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Performance Evaluation of QoS Based Forwarding and Non Forwarding Energetic Node Selection Algorithm for Reducing the Flooding in Multihop Routing in Highly Dynamic MANET

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Abstract**—**The aim of this paper is to propose a novel technique to guarantee Quality of Service (QoS) in a highly dynamic environment. The MANET changes its topology dynamically as the nodes are moved frequently. This will cause link failure between mobile nodes. MANET cannot ensure reliability without delay. The relay node is selected based on achieving QoS in previous transmission. It considers one more factor *Connection Existence Period (CEP)* to ensure reliability. CEP is to find out the period during that connection exists between the nodes. The node with highest CEP becomes a next relay node. The relay node is selected dynamically to avoid frequent failure. The bandwidth of each link changed dynamically based on service rate and request rate. This paper proposes Active bandwidth setting up algorithm to guarantee the QoS. The series of results obtained by using the Network Simulator (NS-2) demonstrate the viability of our proposed techniques.

Keywords**—**Bandwidth, Connection Existence Period (CEP), Mobile Adhoc Network (MANET), Quality of Service (QoS), Relay node.

I. Introduction

THE rapid progress in the wireless communication technology has made the wireless nodes very smaller and less exclusive and more potent. Generally the wireless network is classified into two. They are Infrastructure Network and Adhoc network (Infrastructure less networks). Infrastructure network means the network having the predefined topology where as the Infrastructure less networks in the sense the topology of the network changes dynamically. The Mobile Adhoc Network (MANET) [9], [10] comes under the category of infrastructure less networks. It is a challenge to build the efficient routing scheme for a long time in MANET as the topology of the network changes dynamically. The architecture of MANET is shown in Fig. 2. Each and every wireless node has certain communication range. If the intended receiver is present in the communication range, the sender will transmit the data directly without the help of other nodes.

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However, if the receiver is present out of communication range, the sender node transmits the data through some intermediate nodes as shown in Fig. 1. That kind of communication is called as cooperative communication. In Fig. 2 the green color links denote the route established from source to destination. The route may change dynamically according to the movement of all the nodes participating in the communication.

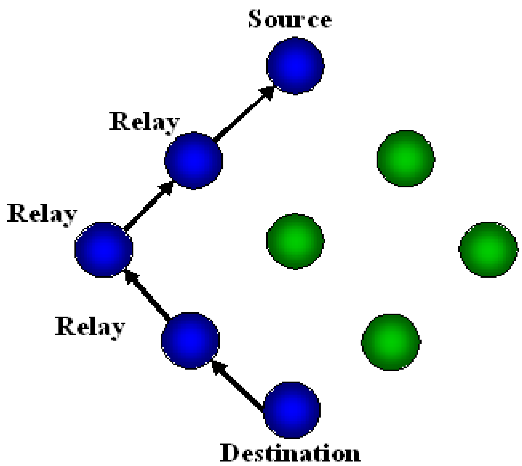

Fig. 1 Illustrations of Co-operative communication

The technical challenges [16] of MANET include routing, reliability, QoS and Power Consumption. As of the topology of the network permuted dynamically, the effect of routing packets between two nodes is a challenging task. As of limited communication range of wireless node the reliability problem occurs in the MANET.

Rendering different levels of QoS in a frequently changing topology is a challenge. The power consumption of the mobile terminals should also be considered while transmitting the data. The Power Efficient algorithm is proposed [17] in the MANET is proposed with Dynamic Source Routing protocol to reduce the power consumption problem. This scheme uses the concept of power awareness along with route selection. The nodes in the route are selected by checking the power status for each one in the topology. This will prolong the lifetime of the MANET.

The Wireless technology,WiFi (Wireless Fidelity) and WiMAX (Wireless Microwave Access) are infrastructure based networks. They are centralized network (i.e. the centralized authority is control over all wireless nodes in the network). This may lead to cost effective and overhead. But the MANET is an infrastructure less and decentralized network. It is a low expensive network as it is a self configuration network. The MANET can set up at any place and time. Many applications such as a disaster, Military battlefield, commercial sector and disaster recovery uses MANET because of its flexibility.

II. Literature Review

The traditional routing protocols in MANET cannot ensure reliability in the context of nodes with high mobility. Those are tried to handle the link breakage in the route due to mobility of nodes in the MANET. This paper aims to reduce the link failure in the route to reach the destination. The survey takes on routing protocols of MANET in [1] [8]. With that, three types of routing protocols such as proactive, reactive and hybrid are compared.

Proactive routing protocol maintains the list of destinations and their corresponding route by distributing routing table to the whole network (e.g. Optimized Link State Routing Protocol (OLSR) [18], Destination Sequence Distance Vector (DSDV)). Reactive routing protocols discover the route only on demand by flooding the Route Request (RREQ) throughout the network until finding the route to the destination. The MANET is vulnerable to route request flooding attack. The solution to mitigate this attack is provided in [19] from MANET environment.

The Adhoc On demand Distance Vector (AODV) and Dynamic source Routing (DSR) are the examples of Adhoc routing protocols. Hybrid routing protocols combines the advantages of the reactive and proactive routing protocols. Zone Routing Protocol (ZRP) [20] is one of the hybrid routing protocols. It takes the advantages of proactive and reactive component. The end to end delay is the main concern of QoS in the MANET [21] routing protocols because the real time data should be reach the destination within a particular time interval. The traditional routing approaches of MANET are analyzed in the following lines.

The Efficient routing protocol has been proposed in [2], [15], [11] for highly dynamic MANETs. The position based opportunistic routing [22] is used to achieve reliable data delivery. The node which overhears the transmission forwards the data towards the destination. If it failed to forward the data properly in the sense, next node will serve as the relay node until the best relay node found. So, it will take more time to select the best relay node since it does not choose the relay node based on the characteristics. In the proposed scheme, the relay node is selected based on the QoS parameters and the link residual life to ensure reliability with minimum delay.

The Local route repair scheme is proposed in [3] in MANET by using the stable Connected Dominating Set (CDS). The link failure is handled by reconstructing the Minimum Connected Dominating Set (MCDS) by using the neighborhood information. This will take more time to reconstruct the MCDS. In the proposed scheme, the route failure is avoided by using the parameter link residual life.

Ant Colony Optimization (ACO) based QoS aware, intelligent routing is proposed in [4] to guarantee QoS in the heterogeneous MANET. This is a cluster based routing scheme [23] in which the cluster head is selected by using ACO. These will causes calculation overhead in the resource limited MANET. In the proposed scheme, the overhead is reduced by avoiding the flooding of a Route Request (RREQ) messages. Flooding is the mechanism of forwarding a packet from a node to every node in the network.

The routing overhead in the MANET is reduced by Swarm Intelligence (SI) in [5], [24]. The optimal path is constructed by using the neighbor to neighbor communication without the knowledge of global topology. This scheme is applicable for highly dynamic MANET. But it does not consider the reconstruction of paths when one of the nodes cannot hear another.

The Dynamic Source Routing (DSR) protocol has been modified to guarantee QoS in the MANET communication. The Advanced Dynamic Source Routing (ADSR) [6] protocol and Authenticated DSR [25] discover routes with highest link stability factor. It continuously monitors the changes in the network topology to reroute the data packets before the route become unavailable. The continuous monitoring will lead to high energy consumption. So, it is not applicable for resource limited MANET.

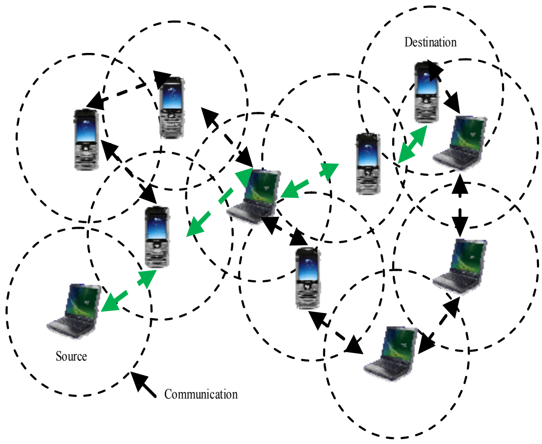

Fig. 2 Architecture of MANET

The Optimized Link State Routing (OLSR) is enhanced to guarantee QoS in MANET by including QoS and the energy constraints while selecting the path in [7]. This scheme provides better performance in the resource limited MANET in terms of energy. But the bandwidth of a node is not considered while to discover the route. This will overcome by the proposed method. Our proposed method uses the efficient bandwidth scheduling algorithm for this purpose.

In [12] the EX-OR is proposed which is the incorporation of Opportunistic Routing and the MAC (Medium Access Control) technique. It increases the throughput by using longer radio links with high loss rate for transmission. The traditional opportunistic routing schemes require additional radio channel [14] for each intermediate node in the case of multihop wireless transmission.

The existing approach Co-operative Opportunistic Routing [13] in the MANET (CORMAN) provides the routing solution for the highly dynamic MANET. It uses the Proactive Source Routing (PSR) protocol to detect the intermediate nodes to reach the destination. Each and every packet is installed with the forwarder list of the source node. As the topology of the network changes dynamically, the intermediate nodes also have the rights to update the forwarder list. It will cause the overhead in the network. The proposed scheme is not using additional routing scheme to entreat the data towards the destination. The next forwarder node is selected based on the link strength and the QoS metrics. So, the proposed scheme reduces the communication overhead and provides reliable data delivery by reducing link failure between the nodes participating in the communication.

III. Proposed Algorithms

Most of the existing routing protocols discover the route by flooding the RREQ messages. The straight forward approach to perform flooding is called as broadcasting [26]. The broadcasting of RREQ messages through flooding is very expensive and may induce redundant retransmission and contention, which is called as the broadcast storm problem. The redundant retransmission will occur when the mobile host in the MANET decides to broadcast message to its neighbour even the neighbour received the same message already from other host. At a same time many of the mobile host decides to broadcast the RREQ message. Due to that, the radio signals are content with each other. So, the RREQ messages are restricted to broadcast only to their neighbors. Then the selected relay node only has an obligation to broadcast it again.

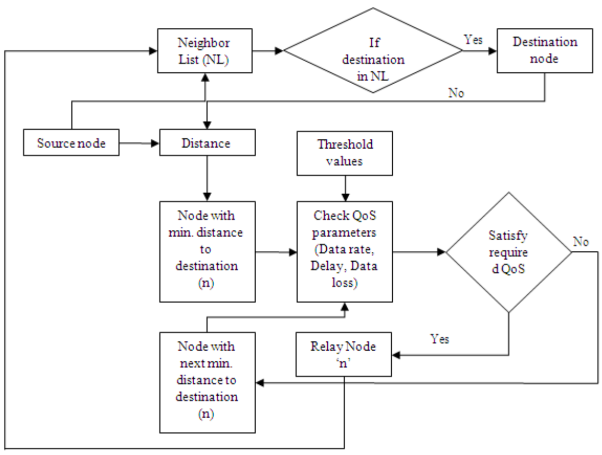

Fig. 3 Block diagram of the proposed system

An algorithm is proposed for selecting the relay node to guarantee the QoS requirements and to avoid the frequent link failure due to the dynamic environment of the MANET. This paper assumes that each node is moving with the same speed and has the same communication range. This paper proposes two algorithms, one for selecting the relay node dynamically and another one for schedule the bandwidth of the link between the nodes to avoid collision and congestion in the interface queue. This section presents these two algorithms in a detailed manner.

A. Dynamic Relay Node Selection Algorithm

In this algorithm, the source itself doesn't know the route to reach the destination. The source node and every intermediate node are having chance to select the next relay node. The relay node is selected based on the previous record of QoS parameters and also the link residual life. The following lines present the proposed algorithm.

Algorithm 1

1. Sn → ID of source node
2. Dn →ID of destination node
3. Relay node (RN) ← Sn
4. NL (i) →Neighbor list of node i
5. LRL_i → Link residual life of node i
6. /* determined based on previous transmission */
7. DR_i →Data rate of node i
8. S_d→ Size of the data
9. L_i→ Latency of node i
10. DL_i → Data Loss of node i
11. nPD_i^{prev}→No. of packets drooped by node i in the previous transmission
12. /* Threshold QoS values */
13. DR_i^{th}→ $S_d/_T$
14. L_i^{th}→T
15. DL_i^{th}→$S_d - nPD_i^{prev}$
16. D
17. For each node n in NL (RN)
18. Call procedure Distance (n, Dn)
19. n ← node with minimum distance
20. End For each
21. If $DR_n > DR_n^{th}$ then
22. If $L_n < L_n^{th}$ then
23. If $DL_n < DL_n^{th}$ && $CEP_i \geq T$ then
    a. RN ←n
    b. Break // to come out of the loop
24. End If
25. End If
26. End If
27. Until RN== Dn
28. Proc Distance (n1, n2) {
29. Distance→$\sqrt{\left(X_{pos}^{n1} - X_{pos}^{n2}\right)^2 - \left(Y_{pos}^{n1} - Y_{pos}^{n2}\right)^2}$
30. }

Algorithm 1 is used to select the best relay node based on the QoS values and the link quality. This algorithm determines the QoS values based on the last transmission history. Each node stores the record of achieving QoS requirements. The QoS parameters include Packet Delivery ratio, Packet loss ratio, and End to End delay. Packet Delivery Ratio is the ratio of the packets delivered to the destination successfully with respect to the number packets that have been transmitted by the source node. Packet loss ratio is the ratio of the packets dropped due to congestion or collision compared to the number of packets delivered to the destination successfully. End to End delay is the time taken by the data packet to travel from source to destination. The threshold values for Data rate (DR_i^{th}), Latency (L_i^{th}) and Data Loss (DL_n^{th}) calculated in the algorithm. The node should satisfy the following condition to become a relay node

- The Data rate should be greater than the DR_i^{th} value.
- The Data loss rate should be lower than DL_n^{th} value.
- The Latency or delay of a node should be lower than the threshold valueL_i^{th}.
- The Connection between the nodes should exist until the transmission ends.

The Connection Existence Period 〖CEP〗_i is the parameter used to calculate the link residual lifetime between two nodes. This parameter plays an important role as the link between the nodes changes dynamically in the MANET. This algorithm reduces the delay by selecting the relay node based on the distance between the relay node and the destination node. The distance is calculated in the graphical way. The following procedure is used to calculate the distance between each pair of nodes. The variable X_pos^n1 is used to denote the latitude of the node n1 and Y_pos^n1 is used to denote the longitude of the node n1. The node which is having least distance to the destination is selected if two or more nodes satisfy the QoS requirements.

In MANET communication the loss occurs due to the dynamic topology (Frequent link failure). But in the proposed scheme, the link failure is reduced by considering the parameter Connection Existence Period. The Connection Existence Period is the time during which that particular node is present in its communication range. A link between two mobile nodes will be active only, during which that two nodes are in the transmission range of each other. The following formula is used to calculate the CEP:

$$CEP(i,j) = {}^{D(i,j)}/_{V_r}$$

where,

$D(i,j)$ → The distance between the node i and j

V_r → The relative velocity between the nodes i and j

The CEP is the important parameter in this technique to ensure the reliability in the network. This is used to avoid the frequent link failure in the MANET.

B. Active Bandwidth Setting up Algorithm

The bandwidth is the rate at which the node receives the data packets with respect to time. So, the bandwidth setting up plays an important role in the communication. Bandwidth scheduling is the method in which the bandwidth is allocated to each and every node based on the data request rate and service rate. The bandwidth is allocated to each node is scheduled based on the following algorithm to ensure the bandwidth in the QoS parameters.

//Bandwidth Scheduling

1. q_s→ Size of the Queue
2. Req_{rate}→Data request rate
3. Ser_{rate} →Service rate
4. Bl_i^j (Backlog of the queue exists between node I and j
5. EM_i^j→Size of the queue which is free
6. If $Req_{rate} > Ser_{rate}$ then
7. Req_{rate} → $Req_{rate} - Bl_i^j$
8. Else
9. Req_{rate} → $Req_{rate} + EM_i^j$
10. End If

This algorithm is used to schedule the data request rate for the source node. In this algorithm, Service rate and Data request rate are used as important parameters to schedule the bandwidth for each node. The Service rate is referred as the rate at which the data is received by the destination. The Data request rate is the rate at which the data is sent out by the sender. Most of times the data delivery rate of the sender is equivalent to the service rate of the receiver. Usually, data are stored in the interface queue before transmitting to the destination.

The number of packets which is not yet processed is called as backlog. The bandwidth is scheduled based on the relationship between the data request rate and service rate. The data request rate is reduced by number of backlogs in queue, when the request rate is greater than the service rate. If the request rate is lesser than the service rate, the request rate is incremented by the number of empty spaces in the queue.

IV. Simulation and Analysis

We conduct a series of experiments wherein the number of nodes varies from 10 to 100 and the node mobility speed varies from 10 to 40. The nodes are distributed in the simulation area of 1500×1000m. The UDP/CBR (Constant Bit Rate) traffic is generated between the source and destination. The bandwidth for each channel is 2Mb at the initial time. After that it will update by using the dynamic bandwidth allocation algorithm. The data packets are scheduled after 0.05ms. The detailed simulation parameters are listed in Table I.

TABLE I
SIMULATION PARAMETERS

Parameter Type	Parameter Value
Simulation time	20ms
Simulation area	1500×1000m
Number of nodes	10,20,30…,100
Mobility Speed	10,20,30,40m/ms
Path loss model	Two Ray Ground
Channel bandwidth	2Mbps
MAC protocol	802.11
Transmission range	250m
Traffic model	CBR

A. Simulation Results

The NS2 Simulator is mainly used in the research field of networks and communication. The NS2 is a discrete event time driven simulator which is used to evaluate the performance of the network. Two languages such as C++, OTCL (Object Oriented Tool Command Language) are used in NS2. The C++ is act as a back end and OTCL is used as a front end. The X-graph is used to plot the graph. The performance evaluated by using the network parameter packet delivery ratio, packet loss ratio, end to end delay, routing overhead and throughput.

The Packet delivery ratio is the ratio of the data packets delivered to the destination successfully. The Packet delivery ratio is one of the important parameter to evaluate the quality of the network.

The formula used to find the Packet delivery ratio is as follows:

$$PDR = \frac{No.of\ packets\ deliverd}{TIme}$$

Fig. 4 (a) gives the graph for Packet delivery ratio. The graph shows that, the proposed scheme Dynamic relay node selection algorithm provides high performance when increasing the mobility speed too. But the performance slightly varies according to the node speed. Fig. 4 (b) gives the comparison analysis output of the proposed scheme with the existing approach CORMAN. The proposed scheme outperforms than CORMAN. Higher the Packet delivery ratio indicates that the high performance of the network.

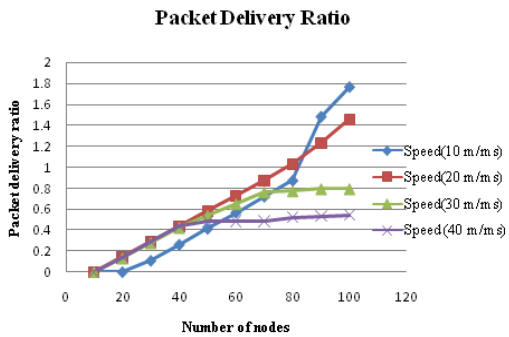

Fig. 4 (a) Packet Delivery Ratio analysis for various mobility speeds

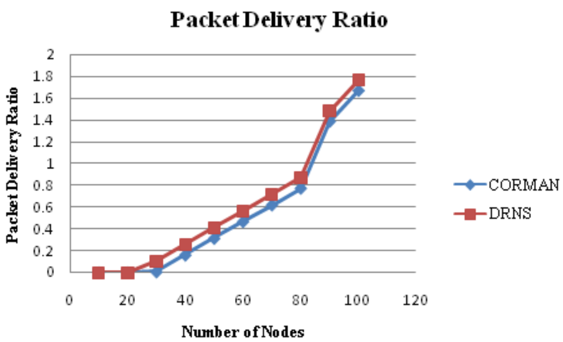

Fig. 4 (b) Packet Delivery Ratio comparison analysis with CORMAN

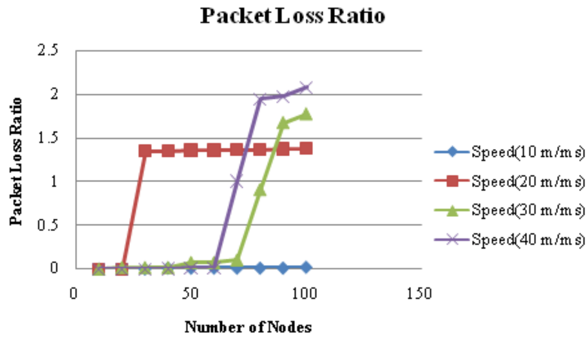

Fig. 5 (a) Packet loss Ratio analysis for various Mobility speeds

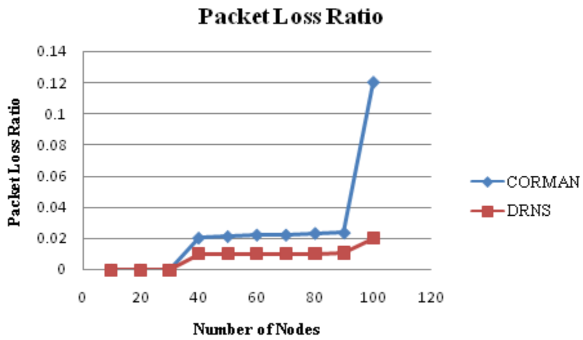

Fig. 5 (b) Packet loss Ratio comparison analysis with CORMAN

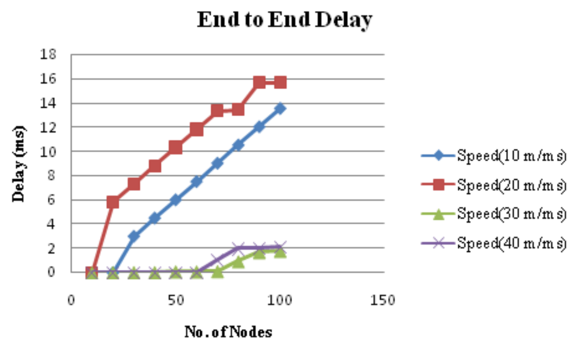

Fig. 6 (a) End to end delay analysis for various Mobility speeds

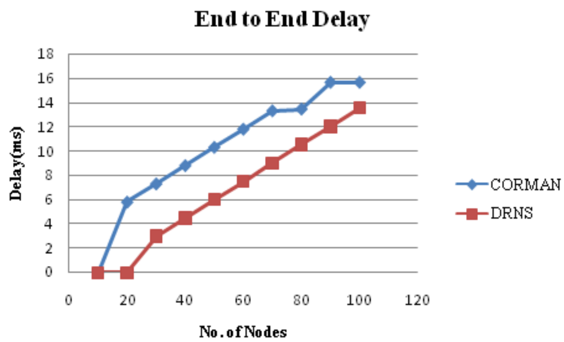

Fig. 6 (b) End to end delay comparison analysis With CORMAN

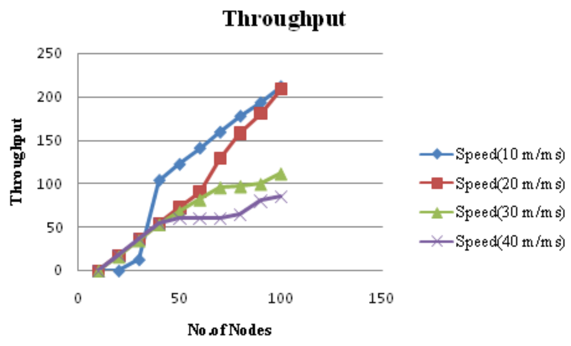

Fig. 7 (a) Throughput analysis of the proposed method for various mobility Speeds

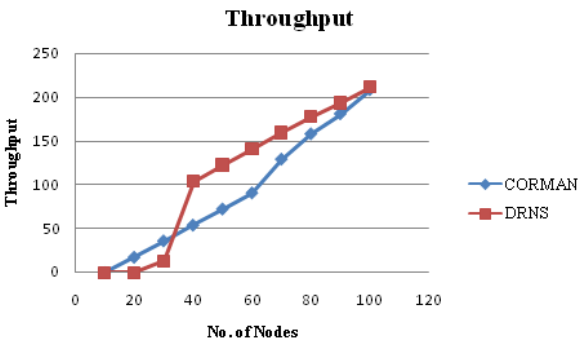

Fig. 7 (b) Throughput comparison analysis with CORMAN

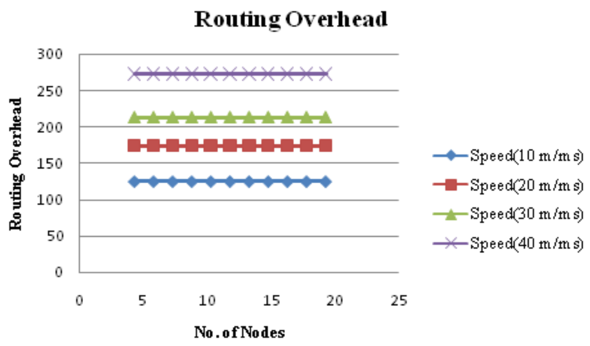

Fig. 8 (a) Routing overhead analysis of the proposed method for various mobility Speeds

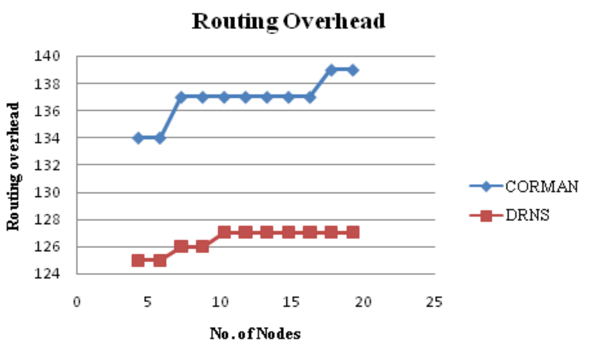

Fig. 8 (b) Routing overhead comparison analysis with CORMAN

The Packet loss ratio is used to evaluate the quality of the network provided by the routing scheme. Fig. 5 (a) shows the graph for Packet loss ratio of the proposed scheme in various simulation environment of different node speed. The packet loss ratio of the proposed scheme is compared with the existing approach CORMAN. The packet loss ratio of the proposed scheme is lower than the CORMAN as shown in Fig. 5 (b). Lower the Packet loss ratio indicates that the high performance of the network.

The time taken by the source node to deliver the data successfully to the destination is called as End to End delay. The following formula is used to calculate the End to End delay

$$EndtoEndDelay = {A_T - S_T}/_{n}$$

where,

A_T →Arrival Time

n →Number of Connections

S_T→Sent Time

Fig. 6 (a) shows that the End to end analysis of the proposed scheme. The delay increases as the moving speed of the node increases. But the slight variation is there. The proposed scheme leads to only tolerated delay in the network, even though the speed increases. Fig. 6 (b) shows that the proposed scheme leads to less delay when compared with the existing approach CORMAN.

The routing overhead is the summation of the number of packets has been transmitted to find out the route to reach the destination. The routing overhead is calculated by the following formula

$$Routing\ Overhead = \Sigma(N_{RREQ} - N_{RREP})$$

where,

N_{RREQ} →Number of Route request packets

N_{RREP} →Number of Route reply packets

The routing overhead increases while increasing the speed of the node, but it remains constant while increasing the number of nodes as shown in Fig. 7 (a). The simulation result shown in Fig. 7 (b) proves that the routing overhead in CORMAN is higher than the proposed scheme.

Throughput is the amount of packets delivered to the destination per unit of time. The Throughput is calculated by using the formula

$$Throughput = {No.of\ packets\ delivered}/_{Time\ period}$$

The system provides high throughput while the node is moving when compared to the node with highest mobility speed as shown in Fig. 8 (a). The comparative analysis of the proposed scheme with the existing approach CORMAN is given by the graph shown in Fig. 8 (b). As a result, the proposed routing algorithm is can able to guarantee QoS requirements in the highly dynamic environment.

V. Conclusion

In this paper, a novel dynamic relay node selection algorithm is proposed to satisfy the QoS requirements in the highly dynamic environment. In the proposed technique each node having a chance to select its next hop node based on the previous record of QoS parameters and the CEP. So, the proposed techniques enable the highly dynamic MANET to satisfy the QoS requirements without long delay. The simulation results show that the proposed technique provides high performance than the existing Cooperative routing protocol CORMAN when the packet delivery ratio, delay and overhead is used as the performance metric. Thus, the proposed routing algorithm is proved to be able to guarantee QoS requirements in the highly dynamic environment.

References

[1] Ipsita Panda, "A Survey on Routing Protocols of MANETs by using QoS Metrics**"**, *IJARCSSE Journal*, October 2012.

[2] Ramkumar. V.D," Efficient Routing Protocol for Highly Dynamic Mobile Ad Hoc Networks", *IJCMC Journa*l, July 2013.

[3] S.Revathi and T.R.Rangaswamy , "Efficient Flooding and Local route repair using the stable Connected Dominating Set for Mobile Adhoc Networks", *AJSR*, 2014.

[4] Debajit Sensarma and Koushik Majumder, "A novel hierarchical ant based QoS aware Intelligent routing scheme for MANETS", *IJCNC*, November 2013.

[5] Z. Liu, M. Z. Kwiatkowska, and C. Constantinou. "A swarm intelligence routing algorithm for Manets". In Proceedings of the *IASTED International Conference on Communications, Internet and Information Technology*, 2004.

[6] Youyuan Liu, "Advanced Dynamic Source Routing with QoS Guarantee", *International Computer Science and Computational Technology(ISCSCT '09)* Huangshan, P. R. China, 26-28,Dec. 2009, pp. 504-506.

[7] Suman Banik, Bibhash Roy, Parthi Dey, "QoS Routing using OLSR with optimization for flooding",*IJICT*, August 2011.

[8] Amandeep Kaur, Dr.Rajiv Mahajan ," Survey of QoS Based Routing Protocol for MANET's" , *IJARCSSE*, July2013.

[9] I. Chlamtac, M. Conti, and J.-N. Liu, "Mobile Ad hoc Networking: Imperatives and Challenges," Ad Hoc Networks, vol. 1, no. 1, pp. 13–64, July 2003.

[10] R. Rajaraman, "Topology Control and Routing in Ad hoc Networks: A Survey," *SIGACT News*, vol. 33, pp. 60–73, June 2002.

[11] S. Biswas and R. Morris, "ExOR: Opportunistic Multi-Hop Routing for Wireless Networks," in Proc. *ACM Conference of the Special Interest Group on Data Communication (SIGCOMM)*, Philadelphia, PA, USA, August 2005, pp. 133–144..

[12] Sanjit Biswas and Robert Morris "ExOR: Opportunistic Multi-Hop Routing for Wireless Networks", *CiteseerX* (2005).

[13] S. Chachulski, M. Jennings, S. Katti, and D. Katabi, "Trading Structure for Randomness in Wireless Opportunistic Routing," in Proc. *ACM Conference of the Special Interest Group on Data Communication (SIGCOMM)*, Kyoto, Japan, August 2007, pp. 169–180.

[14] P. Larsson, "Selection Diversity Forwarding in a Multihop Packet Radio Network With Fading Channel and Capture," *ACM Mobile Computing and Communications Review,* vol. 5, no. 4, pp. 47–54, October 2001.

[15] S. Yang, F. Zhong, C. K. Yeo, B. S. Lee, and J. Boleng, "Position Based Opportunistic Routing for Robust Data Delivery in MANETs," in Proc. *2009 IEEE Conference on Global Telecommunications (GLOBECOM),* Honolulu, Hawaii, USA, December 2009, pp. 1325–1330.

[16] Jun-Zhao Sun "Mobile Ad Hoc Networking: An Essential Technology for Pervasive Computing", *Machine Vision and Media Processing Unit, InfoTech Oulu.*

[17] Shivashankar et al., "Performance Metrics Evaluation of Routing Protocols in MANET", *IJARCCE*, Vol. 2, Issue 3, March 2013

[18] Loutfi, A., Elkoutbi, M. "Enhancing performance OLSR in MANET", *Multimedia Computing and Systems (ICMCS), IEEE Conference 2012.*

[19] Choudhury, P. , Nandi, S. ; Pal, A. ; Debnath, N.C., "Mitigating route request flooding attack in MANET using node reputation", *IEEE Conference on July 2012***.**

[20] Kyoung-Ja Kim ; Hyun-Woo Koo ," Optimizing Power-Aware Routing using Zone Routing Protocol in MANET "Network and Parallel Computing Workshops , *NPC Workshops. IFIP International Conference on 2007*.

[21] Calafate, C.T.; Malumbres, M.P. ; Oliver, J. ; Cano, J.-C. ; Manzoni, P. "QoS Support in MANETs: a Modular Architecture Based on the IEEE 802.11e Technology ", *IEEE Transaction 2009*.

[22] Shengbo Yang ; Feng Zhong ; Chai Kiat Yeo ; Bu Sung Lee ; Boleng, J, "Position Based Opportunistic Routing for Robust Data Delivery in MANETs ", *Global Telecommunications Conference, IEEE2009*.

[23] Atiq, M.K. ; Hyung Seok Kim ; Manzoor, K, "Cluster based routing protocol for public safety networks " *ICT Convergence (ICTC), 2013 International Conference***.**

[24] Xin Li ; Zhiliang Zhu, "A Gateway Discovery Method for MANET Accessing Internet Based on Overhead Control " *Wireless Communications, Networking and Mobile Computing (WiCOM), 2011 7th International Conference*.

[25] Tornos, J.L. ; Piles, J.J. ; Salazar, J.L. , "ADSR: Authenticated DSR" Risk and Security of Internet and Systems *(CRiSIS), 2011 6th International Conference.*

[26] Sze-Yao Ni, Yu-Chee Tseng, Yuh-Shyan Chen, and Jang-Ping Sheu, "The Broadcast Storm Problem in a Mobile Ad Hoc Network*", National Central University* Chung-Li, 32054, Taiwan.