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An Investigation on the Impact of Weather Modelling on Various MANET Routing Protocols

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Abstract

The objective of the work is to analyze the impact of weather conditions on different types of MANET routing protocols. The influence of weather on the performances of MANET protocols such as AODV, STAR, RIP and ZRP are compared with and without considering weather conditions. Most of the works are not considering the effect of weather, when analysing the performances of MANET protocols. The simulations are carried out using Qualnet 5.0 with 100 nodes. The mobility model used for simulation is the Random waypoint model, where each node is moving independently to reach the destination with a random velocity. The velocity of each mobile node varies from 10 m/s to 50 m/s with the weather intensity of 1000 deg/m^2. The performance metrics such as end to end delay, jitter, through put and packet delivery ratio are analysed and compared. The simulation results reveals that AODV provides better throughput and high packet delivery ratio compared to other protocols under with and without considering weather. STAR protocol yields good performance with respect to end to end delay and jitter under both conditions.

Keywords: AODV, MANET, Mobility, STAR, Throughput, Weather

1. Introduction

Present wireless technologies face severe reliability issues due to the wireless channel being susceptible to weather disruptions. Particularly, precipitation heavily attenuates the high frequency transmissions. Thus the reliability of such link is impaired. In such cases, the routing protocol in the network must adapt itself to ensure reliable communication between the source and the destination via some alternative paths. This work focuses on the behaviour of few of the routing protocols in the absence of weather modelling and also in different precipitation levels of the weather as in real time scenarios. For modelling the weather conditions, the altitude and the precipitation intensity values are chosen arbitrarily in the QUALNET simulator. Precipitation intensity is an approximation of the rate of fall or the rate of accumulation of precipitation (hail or ice crystals)[1, 2].

The organization of this paper is as follows: Section 2 presents the description about various MANET routing protocols and the metrics for analysis. Section 3 describes the simulation setup and the Section 4 describes the mobility modelling carried out in the physical layer. Discussion of the simulation results is done in Section 5 and the Section 6 presents a conclusion of this work.

2. Routing Protocols

A router uses a protocol, called the routing protocol to determine the appropriate path over which data is transmitted. The protocol also specifies how routers in a network share information with each other and report changes. The routing protocol enables a network to make dynamic adjustments to its conditions, so routing decisions do not have to be predetermined and static. Some of the routing protocols are: STAR, AODV, RIP and ZRP[3].

The Source Tree Adaptive Routing protocol (STAR) protocol is a table-driven routing protocol based on the link state algorithm, where the Protocols maintain routing tables at each node, which are updated periodically, and the routing procedure is based on this data. Each router maintains a source tree, which is a set of links containing

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the preferred paths to destinations. This protocol uses a Least Overhead Routing Approach (LORA) to exchange routing information. This approach eliminates the periodic updating procedure present in the Link State algorithm by making update distribution conditional. As a result the Link State updates are exchanged only when certain event occurs. Therefore STAR perfectly suits for large network as it has significantly reduced the bandwidth consumption for the routing updates. At the same time, STAR uses predetermined routes thus reducing latency[4].

The Ad hoc On-Demand Distance Vector (AODV) routing protocol uses an on-demand approach by employing destination sequence numbers to identify the most recent path. This protocol maintains the routing information for only those destinations that need to relay information. A router that does not know the route to reach a destination sends a flood-search message to obtain the path information it needs. Here, the source node and the intermediate nodes store the next-hop information corresponding to each flow for data packet transmission. In an on-demand routing protocol, the source node floods the Route Request packet in the network when a route is not available for the desired destination. It may also obtain multiple routes to different destinations from a single Route request[5–7].

Zone Routing Protocol (ZRP) is a hybrid protocol which reduces the control overhead of table-driven routing protocols and decrease the latency caused by routing discovery in on demand routing protocols. ZRP defines a zone around each node consisting of its k-neighborhood. A routing zone is similar to a cluster with the exception that every node acts as a cluster head and a member of other clusters. In ZRP, the distance and a node, all nodes within hop distance from node belong to the routing zone of node. Within a zone, table driven routing is performed. i.e., route updates are computed for nodes within a node. Each node, therefore, has a route to all other nodes within the zone. If the destination resides outside the zone, an on-demand search-query routing method is used. ZRP is formed by two sub-protocols: Intra zone routing protocol and Inter zone routing protocol[8].

RIP (Routing Information Protocol) is a distance-vector routing protocol that manages the router information within a self-contained network (LANs) or an interconnected group of such LANs. RIP is classified as one of several internal gateway protocols (Interior Gateway Protocol). Using RIP, a gateway host (with a router) sends its entire routing table to its closest neighbor host at a period of 30 seconds. The neighbor host in turn will pass the information on to its next neighbor and so on until all hosts within the network have the same knowledge of routing paths. This state is known as network convergence. RIP uses a hop count as a metric to determine network distance. Each host with a router in the network uses the routing table information to determine to which host the packet must be routed to reach a specified destination. For larger networks, RIP's transmission of the entire routing table every 30 seconds increases the overhead of traffic in the network[9].

These four protocols have been used for simulating the MANET scenario under different setup to analyze various performance metrics and to study the impact of weather on these protocols.

2.1 Performance Metrics

2.1.1 Average Jitter

As the packets move from source to destination, they will reach the destination with different delays. The delay of a packet varies with its position, which can vary unpredictably in the queues of the routers in between the source and the destination. This variation in delay is known as Jitter. Jitter can degrade the quality of audio and/or video streaming. A network must ideally have zero Jitter.

2.1.2 Average End - to - End Delay

Due to queuing at the routers and different routing paths, a data packet may take some time to reach its destination. The end-to-end delay experienced by the packets for each flow the individual packet delay are summed and the average is computed.

2.1.3 Throughput

Throughput is the average rate of successful message delivery over communication channel. It is measured in bits per second (bit/s or bps) and sometimes in data packets per second. Due to variations in the traffic load from other users sharing the same network resources, the bit-rate (the maximum throughput) that can be provided to a certain data stream may be low for some multimedia services if all data streams get the same scheduling priority.

2.1.4 Packet Delivery Ratio

The ratio of total number of packets received per second to the total number of packets sent per second is known as the packet delivery ratio.

3. Simulation Setup

For the analysis of various routing protocols, the network simulator QualNet version 5.0 has been used in a system having Intel corei5 -3470 CPU operating at 3.20 GHz with a 32 bit operating system.

The simulation scenario, 100 mobile nodes are deployed in a terrain of 1500x1500 m^2 under a wireless radio network of type IEEE 802.11 standard (Wi-Fi). A Constant Bit Rate (CBR) link transmits packets at an interval 1sfrom the source node to the destination node.

A snapshot of the scenario during the simulation of the network without any weather pattern setup is shown in Figure 1. Various performance metrics such as throughput, packet delivery ratio, average jitter and average end to end delay are observed from the simulation.

A weather pattern is setup all over the network terrain with an altitude of 100 m and a precipitation intensity of 1000 degrees/m^2 as described in Table 1. A snapshot of this scenario during the simulation is shown in Figure 2. Both the simulations are carried out for a MANET with 100 nodes for 100 seconds and the packets are transmitted at an interval of 1 second.

4. Mobility Modelling

A mobility model attempts to mimic the movement of real mobile nodes that change the speed and direction with time. The mobility model that accurately represents the characteristics of the mobile nodes in an ad hoc network is the key to examine whether a given protocol is useful in a particular type of mobile scenario in MANET.

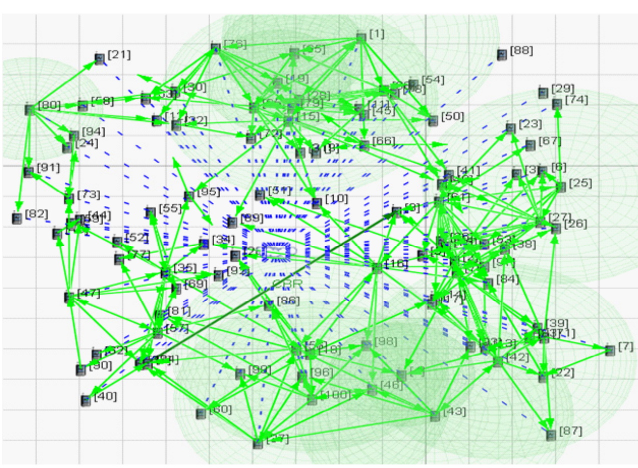


Figure 1. A Snapshot of the simulation scenario without weather setup.

Table 1. Simulation Parameters

Number of nodes	100
Simulation time	100s
Battery model	Residual life estimator
Type	Duracell AAA(MN-2400)
Energy model	MicaZ
Radio type	802.11b
Traffic Type	CBR
Data Rate	2 Mbps
T_x power	20 dBm
Channel bandwidth	20 MHz
Antenna model	Omnidirectional
Item size	1024 bytes
Path loss model	Two ray
Channel frequency	2.4 GHz
Routing protocol	AODV, STAR, ZRP, RIP
Mobility model	Random way point
Polarization	Horizontal
Height	100 m
Intensity	1000 deg/m^2
Speed	10 m/sec to 50 m/sec

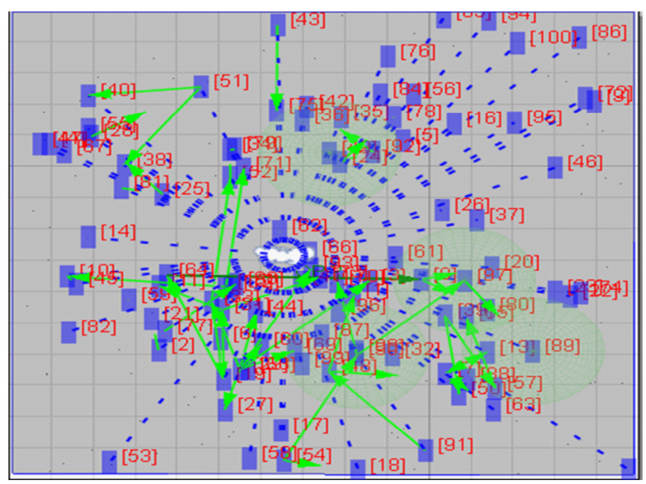


Figure 2. A Snapshot of the simulation scenario with weather setup.

Over the years, many mobility models have been used to analyse the mobile ad hoc network performances. Many mobility models are designed in order to recreate the real world scenarios better for application to MANET. Various mobility models have impact on the performances of different networking protocols including grouting, service discovery, and mobile peer-to-peer applications. Thus, when evaluating MANET protocols, it is necessary to choose the proper underlying mobility model[10].

One frequently used mobility model in MANET simulations is the Random waypoint model, in which nodes move independently to a randomly chosen destination with a randomly selected velocity. The simulations in this work are carried out for the mobile node's velocity ranging from 10 m/s to 50 m/s.

5. Results and Discussion

For analysing the impact of weather conditions on various MANET routing protocols, the simulations have been carried out using AODV, STAR, RIP and ZRP routing protocols without any weather modelling and in the presence of weather modelling.

For weather modelling, the altitude is fixed at 100 m above the ground and an intensity of precipitation is chosen to be 1000 degree/m^2.

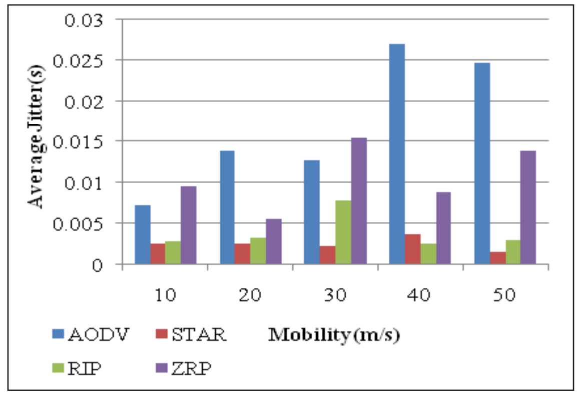
5.1 Average Jitter

From the definition in section 2.1, it is observed that the average jitter in a network must be as small as possible and also must be devoid of large variations for an efficient routing performance. The simulation results from Figure 3 show that STAR protocol imparts lower jitter with lesser deviations than the other protocols discussed.

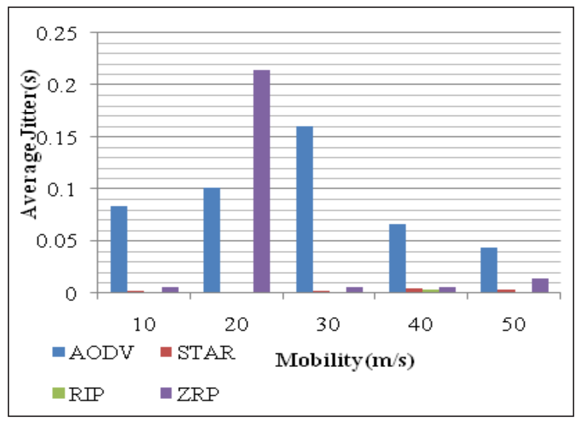
The values of average jitter for the simulations with and without weather pattern setup are tabulated in Table 2. The comparison shows an increase in the jitter values for weather simulation. The observed values from Table 2 also prove that the STAR protocol offers lesser jitter which is negligible when compared to those values of the other protocols even when a weather mode is considered. Even though the jitter values increase with the effect of real time weather modelling being considered, AODV, RIP and ZRP has larger jitter variations which is not desirable for an efficient communication. So STAR outperforms the other three protocols when jitter is considered under the specified weather conditions.

5.2 Average End to End Delay

Delay sensitive applications like live telecast or video conferencing can be effective when the average end to end delay for the transmitted packets is less. Figure 4 exhibits that the average end to end delay increases as the mobility speed increases in all the protocols except the STAR protocol. The real time weather scenario shows an increased delay for all the protocols but still STAR protocol providing the least delay among the other protocols for all mobility conditions.



(a)

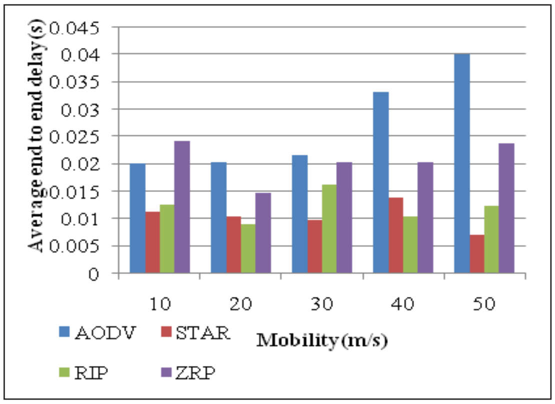


(b)

Figure 3. (a) Average jitter (b) Average jitter with weather modeling.

Table 2. Average Jitter Values for Various Protocols

Mobility (m/s)	AODV		STAR		RIP		ZRP	
	Weather modelling		Weather modelling		Weather modelling		Weather modelling	
	×	✓	×	✓	×	✓	×	✓
10	0.0072	0.0832	0.0026	0.0022	0.0027	0.0013	0.0096	0.0058
20	0.0139	0.1011	0.0026	0.0005	0.0033	0.0015	0.0055	0.2144
30	0.0128	0.1608	0.0023	0.0016	0.0078	0.0002	0.0155	0.0062
40	0.0270	0.0656	0.0037	0.0036	0.0026	0.0034	0.0088	0.0058
50	0.0246	0.0436	0.0015	0.0025	0.0030	0.0013	0.0138	0.0145



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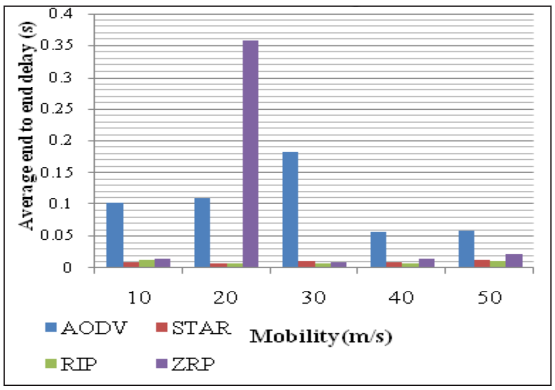


(b)

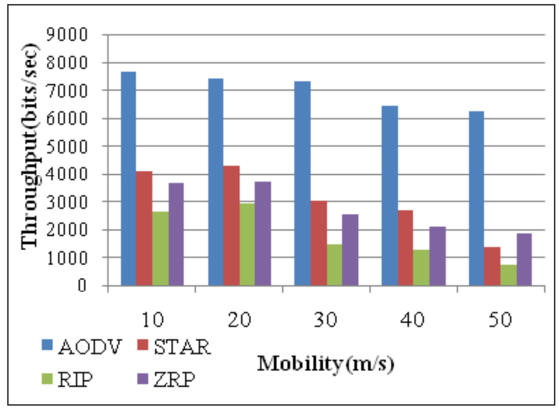
Figure 4. (a) Average end to end delay (b) Average end to end delay with weather modeling.

5.3 Throughput

Unlike the results for the delay and jitter measurements, the throughput analysis show that AODV is suitable for routing since an efficient communication network must deliver more bits per second. (i.e., a large value for throughput). STAR also provides a slightly higher throughput than RIP and ZRP. This Throughput analysis is shown in Figure 5. Under the simulated weather conditions, the communication is degraded. i.e., the throughput is reduced for all protocols but still AODV provides the highest throughput among all the other protocols for all mobility speeds. But the efficiency of the STAR protocol is affected under the weather setup thus it provides a lesser throughput but can be considered to be robust to weather than RIP and ZRP.

5.4 Packet Delivery Ratio

A worthy routing must be such that most of the packets are delivered to the appropriate destination which means a high packet delivery ratio is needed. The results in



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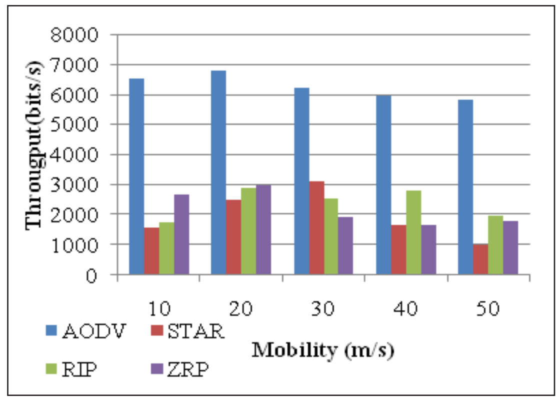


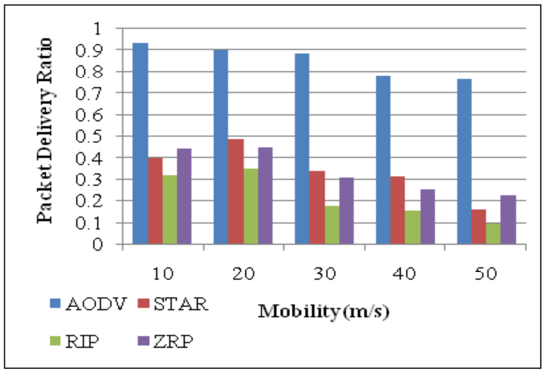
(b)

Figure 5. (a) Throughput (b) Throughput with weather modeling.

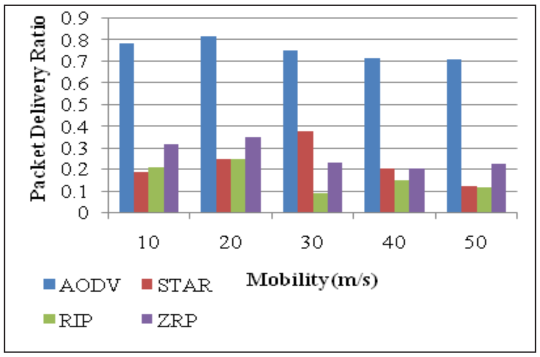
Figure 6 show that AODV offers a higher packet delivery ratio than the other routing protocols for all mobility speeds. However the number of packets delivered is reduced as the mobility of the nodes increases. But under the weather setup, the packet delivery ratio falls. AODV gives the maximum packet delivery and STAR provides an acceptable response than ZRP and RIP under weather conditions.

6. Conclusion

In this work, a comparative analysis of the performance of MANET routing protocols under simulated weather conditions and without any weather setup is presented. The performance evaluation has been based on the metrics like throughput, average end-to-end delay, average jitter and packet delivery ratio. The simulation also considers the mobility of the nodes running each of the protocols. For the applications that are delay-sensitive, the STAR protocol seems to be well suited since its jitter and delay measurements are lesser in both weather setup and the



(a)



(b)

Figure 6. (a) Packet delivery ratio (b) Packet delivery ratio with weather modeling.

ideal simulation setup. However, when the packet delivery ratio and the throughput of the protocols are considered, AODV fits better. But with some tolerance to capacity STAR protocols proves to be robust to weather conditions.

7. References

1. Jabbar A, Rohrer JP, Oberthaler A, Cetinkaya EK. Frost V, Sterbenz JPG. Performance comparison of Weather Disruption-Tolerant Cross layer routing Algorithms. Proceedings of IEEE Communications society INFOCOM; Rio de Janeiro; 2009. p. 1143–51.
2. Jabbar A, Rohrer JP, Oberthaler A, Cetinkaya EK, Frost V, Sterbenz JPG. Weather Disruption-Tolerant self-optimising millimetre mesh networks. Proceedings of IWSOS: Third international IFIP/IEEE workshop on self-organizing systems, Ser. Lecture notes in Computer science. 2008. p. 242–55.
3. Mona N, Alslaim HA, Alaqel SS, Zaghloul. A Comparative Study of MANET Routing Protocols. Proc. Third International Conference on e-technologies and Networks for Development (ICeND); Beirut; 2014. p. 178–82.
4. Karthikeyan B, Kanimozhi N, Hariganesh S. Analysis of Reactive AODV Routing Protocol for MANET. World Congress on Computing and Communication Technologies (WCCCT); Tiruchirappall; 2014. p. 264–7.
5. Kevre P, Shrivastava L. Compare Three Reactive Routing Protocols in Grid Based Cluster wireless Sensor Network Using Qualnet Simulator. Journal of Information Engineering and Applications. 2014; 4(4):125–32.
6. Razouqi Q, Boushehri A, Gaballah M, Alsaleh L. Extensive Simulation Performance Analysis for DSDV, DSR and AODV MANET Routing Protocols. Proceedings 27th International Conference on Advanced Information Networking and Applications Workshops (WAINA); Barcelona; 2013. p. 335–42.
7. Kim YD, Moon IY, Cho SJ. A Comparison of Improved AODV Routing Protocol Based on IEEE 802.11 and IEEE 802.15.4. Journal of Engineering Science and Technology. 2009; 4(2):132–41.
8. Garg Mukesh Kumar, Vir Dharam, Agarwal SK. Simulation Analysis of AODV, DSR and ZRP Routing Protocols in MANET using QualNet 5.0 Simulator. International Journal of Scientific and Research Publications; 2013; 3(3):1–6.
9. Maan F, Mazhar N. MANET Routing Protocols vs Mobility Models: A Performance Evaluation. Proceedings Third International Conference on Ubiquitous and Future Networks (ICUFN); Dalian; 2011. p. 179–84.
10. Jindal A, Singh C, Vir D. Simulation Analysis of Different Routing Protocols Using Directional Antenna in Qualnet6.1. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering. 2014; 3(5):9408–14.