Journal of the Nigerian Association of Mathematical Physics
***Volume 33*, (*January, 2016*), pp 215 – 222**
© J. of NAMP

Performance Analysis of AODV and GRP MANET Routing Protocols

[1]I.A. Alhaji, [2]F. S. Ishaq and [3]S. A. Sani

[1]Department of Physics, [2]Department of Mathematics and Computer Science, [3]ICT Directorate, Federal University, Kashere, P.M.B. 0182, Gombe, Nigeria.

Abstract

MANET network is characterized by frequent and unpredictable topology changes due to uncontrolled mobility patterns of wireless mobile nodes forming the network. Good and bandwidth-efficient routing protocols that dynamically adapt to the ever changing MANET topology and time-varying wireless channel are required to maintain network connectivity. Several routing protocols exist but selecting which among them suits which network type like MANET is a challenging task. In this work, performance analysis on AODV and GRP routing protocols, the best suited for MANET operations, were made under four different network settings; default, higher buffer size, RTS mechanism and packet fragmentation settings. Four performance metrics were chosen for the analysis that is throughput, delay, retransmission attempts and data dropped due to buffer overflow. We then comparethe performance of AODV and GRP with respect to the above metrics. It was found that for both AODV and GRP, MANET suffers less delay and achieves better throughput with RTS and higher buffer size settings respectively. It was also found that AODV out performs GRP routing protocol in all the performance metrics considered.

1.0 Introduction

A mobile ad hoc network (MANET) is a collection of two or more wireless mobile nodes communicating with one another without using any fixed networking infrastructure. Communication from a node is maintained by the transmission of data packets over a common wireless medium or channel. The absence of any fixed infrastructure, such as an access point (AP) in a Wireless local area networks (WLANs) make ad hoc networks (Independent Service Set-IBSS) different from infrastructure wireless networks (Basic Service Set-BSS). Whereas communication from a mobile node in a BSS is always maintained with a fixed AP, a mobile node in MANET communicates directly with another node within its radio transmission range. In order to transmit data to a node that is outside its radio range, packets are routed over intermediate nodes between the source and destination [1].

Since no access points (APs) are needed in case of WLANs or base stations (BSs) in cellular networks, adhoc networks can be easily and efficiently deployed and managed without any advance planning [1]. In MANET each node is independent and can act as both host and router. The nodes in this type of network, having no central infrastructure to control their operations, coordinate among themselves in a distributed manner to implement functions such as relying and security features [2]. The network topology is dynamic since the nodes are mobile therefore the connection between them is unpredictable and varies with time [2]. As a result the nodes have to constantly adapt to the traffic and propagation variations as well as topology changes. To overcome these challenges, efficient and dynamic routing protocols are developed to provide reliable performance in MANET [3].

Routing protocols are categorized into three; proactive, reactive (on demand) and hybrid routings based on when routing activities are initiated. Proactive routing protocols maintain routes in the network endlessly irrespective of whether or not such routes are active. Whereas reactive routing protocol on the other hand maintains routes only when needed. Hybrid routing protocols sort of combines the approach of both proactive and reactive routing protocols [4].

Of all the routing protocols, AODV (reactive) and Gathering-based Routing Protocol(GRP) are best suited for MANET operations [5] hence our resolve to analyze and compare their performance using IEEE 802.11n [6] with regard to the following metrics; delay, throughput, data dropped and retransmission attempts. Delay (s) measures the end-to-end packets delay experienced by all nodes, throughput (bits/s) is the total number of bits forwarded in all nodes, data drop (bits/s)

Corresponding author: I.A. Alhaji, E-mail: alhaji259@gmail.com, Tel.: +2348084998581

indicates the total data traffic dropped by the network nodes while retransmission attempts (packets) measures the total number of retransmission attempts of packets by all the network nodes. The rest of the paper is outlined as follows; section 2 gives background on reactive (AODV) and hybrid (GRP) routing protocols, sections 3 highlights the simulation set up and the scenarios run, in section 4 results and discussion are presented while the conclusion and references form the last parts of the paper in that order.

2.0 Routing Protocols

One of the ways to easily differentiate MANET routing protocols is based on how routing knowledge is gained and maintained by mobile nodes. By this, MANET routing protocols are classified, as highlighted above, into proactive routing, reactive routing, and hybrid routing.

In proactive routing protocol, MANET endlessly evaluates routes to all nodes within the network and attempts to maintain consistent, current routing information. Therefore, a source node gets a routing path instantly when the need arises. All nodes maintain a constant view of the network topology. When a network topology varies, corresponding updates must be communicated throughout the MANET to effect the change. Proactive routing algorithms make nodes to update the current network information and maintain routes irrespective of whether traffic exists or not. As a result the overhead to maintain present network topology status is huge [7]. This makes proactive routing protocols not suitable for MANET operations. Due to this, individual proactive routing protocols would not be discussed here.

Reactive or on-demand routing protocols for MANETs are designed to minimize routing overhead. These protocols searched for routes only when needed. They initiate route discovery process between the source and destination nodes when the route to the respective destination is not known or breaks. Route maintenance is performed when a route is live. Flooding the whole MANET by reactive routing protocols with query packets due to route discovery may be a bottleneck. The main advantage of reactive over proactive protocols is that they have lower routing overhead in comparison [1,3]. Typical example of reactive routing protocol is Ad Hoc On-Demand Distance Vector (AODV). The AODV uses symmetric links between nearby nodes [7] and also uses a broadcast route discovery mechanism. It does not attempt to follow paths between nodes when they cannot hear each other. AODV routing protocol relies greatly on establishing route table entries at intermediate nodes in a dynamic passion. This actually helps in networks with many nodes where a larger overhead is incurred by carrying source routes in each data packet. To maintain the most recent routing information between nodes each MANET node maintains a number counter which is used to replace out-of-date cached routes. The combination of these techniques results in an algorithm that utilizes bandwidth economically by minimizing control and broadcast overhead and making data traffic receptive to changes in topology and ensures loop-free routing [7].

Hybrid routing protocols are proposed to strike a balance between routing overhead and the adaptation to the unpredictable variation of the MANET topology due to mobility. Hybrid protocol combines both proactive and reactive routing procedures depending upon the nature of the topology and network connectivity to evaluate and maintains routes [7]. GRP [8], being one of Hybrid protocols and the one best suited for MANET applications among them [5], gathers network information quickly with little overhead [9] by sending query to the destination using RREQS just like AODV [10]. The destination responds by sending network information gathering (NIG) packet to the source that contains the network information thereby equipping it with reliable routes upon which it continues data transmission [9].

3.0 Simulation Set Up

Eight (8) simulation scenarios were designed and run with each scenario having a run-time of fifty seconds (50s). IEEE 802.11n physical characteristic was implemented in the MANET nodes. Optimized Network Engineering Tool (OPNET) modeler academic edition version 17.5 [11] was used for the simulations. The following settings were effected in the modeler; 0.1, 0.00012, 65 (base) ~ 600 (max) and random for start time, packets inter-arrival time, bit rate and destination IP address respectively.

3.1 Scenarios

In the first four scenarios all MANET nodes employed AODV routing protocol. The nodes transmit with their default setting in the first scenario. In the second scenario the buffer size of the MANET nodes was change from the default (256Kb) to 1024Kb. RTS threshold of 1024 bytes was employed by the nodes in the third scenario while packet fragmentation was effected in the fourth scenario at a threshold of 256 bytes.

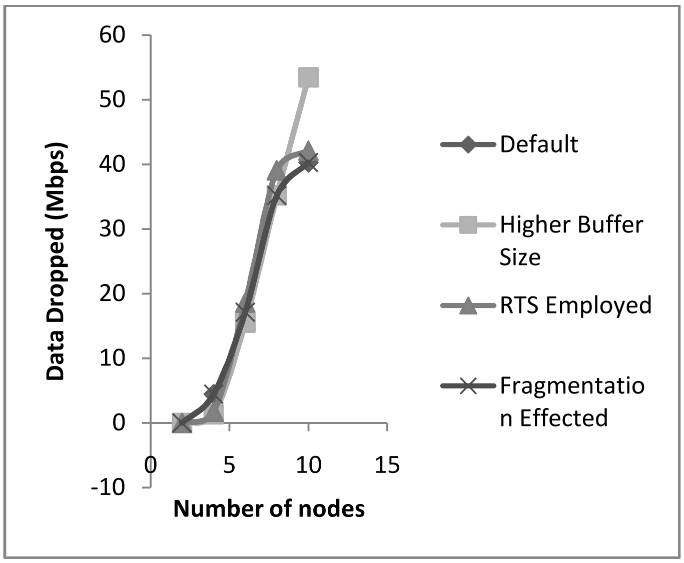
Same simulation scenarios discussed above were repeated with the MANET nodes adopting GRP as their routing protocol. In all the scenarios simulated the number of nodes was varied from two (2) to ten (10) to enable us see the influence of node's number on the routing protocols. The wisdom behind buffer size increment is to help reduce data being dropped to buffer overflow and to check whether the routing protocols will respond to that. Normally in MANET operations the issue of hidden node(s) is inevitable hence the employment of RTS to observe its effect on the routing protocols. Due to the nature of the time-varying wireless channel, packet fragmentation was employed to check whether it has any benefit in the operation of MANETs.

4.0 Results and Discussion

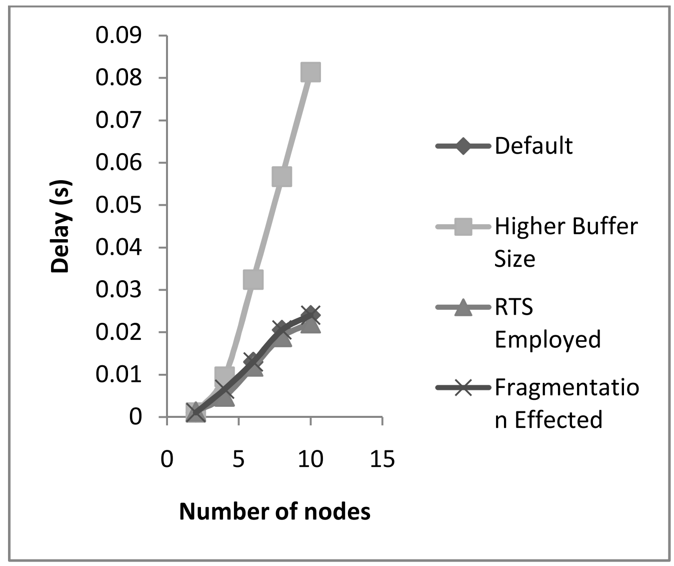
The results of the scenarios described in section 3 are presented and discussed here.

4.1 Influence of Nodes' Density, Buffer Size, RTS Mechanism and Packet Fragmentation on AODV Routing Protocol

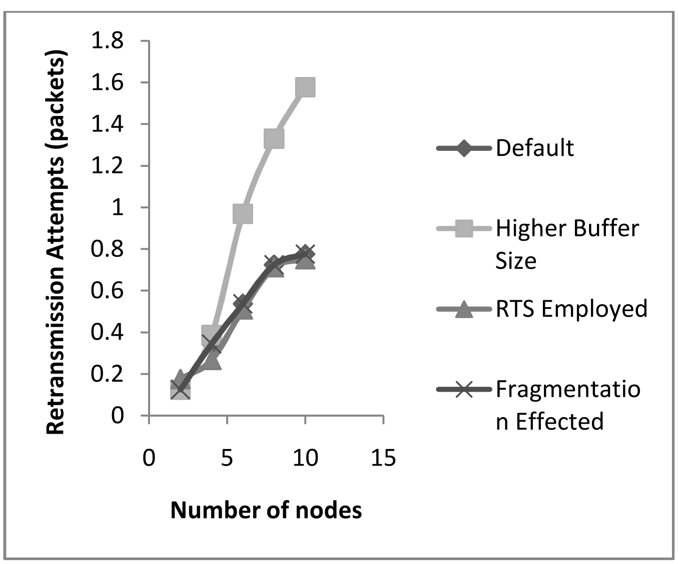
Figure 1 shows that packet fragmentation has totally no influence on AODV routing protocol as it recorded identical results with the default setting. Same, however, could not be said of RTS and higher buffer size settings. These settings reveal that AODV protocol suffers worst in terms of data dropped due to buffer overflow. The total data traffic discarded by default, buffer size varied and RTS settings are 97.08, 105.47 and 101.52Mbps. Since packet fragmentation has no effect whatsoever on AODV routing protocol we need not to mention it again. (b) part of same figure reveals that RTS setting suffers lowest delay while changing the buffer size makes AODV to experience highest retransmission attempts (c part of Figure 1). But increasing the buffer size does have its benefit as AODV protocol enjoys the highest throughput as against the other settings.



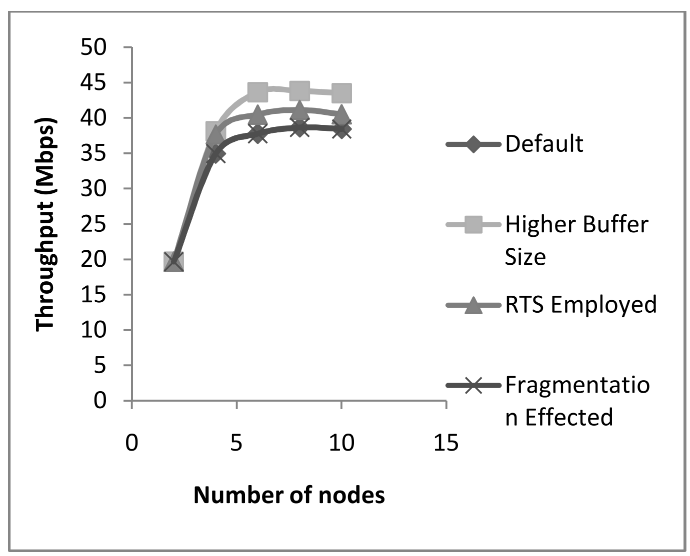
(a) Data Dropped



(b)Delay



(c) Retransmission Attempts

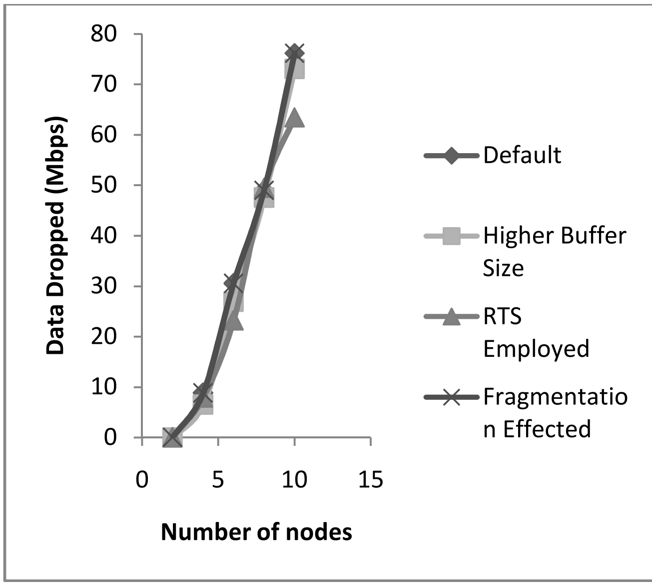


(d) Throughput

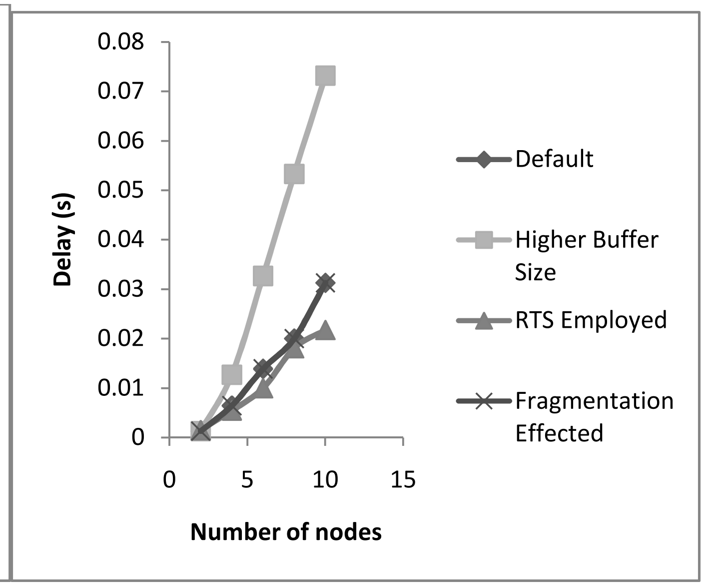
Figure 1: Comparison of AODV Routing Protocol Performance with Changing Number of Nodes' Density (a) Data Dropped, (b) Delay, (c) Retransmission Attempt, (d) Throughput for Different Settings

4.2 Influence of Nodes' Density, Buffer Size, RTS Mechanism and Packet Fragmentation on GRP Routing Protocol

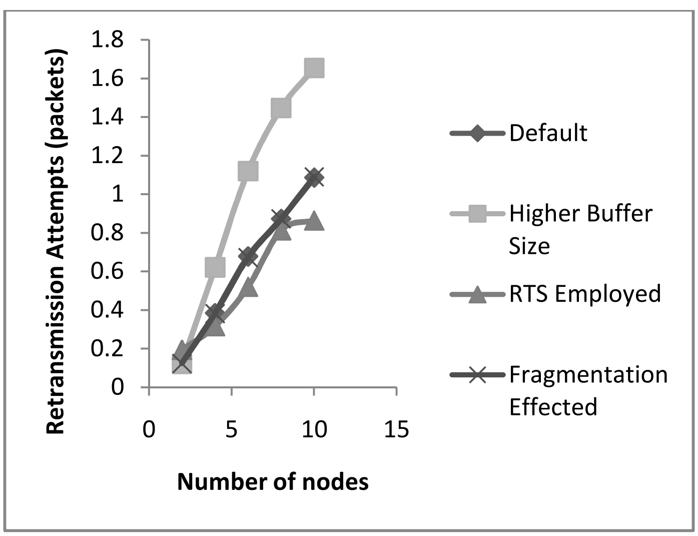
In Figure 2 (a), RTS setting achieves lowest data traffic discarded while default and higher buffer size settings suffer the worst data dropped due buffer overflow. RTS setting suffers the shortest delay followed by the default setting while the higher buffer size settings suffers the longest delay as attested by Figure 2 (b) and (c). Figure 2 (d) shows that with GRP routing protocol the network get highest throughput when the buffer size is increased followed by RTS and default settings respectively.



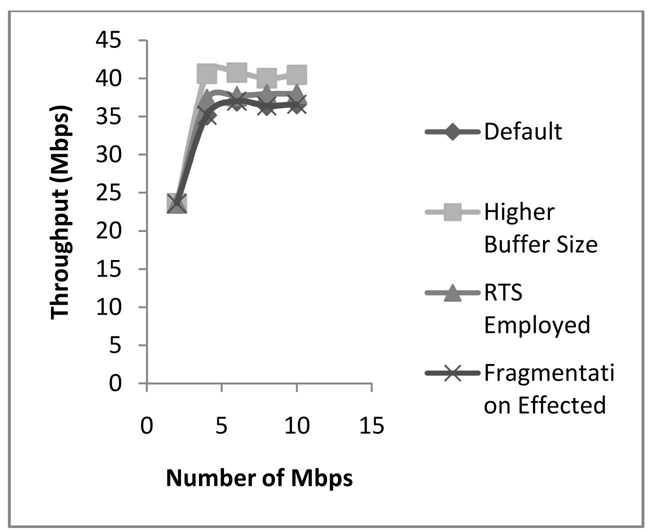
(a) Data Dropped



(b)Delay



(b) Retransmission Attempt

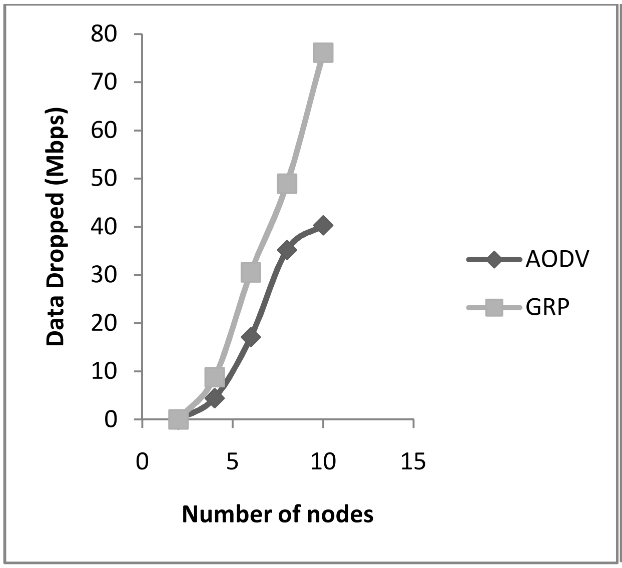


(d)Throughput

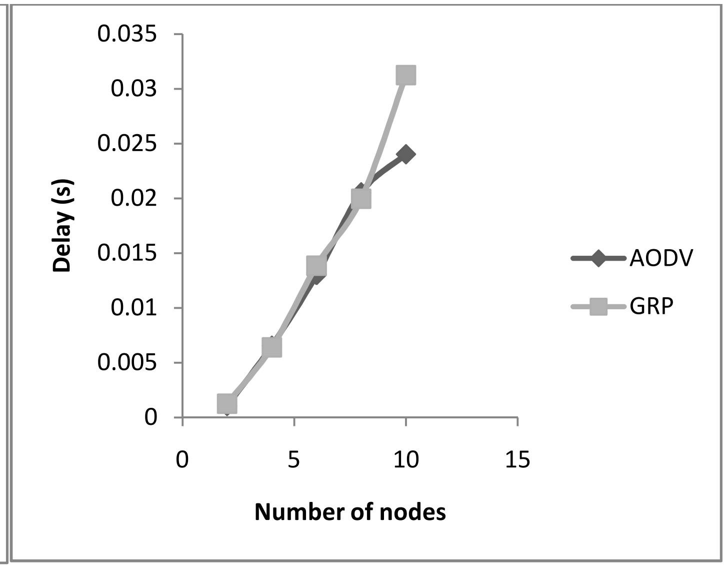
Figure 2: Comparison of GPR Routing Protocol Performance with Changing Number of Nodes' Density (a) Data Dropped, (b) Delay, (c) Retransmission Attempt, (d) Throughput for Different Settings

4.3 Comparison of AODV and GRP Performance under Default Setting

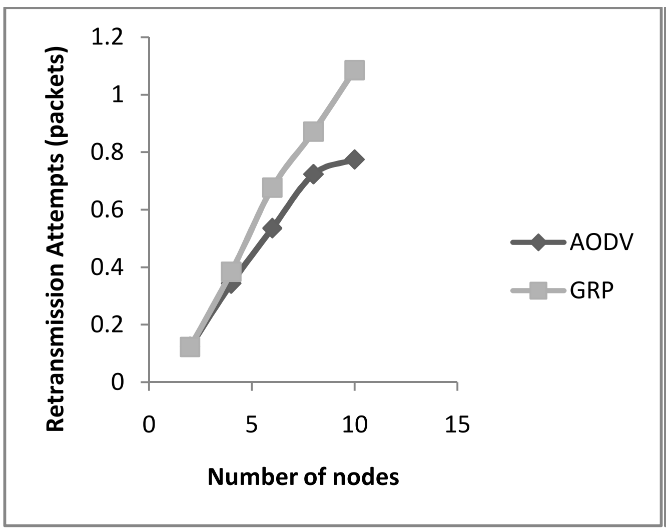
Figure 3 shows that AODV routing protocol at default setting, that is when no RTS or packet fragmentation is employed and the buffer size is 256Kbits, out performs GRP protocol especially by looking at (b) and (d) of the same figure where the highest delay and throughput were found to be 0.024s, 0.031s, 38.45Mbps and 36.58Mbps for AODV and GRP respectively. It is noted also that at lower nodes' density both AODV and GRP performance metrics were fairly the same.



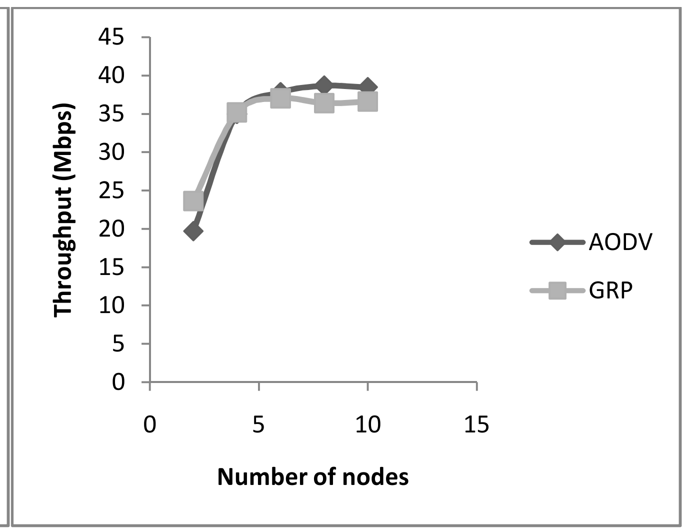
(a) Data Dropped



(b) Delay



(c) Retransmission Attempts

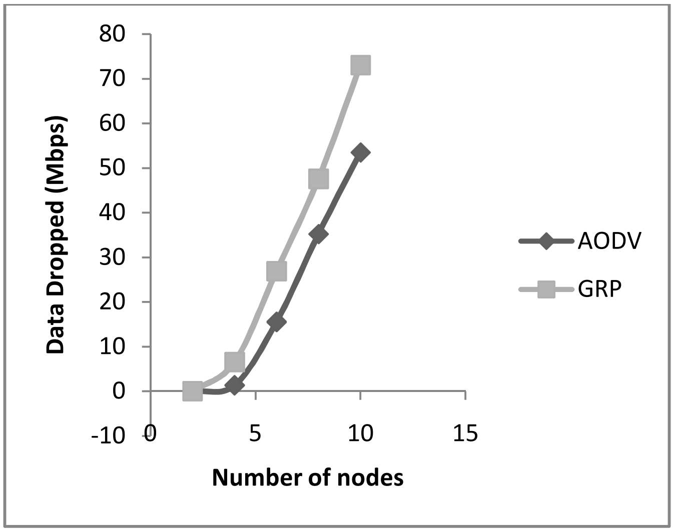


(d)Throughput

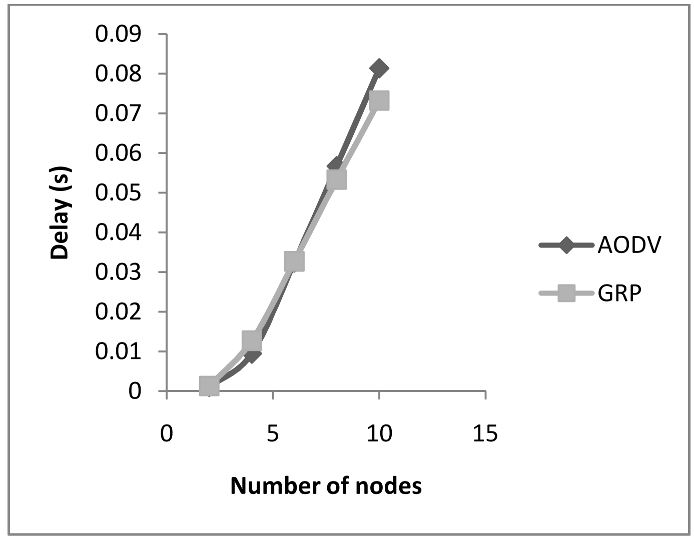
Figure 3: Performance Comparison of AODV and GRP under Default Setting

4.4 Comparison of AODV and GRP Performance under Higher Buffer Size Setting

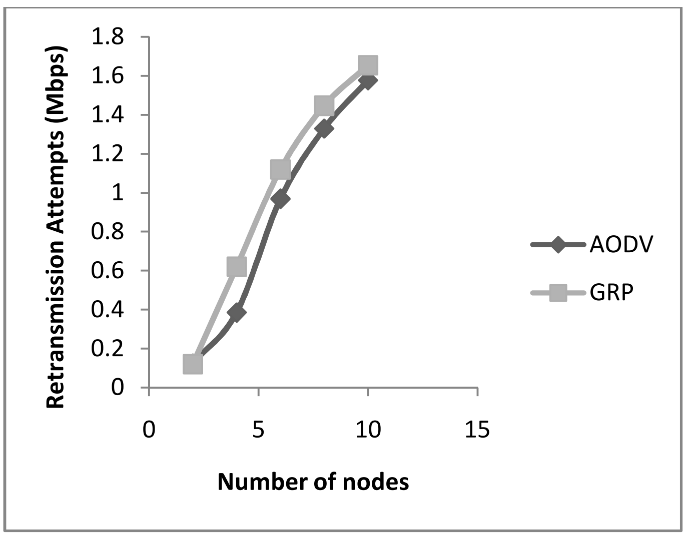
In Figure 4 (a) the MANET discarded less data traffic with AODV protocol but suffer the shortest delay with GRP routing protocol. The number of retransmission attempts is slightly lower with AODV while at the same time achieving higher throughput in Figure 4 (c) and (d) respectively.



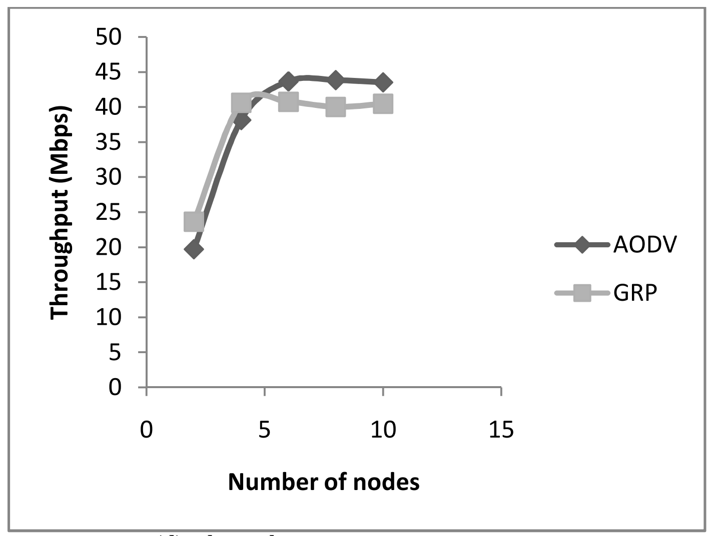
(a) Data Dropped



(b)Delay



(d) Retransmission Attempts

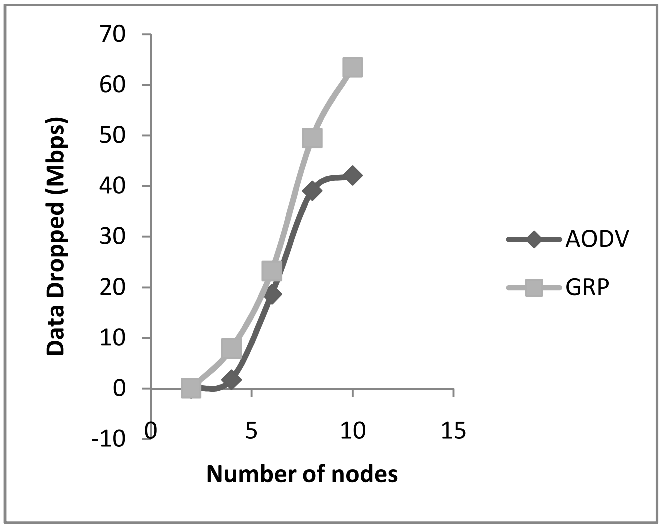


(d) Throughput

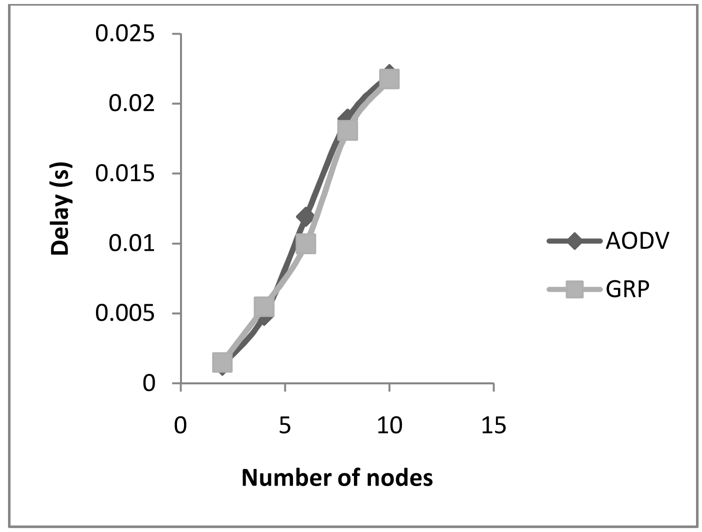
Figure 4: Performance Comparison of AODV and GRP under Buffer Size Varied Setting

4.5 Comparison of AODV and GRP Performance under RTS Setting

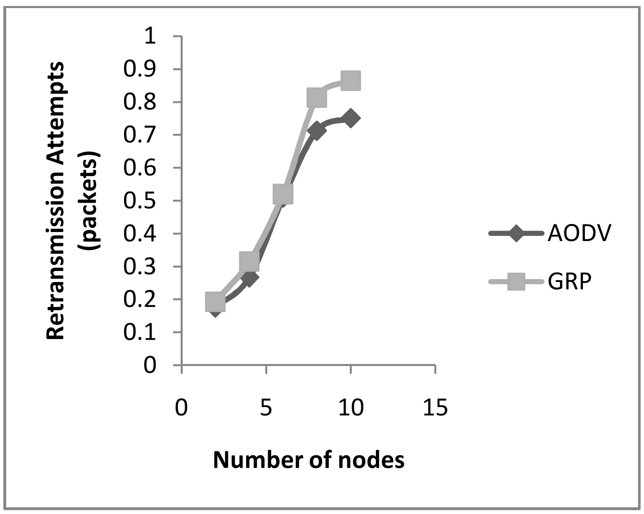
With RTS setting in Figure 5 (a) the MANET suffers more data traffic waste with GRP while the network experiences almost equal delay (Figure 5b) under both AODV and GRP routing protocols. Still the number of retransmission attempts tried by the MANET is higher with GRP routing protocol. When it comes to the throughput as expected AODV excels over GRP routing protocol as attested by Figure 5(d).



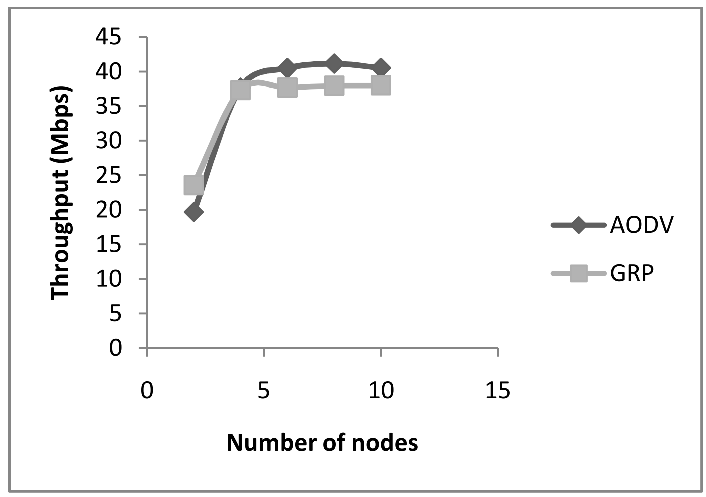
(a) Data Dropped



(b) Delay



(b) Retransmission Attempts



(d) Throughput

Figure 5: Performance Comparison of AODV and GRP under RTS Setting

5.0 Conclusion

We have simulated and analyzed the performance of AODV and GRP MANET routing protocols in IEEE 802.11n under four different settings; default, higher buffer size, RTS mechanism and packet fragmentation settings. The performance metrics employed were; data dropped due to buffer overflow, delay, retransmission attempts and throughput. It is discovered that among the four settings MANETsuffers the shortest delay under RTS mechanism, highest throughput and retransmission attempts under higher buffer size. The MANET recorded worst performance under default and packet fragmentation setting. When the performance metrics of AODV and GRP routing protocols were compared under the four setting it was found that AODV actually out performed GRP routing protocol and both protocols are susceptible to higher nodes' number. Based on our finding for MANET operations, RTS mechanism should be employed for applications that are delay sensitive like video streaming. For reliability-sensitive applications like FTPhigher buffer size should be used. As for the choice of a routing protocol for MANET applications, we recommend AODV routing protocol.

6.0 References

[1] Dowla, F.: Handbook of RF and Wireless Technologies. Elsevier, Inc. (2004).

[2] Sun, J.: Mobile Ad hoc Networking: An Essential Technology for Pervasive Computing.Proceedings of international Conferences on Info-tech and Info-net, vol. 3, pp. 316-321 (2001).

[3] Mohapatar, P., Krishnamurthy, S. V.: Ad hoc Network: Technologies and Protocols. Springer Science + Business Media, Inc. (2005).
[4] Kumar, R., Singh, P.: Performance Analysis of AODV, TORA, OLSR and DSDV Routing Protocols using NS2 Simulation. IJIRSET, vol. 2, issue 8, pp. 3857-3864 (2013).
[5] Singh, H., Kaur, H., Sharma, A., Malhotra, R.: Performance Investigation of Reactive AODV and Hybrid GRP Routing Protocols under Influence of IEEE 802.11n MANET. Fifth International Conference on Advanced Computing & Communication Technologies, pp. 325-328 (2015).
[6] IEEE 802.11n Standard: Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. ANSI/IEEE 802.11 (2009).
[7] Sarkar, S. K., Basavaraju, T. G., Puttamadappa, C.: Ad hoc Mobile Wireless Network: Principles, Protocols, and Applications. Auerbach Publications, Taylor & Francis Group (2008).
[8] Ahn, C. W.: Gathering-Based Routing Protocol in Mobile Ad hoc Networks. Computer Communication, vol. 30, pp. 202-206 (2006).
[9] Jassim, S. I.: Performance Study of AODV, GRP and OSPFv3 MANET Routing Protocols Using OPNET Modeler. Journal of Engineering, vol. 19 (8), pp. 1039-1055 (2013).
[10] Bilandi, N., Verman, H. K., Suryakant.: Comparative Analysis of GRP and TORA Manet Routing Protocols using OPNET. IJARCSSE, vol. 2 (4), pp. 34-37 (2012).
[11] www.riverbed.com (2015): OPNET Modeler. Retrieved on 7th December, 2015 by 8.02PM