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NETWORK MOBILE TOPOLOGY IMPACT QOS IN MULTI-SERVICE MANET

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Abstract: Mobile Ad-Hoc Network is a set of mobile nodes without infrastructure connectivity. Although the type of data exchanged between MANET QoS knots is significant, multiservice data have not been processed by further previous researches. In this paper, it has suggested an adaptive approach that provides the best delay and output efficiency. It investigated effects of the mobility models and the density of nodes on the performance of On-Demand Distance Vector, AODV routing protocol, using multiservice VBR (MPEG-4) and Constant Bits Rate (CBR) in the first place. Ultimately, in both cases, we compare the performance. Experimentally, we considered Random Waypoint, Random Direction and Mobgen Steady-State as three mobility models. The experimental results indicate that the behaviour of AODV changes depending on the model and the traffic used.

Keywords: AODV, CBR, MANET, QOS, mobility models

INTRODUCTION

The mobile ad-hoc network (MANET) [1] is a self-configuring network of mobile nodes connected to a random topology using wireless connections. The nodes move around freely. The wireless network topology is unpredictable. The limited setup, quick deployment and lack of a central governing body make ad hoc networks ideal for multimedia conferences, construction sites, residential networks and military conflicts [1-3], [2-4].

Mobility models describe the pattern for nodes movement in ad hoc networks. The random nature of these models, as well as their final (computer, tel...) implementation, involves some work in the evaluation of simulation-based routing protocols.

The purpose of the routing protocol is to find the best way to connect two nodes while maintaining a communication QoS. The rapid and unpredictable shift in the topology of the MANET network based on the random mobility of the nodes makes it hard to scan the path.

It is clear that MANET does not guarantee the quality of service, QoS [4] because of the inherently dynamic nature of a mobile ad hoc environment. The performance obviously depends on the routing system and the mobility itself. To guarantee the QoS, it needs to perform deeper assessment studies in order to find the routing protocol and the usability model more suited to an application. The QoS needs some of the output metrics such as throughput, end-to-end delay and jitter. Therefore, several researchers conducted on MANETs' assessment efficiency as a performance analysis of the various routing protocols and the impact of random mobility models on ad hoc networks [5-12].

The rest of this paper is structured as follows: it is shown survey related work in the next section. The problem formulation, followed by the simulation model used in this analysis, is discussed in section 3. In section 4, it explains simulation. In section 5 addresses the results obtained in this simulation.

RELATED WORK

In [14], Gupta and Kumar developed a random network model for the study of performance scaling on a fixed wireless network; the authors in [14] showed that the performance scaling changes entirely during the time of motion nodes. According to [13,14] the authors in [15] showed that there are three parameters for throughput and delay: hop number, scope, mobility and speed of the node. The authors propose schemes that use the three characteristics to achieve different points in the curve in an optimum manner.

In [16], the authors have shown that different network parameters affect the delay: the probability of channel access, transmission power or distance, load of the network and node density. The agreement pause is the topic of a review by the authors of the paper [17]. The same authors developed an algorithm to achieve optimal delay performance under certain delay conditions. In [9], the experimental results show that the random movement models differ in the efficiency of the AODV routing protocol: Random Waypoint, Random Walk with Reflections and Random Walk with Wrapping.

In [1], the effects of different mobility models on the efficiency of both the (DSR-Reactive) and (DSDV-Proactive protocol) routing protocols were studied. Such four mobility models are Random Waypoint, Team Mobility, Freeway and Manhattan. The study showed that the performance of the mobility models improved.

In [18] with an AODV routing protocol, the performance of the three mobility models: Random WayPoint, Random Walk with Reflections and Random Walk with Wrapping were evaluated. The results demonstrate that the best Random Waypoint model, with two different scenarios, outperforms the Random Walking Model and Random Direction Model. The results show that the Random Waypoint produces the highest output, whereas the Random Walk Model and Random Direction output falls dramatically over a time period.

The authors of this article [19] present the accomplishments of the Displacement-Sequenced Distance Vector (DSDV) in four separate mobility models: Random Waypoint, RPGM, Gauss Markov and the Manhattan Mobility Model. The findings in this paper show that the DSDV protocol with the RPGM mobility model has improved results with different network load and speed.

Various protocols such as AODV, DSDV, Dynamic Source Routing (DSR) and TORA are compared in [20]. Packet delivery fraction and the end-to-end delivery time according to availability, traffic and network size are the output parameters considered for review. Random Waypoint, Random Walk and Random Directions are the principles of mobility. AODV has been shown to do more than DSDV, TORA and DSR and also with Random Walk and Random Direction models. AODV is recommended to be used under high mobility as it is as effective as protocols DSDV, TORA and DSR.

In [21] the authors were able to evaluate the performance of dynamic source routing (DSR) in multi-service traffic in MANET as a delay.

In [22], the routing problem is proposed in multi-service MANETs as well as the adaptation of the DSR protocol.

The three models of mobility (Random Waypoint, Random Directorate and State of Mobgen-Steady) have been evaluated with CBR traffic in [5] by Random Way Point in low node densities and Mobgen-Steady State with high node density demonstrate the maximum delay.

Nonetheless, Random Way Point achieves optimum performance during the low and high node densities. In paper [6] it is evaluated the AODV protocol's behaviour with the same earlier models of mobility. But this time the analysis is being performed on multi-service (VBR) traffic. The AODV protocol has been adaptive to the type of traffic used. This AODV behaviour change allows this comparative study to be conducted using both traffic forms (CBR) and (VBR).

PROBLEM FORMULATION

It is clear that the QoS maintains a certain level of performance for various applications. The ad hoc network is however used in applications with specific QoS rates. Network traffic is marked as time-sensitive. In this category, we find real-time traffic applications that require a minimum guarantee. This generally works without losing data (e.g. video conferencing) [23]. Most real-time systems include delay limits to be assured, but these limitations can be slightly exceeded. Most applications in this group can also handle a small amount of packet loss [24]. The second category is data traffic that does not require delays, but it requires a short average delay. The transmission of data requires lossless transmission [23].

The research includes two types of Constant Bit Rate (CBR) and Variable Bit Rate (VBR) traffic. Those technologies produce traffic at a fixed rate in the first class. As far as experience is concerned, certain implementations generate a CBR flow. Many applications produce variable bit rate streams (VBR) in the second class. This traffic affects the amount of information transmitted per unit time (i.e. bit rate). The degree of variance in the bit rate varies from application to application [25].

Among the major challenges of research architectures in ad hoc node density networks, what are the routing protocols and suitable mobility models to use for a given application scenario? To achieve this goal, some work was focused on routing protocol performance assessments and models of mobility as most previous research entered on CBR traffic which is not suited to multimedia VBR applications [26].

This research aims to measure the performance of the AODV Routing Protocol differently and to test the conduct of this protocol by using the CBR and VBR traffic models with various mobility models. It is then proposed an adaptable method that takes advantage of the results and represents the optimum delay and performance. In this way the minimum acceptable delay values assigned to each number of nodes are considered for the optimal delay of the three mobility models. For the optimal performance of three mobility models, the maximum output values are considered for each number of nodes.

This work analysed the effect of the node density on the performance of the AODV routing protocol (end-to-end delay, throughput and packet delivery rate). The three models of mobility are: Random Way Point, Mobgen-Stanty State and Random Management.

The VBR traffic is closely consistent with the statistical features of an actual video frame trace created by an MPEG-4 encoder [26]. The traffic stream was regulated by two parameters. The first parameter, the first seed, results in traffic variants. This parameter was kept continuously at 0.4 [25], since all experiments had to use the same traffic trace.

The second parameter, the rate factor has defined the degree of video input scaling up or down while the same sample path and autocorrelation function for the frame size distribution is preserved. The meaning is 0.33 for 40 and 0.25 for 10, 20 and 30 sources [24]. On the basis of [20] the AODV works better than DSDV, TORA and DSR protocols and can be used with high mobility.

The reliability of the performance results is clearly based on the successful selection of the simulation parameters. In mobile ad hoc network simulations, the probability distribution that governs the motion of nodes typically varies over time and converges to a' state-specific' distribution. Once node speeds and positions are chosen from their constant-state distribution, the output parameters of a given protocol converge to their values as well. In [27], the authors show that it may take more than 1000 seconds of simulation time to achieve stable state [28]. That is why our works take 1200 seconds to simulate.

The ad hoc reactive routing protocol considered Ad hoc on-demand remote routing [20] to be a dynamic on-demand multi-hop routing protocol for mobile ad hoc wireless networks. AODV discovers source routing paths and maintains route cache table case. It is free of loops and uses target sequence numbers. Within AODV a node informs its neighbours by sending "hello messages" constantly at a given interval about its very nature. It helps all nodes to know their neighbours ' status, that is, if they have gone down or out of control. A Route Request (RREQ) is used to solve a route to another node in the AODV network.

The receiving node verifies whether it has a path to the specified node. If there is a path, the receiving node answers the question by sending a route response. If there is no path, the receiving node must send a RREQ itself to try to find a route for the requesting node. If the first node does not receive a reply in time, the node will infer that the nodes sought are unavailable. For order to ensure that the route persists, the sender has to keep the route alive by sending packets frequently.

Both nodes along the route are responsible for upstream connections, so the next node is a broken link. This node signals the broken link by sending a downstream error message (RERR) so that users can start looking for a new path.

The mobility model is designed to understand how mobile users move and how their position, movement direction, [35] pause distribution, speed and acceleration change over time. The mobility models are a valid scenario for how people move into, for instance, a meeting or museum.

— **Random Way Point (RWP)**

Each node is assigned initial location, destination, and speed in this model. The initial location and destination points are selected independently and uniformly in the area where nodes move. The speed is selected uniformly at an interval, regardless of location and destination.

After reaching destination, a new destination is selected from the uniform distribution and a new speed is selected uniformly on [min-speed, max-speed], regardless of previous destinations and speeds. The node stays at each destination for a specified pause before repeating the process [9,11,26].

— **Random Direction (RD)**

The Random Direction Mobility Model [36] assigns each node an initial direction, speed and finite travel time. The node then travels in that direction to the simulation area border. The node pauses for a specified time after hitting the simulation limit, selects a different angular direction (between 0 and 180 degrees) and continues.

Random Direction Mobility Model was designed to resolve node clustering in one part of the Random Waypoint Mobility Model simulation area. For the Random Waypoint Mobility Model, this clustering occurs near the simulation area core.

— **Mobgen Steady-State (Mbg-SS)**

Implementing the RWM model with NS2 testbed [20] begins with a constant pause to the initial location [29,30]. In comparison, the initial positions are uniformly chosen.

With mobgen for NS2[31], another model of RWM in NS2 starts approximately half of the nodes in motion and the second half in pause [32]. For this reason, simulations with setdest take more time to converge with mobgen simulations. If node speeds and positions from their steady-state distribution are chosen, the performance metrics for a given protocol are also convergent to their values.

Therefore, when using setdest or mobgen, the output network will shift systematically as time passes and the calculation of collected results in the conversion cycle is incapable of representing the long term values [33].

The stability model Mobgen-Steady State strengthens the RWP model [27]. In this model, the initial positions and knots speeds from their stationary distributions are selected. Convergence is instant and performance outcomes are trustworthy. The Mobgen-Steady State model code is available to [33].

SIMULATION ENVIRONMENT

To achieve the goal, it needs to investigate how the AODV protocol works when loading nodes increases with specific Mobility Models (Random Waypoint, Random Path, Mobgen Steady-State).

Table 1. Simulation parameters

Parameter	Value
Simulation Time	1600 sec
Number of nodes	10, 20, 30, 40, 50, 60, 70, 80, 90, 100.
Pause Time	0, 10 Sec
Environment Size	2000 m × 2000 m
Traffic Type	Variable Bit Rate (VBR) MPEG-4
Maximum Speeds	20 m/s
Mobility Models	Random Waypoint, Random Direction, Mobgen Steady-State

Network simulator 2.34 NS-2 performed simulations. Using multimedia VBR (MPEG-4) and CBR. Table 1 contains all simulation parameters.

— Performance Metrics

For the simulation results, we selected the end-to-end delay and throughput as metrics to measure the efficiency of the different protocols: Average end-to-end latency: the delay of a packet is the time it takes to reach the destination after leaving the source. The total network packet delay is measured by comparing all packets and all destination pairs. The End-to-End TAVG is determined as shown in equation (1):

$$T_{AVG} = \frac{\sum_{i=1}^{N}(H_r^i - H_i^1)}{N_r} \quad (1)$$

In equation (1), H_t^i emission instant of package I, H_r^i reception instant of package i,

N_r the total number of packets received.

Throughput: the ratio of successfully transmitted data per second (2).

$$T = \frac{L-C}{L} Rf(\gamma) \quad (2)$$

In equation (2), $\frac{L-C}{L}$ is the payload transmission rate, (R)b/s Binary transmission rate, L Packet size, and $f(\gamma)$ is the packet success rate defined as the probability of receiving a packet correctly. This probability is a function of the signal-to-noise ratio (γ).

Packet Delivery Ratio: the ratio of the data packets successfully delivered to the destination.

RESULTS DISCUSSION

This section presents our findings of simulation and performance analysis. Analysis based on comparing the different mobility model metrics that defined in Section 3.

— Variable Bit Rate (VBR)

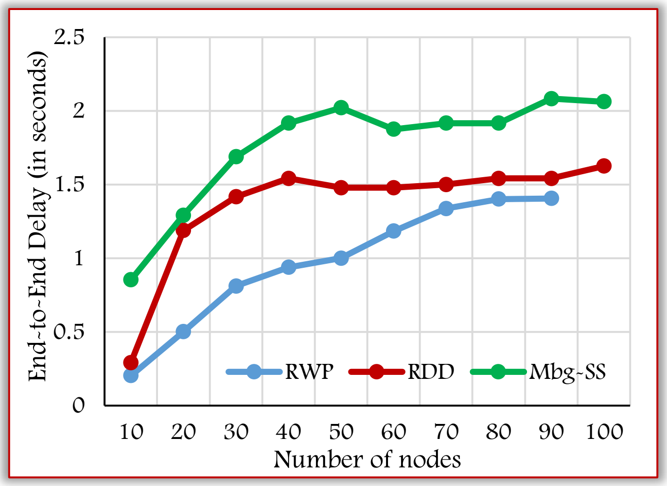

Figure 1. End-to-End Delay vs No. of nodes with VBR

As showing in Figure 1, with AODV, the delay increased. As node density increases.

Once density is important, the delay for the three models is still consistent. With Random Path, AODV takes less time to transmit packets than the other two versions (Random Way Point, Mobgen-ss). On the other hand, Mobgen-ss gives the best performance in terms of delay than Random Way point.

Based on Figure 2, AODV demonstrates higher throughput than both Random Way Point and Mobgen-ss. Also, total node count, the three mobility models are performed. So in the first section, Random Way point produces a high throughput than the Mobgen-ss model, in the second part, Mobgen-ss almost outperforms Random Way point.

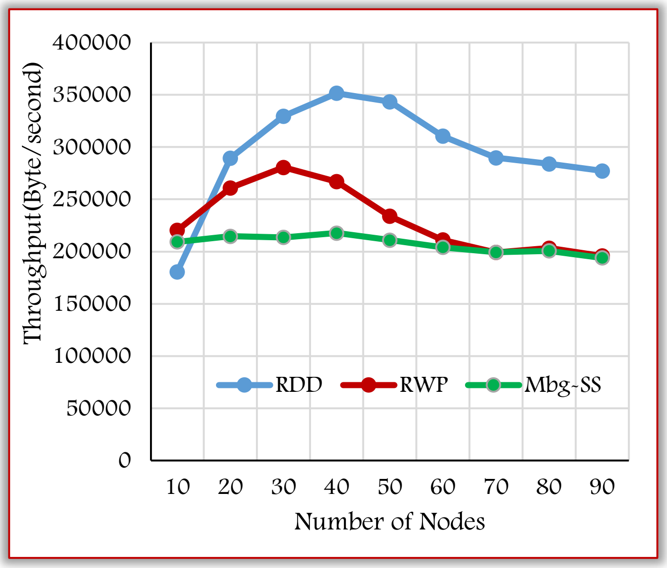

Figure 2. Throughput vs No of nodes with VBR

Figure 3 reveals that, in Random Direction, AODV ensures more packet transfer than Random Way-point and Mobgen-ss. But, for the three mobility models, the packet delivery ratio decreases and is insufficient over all node density.

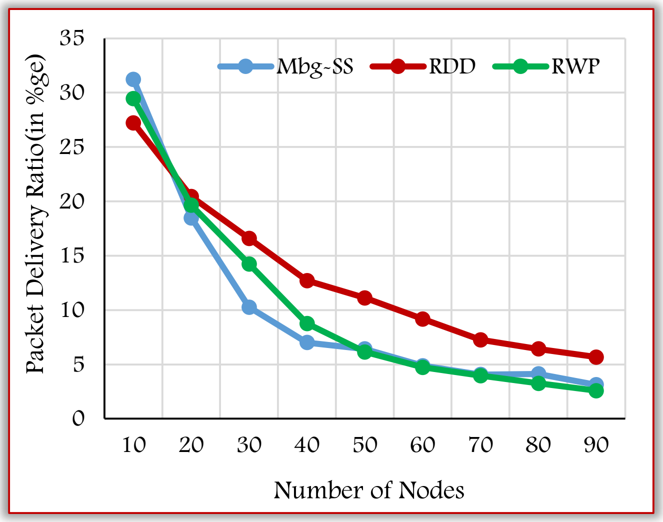

Figure 3. Packet Delivery Ratio vs No. of nodes with VBR

Generally, with AODV and using VBR (MPEG-4) traffic, results (Figures 4-6) suggest using Random Direction in real-time applications with delay limits to be met. It can also be used on applications that tolerate little packet loss.

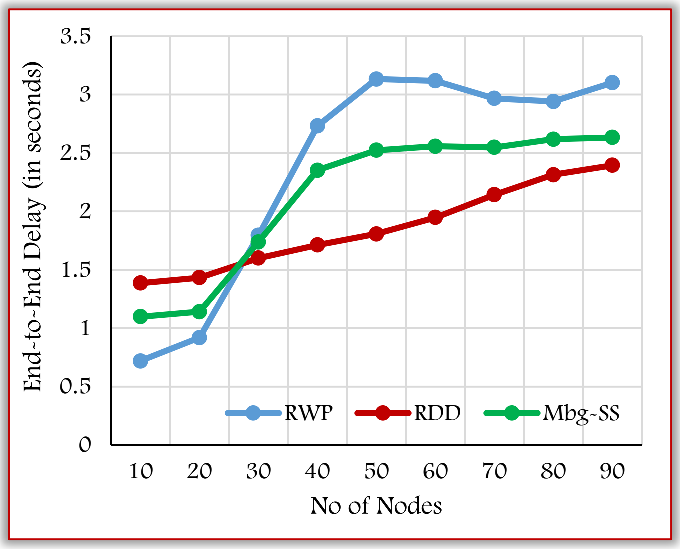

Figure 4. End-to-End Delay vs No. of nodes with CBR

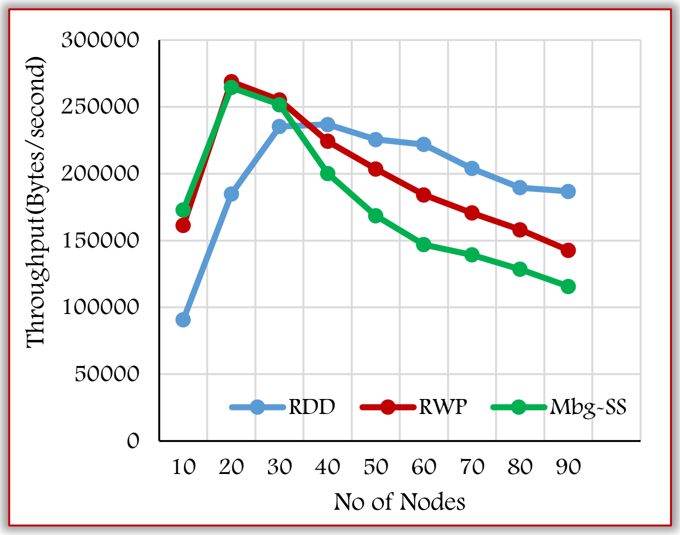

Figure 5. Throughput vs No. of nodes with CBR

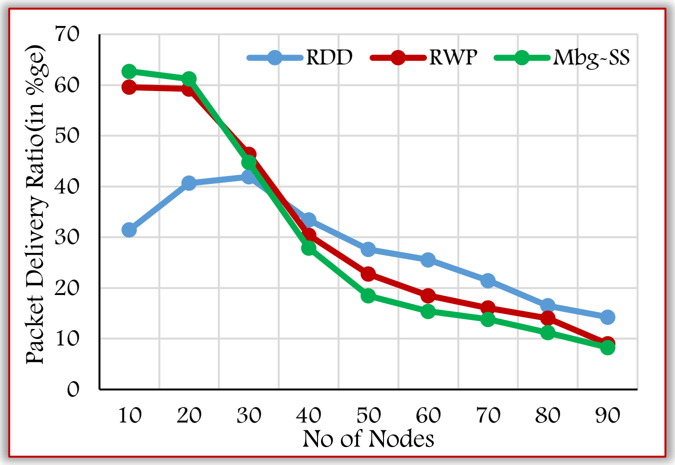

Figure 6. Packet Delivery Ratio vs No. of nodes with CBR

— **Constant Bit Rate (CBR)**

End-to-end routing protocol is less, constant and consistent when using low node density. In this section, compared to Random Direction and Mobgen-ss mobility models, AODV takes less time to deliver the packets. Once density is high, AODV's behaviors change drastically. End-to-end delay greatly increases. In this part, AODV's delay in Mobgen-ss is less than Random Way point, and high in Random Direction model. AODV performs better in Random Direction than other versatility models.

If we consider only applications that are sensitive to delay, the optimal delay achieved with Random Way Point and heavy density is achieved by Random Direction. So for implementations, the results suggest using Random Way Point on low density and Random Direction on high.

Based on Figure 5 results, AODV with Random Way Point and Mobgen-ss models show higher than Random Direction. After that, AODV's throughput with the three mobility models decreases as node density increases. Nevertheless, with Random Direction, AODV produces better performance of both Random Way Point and Mobgen-ss. On the other hand, considering applications needing a certain amount of throughput, the results suggest using AODV with Random Way Point in low densities and Random Direction mobility model in large densities.

As shown in Figure 6, a higher Packet Delivery Ratio is achieved when using AODV with Random Way Point and Mobgen-ss mobility models. In the Mobility Model Random Direction, AODV performed better in transmitting packet data to destination by increasing node density.

VBR and CBR

That's right. The most common literature mobility model is Random Way Point [29]. This model, with CBR, provides maximum performance in terms of latency, throughput and low-density packet delivery ratio (Figures 4-6).

When moving traffic from CBR to VBR (MPEG-4) on efficiency (end-to-end delay, throughput and packet delivery ratio) on AODV routing protocol, the behavior of AODV changes when using a small node number.

When density is high, AODV (with CBR and VBR traffic) retains the same behavior (Figures 1-6) in terms of delay and Packet Delivery Ratio, excluding throughput. On the other hand, rising node density from low to strong has no effect at AODV protocol behavior in connection with VBR traffic (MPEG-4).

Because the Mobgen Steady State is more realistic than the Random Direction model, the optimal delay is achieved with Random Way Point in small density and with Mobgen Steady State in heavy density. Random Way Point achieves maximum efficiency over all densities of nodes used, in the case of CBR traffic. On the other hand, in the case of VBR traffic, the optimal delay Figure 1 is similar to that of Mobgen Steady State and with low densities the optimal throughput Figure 2 is obtained by Random Way Point when the high densities used the optimal one are represented by both Random Way Point and Mobgen Steady State.

We therefore encourage the use of the Mobgen Steady State model in applications that are prone to delay (Figures 1 and 4) and that use high node density without considering traffic type (CBR or VBR (MPEG-4)) but for a limited density associated with CBR traffic, we recommend using Random Way Point and Mobgen Steady State for VBR traffic.

On the other hand, if we find applications needing a certain amount of throughput (Figures 2 and 5) and both Random Way Point and Mobgen Steady State are more practical than Random Path, we suggest using the first one mobility model in low node densities without considering the form of traffic (CBR or VBR (MPEG-4)). The Random Way Point will give the best results for the same applications with a CBR traffic when using high knots densities. The Random Way Point will give the best results for the same applications with a CBR traffic when using high knots densities. Inverse with traffic VBR, we suggest using the Mobgen Steady State model with high knots densities.

Eventually, based on VBR variability activity (MPEG-4), Packet Delivery Ratio remains inadequate over all node sizes. That's all three mobility models. AODV protocol can therefore be used on systems tolerating a small amount of packet loss.

CONCLUSIONS AND FUTURE WORK

We presented AODV routing protocol behaviour with multimedia traffic (VBR) and CBR using various mobility models such as Random Way Point, Random Direction and Mobgen Steady State.

For AODV model in combination for CBR traffic, Random Way Point in small density and Mobgen Steady State in heavy density achieve the optimum delay in the first. In the second, Random Way Point achieves optimum throughput.

In the association of AODV model with VBR traffic (MPEG-4), the optimum delay is obtained by Mobgen Steady State. Random Way Point and Mobgen Steady State achieve optimum throughput in the second.

With this process, we hope to help future studies choose parameters. To design the realistic scenarios that more accurately depict real-world applications and QoS.

Another key point in this paper is AODV's actions, with the three versatility mentioned above, depending on the traffic used (CBR or VBR). This activity is affected specifically in low node densities.

One of the most important criteria for promoting real-time communication is delay jitter. In the future, delay jitter metric also needs further analysis.

On the other hand, further analysis should be dedicated to optimizing the Packet Delivery Ratio when using VBR traffic.

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