AN INVESTIGATIVE STUDY ON THE ENERGY EFFICIENT ROUTING AND DATA DELIVERY TECHNIQUES IN MANET

D.Sathiya[1], Dr. S. Sheeja[2]

ABSTRACT

A mobile ad hoc network (MANET) is an infrastructure-less network comprising mobile devices which are linked in a wireless manner. Every device moves in any direction and changes its links frequently. Routing is a method of choosing the suitable path for managing traffic in a network. The mobile node (MN) within the transmission range transmits the information directly. MN that is not in the transmission range transmits the data packet (DP) through the intermediate nodes with minimal energy consumption (EC). Data delivery is defined as the process of delivering the DPs to an exact destination without any loss. But, the existing techniques failed to lessen EC during DP transmission and data delivery task. The key objective is to enhance the data delivery task with less energy and time consumption (TC) during data communicationin MANET.

Keyword : MANET, routing, transmission range, data delivery, data transmission

I. INTRODUCTION

MANET is a group of different nodes that communicate with other nodes in the transmission range without a centralized control. MANET has gained large interest due to considerable merits like multi-hop and infrastructure-less transmission. Routing is exploited in the communication process to identify the best path between two nodes. The mobility of nodes is an essential factor in MANET due to lesser wireless transmission range to vary randomly, when the nodes enter and leave a network. Communication is very demanding one because of the active mobility of nodes.

This paper is organized as follows: Section II explains the review on different energy efficient routing and data delivery techniques, Section III illustrates the study and analysis of existing energy efficient routing and data delivery techniques, Section IV describes the possible comparison of existing techniques. In Section V, the discussion and limitations of the existing energy efficient routing and data delivery techniques are discussed with future direction and Section VI concludes the paper.

2. LITERATURE REVIEW

A power-proficient reliable routing (P2R2) protocol was introduced in [1] for MANET communication that lessened route failure during data transmission. However, packet delivery ratio (PDR) was not improved using routing protocol. An energy efficient quality of service(QoS) aware hierarchical KF-MAC routing protocol was presented in [2], where K-means cluster-formation-firefly-cluster-head-selection-based

[1] Research Scholar, Dept of CS, Karpagam Academy of Higher Education

[2] Research Supervisor, Dept of CS, CA & ITS, Karpagam Academy of Higher Education KAHE

MAC routing (KF-MAC) protocol lessened the attention of QoS parameters if a node transmitted data from source to destination node (DN). But, it did not lessen the delay using labeled packet exchanging protocol.

Endcast concept model was presented in [3] for solving the broadcast storm issues and broadcast flood issues. An Endcast scheme controlled storm condition and flood condition. But, the ECwas not minimized for the data delivery by the Endcast concept model. In [4], an efficient and stable multipath routing approach was designed. Residual energy (RE) and stability of links were evaluated in network. But, the PDR was not enhanced.

Using adaptive genetic algorithm, Energy Efficient Lifetime Aware Multicast (EELAM) Route Selection plan was introduced in [5]. Based on tree topology, EELAM functioned discriminating additional tree by multicast routing topologies with maximum RE and minimum EC. But, the routing overhead (RO) was not lessened using EELAM route selection plan.

Based on acknowledgements (ACKs) and coding at source, a reliable transport mechanism was designed in [6]. It permitted the mean file completion time and EC for data delivery of last ACK at source. But, reliable transport mechanism failed to improve the network lifetime (NL) during the data transmission process.

A new opportunistic routing protocol called JOKER was introduced in [7] for candidate selection and coordination. The designed protocol enhanced the performance of multimedia traffic and energy efficiency. But, JOKER failed to present an efficient management with inherent features by improving the node's energy efficiency. For local packet buffering and congestion identification, a link failure and congestion-aware reliable data delivery was presented in (LCRDD) [8]. However, LCRDD failed to choose the optimal nodes for efficient data delivery in a dynamic manner.

3. ENERGY EFFICIENT ROUTING AND DATA DELIVERY IN MANET

In MANET, the light weight MN is communicated through wireless technology. Each device in MANET moves separately in all directions and varies links to another device often. Routing is the process of choosing the paths in a network to transmit DPs. The transmission of DP among the computing devices is monitored by an ad hoc routing protocol.

3.1A Robust against route failure using power proficient reliable routing in MANET

In MANET, nodes communicate with one another when they are within the communication range. To broadcast DP with centralized control, each node reconfigures the router. Reliable communication is achieved through high QoS. The node-to-node channel quality (CQ) varies changing multi-hop data flows.

P2R2 confirms the channel capacity of source and destination, and when it is higher than that of the threshold, it permits source and destination to communicate. The relay nodes in multi-hop path are chosen through the three parameters, which help lessen route failure during transmission in MANET in the route discovery process.

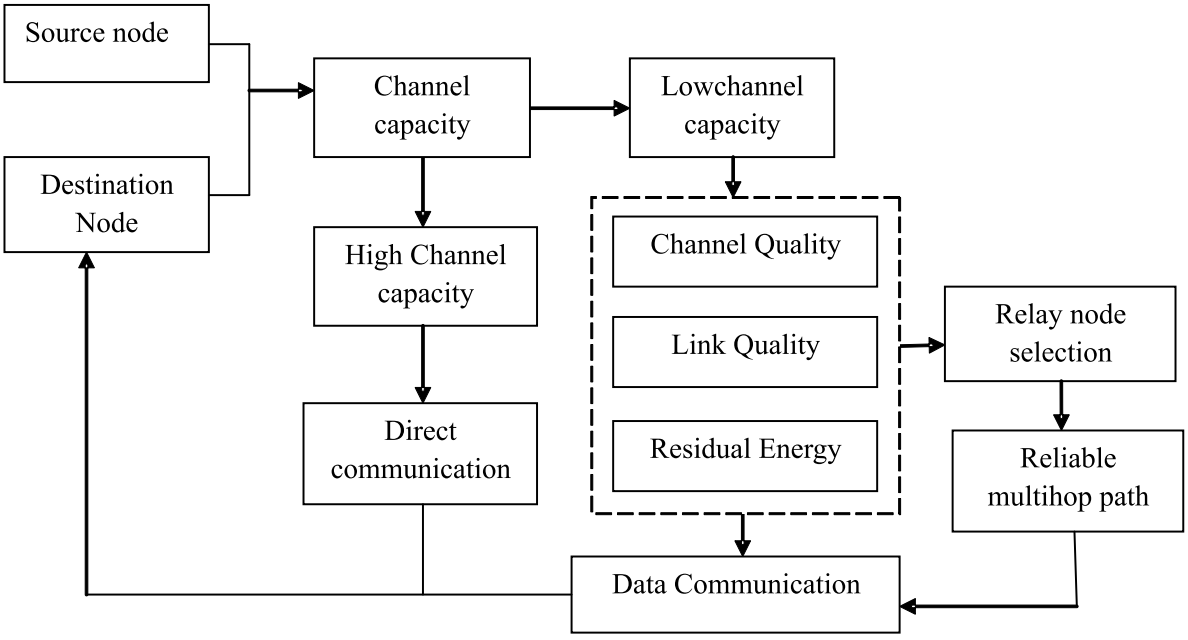

Figure 1 Power Proficient Reliable Routing (P2R2) Protocol

A reliable routing scheme for MANET is introduced in figure 1. The designed routing scheme selects forwarder nodes by three parameters, i.e.

"Channel quality

"Link quality

"RE

Channel quality

CQ describes the accessibility of channel during the transmission. The interference in channel exploits resources well to assure trustworthy communication. CQ metric lessens end-to-end (E2E) delay, through the allocation of resources. Signals are transmitted via channel. CQ is defined as rate where the data gets consistently transmitted over a medium.

Link quality

Link quality (LQ) is calculated from the quality of a received signal. To determine LQ, the duration of the link between nodes is taken. Route failure is lessened by LQ. Based on the communication range and the relative velocity among nodes, the new metric link residual life is computed.

Residual energy

RE is the quantity of energy remaining in the node. The unintended route failure is because of channel fading, link failure and less energy in nodes. The link failure results in the reconstruction of a route. The frequent route reconstruction lessens E2E delay and RO. Energy is imperative for a node to function precisely. If the node energy is exhausted, then it turns dead. The path gets reconstructed, when a node in the path is dead. The designed scheme lessens route failure by considering CQ, LQ and RE to choose a forwarding node in the path.

3.2 Energy Efficient QoS Aware Hierarchical KF-MAC Routing Protocol in MANET

MANETs comprise a number of wireless MNs that

communicate with one another by wireless links and move arbitrarily. They have less amount of communication resources like bandwidth, energy and buffer space. For packet forwarding, every node performs router to detect the feasible path. MANETs are exploited in military, civilian and rescue operations. The energy source for expansive devices utilizes rechargeable battery which poses limits on NL and network performance by influencing network metrics. For data gathering, information processing and transmission, node energy is exploited. Ad-hoc routing is grouped as proactive and reactive routing. Reactive or dynamic routing is exploited when courses have settled. Dynamic routing takes a huge amount of battery power. Pre-defined courses lose their authenticity in a network when their topology varies rapidly. Reactive routing structure is imperative for remote ad-hoc routing which offers adaptable reaction and large framework topologies. Reactive protocols are termed as demand or source initiated routing protocols. A request is generated for route if a node desires to communicate with another node.

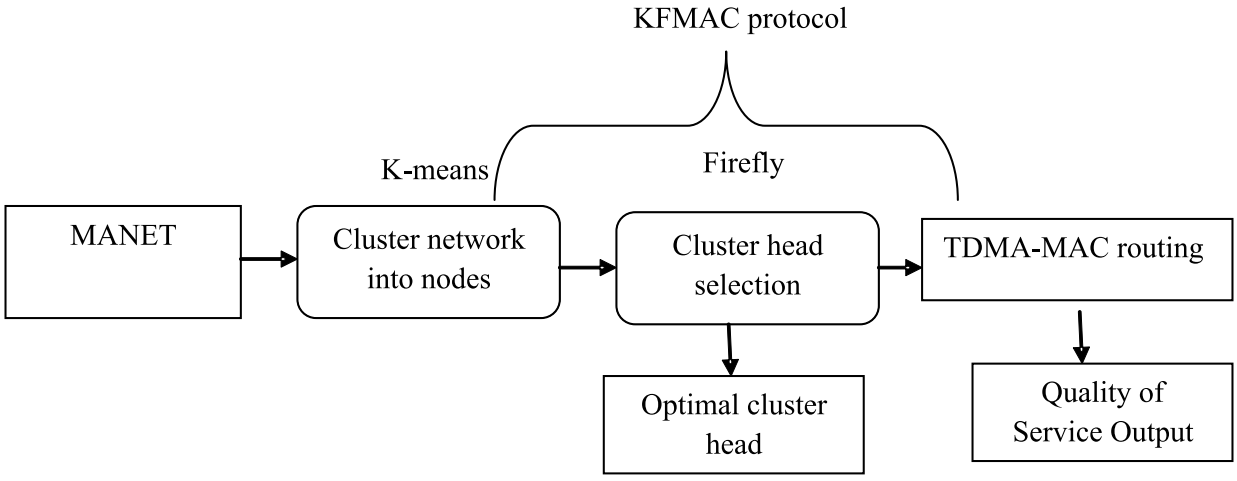

Figure 2Energy Efficient QoS Aware Hierarchical KF-MAC Routing Protocol

In figure 2, an energy efficient QoS aware hierarchical KF-MAC protocol is described. KF-MAC protocol lessens attention of QoS parameters when a node broadcasts data from SN to DN. For clustering nodes in a network, K-means clustering technique is employed. To detect cluster heads for clustered nodes, the nodes are partitioned and optimized by firefly optimization algorithm. The transmission of data begins with nodes and TDMA based MAC-routing-carry-out-communication. KF-MAC protocol executes for QoS parameters. To lessen RO and improve network scalability, the structure of cluster is exploited. TDMA is also exploited to avoid collision and lessen packet loss rate (PLR).

3.3Endcast: mobile stateless data delivery in MANETs

An Endcast protocol has broadcast-storm and broadcast-flood-control mechanisms. An Endcast scheme is introduced to control the storm situation by counter-based flooding and flood situation by negative acknowledgement packets. The enlargement of biological organs is regulated by a storm control scheme. Endcast is a communication from SN to DN

where data's are sent via controlled flooding, and data propagation is lessened once it reaches DN. If any flooding is employed for E2E data forwarding, dissipation of network resources happens because of Broadcast storm and Broadcast flood. In broadcast storm, one message circulates from SN to DN, when flooding causes a huge number of messages being propagated in a network. In broadcast flood, after reaching DN, the message is propagated and gathered in a network unless explicit mechanisms are in place to stop the propagation of messages and eradicate them.

3.4 Energy-efficient stable multipath routing in MANET

Multipath routing comprises the many routes among source node (SN) and DN. SNs are exploited for conserve links although one route failure happens during fault tolerance. It lessens data transmission failures and delay time caused by route disconnection. SN transmits route request packet to each neighbor node (NN). NN gathers route request packet and confirms whether it has obtained a similar packet earlier or not. The battery level of nodes is conserved and verified before routing in a network. Battery level information helps nodes maintain the minimal remaining energy. SNs detect a higher energy efficient route in the route discovery phase. SN floods Route Request (RREQ) to each node, when SN does not detect route to DN. RREQ packet header holds two unique fields called lower energy and average energy of nodes (i.e., minE and aveE) in a path. To evade the overlapped route issue in a network, the intermediate nodes do not pass every duplicate RREQ. Also, they broadcast second copy packets which traverse by diverse incoming route where first RREQ message is received.

An efficient and stable multipath routing model is carried out in MANETs with congestion awareness. Network computes RE and stability of the links. The receiving and transmitting energy of nodes is considered to compute RE. Then, the stability of link LET is evaluated; LET is accomplished by motion parameters. The network decides the path through parameters to broadcast DP among MNs.

4.THE PERFORMANCE ANALYSIS OF ENERGY EFFICIENT ROUTING AND DATA DELIVERY IN MANET

To evaluate energy efficient routing and data delivery performance, the number of MNs and the number of DPs are taken to conduct an experiment. Different parameters are exploited for reducing ECwith better delivery rate.

4.1Energy Consumption (EC)

ECis defined as the total amount of time consumed for performing the energy efficient routing in MANET. It is measured as the product of energy taken by a single MN and the total number of MNs. It is measured in joules (J) and formulated as,

EC= Number of mobile nodes*Energy consumed by single mobile node (1)

From (1), the EC is calculated. The lower the EC, the more efficient method is said to be.

Table 1 Tabulation for Energy Consumption

Number of Mobile nodes (Number)	Energy Consumption (J)			
	P2R2 protocol	Energy Efficient QoS Aware Hierarchical KF-MAC Routing Protocol	Endcast protocol	Efficient and Stable Multipath Routing model
50	35	27	41	48
100	37	29	43	51
150	40	32	47	54
200	42	34	50	57
250	45	37	52	59
300	43	35	49	54
350	39	32	46	52
400	41	36	48	55
450	44	40	52	58
500	46	42	56	60

Table 1 explains the EC with respect to the number of MNs ranging from 50 to 500. EC comparison takes place on existing [1], [2], [3] and [4]. The graphical representation of EC is described in figure 3.

From figure 3, EC for different number of MNs is described. From the above graph, it is observed that the EC using [2] is less when compared with P2R2 protocol, Endcast protocol and efficient and stable multipath routing model. This is because KF-MAC protocol minimizes the interest of QoS parameters, when nodes send data from SN to DN. K-means clustering is exploited for clustering nodes.

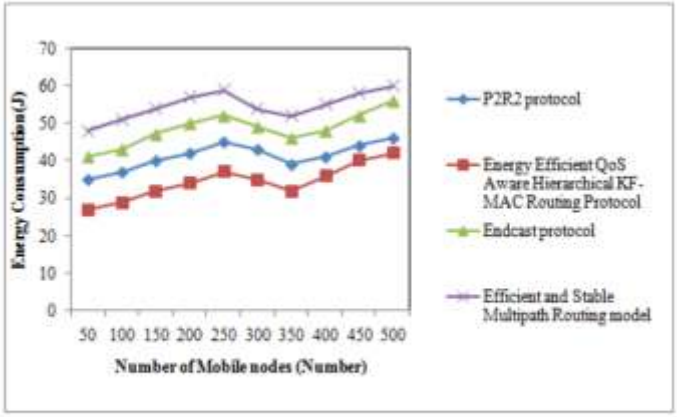

Figure 3 Measure of Energy Consumption

The clustered nodes are partitioned and optimized through firefly optimization to identify the energy efficient cluster heads for the clustered nodes. Through the cluster heads, the routing process is carried out to minimize energy consumption. EC using [2] is 17% less than P2R2 protocol, 29% less than Endcast protocol and 37% less than Efficient and Stable Multipath Routing model.

4.2 Data Delivery Rate (DDR)

DDR is measured as the ratio of total number of DPs transmitted correctly to destination. It is measured in percentage (%) and formalized as below:

$$DDR = \frac{\text{No of data packets transmitted correctly to the destination}}{\text{Total number of data packets}} \quad (2)$$

From (2), the DDR is computed. The greater the DDR, the more efficient the method is said to be.

Table 2 Tabulation for Data Delivery Rate

Number of Data packets (Number)	Data Delivery Rate (%)			
	P2R2 protocol	Energy Efficient QoS Aware Hierarchical KF-MAC Routing Protocol	Endcast protocol	Efficient and Stable Multipath Routing model
50	64	73	85	80
100	66	75	86	82
150	67	78	88	83
200	70	81	89	85
250	68	80	87	84
300	71	83	90	86
350	73	85	92	88
400	72	84	91	87
450	75	86	94	88
500	78	87	96	90

Table 2 describes the DDR with respect to the number of DPs ranging from 50 to 500. DDR comparison takes place on existing [1], [2], [3] and [4]. The graphical representation of DDR is explained in figure 4.

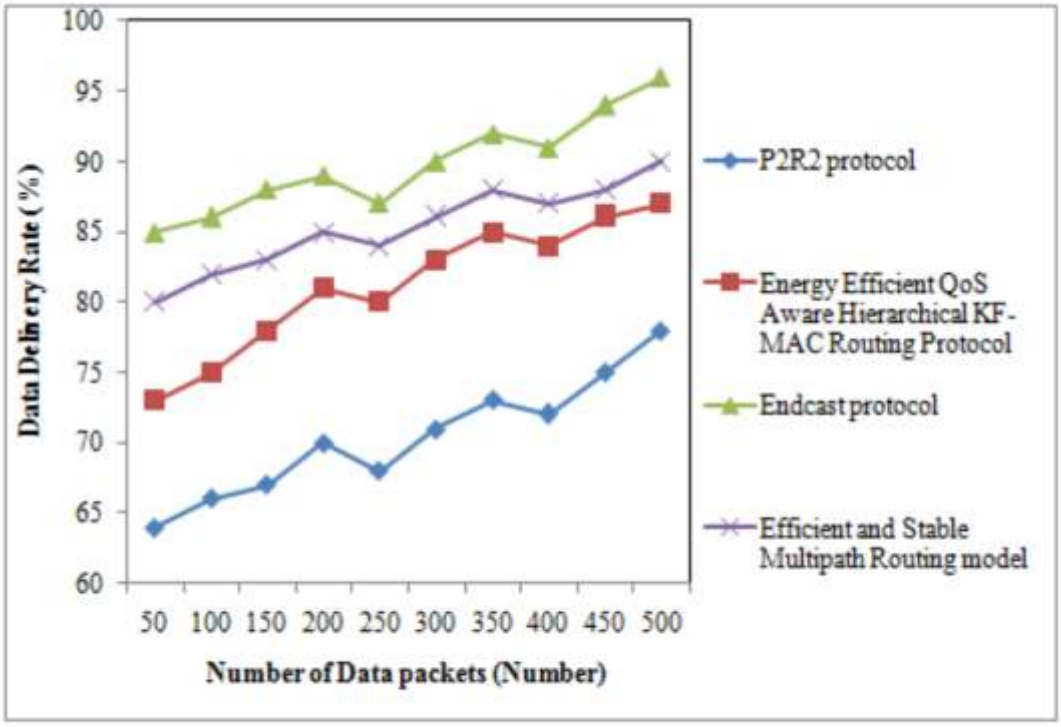

Figure 4 Measure of Data Delivery Rate

Figure 4 portrays DDR for different number of MNs. From figure 4, it is clear that DDR using Endcast protocol is higher when compared to [1], [2]and [4]. This is owing to the application of broadcast storm control mechanism and broadcast flood control mechanism. The designed protocol controls the storm situation and flood situation. The storm control scheme is stimulated by chalone mechanism which normalizes the enlargement of biological organs. By avoiding the storm situation and flood situation, the DDR gets improved. The DDR of Endcast protocol is 28% higher than that of P2R2 protocol, 11% higher than that of [2] and 5% higher than that of Efficient and Stable Multipath Routing model.

4.3Data Delivery Time (DDT)

DDTis defined as the amount of time taken for performing data delivery process. It is the difference of starting time and ending time of the data delivery process. It is computed in milliseconds (ms) and formulated as:

Data Delivery Time=Ending time-Starting Time of data delivery (3)

From (3), the DDT is calculated. The lower the DDT, the more efficient method is said to be.

Table 3 Tabulation for Data Delivery Time

Number of Data packets (Number)	Data Delivery Time (ms)			
	P2R2 protocol	Energy Efficient QoS Aware Hierarchical KF-MAC Routing Protocol	Endcast protocol	Efficient and Stable Multipath Routing model
50	45	37	34	22
100	47	39	36	24
150	48	41	38	25
200	50	43	39	27
250	51	44	40	28
300	53	46	42	30
350	56	48	45	32
400	52	45	41	29
450	57	49	46	33
500	60	52	50	36

Table 3 demonstrates DDT with the number of DPs ranging from 50 to 500. DDT comparison takes place on [1], [2], [3] and [4].The graphical representation of DDTis explained in figure 5.

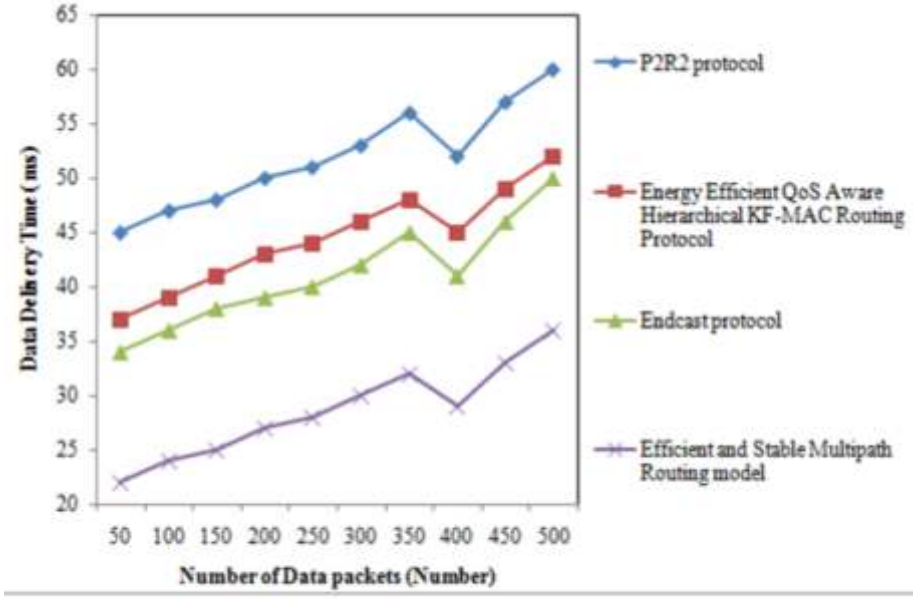

Figure 5 Measure of Data Delivery Time

In figure 5, DDT for different number of MNs is depicted. From the graph, it is clear that the DDT using efficient and stable multipath routing model is less when compared to [1], [2] and [3]. This is because of avoiding the congestion awareness in MANET. An efficient and stable multipath routing model is carried out to computes RE and stability of links. While calculating RE, the receiving energy and transmitting energy of node are considered. By avoiding the congestion, the DDT gets reduced. The DDR of Efficient and Stable Multipath Routing model is 45% less than that of P2R2 protocol, 36% less than that of [2] and 31% lesser than that of Endcast protocol.

5. DISCUSSION AND LIMITATION OF ENERGY EFFICIENT ROUTING AND DATA DELIVERY IN MANET

A P2R2 protocol is intended for MANET communication. It assures the capacity of the channel among SN and DN. The designed routing protocol employs three salient parameters to detect a path for reliable communication. P2R2 protocol reduces the route failure during transmission. PDR is not improved using routing protocol. KF-MAC exploits the structure of clusters to lessen RO and improve network scalability. KF-MAC protocol minimizes the concentration of QoS parameters, when data are transmitted from source to DN. But, Energy efficient QoS aware hierarchical KF-MAC routing protocol does not lessen delay during DPs flowby labeled packet-exchanging protocol.

An end cast scheme controls a storm situation by counter-based flooding and flood situation by negative acknowledgement packets. The Endcast concept model solves the broadcast storm and broadcast flood issues. But, EC is not minimized for data delivery using the Endcast concept model. Efficient and stable multipath routing approach enhances the throughput and efficiency. The designed approach is introduced where the bandwidth and delay are considered during the routing process. PDR is not enhanced by designed approach.

5.1 Related Works

The data replication was required in [9] to guarantee data sharing. The key intention was to design an energy efficient and node mobility-based data replication algorithm. An efficient route discovery technique was introduced in [10] with Three Fish algorithm depending on neighboring clusters to minimize the RO in CEAACK MANET. The designed protocol identified the forwarding order and neighbor coverage knowledge effectively. Though the RO was minimized, EC remained unaddressed.

To elect an energy efficient path, an energy efficient multipath routing protocol was introduced in [11]. The designed system considered the nodes transmission power and RE for increasing the NL as well as minimizing the EC of MNs. Energy and Mobility Aware Multi-Point Relay (EMA-MPR) mechanism was designed in [12]. But, E2Edelay was not lessened.

5.2 Future Direction

The future direction of the energy efficient routing and data delivery technique is to reduce the EC and TC using machine learning and ensemble classification techniques.

6. CONCLUSION

A comparison of different existing energy efficient routing and data delivery techniques is made. From the survival study, it is clear that the existing techniques have failed to improve the data delivery performance with minimal energy consumption. The review explains that the existing methods have failed to lessen delay during DPs flow through labeled packet exchanging protocol. In addition, DDT is not reduced. A wide range of experiments on the existing methods reveal the performance of many data delivery techniques. Lastly, the research work has been carried out using machine learning techniques for improving the performance of energy efficient routing and data delivery.

REFERENCES

[1] M. Malathi and S. Jayashri, "Robust against route failure using power proficient reliable routing in MANET", Alexandria Engineering Journal, Elsevier, 2018, Volume 57, Pages 11-21

[2] Meena Rao and Neeta Singh, "Energy Efficient QoS Aware Hierarchical KF-MAC Routing Protocol in MANET", Wireless Personal Communications, Springer, Volume 101, Issue 2, July 2018, Pages 635-648

[3] SulochanaSooriyaarachchi and Chandana Gamage, "Endcast: mobile stateless data delivery in MANETs", EURASIP Journal on Wireless Communications and Networking, Springer, Volume 147, December 2017, Pages 1-25

[4] A. Pratapa Reddy and N. Satyanarayana, "Energy-efficient stable multipath routing in MANET",Wireless Networks, Springer, Volume 23, Issue 7, October 2017, Pages 2083-2091

[5] N. Papanna, A. Rama Mohan Reddy and M. Seetha, "EELAM: Energy efficient lifetime aware multicast route selection for mobile ad hoc networks",Applied Computing and Informatics, Elsevier, 2018, Pages 1-9

[6] Lucile Sassatelli, Arshad Ali, Manoj Panda, Tijani Chahed and Eitan Altman, "Reliable Transport in Delay-Tolerant Networks with Opportunistic Routing", IEEE Transactions on Wireless Communications, Volume 13, Issue 10, October 2014, Pages 5546-5557

[7] Ramon Sanchez-Iborra and Maria-Dolores Cano, "JOKER: A Novel Opportunistic Routing Protocol",IEEE Journal on Selected Areas in Communications, Volume 34, Issue 5, May 2016, Pages 1690-1703

[8] Manowarul Islam, Abdur Razzaque, Mahfuzur Rahman Bosunia, Atif Alamri, and Mohammad Mehedi Hassan, "Link failure and congestion-aware reliable data delivery mechanism for mobile ad hoc networks", Annals of Telecommunications, Springer, October 2013, Volume 68, Issue 9-10, Pages 539-551

[9] P. Mukilan and A. Wahi, "EENMDRA: Efficient Energy and Node Mobility based Data Replication Algorithm for MANET", International Journal of Computer Science

Issues (IJCSI), Volume 9, Issue 3, May 2012, Pages 357-364

[10] J. Sathiamoorthy, B. Ramakrishnan and Usha M, "Design of a proficient hybrid protocol for efficient route discovery and secure data transmission in CEAACK MANETs", Journal of Information Security and Applications, Elsevier, Volume 36, 2017, Pages 43-58

[11] May Cho Aye and Aye Moe Aung, "Energy Efficient Multipath Routing for Mobile Ad Hoc Networks", International Journal of Information Technology, Modeling and Computing (IJITMC) Volume 2, Issue 3, August 2014, Pages 11-18

[12] Waheb A. Jabbar, Mahamod Ismail and RosdiadeeNordin "Energy and mobility conscious multipath routing scheme for route stability and load balancing in MANETs" Simulation Modelling Practice and Theory, Elsevier, Volume 77, 2017, Pages 245-271