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

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sensors
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# Introduction

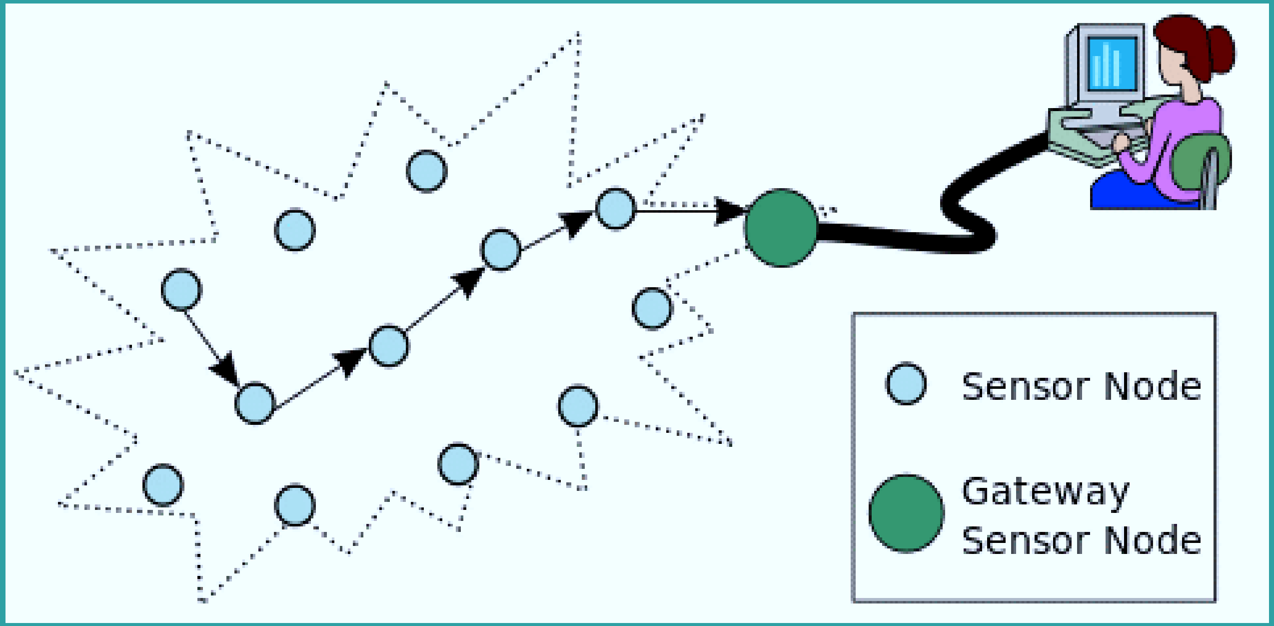


**Figure 1: Wireless Sensor Network**

- ✓ Today communication based on the internet has become an integral element of daily life.
- ✓ 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).
- ✓ Routing in Wireless Sensor Networks (WSNs) plays a significant role in the field of environment-oriented monitoring, traffic monitoring, etc. Here, wide contributions that are made toward routing in WSN are explored.
- ✓ In WSN, routing is a very important task that is to be handled carefully. Routing technique is needed for sending the data between the sensor nodes and the base stations, so as to establish communication.

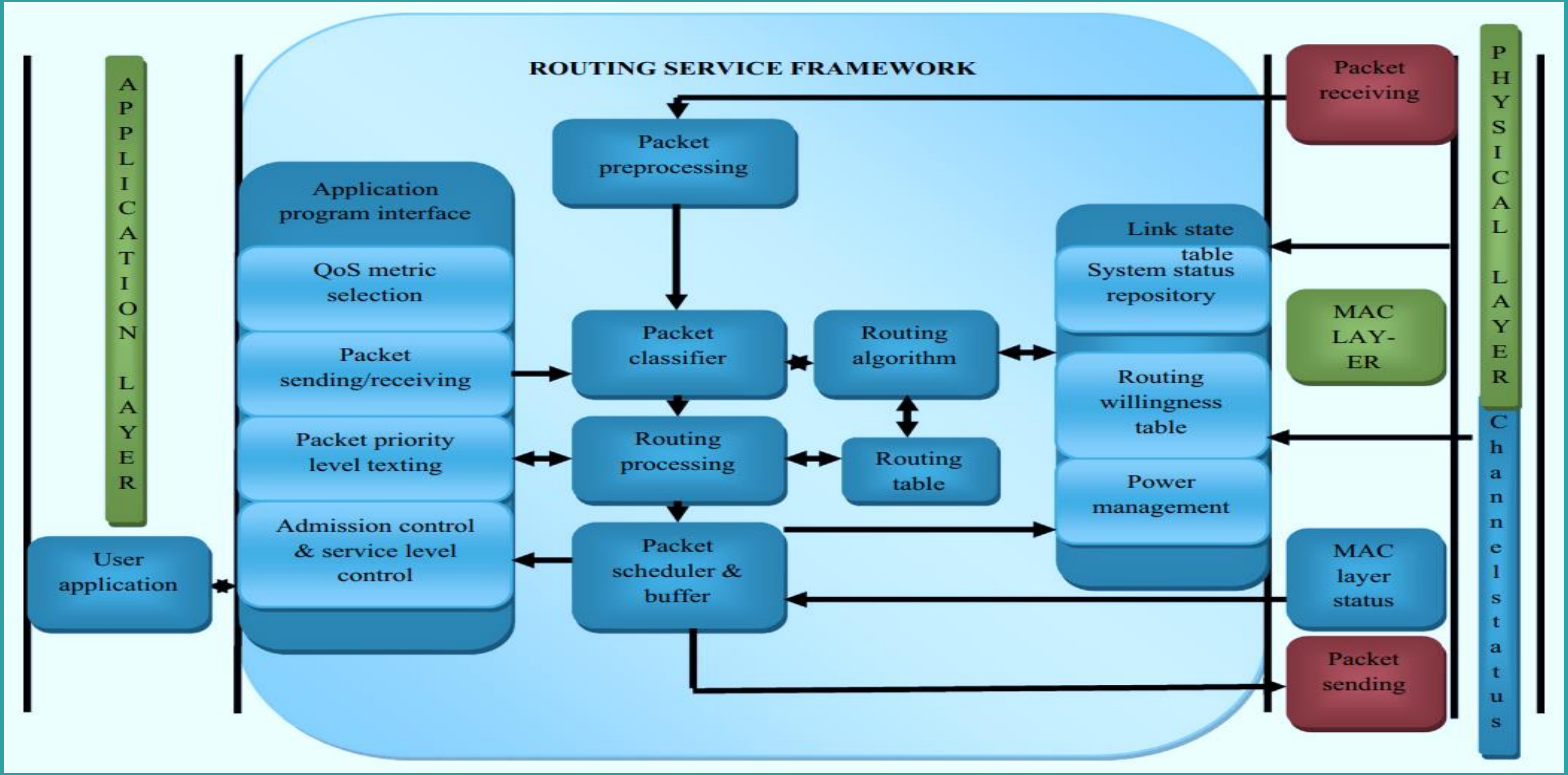


**Figure 2 Architecture of the routing protocol in WSN**

Fig. 2 explains the routing protocol of the wireless sensor networks [2].

# Problem Statement

- ✓ The flow of detected data is compulsory from a number of sources to a specific base station.
- ✓ The created data traffic has significant redundancy in most of cases.
- ✓ The time needed to transmit the sensed data is required to be as little as possible in above cited WSN applications.

# Contribution of this Research

- ✓ This research mainly aims to **minimize the routing delay problems by determine the optimum path/route** of data packets to be transmitted from source to destination.
- ✓ To **find delay-less routing protocols for the massive mesh-based enterprise** wireless sensor network.
- ✓ 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.

# 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].
- ✓ 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.

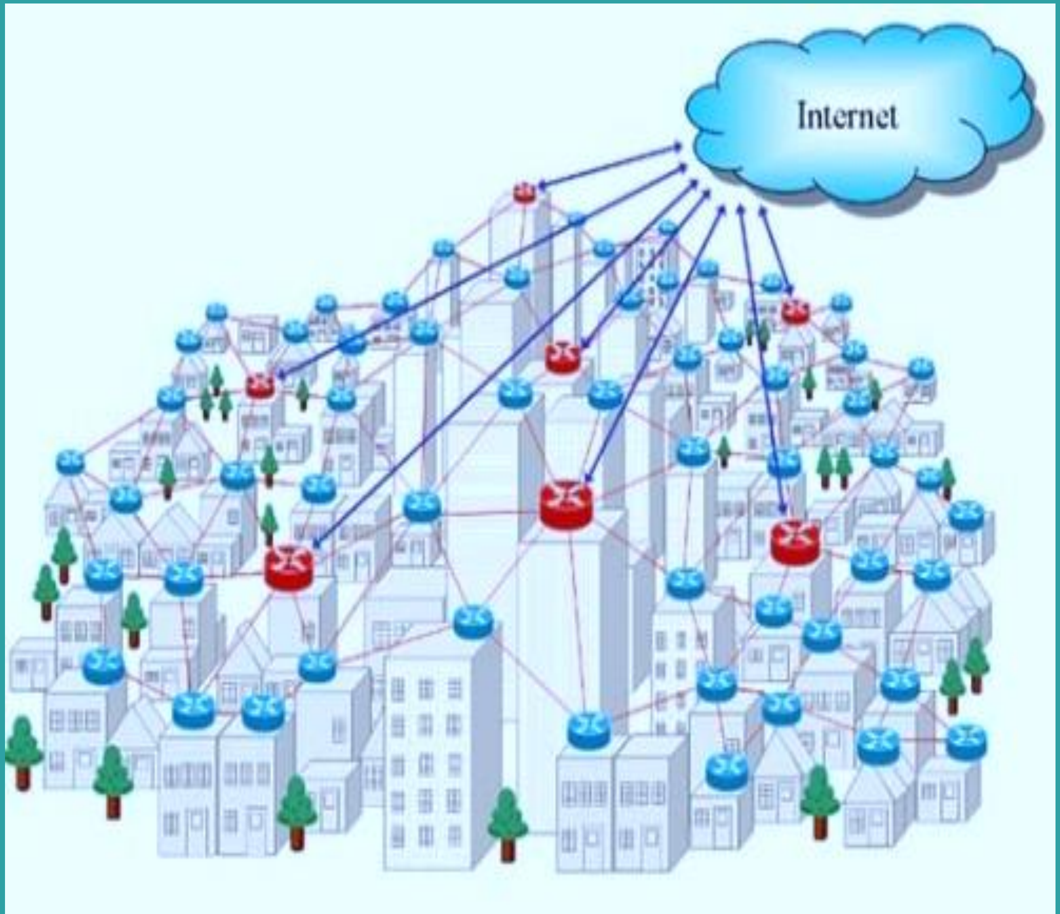


**Figure 3. Mesh-based Enterprise Wireless Sensor Network.**

# Scenario Analysis

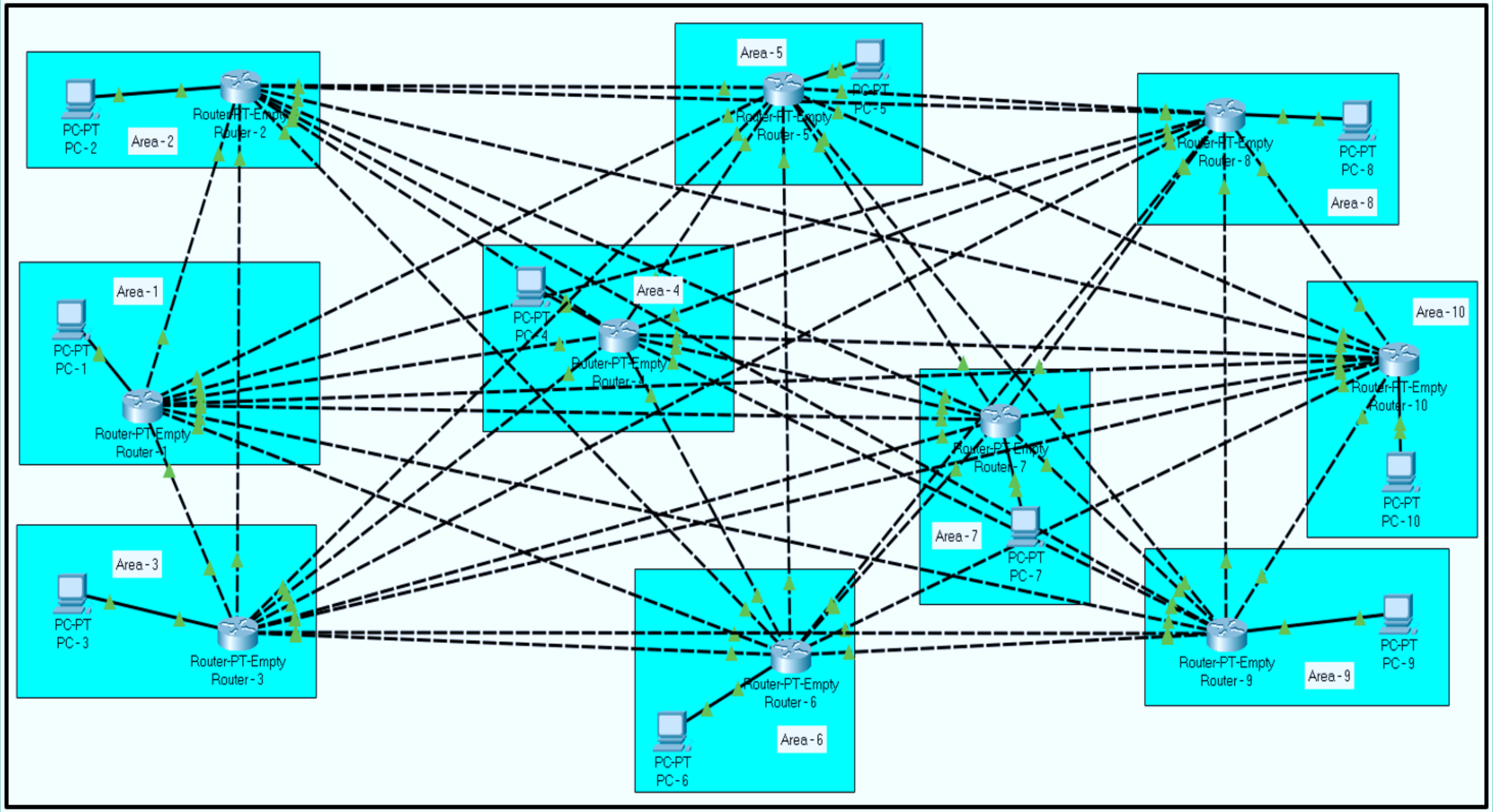


**Figure 4. Proposed Mesh-based Simulation Enterprise Wireless Sensor Network.**

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 |

# Testing Scenario

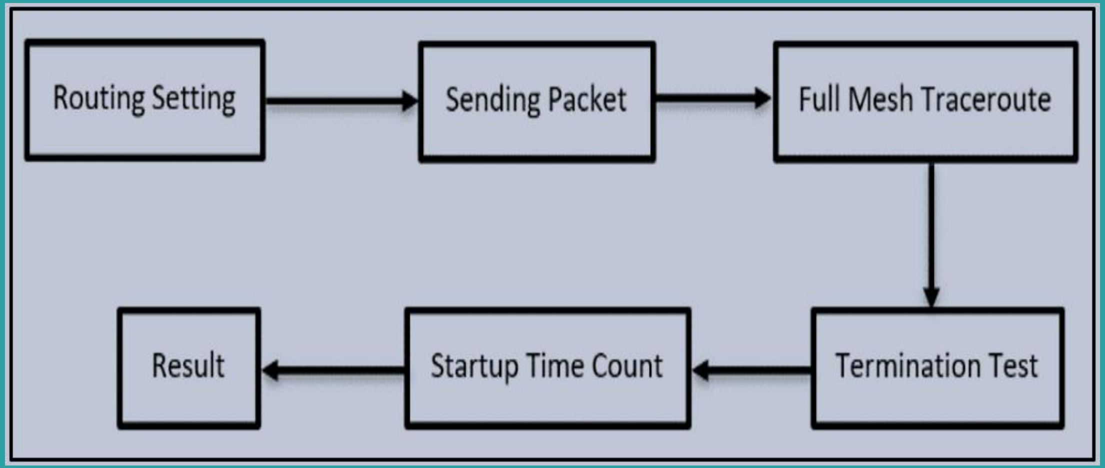


**Figure 5. Testing Process of Mesh Network Topology**

The network topology is testing the scenario shown in figure 5.
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.

# Data Transmitting

Afterward, the process of transmitting data packets from one network to another is carried out via ping test and traceroute, as seen in Figure **6**

```
C:\>ping 193.169.90.10

Pinging 193.169.90.10 with 32 bytes of data:

Reply from 193.169.90.10: bytes=32 time<1ms TTL=126
Reply from 193.169.90.10: bytes=32 time<1ms TTL=126
Reply from 193.169.90.10: bytes=32 time<1ms TTL=126
Reply from 193.169.90.10: bytes=32 time<1ms TTL=126

Ping statistics for 193.169.90.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>tracert 193.169.90.10

Tracing route to 193.169.90.10 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      193.169.1.1
  2   0 ms      0 ms      0 ms      193.169.10.2
  3   0 ms      0 ms      0 ms      193.169.90.10

Trace complete.
```

**Figure 6. Packet Sending and Tracert Checking on Route 1 to Route 10 using RIP**

Afterward, the process of transmitting data packets from one network to another is carried out via ping test and traceroute, as seen in Figure **7**

```
C:\>ping 193.169.90.10

Pinging 193.169.90.10 with 32 bytes of data:

Reply from 193.169.90.10: bytes=32 time<1ms TTL=126
Reply from 193.169.90.10: bytes=32 time<1ms TTL=126
Reply from 193.169.90.10: bytes=32 time<1ms TTL=126
Reply from 193.169.90.10: bytes=32 time<1ms TTL=126

Ping statistics for 193.169.90.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>tracert 193.169.90.10

Tracing route to 193.169.90.10 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      193.169.1.1
  2   0 ms      0 ms      0 ms      193.169.10.2
  3   0 ms      0 ms      0 ms      193.169.90.10

Trace complete.
```

**Figure 7. Packet Sending and Tracert Checking on Route 1 to Route 9 using EIGRP**

Afterward, the process of transmitting data packets from one network to another is carried out via ping test and traceroute, as seen in Figure **8**

```
C:\>ping 193.169.90.1

Pinging 193.169.90.1 with 32 bytes of data:

Reply from 193.169.90.1: bytes=32 time<1ms TTL=254
Reply from 193.169.90.1: bytes=32 time<1ms TTL=254
Reply from 193.169.90.1: bytes=32 time<1ms TTL=254
Reply from 193.169.90.1: bytes=32 time<1ms TTL=254

Ping statistics for 193.169.90.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>tracert 193.169.90.1

Tracing route to 193.169.90.1 over a maximum of 30 hops:

  1   0 ms      0 ms      0 ms      193.169.1.1
  2   0 ms      0 ms      0 ms      193.169.90.1

Trace complete.
```

**Figure 8. Packet Sending and Tracert Checking on Route 1 to Route 8 using OSPF**

# Time Testing

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

| Full Mesh | | | | |
|---|---|---|---|---|
| **Client PC** | **Client PC** | **RIP** | **EIGRP** | **OSPF** |
| **PC – 1** | **PC – 2** | 8 ms | 1 ms | 2 ms |
| **PC – 1** | **PC – 3** | 6 ms | 7 ms | 2 ms |
| **PC – 1** | **PC – 4** | 8 ms | 8 ms | 3 ms |
| **PC – 1** | **PC – 5** | 8 ms | 8 ms | 5 ms |
| **PC – 1** | **PC – 6** | 7 ms | 8 ms | 6 ms |
| **PC – 1** | **PC – 7** | 8 ms | 9 ms | 4 ms |
| **PC – 1** | **PC – 8** | 9 ms | 9 ms | 9 ms |
| **PC – 1** | **PC – 9** | 11 ms | 9 ms | 5 ms |
| **PC – 1** | **PC – 10** | 12 ms | 8 ms | 6 ms |

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

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

# Performance Analysis Parameter

The performance of the network as a whole is measured by analyzing the following parameters [3 – 6]:

**Latency**

Latency is calculated using the following formula:

$$Latency = \frac{Round\ Trip\ Time}{2}$$

**Round-trip Time**

Round-trip time is also called round-trip delay, is the time required for a signal pulse or packet to travel from a specific source to a specific destination and back again.

**Throughput**

Throughput is calculated using the following formula:

$$Throughput = \frac{Latency}{Packet\ Size}$$

Throughput is the amount of data moved successfully from one place to another in a given time period, and typically measured in bits per second (bps), as in megabits per second (Mbps) or gigabits per second (Gbps).

# 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.

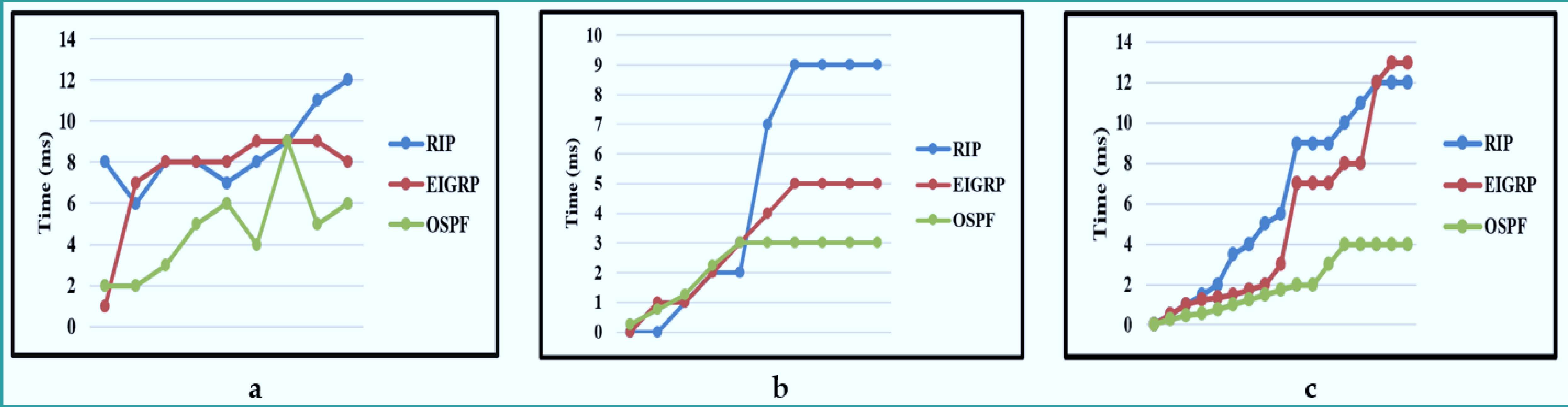


Figure **9a.** The Average Voice Packet end-to-end Latency, **9b.** The Average Value of HTTP Page Response Time, **9c.** The Average Video Packet end-to-end Latency.

Figure 10 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.

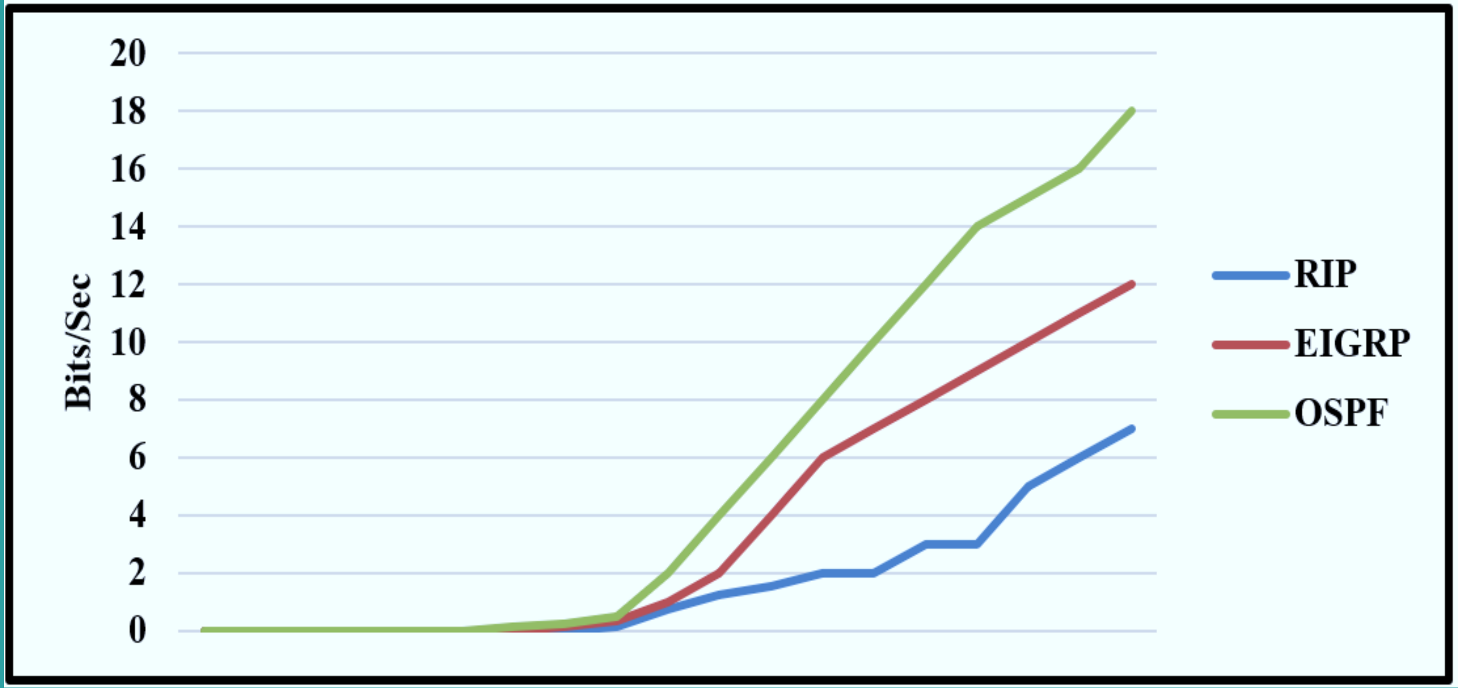


**Figure 10. The Average Point to Point Throughput (bit/sec).**

# 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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# Thank You for Your Time and Attention!!