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A Dynamic Buffer Management Technique with Integrated Cross-Layer Approach for Effective Routing Strategy in Zone Routing Protocol for MANETs

[1]Suhaas K P, [2]S Senthil

[1]Research Scholar, School of Computing and Information Technology, REVA University, Bengaluru
[2]Director, School of Computer Science and Applications, REVA University, Bengaluru

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Abstract

The major upsurge in the pressures for Quality of Service (QoS) domain in transmission of data in wireless systems hasrejuvenated the researchers to build furthercost-effective routing results to assist trust worthy interaction between the systems. But, older protocols in wireless communication are restricted mainly due to unchanging and inadequatere source network parameters. Ever increasing challenges and claims in communication using mobile networks suggest highly accessible, consistent, QoS-based routing protocol while under ever changing network topology constraints and scenarios. Considering this as the motivation, this paper showcases a vigorous Cross-Layer Approach for efficient routing solutions for the assurance of QoS in the considered scenario of MANETs. Considering the fact of traditional ZRPs, the showcased cross-layer architecture considers Network layer, Medium Access Control (MAC) layer and Physical layer to accomplish boosted Differentiation of Service and Impartial Resource Assignment (DSIRA) and Proactive Network Management (PNM), that are completed at the various layers of the normal protocol model. The numerous network constraints based efficient solution enables MANETs to presenthigh packet delivery ratio, lowest possible packet loss for data classified for real-time and non-real-time data.

***Keywords:** MANET, Zone Routing Protocol, Cross-layer Architecture, Quality of Service, Service Differentiation.*

1. Introduction

The major upsurge in the pressures for Quality of Service (QoS) domain in transmission of data in wireless systems has rejuvenated the researchers to build further cost-effective routing results to assist trustworthy interaction between the systems. Nevertheless, empoweringun failing, resource efficientplus QoS centralobservanceestablishment has continuously been the wide-openinvestigationfield for researchers. Considering this as a consequence, the researchers have obtained a wide horizon tosucceedin development of more and more resource efficient routing solution.

Out of the various strategies and communication systems currently active, the Ad-hoc networks, which is highly dynamic and being dispersed and infrastructure-less networking result have reaped enormous consideration. In preparation, three prime routing advances are reactive routing protocol, proactive protocol and hybrid routing protocol, that can be applied to achievetransmission of data over network, preferably wireless; but certain factors such as placement of the node also plays a vital role in establishing the network statistics and hence the efficiency. Functionally, reactive routing protocol mainlydepend on the limited distance component to execute routing judgment; but node movements

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restrictsits effectiveness for the applications like Mobile-Ad-hoc Network (MANET) [1]. Dissimilar to thetraditional reactive or proactive routing strategies Zone-routing protocols utilizesfunctionality of the both to perform intra-zone routing and inter-zone transmission techniques with the help of reactive and Proactive Network Management (PNM) methods, respectively. It must be taken care of excessive number of hops to the destination shall create a chance of link collapse and increase the probability of data loss. In other words, the more the number of hops, the performance of the network shall seem to be compromised and degrade QoS [2-5]. To accomplish these results, coming up with a different routing protocol with integrated parameter from different layers of the protocol stack is need of the hour. This becomes a motivation to study further and develop a better routing protocol.

Judgingthe Zone-Routing Protocol (ZRP), there is often enhanced probability of degree of congestion at the boundary zone or also in the transmission of inter-zone which gets enhanced multiple times with movement/mobility. In supplement, movement/ mobility enforces probability of link-outage substantially during transmission in inter-zone scenario. To attainsuch goals, cross-layer approach centered routing protocol can be a prospective answer [3][10-18].

With this aim, in this research paper Adaptive and Integrated Cross-Layer Approach for Efficient Routing Solutions in Zone Routing Protocol for MANET has been established for assurance of QoS. Unlike traditional zone routing approaches the proposed adaptive and integrated protocol accomplishes Differentiation of Service (DoS) and Fair Resource Scheduling with Proactive Network Management (PNM) at the Network layer.

This manuscript is divided into six consecutive sections where Section II presents related work followed by problem formulation in Section III. Section IV presents system implementation. In Section V results obtained and respective inferences are discussed, which is followed by conclusion in Section VI. References used are mentioned at the end of manuscript.

2. Related Work

To exploit effectivity of ZRP for wireless communication functions totally different optimization efforts are proposed. Chellathurai et al. [19] developed associate evolutionary ZRP (EZRP) model that preserved inner zone half in ZRP as intact whereas the outer zone exploited evolutionary computing technique for estimating best forwarding path. However, authors [1] couldn't address the problem of network dynamism and its impact on topological variations, link-vulnerability, congestion likelihood, etc. SreeRangaRaju et al. [20] centered on augmenting ZRP by reducing management packets overload whilst exploring best forwarding node. Additionally, they applied a question control theme for control. Primarily, it augments routing zone structure to perform overlapping query detection and rejection. Their model enabled ZRP to determine routes to all or any connected nodes having minimum overhead traffic demand as compared to classical proactive route discovery ways. Researchers like Malwe et al. [21], Minh et al. [22] exploited location data to perform ZRP optimization. Considering network dynamism in Ad-hoc network, authors [21] initially enforced selective bordercast theme to perform route estimation. The key novelty of this approach was that during this protocol route request was transmitted solely by the peripheral nodes. Much, all comprising nodes during a network can’t be ready to perform best route selection; it had been executed solely by sure specific peripheral nodes with higher connectivity. It reduced storage complexness and memory needed for proactive node table management. In [22], authors exploited ZRP conception to derive a geographical routing protocol for MANET that confined search domain for route discovery [33]. Location-Aided Zone Routing Protocol (LAZRP) [22] applied node location to perform routing the decision; but couldn't address the key problems with dynamic topology and ensuing link-vulnerability, congestion etc. Benni et al. [23] centered on performance optimization by augmenting best forwarding route call wherever they found distance primarily based ZRP higher than Intra Zone Routing Protocol (IARP) and inter Zone Routing Protocol (IERP). In [24], Madasamy et al. applied random Dynamic Programming (SDP) theme in conjunction with a geographic angular zone-based two-phase dynamic resource allocation theme to perform routing over VANETs. Authors applied SDP model to attain the best resource allocation strategy, whereas, holding best viability routing choices. The same effort was created in [25][26], wherever authors applied location data of node to perform best forwarding route choice. Authors exploited distance data to estimate a route that might accommodate all connected nodes to attain higher packet delivery magnitude relation. In [26] authors applied the conception of moving object modeling and compartmentalization techniques to perform routing the call in VANETs. Considering routing overhead in ZRP Ghode et al. [27] developed a node energy monitoring algorithmic program (NEMA) to perform zone head choice over MANET to attain higher performance. Authors derived Zone Head choice algorithmic program (ZHSA) to represent totally different zones followed by zone head choice with most residual power. However, cognitive content of link vulnerability, outage-probability, congestion condition, etc in MANETs reach its suitableness with real time applications. Religious belief et al. [28] centered on resource management to attain increased performance in MANETs. Multi-zonal conception was applied in [29] to attain reliable communication over heterogeneous

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WSNs. Authors applied triangle-zone primarily based cluster conception to attain enhanced period. But this approach couldn't agitate mobile topology conditions. To attain route with marginal utilization of network resource such as bandwidth, time, and energy Singh et al. [30] applied statistical regression conception with curve point of intersection area to cut back requested flooding (message) and energy-aware routing call.Authors [31] developed Zone based Geographical Multicast Routing (ZGMR) that employs stateless unicast routing protocol for data transmission over MANET. Authors applied link duration and distance as network parameter to perform Best Forward Node (BFN) selection. Considering impact of the quality of link on BFN selection.To achieve QoS performance authors proposed a Virtual Base Station (VBS) selection model for MANET. Authors applied mobile node's Signal-to-Noise Ratio (SNR) parameter to

3. Problem Formulation

Learning the inevitable prerequisite of the mobile wireless networks like MANET, building a trustworthy and efficient and time-keeping routing protocol is of enormous importance. Allowing QoS centered and unfailing transmission of data over MANETs which that one experiences drastically very extreme variations in topological aspects, need the concerned routing protocol to be added with routing strategies such as proactive ones, while surrounding the functionalities of self-motivated network sensitivity that finally help in creation of best routing choice and strategy. As previously asserted Zone-Routing Protocol (ZRP) with enhanced proactive network management can be a crucial explanation to gather above indicated requirements. Being a cross kind of protocol, the ZRP encompasses together reactive as well as proactive routing approaches; nevertheless, the consequence of the latter come to be more essential when trading parameters with ever changing mobile network condition with extremely elevated variations in topology. Though, accomplishing this objective involves coordinated operational actions throughout the layers of protocol stack. To reach the above said goal, in this paper an Adaptive and Integrated Cross-Layer Approach for Effective Routing Solutions in Zone Routing Protocol for MANETs is developed to offer delay resilient routing approach to minimize data holding period with maximum packet velocity. This approach can be of utmost substantial that can help assist the Physical layer to perform better routing decision.

In combination with ZRP, the proposed routing protocol accentuates on enhancing proactive routing with cross-layer characteristics where it utilizes dynamic parameters from the various levels of the protocol to achieve QoS-centric optimum routing outcome. Here, it is presumed that every node is resistant with the protocol encompassing one hop-distant neighbor’s data. The understanding regarding node’s considerations such as congestion status, channel information (i.e., buffer availability) can assist reaching ideal routing protocol. Hence, our purported model utilizes main potential node data to perform optimal routing, where cross-layer approach has been incorporated with PNM and DSIRA strategy.

In addition, contemplating the responsibility of optimum resource sharingin cooperation for event driven Real-TimeData (RTD) in addition to Non-Real-Time Data (NRTD),the protocol applies a robust Differentiation of Service and Impartial Resource Assignment (DSIRA) and Proactive Network Management (PNM), that accomplish best QoS centric allocation of resource. To attain these intentions, the node data from the distinct levels has been accumulated. A fragment of the various levels under respect to the development and associated roles at the corresponding layers is given in Fig. 1. Studying the crucial requirement of event-driven objective crucial interaction over MANET, the proposed model protocol expects to achievefull potential throughput with bare minimum data decline likelihood and time limit miss percentage.

4. Proposed System

This section primarily discusses the proposed routing protocol for MANET.

The Proposed Protocol

The proposed routing protocol exploits dissimilar parameters of active network scenario from the various levels of the protocol stack to best routing solution. To accomplish such, the proposed protocol uses cross-layer routing approach model containing different layers such as application layer, network layer, MAC layer and PHY layer as in Figure 1. As portrayed in Figure 1, the application layer of the proposed protocol relates a innovative Differentiation of Service and Impartial Resource Assignment (DSIRA) structure that recognises category of data to guarantee QoS centric allocation of resource. The employed Differentiation of Service (DoS) prototypical supports in recognising RTD and NRTD data categories which shall ultimately help in optimal resource allocation. With this anticipation the proposed protocol makes congestion detection at the network layer that operates in conjunction with DSIRA model to achieve best possible QoS-centric management of resource. In an overall manner, our proposed routing protocol achieves Differentiation of Service and Impartial Resource Assignment(DSIRA) and Proactive Node table management at the Network Layer. Noticeably, DSIRA applies at the application layer as well. The key tasks by the proposed routing protocol at the different levels of the protocol stack are:

1) Proactive Network Table Management,
2) Differentiation of Service and Impartial Resource Assignment (DSIRA)

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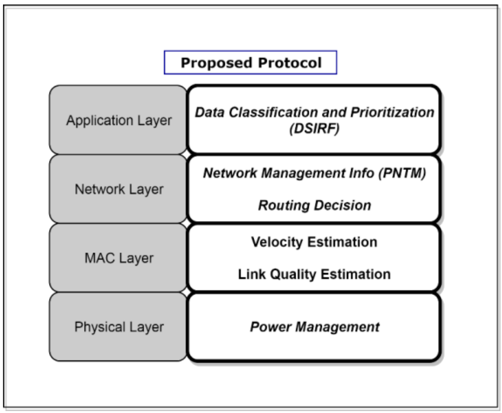

Figure 1: Proposed Cross layer Architecture for QoS centric Routing Protocol for MANETs.

The argument of the planned routing protocol is introduced in the successive sections.

Pro-active Network Table Management

Being a highly dynamic topology centred expertise, the MANET regularly experience sex tremely high-pitched complex constraint (link quality, inter-node distance, buffer availability, congestion, etc) disparity. The topological variations may possibly influence distance of one node to another or inter-node distance and consequently may affect quality of the link. Likewise, dynamic environment of nodes could influence the node to suffer blocked network circumstances influencing general communication efficacy. On the other hand, in the scenario of dynamically changing network conditions, utilizin gold or outdated network data may well trigger link to collapse, thus making massive transmission of data again and increasing the delay and ultimately loss of energy resources. Considering these kinds of cases, the utilization of Proactive Network Table Management (PNTM) can be a prospective answer that still equips optimally for ZRP requests. The agreement with such kind of circumstances the proposed model utilizes PNTM that shall update the network parameters with dynamism to improve best possible routing judgment. Dissimilar to the reactive routing methods, the PNTM empowers active network factors revise to improve network-condition informed decision-making process. Distinctly, dissimilar to the conventional proactive routing methodologies, the proposed PNTM paradigm improves the likelihood of the repeated process of Discovery of Node (DoN) that shall reduce indicating expenses. In our proposed protocol each contributing node holds evidence and information about neighbour which is one-hop distance away by the *Beacon* transmission method. The used beacon information includes important node info com prising the NodeID, maximum memory/buffer capacity, available buffer space, node location, packet velocity, and quality of the link. Remarkably, in the proposed protocol these values of the parameters are obtained over the acknowledgement of the message that diminishes unwanted and iterative process of communication and signalling overhead. Studying control packet design, we have measured every packet of 512 bytes holding three different disciplines that are dedicated such asNodeID, Dynamic Node factor, such as buffer availability and node location identifying position vector. Consequently, conveying a beacon message, the protocol gathers one-hop node data and revised node table to complete the transmission of data. Hence forth the proposed routing protocol allows a node to send beacon message to selected nodes around the sender.

After obtaining communication request from a different node, a receiving node reorganizes its timer to 0,thenthereforepreventsunsoliciteddemands from further nodes. That helps in lowering congestion. In PNTM style,every node holds a node information table. Consider $\mathrm{N_j}$ be a neighbour which is one-hop distance away and $\text{Best Forward Node}_\mathrm{i}$ be the optimumre directing node in zone-based routing, and next the node table is revised as (1)

$$P\mathbb{N}_{Table} = \{Node_i \in \mathbb{N}_j | D_{Eucl\_d} - D_{Eucl\_F} \geq 0\} \tag{1}$$

In equation (1),D_{Eucl_d} is the Euclidean space between the source and destination, and D_{Eucl_F} refers the distance between source and the nearbybest next node.

Differentiation of Service and Impartial Resource Assignment (DSIRA)

Undeniably, providing QoS centric transmission demands necessitate optimum allocation of resources; but the distinct kind of data and its significance requires priority based on resource-sensitive data. For instance, a network can be affected by both RTD as well as NRTD information for transmission; but it can have distinctive priority to make best possible conclusion. In such situations, detecting types of data and earmarking limited and dynamic supply is a huge mission to maintain QoS specification in mission-critical transmission situation. Distinguishing the data types, the proposed system implements DSIRAto guarantee optimum allocation of resource for RTD information while, also retaining highest potential resource or buffer for NRTD. In our proposed routing prototype, every node holds two separate types of equal-capacity buffer. Being an RTD centric ZRP, when a node suffers entire buffer utilization to ensure QoS centric communication, the additional buffer is offered from NRTD buffer while guaranteeing that it doesnot dispose of all the NRTD information and retain QoS. To accomplish it, the proposed routing strategy performs dual-model arrangement where RTD buffer supports prioritized data storage and allotment, while NRTD buffer uses First-In-First-Out (FIFO) centered allotment. In issue for the duration of functional scenario, when a node endures full resource exhaustion for RTD communication, it borrows extra

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buffer space from NRTD buffer to help RTD dips for managing the newly added NRT-data in queue. Dissimilar to the conventional resource allotment methodologies, where NRTD buffer is cleared entirely to hold RTD data, the proposed DSIRA version plummets only few newly arrived packets in NRTD buffer line. Using this approach, the packets waiting for long time and queue up in NRTD buffer persists in queue up to preserve QoS. This, DSIR A model ensures best possible resource allotment to the RTD data whilst preserving highest possible resource provisioning to the NRTD. This method confirms optimum QoS trade-off for RTD along with NRTD information and hence makes the proposed model appropriate for chief transmission system requirements.

Algorithm for Dynamic Buffer Management Selection

Input: *Total number of nodes, initial buffer capacity, one-hop distance node information.*
Output: *'n' slots of buffer from NRTD to RTD*
Initialize both NRTD and RTD Buffer
For each *node 'i' do*
if BuffScore $_{(RTD)} \leq$ *BuffScore* $_{(NRTD)}$
&& no. of RTD packets > no. NRTD packets, ***then,***
Transfer 'n' slots of NRTD Buffer to RTD Buffer
end
end

Figure 2: Pseudo-algorithm for Dynamic Buffer Management technique

The results achieved and their corresponding implications are examined in Section V.

5. Results and Discussion

This research effort is principally centered on forming acost-effective and resource utilization Zone Routing Protocol (ZRP) with improved proactive routing policies to be appropriate for routing network solutions. ZRP self, has the arrangement of both reactive and proactive routing strategy and involves strong routing assessment method. Reactive routing methods utilizes stationary node and network characteristics to execute routing assessment, on differing with proactive routing technique involves dynamic network constraints update to allow fault-resistant routing assessment. Studying the MANETs, allowing optimum routing choice with a strong proactive network supervision can be of maximum importance. Considering the present study, the concentration was made on utilizing a new ZRP model withDynamic Buffer Management Technique with Integrated Cross-Layer Approach has been built. Dissimilar to the traditional routing methodologies, where single network parameters such as inter-node distance or residual energy was utilized to perform routing choice, the proposed model exploits cross-layer architecture that employs Application layer and Network layer. This model is strengthened with Differentiation of Service(DoS) and proactive network table management (PNTM), Prominently, to guarantee optimum performance of the routing employed target sensitive resource provision and fair resource allocation that helped best resource establishment for both RTD along with NRTD. The whole proposed prototype was established based on IEEE 802.11a protocol for which MATLAB simulation platform has been utilized.

The key simulation parameters used is presented in Table I.

Table 1: Experimental Setup

Parameter	Specification
OS	Windows, 8GB RAM, Intel i5 processor.
Programming	MatLab Scripting
Simulation Used	MATLAB
Physical Layer	IEEE 802.11PHY
MAC Layer	IEEE 802.11MAC
Mobile Nodes	10 to 60
Protocol Named	Dynamic Buffer Management
Link-layer	CSMA-CD
Size of Packet	512 B
Radio Range	100 to 150 meters
Packet Deadline time	8 Sec.
Traffic	Constant Bit Rate
Mobility	Athelete Circular Running Competition
Simulation Period	600 Sec.
Payload	250, 500, 750, 1000, 1250, 1500, 1750, 2000, 2250, 2500, 2750, 3000.

The simulation results were acquired for RTD as well as NRTD information transportation where it was expected to accomplish highest achievable or optimum Packet Delivery Ratio (PDR). Contemplating the present methods and techniques and their efficiency to accomplish QoS provision, in this research effort two key works done in [31][32] are counted for performance appraisal. The performance of the measured algorithms has been done in terms of packet delivery ratio (PDR) of the RTD and NRTD information traffic. Observing outcome, it can be clearly noticed that the proposed routing protocol outshines other state-of-art techniques (ZGMR and VBS-ZRP) in terms of higher PDR performance. Appreciably, the maximum data delivery for RTD, which is a mission-critical prioritized data traffic type to retain QoS provision, the protocol shows estimated 97.92% PDR, which is more than other approaches (i.e., ZGMR (88.9%) and VBS-ZRP (82.0%)). Since, both the traditional methodologies, ZGMR and VBS-ZRP donot have any advanced various buffer requirement and associated resource planning, and consequently it has caused into lower PDR performance.

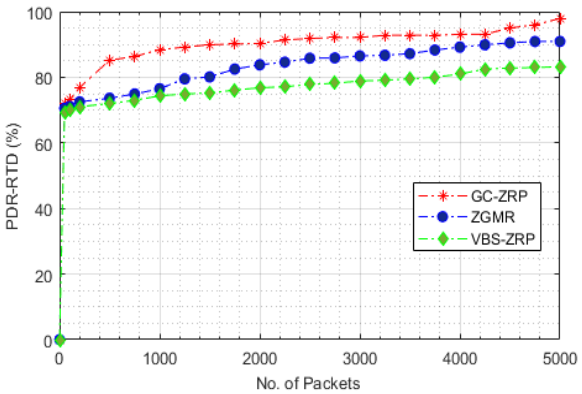

Figure 3: PDR performance for RTD traffic

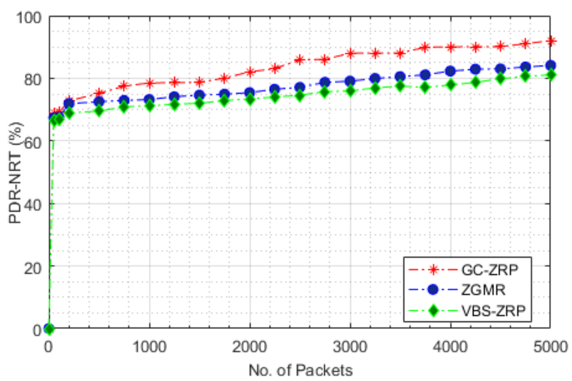

Figure 4: PDR performance for NTD traffic

The above results do acknowledge that our projected routing protocol accomplishes more trustworthy and consistent data transmission for both RTD as well as NRTD traffic.

6. Conclusion

Zone Routing Protocol (ZRP) being a hybrid routing method involves extremely effective proactive network management capability, particularly for MANET. In such a situation, expanding a robust and reliable proactive network management approach with dynamic network knowledge capability can be crucial to ensure consistent with trustworthy factor and QoS centric transmission. The changes may compel system to endure outage condition or drop of data. To improve such difficulties in this paper, an extremely robust Dynamic Buffer Management Technique with Integrated Cross-Layer Approach was developed that utilized the characteristics of the cross-layer network model. Being a cross layer routing strategy, the protocol performed proactive node table management and service differentiation and fair resource scheduling at the network layer and Application Layer. The simulation outcomes disclosed that the proposed routing protocol attains maximum packet delivery ratio of 98% for RTD information whilst preserving approximate 92% of packet delivery ratio for non-real-time data. This indicates the robustness and trustworthiness of the proposed multi-network constraint fair resource allocation strategy.

References

[1] S. Corson and J. Macker, “Mobile Ad hoc Networking (MANET): Routing Protocol Performance Issues and Evaluation Considerations”, IETF WG Charter, http://www.ietf.org/html.charters/MANET-charter.html, 1999.

[2] Hyunchul Joo, Ki Jin An and Hwangjun Song, "Urgency-based packet scheduling and routing algorithms for video transmission over MANETs," IET International Communication Conference on Wireless Mobile and Computing, Shanghai, 2011, pp. 403-408.

[3] M. Rath, B. Pati and B. K. Pattanayak, "Cross layer based QoS platform for multimedia transmission in MANET," 2017 11th International Conference on Intelligent Systems and Control (ISCO), Coimbatore, 2017, pp. 402-407.

[4] M. Conti, Gaia Maselli, G. Turi, S. Giordano “Cross-Layering in Mobile Ad Hoc Network Design” IEEE Computer Society, February 2004.

[5] R.Venkatachalam, Dr.A.Krishnan “Multiple Cross-Layer Design Based Complete Architecture for Mobile Adhoc Networks” (IJCSIS) International Journal of Computer Science and Information Security, Vol. 5, No. 1, 2009.

[6] R. El Mezouary, A. Loutfi and M. El Koutbi, "A cross-layer architecture for service differentiation in Wireless Sensor Networks with multiple sinks," 2014 International Conference on Multimedia Computing and Systems (ICMCS), Marrakech, 2014, pp. 843-848.

[7] Y. Ozen, C. Bayilmis, N. Bandirmali and I. Erturk, "Two tiered service differentiation and data rate adjustment scheme for WMSNs cross layer MAC," 2014 11th International Conference on Electronics, Computer and Computation (ICECCO), Abuja, 2014, pp. 1-4.

[8] M. Wan, Z. Lu, L. Wang, X. Xia and X. Wen, "A QoE-oriented cross-layer resource allocation scheme for mobile service over Open Wireless Network," 2014 International Symposium on Wireless Personal Multimedia Communications (WPMC), Sydney, NSW, 2014, pp. 186-191.

[9] D. Krishnaswamy, “Network-assisted link adaptation with power control and channel reassignment in wireless networks,” in Proc. 3G Wireless Conf, 2002.

[10] C. Lal, V. Laxmi and M. S. Gaur, "An adaptive cross-layer routing protocol for

delay-sensitive applications over MANETs," International Conference on Advances in Computing, Communications and Informatics, 2013.
[11] M. Rath, B. Pati and B. K. Pattanayak, "Cross layer based QoS platform for multimedia transmission in MANET," 2017 11th International Conference on Intelligent Systems and Control (ISCO), Coimbatore, 2017, pp. 402-407.
[12] M. A. Gawas, L. J. Gudino and K. R. Anupama, "Cross layer multi QoS metric routing for multimedia traffic in 802.11E over MANETs," 2016 Eighth International Conference on Ubiquitous and Future Networks (ICUFN), 2016.
[13] R. Chauhan, P. Saini "Performance Evaluation of Layered and Cross Layered based MANETs" International Journal of Computer Applications (0975 – 8887) Volume 145 – No.11, July 2016.
[14] M. Conti, Gaia Maselli, G. Turi, S. Giordano "Cross-Layering in Mobile Ad Hoc Network Design" IEEE Computer Society, February 2004.
[15] R.Venkatachalam, Dr.A.Krishnan "Multiple Cross-Layer Design Based Complete Architecture for Mobile Adhoc Networks" (IJCSIS) International Journal of Computer Science and Information Security, Vol. 5, No. 1, 2009.
[16] Z. Iqbal, S. Khan, Amjad Mehmood, Jaime Lloret, and Nabil Ali Alrajeh "Adaptive Cross-Layer Multipath Routing Protocol for Mobile Ad Hoc Networks" Hindawi Publishing Corporation Journal of Sensors Volume 2016.
[17] P.A. Abdul Saleem, Dr. Naveen Kumar "Cross Layer Design Approach in Wireless Mobile ADHOC Network Architecture" International Journal of Advanced Research in Computer and Communication Engineering, 2013.
[18] S. Thacker "Enhancing Routing With Cross Layer Optimization in MANETs" International Journal of Computer Science and Information Technologies (IJCSIT), Vol. 5 (3) , 2014, 3708-3710.
[19] [19] A. S. Chellathurai and E. G. Darma Prakash Raj, "EZRP: Evolutionary Zone Routing Protocol," 2013 International Conference on Advanced Computing and Communication Systems, Coimbatore, 2013, pp. 1-5.
[20] M. N. SreeRangaRaju and J. Mungara, "Tuning ZRP framework for CR networks and MANETs," International Performance Computing and Communications Conference, Albuquerque, NM, 2010, pp. 289-293.
[21] [S. R. Malwe, S. Rohilla and G. P. Biswas, "Location and selective-bordercast based enhancement of zone routing protocol", 3rd International Conference on Recent Advances in Information Technology (RAIT), Dhanbad, 2016.
[22] T. Pham Thi Minh, T. T. Nguyen and D. S. Kim, "Location Aided Zone Routing Protocol in Mobile Ad Hoc Networks," 2015 IEEE 20th Conference on Emerging Technologies & Factory Automation (ETFA), 2015, pp. 1-4.
[23] N. S. Benni, S. S. Manvi and Anup T H, "A performance study of hybrid routing protocols for variation of nodes in wireless Mesh Networks," 2015 International Conference on Communications and Signal Processing (ICCSP), Melmaruvathur, 2015, pp. 1366-1369.
[24] B. Madasamy and P. Balasubramanian, "Geographical angular zone-based optimal resource allocation and efficient routing protocols for vehicular ad hoc networks," in IET Intelligent Transport Systems, vol. 12, no. 3, pp. 242-250, 4 2018.
[25] J. R. Maranur and B. Mathpati, "VANET: Vehicle to vehicle communication using moving zone based routing protocol," 2017 International Conference on Electrical, Electronics, Communication, Computer, and Optimization Techniques (ICEECCOT), Mysuru, 2017, pp. 1-7.
[26] D. Lin, J. Kang, A. Squicciarini, Y. Wu, S. Gurung and O. Tonguz, "MoZo: A Moving Zone Based Routing Protocol Using Pure V2V Communication in VANETs," in IEEE Transactions on Mobile Computing, vol. 16, no. 5, pp. 1357-1370, May 1 2017.
[27] S. D. Ghode and K. K. Bhoyar, "NEMA: Node Energy Monitoring Algorithm for Zone Head Selection in mobile ad-hoc network using residual battery power of node," 2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), Chennai, 2016, pp. 1999-2004.
[28] P. Jain and V. Prakash, "A buffer management scheme to control packet loss in MANET," 2016 Symposium on Colossal Data Analysis and Networking (CDAN), Indore, 2016, pp. 1-5.
[29] A. Mahboub, E. M. En-Naimi, M. Arioua, I. Ez-Zazi and A. El Oualkadi, "Multi-zonal approach clustering based on stable election protocol in heterogeneous wireless sensor networks," 2016 4th IEEE International Colloquium on Information Science and Technology (CiSt), Tangier, 2016, pp. 912-917.

May-June 2020
ISSN: 0193-4120 Page No. 3480-3487

[30] K. Singh, A. Sharma and N. K. Singh, "Linear Regression Based Energy Aware Location-Aided Routing Protocol for Mobile Ad-Hoc Networks," 2015 International Conf. on Computational Intelligence and Communication Networks (CICN), Jabalpur, 2015, pp. 114-121.

[31] R. Shankar and E. Ilavarasan, "Geographie multicast routing protocol for achieving efficient and scalable group communication over MANET," Proceedings of IEEE International Conference on Computer Communication and Systems ICCCS14, Chennai, 2014, pp. 068-072.

[32] I M. A. Fahmy, L. Nassef, I. A. Saroit and S. H. Ahmed, "QoS parameters improvement for the hybrid Zone-based Routing Protocol in MANET", The 7th International Conference on Informatics and Systems (INFOS), Cairo, 2010.