Simulation Analysis of New 802.11KT MAC Protocol And IEEE 802.11 MAC Protocol for Grid Topology in MANET Using NS-2

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Abstract— This paper compare the performance analysis of newly designed 802.11KT MAC protocol for a mobile ad-hoc network (MANET) communication system which aims to provide low cost, small end to end delay and more throughputs with the existing IEEE 802.11 MAC protocol. Simulation is the main method for evaluating the performance of protocol. It is subjected to comparison of performance of existing IEEE802.11 Mac protocol and new 802.11KT Mac protocol for random topology in MANET. The Adhoc On Demand Distance Vector (AODV) is used as routing protocol with NS-2 simulator. Simulation results indicated that newly designed 802.11KT MAC protocol has better performance than existing IEEE 802.11 MAC protocol.

Keywords - MANET, AODV,IEEE 802.11, NS-2.

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I. INTRODUCTION

Mobile Ad-hoc Network represents a system of wireless mobile nodes that can freely and dynamically self-organize in to arbitrary and temporary network topologies, allowing people and devices to seamlessly communicate without any pre-existing communication architecture. Every node in the network also acts as a router, forwarding data packets for other nodes. A dominant challenge in the design of ad hoc networks is the development of new MAC protocol that can improve the performance of communicating nodes in MANET. The goal of this paper is to carry out a systematic performance study of a newly designed 802.11 KT MAC protocol and existing IEEE 802.11 MAC protocol for ad hoc networks. The simulation analysis is based on varying packet size of nodes in the Mobile Ad Hoc Network in grid topology. The remaining of the paper is organized as follows: The work contributed in this area is provided in section II. The AODV, 802.11 MAC protocol & 802.11KT MAC protocol description is summarized in section III. The simulation environment and performance metrics are described in Section IV.The simulation results and observation are described in section V and the conclusion is presented in section VI.

II. RELATED WORK

Many researchers have done the qualitative and quantitative analysis of Ad Hoc Routing Protocols by means of different performance metrics. *Rafi U Zamam et.al* [1] studied, simulated & compared the performance of DSDV, AODV and DSR routing protocols for ad hoc networks using NS-2 simulations. In this paper, he has observed that the competitive reactive routing protocols, AODV and DSR, both show better performance than the other in terms of certain metrics. It is very difficult to determine which of them has overall better performance in MANET. *Vahid Garousi et.al* [2] studied an analysis of network traffic in ad-hoc networks based on the DSDV protocol with a thrust on mobility and communication patterns of the nodes. In this paper, the auther observed that simulations measured the ability of DSDV routing protocol to react to multi-hop ad-hoc network topology changes in terms of scene size, mobile nodes movement, number of connections among nodes, and also the amount of data each mobile node transmits. *Das,S.R., Perkins,C.E. et.al* [4] studied, simulated & compared the performance of DSDV, AODV and DSR routing protocols for ad hoc networks using NS-2 simulations. In this paper, the authers observed that DSDV uses the proactive table-driven routing strategy while both AODV and DSR use the reactive on-demand routing strategy. Both AODV and DSR perform better under high mobility simulations than DSDV. The high mobility results in frequent link failures and the overhead involved in updating all the nodes with the new routing information as in DSDV is much more than that involved AODV and DSR, where the routes are created as and when required. *Chao,C-M. et.al [5]* simulated,studied the performance comparison based on packet delivery fraction and normalized routing load.

III. DESCRIPTION OF PROTOCOLS

This section briefly describe the key features of 802.11 protocol, AODV protocol & newly designed 802.11KT MAC protocol that being studied in this paper..

A) IEEE 802.11 Mac Protocol

The main access method in the IEEE 802.11 MAC protocol is DCF, which is based on carrier sense multiple access with collision avoidance (CSMA/CA). Before starting a transmission, every node performs a backoff procedure, with the backoff timer uniformly chosen from [0, CW − 1] in terms of time slots, where CW is the current contention window. When the backoff timer reaches zero, the node transmits a DATA packet. If the receiver successfully receives the packet, it acknowledges the packet by sending an acknowledgment (ACK). If no ACK is received within a specified period, the packet is considered lost; so the transmitter will double the size of CW, choose a new backoff timer, and start the above process again. When the transmission of a packet fails for a maximum number of times, the packet is dropped. To avoid collisions of long packets, the short request to send/clear to send (RTS/CTS) frames can be employed. Note that the IEEE 802.11 MAC also incorporates an optional access method called PCF, which is only usable in infrastructure network configurations and is not supported in most current wireless cards. In addition, it may result in poor performance as shown in [10] and [12].

B) Ad Hoc On-Demand Distance Vector (AODV)

i) Route Discovery Process

During a route discovery process, the source node broadcasts a route query packet to its neighbours. If any of the neighbours has a route to the destination, it replies to the query with a route reply packet; otherwise, the neighbours rebroadcast the route query packet. Finally, some query packets reach to the destination.

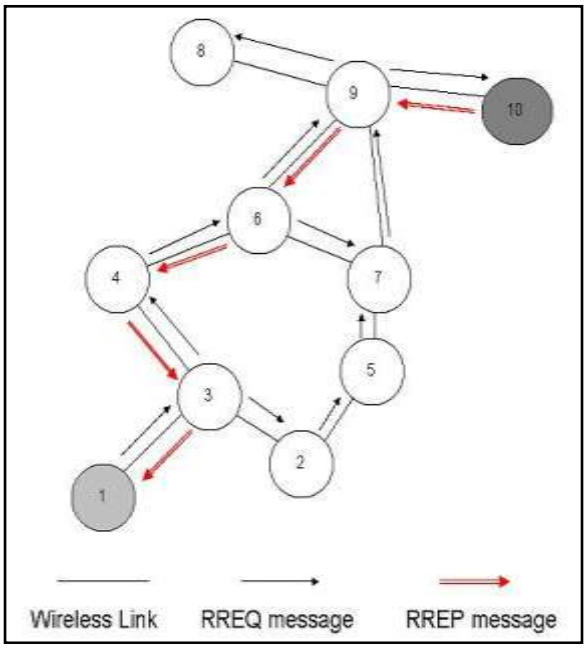

Fig 1. AODV Route Discovery Process

"Fig. 1" shows the route discovery process from source node1 to destination node 10. At that time, a reply packet is produced and transmitted tracing back the route traversed by the query packet as shown in "Fig. 1".

ii)AODV Route Message Generation

The route maintenance process in AODV is very simple. When the link in the path between node 1 and node 10 breaks the upstream node that is affected by the break, in this case node 4 generates and broadcasts a RERR message. The RERR message eventually ends up in source node 1.After receiving the RERR message; node 1 will generate a new RREQ.

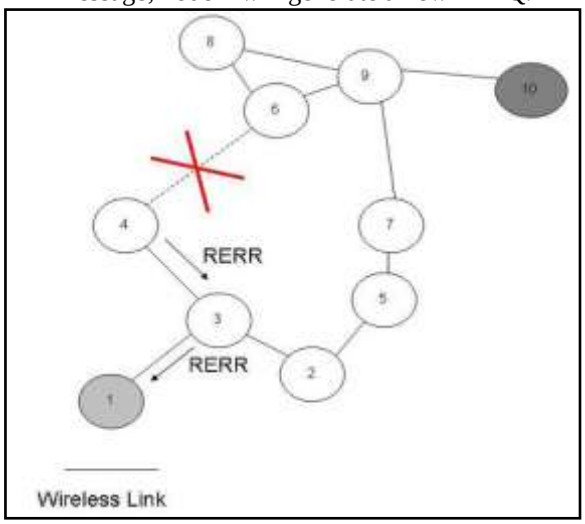

Fig 2. AODV Route Error message generation

iii) AODV Route Maintenance Process

Finally, if node 2 already has a route to node 10, it will generate a RREP message, as indicated in Figure 3.Otherwise, it will re-broadcast the RREQ from source no1 to destination node 10 as shown in "Fig. 3".

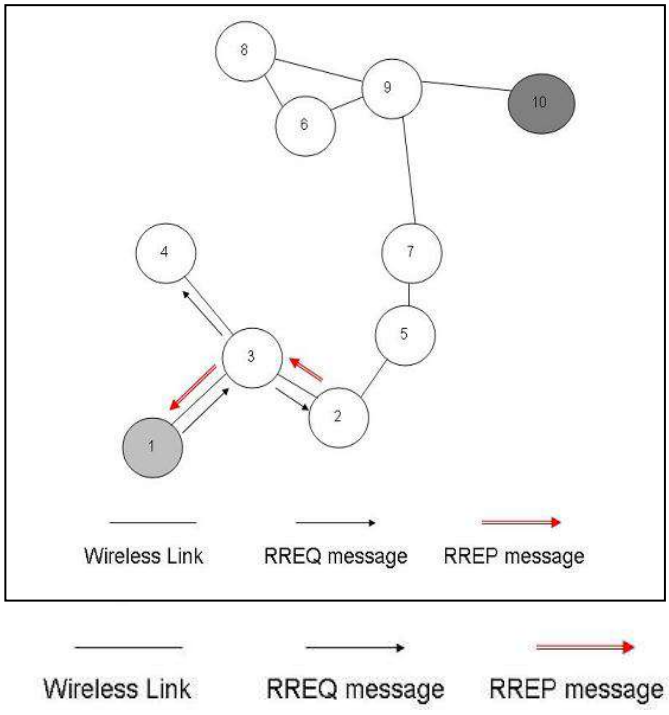

FIG 3. AODV ROUTE MAINTENANCE PROCESS

C) *MAC 802.11KT PROTOCOL*

The new proposed MAC 802.11KT protocol is designed for better RTS/CTS handshake on transmitter (RTS) and receiver (CTS), respectively. This protocol is designed by considering better parameters for various inter frame space, contention window for minimum and maximum size to obtain high system throughput and small end to end delay. This protocol have better security mechanism, power management mechanism, synchronization mechanism, association and reassociation mechanism of nodes with access point. It also have better management information base required for network management purpose for external entities. The main goals is to obtain the maximum throughput, less numbers of data packets dropped, high packet delivery ratio and small end to end delay by the 802.11KT protocol as compared to that of the conventional 802.11 system. Simulation evaluation of the proposed analysis framework indicates that the newly designed 802.11KT MAC protocol system can provide a significant increase in throughput and decrease in end to end delay for any type of topology in MANET.

IV SIMULATION ENVIRONMENT

A) Simulation Model

This section have given the emphasis for the simulation of performance of IEEE 802.11 MAC protocol and 802.11KT MAC protocol with AODV as routing protocol varying packet size of mobile nodes. The simulations have been performed using Network Simulator NS-2 [12]. The NS-2 is discrete event simulation software for network simulations which means it simulates events such as sending, receiving, forwarding and dropping packets. The latest version, ns-allinone-2.34, supports simulation for routing protocols for ad hoc wireless networks such as AODV, TORA, DSDV, and DSR. Ns-2 is written in C++ programming language and Object Tool Common Language (OTCL). Although ns-2.34 can be built on various platforms, we chose a Linux platform [FEDORA 7] for this paper, as Linux offers a number of programming development tools that can be used along with the simulation process. To run a simulation with ns-2.34, I have written the simulation script in OTCL, got the simulation results in an output trace file. The performance metrics are calculated using AWK file and the results are graphically visualized. NS-2 also offers a visual representation of the simulated network by tracing nodes movements and events and writing them in a network animator (NAM) file.

B) Simulation Parameters

The paper have consider a ad-hoc network in grid topology composed of 36 nodes situated in a square forming 6 rows and 6 columns within a 1000m X 1000m area Each node is separated 200 meters from its neighbours. The transmission range is 250m for each node. This is a static scenario where the nodes have no mobility. The performances of IEEE 802.11 MAC and 802.11KT MAC are simulated and evaluated by varying the network data payload and keeping the mobility of mobile Ad-hoc nodes constants. The traffic type used is Constant Bit Rate with packet rate of 4 packet/sec and data packet size is varied from 500 to 3000 bytes/ packets. The total simulation time is 150 seconds. Table 1 shows the simulation parameters used in this evaluation.

TABLE 1
PARAMETERS VALUES FOR SIMULATION

Simulation Parameters	
Simulator	ns-2.34
MAC Protocols	802.11,802.11KT
Simulation duration	150 seconds
Simulation area	1000 m x 1000 m
Number of nodes	6x6
Transmission range	250 m
Movement model	Grid topology
Routing Protocol	AODV
Data Packet size in bytes/packets	500,1000,1500.2000.2500.3000
Packet rate	4 packets/sec
Traffic type	CBR (UDP)
Data payload	512 bytes/packet

C. Performance Metrics

The performance of IEEE 802.11 MAC and 802.11KT MAC protocol are done based on the data packet size of the ad-hoc node. The perform matrices consists of parameters like Total packets generated, Packets dropped, Packets Delivery ratio & Average End to End delay,.

V.SIMULATION RESULTS & OBESRVATION

The simulation results are shown in the following section in the form of line graphs. The performance of IEEE 802.11 MAC and 802.11KT MAC protocol are done based on the data packet size of the node. The perform matrix consists of parameters like Total packets generated, Packets dropped, Packets Delivery ratio & Average End to End delay,. “Fig. 4” shows the creation of 6x6 numbers of mobile nodes in grid topology. “Fig.5” highlights the Ad-hoc mobile nodes with the data packet size of 500 bytes/packet. It is observed that the source node communicating with other nodes.

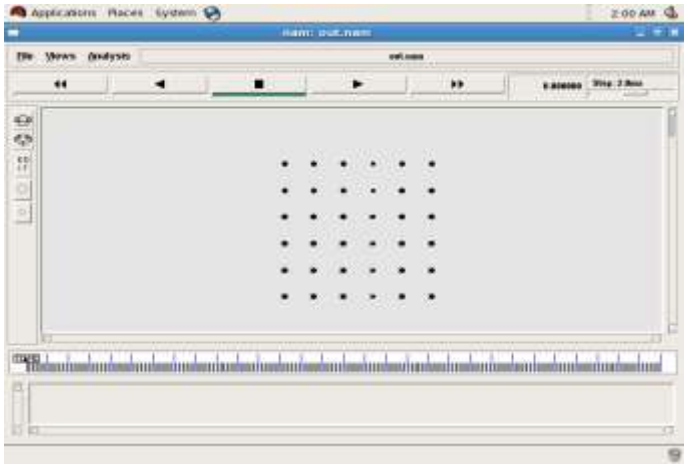

Fig 4. : 6x6 no. of nodes in Grid Topology

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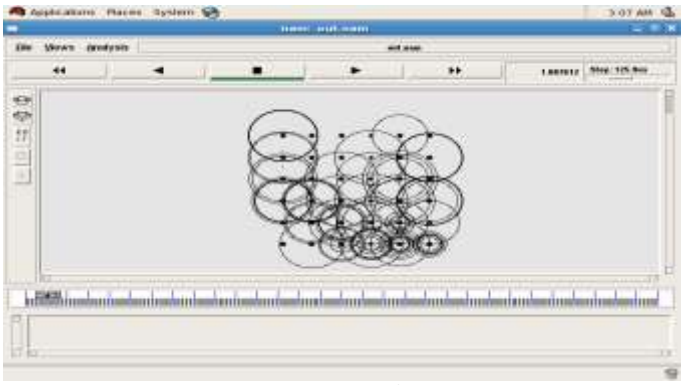

Fig 5. Nodes with packet size of 500 bytes/packet

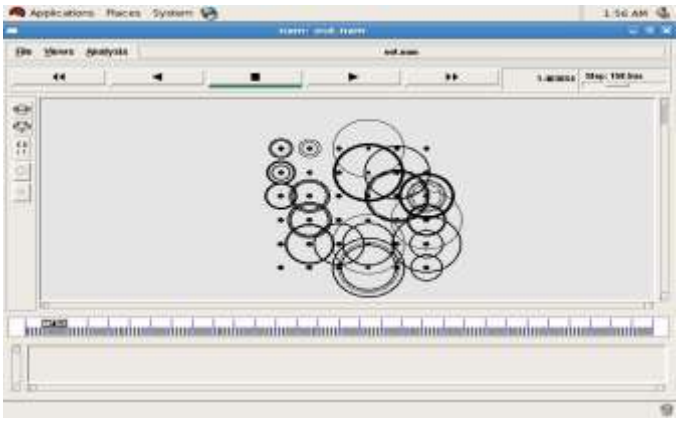

Fig 6. Nodes with packet size of 1000 bytes/packet

"Fig. 6" highlights communication of ad-hoc mobile nodes with data packet size of 1000 bytes/packet from the source node. Nodes are communicating with each other with good synchronization between them

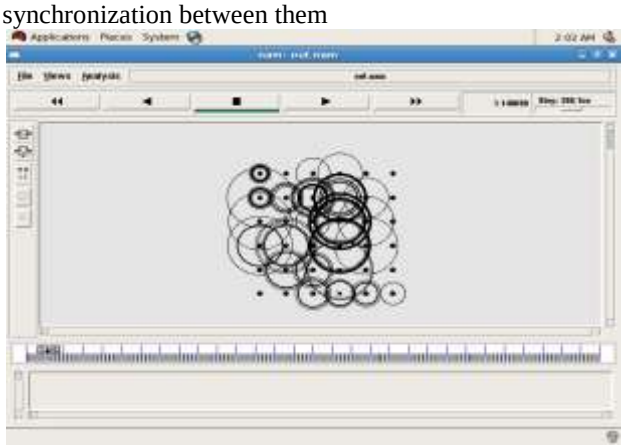

Fig 7 Nodes with packet size of 1500 bytes/packet

"Fig 7" illustrates data packet communication between ad-hoc nodes at data packet size of 1500 byte/packet in ad-hoc network area. "Fig.8 and Fig.9" highlights the data packet of movement between ad-hoc nodes with data packet size of 2000 bytes/packets and 2500 bytes/packet respectively. "Fig.10" illustrates the communication of data packet amongst various ad-hoc nodes with a data packet size of 3000 bytes/packet.

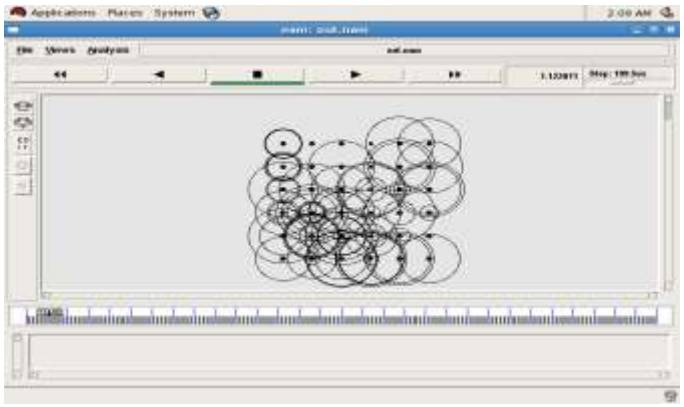

Fig 8. Nodes with packet size of 2000 bytes/packet

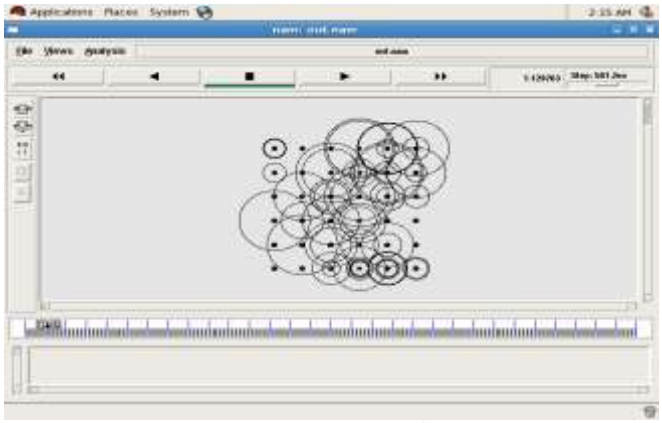

Fig.9. Nodes with packet size of 2500 bytes/packet

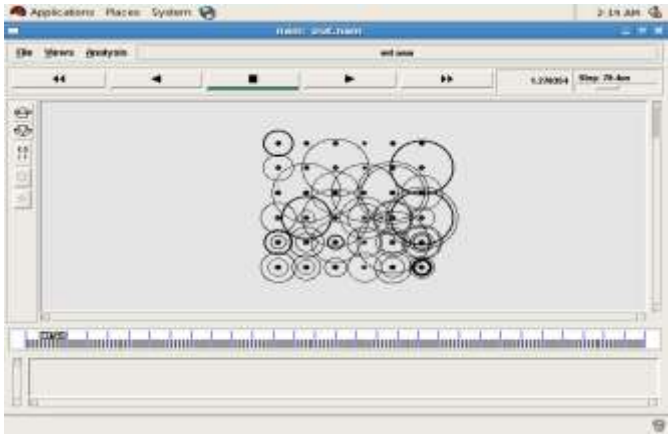

Fig. 10. Nodes with packet size of 3000 bytes/packet

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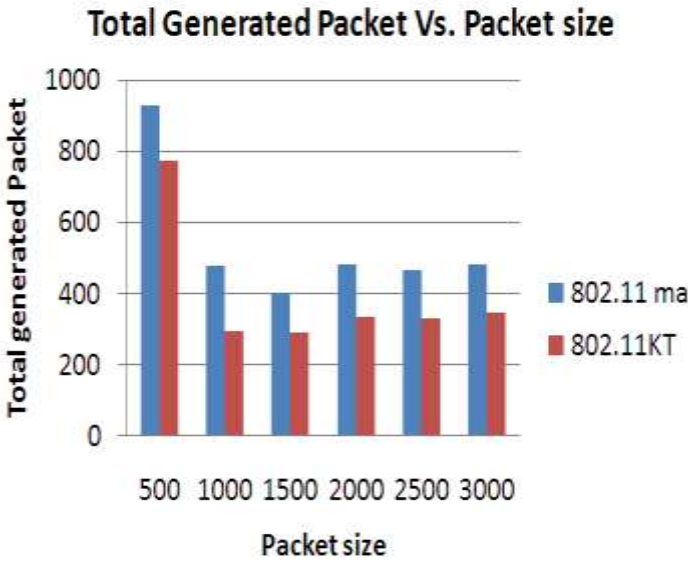

Fig 11.Total Generated Packets vs. Packet size

"Fig. 11" highlights the relative performances of IEEE 802.11 MAC protocol and 802.11KT MAC protocol for Generated Packets with varying packet size of nodes. These graphics show in the vertical axis the Total generated packets for IEEE 802.11MAC protocol (Blue column) and for the proposed MAC 802.11KT protocol (Red column).The horizontal axis show the packet size of nodes. It is observed that data packet required to transfer information from source to destination is small for 802.11KT MAC protocol than IEEE 802.11 MAC protocol. This saves considerable amount of transmitter power. The proposed MAC 802.11KT protocol need approximately 15% less total generated packet to carry information than existing IEEE 802.11 MAC protocol.

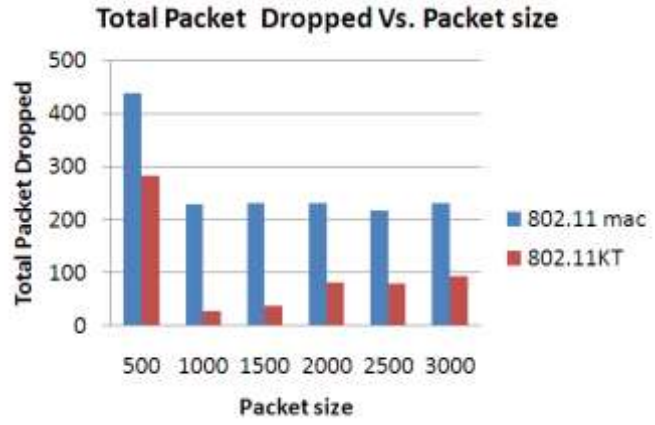

Fig 12. Total Dropped Packets Vs. Packet size

Fig.12 highlights the relative performance of IEEE 802.11 MAC protocols and 802.11KT MAC protocol for Total Dropped Packet with varying packet size of nodes. These graphics show in the vertical axis the Total packets Dropped for IEEE 802.11MAC protocol (Blue column) and for the proposed MAC 802.11KT protocol (Red column).The horizontal axis show the mobility of nodes. It is observed that due to proper beacon interval of proposed MAC 802.11KT protocol, it provides better synchronization between nodes than IEEE 802.11 MAC. Therefore, data packets drop is small for proposed MAC 802.11KT protocol than IEEE802.11 protocol. This helps in providing better redundancy of information transmission between nodes of ad-hoc network area and maximum information is communicated between nodes. The proposed MAC 802.11KT protocol has approximately 20% to 80% fewer packets dropped than the existing IEEE 802.11 protocol.

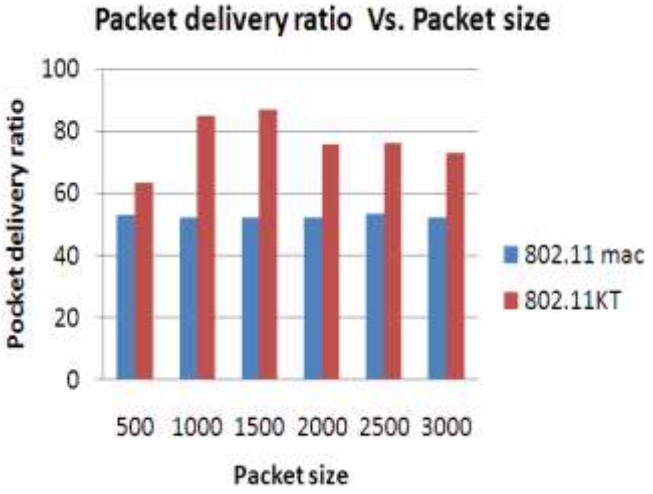

Fig.13. Packet Delivery Ratio Vs. Packet size

Fig.13 highlights the relative performance of IEEE 802.11 MAC protocol and 802.11KT MAC protocol for Packet Delivery Ratio with packet size of nodes. These graphics show in the vertical axis the Packets Delivery Ratio for IEEE 802.11MAC protocol (Blue column) and for the proposed MAC 802.11KT protocol (Red column).The horizontal axis show the packet size of nodes. It is observed that due to implementation of proposed 1.5 TDDI backoff algorithms, the data packet collision is less for proposed MAC 802.11KT protocol than existing IEEE 802.11 protocol. The data packet drop due to collision is small for proposed MAC 802.11KT protocol than IEEE 802.11 protocol. Hence proposed protocol has more Packet Delivery Ratio than existing protocol. The proposed MAC 802.11KT protocol have approximately 20% to 40% more packet delivery ratio than the IEEE 802.11 MAC protocol.

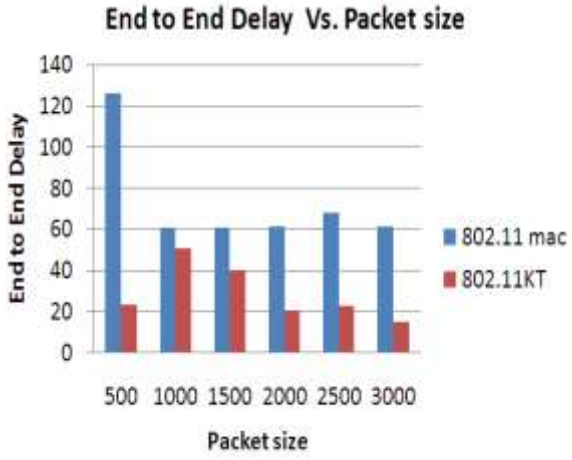

Fig.14. End to End delay Vs. Packet size

Fig.14 highlights the relative performance of 802.11KT protocol and IEEE 802.11 MAC protocol for Average End To End delay with packet size of nodes. These graphics show in the vertical axis the End to End Delay for IEEE 802.11MAC protocol (Blue column) and for the proposed MAC 802.11KT protocol (Red column).The horizontal axis show the packet size of nodes. It is observed that due to implementation of proposed small duration frame format of RTS and CTS control fields in proposed MAC 802.11KT protocol, the End to End Delay for data packet communication between nodes is small for proposed protocol than the existing IEEE 802.11 Mac protocol. The proposed MAC 802.11KT protocol has approximately 40% to 80% small end to end delay than the IEEE 802.11 MAC protocol.

VI. CONCLUSION

The work presented in this paper gave an overview of relative performance comparison of available IEEE 802.11 MAC protocol and 802.11KT MAC protocol in grid topology. Simulation performance shows that 802.11KT MAC protocol have better performance than IEEE 802.11 MAC in terms of Total Data Packets generated, Total Packet Dropped, Packet Delivery Ratio and End to End delay parameters with packet size of node. It is also indicate that 802.11KT MAC protocol have better synchronization mechanism, efficient link layer recovery mechanism, less numbers of collision and less inter link interference than IEEE 802.11 MAC. This paper shows that the newly designed MAC 802.11KT protocol outperforms IEEE 802.11 MAC protocol in grid topology. Therefore this protocol is more suitable as small delay and low cost wireless network protocol for ad-hoc network. The dominant cost of constructing a wireless ad-hoc network based on proposed 802.11KT MAC protocol will be less to provide better wireless services for ad-hoc network.

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