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An Adaptive Model for Congestion Resilient and Deadline Sensitive Communication in Zone-Routing Based MANETs using Cross-Layer Architecture

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Abstract
Considering a larger picture of wireless communication scenario, a hybrid protocol is very much in need of the hour, especially the Zone Routing Protocol. The Zone Routing Protocol encompasses the approaches of routing from reactive and as well as proactive routing scenario. This routing management technique has been observed to be more important in terms of efficiency of the transmission of the data. But the traditional routing mechanisms restricts the efficiency for the ever-changing topology supported networking answers in Mobile Ad Hoc Networks (MANETS). 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 the fact of traditional ZRPs, the showcased cross-layer architecture considers Network layer, Medium Access Control (MAC) layer and Physical layer to accomplish Dynamic Link Quality Estimation, packet velocity estimation, that are completed at the various layers of the normal protocol model. Considering this as the motivation, this paper showcases a vigorous Cross-Layer Approach for efficient routing solutions for the assurance of QoS in terms of throughput in the considered scenario of MANETs. Considering the fact of traditional ZRPs, the showcased cross-layer architecture considers packet velocity estimation and congestion detection models, that are completed at the various layers of the normal protocol model. The numerous network constraints based efficient solution enables MANETs to present high packet delivery ratio, lowest possible packet loss for data classified for real-time and non-real-time data.

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1. Introduction

Communications in Wireless domain and system has always been performing un-interchangeable responsibility to converge up rising and falling transmission of data and associated challenges in the area mobile communication. But, allowing trustworthy, resource economical plus QoS central observance establishment has continuously been the wide-open investigation field for academicians. 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. Ad-hoc networks is the most cost-effective and successful routing protocols that utilize two methods, intra-zone and inter-zone routing to implement communication from one end node to the other. Divergent to the old-fashioned reactive or proactive routing strategies Zone-routing protocols utilizes functionality of the both to perform intra-zone routing and inter-zone transmission techniques with the help of reactive and Proactive methods, respectively. MANETs with sparsely and dynamically adopted mobile nodes repeatedly require very high topological changes, and hence rises the link-vulnerability, probability of packet-loss, delay in end-to-end etc. and there fore need side al routing choice to improve the said issues. Functionally, MANET uses multi-hop data transmission process everywhere each node consists of a routing mechanism to advance the data to the next leap nodes towards the direction of the destination. To realize these outcomes, arriving with a distinct routing protocol with cohesive parameters from distinct layers of the protocol stack is necessity of the hour. This turns out to be a reason to report additional and build on a better routing protocol.

In practice, sophisticated communication systems accommodate both data consisting of real-time values consisting data (RTD) as well as Non-Real-Time Data (NRTD), where the real time data consists of data such as event-driven RTD information while latter transmits multimedia data consisting of comparatively lesser priorities [1]. Assessing Zone-Routing Protocol (ZRP), there is often increased likelihood of degree of congestion at the boundary zone and that may also be increased with the scenario of mobility. In enhancement, mobility may create probability of link-outage substantially during transmission in inter-zone scenario and may in turn lead to congestion. And hence reviewing congestion and quality of link can assist in avoidance of link-breakage or data drop.

With this motivation, in this research paper Adaptive and Integrated Cross-Layer Approach for Efficient Routing Solutions in Zone Routing Protocol for Manetas been established for assurance of better throughput as a QoS. Unlike traditional zone routing approaches, the proposed Adaptive and Resilient Model will detect and control the traffic in the event of any congestion and hence take suitable measures to reduce the traffic.

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 optimisation efforts are proposed. SreeRangaRaju et al. [5] centred 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 with minimum overhead traffic demand as compared to classical proactive route discovery ways.In [6], authors exploited ZRP conception to derive a geographical routing protocol for MANET that confined search domain for route discovery [7]. Location-Aided Zone Routing Protocol (LAZRP) [6] applied node location to perform routing the decision; but couldn't address the key problems with dynamic topology and ensuing link-vulnerability, congestion etc. Considering routing overhead in ZRP Ghode et al. [8] 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. Singh et al. [9] applied statistical regression conception with curve point of intersection area to cut back requested flooding (message) and energy-aware routing call. Samarasinghe et al. [10][11] developed a greedy ZRP (GZR) protocol that used greedy coordinates to perform alternate routing path. During this model GZR allocates greedy coordinates for every zone, as opposed to individual nodes. In GZR messages area unit transmitted in two ways; greedy geographic routing in between zones and ancient tree-based routing at intervals a zone. This technique enabled tree to possess manageable sizes thanks to confine depth by the zone-diameter. This approach might simply alleviate the difficulty of re-estimation of the coordinates of the network topology and therefore reduces overheads. Shankar et al. [12] suggested geographic multicast routing to construct a virtual tree structure with node location data. However, the requirement of link repair model and outage likelihood reach best multicast tree formation. To alleviate this issue, authors [12] developed Zone primarily based Geographical Multicast Routing (ZGMR) that employs stateless unicast routing protocol for information transmission over MANET.

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Authors applied link period and distance as network parameter to perform BFN choice. Considering impact of the standard of link on BFN choice Yélémou et al. [13] developed a Binary Error Rate (BER) primarily based ZRP (BER-ZRP) routing protocol that enabled improved ZRP Packet Delivery magnitude relation performance. To attain timely digital communication authors applied speed parameter to perform adaptive ZRP (OVBAZRP) for stable and higher routing [14]. However, this approach in the main centered on achieving different zone radius (per node) moving at different speeds.

2. Problem Formulation

Taking the fact of the predictable necessity of the mobile networks such as MANET, forming a consistent and trustworthy with time effective routing procedure enhancement is of immense importance. Supporting QoS centric such as better throughput among many, and consistent data transmission over MANET swhich itself suffers substantially high variations in topological aspects necessitate the associated routing procedure to be improved with proactive routing strategies while also implanting the features of dynamic network sensitiveness (channel complaint awareness and node appropriateness) that ultimately can help creation of ideal routing decision. In point, below mobile topology, as it is very common in MANETs the network constraints in particular the congestion, quality of the link, might fluctuate over recreation time that in the end might lead to link-outage and consequently compelling network to experience iterative and continuous node finding and retransmission of the data. It can trigger considerably very elevated loss of energy, resource utilization, and added to that, significantly improved time taken in end-to-end delay that cannot be suggested for event-driven mission crucial transmission of data. Expanding proactive routing management with ever changing dynamic network knowledge can help network type to avoid congestion, outrage of link, probability of data drop, high end-to-end delay time, lesser throughput etc.

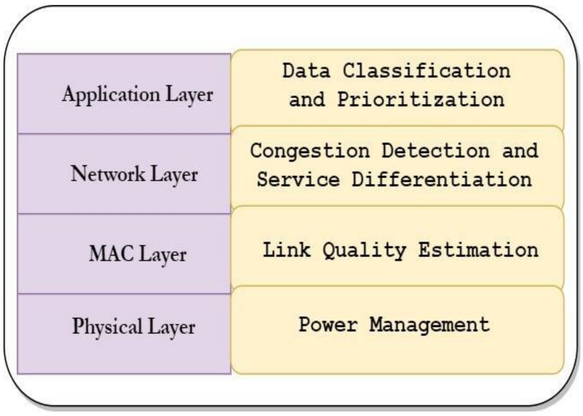
To accomplish the lesser congestion scenario along with detection and avoidance, this research paper proposes a Adaptive and Resilient Model for Congestion Detection and Control in Zone-Routing Based MANETs using Cross-Layer Architecture Routing Strategy, that shall be established over the IEEE 802.11a protocol list to achieve a higher throughput. In this conjunction with ZRP, concept of congestion avoidance protocol underlines on increasing proactive routing with cross-layer characteristics everywhere it develops dynamic network issues from the various levels of the protocol stack to perform QoS-centric optimum routing strategy. Mainly, the proposed congestion detection and control protocol utilizes the information from Application layer, Network Layer, and MAC layer. At this time, it is understood that every node is covered with the protocol encompassing distance from one hop to another hop neighbour's information. In extra, the proposed protocol encompasses node factors from the various separate layers of the protocol stack. The knowledge about every node's crucial factors such as status of congestion, quality of link, channel state information or buffer availability and data holding period be able to support achieving optimum protocol design to minimize congestion and take up necessary steps to improve the efficiency of the network. Although, limited efforts have taken advantage of the conventional features such as distance from one node to another i.e., inter-node distance, and probability of congestion as the node constraint to perform routing choice; but below is the extremely dynamic topology as these restricted parameters cannot guarantee appropriateness of a node to maintain high throughput as QoS-centric interaction and transmission over a long duration of time. Hence, our proposed version utilizes most important and likely node data and network characteristics to perform routing to the destination where dynamic quality of the link,velocity of the buffer/memory accessibility and congestion likelihood have been utilized to perform routing node selection. A fragment of the various layers in understanding and associated roles at the individual layers is presented in Figure 1. Studying the crucial requirement of event-driven mission critical interaction over MANETs, the proposed protocol aims to achieve highest possible throughput with minimum probability of data drop probability.

Proposed System

This portion mainly considers the offered routing protocol for MANETs.

Congestion Detection and Avoidance Model,

Dynamic Link Quality Measurement



Proposed Cross layer Architecture for QoS centric Routing Protocol for MANETs (GC-ZRP)

The comprehensive examination of the proposed routing protocol is introduced in the below sectors.

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Congestion Detection

As previously indicated in earlier portions, the changing and dynamic topology of MANETs can force it to suffer congestion for the period of transmission. Movement of nodes on the additional side shall enhance the possibility of bottleneck that powers it to suffer loss of data, transmission of repeated data and resource collapse and exhaustion. To ease such concerns, the proposed model employs a congestion finding technique that utilizeshig hestmemory capability and existing memory accessibility measurements to approximate bottle neck likelihood of a node. As previously considered in prior section, the proposed modeless balanced timer based communication management method that preventsundesir able communication demands thus preventing congestion possibility. In supplement, our recommended paradigm integrates a unique Detection of Congestion and Avoidance Model (DCAM) that processes memory accessibility dynamically. Therefore, with the projected extreme memory capacity and existing offered memoryDCAM assesses congestion possibility of a node that further denotes appropriateness of that node to be converted into"Best Node" for optimal route finding to the destination. A node with enough resource accessibility and lowestbottleneckpossibility is considered as a "Best Node" candidate. Being a cross-layer routing procedure, the protocol uses in combination with Differentiation of Service and Impartial Resource Allocation that designates two different buffers for RTD and NRTD to prevent congestion likelihood. As indicated, RTD-buffer stores information in selected queue approach while NRTD buffer utilizes FIFO system to store information. Meanwhile, in preparation very data packet holds specified well-defined lifetime and consequently demands to achieve objective before target time to support appropriate decision.

Some of the crucial provisions of the proposed routing protocol is its time limit classified resource programming. To facilitate packet time limit sensitive resource distribution, the procedure approximates distance between source and destination node. It supports in finding information with the maximum significance (1). Examining calculation (1), maintaining minimumT_{Ratio} can be considered for prioritization.

$$T_{Ratio} = \frac{RDT_i}{d_i^j} \qquad (1)$$

In (1), RDT_ishows the "Residual Deadline Time" (RDT), d_i^j is the Euclidian length from the forwarding node i and the nearby destination j. In the proposed routing model RDT is approximated by calculating the arrival point in time of each packet and RDT_i is revised for every packet under communication before transmitting the same packet. Comparably, the total queue time is deducted fromRDT_i. In the proposed routing protocol, the existing memory availability data is utilized to regain congestion possibility at a node. Now, we develop a parameter called Congestion Level Index (CLI) which indicates congestion probability at that respective node (2). Let us assume the total number of neighbouring nodes be denoted asS_n. So, the total congestion at particular node and specified node can be valued as:

$$CLI_r = \sum_{i=1}^{\square-1} \frac{CLI_{NRTD\_Buff} + CLI_{RTD\_Buff}}{CLI_{NRTD\_BuffMax} + CLI_{RTD\_MaxBuff}} \qquad (2)$$

In the above,$CLI_{NRTBuff}$ refers to the buffer available at NRT-buffer, CLI_{RTD_Buff} states for the buffer free at RTD buffer. Likewise, in denominator variables $CLI_{RTD\_MaxBuff}$ and $CLI_{NRTD_BuffMax}$represent the highest buffer capability of the RTD-buffer and the NRTD-buffer. Hence, once assessing the CLI of the adjoining node, that node can determine its appropriateness to grow into the "Best Next Node" or the BNN. In our proposed routing protocol, a node with least CLI is chosen as the node for BNN selection.

Link Quality Measurement

Unquestionably, establishing best route towards the destination using the situation of dynamic link data can be important to guarantee trustworthy and reliable transmission of data. Then, quality of the link frequently fluctuates over the distance and therefore linking a node with better link condition can be crucial for best route selection. On the other side, a greater portion of precisely obtained data such as throughput, indicates greater quality of the link, that can be clearly anticipated in the MAC layer of the protocol stack. Considering this as the motivation, in the proposed routing model, the collected packet and the overall transmitted packet info is utilized to develop dynamic link quality. Precisely, we use the below equation to estimate link quality.

$$\eta i = \alpha * \square + (1 - \square) * \left(\frac{\square_{rx}}{\square_{tx}}\right) \quad (3) \qquad (3)$$

where, ηasserts the dynamic link quality Index, $\square_{rx}$ and $\square_{tx}$denote the total number of accepted and the sent packets. The parameterα, is also known as network coefficient, that always stays within the range of0 to 1. In the proposed routing protocol, a node having the maximum link quality is selected as the BNN to represent Best Route.

The outcomes achieved are examined in Section IV.

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3. Results and Discussion

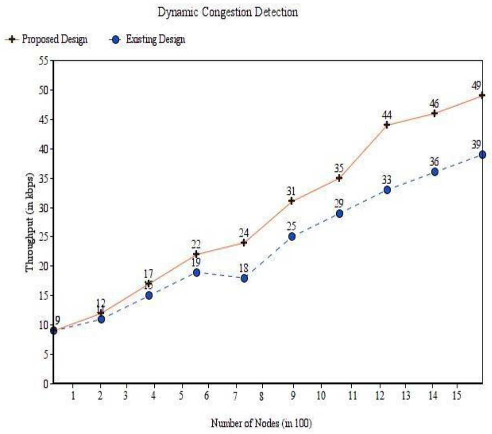
This exploration work is mainly intensive on evolving competent Zone Routing Protocol (ZRP) with improved proactive directing tactics to be relevant for mobile network explanations. ZRP being the blend of both reactive and proactive routing choice involves robust and consistent routing verdict mechanism, particularly at the outside layer. Reactive routing methods exploits stationary node and its grid geographies to achieve routing choice, but on the different proactive routing technique, itnecessitatesever changing dynamic network constraints and revises to permitfault-resilient routing choice. Taking into consideration, applications like MANETs, allowingoptimum routing choice with a robust proactive network administration and supervision can be of utmost consequence. Reflecting the existing study where the importance was completed on evolving a novel adaptive model for congestion resilient model for deadline sensitive information has been established. Dissimilar to the traditional routing methods where sole network parameters for instance inter-node distance or outstanding energy was utilized to achieve routing decision, this proposed model achieves cross-layer manner that services different layers of the protocol stack. This proposed protocol is armoured with classification of data, detection of congestion.Thecomplete proposed model was established based on IEEE 802.11a protocol for which MATLAB simulation has been used. Few key simulation constraints used is represented in the below table.

Experimental Setup

Table 1: Experimental Setup

Parameter	Specification
OS	Windows, 8GB RAM, Intel i5 processor.
Simulation Used	MATLAB
Physical Layer	IEEE 802.11PHY
MAC Layer	IEEE 802.11MAC
Mobile Nodes	10 to 60
Protocol Named	Congestion Resiliency Model
Link-layer	CSMA
Size of Packet	512 B
Radio Range	100 to 150 meters
Packet Deadline time	8 Sec.
Traffic	Constant Bit-Rate
Mobility	Circular
Simulation Period	300 Sec.
Payload	250, 500, 750, 1000, 1250, 1500, 1750, 2000, 2250, 2500, 2750, 3000.

Though, several versions of ZRP routing protocols have been developed so far; but, a very insufficient efforts have remained on exploiting cross-layer notion to originate a mixture routing conclusion. But, reflecting the essential of presentation valuation, in this research effort a reference model [1-3] has been established. Reflecting, the model is to be useful for a assignment critical transmission situation where allowing bottleneck free routing, fault-outage resistant communication arrangement is must, in this research paper, the normalizing network factor (i.e. weight ω) has been assigned 0.5, equally for considered parameters, $(\omega_{1(LQE)} = 0.5; \omega_{2(Cong)} = 0.5$.. The researcher in future can apply these weight parameters based on its application specific demands and self-consciousness. The simulation outcomes were obtained for the varying number of nodes and it can be observed from the Figure 3 that the throughput is considerably higher than the existing protocol. This means the weighted parameters shall allocate equal weighted resource to the Link Quality and the Congestion Detection procedure. Noticeably, the maximum data delivery, called as throughputis significantly more as compared to the existing method of routing protocol. On the other hand, the presence of an extremely robust and efficient buffer/memory management technique in aggregation with congestion resilient communication determination, has strengthened our proposed protocol to display better performance. Here, it can effortlessly be envisioned that the enhanced proactive routing strategy and congestion reduction model has permitted it to display better Inter-Zone Best Next Node selection (BNN). This as a result, has assisted in lowering undesirable link breakage or retransmission of packet and ultimately congestion retransmission which is the main reason for rise in the packet loss. Thus, in relative to the previously obtained results, the proposed model has demonstrated lowest packet loss than the existing other approaches. The below graph clearly showcases that the proposed Congestion resilient model has higher throughput than the existing approach as in [17].



Throughput in Existing Vs. Proposed Design

Though Adaptive Cross Layered Cooperative Routing Algorithm (ACCARA) was a unique attempt to exploit network channel situation for routing strategy; but important node-features such as packet velocity and congestion probability during movement could not be delivered. Much as the likelihood of contention and data sensitive allocation of resource could not be evaluated. Such constraint shave been considered in our proposed routing protocol. These characteristics have the protocol to exhibit traffic classified allocation of resource along with Link Quality and Congestion Degree.

4. Conclusion

Zone routing protocol being a hybrid routing method requires highly competent and effective proactive network management capacity, particularly for networking for mobile answers such as MANETs. In that case, emerging with a effective and robust network administration strategy with ever-changing network consciousness capability can be important to guarantee and reliable and QoS centric transmission. The ever-changing dynamic topology of a network can execute enormous network parameter disparities such as probability of congestion and distance in inter-node, quality of link, remaining energy, rate of packet transmission of a node etc. Such differences might strengthen network to experience collapsing of condition or drop of data. Such proceedings are frequently understood in ZRP-based routing methods, particularly in inter-network transmission. To improve such difficulties in this research paper anextremely robust and novel Adaptive Model for Congestion Resilient and Deadline Sensitive Communication in Zone-Routing Based MANETs using Cross-Layer Architecture was developed that oppressed the functionalities of the cross-layer network strategy and parameter allocation to accomplish optimum best next node collection. Being a cross layer routing methods, the proposed protocol completed detection of congestion and differentiation of service and impartial resource allocation at the network layer and link quality estimation at the MAC layer that collectively achieved to guess best next node to empower QoS centric transmission in MANET. The time limit dependent resource allocation and utilization features and many important parameters based BNN selection aided optimum progressing route choice for both mission-critical information and non-mission critical information. The simulation outcomes exposed that the projected routing protocol attains maximum throughput as compared to the existing routing protocol approaches. This indicates the efficiency and robustness of the proposed multiple-constraint network based best route to the destination selection and impartial resource distribution methods.

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