance vector routing protocol. IGRP broadcasts routing tables to neighboring routers at predefined intervals. IGRP uses update, invalid, hold down and flush timers. IGRP does not support VLSM. IGRP uses split horizon, triggered updates and route poisoning

3.3 Primary Difference Between IGRP and RIP

1) IGRP uses the autonomous systems(AS)
2) IGRP supports a much more complex and flexible metric.
3) More scalability as compared to RIP. IGRP can span network of upto 255 hops IGRP's load-balancing mechanism is different.
4) IGRP uses longer timers

Although IGRP can span upto 255 hops, the default (and recommended) limit is 100 hops.

Autonomous Systems: - An IGRP autonomous system (AS) is what is known as a process domain. A process domain is an area in which a specific routing protocol instance is processed on all routers. IGRP accepts or sends updates to routers only within its own AS, you could have two or more separate process domains within a single routing domain.

In addition to distinguishing between ASs, IGRP also distinguishes routes depending on the network topology. IGRP defines three types of routes: internal, system and external.

1) An internal route is a route to a router that is a subnet of the connection between the sending router and the receiving router.
2) A system route is a summary route to a major network.
3) An external route is a default network. Like the default route, the default network is where the router sends packets when it cannot find a better route. IGRP uses complex calculations to produce a single composite metric. The calculations IGRP uses includes bandwidth, delay, reliability and load, but only bandwidth and delay are used by default.—

For default weights k1=k3=1, the formula for metric calculations is

Metric= bandwidth + (bandwidth/(256-load))+delay.

Bandwidth in IGRP specifies the lowest-rated bandwidth used in the entire path and is manually defined. Delay is the amount of time it takes a single packet to reach the destination. Assuming an uncongested network.

The number of packets that arrive on the link undamaged defines reliability. This calculation is measured.

Load specifies the amount of traffic that crosses the link relative to the bandwidth. Load describes how under or oversubscribed the line is

Metric = k1 x be +(k2 x Be)/(256-load)+k3 x Dc) x (k5/(reliability + k4)

In actually, IGRP metrics are 24bit, making the infinite metric 16.7 million, not 4 billion. (Which is infinite value of EIGRP). However, this is a miniscule point in most environments, where the metrics typically never reach either maximum value.

3.4 OSPF [6,9] versus RIP:

Two protocols are designed for completely different Environment.OSPF is designed for larger, more complex networks.While RIP is designed for small networks.

Advantages

1) OSPF is much more scalable than RIP.
2) It supports VLSM but RIP does not support.
3) Better path selection in OSPF[6,9].
4) Graceful avoidance of routing loops.
5) A more useful metric
6) Hierarchical design and fast convergence.

Disadvantages

1) Hierarchical design does not work well with poorly designed IP structures.
2) Much more complicated than RIP
3) Requires more processor and memory overhead.
4) Requires more design & implementation time.

3.5 OSPF [6,9]versus IGRP

Advantages

1) Support VLSM
2) Lower overall network use for fairly stable networks. Graceful avoidance of routing loops.
3) Hierarchical design. Fast Convergence.
4) Metric is not as complicated as IGRP's composite metric.
5) Vendor independent.

Disadvantages

1) Metric is not as flexible as IGRP's composite metric. Cannot perform unequal-cost load balancing.

2) Hierarchical design doesn't work well with poorly designed IP structures.

3) Much more complicated than IGRP.

4) Requires more processor & memory overhead.

5) Requires more design & implementation time.

3.6 OSPF versus EIGRP[8]

Advantages

1) Hierarchical design

2) Metric is not as complicated as EIGRP's composite metric.

3) Vendor independent

Disadvantages

1) Metric is not as flexible as EIGRP's composite metric.

2) Cannot perform unequal-cost load balancing.

3) Hierarchical design does not work well with poorly designed IP structures.

4) Requires more processor and memory overhead.

5) Requires more design and implementation time.

4.0 Conclusion

Link-State algorithm is better than distance-vector routing algorithms in many aspects. Link-State algorithms have better scalability as compared to distance vector so Link-State routing algorithms are suited for large networks Similarly Convergence of Link-State routing algorithm is better than distance-vector routing algorithm. The Link-State protocols are hierarchical in nature, which helps in improving the scalability of the network. Link-State routing algorithm supports VLSM technology, which is not supported by most of the distance vector routing algorithms like RIP, IGRP. So due to the support of important features like scalability, lower convergence time, better metric, hierarchal, better load balancing the link state routing algorithms are considered better as compared to Distance Vector routing Algorithm. But this is not the end of the Conclusion because there are many research prospectuses particularly in traffic engineering in dynamic adaptive routing algorithms.

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Book Review

OFDM for Wireless Communication Systems
by Ramjee Prasad- Artech House Inc. Borton, London, 2004, 272 pages

As a sequel to the book "OFDM for Wireless Multi Media Communications" by Richard Van NEE and Ramjee Prasad, the book under review is very timely for students and research workers working in the area of OFDM.

The book offers the following novel features:

1. An overview of WLAN, WPAN technologies in the first three chapters.
2. A novel Hybrid OFDM concept and
3. A practical OFDM System based on Fixed Broad Band Wireless Access (FBWA) Technology.

The book proposes a new hybrid approach involving OFDM/CDMA/SFH for yielding high bit rates. Such amalgamation of systems for achieving 60GHz frequency and 155 Mbs data is based on 16-QAM modulation as against the usual QPS technique for low bit rate OFDM systems. In the proposed system Pseudo Noise Sequences are used for a synchronous uplink while Orthogonal Walsh-Hadamard sequences are used for the down link. Also the author has presented a Fuzzy Logic based algorithm for the synchronizing scheme. The author has discussed the performance of such systems in AWGN and fading channels. Such systems give acceptable BER performance. It is claimed that this technique is useful for dealing with frequency and timing offsets.

Finally, the author proposes a Fixed Broadband Wireless Access (FBWA) System which is based on a point to multipoint Distribution System. Enumerating the difficulties with the cell based systems, specially the requirement of central location (like a mobile switching centre) through which all the traffic must be channeled, infrastructure is recommended for FBWA. The proposed FBWA has the advantage that the network can be deployed incrementally providing scalability and diversity. Also the frequency space diversity can be added to enhance a communication link and channel capacity and all nodes in the network employ similar equipment. In view of the following well established advantages of OFDM for high bit rate systems namely·

- OFDM offers an efficient solution to multi path fading. Designing an equalizer for a single carrier system is much more complex.
- OFDM is robust against narrow band interface as such interfaces affect a small number of SCs
- By selecting a data rate for SCs, it is possible to enhance the capacity depending upon signal to noise ratio (SNR) of a particular SC.
- OFDM based Hybrid Systems like OFDM-CDMA-SFH offer high capability in possible data transmission rates.

An important feature of the book is that a full Chapter (Chapter 4) has been devoted to the topic "Channel Model for OFDM" where a model appropriate to OFDM systems has been discussed to achieve

(i) Analytical treatment of OFDM – related problems
(ii) Efficient computer simulation schemes for the above.

The FD model discussed is the dual of Jake's Doppler Spectrum model, where frequency selectivity is described by the frequency-spaced correlation function and by the delay power spectrum. This

model is stated to have

- good agreement with physical propagation channels, in millimeter wave frequency bands and in indoor environments.
- Provide analytical expressions relating model parameters with physical channel parameters.
- Suitability for OFDM systems.

I offer two minor suggestions, which in my opinion would add to the convenience of reference and make the presentation more logical:

(i) It is felt that the OFDM System Model discussed in Chapter 4 should follow the matter in Chapter 5 where OFDM basics have been discussed.

(ii) A listing of abbreviations used in the book if provided at the end of the book, would greatly add to the convenience of a first time reader of the book.

To sum up, the book offers an excellent update in OFDM, Hybrid OFDM systems and suggested FBW based practical OFDM Systems. The book can be said to be a timely contribution to the subject and would prove a boon to the research workers in this field.

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