

## Evaluation Of Low Cost Wireless Network Protocol For Rural Villages Based On 802.11KT MAC Protocol

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### Abstract

802.11KT MAC protocol is a modified wireless network protocol independent on topology of nodes that aims to provide low-cost broadband wireless network for rural regions. Nodes in this protocol communicate using long-distance point to-point wireless links that are established using antenna. For the rural areas like villages, 802.11 MAC protocol plays a important role for networking because of its cost, which is very low as compared to the other networking. Moreover the MAC protocol provides higher rate of data transfer. This paper is subjected to comprehensive performance analysis between IEEE 802.11 MAC protocol and our modified MAC 802.11KT protocol with AODV routing protocol in random topology using Network Simulator-2(NS-2). Various important performance metric such as Total packet generated, Total packet received Total dropped packets, Average end to end delay, Packet Delivery Ratio Vs. Mobility of node are investigated. Protocols are simulated using NS-2 simulator. It is observed that modified MAC 802.11KT protocol outperform IEEE 802.11 MAC protocol and it is suitable as low cost wireless network protocol for rural villages.

**Keywords** - AODV,, IEEE 802.11, NS-2 Simulation.

### INTRODUCTION

Rural networks exist in population areas with very low paying capacity. Hence a very important requirement for these networks is to minimize the infrastructure costs. The cost of laying wire to rural areas is prohibitively expensive and this is also true of traditional wide area wireless technologies such as cellular networks and upcoming technologies like IEEE 802.16 Wi-Max. Recent technologies has demonstrated an alternative approach by building rural wireless network prototypes using IEEE 802.11 equipment. IEEE 802.11 equipment is highly commoditized and goes a long way. We have consider the principal of mobile ad-hoc network for all types of topology. A Mobile Ad hoc Networks represents a system of wireless mobile nodes that can freely and dynamically self-organize into arbitrary and

temporary network topologies, allowing people and devices to seamlessly communicate without any pre-existing communication architecture. Each node in the network also acts as a router, forwarding data packets for other nodes. A central challenge in the design of ad hoc networks is the development of dynamic routing protocols that can efficiently find routes between two communicating nodes. The goal is to carry out a systematic performance & comparative study of 802.11 MAC & our modified MAC protocol i.e.802.11KT protocol for Random scenario topology for ad hoc networks in rural villages. Moreover performance analysis & comparative study is based on varying mobility of nodes in the Mobile Ad Hoc Network in Random topology within area of rural village. The rest 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.

### RELATED WORK

A Several researchers have done the qualitative and quantitative analysis of Ad Hoc Routing Protocols by means of different performance metrics. They have used different simulators for this purpose. Rafi U Zamam *et.al* [1] studied & compared the performance of DSDV, AODV and DSR routing protocols for ad hoc networks using NS-2 simulations. In this paper, author observed that the competitive reactive routing protocols, AODV and DSR, both show better performance than the other in terms of certain metrics. It is still 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 an emphasis on mobility and communication patterns of the nodes. In this paper, he 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 & compared the performance of DSDV, AODV and DSR routing protocols for ad hoc networks using NS-2 simulations. In this paper, they 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. 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 in AODV and DSR, where the routes are created as and when required. Chao, C-M. et.al [5] studied the performance comparison based on packet delivery fraction and normalized routing load. In the future, extensive complex simulations could be carried out to gain a more in-depth performance analysis of the ad hoc routing protocols. This would include delay of data packet delivery and performance comparison on location-based ad hoc routing protocols.

## DESCRIPTION OF THE PROTOCOLS

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

### A) IEEE 802.11 Mac Protocol

The basic 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, each 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 [24] and [27].

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

AODV is a distance vector type routing. It does not require nodes to maintain routes to destination that are not actively used. As long as the endpoints of a communication connection have valid

routes to each other, AODV does not play a role. Same as DSR, the Protocol is also composed of route discovery and route maintenance. The protocol uses different messages to discover and maintain links such as ROUTE REQUEST, ROUTE REPLY and ROUTE ERROR. This message types are received via UDP, and normal IP header processing applies. AODV uses a destination sequence number for each route entry. The destination sequence number is created by the destination for any route information it sends to requesting nodes. Using destination sequence numbers ensures loop freedom and allows knowing which of several routes is fresher. Given the choice between two routes to a destination, a requesting node always selects the one with the greatest sequence number. When a node wants to find a route to another one, it broadcast a ROUTE REQUEST to all nodes in the network until either the destination is reached or another node is found with a fresh enough route to the destination.

Fresh enough route is a valid route entry for the destination whose associated sequence number is at least as great as that contained in the ROUTE REQUEST. Then a ROUTE REPLY is sent back to the source and the discovered route is made available. For route maintenance, nodes that are part of an active route may offer connectivity information by broadcasting periodically local Hello messages (special ROUTE REPLY message) to its immediate neighbors. If Hello messages stop arriving from a neighbor beyond some given time threshold, the connection is assumed to be lost. When a node detects that a route to a neighbor node is not valid it removes the routing entry and sends a ROUTE ERROR message to neighbors that are active and use the route. This is possible by maintaining active neighbors lists. This procedure is repeated at nodes that receive ROUTE ERROR messages. A source that receives a ROUTE ERROR can reinitiate a ROUTE REQUEST message.

### C) MAC 802.11KT protocol

The MAC 802.11KT protocol modifies the IEEE 802.11 RTS/CTS handshake on transmitter (RTS) and receiver (CTS), respectively. This protocol modifies IEEE 802.11 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 modifies the security mechanism, power management mechanism, synchronization mechanism, association and reassociation mechanism of nodes with access point. It also modifies management information base required for network management purpose for external entities. Our 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. Numerical evaluation of the proposed analysis framework indicates that the 802.11KT protocol

system can provide a significant increase in throughput and decrease in end to end delay for any type of topology in MANET. Hence it is very much suitable as low cost wireless protocol in rural villages for communication.

## 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 the mobility of mobile nodes. The simulations have been performed using network simulator NS-2 [12]. The network simulator 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, we 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 result 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

We consider a network of nodes placing within a 2200m X 500m area. The performances of IEEE 802.11 MAC and 802.11KT MAC are evaluated by keeping the network payload constant and varying the mobility of mobile nodes. Table 1 shows the simulation parameters used in this valuation.

TABLE 1  
PARAMETERS VALUES FOR SIMULATION

Simulation Parameters	
Simulator	ns-2.34
MAC Protocols	802.11,802.11KT
Simulation duration	150 seconds
Simulation area	2200 m x 500 m
Number of nodes	50
Transmission range	250 m
Movement model	Random topology
Routing Protocol	AODV
Maximum speed	5,10,15,20,25,30m/s
Packet rate	4 packets/sec
Traffic type	CBR (UDP)
Data payload	512 bytes/packet

### C. Performance Metrics

While analysing IEEE 802.11 MAC protocol and 802.11KT MAC with random topology, we focused on performance metrics such as Generated Packets vs. No. of nodes, Received Packets Vs. no. of nodes, Packet delivery ratio Vs. no. of nodes, Total dropped packets Vs. no. of nodes, Average end to end delay Vs. No. of nodes.

## SIMULATION RESULTS & OBSERVATION

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 mobility of the node. The perform matrix consists of parameters like Total packets generated, Packets dropped, Packets Delivery ratio & Average End to End delay,. "Fig. 2" shows the creation of 50 numbers of mobile nodes in rural village in random topology. "Fig.3" highlights the movement of nodes in the rural village with the mobility of 5 m/s. It is observed that the nodes are communicating with each other. There is best synchronisation between nodes.

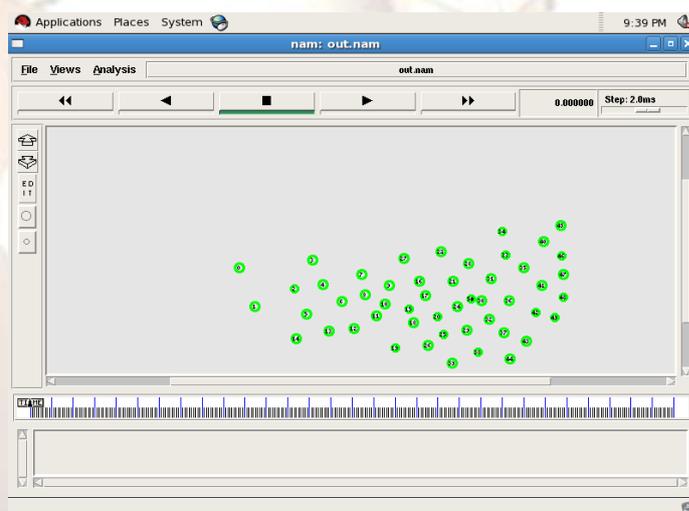


Fig 2. 50 numbers of nodes in rural village in random Topology

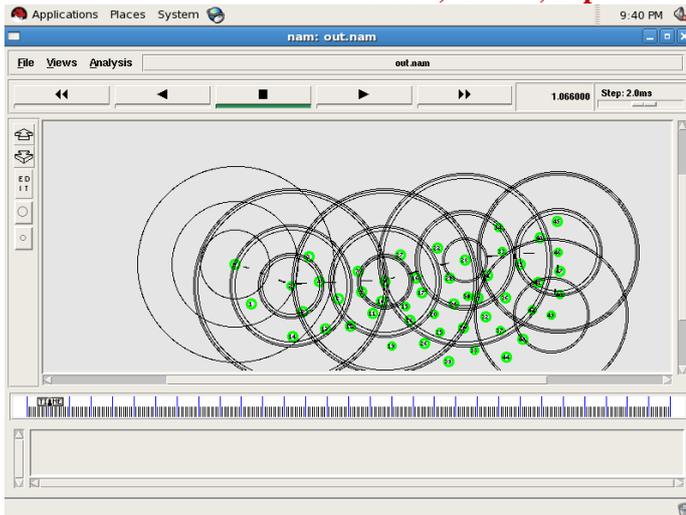


Fig 3. Mobility of nodes with 5 m/s

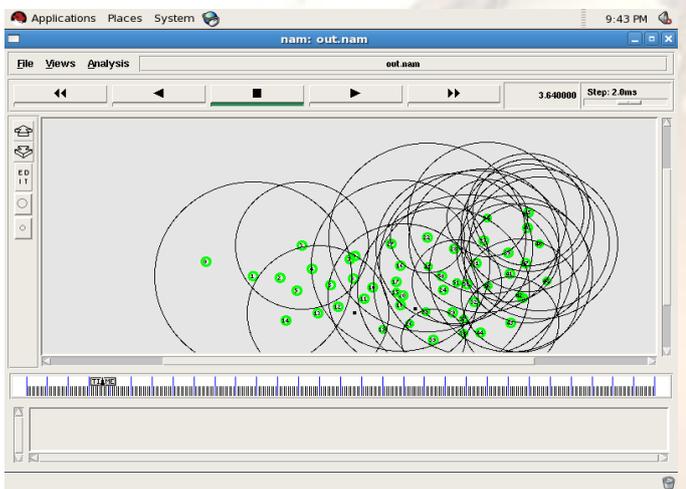


Fig 4. Mobility of nodes with 10 m/s

“Fig. 4” highlights movement of nodes with mobility of 10 m/s in rural village .Nodes are aligning at new position with better communication between them.

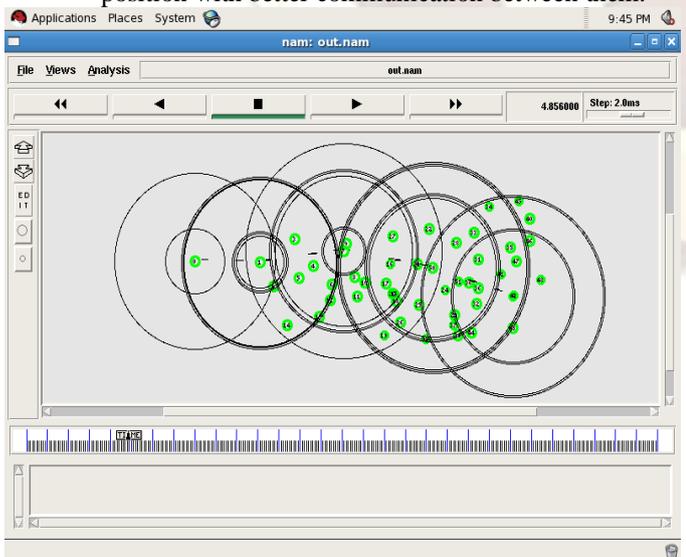


Fig 5. Mobility of nodes with 15 m/s

“Fig.5” illustrate data packet communication between nodes at mobility at 15 m/s in rural village area. It represent that at this mobility, nodes are maintaining synchronisation between them. “Fig.6” highlights movement of mobile nodes with mobility of 20 m/s rural area. It illustrate that at high mobility, nodes are changing their position with proper coordination between them. There is a perfect synchronisation and communication between them. “Fig. 7” illustrate the position of various node reached with a mobility of 25 m/s. It highlights those nodes able to communicate with each other with minimum data packets dropped.

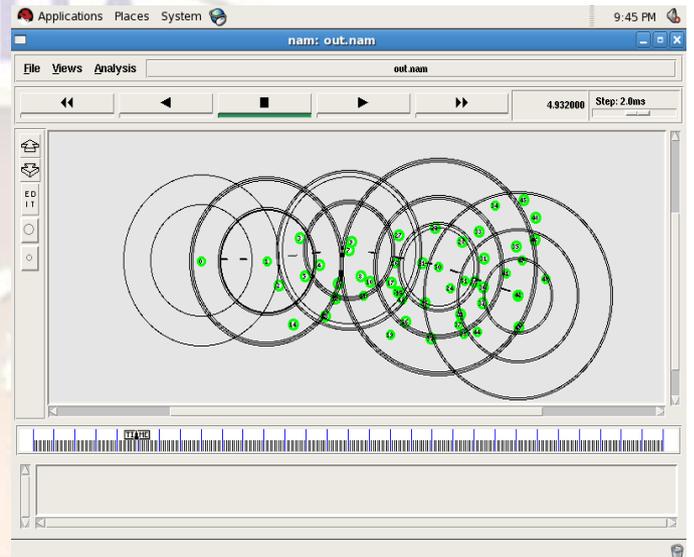


Fig 6. Mobility of nodes with 20 m/s

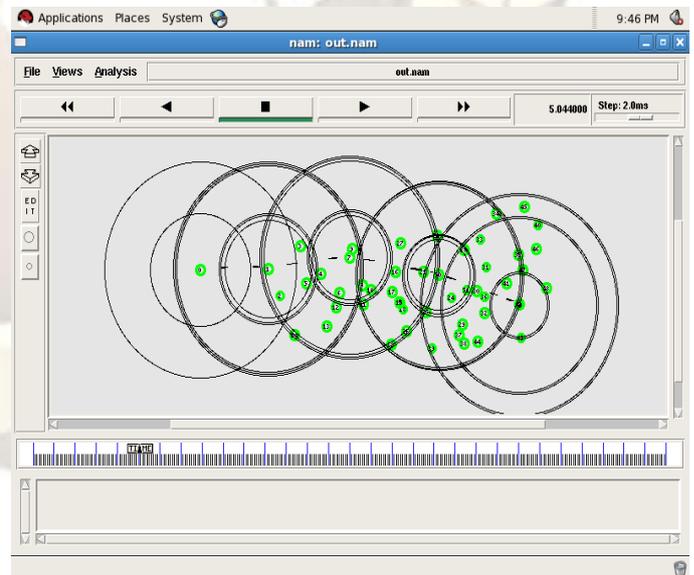


Fig. 7. Mobility of nodes with 25 m/s

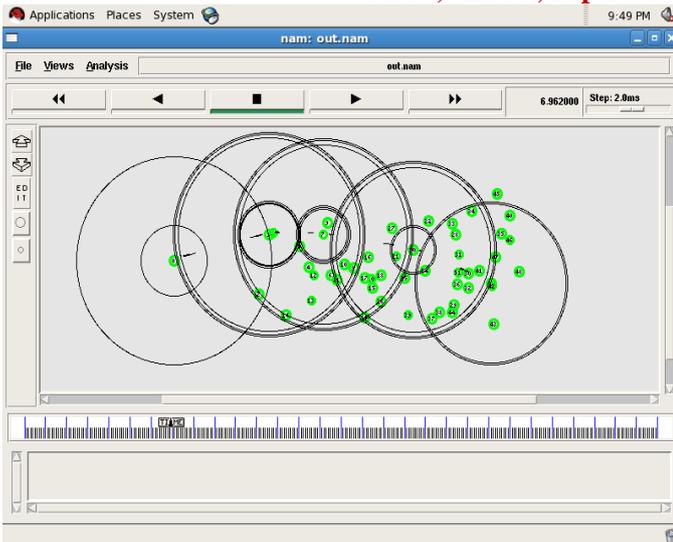


Fig. 8. Mobility of nodes with 30 m/s

“Fig. 8” illustrates the final position of location of 50 nodes in rural village area with a mobility movement of 30 m/s. At such high mobility (approximately 90 Km/hr.), mobile nodes are maintaining proper synchronisation with minimum numbers of data packet dropped, minimum end to end delay and high packet delivery ratio i.e. high throughput.

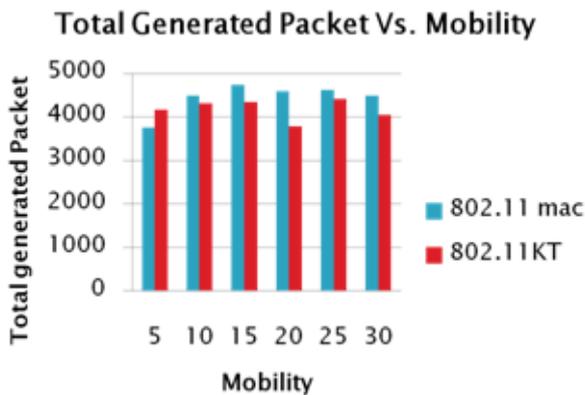


Fig 9.Total Generated Packets vs. Mobility

“Fig. 9” highlights the relative performances of IEEE 802.11 MAC protocol and 802.11KT MAC protocol for Generated Packets with varying mobility of nodes. From figure 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 power of transmitter.

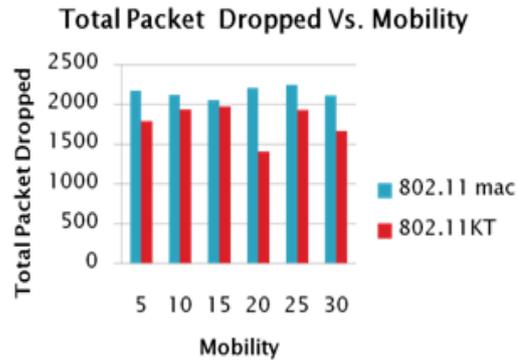


Fig 10. Total Dropped Packets Vs. Mobility

Fig.10 highlights the relative performance of IEEE 802.11 MAC protocols and 802.11KT MAC protocol for Total Dropped Packet with mobility of nodes. From figure it is observed that 802.11KT MAC protocol provides better synchronisation between nodes than IEEE 802.11 MAC. Therefore, there is less numbers of data packet loss for 802.11KT MAC protocol. This helps in providing better redundancy of information transmission between nodes of rural village area and complete information is communicated between them. Fig.11 highlights the relative performance of IEEE 802.11 MAC protocol and 802.11KT MAC protocol for Packet Delivery Ratio with mobility of nodes. From figure it is observed that 802.11KT protocol have better performance over IEEE 802.11 MAC protocols in term of Packet Delivery Ratio. 802.11KT MAC protocol have better synchronisation between nodes, dropped less number of data packets and delivered more data packets to the destination than IEEE 802.11 MAC protocols.Hence,802.11KT protocol have more throughput of system network than IEEE 802.11 MAC protocol.

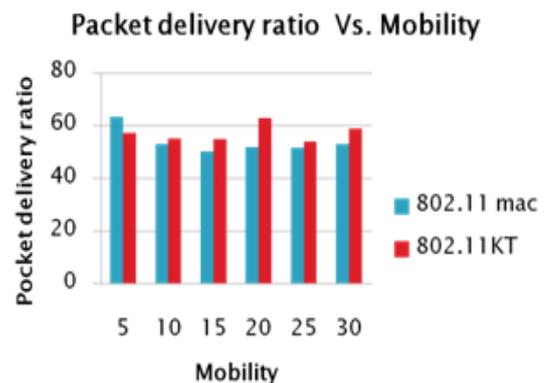


Fig.11. Packet Delivery Ratio Vs. numbers of nodes

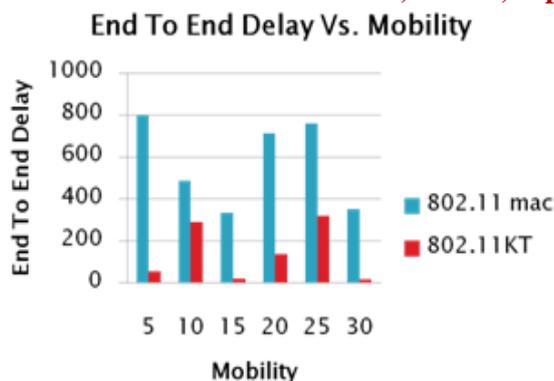


Fig.12. End to End delay Vs. Mobility

Fig.12 highlights the relative performance of 802.11KT protocol and IEEE 802.11 MAC protocol for Average End To End delay with mobility of nodes. From figure it is observed that 802.11KT MAC protocol have better performance over IEEE 802.11 MAC protocol in terms of Average End To End delay. Beacon frame of 802.11KT MAC protocol provides efficient synchronization than IEEE 802.11 MAC between nodes. This result in better data transfer with minimum time required and improves the end to end delay.

## 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 for rural village area in random topology. Simulation performance analysis indicate 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 mobility of node. 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. Therefore the dominant cost of constructing a wireless network based on 802.11KT MAC protocol will be less to provide better wireless services to rural villages to enhance communication of rural areas.

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