UDP And TCP Based Performance Analysis of EPLAODV Routing Protocol In Disastrous Situation

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ABSTRACT

In the occurrence of disaster the telecommunication infrastructure usually collapses badly, and do not provide telecommunication services among the users. In such emergency situation, the responders first deploy MANET ad hoc network to launch rescue and relief operation in order to reduce property losses and save disaster victims. In this paper, the EPLAODV, energy efficient and link aware routing protocol is designed and implemented in NS-2 environment to meet during the emergency situation and improves the network lifetime. Furthermore, this study focuses to evaluate the performance of UDP and TCP protocols under AODV and EPLAODV routing protocols. Many emergency related scenarios are designed and simulated in NS-2 simulator software. PDR, End-to-End Delay and energy consumption are the main performance metrics. The simulated results show that the TCP agent produces better results than UDP under the EPLAODV and AODV in the disastrous situations.

.Keywords-; AODV; EPLAODV; TCP; UDP; DISASTER; ENERGY EFFICIENT

I. INTRODUCTION

A MANET routing protocol plays an important role in the forwarding of data packets to the destination. A MANET supports both the reactive and proactive routing protocols. The reactive routing protocols have less overhead whereas the proactive routing protocols have less latency [1]. A well designed reactive routing protocol reduces packet loss and sends more number of data packets to the destination, which significantly improves the performance of the network. The energy efficient routing protocols are designed for the energy conservation because MANET has a limited battery constrained. The inefficient or dead nodes are eliminated from the route, which may cause the network interruption. The energy efficient MANET routing protocol selects energy efficient routes during the route setup process, which helps to maximize network life time. The energy efficient routing protocols have a great importance in the disastrous situation, where critical or emergency related information requires less energy consumption with more data rate [2]. In the disaster situations, a rescue and relief operation is carried out on the basis of information which is provided by the first responders. The rescue workers such as policemen, medical staff, fire fighters, ambulance drivers, journalist, heavy machine operators and skilled supervisors are rushed to disaster site and working as a virtual team to start evacuation process and provide first aid , food, drinking water and shelters to the victims of the disaster [3]. In such emergency situation a decentralized mobile ad-hoc network may easily be deployed at the disaster site in order to carry out relief and rescue operations, which will help to rescue disaster victims and minimize telecommunication infrastructure losses. In rescue and relief operations a robust, reactive and energy efficient routing protocol is used to share maximum emergency related information amongst first responders and their supervisors. The reactive routing protocols support sharing of critical and non-critical information such as voice, video, WhatsApp and textual information [4]. The AODV is implemented in emergency situation due to its node mobility and dynamic network topology, where mobile nodes of the network move within the transmission range and may leave from the network without any prior information [5].

AODV is a reactive routing protocol which discovers feasible routes when demanded. The source node discovers new routes, if the route to the destination is not found, the current route becomes the failure or the existing route to the destination has expired [6]. In the route discovery phase AODV sends two control packets: RREQ and RREP to establish a new feasible route, whereas in the route maintenance phase, AODV broadcasts RERR and HELLO packets to check the status and neighborhood of the nodes. For the forwarding of data packets, source node broadcasts RREQ control packet to the one hop neighbors. The neighbor nodes act as the router and rebroadcast RREQ control packets to their one hop neighbor, until the RREQ control packet arrives at its destination. This process is repeated continuously. The destination node unicasts RREP control packet to their neighbor nodes. The neighbor nodes further unicast RREP control packets to their upstream neighbors until the RREP control packet arrives at source. This process is also repeated continuously. The AODV routing protocol supports both the TCP and UDP protocols. The SYN-ACK method is used by the TCP protocol to create a network connection. UDP is seen as an unreliable in successful data delivery [7]. The remaining paper consists of the following sections: Section 2 gives an overview of the related work. Section 3 discusses the proposed disaster response communication framework. Section 4 presents the simulations and results and Section 5 conclusion the paper and suggests future recommendations.

II. RELATED WORK

Sakano et al. [8] developed movable and deployable rescue unit (MDRU). They introduced a van type movable unit which deployed easily at the disaster site for rescue and relief operations. During the natural disaster the telecommunication services were not responding, and making disaster response extremely difficult. In such critical situation, the MDRU plays an important role in the evacuation of disaster victims and ensure their safety and seek assistance. The van type recovery unit carries all possible equipment to initiate response and recovery operation at the disaster site in order to save lives of people and reduce infrastructure losses. In [9] authors proposed SAFIRE architecture, and focused on reliable and robust telecommunication services for the exchange of emergency related information among the first responders. To save lives and property, disaster relief activities must be mobilized quickly. A dependable communication infrastructure is essential for disaster response teams for an effective coordination and communicates. Existing disaster response options are insufficient due to interoperability issues and lack of flexibility. They proposed a decentralized architecture with cognitive radio-based communication which improved performance and enhanced usability among the first responders. The GeoBIPS was proposed in [10]. The authors introduced crisis management system architecture which collected emergency related information quickly in the disastrous situation. The first responders combined both static and dynamic type information at the disaster site. GeoBIPS used wireless mesh network, which enabled telecommunication services in critical situations. The first responders made decisions based on the information in order to save lives of people. The GeoBIPS was evaluated and implemented by firemen at simulated fire house. Channa et al. [11] proposed reliable routing scheme for post-disaster communication network. In the suggested scheme, the authors provided a trustworthy routing method that chose the shortest routes through all trustworthy nodes. The suggested method also detected packet forwarding problems brought on by network issues or traffic jams on an active route and rerouted packets to a more dependable path. The performance of the proposed strategy was evaluated by extensive simulations in terms of packet delivery ratio, end-to-end delay, and routing overhead. In [12] authors proposed a public safety communication network. The authors focused on how wireless mesh networks (WMN) can be used for communication in public safety and crisis management. WMNs are a potentially useful technology for a variety of applications because to their quick deployment, ease of self-configuration, and capacity to provide wireless broadband access at a reduced cost. In [13] geospatial framework is designed for the smart cities. The suggested framework made it easier to comprehend and manage crises. This study focused on the smart cities, which helps to reduce property losses due to the disaster. The majority of people in this developed era reside in cities, and the population of cities is growing. Population variations during an emergency situation raise the danger of losses, including those to people, property, and the environment. In many developing countries, the trend of smart cities is growing quickly. To fulfil the goals of smart cities, the infrastructure of cities is being modified. In [14] EMAODV routing algorithm was proposed based on AODV. The automatic update technique introduced by the authors updated the information of other nodes as the route was being set up. The transmission time of messages was decreased via algorithms. In order to maximize battery life, the suggested method introduced a new field power dissipation factor (PDF). The PDF is diminished to establish feasible routes from source to destination throughout the route setup process, a node with the lowest routing cost is chosen. In [15] authors proposed energy efficient routing scheme PEER which discovered the routes quickly. The proposed analytical model tracked the energy consumption. The PEER routing algorithm was used to select the energy efficient route quickly and maintain topological changes during route setup process. The PEER routing protocol improved the performance by reducing routing overhead, delay and energy consumption during route setup process. A priority based routing scheme P-AODV [16] introduced a new priority based field. There are different mobile nodes for high priority and low priority communications. The neighbour table and Hello packets both provide information about the priority. During the route-setting setup, the high priority nodes were chosen. To reduce re-route discovery and avoid the flooding of control packets, a controlled re-route discovery approach was introduced. In [17] authors proposed energy efficient routing algorithm EAODV. During the route setup process, the algorithm considered low node mobility and restricted node energy. When a node left the communication range, EAODV enabled the interrupt update strategy. To extend the lifespan of the network, the algorithm detected routes dynamically and switched to more energy-efficient paths. In [18] authors designed a QoS framework and integrated with OLSR routing protocol. The suggested frameworks combined resource reservation and a bandwidth estimation algorithm. They adopted a cross-layer method to focus on performance difficulties associated with node mobility speed. In [19] authors enhanced the Cluster Based Routing Protocol by using multiple paths. In this study an analytical model was introduced to estimate end-to-end delay and queue length. The network traffic was distributed among multiple paths to reduce congestion and network delay. In [20] authors categorized wireless mobile routing protocols into reactive, proactive and delay tolerant network routing protocols. They simulated different table driven and link state routing protocols in disaster scenarios and concluded that the proactive displays significant overhead and power consumption, while DTN exhibits high delay and dependable message delivery. The reactive protocols experience large delays as they wait for a path to be developed. In [21] authors compared reactive routing protocols in various situations. The performance evaluation of routing protocols was compared based on the energy consumption and average receiving rate. AODV and DSR consumed more energy due to the highest packet receiving rate, whereas DSDV consumed low network energy. In [22] authors proposed LE-AODV routing protocol. They used a receive signal strength indicator (RSSI) to select strong links during the route setup process. The proposed protocol utilized low energy to select optimum path. In [23] authors proposed an EAODV routing protocol. In their study, reactive routing protocols were compared with EAODV. The suggested scheme maximized packet delivery ratio and improved network life time.

III. PROPOSED DISASTER RESPONSE COMMUNICATION FRAMEWORK

Managing emergency conditions during the natural catastrophes is extremely difficult for government and local administration. Earthquakes, floods, and the collapse of high-rise buildings are among the most prevalent natural calamities. Buildings and other telecommunication infrastructures are mostly destroyed during the natural disasters. It is critical for the first responders to handle such emergencies and carry out relief operations in a coordinated manner. In the occurrence of a large-scale disaster, multi-organizational teams such as government officials, NGOs, and media personnel works virtually as a team to deliver emergency relief and rescue operations that saves lives and reduce property damages.

The emergency scenario for the post-disaster aid activities is illustrated in "Figure 1". The example illustrates the value of MANET in emergency situations where existing telecommunication infrastructure has been severely damaged and cannot provide telecommunication and other services. The figure 1 shows how readily MANET can be deployed in disaster-stricken areas. Mesh topology is used in emergency response communication networks. For sharing critical information, the mobile nodes are connected to the access point through wireless networks. Due to node mobility speed or harsh behavior of broken networks, wireless communication links are broken frequently. Multi-organization headquarters are linked via gateways to communicate emergency-related information and provide guidance for dealing with the crisis.

In an emergency, the scenario conceptually represents disaster relief and rescue operations. Emergency management centres such as hospitals, media centres, information centres, command and control centres, police department, fire station, location information system, and volunteer organizations are all linked to the disaster-stricken areas. The disaster management centers manage rescue and relief operations for disaster victims. Disaster victims are rescued and the rescue operations are carried out by first responders. First responders assist at medical relief camps, ambulance stations, and fire stations. To discuss human and property losses, first the responders exchange data messages, real-time videos and audio conversations with command and control centres.

The medical team sets up an emergency medical camp in catastrophe-affected areas to provide disaster victims with first aid. The disaster victims are divided into groups based on their health conditions. Serious patients receive first aid while being stabilized before being sent to the hospitals for treatment.

Fig. 1. An Emergency Scenario for Post-disaster Relief Operations [24].

The media is rushed to disaster-stricken areas to report on disaster victims and various other types of losses. The police department maintains law and order situation and does not allow irrelevant individuals to conduct such operations. The maps and locations of the catastrophe areas are provided via the global positioning system. The command and control centre makes choices based on the information gathered from both the internal and external sources.

IV. PERFORMANCE EVAUATION

"Table 1" shows the simulation parameters and the values of EPLAODV and AODV routing protocols.

TABLE I. SIMULATION PARAMETERS

Parameters	Values

Mac Layer	IEEE 802.11
Routing Protocols	AODV, EPLAODV
No. of Nodes	30-70
Packet Size	512
Node speed	2,4,6,8,10 m/s
Traffic load	2, 4, 6, 8,10 active connections
Traffic Type	CBR, FTP
Initial Energy	30 Joules
Simulation Time	1000seconds

The network simulator NS-2 version 2.35 is installed in operating system Ubuntu 14.04. The EPLAODV is implemented in NS-2 environment. Many emergency related scenarios are designed in TCL to evaluate the performance of both protocols in disastrous or emergency related situations. The AWK script files are used to execute the performance parameters of EPLAODV and AODV routing protocols. The initial energy used by simulation model is 30 joule. The IEEE 802.11 standard is used in wireless communication. The network size of 70 mobile nodes uses Flat-grid topology, the nodes move within the coverage area of 1000m X 1000m. The radio range of mobile nodes is 250m. The node mobility speed is 2 m/s to 10 m/s. The traffic load varies from 2 active connections to 10 active connections. The packet size of FTP and CBR traffic is 512 Bytes. Each emergency related scenario runs up to 1000 seconds.

The performance evaluation of both protocols is presented in terms of Packed Delivery Ratio (PDR), End-to-End Delay and Consumed Energy. The PDR, Consumed Energy and End-to-End Delay of AODV and EPLAODV protocols compares with varying node mobility speed from (2 to 10 m/s), traffic load (from 2 active connections to 10 active connections) and no of mobile nodes from (30 to 70). The description of routing metrics is given below:

A. *Packet Delivery Ratio*

The PDR [25] is the ratio of data packets supplied by the source node to data packets received by the destination node as shown in equation 1. The data packets sent by the source node are represented by Ps, whereas the number of data packets delivered by the destination node is represented by Pr.

$$\text{PDR} = \frac{Pr}{Ps} * 100 \qquad (1)$$

B. *End-to-End Delay*

It is a time required for the data packets to reach to the destination node [26]. The mathematical expression calculates the total amount of time by subtracting the sending time from the arrival time, whereas number of connections represents the total data packets as shown in equation 2.

$$\text{End To End Delay} = \frac{\sum Arrivetime - Sendtime}{\sum Number\ of\ Connections} \qquad (2)$$

C. *Consumed Energy*

It is the receiving and transmitting energy of the mobile nodes consumed during the forwarding of data packets. As the number of control and data packets is increased, more energy is consumed by the nodes. Equation 3 shows the average energy consumption [27] of mobile nodes, E*ik* and E*fk* represents the initial and final energy level of node k respectively whereas n is the total number of mobile nodes.

$$Average = \frac{\sum_{k=1}^{n}(Eik - Efk)}{n} \qquad (3)$$

"Figure 2" shows the PDR of EPLAODV and AODV. The figure shows that PDR of EPLAODV produces better results, because TCP is connection oriented protocol which provides the facility of retransmission of lost packets. It is observed that the PDR of EPLAODV slightly decreases when the traffic-load increases. EPLAODV outperforms AODV in terms of PDR.

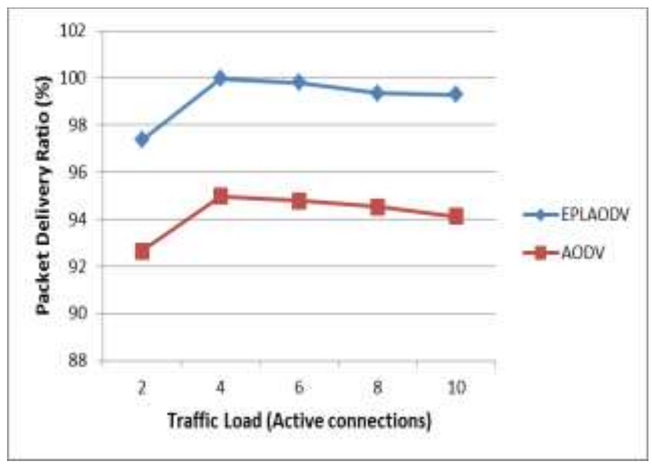

Fig. 2. PDR vs Traffic Load (TCP agent)

"Figure 3" shows the PDR of EPLAODV and AODV with UDP connection. The results show that the PDR of EPLAODV decreases when the traffic load (active connections) are increased. Being connection less, UDP does not retransmit the lost data packet. It is observed that the EPLAODV outperforms AODV in terms of PDR.

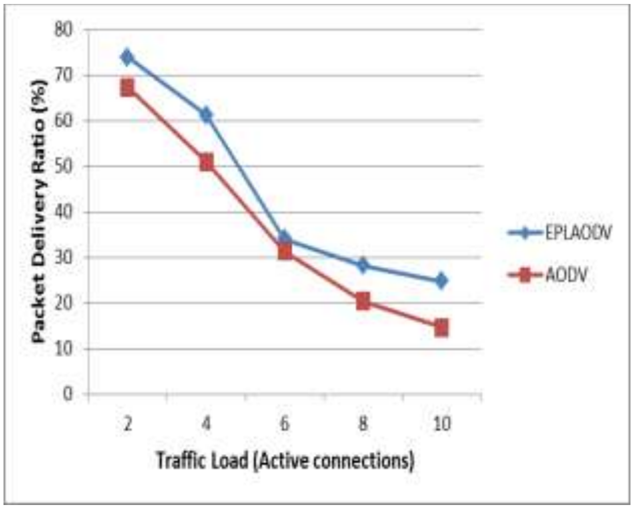

Fig. 3.PDR vs Traffic Load (UDP agent)

The End-to-End Delay of EPLAODV and AODV is shown in "Figure 4". The TCP connection is established. It is observed from the results that the End-to-End Delay of EPLAODV performs better than AODV. Moreover, from interval 4, End-to-End Delay of EPLAODV increases when the traffic load is increased.

The End-to-End Delay of EPLAODV and AODV is shown in "Figure 5". The UDP connection is established to evaluate the performance of routing protocols. The End-to-End Delay of EPLAODV outperforms than AODV. The results show that the End-to-End Delay of EPLAODV increases when the traffic load is increased. It is also observed from

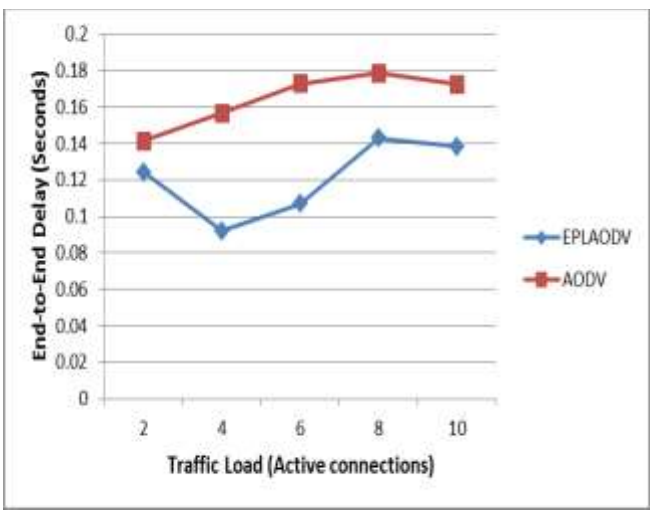

Fig. 4. End-to-End Delay vs Traffic Load (TCP agent)

the results that after the interval 8, End-to-End Delay of EPLAODV decreases when the traffic load is high (increased).

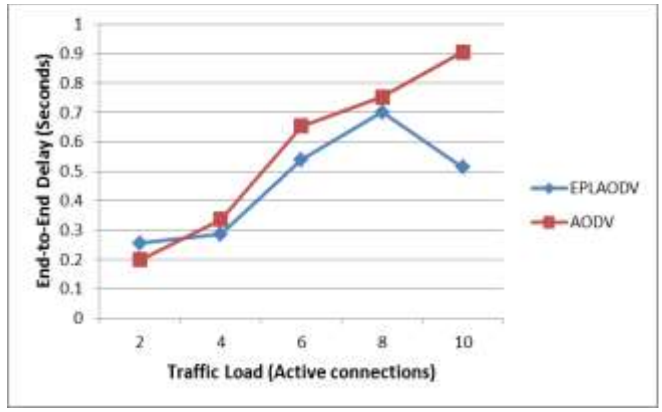

Figure 5.End-to-End Delay vs Traffic Load (UDP agent)

"Figure 6" illustrates the energy consumed by EPLAODV and AODV. It is observed that the consumed energy of EPLAODV produces better results than the AODV. The results show that the consumed energy of EPLAODV increases when the traffic load is increased. The consumed energy of EPLAODV is almost stable with the high traffic load. The EPLAODV outperforms than AODV in terms of energy consumption.

The energy consumption of EPLAODV and AODV with UDP connections is shown in "Figure 7". The UDP connection is established to evaluate the performance benchmarking routing protocols. The results show that the consumed energy of EPLAODV produces better results as compared to the AODV. The consumed energy of EPLAODV increases when the traffic load is increased. It is observed that EPLAODV consume less

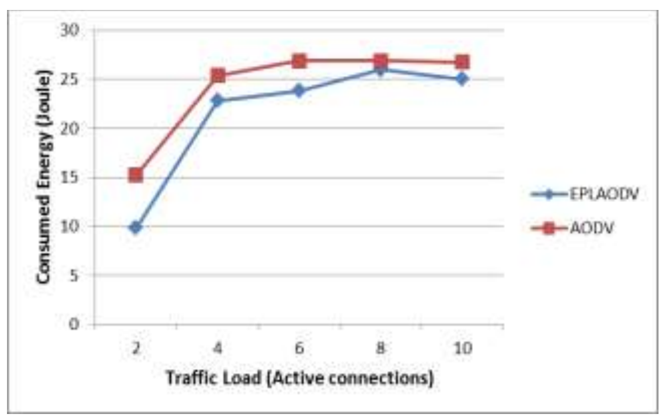

Fig. 6.Consumed Energy vs Traffic Load (TCP agent)

Energy when the traffic load is low. The EPLAODV outperforms than AODV in terms of energy consumptions.

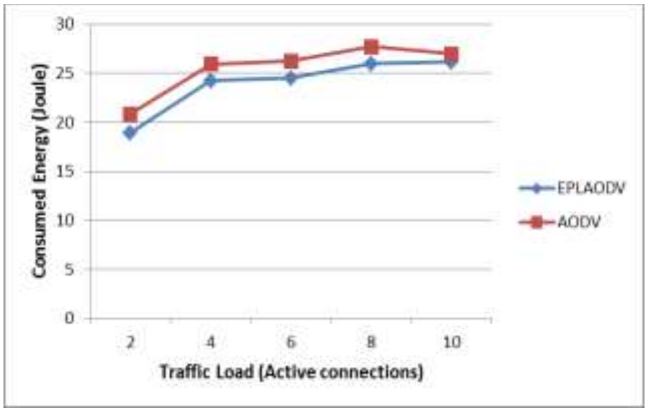

Fig. 7.Consumed Energy vs Traffic Load (UDP agent)

"Figure 8" illustrates the PDR of EPLAODV and AODV. To evaluate the performance, a TCP connection is established. The results show that the PDR of EPLAODV produces better results as compared to AODV. Due to the FTP traffic pattern, more than 99% of the data packets reach to their destination.

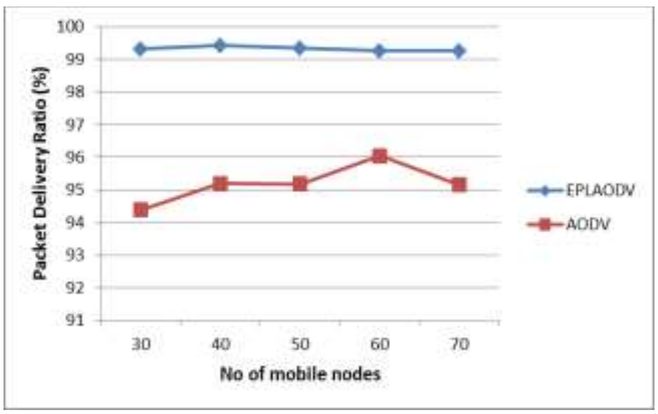

Fig. 8.PDR vs No of mobile nodes (TCP agent)

It is observed from the results that the PDR of EPLAODV remains stable when increasing number of mobile nodes. The EPLAODV outperforms than AODV in terms of PDR.

"Figure 9" illustrates the PDR of EPLAODV and AODV. To evaluate the performance, a UDP connection is established. The results show that the PDR of EPLAODV decrease when the no of mobile nodes are increased. Here CBR traffic patterns are used to compare the PDR. It is observed that the PDR of EPLAODV produces better results than AODV.

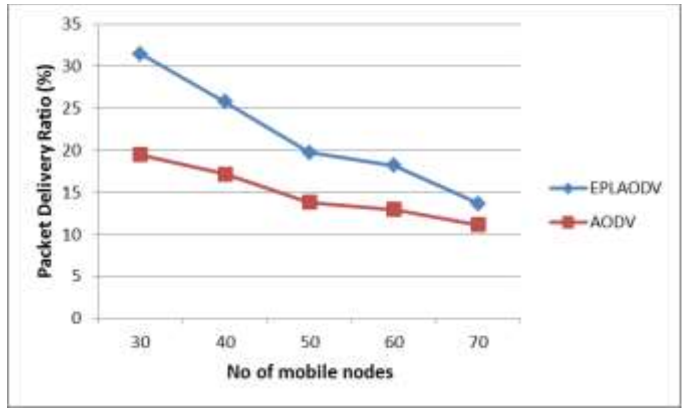

Fig. 9.PDR vs No of mobile nodes (UDP agent)

"Figure 10" illustrates the End-to-End Delay of EPLAODV and AODV. Here a TCP connection is established. It is observed from the results that the End-to-End Delay of EPLAODV performs better than the AODV. It is also observed that the End-to-End Delay of EPLAODV is almost stable when the mobile node are increased.

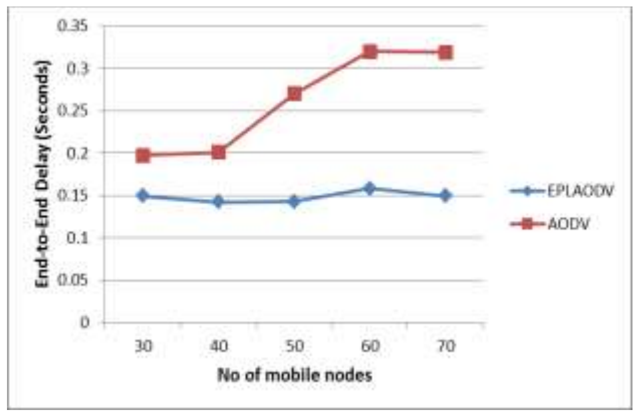

Fig. 10.End-to-End Delay vs No of mobile nodes (TCP)

"Figure 11" illustrates the End-to-End Delay of EPLAODV and AODV. Here a UDP connection is established. It is observed from the results that the End-to-End Delay of EPLAODV performs better than the AODV. It is also observed that the End-to-End Delay of EPLAODV is increased when the mobile nodes are increased.

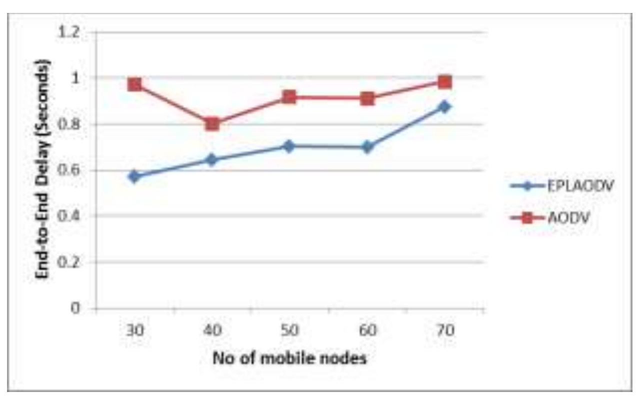

Fig. 11.End-to-End Delay vs No of mobile nodes (UDP)

"Figure 12" illustrates the energy consumption of EPLAODV and AODV. The results show that the energy consumption of EPLAODV produces better results than the AODV. Furthermore, the energy consumption of EPLAODV increases when the mobile nodes are increased. Moreover, from interval 60, the energy consumption of EPLAODV decreases when the nodes are increased. The EPLAODV outperforms than AODV in terms of energy consumption.

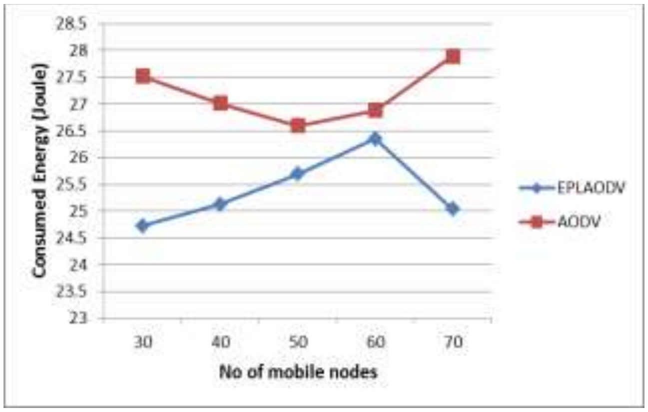

Fig. 12.Consumed Energy vs No of mobile nodes (TCP)

"Figure 13" illustrates the energy consumption of EPLAODV and AODV.

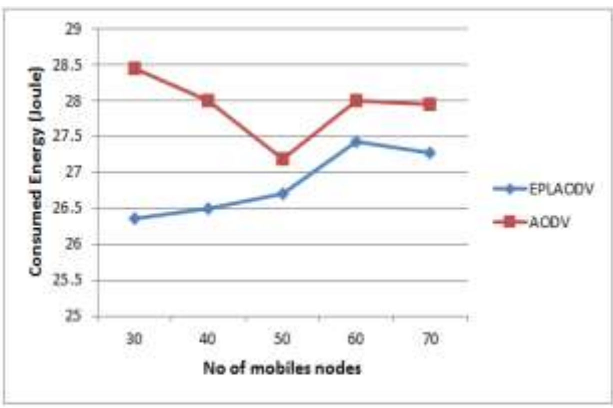

Fig. 13.Consumed Energy vs No of mobile nodes (TCP)

It is observed that the energy consumption of EPLAODV produces better results than the AODV. The results show that the energy consumption of EPLAODV increases when mobile nodes are increased. Moreover, from interval 60, the energy consumption of EPLAODV slightly decreases. The EPLAODV outperforms than AODV in terms of energy consumption.

CONCLUSION

In this research study, the TCP and UDP protocols are used to analyze and compare the behavior of EPLAODV and AODV routing protocols in the emergency or disastrous situations. Various emergency related scenarios are designed in TCL to evaluate the performance of the routing protocols. The EPLAODV and AODV routing protocols are evaluated in terms of PDR, End-to-End Delay and energy consumption. It has been found that for TCP traffic EPLAODV perform better than the AODV in all performance parameters. It is concluded that the TCP traffic pattern under EPLAODV routing protocols gives better results in disastrous situation. In future, the link quality of EPLAODV will be updated to minimize frequent link failures during the disastrous situations.

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