Proceeding Paper

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

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† Presented at the 8th International Electronic Conference on Sensors and Applications, 1–15 November 2021;
Available online: https://ecsa-8.sciforum.net.

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 network 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

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 protocols
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. However, 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 between 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 network topology by upgrading routing protocols mechanisms (such as EIGRP and 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 protocols only convey information about direct connections. There are also variations in speed and scalability across protocols [17–20].

This research will compare the performance of several inner gateway dynamic routing protocols, including RIPv2, EIGRP and OSPF, using Cisco packet tracer software. 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, robustness and convergence.

This work has three parts. First, a theoretical analysis of the three routing methods will be presented. Second, we will look at how to create and execute a standard model for testing routing protocols. The simulation was performed using a CISCO PACKET TRACER network simulation tool. Finally, we will 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 shown in Figure 1. 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. Moreover, specific WAN architectures, like the Internet, use mesh routing, which works even in disaster [1].
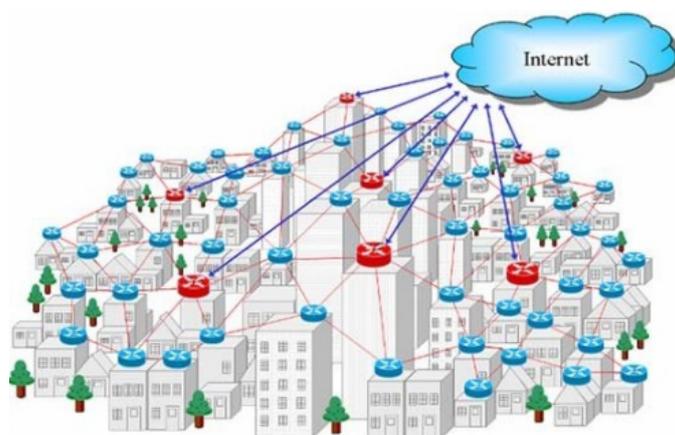

Figure 1. Mesh based enterprise wireless sensor network.

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 database.
✓ 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.
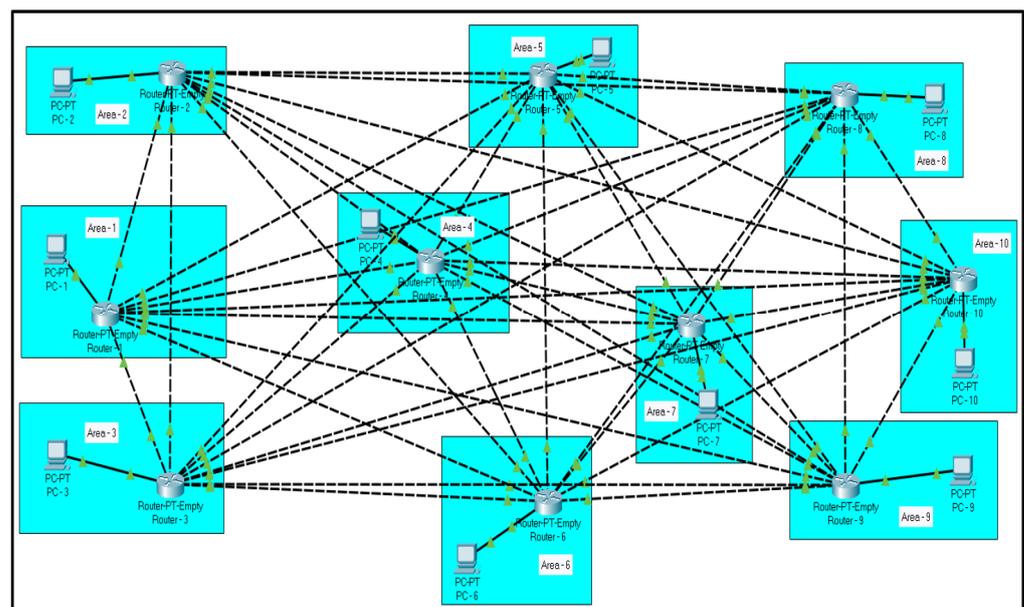

Figure 2. Proposed mesh based simulation enterprise wireless sensor network.

The next step is to test the system after all the settings and perform the configurations. The network topology is testing the scenario shown in Figure 3.
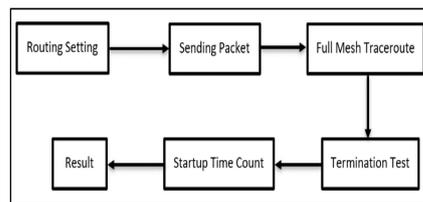
Figure 3. Testing process of mesh network topology.

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–c.

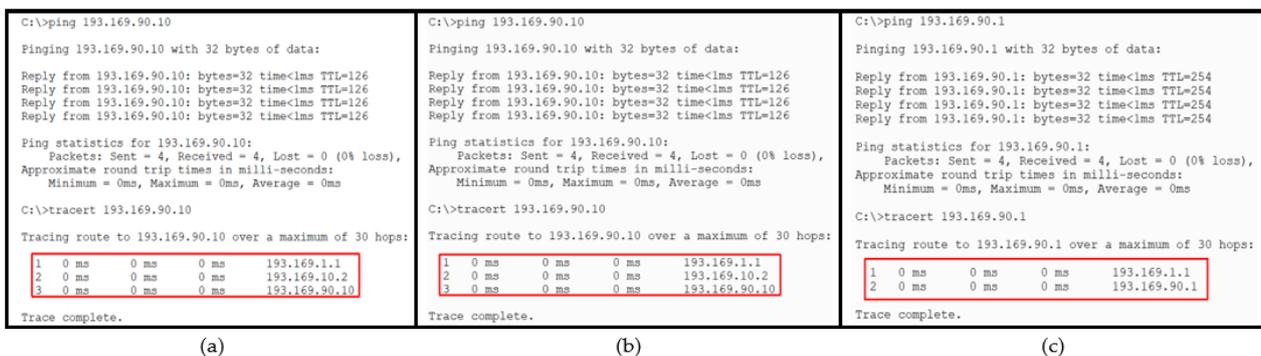**Figure 4.** (**a**) Packet sending and tracert checking on Route 1 to Route 10 using RIP, (**b**) packet sending and tracert checking on Route 1 to Route 9 using EIGRP and (**c**) packet sending and tracert checking on Route 1 to Route 8 using OSPF.

5. Time Testing

Time testing is performed 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 and 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 and 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.

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.
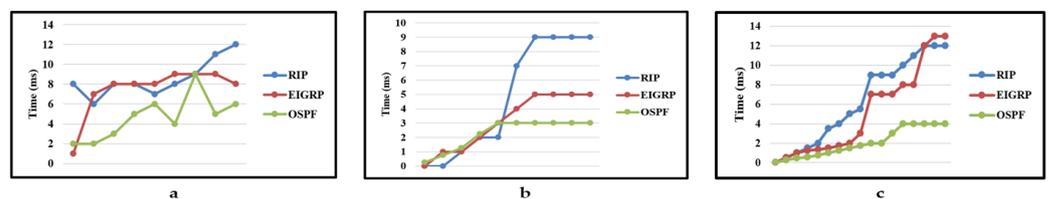

Figure 5. (**a**) The average voice packet end-to-end latency, (**b**) the average value of HTTP page response time and (**c**) the average video packet end-to-end latency.

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.
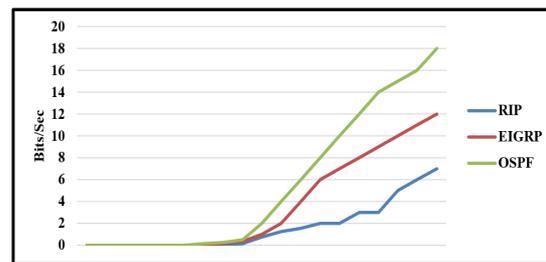
Figure 6. The average point to point throughput (bit/sec).

7. Conclusions

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.

Author Contributions: Conceptualization, M.H.K.; software, M.H.K. and M.G.M.; writing—original draft preparation, M.H.K.; writing—review and editing, M.A.K., M.S.I. and M.M. supervision, M.S.I. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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