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# A Study on effect of Mobility Models on the performance of Routing Protocols in Mobile Ad-HOC Network

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***Abstract - A mobility model depicts how nodes are dispersed and move throughout a network. Multiple studies have shown that the results of routing performance simulation in Mobile Ad Hoc Networks may be impacted by the mobility model used. Therefore, a routing protocol may work well with one kind of mobility model or scenario but poorly with another. Because of this, it is very uncommon for studies of routing protocol performance to be based on insufficient data, which in turn leads to flawed argumentation and conclusions. This research aims to evaluate the efficiency of energy-consuming routing methods in a mobile Ad-hoc network using the QualNet simulator. The examination of performance has been carried out by the researcher using a number of performance indicators, including End-to-End Delay, Jitter, Throughput, and Energy Consumption. The impact of mobility on MANET routing protocols using OLSR and STAR routing protocols with Random Waypoint mobility model has been investigated The performance comparison of OLSR and STAR routing protocols using random waypoint mobility model in case of mobility for 50 nodes scenario has been presented. The performance of OLSR and STAR routing protocols have been analyzed on the basis of performance metrics namely Average Jitter (s), Average End-to-End Delay (s), and Throughput (bits/s).***

***Keyword - MANET, Protocols***

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## INTRODUCTION

A mobile ad hoc network, or MANET, is an infrastructure consisting mostly of wireless mobile devices that is automatically optimized in real time. In Latin, ad hoc means "for this reason." Without the need for or ability to centrally operate preexisting 5 networks, remote ad hoc networking is made up of a dispersed set of mobile Wi-Fi nodes arranged in a complicated topology. Each node in a mobile ad-hoc network acts as both an end system and a router for other networks, making the network itself autonomous. Different types of MANET protocols exist. Among protocols, the least power routing method is a special case. It picks a route that minimizes overall energy consumption between the source and the destination. The group's lack of patience is shown in its tendency to choose control strategies with the shortest time until expiration. The addition of a second group requires more network time. The transmission charge is spread in many different directions. To do this, we may put some of the nodes in charge of transmission to bed at odd hours. This helps maintain a steady flow of data across the MANET and extends the networks' useful lifespan. Several reactive protocols have been proposed to ensure the success of MANETs. Due to the proliferation of portable computers and 802.11/Wi-Fi wireless networks, research into MANETs has grown widespread since the mid-1990s. Some academic publications examine the flexibility of protocols and their abilities within a certain environment. Then, metrics like packet propagation ratio, overhead routing, end-to-end latency, network transmission, etc., may be used to compare and contrast the different Protocols. [1]

## MANET

In computer networking, a "Mobile Ad Hoc Network" (MANET) is a group of mobile devices that have the ability to automatically configure themselves into a wireless ad hoc network (MANET). Because of this, the Latin phrase meaning "because of this" is ad hoc. A second definition of an ad hoc network is one that lacks a preexisting framework and centralized administration. Every node in an ad hoc mobile network has the potential to serve as an end system and a router for its immediate neighbors. Self-organizing and cooperating nodes may create network topologies that enable spontaneous communication between users and devices. Most often, MANETs are Routable Networking Environments for Wireless Ad Hoc Networks, as opposed to Link Layer Ad Hoc Networks. While mobile ad hoc networks don't have a centralized administration, a mesh network does. In radio ranges, mobile nodes are linked wirelessly. Since distant nodes rely on one another for communication, the network's topology is always shifting. For both military and civilian applications, mobile ad hoc networks' ability to self-organize and -configure is a major plus.[2-4]

Commonly utilized in these networks are routing protocols that facilitate data transfer between individual nodes. The protocols used in a MANET may be classified into two categories. The technique for minimum power routing is only one example of a protocol. It starts at the beginning and works its way to the finish using the most efficient path possible. The problem with this kind is that it always picks the quickest-to-expire, lowest-cost routes. There is a growing trend of longer networks in the second category. To ease congestion, a multi-path forwarding approach is used. The number of forwarding nodes may be reduced and some of them given permission to sleep for varied amounts of time. Due to the more uniform distribution of traffic, the MANET is able to function for longer periods of time. There are a number of reactive routing strategies that may increase the speed of a MANET. [5]

## Routing Protocols

In a local area network (LAN), router communication protocols define how routers exchange information and find connections between nodes. There are techniques called routing protocols that may be used to determine the most efficient path. Each router can only anticipate a small number of networks, and those networks must be physically connected. Initially, routing protocols broadcast this data to their close network neighbors. That's why routers could pick up on the network topology. It was with routers in mind that routing protocols were developed. Routers may more readily exchange their routing tables, or lists of known networks, when using these protocols. Different routing protocols can handle networks of different sizes. Ad hoc networks rely on routing algorithms to ensure packets are delivered promptly with minimal overhead and network throughput. [6]

## LITERATURE REVIEW

**Ashish K. et al (2010):** To test the efficacy of AODV, FSR, and ZRP routing protocols, they simulated two scenarios. The network was built for the pause time separately using a random adaptability model. Network of randomly chosen nodes, capable of taking on a variety of configurations, [7]

**Sree Ranga Raju, et al (2010):** The outcomes of DSR and AODV were compared. Typical elapsed time, packet delivery rate, and throughput are the four output characteristics used to compare AODV, FSR, and ZRP. When comparing AODV, FSR, and ZRP in terms of package delivery rate and quality, the former displays clear superiority. Over 80% of CBR network packets are distributed as a series of nodes as a network time-functionality, and AODV delivers over 60% of these packets. [8]

**Ayyaswamy Kathirvel, et al (2007):** Examining the strengths of DSR, AODV, FSR, and ZRP as models for propagation. For the reactive riding procedures, there is a high package distribution ratio (AODV and DSR). When compared to proactive and alternative routing protocols, the intermediate routing protocol comes out on top. Latency is reduced in similarly reactive routing methods. [9]

**Shivlal Mewada et. al (2012):** Lacking fixed infrastructure, a mobile ad hoc network (MANET) is characterized by its decentralized nature and its tangled nature as a whole. The inherent difficulty of ad hoc networks stems from the mobility of individual nodes. A thorough discussion of the On Demand distance vector, complicated source routing, network size, nudity, and pause-based simulation output analysis, as well as a simulation-based evaluation of MENET's DSR and AODV protocols, can be found in this study. Using NS-2 as a network simulator, the matrix includes data like overall delay and packet delivery ratio. [10]

**Vahid Nazari (2006):** The effectiveness of DSDV, AODV, DSR, and TORA is compared on the NS2 platform, with the results showing that AODV is preferable than the other three in most cases. Scientists found that AODV and DSR operate well under light to moderate network loads, but that the liaison state outperforms reactive methods under heavy traffic. We dug further into the stats for the Basic 5 State Protocol, AODW, and DSR. The authors analyze the impact of real-world simulations by looking at DSR and DSDV. [11]

**Misra and Mandal (2005):** The performance of on-demand protocols was evaluated with the help of AODV and DSR using the Glomosim Simulator. A definitive verdict on the procedures' results is presented by the authors. They anticipate AODV to go beyond DSR, using several data transmission methods to reach various locations. When several sources provide traffic to the same destination, however, AODV's total packet delivery rate likely suffers. You warn that this may lead to issues if conventional entry points are used, and you provide solutions to this potential obstacle. In this project, MANET nodes are all transmitting data to the same place, under the same conditions. Since we run simulations in many different environments, we do not want to either confirm or dispute the authors' conclusions. However, we arrive at our own interpretations of the evidence. [12]

**Demers and Kant (2006):** Ad hoc networks are cellular networks in which no central authority or set of rules has been established. The lack of ad hoc infrastructure severely hinders the usefulness of these networks. For wireless networks that include nodes that are constantly moving, like cellular ad hoc networks, we deploy what is called a Handheld Hoc Network (MANET).[13]

**Zahary, Ayesh, (2007):** The energy performance of nodes, changes in topology, unstable connection, and restricted bandwidth are all factors that need to be considered while developing a MANET, since these characteristics define the nature of MANETs. With a mobile ad hoc network (MANET), individual nodes may both forward and receive traffic from their surrounding networks. As the network and its nodes become more adaptable, so do the accompanying self-configuration problems. Reduced energy consumption from mobile nodes is achieved via more frequent connections and preassemblies. Ad hoc routing systems include built-in mechanisms to handle the complexities of MANETs. The effectiveness of the routing algorithm is affected by a variety of factors, one of which is the use of the battery capacity and node routing of the participating nodes. How fast the routing mechanism adjusts to broken and repaired links is also deemed crucial. AODV, OLSR, DSR, TORA, WRP, and ZRP are all examples of ad hoc routing protocols. These results offer OLSR, AODV, DSR, and TORA in a clear and succinct format. [14]

**Alex Hinds et.al, (2013):** The AODV core protocol has multicasting capabilities, which may be used to test the development of an AODV protocol by comparing it to implementations based on a multicast ad hoc on-demand distance vector (MAODV). The author has reviewed literature on the AODV protocol's security in order to address the safety issues raised by studies like the security-aware ad hoc on-demand distance vector routing protocol (SAODV).[15]

**Dr. V.V.Rama Prasad et. al. (2012):** One of the main topics of interest in MANET research is routing. Thus, several distinct routing protocols for MANETs were created. There are many different kinds of reactive protocols, and the author summarizes and evaluates several of them, including those used for unicast and multicast routing. When this is required is determined by "on demand" routing protocols. A constant stream of updates is unnecessary. However, periodic photographs may be required of any nodes. Take ABR as an example. Except for CBRP, the routing designs of reactive protocols are typically flat. When compared to global routing, which has improved with GPS, the amount of traffic management is much lower. So, take LAR as an example. To deal with the fallout of adaptability, ABR uses LBQ. ROAM makes adjustments to the threshold. AODV employs local path discovery. The amount of space needed for a reactive procedure is proportional to the number of active or needed tracks. The ratio of delays to effective actions is often higher than in proactive situations but lower than in those involving constructive methods. Finally, multihopping levels may go up to a few hundred knots, and the scalability of source routing techniques varies with the volume of traffic. [16]

## RESEARCH METHODOLOGY

### Research Design

Researchers have speculated that the mobility of nodes in mobile Ad-hoc networks impacts performance measures like energy usage. To achieve the goals of this study, simulations need to be run across a wide range of simulation parameters and network situations to test and validate this theory in the context of mobile Ad-hoc networks.

The effectiveness of several routing algorithms and the effect of mobility on energy consumption in mobile Ad-hoc networks have been analyzed using the QualNet 5.0.2 simulator. All simulations have been performed while keeping in mind the following parameters:

- **Terrain size:** Each simulation has a set terrain size of 500 × 500 meters.
- **Node density:** Node densities ranging from 30 to 110 mobile nodes have been simulated.
- **Mobility speed:** Node mobility speeds from 0 to 50 meters per second have been used in the research.
- **Mobility models:** This research employs the Random Waypoint and Group Mobility models.
- **Energy models:** Generic, Mica-motes, and MicaZ are the three different types of energy models have been applied to the assessment of power consumption in a variety of settings.
- **Traffic Pattern:** There is a constant bit rate (CBR) traffic pattern in place from the source to the destination node.
- **Simulation Time:** 120 each simulation lasted 120 seconds.

Research study results have been analyzed based on performance metrics, and conclusions have been drawn after the completion of the various simulations.

### Scope of the Research Study

Researchers are drawn to the topic of wireless communication because of its high demand, broad potential, and adaptability to meet the needs of modern society in a variety of contexts. The field of mobile communication is expanding rapidly, with mobile Ad-hoc networks being a particularly active area of study. This research aims to evaluate the efficiency of energy-consuming routing methods in a mobile Ad-hoc network using the QualNet simulator. The examination of performance has been carried out by the researcher using a number of performance indicators, including End-to-End Delay, Jitter, Throughput, and Energy Consumption. Routing protocols in MANETs have also been analyzed, along with their effects on energy consumption and mobility.

**Tools and Techniques**

In a mobile Ad-hoc network, routing techniques are crucial to effective two-way dialogue. In a mobile Ad-hoc network, the routing protocol specifies how the mobile nodes interact with one another to disseminate data that allows the nodes to find the most effective paths between any two given nodes.

The performance of routing protocols may be studied with the use of a wide range of simulation tools, such as QualNet, OPNET, NS-2, NS-3, GloMoSim, P2PSim, etc. The following hardware and software packages were utilized in this investigation:

**1. Network Simulator**

In order to carry out the simulation-based analysis, the researcher has employed the network simulator QualNet 5.0.2. The software company Scalable Network Technologies created QualNet. QualNet simulates a mobile Ad-hoc network with thousands of nodes. The interface and platform compatibility of the QualNet simulator are unparalleled. The QualNet simulator has undergone extensive testing and is widely approved for use in mobile Ad-hoc network research. In contrast to other network simulators, the QualNet simulator makes it simple to control the simulation through the use of graphical user interfaces. It is also thoughtfully constructed to provide realistic case studies for research into mobile Ad-hoc networks. Scientists using the QualNet simulator can make educated guesses about the performance and behaviour of a mobile Ad-hoc network, which can lead to advancements in the network's architecture, administration, and operation.

**2. Operating System**

QualNet is compatible with Unix, Microsoft Windows, Mac OS X, and Linux, as well as their parallel and sequential variants. The simulation study in this paper was run on a Windows PC using the QualNet simulator.

**3. Application Software**

The outcomes of several simulated network situations in a mobile Ad-hoc network have been provided, and QualNet 5.0.2 has been utilized for this purpose. The simulator has sent the findings in the form of stat files. Several graphs have been plotted to examine the performance of mobile Ad-hoc networks using different performance indicators. Graphs and data analysis in this study were created using Microsoft Office Excel 2007.

## DATA ANALYSIS

**Impact of mobility on MANET routing protocols**

The impact of mobility on MANET routing protocols using OLSR and STAR routing protocols with Random Waypoint mobility model has been investigated. The next part of the section covers the effect of varying mobility speed on DSR and DYMO routing protocols.

**Performance comparison of OLSR and STAR routing protocols under with mobility effect and without mobility effect**

The performance comparison of OLSR and STAR routing protocols using random waypoint mobility model in case of mobility for 50 nodes scenario has been presented. The performance of OLSR and STAR routing protocols have been analyzed on the basis of performance metrics namely Average Jitter (s), Average End-to-End Delay (s), and Throughput (bits/s).

**i) Average Jitter(s):**

It has been observed that in both conditions with mobility and without mobility effect the OLSR have less jitter as compared to STAR routing protocol.

**Table 1: Average Jitter(s) and Average End-to-End Delay(s) for OLSR and STAR routing protocols with and without mobility effect**

| Routing Protocol | Average Jitter (s) | Average End-to-End Delay (s) |
|---|---|---|
| OLSR_M | 7.16E-03 | 6.54E-02 |
| OLSR_NM | 5.40E-03 | 1.22E-02 |
| STAR_M | 8.73E-03 | 1.28E-01 |
| STAR_NM | 5.76E-03 | 2.77E-02 |

**ii) Average End-to-End Delay(s):**

The STAR protocol has the higher average end-to-end delay in comparison to OLSR in both of the cases with mobility effect and without mobility effect.

**iii) Average Throughput (bits/s):**

It has been indicated that the STAR routing protocol has the less throughput as compared to OLSR protocol in case of mobility effect. However, the throughput of STAR and OLSR routing protocols is much higher in absence of mobility.

**Table 2: Average Throughput for OLSR and STAR routing protocols with and without mobility effect**

| Routing Protocol | Average Throughput (bits/s) |
|---|---|
| OLSR_M | 1.64E+05 |
| OLSR_NM | 1.68E+05 |
| STAR_M | 1.63E+05 |
| STAR_NM | 1.69E+05 |

**Impact of mobility on MANET routing protocols under different traffic pattern**

The Impact of mobility on MANET routing protocols under different traffic pattern is investigated in this section. In first part of this section the performance of AODV and DSR routing protocols using CBR and FTP traffic patterns under random waypoint mobility model has been presented.

- **Simulation of AODV and DSR routing protocols with CBR and FTP traffic patterns in both cases of with and without mobility effect**

The simulation results for both AODV, DSR routing protocols for 150 nodes have been analyzed. The scenario of 150 nodes has been created under Random Waypoint mobility model in case of mobility using CBR and FTP traffic patterns.

**i) Average Jitter(s):**

It has been found that in both cases with mobility and without mobility effect, the AODV has less average jitter as compared to DSR protocol.

**Table 3: Average Jitter(s) and Average End-to-End Delay(s) for AODV and DSR with and without mobility effect**

| Routing Protocol | Average Jitter(s) | Average End-to-End Delay (s) |
|---|---|---|
| AODV_NM | 1.77E-02 | 4.96E-02 |
| DSR_NM | 2.24E-02 | 6.76E-02 |
| AODV_M | 3.93E-02 | 2.56E-01 |
| DSR_M | 8.93E-02 | 4.56E-01 |

**ii) Average End-to-End Delay(s):**

The average end-to-end delay(s) is higher for DSR protocol than that of AODV protocol in both of cases with mobility and without mobility effect. The results have been shown in Table-5.5 and Fig.-5.8. This is happens because AODV has reduced routing overhead and queuing delay.

**iii) Average Throughput (bits/s):**

The AODV clearly outperform DSR routing protocol in term of throughput. The throughput of DSR is less in comparison to AODV routing protocol in both cases of with mobility and without mobility effect in CBR and FTP traffic patterns. The results have been shown in Table-5.6, Fig.-5.9, Fig.-5.10, and Fig.-5.11.

**Table 4: Average Throughput (bits/s) for AODV and DSR in CBR and FTP traffic patterns with mobility effect and without mobility effect**

| Average Throughput(bits/s) | Routing Protocol | | | |
|---|---|---|---|---|
| | AODV_NM | DSR_NM | AODV_M | DSR_M |
| Throughput under CBR Traffic | 1.64E+05 | 1.33E+05 | 1.53E+05 | 1.23E+05 |
| Throughput(bits/s) under FTP Traffic | 1.47E+05 | 1.17E+05 | 1.47E+05 | 1.17E+05 |

**Impact of Mobility on MANET routing protocols with different mobility models**

This section embodies the outcomes related to the impact of mobility on MANET routing protocols using Group, Random Waypoint and File mobility models with CBR traffic. The section begins with the performance comparison of nine routing protocols namely: Bellman Ford, FISHEYE, LANMAR, RIP, STAR, AODV, DSR, DYMO, and ZRP using varying node density under Group mobility model. The next part of this section summarizes the performance of five proactive (FISHEYE, LANMAR, Bellman ford, RIP and STAR), three reactive (AODV, DSR, and DYMO) and one hybrid routing protocol (ZRP) under the Random Waypoint mobility model. The section ends with the discussion related to the impact of mobility models on MANET routing protocols.

**Table 5: Average End-to-End Delay(s) under Group Mobility Model**

| Routing Protocol | Number of Node | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 60 | 100 | 140 | 180 | 200 |
| AODV | 7.01E-02 | 9.42E-02 | 3.20E-02 | 5.76E-02 | 6.05E-02 | 6.47E-02 |
| Bellman Ford | 9.73E-01 | 1.21E+00 | 4.32E-02 | 8.60E-02 | 1.56E-01 | 2.02E-01 |
| DSR | 8.25E+00 | 7.36E-02 | 4.61E-02 | 6.97E-02 | 5.36E-02 | 5.86E-02 |
| DYMO | 1.12E-01 | 1.54E-01 | 5.62E-02 | 1.74E-01 | 1.30E-01 | 1.60E-01 |
| FSR | 5.74E-02 | 2.38E-01 | 1.06E-01 | 3.24E+00 | 6.54E+00 | 9.41E+00 |
| LANMAR | 4.69E-02 | 6.00E-01 | 2.36E-01 | 2.44E-01 | 4.09E-01 | 4.46E-01 |
| RIP | 1.85E-01 | 8.14E-02 | 3.15E-02 | 8.29E-02 | 1.12E-01 | 1.43E-01 |
| STAR | 5.72E-02 | 8.00E-02 | 4.71E-02 | 2.71E-02 | 8.32E-02 | 5.95E-02 |
| ZRP | 1.02E+01 | 2.57E+00 | 5.42E-02 | 5.24E+00 | 7.31E+00 | 1.07E+01 |

**Impact of Mobility Models on MANET routing protocols**

In this section, the impact of three mobility models namely File mobility model, Random Waypoint mobility model and Group mobility model on MANET routing protocols has been analyzed. For this purpose, the network of 20 and 60 nodes has been used. To make comparative study of mobility models we have used the outcomes. The performance of five proactive protocols namely

FSR, LANMAR, Bellman Ford, RIP and STAR, three reactive protocols namely AODV, DSR, and DYMO and one hybrid routing protocol ZRP has been evaluated under these mobility models. To measure the impact of mobility model, outcomes of average end-to- end delay(s), average jitter(s) and average throughput (bits/s) are given below:

**Table 6: The Average End-to-End Delay(s) under different mobility models**

| Routing Protocols | File Model | | RWP Model | | Group Model | |
|---|---|---|---|---|---|---|
| | Number of Nodes | | | | | |
| | 20 | 60 | 20 | 60 | 20 | 60 |
| AODV | 8.79E-02 | 5.45E-02 | 7.50E-02 | 9.55E-02 | 7.01E-02 | 9.42E-02 |
| DSR | 6.90E-01 | 5.86E+00 | 5.64E+00 | 9.19E+00 | 8.25E+00 | 7.36E-02 |
| DYMO | 1.38E-01 | 1.85E-01 | 7.58E-01 | 7.50E-02 | 1.12E-01 | 1.54E-01 |
| FSR | 4.00E+00 | 1.86E-01 | 1.08E-01 | 1.56E-01 | 5.74E-02 | 2.38E-01 |
| LANMAR | 2.63E+00 | 9.25E-01 | 2.85E-01 | 3.47E-01 | 4.69E-02 | 6.00E-01 |
| Bellman Ford | 8.33E-01 | 5.90E-01 | 1.07E+00 | 6.22E-02 | 9.73E-01 | 1.21E+00 |
| RIP | 7.97E+00 | 2.04E-01 | 7.73E-02 | 7.69E-02 | 1.85E-01 | 8.14E-02 |
| STAR | 5.00E-02 | 1.12E+00 | 7.66E-02 | 1.67E-01 | 5.72E-02 | 8.00E-02 |
| ZRP | 4.90E+00 | 3.14E+00 | 8.95E-02 | 3.24E-01 | 1.02E+01 | 2.57E+00 |

## CONCLUSION

Rapid growth of Wi-Fi, Laptops, and mobile computing devices makes MANET a prominent area of research at the present time. The primary objective of this study is to investigate the impact of node mobility on MANET routing protocols. To meet the objective of research, the analysis has been carried on four parts serving the main and sub objectives. Study of mobility impact includes comparative performance evaluation of routing protocols. The performance of AODV, DSR and DYMO routing protocols with CBR and FTP traffic patterns has been evaluated with varying node density. The simulation results indicated that the AODV routing protocol has given the better performance in both CBR and FTP traffic than that of DYMO and DSR routing protocols. DYMO has higher throughput in case of FTP than that of DSR. On other hand, the DSR outperform DYMO in case of CBR traffic. It has been concluded that the CBR and FTP traffic patterns have significant effect on the performance of routing protocols under mobility. However, the results of these observations cannot be generalized as the performance of routing protocols varies with different network scenarios.

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