Framework of an Improved Distance-Vector Routing Protocol Mechanism for Reliable Network Transmission in Local Area Networks

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Abstract: Routing protocols are used to govern the prime path for data communication amongst network nodes. These protocols are employed once there is a major growth in organisation where, static routes are uncontrollable. Distance vector routing protocols of which is one of two main routing protocols for communications methods uses data packets sent over Internet Protocol. Enhance interior gateway routing protocol (EIGRP) and Routing information protocols (RIP) are dynamic Internet gateway protocols meaning they route packets within one autonomous system. However there is need for an advance distance vector routing protocols that can route packet from RIP to EIGRP as EIGRP seems to be a cisco proprietary protocol.

This research presents a framework of an improved distance-vector routing protocol mechanism for reliable network transmission in local area networks. The mechanism introduced will provide a change over where a packet from RIP can be transformed to EIGRP if RIP exhausts its maximum hop count.

Index terms: EIGRP, RIP, Routing.

I. INTRODUCTION

Routing protocols specify how routers communicate with each other, disseminating information that enables them to select routes between any two nodes on a computer network. Routing algorithms determine the specific choice of route. Each router has a priori knowledge only of networks attached to it directly. A routing protocol shares this information first among immediate neighbours, and then throughout the network. This way, routers gain knowledge of the topology of the network.

Although there are many types of routing protocols, three major classes are in widespread use on IP networks:

Interior gateway protocols type 1, link-state routing protocols, such as OSPF and IS-IS

Interior gateway protocols type 2, distance-vector routing protocols, such as Routing Information Protocol, RIPv2, IGRP.

Exterior gateway protocols are routing protocols used on the Internet for exchanging routing information between Autonomous Systems, such as Border Gateway Protocol (BGP), Path Vector Routing Protocol.

Routing protocols, according to the OSI routing framework, are layer management protocols for the network layer, regardless of their transport mechanism:

1. IS-IS runs on the data link layer (Layer 2)
2. Open Shortest Path First (OSPF) is encapsulated in IP, but runs only on the IPv4 subnet, while the IPv6 version runs on the link using only link-local addressing.
3. IGRP and EIGRP are directly encapsulated in IP. EIGRP uses its own reliable transmission mechanism, while IGRP assumed an unreliable transport.
4. RIP runs over UDP
5. BGP runs over TCP

Routers are small physical devices that join several networks together and a layer 3 device of the OSI model. Most of our home network uses either the wired or the wireless internet protocol router (IP Router) which is the most used and common in the OSI Model.

By evaluating and maintaining the configuration information in a stage known as Routing Table, router have the ability to filter traffic which are either coming in or going out depending on the internet protocol (IP) address of both the sender and the receiver. Most routers give permission to the network administrator to update its routing Table manually using a web browser interface. Most of these routers are classified into several types which are:

II. LITERATURE REVIEW

The cornerstone of the Internet are the routers. They determine the way data packets take and send them on their next hop in the journey to their destinations. So many people make use of the internet daily having no clear understanding on how it works. It is not easy to understand how the Internet looks like. Research has been made which focuses on the possibility of moving routing from the routers into the network itself by having a separate routing platform that selects routes on behalf of routers [1]. However, the routers are crucial for networking and will continue to be in the near future. The routers must be configured in some way, depending on their place in the network, the vendor and on the policies of the owner (e.g. private person, company, Internet service provider (ISP), government). The configuration process is generally not straightforward; it is quite error-prone. Moreover, the configurations are mostly made manually and this can be very time consuming and tedious [2].

Routing is the way of determining the path network traffic should take. This process is carried out by routers. When a packet arrives to a router, the router determines the next hop for the packet by matching the contents of the packet with its routing Table. The actual transit of packets is called forwarding and is directed by routing [3]. The routers communicate with each other using routing protocols. Routing protocols are divided into two categories which are the interior gateway protocols (IGPs) and the exterior gateway protocols (EGPs). IGPs are responsible for routing inside an Autonomous System (AS) and EGPs are responsible for routing between AS’s. AS’s are groups of both networks and routers within a single administration and are designated by a number. For instance, SUNET (Swedish University Computer Network) has AS number 1653. The difference between IGP and EGP is shown in Figure 1.

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Distance Vector Routing

DVR Protocol presents the routes as distance vector and direction vector. The distance is represented as hop count and metrics while the direction is represented as the exit interface. In distance vector routing, Bellman Ford algorithm is used to calculate the path while the nodes takes the position of the links and the vertices. Talking about distance vector routing, in reaching its destination, a certain distance vector is maintained in the entire node used in the network. The distance vector comprises of destination ID, shortest distance and next hop. Here, each of the node passes a distance vector to its neighbour and informs about the shortest paths. Thus, the route coming from the adjacent routers are discovered and advertised from its own side. Each node depends on its neighbouring nodes for collecting the route information. The nodes in the network are responsible for the exchange of distance vector which can take between 10 to 90 seconds to be accomplished. Once a node in a network path receives the lowest cost advertisement from its neighbours, the receiving node adds the entry to its routing Table [5]

Characteristics of Distance Vector Routing Protocol [6]

1. Distance Vector (DV) routing protocol is described as routing Table where all the neighbours are connected directly with the Table within a regular period of time.
2. As soon as the root becomes unavailable, the updated information should be in the routing Table.
3. DV routing protocols are more efficient and easy in smaller networks, thus, needs little management.
4. DV routing is mainly based on hop count vector.
5. The distance vector algorithm is iterative.
6. A fixed subnet mask length is used.

Advantages of DV Routing

According to [5], DV routing protocols have different advantage and some of them are:
1. More efficient in smaller networks.
2. The configuration is easy.
3. There resource usage is very low.
4. DV routing protocol experiences counting problem to infinity. In contrast, routing loops cannot be prevented by Bellman Ford algorithm which is the main disadvantage of this [7].

Disadvantages of DV routing protocols are:
1. Loop creation.
2. Slow convergence.
3. Problem in scalability.
4. Lack of metrics.

III. RESEARCH ARCHITECTURAL DESIGN

The architecture of the advance distance vector routing mechanism is composed of the following components: protocol, configuration, changeover mechanism and the local area network (LAN) as shown in Figure 2 and described as follows:

1. Protocol component
   The protocol component integrates EIGRP and RIP, these two routing protocols where choosing because of their performances. EIGRP support variable length subnet mask (VLSM) / classless inter domain routing (CIDR), efficient neighbour discovery, support for summaries and discontiguous networks. While RIP uses the hop counts, split horizon and holds down time.

2. Router configuration
   The router configuration component configures the settings for the two routing protocols (EIGRP and RIP).

3. Change over component
   This components is to detect optimal protocol and make a switch over from hop layer 1 to hop layer 2

4. LAN component
   The LAN component represents the networks platform on which the protocols configured are tested.

Figure 2: Framework of Architectural Design
IV. PERFORMANCE METRICS

The performance analysis component shows the result of the performance experiment of the routing protocols. This metrics will be used to calculate the parameters 1 and 2 respectively.

1. EIGRP Composite Cost Metrics

The Enhanced Interior Gateway Routing Protocol (EIGRP) uses bandwidth, delay, reliability, load, and K values (various constants that can be configured by a user to produce varying routing behaviours) to calculate the composite cost metric for local Routing Information Base (RIB) installation and route selections. The EIGRP composite cost metric is calculated using the following formula:

EIGRP composite cost metric = \(256 \times ((K1 \times \text{Scaled Bw}) + (K2 \times \text{Scaled Bw}) / (256 – \text{Load}) + (K3 \times \text{Scaled Delay}) \times (K5/(\text{Reliability} + K4)))\)

2. RIP Metric

The metric that RIP uses to rate the value of different routes is hop count. The hop count is the number of routers that can be traversed in a route. A directly connected network has a metric of zero; an unreachable network has a metric of 16. This small range of metrics makes RIP an unsuitable routing protocol for large networks.

A router that is running RIP can receive a default network via an update from another router that is running RIP, or the router can source (generate) the default network itself with RIP. In both cases, the default network is advertised through RIP to other RIP neighbours.

RIP sends updates to the interfaces in the specified networks. If the network of an interface network is not specified, it will not be advertised in any RIP update.

3. Simulator (Cisco Packet Tracer v 5.3)

This is a network Simulation program which allows students to experiment and monitor behaviour of packets and ask questions like “what if”. Being an important part of the comprehensive learning experience of networking academy and in the progress of this research, this simulator provides simulation, assessment, collaboration capabilities, authoring, learning of complex technology concept and visualization [8].

Figure 3, shows the LAN setup and the packet tracer simulator platform used in configuring the routing protocols.

V. PERFORMANCE ANALYSIS

1. Round Trip Time

Round trip time (RTT) which is the length of time taken for a signal to be sent from Source router to destination router plus length of time which an acknowledgement is received. After observing the RTT of both EIGRP and RIP routing protocol, we realised the minimum, average and maximum RTT through the flow of internet control message protocol (ICMP) packets in 30 scenarios.

\[
\begin{align*}
\text{Minimum} &= \frac{\sum \text{total number of minimum value}}{\text{total number of scenarios obtained}} = 95.50ms \\
\text{Average} &= \frac{\sum \text{total number of average value}}{\text{total number of scenarios obtained}} = 107.96ms \\
\text{Maximum} &= \frac{\sum \text{total number of maximum value}}{\text{total number of scenarios obtained}} = 117.10ms
\end{align*}
\]

RRT Formulae for EIGRP

\[
\begin{align*}
\text{Minimum} &= \frac{\sum \text{total number of minimum value}}{\text{total number of scenarios obtained}} = 94.70ms \\
\text{Average} &= \frac{\sum \text{total number of average value}}{\text{total number of scenarios obtained}} = 107.86ms \\
\text{Maximum} &= \frac{\sum \text{total number of maximum value}}{\text{total number of scenarios obtained}} = 119.20ms
\end{align*}
\]
Chart Representation

We were able to represent the minimum, average and the maximum round trip time of EIGRP and RIP in a bar chart as shown in Figure 4.

![Bar Chart of RIP and EIGRP RTT](image)

**Figure 4: Chart Representation of RIP and EIGRP RTT**

2. **EIGRP Metrics**

The performance metrics which EIGRP implemented for efficient packet delivery from router 1 with a LAN address 200.200.200.0 to router 21 with a LAN address 200.200.2.0 is calculated using the value of k5.

Using the show ip route command on the router to display the calculated metrics to network 200.200.2.0 as shown in Figure 5

![IOS Command Line Interface](image)

**Figure 5: EIGRP Route Metrics**

We came to realise that the route metrics calculated is 30242560 with a total delay of 400100 microseconds, bandwidth 126kbit.

The calculation in example 1 shows how EIGRP arrived at 30242560 as its metrics value.

**Metric** = \[
256 \times \left( k1.\text{Bandwidth} + \frac{k2.\text{Bandwidth}}{\text{256-Load}} + k3.\text{Delay} \times \frac{k5}{k4.\text{Reliability}} \right)
\]

Default values for k are:
- K1 = 1
- K2 = 0
- K3 = 1
- K4 = 0
- K5 = 0

Bandwidth = 128 kbit
Delay = 400100 microseconds and are calculated in tens of microseconds = 60100/10 = 40010

\[
= 256 \times \left( \left( \frac{10^7}{\text{minimum Bandwidth}} + \text{Delay} \right) \right)
\]

Where the minimum bandwidth is in Kbps and delay is in \(\mu\text{sec}\). The metric from Router 1 to Router 21 is calculated as follows:

\[
= 256 \times \left( \left( \frac{10000000}{128 \text{ (Kbps)}} + 40010 \text{ (\mu sec)} \right) \right) = 30242560.
\]

3 **RIP Metrics**

Using the show ip route to obtain the metric of RIP as shown in Figure 6, we see that the metrics is calculated as 15, because in getting to the 192.168.16.0, network the hello packet sent from 192.168.1.1 network passes through 15 routers known as hops, with an administrative distance of 120 as default.

![IP Route From Network 192.168.16.0 to 192.168.16.0](image)

**Figure 6: IP Route From Network 192.168.16.0 to 192.168.16.0**

VI. **COMPARISON WITH OTHER STUDIES**

Several researchers have carried out research on the analysis of routing protocols such as [9], which analysed the performance of the routing protocols namely, RIP, OSPF, IGRP, and EIGRP for the parameters: packets dropping, traffic received, End-to-End delay, and variation in delay (jitter). Simulations have been done in OPNET for evaluating these routing protocols against each parameter. The results graphically show that IGRP performs the best in packets dropping, traffic received, and End-to-End delay as compared to its other companions (RIP, OSPF, and EIGRP). [10], Technical Era Language of the Networking – EIGRP. They did comparisons of OSPF, IGRP and RIP with EIGRP, it was noted that there are problems with redistributing routes between RIP, OSPF or IGRP than in case of EIGRP. It includes the various trouble resolving techniques and traffic handling techniques during communication in simple as well as in bulky networks. [11], Performance Comparison of EIGRP and ISIS/RIP Protocols. They use OPNET to design and simulate the network and compare the performance of the EIGRP, IS-
IS/RIP routing protocols in terms of convergence time, throughput and end-to-end delay and propose a suitable routing for IP networks after several simulations in OPNET, the combination of IS-IS/RIP protocol shows better performance compared to EIGRP protocol in terms of throughput and end-to-end delay. Whereas, the network convergence of EIGRP protocol is better than IS-IS/RIP protocol.

Despite all the analysis and comparison of EIGRP and RIP which shows that in some cases one performs better than the other, there is need for an advanced distance vector routing protocol that proffer a better packet delivery in the network. However this research will produce a frame framework that will help to integrate EIGRP and RIP routing protocol for a better performance.

VII. SUMMARY, CONCLUSION AND REALISED OBJECTIVES

The research work focused on developing an improved distance vector routing protocol to overcome the limitation associated with routing information protocol. The procedure proposed a mechanism that can transform packets from RIP network interface to EIGRP network interface, and designing a framework that is suitable for transformation.

To achieve the objective of the research, the researcher consulted a considerable amount of literature to know what has been done, together with consultations with learned academicians for additional knowledge and ideas, the problems and solutions of other researchers was studied.

The researcher, with the use of packet tracer simulator from Cisco networking academy was able to study the functionality of the simulator and its application for the purpose of the research work. This simulator was used to configure several numbers of routers which the routing protocols were implemented, capturing packet flow and monitoring the behaviour of the routing protocols.

Thirty (30) different routers were configured to show and test the limitations of the RIP routing protocol as this distance vector protocol seems to have several challenges associated with it. However, EIGRP, which seems to be a Cisco proprietary protocol, was introduced to serve as an extension to an organisations network as it increases.

Both the Bellman-Ford algorithm and Dijkstra’s algorithm were used to calculate ‘metrics’ (distance/cost of traversing a link) in routing protocols. Both of them consider only hop count (the number of machines between the source of the message and the destination) as the metric between two nodes. Other factors such as bandwidth and delay were also used to calculate the metric.

REFERENCES


