Design a Wireless Network Scenario Using CBR

Bhupal Arya
Research Scholar, Quantum University Uttarakhnad
Amrita kumari
Assistant Professor, Department of Computer Science and Engineering, Quantum University Uttarakhnad
Jogendra Kumar
Assistant Professor, Department of Computer Science and Engineering GBPIET Ghurdauri Pauri Garhwal Uttarakhand

Abstract: Design a wireless network scenario adapted for evaluating routing protocols allows researchers and network designers to gain valuable insights into protocol performance. These scenarios enable informed decision-making, parameter optimization, and the development of efficient routing solutions for wireless networks. Performance metrics, including packet delivery ratio, end-to-end delay, routing overhead, and network throughput, are utilized to evaluate the effectiveness of the protocols. These metrics provide insights into the behavior, efficiency, and reliability of the routing protocols under various network conditions. The scenario encompasses factors such as network topology, mobility patterns, and traffic generation to facilitate a comprehensive analysis.

1. Introduction

By carefully considering various factors, including network topology, mobility patterns, and traffic generation, researchers and network designers can conduct comprehensive performance analyses and make informed decisions regarding protocol selection, parameter optimization, and development of efficient routing solutions [1-3]. The design of the network topology is a crucial component of creating an effective wireless network scenario. It should closely resemble real-world network deployments and consider factors such as node density, geographical distribution, and network size. By selecting appropriate topologies, such as random, grid, or map-based layouts, the scenario can accurately represent the challenges and characteristics of practical wireless networks. Incorporating realistic mobility patterns within the wireless network scenario is essential for evaluating the performance of reactive routing protocols.

Mobility models, such as the Random Waypoint model or Gauss-Markov model, can simulate node movements based on factors such as speed, pause time, and direction [4-6]. By introducing mobility, researchers can assess how the protocols adapt to dynamic network conditions, including node mobility and topology changes. Generating realistic traffic patterns is vital for evaluating the effectiveness of reactive routing protocols. Various traffic models, such as Constant Bit Rate (CBR) [8], Poisson, or real network traces, can be used to replicate the characteristics of network traffic observed in real-world scenarios. By considering factors such as data transmission rates, packet sizes, and traffic load, researchers can assess the protocols' performance under different traffic conditions and congestion levels.

To evaluate the performance of reactive routing protocols, several key performance metrics are considered. These metrics include packet delivery ratio, which measures the proportion of successfully delivered packets, end-to-end delay, which quantifies the time taken for a packet to traverse from source to destination, routing overhead, which accounts for the control traffic exchanged during route establishment, and network throughput, representing the volume of data successfully transmitted. By analyzing these metrics, researchers can assess the protocols' behavior, efficiency, and reliability in various network scenarios [9-12].

2. Related Work:

Kumar, Pattnaik, and Jena (2020) conducted a performance analysis of AODV, DSR, and ZRP routing protocols specifically for IoT applications. Their study aimed to evaluate the protocols' performance in terms of parameters such as packet delivery ratio, end-to-end delay, and throughput in IoT environments. Yadav, Lal, and Wadhawan (2020) performed a performance evaluation of AODV, DSR, and ZRP routing protocols in VANETs. Their study focused on assessing the protocols' performance in terms of packet delivery ratio, average end-to-end delay, and routing overhead in VANET scenarios.

Poddar, Sengupta, and Ghosh (2020) conducted a comparative performance analysis of AODV, DSR, and ZRP routing protocols in VANETs. They evaluated the protocols based on parameters such as packet delivery ratio, average end-to-end delay, and routing overhead to assess their suitability for VANET environments. Sharma, Tiwari, and Mishra (2021) performed a comparative performance analysis of AODV, DSR, and ZRP routing protocols in MANETs. Their study focused on evaluating the protocols in terms of packet delivery ratio, average end-to-end delay, and routing overhead in MANET scenarios.

Jain, Kaur, and Garg (2021) conducted a performance evaluation of AODV, DSR, and ZRP routing protocols in vehicular ad hoc networks (VANETs). Their study aimed to assess the protocols' performance in terms of packet delivery ratio, average end-to-end delay, and routing overhead in VANET environments. Singh, Sharma, and Sharma (2022) performed a comparative performance analysis of AODV, DSR, and ZRP routing protocols in mobile ad hoc networks (MANETs). Their study focused on evaluating the protocols based on parameters such as packet delivery ratio, average end-to-end delay, and routing overhead in MANET scenarios.

Yadav, Das, and Tripathi (2022) conducted a comparative analysis of AODV, DSR, and ZRP routing protocols in mobile ad hoc networks. Their study aimed to evaluate the protocols in terms of packet delivery ratio, average end-to-end delay, and routing overhead in mobile ad hoc network scenarios. Agarwal, Goyal, and Kishore (2023) performed a comparative performance evaluation of AODV, DSR, and ZRP routing protocols for MANETs. Their study aimed to assess the protocols' performance in terms of packet delivery ratio, average end-to-end delay, and routing overhead in MANET environments.

3. Routing Protocols in Wireless Networks:

Ad hoc On-Demand Distance Vector (AODV) is a reactive routing protocol designed for mobile ad hoc networks. It establishes routes on-demand by broadcasting route request messages, utilizing sequence numbers for routing information freshness. AODV incorporates route maintenance mechanisms to handle link failures and superior routes, reducing control overhead and adapting to dynamic network conditions.

Dynamic Source Routing (DSR) is a reactive protocol widely used in wireless networks. It utilizes source routing and route caches to efficiently discover routes. Nodes maintain a route cache storing recently discovered routes and initiate route discovery when a suitable route is not available. The route request packet floods the network, and intermediate nodes append their routing information, creating a source-routed path. Route reply messages establish routes, cached for subsequent data packet transmission. DSR's source routing and route caching minimize control overhead and adapt to dynamic network topologies.

Zone Routing Protocol (ZRP) is a hybrid protocol for mobile ad hoc networks, combining proactive and reactive approaches. It divides the network into zones, with proactive routing within each zone and reactive routing between zones. The Intrazone Routing Protocol (IARP) maintains routing information for nodes within a zone, ensuring fast and efficient routing. The Interzone Routing Protocol (IERP) handles routing between different zones, dynamically discovering routes. ZRP's proactive and reactive components optimize routing overhead, adapt to topology changes, and support communication across the entire network. ZRP offers a balanced approach, combining proactive and reactive strategies, making it a promising routing protocol for mobile ad hoc networks with dynamic environments.

4. Simulation Parameters Setup

Parameters	Values
Simulation Time	900 seconds
Channel Frequency	2.4 GHz
No. of Nodes	200 nodes
Area	1500m x 1500m
Routing Protocols	AODV, DSR, and ZRP
Traffic Source	Constant Bit Rate (CBR) traffic load
Shadowing Model	Constant Energy Model
Terrain File	Digital Elevation Model (DEM)
Node Placement Model	Random Waypoint Model
Fading Model	Rayleigh
Mica Motes Battery Model	Simple Linear Model

Table 1 Parameters List

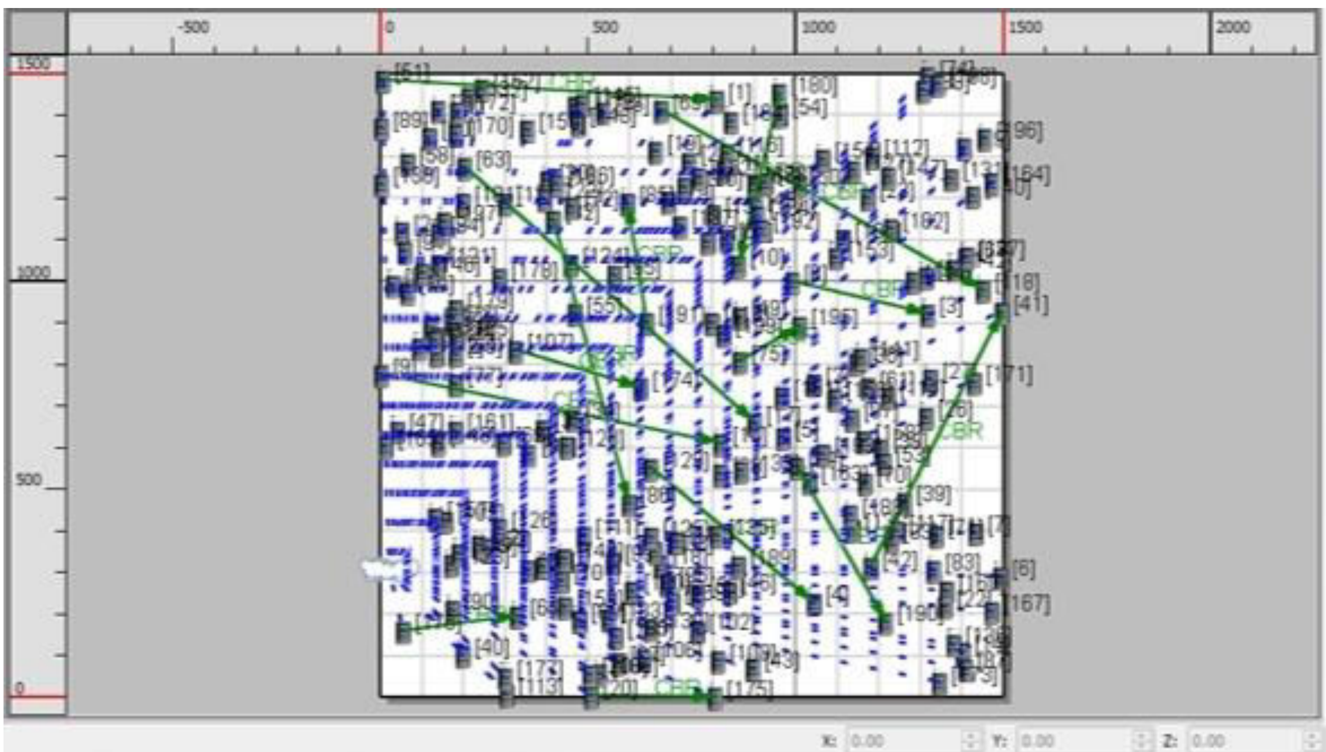

Figure 1 Wireless Networks Scenario for Routing Protocols

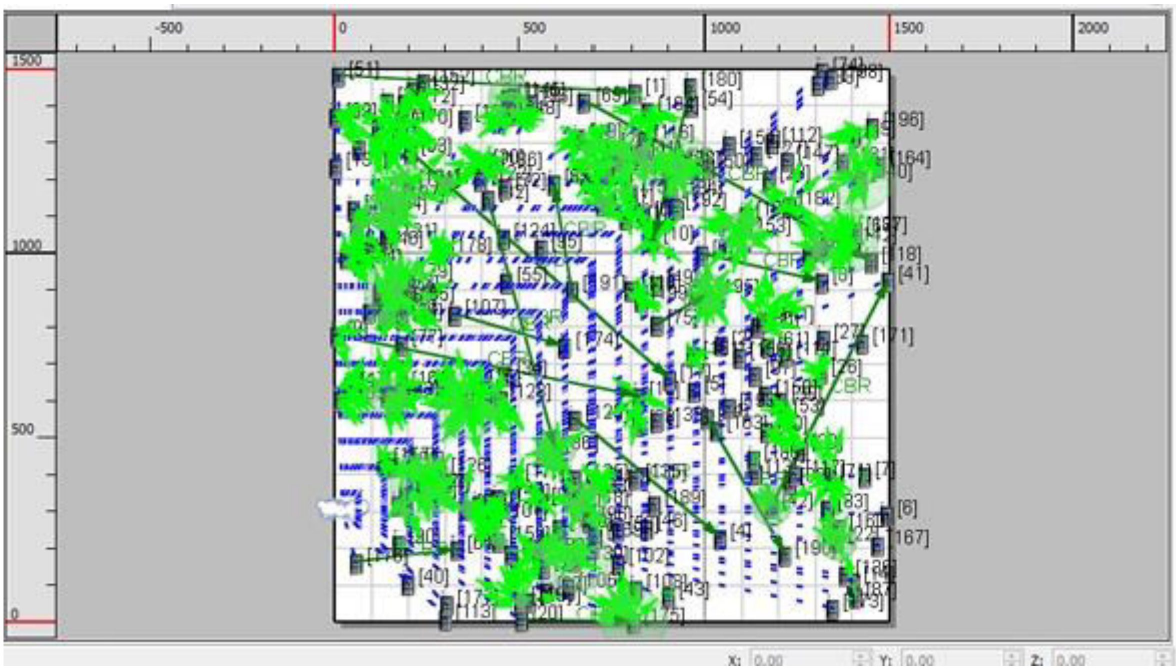

Figure 2 Simulation View

A. Performance Metrics:

1. **Average End-to-End Delay:** The formula for calculating the average end-to-end delay is:
   Average End-to-End Delay = (Total Delay of all packets) / (Total number of packets)

2. **Jitter:** Jitter can be calculated using the following formula:
   Jitter = (Sum of |Packet Delay - Average Delay|) / (Total number of packets - 1)

3. **Throughput:** The formula for calculating throughput is:
   Throughput = (Total data transmitted) / (Total time taken)

4. **TTL-based hop count:**The formula to calculate TTL-based hop count is:
   Hop count = Initial TTL value - Current TTL value

5. **Results and Discussion:**

In this section, the performance of three routing protocols, namely Ad hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR), and Zone Routing Protocol (ZRP), is evaluated within the context of a wireless network scenario. The analysis focuses on several performance metrics, including total bytes sent and received, average end-to-end delay, jitter, throughput, and TTL-based hop count.

Figures 3 and 4 present the total bytes sent from the source node using Constant Bit Rate (CBR) and the total bytes received at the destination, respectively. These figures provide insights into the data transmission efficiency of the protocols. The average end-to-end delay, a critical metric for assessing routing protocol efficiency, is discussed in Figure 5. Lower delay values indicate faster packet delivery and improved real-time communication. The simulations demonstrate that all three protocols exhibit relatively low average end-to-end delay values. However, AODV shows slightly lower delay compared to DSR and ZRP, attributed to its efficient route discovery mechanism and quick route establishment capabilities. Jitter, which quantifies the variation in packet delivery delay, is examined in Figure 6. Lower jitter values are desirable for applications requiring consistent and predictable packet delivery. The results indicate that all three protocols maintain relatively low jitter values. DSR shows slightly lower jitter compared to AODV and ZRP, attributed to its source routing mechanism that ensures packets follow predefined paths, resulting in more consistent delivery times. Throughput, reflecting the data transmission capacity within a network, is analyzed in Figure 7. Higher throughput values indicate better network efficiency and the ability to handle larger data volumes. The simulations demonstrate that all three protocols exhibit commendable throughput values. DSR showcases slightly higher throughput compared to AODV and ZRP, thanks to its reduced overhead in route discovery and maintenance. TTL-based hop count, shown in Figure 8, indicates the efficiency of route establishment and maintenance. All protocols maintain relatively low hop counts. However, AODV demonstrates slightly fewer hops compared to DSR and ZRP, potentially due to its effective route maintenance mechanism.

Overall, the choice of routing protocol should consider specific network requirements, mobility patterns, traffic load, and application characteristics. AODV, DSR, and ZRP all exhibit strengths in different areas, such as low delay, low jitter, and high throughput, and understanding their performance characteristics can aid in selecting the most suitable protocol for a given wireless network scenario.

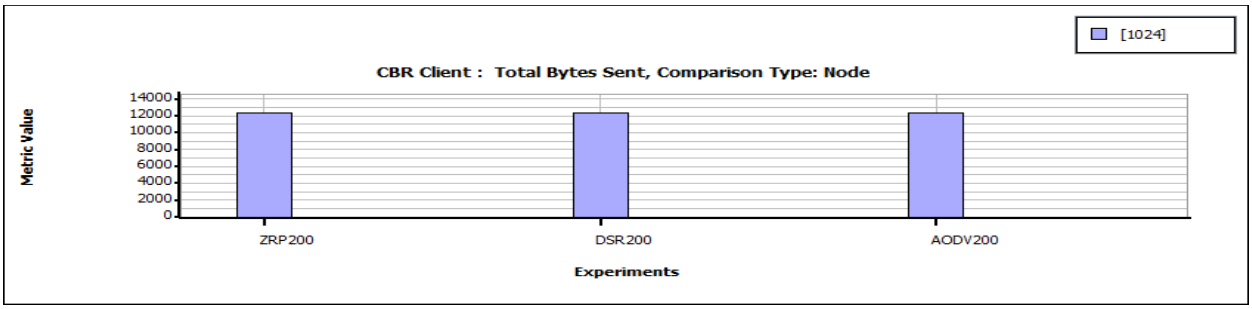

Figure 3 Total Bytes Sent

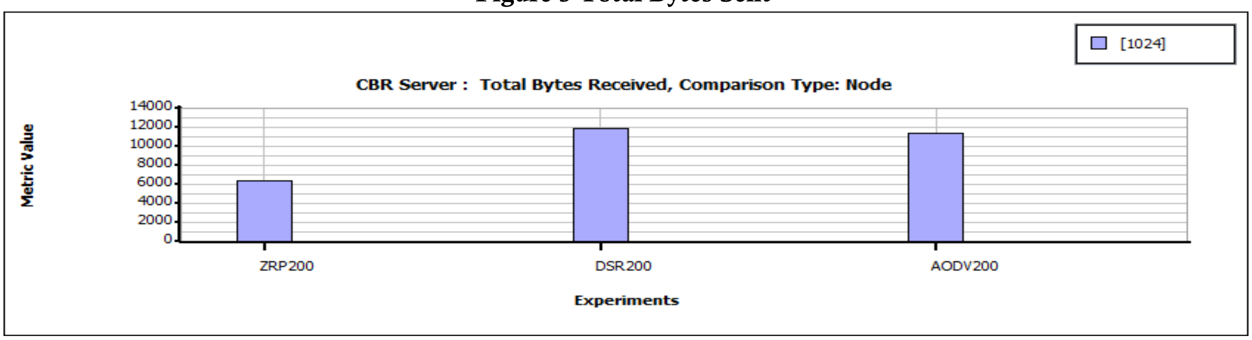

Figure 4 Total Bytes Received

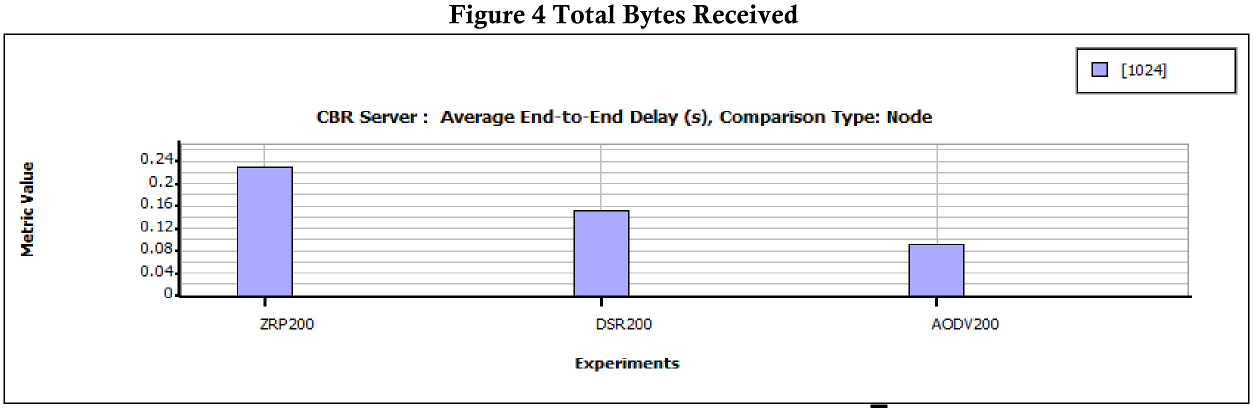

Figure 5 Average End to End Delay (s)F

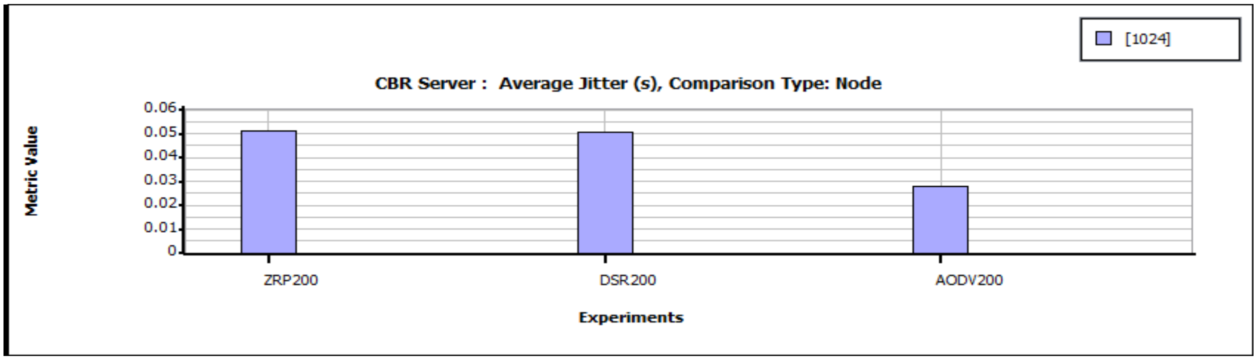

Figure 6 Average Jitter (s)F

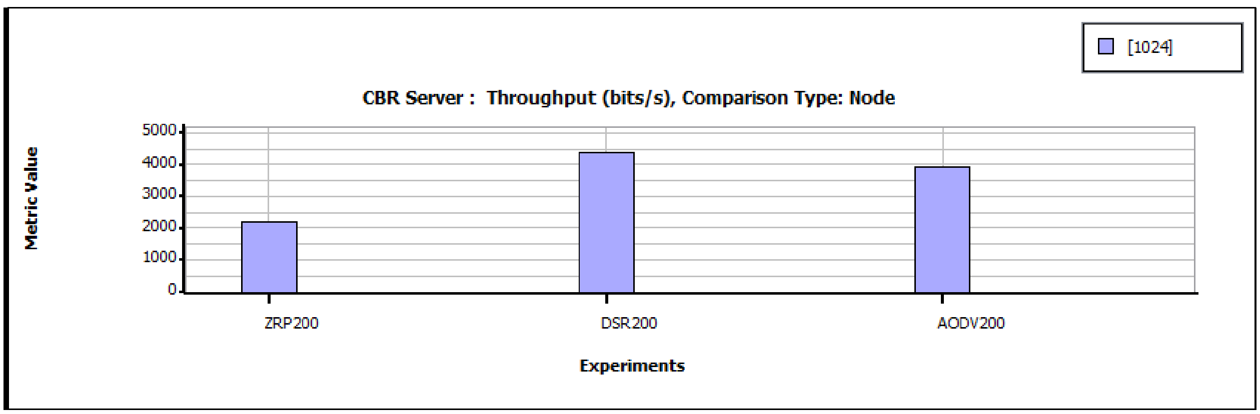

Figure 7 Throughput (bits/s)F

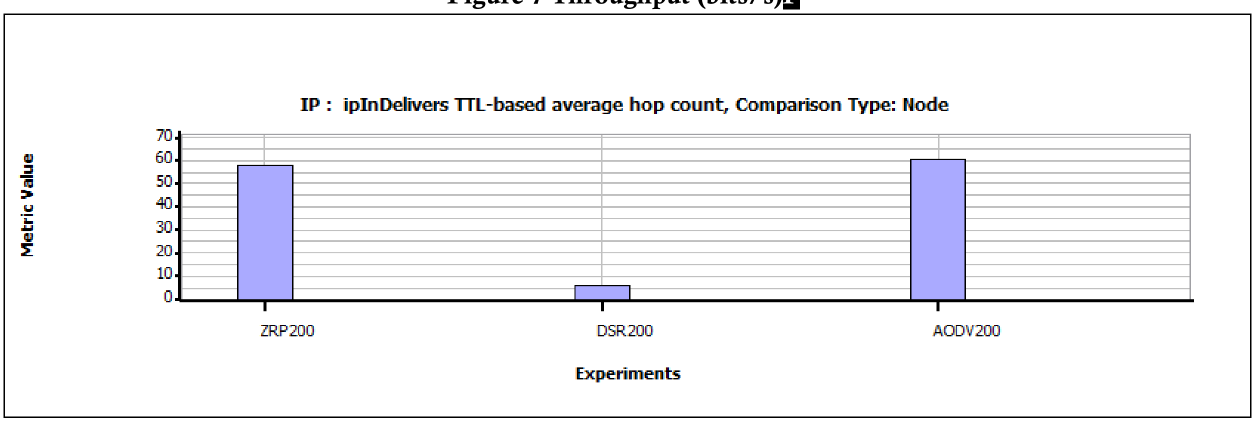

Figure 8TTL based average hop count g

6. **Conclusions:**

In conclusion, the evaluation of AODV, DSR, and ZRP routing protocols in the wireless network scenario reveals their performance in terms of various metrics. AODV demonstrates efficient data transmission with slightly lower average end-to-end delay compared to DSR and ZRP, attributed to its effective route discovery mechanism and quick route establishment. All three protocols maintain relatively low jitter values, but DSR exhibits slightly lower jitter due to its source routing mechanism ensuring consistent packet delivery times.In terms of throughput, DSR outperforms AODV and ZRP, benefiting from reduced overhead in route discovery and maintenance. TTL-based hop counts indicate that all protocols establish and maintain routes efficiently, but AODV showcases slightly fewer hops, indicating its effective route maintenance mechanism.The selection of a routing protocol should be based on the specific requirements of the network, including mobility patterns, traffic load, and application characteristics. AODV, DSR, and ZRP offer distinct advantages, such as low delay, low jitter, and high throughput, in different scenarios. Therefore, a comprehensive understanding of their performance characteristics is crucial for making an informed decision.It is important to note that the evaluation is based on simulations in a specific wireless network scenario, and real-world deployment may yield different results. Further research and experimentation are necessary to validate the findings in various network environments and scenarios. Nonetheless, this analysis provides valuable insights for network administrators and designers in selecting an appropriate routing protocol to optimize the performance of wireless networks.

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