Journal of Theoretical and Applied Information Technology
10th July 2014. Vol. 65 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

IMPACT OF RADIO PROPAGATION MODEL AND MOBILITY IN ON-DEMAND ROUTING PROTOCOL OF MANET

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ABSTRACT

Accuracy of routing protocol performance in mobile ad hoc network (MANET) depends on many parameters. Besides many parameters propagation model and node velocity are the two among them. Node mobility is responsible for network topology and propagation model for calculating signal strength at receiver. In wireless network MANET suffers a huge loss in performance due to obstacle between transmission and variation in signal strength at receiver. Many routing protocols are proposed based on which neglect the effect of fading and path loss. So it is important to find the effect of fading and node velocity for accurate estimation and analysis of performance of routing protocols in MANET. We investigate the effect of propagation model (both non-fading and fading) and mobility on the performance of the ad hoc routing protocol such as Ad hoc On Demand Distance Vector (AODV), Dynamic Manet On Demand (DYMO) and Dynamic Source Routing (DSR) and present the results gathered from simulation using NS2. The result shows that propagation model and mobility has strong impact on the performance of MANET routing protocol.

Keyword: *MANET; AODV; DYMO; DSR; Propagation Model; Mobility Model.*

1. INTRODUCTION

In MANET wireless user creates a network temporarily without relying on fixed infrastructure. Every mobile node discovers route through basic route discovery mechanism and changes topology dynamically. Almost all routing protocols majorly depend on radio signal propagation for the successful transmission. Routing protocols are responsible for communicating and maintaining route between the nodes. Either it may be single hop or multi hop between source and destination. In the other hand, establish a wireless network requires finding out the coverage of radio waves in order to determine number of equipment to be used. The radio coverage depends on wave spread, emission power and utilized frequency of environment where it is established. Performance of routing protocol relies on determining good link from bad link during active communication on given scenario [1]. Radio frequency of a node may be changed due to movement of node which causes a change in signal strength of receiver [2]. The signal strength may fades due to many reasons such as transmission power, antenna position distance between sender and receiver, attenuation due to building. Signal propagated through a wireless network brings the problem of path loss, multipath fading and shadowing fading [3] which is related to environments. Thus it became utmost important to get accuracy of the data passing though mobile wireless ad hoc network. In this paper we study the importance of mobility and propagation model on ad hoc routing protocols with respect to packet delivery ratio, routing overhead and average end to end delay. We use NS2 simulator to analyze the performance of routing protocols such as AODV, DSR and DYMO over two ray ground, free space and Rayleigh, shadowing and Nakagami's model.

Rest of the work is organized as follows. Section 2 give summary of related work and section 3 will explain Propagation model. Section 4 gives overview of ad hoc routing protocol. The simulation set up and result analyses are given in section 5 and 6, respectively. Finally the conclusion of the work is given in section 7.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

2. RELATED WORK

For multi-hop ad hoc networks where nodes move according to the random waypoint mobility model, the author modified the models introduced in [4] to capture the effect of nodes mobility and interaction between the source node and the carrier sensing, interfering and hidden nodes.

In [5] author studied the performance of different ad hoc routing protocol under different propagation model. The result shows that the propagation model has a strong impact on ad hoc routing protocols performance.

This paper [6] investigates the influence of propagation model and physical layer on the routing protocol of ad hoc network. Author investigated a realistic physical layer simulator which is able to quantify the radio link through different physical layer parameter.

Author in [7] investigated the effects of non-line of sight propagation model on the performance of routing protocol in an urban-street environment. They implemented peer to peer propagation model with non-line of sight paths and proved that it is appropriate for street-grid environment. Through the simulation they have shown that in an urban-street environment multiple reflected signals are appropriate significant and strength of received signal cannot be chosen randomly.

Although we have some radio propagation model, they need some computational resources and hence they may not be suitable for a resource-constraints environment such as MANE. Therefore the author [8] proposed scalable ray-optical radio frequency propagation model which is suitable to increase the network performance and enhance the accuracy in the frequency range currently used by wireless networks. Author has proved through simulation and experiment.

In [9] the author studied the performance of ad hoc routing protocol under different propagation models based on Finite State Markov Chain channel model. A joint cross layer algorithm comprised of physical and routing layer is proposed wireless ad hoc network. Also it is applied Optimized Link State Routing (OLSR), protocol. Their objective was to find most optimal route by addressing the problem of link and route stability by focusing particularly on multipoint relay (MPR) selection method. Their result shows that cross layer techniques improves network throughput and decrease the delay as compared to original OLSR.

3. PROPAGATION MODEL

Propagation models are used in simulators to predict the received signal strength indicator of each packet received by a node. The characteristics of propagation model may change randomly from location to location and time to time. Every wireless channel can be defined as a function of distance, frequency, time, space and received signal strength. The signal passes through wireless channel has several propagation effect like reflection, diffraction and scattering which occurs may be due to certain obstruction. During transmission there may be single line of sight path or obstructed path between transmitter and receiver. The propagation mechanism like reflection, diffraction and scattering has a great impact in mobile communication system [10]. Reflection occurs by a propagating wave when it falls on the object with lower dimension than object. During reflection wave may be partially refracted. When radio path is obstructed with a barrier and its wave is spreads over then diffraction is arise. Scattering occurs if the propagation medium has smaller wavelength and changes the direction of wave. Path loss and fading is the two main characteristics of wireless channel. The propagation models are categorized as fading and non-fading model. Fading is the important part of design of wireless communication. Fading is the signal fluctuation over a propagation media. Fading in mobile radio channel depends on channel properties and transmitted signal. The signal strength measurement of fading propagation model relied on the movement of user or node. Based on the signal parameter like bandwidth and path loss the signal may have different types of fading

In the other hand non-fading model cover its radio wave over a growing area with the increase of distance. The fading may be large scale where signal deviation occurs due to motion over large area or small scale fading due to small changes in the position. Normally large scale fading provide method for computing path loss as a function of distance which is affected by building, forest and mountains. In small scale fading there is sudden change in the amplitude and phase over a short distance. Non-fading model includes free space and two ray ground

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

models [11][12]. It is necessary to understand clearly the distribution received signal strength to get the concept of channel in wireless network. Shadowing is most frequently used distribution for large scale and rayleigh and nakagami is used as small scale fading model [13][14].

3.1 Free Space Model

This model estimates the signal strength based on the assumption that there is only one clear of sight between sender and receiver. This model basically represents the communication range as a circle around the transmitter. The receiver receives all the packets within this circle; otherwise it loses all the packets. The following formula is used to calculate the received signal power at distance *d*

$$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L}$$

where Pt is the transmitted signal power and G_t and G_t are the gain of transmitting and receiving antenna, respectively. L (L≥ 1) is the system loss factor and λ is the wave length. This

3.2 Two Ray Ground Model

Two ray ground model assumes that the received signal is the sum of reflected from ground and direct line of sight path. It means the receiver get signal through multiple path (one is direct path and another is ground reflection path). Whereas free space model assumes there is only one direct path. The following formula is used to calculate the received signal power at distance *d.*

$$P_r(d) = \frac{P_t G_t G_r h_t^2 \, h_r^2}{d^4 L}$$

where h_t and h_r are the height of the sender and received antenna, respectively. G_t is the antenna gain of the sender and G_r is the antenna gain of the receiver. L(L >=0) = system loss. Due to oscillation caused by the constructive and destructive combination, two-ray model goes not give good result for a short distance. However free space model shows suitable for short distance.

3.3 Shadowing Model

Previous two models assumed that signal power of receiver data decreases with distance *d* between sender and receiver and communication coverage is ideal circle. To add some environmental influence some Gaussian random variable is added to the path loss. Actually shadowing model comprised of two parts. The first one is based on path loss and second one is based on receiver distance. The path loss model represented by $P_r(d)$ predicts mean received power at distance d, by using following equation.

$$\frac{P_r(d_0)}{P_r(d)} = \left[\frac{d}{d_0}\right]^{\beta}$$

It uses close in distance d_0 as references and β as a path loss exponent. When the β is larger the obstruction becomes higher and there is faster decrease in received power as distance becomes larger. The second part of shadowing model shows the variation in received power at a particular distance. It is log normal random variable. This model is represented by

$$\left[\frac{P_r(d)}{P_r(d_0)}\right]_{dB} = -10\,\beta \log\left[\frac{d}{d_0}\right]$$

where X_{dB} is a Gaussian random variable with zero mean and standard deviation $\sigma_{dB.}$ By changing the value of path loss exponent according to table 1, it can adopt to different environments [15].

Table-1: Reference Value for Path Loss Exponent

Environment	β
Urban macrocells	3.7-6.5
Urban microcells	2.7-3.5
Office building (same floor)	1.6-3.5
Office building (multiple floor)	2-6
Store	1.8-2.2
Factory	1.6-3.3
Home	3
Free-space	2
Two-ray model	4
Outdoors(usually)	2.8

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

3.4 Rayleigh Model

This model is used when there is no direct path between transmitter and receiver where all energy received through scattered path. Because of scatter wave there is a dramatic changes in the received power or fades (multipath fading) which cause the degradation of the performance of network. This model is used to define the statistical time varying notion of the received signal of an individual multipath component or of flat fading signal. It causes the signal amplitude and phase to change rapidly. The probability density function for received power in Rayleigh fading channel is defined by

$$P(r) = \begin{cases} \frac{r}{\sigma^2} exp\left(-\frac{r^2}{2\sigma^2}\right) & 0 \le r \le \infty \\ 0, & otherwise \end{cases}$$

where r is the amplitude of received signal and $2\sigma^2$ is the predicted mean power of the multipath signal. Above distribution is known as Rayleigh distribution and it has been derived for slow fading. When there is strong line of sight (LOS) path channel then it is classified as ricean fading channel. Rayleigh fading is more appropriate when there is no dominant propagation along a LOS between the transmitter and receiver.

3.5 Nakagami Model

It was developed by nakagami by 1940s. The probability density function is given by

$$P(r) = \left\{ \frac{2m^m r^{2m-1}}{\Gamma(m)\Omega^m} exp\left(-\frac{m}{\Omega} r^2\right) \right.$$

where r is the amplitude of received signal and $\Omega = r^2$ is the average signal power. $\Gamma(m)$ is the gamma function and m is the fading factor(always greater than equal to 0.5). When m value is equal to 1, then nakagami model is the Rayleigh model.

4. ROUTING PROTOCOLS IN MANET

In this section we describe the key properties of ad hoc routing protocol. Routing is one of the key issues in MANET [16] due to their highly dynamic and distributed nature. In wired networks route failures occur very rarely while it frequent event in MANET. The main cause of route failures is node mobility. Another factor that may lead to route failures is the link failures due to the contention on the wireless channel, which is the main cause of performance degradation in MANETs. There are many routing protocols available in MANET. Among them ad hoc on demand distance vector (AODV) [17] and dynamic source routing (DSR) [18] and dynamic manet on-demand (DYMO)[19] are reactive routing protocols. Almost all proposed routing protocols are based on minimum hops in mobile ad hoc network. Author in [20] studied the inter layer interaction between MAC and physical layer and demonstrated that even though DSR and AODV share a similar behavior, the differences in the protocol mechanics can lead to significant performance differentials. Author in [21], evaluated the performance of AODV, DSR and OLSR routing protocols in MANETs under CBR traffic with different network conditions.

Generally routing protocols for ad-hoc networks can be classified in two different classes: pro-active and re-active protocols based on how they discover the route. Many reactive routing protocols are available for ad hoc network, including AODV, DYMO and DSR.

4.1 Ad Hoc On- Demand Distance Vector (AODV)

In AODV [17] a source node initiates the route discovery process if it desired to send a message to some destination. It is a reactive routing protocol which discovers route on demand when a packet needs to be sending by a source. Route discovery process starts by sending route request (RREQ) packet to their neighbors. Then the neighbor node forwards the RREQ to their neighbor and so on. This sending process is continued by every neighbor node until the destination gets the message or they have a route to destination. On either case nodes reply back with a route reply (RREP) message. In case of route breakage the intermediate node discover another new route or send a route error (RERR) message to the source. Upon receiving RERR the source node tries to get new route by invoking again route discovery process.

4.2 Dynamic Source Routing (DSR)

The key concept of DSR [18] protocol is the use of source initiated routing. Through the route cache method the sender knows the hop-by-hop information to the every destination. In fact the packet header carries the source route for a destination. It starts discovering the route by flooding the RREQ packets. Up on receiving the RREQ every node rebroadcast it, until it has route to the destination in its cache or it is the

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

destination. Then it replies with RREP packet that is routed back to the original source. The packet RREQ accumulates a path traversed so far to the destination. The RREP packet uses accumulated path of RREQ in backward path to reach to the destination. Then the source node caches the route for future use. In case of route breakage the intermediate node discover another new route or send a route error (RERR) message to the source. Upon receiving RERR the source node tries to get new route by invoking again route discovery process.

4.3 Dynamic Manet On-Demand (DYMO)

Route discovery and route management is the basic operation of DYMO protocol. Like AODV, source initiate route discovery process by disseminating the RREQ for an entire network to get the route to the destination. Each intermediate node records the route during dissemination process. Destination node responds with RREP upon receiving the RREQ packet. . Each intermediate node that receives the RREP creates a route to the target, and then the RREP is unicast hop-by-hop toward the source. The route between source and destination can be established in both directions after getting the REPP from receiver. During route management, node monitor link over which the traffic flowing to cope with change in network topology. Upon route breakage the source node is notified with RERR message. A RERR is sent toward the source to mention the current route to a particular destination is invalid or missing. The source node deletes the route and perform route discovery if it still has packets to deliver to that destination.

5. SIMULATION MODEL

We use discrete-event simulator NS-2.34[22] with Fedora 8.0 LINUX to investigate the effect of Propagation model and node mobility (velocity) on the routing protocol (AODV, DSR and DYMO) of MANET. We measure the performance of these protocols with various metrics i.e. PDR, routing overhead and end to end delay using AWK script [23]. In order to study the effect of propagation model on reactive routing protocol and to realize the difference we use notion of node velocity (speed) and number of connection.

5.1 Environment

Normally performance of routing protocols are studied by three major parameters that is node velocity, traffic volume and node density. We considered other parameter (propagation effect) along with two major parameters mentioned above i.e. node velocity and traffic volume. However we keep node density is constant for our simulation. We considered AODV, DSR and DYMO reactive routing protocol for the simulation. We create a random network of size 100 with a specified simulation area 1000m x 1000m. We use random way point (RWP) mobility pattern [24] to define movement of mobile node. In this model a node select random point within the simulation area by travelling with speed chosen from uniform distribution [0 to V_{max}]. The pause time is set to zero to indicate continuous movement of nodes in the network. We use traffic (UDP) between the source and destination pair. Every source is associated with CBR traffic generator. Each source sends packets of 512 bytes at a different rate of 4 packets per second. Other parameter used for simulations are shown in table 2. Three major parameters are discussed in details in the following.

5.1.1 Node velocity

The velocity of a node in the system characterizes mobility of ad hoc network. The node velocity determines the frequency of link breakage and corresponding routing overhead for a network. Routing overhead of a network is proportional to route maintenance of routing protocol and the packet delivery ratio is decreased with node velocity. The routing protocol behaves differently with different mobility model used [25]. The performance of a network depends on behavior of routing protocols and the movement pattern of particular mobility model [26]. The traffic pattern of network also severely impact on the performance of routing protocol in MANET [27]. Random way point mobility model in MANET is the most widely used mobility model proposed in [24]. For our simulation node velocity is varied by setting different value: 5 m/s(low speed), 10 m/s, 15 m/s and 20 m/s, 25 m/s and 30 m/s (high speed).

5.1.2 Traffic volume

The communication model of a network describes the number of source and traffic volume and other parameters. We used the communication model which is included with

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

RWP mobility model in the ns2 simulator of version-2.34. Our simulation model comprised of the following parameters:

- Node velocity (S)
- Traffic volume (V)

Number of CBR sources is increased to stress the congestion level in the network. The traffic volume describes the aggregate packet rate from all CBR sources in the network. The packet rate per source (K) is calculated as K= V / N packets/sec, where V is the traffic volume and N is the number of source. The traffic volume measurement depends on number of connection (C) per source, N and K. Previously, the communication model is studies in [28][29] to compare the performance of routing protocol by varying the parameter N. We study the effect of changing node velocity and V on the performance of routing protocol with RWP model. The traffic volume V in our model can be realized by changing C for a fixed number of packet rates 4 packets/second. We limit the number of sources to 10. In order to realize the effect of change the value of V, there are 3, 6, 9, 12, 15 and 18 number of connections is created in between source and destination which is selected randomly from entire network. Each connection stays for 300 sec long. While changing the number of connection the maximum node velocity is 20 m/s which are constant.

5.1.3 Node density

Node density represent to the total number of nodes placed in the network. Average hop length of route is increases with increase of node density. For network of *n* number of nodes the average hop length of route is $\Theta(\sqrt{n})$[30]. Node density normally impacts the general traffic patterns of a network. This impact may increase with increases of node density. We keep the node density to constant a value of 100 nodes.

Table 2: Simulation Parameter

PARAMETER	***VALUES***
Mobility Model	Random Way Point
Channel type	Wireless channel
Antenna Model	Omni-directional
MAC	802.11
Routing Protocol	AODV, DYMO and DSR
Number of nodes	100
Pause Time	0 Sec
Node Speed	5, 10, 15, 20 and 25 m/s
Packet size	512 bytes
Packet type	CBR
Channel Bandwidth	2 Mbps
Packet Rate	4 Packets/sec
Number of Connections	3, 6, 9, 12,15 and 18
Number of sources	10
Transmission Range	250 m
Rx Threshold	-84.5 dBm
CS Threshold	-104.5 dBm
Shadowing Deviation	4 dB
Path Loss Exponent	2
IFQ Length	100 packets
Simulation Terrain	1000 m X 1000 m
Time of simulation	300 Sec.

5.2 Simulation Metrics

The following metrics are used to measure the effect of propagation model routing protocol in MANET.

5.2.1 *Packet Delivery Ratio*: It is the ratio between actual data packet received by the receiver to the data packet send by the source.

5.2.2 *Routing Overhead*: It determines the number of control packet transmitted per actual data packet received at the receiver. It includes number of RREQ, RREP and RERR of routing protocol

5.2.3 *Average End-to-End Delay*: This determines the average delay in transmission of packet. These calculations rely on physical

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

properties of link and delay. This includes queuing at interface, retransmission at the MAC, propagation, transfer through channel and delay in buffering at route discovery process.

6. RESULTS AND ANALYSIS

In this section, we provide the results obtained from the number of experiments with various scenarios to estimate the desired true characteristic in ad hoc network. In scenario 1 and scenario 2, we vary node velocity and number of connection, respectively, in order to explore the effect of propagation model on routing protocol. We analyzed the experimental results contained in generated output trace files by using the AWK command. We carry out simulation to evaluate the how the routing protocol behaves according to different propagation effects. As [31] mentioned that the performance of routing protocol may vary dramatically according to the mobility model and performance ranking. Similar work also has been done in [32], but our mobility model, routing protocol and environment are different from them. Our result shows that network performance affected by node velocity, traffic volume and connection pattern.

6.1 Scenario 1

In this section we vary the node velocity to investigate the effect of propagation model on routing protocol in MANET. Velocity is an important parameter that can influence the reactive protocol performance like DYMO, DSR, and AODV. The node velocity determines the rate at which link fails and routing overhead required for route maintenance in reactive protocol. In this section, we present result gathers from various experiment by changing node velocity (mobility) on the ad hoc routing protocols with respect to PDR, routing overhead and average end-to-end delay. Scenario 1 contains the result corresponding to the PDR, routing overhead and average end-to-end delay are shown in figure 1-3 respectively.

6.1.1 Packet Delivery Ratio

From figure 1, the PDR of two ray ground and free space model is better than shadowing, rayleigh and nakagami model over all these routing protocol. It means non fading model such as two ray ground and free space model delivers more packets than fading model (nakagami, rayleigh and shadowing). Fading model will decrease PDR when the nodes are dynamic and will increase of waiting time of packets in case of transmission failure. As shown in figure 1, the performance of shadowing model is very low (PDR about 45 %) as compared to others. This is due to low intensity signal created by obstacle. However two ray ground model deliver slightly more packets than free space over AODV and DYMO with increase of node velocity (speed) (see figure 1). Whenever a link failure occurs, it initiate route discovery in DYMO and AODV and frequency of route discovery increases. DYMO routing protocol delivers more packets than AODV and DSR. The performance of DSR protocol is lower than AODV and DYMO with respect to PDR irrespective of all propagation model (see figure 1). It is due to DSR routing protocols dependency on stored path for routing the packets. The main reason of decreasing packet delivery ratio and increasing packet loss in wireless network is congestion, mobility and wireless characteristics. As shown in figure1, the packet delivery ratio of all these routing protocol decreases with the increase of node velocity. When node velocity of a network increases, the occurrence of link failure becomes frequent this causes more packet loss and decreases PDR. It comes relatively stable at lower node speed. It is concluded that node velocity strongly not only influence routing protocol but also the physical characteristic.

6.1.2 Routing Overhead

As figure 2 shows under all propagation model, DYMO protocol has worst routing overhead as compared to AODV and DSR with the increased node velocity. The Rayleigh model over DYMO protocol achieves higher overhead (about 9000 packets) than other propagation model (see figure 2). When node velocity of a network increases, the occurrence of link failure becomes frequent this causes more packet loss and decreases PDR. Whenever a link failure occurs, it initiate route discovery in DYMO and AODV and frequency of route discovery increases. So RREQ brings more routing overhead in AODV and DYMO due to ineffective usage of routing packets. On the other hand DSR has less overhead due to route re-discovery by using stored path. The reactive protocol discovers routes on demand which causes the increase of percentage of packet overhead and delay with the increase of node speed. There is an increase of routing overhead for all propagation models over all these routing protocol.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

6.1.3 Average End-To-End Delay

In this section we measure the average end to end delay over different node velocity. As shown in figure 3, DSR protocol exhibits higher delay than AODV and DYMO for all node velocity. The intermediate node in DSR may reply with the help of stored path in their cache, which may be often obsolete. So data passing through the broken link will not be passed further and tried later. This unreliable route may force the on demand routing protocol to spend more time in route updates. DSR protocol achieves largest average end to end delay due to poor route maintenance. In the other way AODV has lower delay as compared to DYMO and DSR. In comparison to shadowing, rayleigh and nakagami, the free space and two ray ground model exhibit lower delay under all node velocity and routing protocol. In other words non fading model such as tow ray ground and free space model exhibits lower delay than fading model such as shadowing, nakagami and rayleigh model irrespective of routing protocol(AODV, DSR and DYMO) and node velocity(5,10,15,20,25,30 m/s) used.

6.2 Scenario 2

In this section we vary the number of connections to investigate the effect of propagation model on the performance of routing protocol. The number of connection per source determines the traffic volume from all CBR sources to the network. And it is the one of the important parameter which can influence the performance of routing protocol in MANET. We vary the number of connection to 3, 6, 9, 12, 15 and 18 to investigate the effect of propagation model on routing protocol in MANET.

6.2.1 Packet delivery ratio

Figure 4 shows the performance of routing protocol in terms of number of connection. As the number of connection increases the traffic volume for a network is also increases. The traffic admission ratio becomes very high for network with heavy number of connection. It shows that the data injection rate to the network is too high. The traffic volume becomes very high due to participation of more nodes in a wireless network. In such environment the packet collision ratio increase and as a result degrades the performance. As shown in figure 4 the PDR of DYMO is higher than AODV and DSR for this entire propagation model. DYMO protocol delivers more packets than others. The performance of DSR protocol is affected by increased number of connection (traffic volume) as compared to AODV and DYMO. DSR routing protocol has high MAC load [29] than others. It is found that the effectiveness (PDR) of all schemes decreased with the number of connection increase. When the number connection increases it create more data section (i.e. more traffic admission ratio) and causes more packet collisions. Hence the PDR of all schemes decreases with the number of connection increases. However for different number of connections the PDR of non fading model is higher than fading model. Among fading model, shadowing model provides lower PDR than others.

6.2.2 Routing overhead

In high number of connection (traffic volume) nodes using considered routing protocols send more packets and creates more congestion, thereby sending a larger number of routing packets. As shown in figure 5, the DYMO has higher routing overhead than others. In the other hand DSR has lower routing overhead for different number of connection per source. The Rayleigh fading model suffers more in terms of routing overhead over DYMO routing protocol. However irrespective of fading and non-fading model used the routing overhead increases with increased number of connection for all these routing.

6.2.3 Average end-to-end Delay

Figure 6 displays the DSR protocol has higher delay than AODV and DYMO in terms of number of connection. When the number connection increases it create more data section and causes the packet to wait more in a network, thereby increasing the average end to end delay. Under all routing protocol non fading model shows lower average end to end delay than fading model. Free space model achieve best performance and shadowing achieves worst performance over DYMO and DSR and AODV in terms of average end to end delay for various number of connection.

7. CONCLUSION

We investigate the effect of propagation model (both non-fading and fading) and node velocity on the performance of the ad hoc routing protocol such as AODV, DYMO and DSR with a thorough analysis and present the results gathered from simulation using NS2. It is observed that the node velocity affect the link condition and topology on the performance of

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

MANET routing protocols. This shows interaction among parameters like node velocity, connectivity, and performance. From the simulation results, it is analyzed that DYMO has better PDR than DSR and AODV. On the other hand regardless of mobility, number of connection or propagation model, DSR protocol has less routing overhead than AODV and DYMO. The PDR of these protocols decreases for increasing the node velocity and number of connection in AODV, DYMO and DSR routing. In comparison to fading model such as shadowing, nakagami and rayleigh the non-fading model such as free space and two ray ground has higher PDR and lower delay. Along with the behavior of routing protocols the parameter node velocity, propagation model and number of connection per source determines the overall performance of a MANET. The simulation result shows that propagation model and mobility has major role in the performance of MANET routing protocol. Also the node velocity strongly not only influences routing protocol but also the physical characteristic of wireless network.

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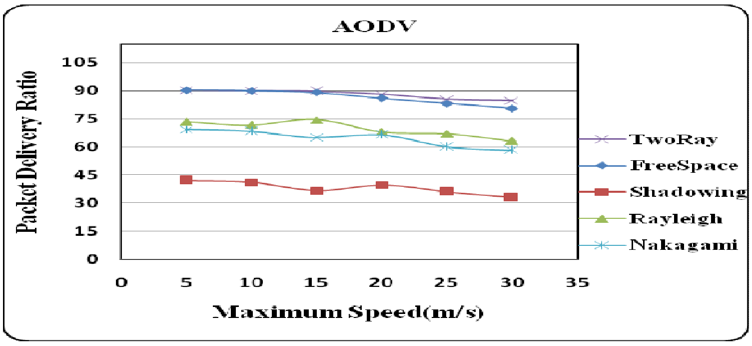

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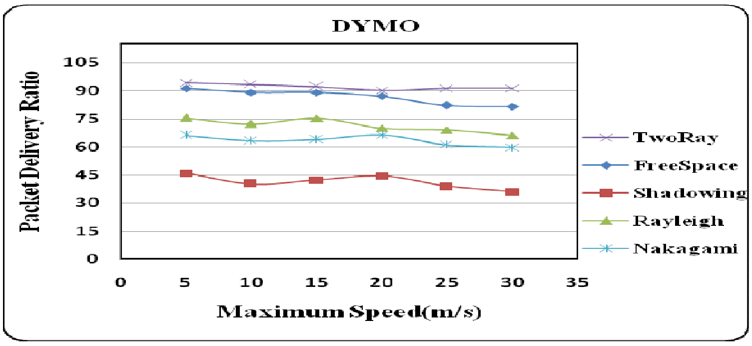

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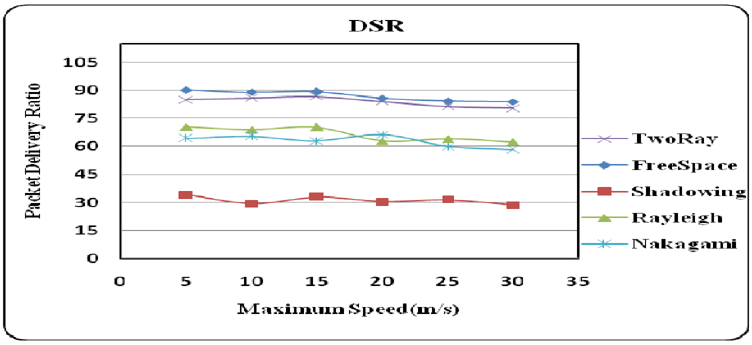

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Figure 1: Packet Delivery Ratio Vs Maximum Speed For (A) AODV (B) DYMO (C) DSR

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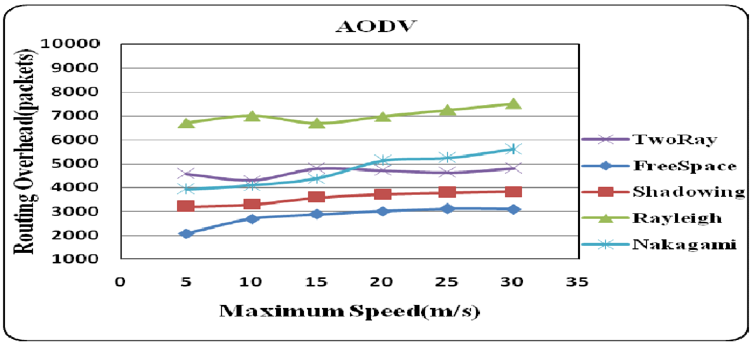

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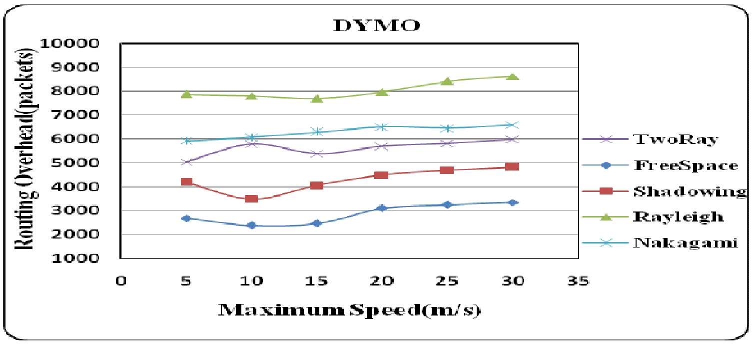

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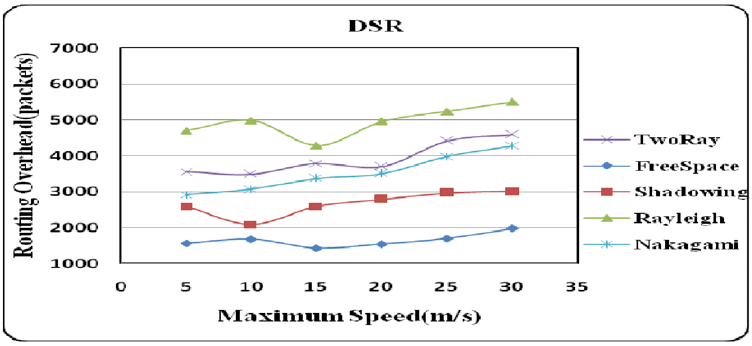

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Figure 2: Routing Overhead Vs Maximum Speed For (A) AODV (B) DYMO (C) DSR

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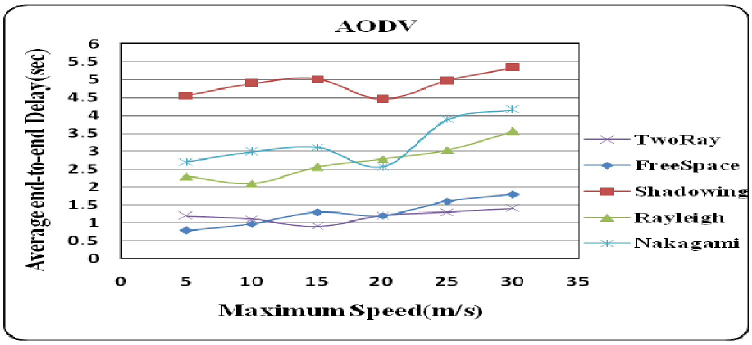

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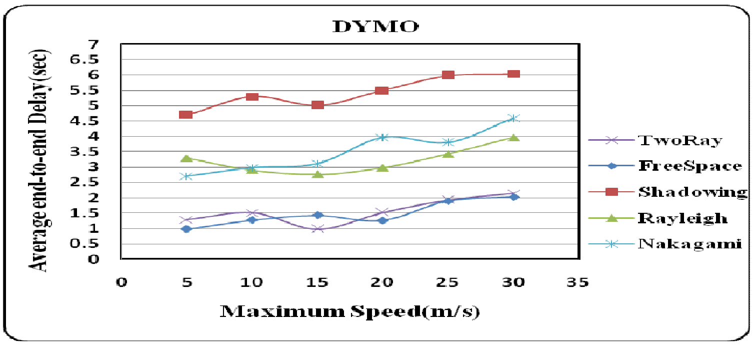

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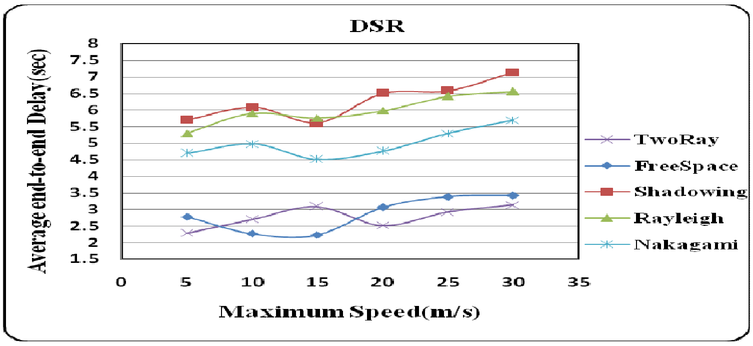

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Figure 3: Average End To End Delay Vs Maximum Speed For (A) AODV (B) DYMO (C) DSR

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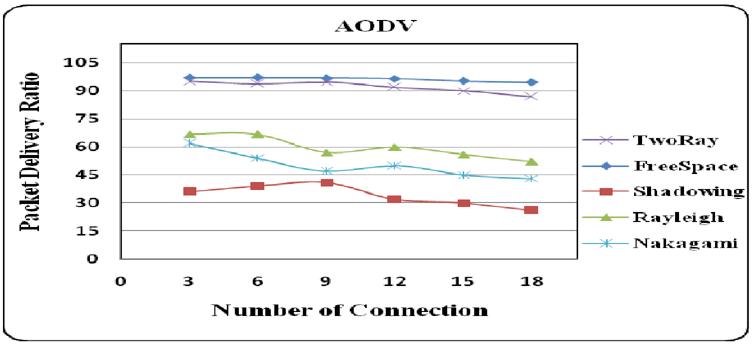

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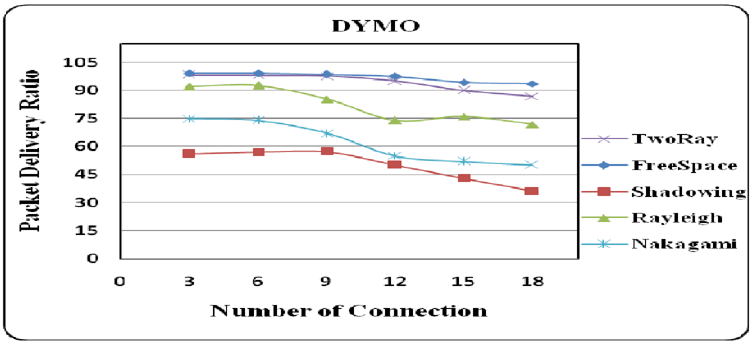

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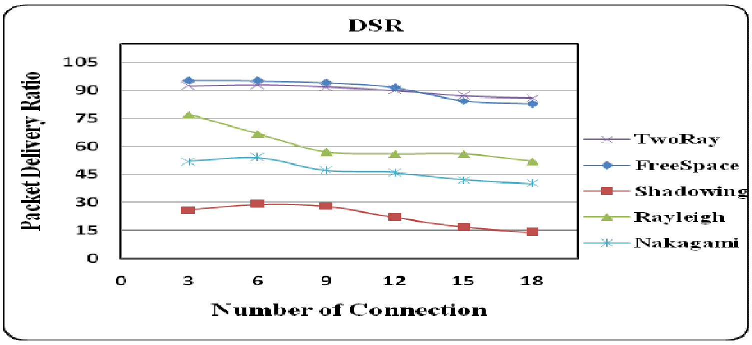

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Figure 4: Packet Delivery Ratio Vs Number Of Connection For (A) AODV (B) DYMO (C) DSR

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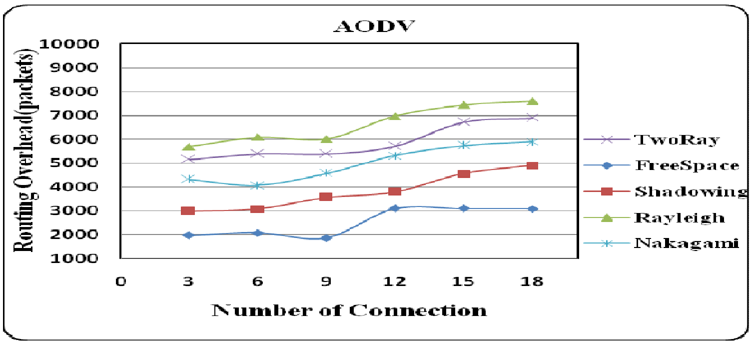

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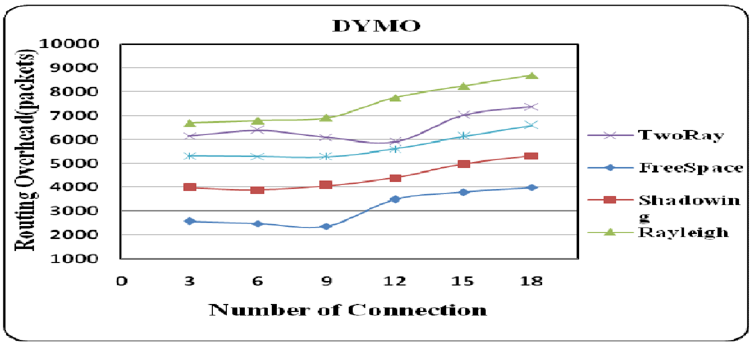

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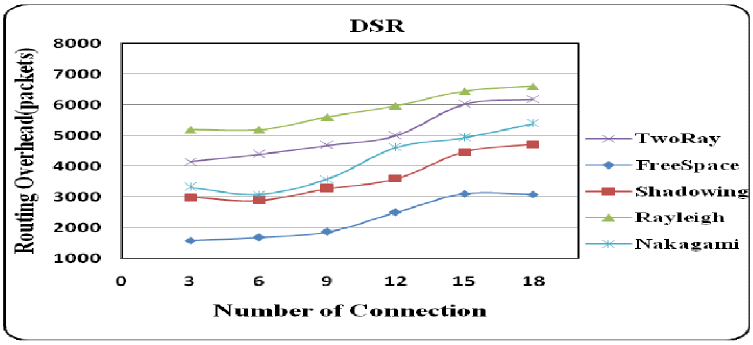

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Figure 5: Routing Overhead Vs Number Of Connection For (A) AODV (B) DYMO (C) DSR

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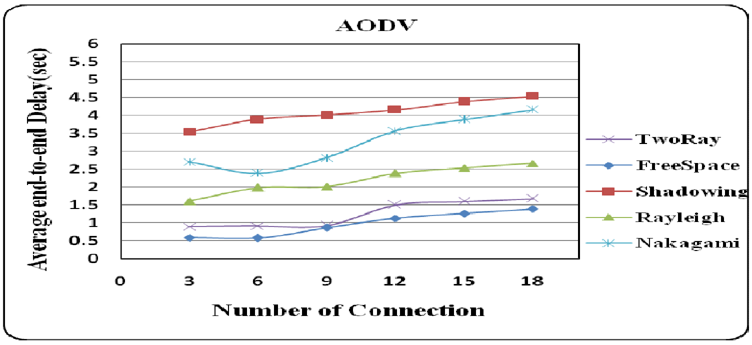

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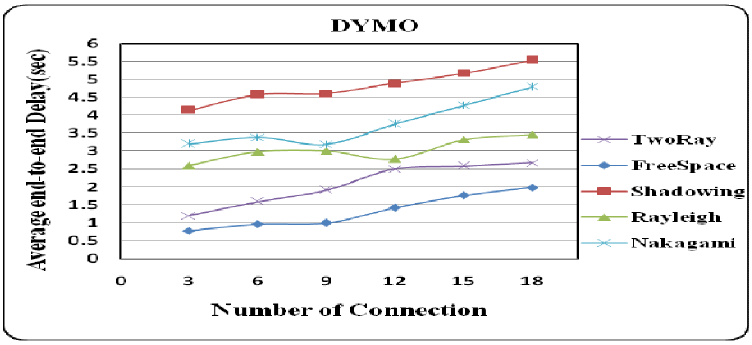

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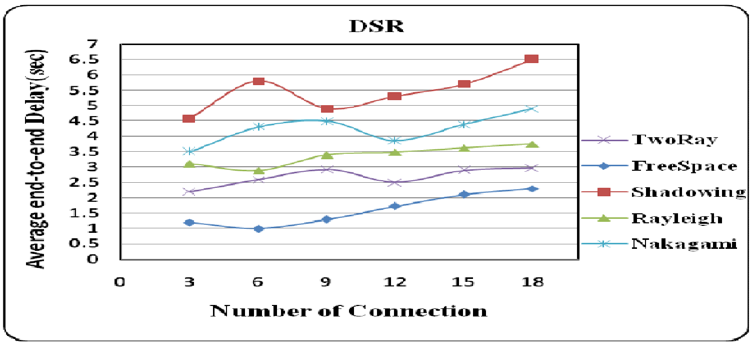

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Figure 6: Average End To End Delay Vs Number Of Connection For (A) AODV (B) DYMO (C) DSR