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Performance Analysis of Mesh Based Enterprise Network using RIP, EIGRP and OSPF Routing Protocols †

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Abstract: Computer network communication is quickly growing in this pandemic situation. Phone Conferencing, Video Streaming, and Sharing File / Printing are all made easier with communications technologies. Data transmitted in time with little interruption become a significant achievement of wireless sensor networks (WSNs). A massive network is interconnection computer networks in the globe connected by the internet and the internet plays a critical role in WSNs. Data access is a key element of any enterprise network and the routing protocol is used to transmit data or access data. Due to the growing use of WSNs, it is essential to know about the network structure, the routing protocol. The routing protocols must be used to route all data sent over the internet between the source and the destination. Which chooses the optimum routes between any two nodes in an enterprise network. This research focused on how the routing table will determine the optimum path/route of data packets to be transmitted from source to destination. The performance of three routing protocols, Routing Information Protocol (RIP), Enhanced Interior Gateway Routing Protocol (EIGRP), and Open Shortest Path First (OSPF), is investigated in this research for the massive mesh-based enterprise wireless sensor network. We also investigated the behaviors of end-to-end packet latency, convergence time on flapping connections, and average point-to-point throughput (bits/sec) between net-work links. Finally, the simulation results are compared to the efficacy and performance of these protocols implemented in the Wireless LAN and internet based Wireless Sensor Network.

Keywords: Wireless Sensor Network, RIP, EIGRP, OSPF, Redistribution, Dynamic Routing Protocol

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1. Introduction

Today communication based on the internet has become an integral element of daily life. Consequently, the development of computer networks based on IP routing proto-cols also plays a significant role in any enterprise network. In small areas of a wireless sensor network, the sensor node and base stations are so close to each other and share information directly with one another with low latency [1]. This type of communication system is known as a single-hop communication system. But in wireless sensor networks, the coverage area is massive, and to cover these large areas need many sensor nodes. Multi-hop communication (indirect connection) is required in this case because most of the sensor nodes are locating so far away from the sensor nodes that they cannot connect directly with the base station [2]. Within a multi-hop network connection, the sensor nodes not only generate and transmit data but also provide a route for other sensor nodes to communicate with the destination base station node. Finding an appropriate route from a source node to a destination node is referred to as routing, and it is the key responsibility of the routing protocol [3]. Routing protocols describe how routers interact with another router, execute this task and identify the optimal paths for transferring data from one node to another. Data transmitted over the internet should be routed be-tween networks using routing algorithms [4–6]. The routing algorithms depend on different parameters for selecting the most suitable path for transmitting information over the internet (i.e., Bandwidth, cost, packet delay, hop count, and maximum transmission unit). The significant benefit of adopting a dynamic routing protocol allows routers to learn about new networks when changes in the network topology and discover alternative routes if a link fails in an existing network [7–10]. Currently, many organizations are shifting towards their previous network topology (such as RIP) to more current net-work topology by upgrading routing protocols mechanisms (such as EIGRP, OSPF) [11– 13]. This research aims to identify the optimal routing protocol topology for each routing protocol since each routing protocol has unique characteristics. Routing protocols define how routers acquire network topology information. Identifying the route should be accomplished using a package router function that analyzes all possible routes to the destination and determines the most optimum [14– 16]. Each routing protocol facilitates the exchange of network information between participating routers. However, some proto-cols only convey information about direct connections. There are also variations in speed and scalability across protocols [17–18].

This research will compare the performance of several inner gateway dynamic routing protocols, including RIPv2, EIGRP, and OSPF, using Cisco packet tracer soft-ware. In addition, to demonstrate how to transfer data across various networks running different routing protocols using route redistribution systems in packet tracer simulation software. Each of these dynamic routing protocols has its own set of advantages and disadvantages; for example, one protocol has rapid convergence, while another has high reliability. However, the dynamic routing is all improved in general scalability, robust-ness, and convergence.

This work has three parts. First, a theoretical analysis of the three routing methods will be presented. Second, we'll look at how to create and execute a standard model for testing routing protocols. The simulation was done CISCO PACKET TRACER network simulation tool. Finally, we'll look at some of the outcomes and check our conclusions about them.

2. Concept of the Mesh-based Enterprise Wireless Sensor Network

It is a core network design with numerous redundant connections between network nodes. Thus, if any nodes fail in a wireless mesh architecture, there are many alternative ways to communicate with each node. A mesh network combines other topologies such as Star, Ring, and Bus in a hybrid topology. Also, specific WAN architectures, like the Internet, use mesh routing, which works even in disaster [1].

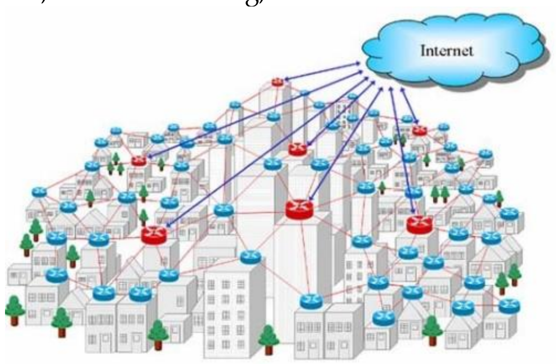


Figure 1. Mesh-based Enterprise Wireless Sensor Network.

Full mesh and partial mesh are the two mesh topologies. When every node in a network has a connection linking it to every other node, this is referred to as full mesh topology. The maximum concentration of redundancy is achieved by using a full mesh. As a result, if a node fails, network traffic may be diverted to any other node. Specific nodes are fully meshed with partial mesh, while others are linked to one or two others. In peripheral networks connected to a full mesh backbone, the partial mesh is prevalent. Partial mesh is less costly but less redundant than complete mesh [18].

3. Problem Description and Main Contribution

The primary objective of this research is to evaluate and compare the proposed routing protocols using various performance metrics. This evaluation is carried out both theoretically and through simulation. Routing is the process of transferring data from one source to a destination. Typically, this data is routed through a series of intermediary devices. The objective of the routing protocols is to give the information necessary for sending the packet appropriately to these intermediate devices. Therefore, the routing protocols are essential in ensuring prevent network devices from connecting with one another. Every routing protocol has an algorithm, and this algorithm must define techniques for routing protocols to work correctly. Simulates networks using the CISCO Packet Tracer 8.0 simulator.

The conventional procedures are:

- ✓ These steps are used to receive and send network information.
- ✓ Second, finding the best route to a location and adding it to the routing data-base.
- ✓ Finally, it is a procedure to identifying, responding, and notifying network changes.

As a result, different algorithms can affect total network performance. Thus, these significant research achievements are:

- ✓ To create two network topologies with RIP, EIGRP, and OSPF to analyze their performance.
- ✓ To simulate various network topologies using packets, transfer, and observe the performance differences between the OSPF, EIGRP, and RIP networks.
- ✓ Summarize and analyze the simulated findings.

4. Scenario Analysis

Figure 2 shows a full-mesh topology with OSPF, EIGRP, and RIP routing protocols.

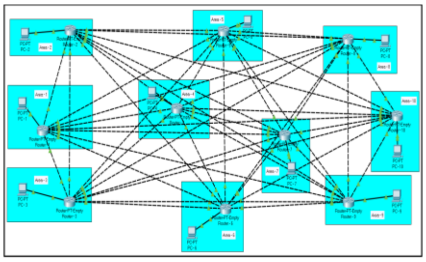


Figure 2. Proposed Mesh-based Simulation Enterprise Wireless Sensor Network.

The next step is to test the system after all the settings and do the configurations. The network topology is testing the scenario shown in figure 3.

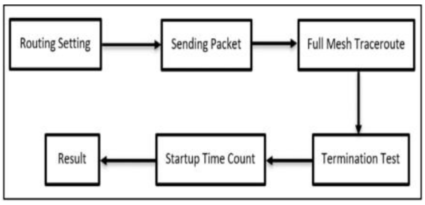


Figure 3. Testing Process of Mesh Network Topology.

The underlying structure created a complete lattice geography reconstruction using ten routers; each router directly connected to its neighbors' routers. Additionally, each of these routers will serve a single client, as seen in Table 1.

Table 1. IP Configuration in Router Port and Client.

Router – 1		Router – 2		Router – 3		Router – 4		Router – 5	
G0/0	193.169.1.1	G0/0	193.169.11.1	G0/0	193.169.20.1	G0/0	193.169.30.1	G0/0	193.169.40.1
G1/0	193.169.2.1	G1/0	193.169.2.2	G1/0	193.169.3.2	G1/0	193.169.4.2	G1/0	193.169.5.2
G2/0	193.169.3.1	G2/0	193.169.12.1	G2/0	193.169.12.2	G2/0	193.169.13.2	G2/0	193.169.14.2
G3/0	193.169.4.1	G3/0	193.169.13.1	G3/0	193.169.22.1	G3/0	193.169.22.2	G3/0	193.169.23.2

G4/0	193.169.5.1	G4/0	193.169.14.1	G4/0	193.169.23.1	G4/0	193.169.31.1	G4/0	193.169.31.2
G5/0	193.169.6.1	G5/0	193.169.15.1	G5/0	193.169.24.1	G5/0	193.169.32.1	G5/0	193.169.41.1
G6/0	193.169.7.1	G6/0	193.169.16.1	G6/0	193.169.25.1	G6/0	193.169.33.1	G6/0	193.169.42.1
G7/0	193.169.8.1	G7/0	193.169.17.1	G7/0	193.169.26.1	G7/0	193.169.34.1	G7/0	193.169.43.1
G8/0	193.169.9.1	G8/0	193.169.18.1	G8/0	193.169.27.1	G8/0	193.169.35.1	G8/0	193.169.44.1
G9/0	193.169.10.1	G9/0	193.169.19.1	G9/0	193.169.28.1	G9/0	193.169.36.1	G9/0	193.169.45.1
PC	193.169.1.10	PC	193.169.11.10	PC	193.169.20.10	PC	193.169.30.10	PC	193.169.40.10
Router – 6		**Router – 7**		**Router – 8**		**Router – 8**		**Router – 10**	
G0/0	193.169.50.1	G0/0	193.169.60.1	G0/0	193.169.70.1	G0/0	193.169.80.1	G0/0	193.169.90.1
G1/0	193.169.6.2	G1/0	193.169.7.2	G1/0	193.169.8.2	G1/0	193.169.9.2	G1/0	193.169.10.2
G2/0	193.169.15.2	G2/0	193.169.16.2	G2/0	193.169.17.2	G2/0	193.169.18.2	G2/0	193.169.19.2
G3/0	193.169.24.2	G3/0	193.169.25.2	G3/0	193.169.26.2	G3/0	193.169.27.2	G3/0	193.169.28.2
G4/0	193.169.32.2	G4/0	193.169.33.2	G4/0	193.169.34.2	G4/0	193.169.35.2	G4/0	193.169.36.2
G5/0	193.169.41.2	G5/0	193.169.42.2	G5/0	193.169.43.2	G5/0	193.169.44.2	G5/0	193.169.45.2
G6/0	193.169.51.1	G6/0	193.169.51.1	G6/0	193.169.52.2	G6/0	193.169.53.2	G6/0	193.169.54.2
G7/0	193.169.52.1	G7/0	193.169.61.1	G7/0	193.169.61.2	G7/0	193.169.61.2	G7/0	193.169.63.2
G8/0	193.169.53.1	G8/0	193.169.62.1	G8/0	193.169.71.1	G8/0	193.169.71.2	G8/0	193.169.72.2
G9/0	193.169.54.1	G9/0	193.169.63.1	G9/0	193.169.72.1	G9/0	193.169.81.1	G9/0	193.169.81.2
PC	193.169.50.10	PC	193.169.60.10	PC	193.169.70.10	PC	193.169.80.10	PC	193.169.90.10

According to table 1, a topology of RIP, EIGRP, and OSPF network and router configuration on route 1 to 10. Next the IP client on the other PC is chosen. The ping command used on each network to check for network connectivity in the following experiment, which is completed successfully. Afterward, the process of transmitting data packets from one network to another is carried out via traceroute, as seen in Figure 4a, 4b & 4c.

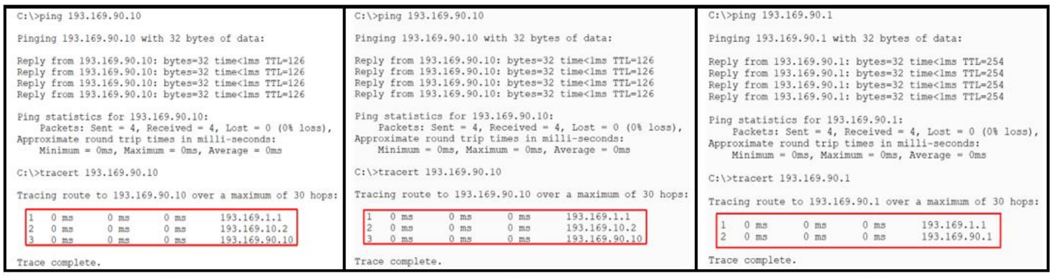


Figure 4a. Packet Sending and Tracert Checking on Route 1 to Route 10 using RIP, **4b.** Packet Sending and Tracert Checking on Route 1 to Route 9 using EIGRP, **4c.** Packet Sending and Tracert Checking on Route 1 to Route 8 using OSPF.

5. Time Testing

Time testing is done after line termination when transmitting packets. The following table summarizes the findings of the time tests performed in Table 2 for full-mesh routing using RIP, EIGRP, and OSPF. First, conduct continuous ping tests, then pause; a delay time will display. In addition, table 2 summarizes the experimental findings for routing RIP, EIGRP, and OSPF on the mesh's entire topology.

Table 2. Router Full Mesh RIP / EIGRP / OSPF.

Full Mesh									
Client PC	**Client PC**	**RIP**	**EIGRP**	**OSPF**	**Client PC**	**Client PC**	**RIP**	**EIGRP**	**OSPF**
PC – 1	PC – 2	8 ms	1 ms	2 ms	PC – 1	PC – 7	8 ms	9 ms	4 ms

PC – 1	PC – 3	6 ms	7 ms	2 ms	PC – 1	PC – 8	9 ms	9 ms	9 ms
PC – 1	PC – 4	8 ms	8 ms	3 ms	PC – 1	PC – 9	11 ms	9 ms	5 ms
PC – 1	PC – 5	8 ms	8 ms	5 ms	PC – 1	PC – 10	12 ms	8 ms	6 ms
PC – 1	PC – 6	7 ms	8 ms	6 ms	-	-	-	-	-

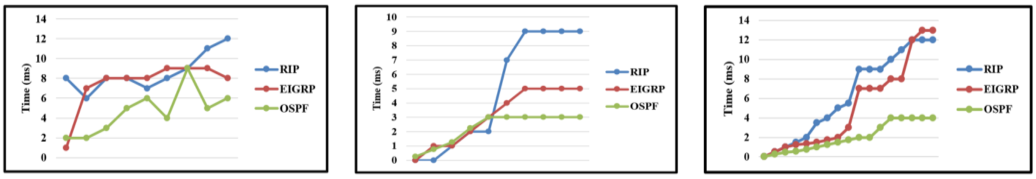
Table 3 below shows half-mesh time results for RIP, EIGRP, and OSPF routing.

Table 3. Router Half Mesh RIP / EIGRP / OSPF.

Half Mesh									
Client PC	**Client PC**	**RIP**	**EIGRP**	**OSPF**	**Client PC**	**Client PC**	**RIP**	**EIGRP**	**OSPF**
PC – 1	PC – 2	12 ms	3 ms	2 ms	PC – 1	PC – 7	8 ms	9.66 ms	5 ms
PC – 1	PC – 3	7 ms	2 ms	2 ms	PC – 1	PC – 8	9 ms	9.33 ms	3 ms
PC – 1	PC – 4	8 ms	5 ms	3 ms	PC – 1	PC – 9	9 ms	9.66 ms	3 ms
PC – 1	PC – 5	9 ms	4 ms	3 ms	PC – 1	PC – 10	10 ms	8.33 ms	5 ms
PC – 1	PC – 6	8 ms	8 ms	4 ms	-	-	-	-	-

6. Analysis Results

A simulation duration of four minutes for voice, HTTP, and video data transport is specified for LAN-to-server and server-to-LAN configurations in full and half mesh RIP, OSPF, and EIGRP. Figure 5a shows the average voice packet end-to-end latency topology.



a b c

Figure 5a. The Average Voice Packet end-to-end Latency, **5b.** The Average Value of HTTP Page Response Time, **5c.** The Average Video Packet end-to-end Latency.

Figure 5b depicts the response time of an HTTP page for a simulated network. Based on distance-vector techniques, the RIP routing protocol showed better performance than other routing protocols. OSPF performs better in video transfer, responds faster to network changes, and better utilizes bandwidth, resulting in a minimal delay, as seen in figure 5c.

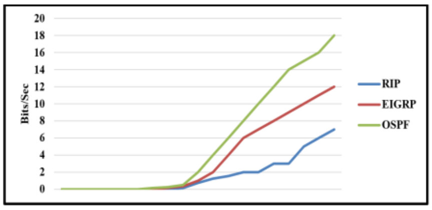


Figure 6. The Average Point to Point Throughput (bit/sec).

Figure 6 illustrates the average network throughput for three protocols. The OSPF protocols produce better throughput than any of the other protocols evaluated in this test case. The following result is the findings of the analysis based on the experiments.

7. Conclusion

In a wireless communication network, identify the optimal path from the sensor node to the destination is more difficult. The routing protocols help to find an optimal path between source and destination nodes and minimize these difficulties. The optimal path selection depends upon several factors. This research discusses and analyzes different parametric aspects of routing protocols. RIP, EIGRP, and OSPF routing protocols were analyzed and evaluated via an extensive simulation process using carefully selected parameters to acquire the features of their routing algorithms. The measured metrics are voice, HTTP, and video traffic transmitted and received, as well as average end-to-end latency and average point-to-point throughput. The protocol RIP has shown the most significant uncertainty, whereas OSPF has demonstrated the lowest latency. Furthermore, the OSPF protocols attain a better throughput than any other protocols evaluated in this test scenario. From the above result, we see that the OSPF routing protocol is more suitable for multi-hop wireless sensor networks.

In future research, we will work on simulations with much more realistic topologies and increased optimization accuracy to enhance and show the efficacy of routing protocols in terms of wireless sensor network performance.

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