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A Reliable Transmission on Cluster Based Wireless Ad Hoc Network with Adaptive Negotiations Using Vector Assisted Energy Efficient Dynamic Opportunistic Routing Mechanism

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ABSTRACT

Reliable data transmission within wireless ad hoc networks is a formidable challenge, owing to the distinct attributes of mobile data communication. Existing routing protocols struggle to accommodate the dynamic nature of data traffic, leading to energy losses and substantial propagation delays. In response to these challenges, we introduce a novel Vector Assisted Energy Efficient Dynamic Opportunistic Routing model, implemented through an Adaptive negotiation-based cluster routing protocol. The approach involves strategically partitioning the network into clusters, each facilitated by an optimal cluster head. These clusters optimize data transmission and network longevity by gathering mobile nodes through negotiations. Our model leverages a reactive opportunistic routing protocol and organizes packet forwarding into vectors. Through extensive simulations using NS2, we evaluate the proposed scheme against conventional routing protocols. Key metrics, including Throughput, Packet delivery ratio, Average end-to-end delay, Network lifetime, and packet drop, demonstrate the efficacy of our model. Notably, our approach outperforms conventional methods, particularly in energy savings during data collection and transmission within high-traffic contexts. And our study contributes a novel solution to the challenges of wireless ad hoc networks. The Vector Assisted Energy Efficient Dynamic Opportunistic Routing model showcases superior reliability, efficiency, and network longevity. This work not only advances data communication in such networks but also provides a template for future research in enhancing wireless communication systems.

1. INTRODUCTION

Wireless ad hoc Network is considered as Self Organizing infrastructure network employed to modern wireless data communication. It accommodates parallel transmission of data over the network to mitigate the high propagation delay, energy losses and packet losses. Reliable data communication of the wireless ad hoc Network is primary research attention by the researchers on various peculiar attributes of the network. Cooperative routing is considered as advanced data transmission approach to ensure time dependent high throughput data communication. However, enabling the cooperative routing for packet routing in dynamic infrastructure less network is highly challenging and requires more decision making mechanism on various traffic patterns and mobility of the nodes on the data forwarding [1-4].

The design of efficient Medium Access Control routing protocol also poses significant challenges. Fully exploitation of the network to discover the optimal paths is required to alleviate the dynamic characteristics of the data traffic and data inferences. Parallel transmission of the packet should be efficiently transmitted to the multiple destinations using opportunity routing techniques through multiple intermediate hops without link failure. As link failure will affect the energy and throughput of the network. However, robust and flexible approach is required to deal with the possible route changes and link failure without compromising the energy and quality of service constraints of the particular topology. Energy is crucial network component and it handles the overall communication of the network. Further it is essential to design the mechanism which manage the transmission of the data packet on the unreliable link [5-10].

In this paper, a new Vector Assisted Energy Efficient Dynamic Opportunistic Routing model has been proposed as Adaptive negotiation to address the design loopholes of the network. Proposed model realizes the network through Cluster Based routing protocol. Initially network is partitioned into clusters on selection of the cluster head for the optimal data transmission and to enhance the lifetime of the network by gathering the mobile nodes on basis of the negotiations like location similarity or node density similarities. It brings more benefits to mobile node operating with less energy. This way, a high throughput of the network is envisioned on implementing the reactive opportunistic approach and enforces the Vector Based routing towards packet forwarding in the optimal path traffic among the intermediate nodes with adaptive negotiations in the densely populated cluster region of the network. Finally, Packet scheduling is carried out to facilitate the graceful mitigation of the network energy and bandwidth requirement.

The rest of the paper is organized into following sections: Section II outlines the significantly related conventional research approaches and their contributory aspects to model the high reliable data communication protocol. Section III details the specification of the proposed dynamic opportunistic routing protocol enabled to reliable high throughput data communication followed by simulation results and performance discussion on various performance metric in section IV and Section V indicates the core findings of the proposed model.

2. LITERATURE REVIEW

This section explores the most significant concept of high density and high traffic routing protocols from the related literatures which is carried out on basis of the theoretical analysis against the various traffic patterns and dynamic characteristic of the nodes.

2.1 Reliable data communication through anchor nodes assisted cluster based routing protocol

In this protocol, reliable data communication has been achieved on partitioning the network into cluster. Cluster is established with Cluster head which acts as anchor node for packet transmission in the network. Clustering of the node is carried out on basis of the node density. The model adopts optimal balance between bandwidth availability and bandwidth utilization within delay and throughput constraints. In this protocol, nodes near to destination consume more energy and it leads high propagation delay and data losses. Further TDMA/CDMA increases the interferences as it is not properly synchronized for negotiation and contention [11-13].

2.2 Void avoidance-anchor assisted cluster based routing protocol for reliable data communication

In this protocol, void avoidance anchor assisted Cluster Based routing protocol has been exploited on the traffic patterns due to varying location and node energy levels. Reliable data routing reduces propagation delay on the traffic patterns by employing the clustering approach on various properties of the network parameters. Further protocol adjusts the networks cluster sizes on basis of the data traffic. Finally, protocol eliminates node failure and transmission delay by employing the void avoidance constraints [14-17].

3. PROPOSED MODEL

In this section, design of the proposed reliable data transfer protocol was presented with various strategies and constraints towards the optimal path determinations. Clustering based routing technique is incorporated in this protocol to achieve high throughput and to increase the quality of service of the network.

3.1 Network model-WANET

Wireless ad hoc networks is established as self organizing network with source and destination nodes towards transmitting and receiving the data packets among. Medium Access Control Protocol is employed to transmit the data among the various destinations from the different sources. Each node has separate ID with dynamic IP address as the node changes its characteristics and links with other nodes frequently. Mostly nodes act as intermediate nodes for assist the data transmission. Further transmission range of node is set equal and transmission links is to set to bidirectional.

3.2 Clustering of nodes

Due to mobility nature of the node in the WANET network, node clustering is considered as vital approach to alleviate the network congestion and interference. Clustering of the nodes increases the stability of the network and to increase longer lifetime of the network on generation of the Clusterhead to administrate the remaining node in the cluster on basis of packet transmission. Clustering ensures the high performance on the dynamic packet communication. Clustering of the nodes is based on the following constraints.

3.2.1 Clustering of node based on weight approach

Clustering of node carried out on weight approach and it explores the network or node metric such as node degree, node distance with its neighbour and node moving speed. In this Clusterhead is selected is based on weight of the node in the network. In this approach, node with highest no of the neighbours is selected as cluster head. Furthermore it is used to enhance the network lifetime throughput and energy consumption. In this node with highest no of the neighbours is selected as cluster head.

3.2.2 Clustering of nodes based on energy approach

Clustering of node carried out using energy approach and it explores the network metric such as degree of nodes, nodes mobility and node energy. In this Clusterhead is selected is based on weight of the node in the network. In this approach, node with highest estimated energy value in the neighbourhood is selected as cluster head. Furthermore it is used to enhance the network lifetime throughput and energy consumption. In this node with highest no of the neighbours is selected as cluster head.

Further constraints for clustering of the network as follow:

- Optimal rate for a node to generate data should more than specified node density.
- The constraints of energy and link capacity of the node with other nodes should be higher compared to other nodes.
- Effective time period to collect data from nodes under the constraints of energy and load capacity has been in the value range for mitigating the retransmission.

3.3 Opportunistic routing

Opportunistic routing is employed to forwarding the data from the source node in cluster to destination node in another cluster through several intermediate nodes in various intermediate clusters to transmit the data as intermediate node. It employs the broadcasting to identify the route and to forward the packet through links to destination which is considered as probabilistic. The protocol is capable in eliminating the duplicates on the condition that only closest intermediate node should forward the node to next hop or destination [18-20].

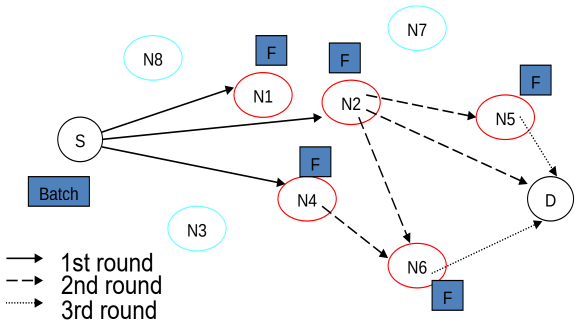

Figure 1. Architecture of opportunistic routing protocol

Proposed protocol resembles like switched network on the fixed path to forward packet to destination node through intermediate nodes. It computes the node diversity on each data transmission. It provides high throughput as each independent to each other and there is exist no interference among the nodes. Opportunity routing protocols forms the subset containing the packet for the data transmission in batch which termed as vector or fragment. Each batch sends packets in map structure which represented as batch map in the Figure 1. Further batch map contains highest priority node to receive the packet. Finally forward list determined on basis of priority i.e. proximity to the destination.

The opportunistic routing protocol computes the candidate list through expected transmission count on the forward delivery probability. It eliminates the link state flooding and calculates the optimal path on basis of weighted shortest path. Further protocol uses the transmission schedule constraints to predict the data transmission rate and allow sending the data through high priority node to destination.

3.3.1 Optimal path computation

Optimal path computation determines the routing structure which enables the source node to identify the highest possible path or best route among available routes during a single route discovery process. Flood of a route request from the several sources learns more than one path to the destination to forward packets through them. It is to decrease the number of route discovery processes since there are backup routes already available and in case one route fails will reduce the end-to-end delay, energy consumption and the network lifetime of the network.

Computation provides the trace file containing the backup routes information to discover the route on failure on node during transmission. The depiction of link longevity within the pathways is illustrated by the likelihood of a link remaining persistently available for a specified duration [21, 22]. Accurate anticipation of link availability over a brief period is facilitated by assessing the distance between nodes. Consequently, node lifetime routing relies on the energy status of nodes, encompassing aspects such as residual energy and energy depletion rate.

Let Ni denotes the link, xi be the connection, Ltxi the lifetime of the connection, Ni-1 and Ni considered as neighbour nodes, whereas BN i and BN i-1 considered as battery lifetime of the node Ni. The lifetime of the connection among the nodes (LTx i) is based on the comparative flexibility and distance among the nodes Ni-1 and Ni at time t. The link lifetime (LTM i) is determined utilizing the subsequent equation:

$$LTMi = min\ (LTxi, BNi - 1, BNi) \tag{1}$$

Thus, the lifetime of route R is defined as the minimum value of the lifetime of both nodes and connections involved in route R. Architecture of the proposed methodology is represented in the Figure 2. Two states may be assumed by the nodes: active and inactive modes. In the active mode, more energy is consumed by the node, resulting in a shorter lifespan compared to the inactive mode. The residual energy of node Ni is represented by Rei, the energy depletion rate by Edi, and the duration in seconds by T. Node lifetime is estimated using the following equation:

$$LTNi = REnTi/EDni\ where, t \in [nT, (n+1)\,T] \tag{2}$$

However highly dynamic wireless ad-hoc networks will lead to frequent occurrences of link failure and route breaks which can managed using the adaptive negotiation of the opportunity routing protocol.

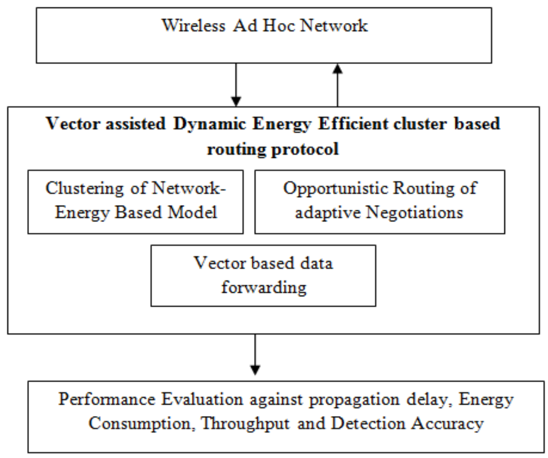

Figure 2. Proposed architecture of the work

3.3.2 Adaptive negotiation

Adaptive Negotiation is to generate node negotiation node on computation of high priority node candidate list to provide high data scalability on the data transmission from source to destination node on the dynamic updates of the data traffic among the intermediate nodes in the densely populated cluster region of the network. Negotiated nodes are represented in the node vector for packet forwarding. Coverage range of the transmission node is computed as follows:

$$R = x = \frac{2R}{\pi} tan(p) \tag{3}$$

where, p is the predicted negotiated nodes and R is the transmission radius.

Further, packet forwarding of the negotiated nodes is organized into vector. Packet scheduling is carried out in the optimal routing paths on basis of packet arrangement in the vector as it facilitates for graceful mitigation of the network energy and bandwidth requirement on the cooperative manner.

Algorithm 1: Specified Channel Data Transmission

Source Node information=SI

Intermediate node information=II

Distance among the node N(xi-1 yi-1) and N(xi yi)=Dt

If (Dt<Threshold limit)

Add node Ni as Negotiated node Vector V

Initiate Data Transmission to the Destination using the optimal path vector

Set fag Value=1

Else

Compute the another node with less distance

Add it that particular node Ni-1 Negotiated node Vector V for data Transmission

Set Flag Value=2

Compute Node Collision and Data Redundancy on Each Vector

For (Vi=1;Vi<Threshold, Vi++)

Packet of Node Pn==Pni-1

Eliminate the data from Ni-1

Algorithm computes the negotiating node vector for optimal data transmission among the nodes in the vector. Communication Range of each cluster head and its lifetime is computed on each packet transmission to destinations using various constraints. Finally the vector containing optimal node on the optimal route employed to eliminate the data collision and redundancy in data processing as it degrades the energy of the network. Data transmission using proposed protocol provides the high throughput and less propagation delay on various time intervals.

- **Path Reliability Estimation**

Proposed path reliability estimation is carried out on the negotiated node to further increase the scalability of the node and enhances the quality of the service. The Path Reliability Computation represents the packet reception ratio of each negotiated node for each the sender Node. It also represents the probability of packet delivery on the projected path. The minimum delay of the network is achieved with redundancy elimination computation as another important factor. The position information of the nodes is employed to support the cooperative cluster head generation, multicast tree construction for the cluster, and packet forwarding, which efficiently reduces the overhead for route searching and tree structure maintenance.

4. SIMULATION RESULTS

In this Section, proposed protocol termed as vector assisted energy efficient dynamic Cluster Based routing protocol for reliable data transfer to the wireless ad hoc Network has been simulated using NS2 Simulator. Evaluation of the proposed protocol demonstrates the effectiveness and reliability of the network against performance measure of the network. Especially network throughput, end to end delay, packet delivery ratio, network lifetime and packet drop has analysed against the conventional approaches.

Proposed model extends the VH-ANCRP and ANCRP approaches on incorporation of the adaptive negotiations and data redundancy elimination in optimal path selection computation. Further proposed model yields better performance on fault tolerance and bandwidth management of the network on its dynamic characteristic. Finally, proposed protocol enhances the packet delivery ratio, network throughput and network lifetime. Table 1 represents the simulation set up of the proposed network.

Table 1. Simulation parameters used to build a protocol

Simulation Parameter	Value
Simulator	NS2
Network Topology Size	500m×500m
Number of Node Protocol simulation	200
Battery Power of the Node	0.5mW/Hz
Network Bandwidth	20MHz
Pause Time of the Network	20seconds
Network Traffic	Constant Bit Ratio
Packet Size	1028bytes
Simulation Time	25minutes

Initially Source node is determined randomly to initiate the route request for data packet transmission using the proposed routing protocol on the mentioned network configuration. Routing protocol processes the route request on accessing the routing information of the network along the dynamic cluster formation of the network. Clustering of the node and cluster head has been computed on basis of the weight and energy factor of randomly selected node and neighbour node on the iterations.

Clustered node and cluster head obtain the route request and provides route reply for data forwarding to protocol to initiate the data transmission. Optimal path has been selected using adaptive negotiation strategies to generate optimal path vector. Optimal path vector contains nodes with constant bit rate. Source transmits the packet to destination through optimal path on providing the better transmission results. Proposed protocol has been time synchronized with network node to transformation of the state of the node on idle period and active period of the node.

In this experiment, node's mobility speed was randomly has been computed as it Cause the collision, frequent link losses and large packet drops. Conventional approach has many routing hops but propose model transmits the data with fewer hops. In order to avoid the collision issue, same intermediate node will not be allocated for more than one source at particular time for forwarding transmission [15]. Node energy consumption at various node speeds during transmission, reception, idle waiting and sleeping has been computed for evaluation of the proposed model. Performance of the proposed model on packet delivery ratio has been described in the Figure 3.

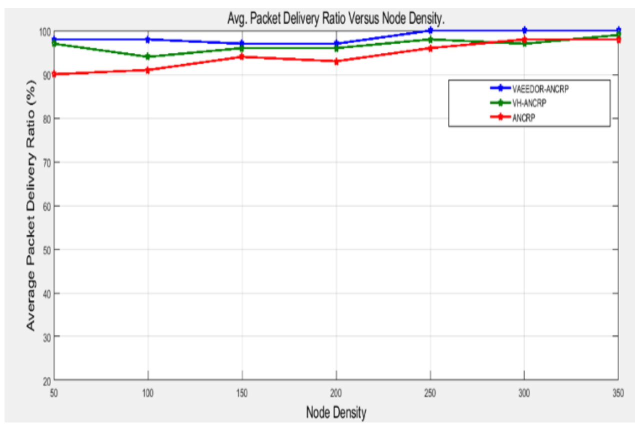

Figure 3. Performance analysis of the packet delivery ratio against various routing protocols

End to end delay performance of the routing protocols has been computed on capability of the data transmission. Packets are forwarded among the nodes with higher transmission link rate. Path length of the particular transmission should be reduced to yield less delay. Scheduling of the packet is carried out to the highest priority node from the cluster head. The Average path length is defined as the packet successfully transmitted to destination from source through intermediate nodes. Figure 4 represent the performance analysis of the end to end delay of the routing protocols.

The performance analysis of the proposed routing model computed on basis of the efficient path of the network in short span of time and transmits the data to destination. Further it analyse the capable of network in predicting the route by rescheduling of the route for data transmission during sudden node failure. Figure 5 represent the performance analysis of the throughput of various routing protocol. Throughput of the network of the routing protocol is calculating rate of data transfer on specified data traffic in the network.

Performance analysis of the routing protocol against the packet drop is computed on basis of the difference of the data bytes initiated by the source to the data bytes received by the destination. On evaluation of the packet drop occurring in the proposed model against the conventional approaches, proposed model is capable of eliminating the packet drop on effective construction of strategies of the routing protocol, Figure 6 represents the performance of the routing protocol with respect to the packet drop.

Controlling of message transmissions on the data traffic on received data packets yields reduce network overhead and increased energy consumption. In all the mobility cases, adaptive negotiation of the opportunistic routing protocols has greater delivery ratios. Table 2 concludes the performance values of the various evaluation metrics on compute the reliable data transfer using adaptive negotiation and Vector Based packet forwarding algorithm.

Table 2. Performance evaluation of the routing protocol for reliable data communication

Technique	Throughput	Network Lifetime in MS	PDR	DELAY	Packet Drop
Vector Assisted Energy Efficient Dynamic Cluster Based routing protocol-Proposed	85.58	15.23	99.78	0.7	0.01
Void Avoidance Anchor Node based Cluster Based Routing Protocol-Existing 1	79.26	12.59	92.85	0.9	0.25
Avoidance Anchor Node based Cluster Based Routing Protocol-Existing 2	74.56	11.59	89.56	0.11	0.24

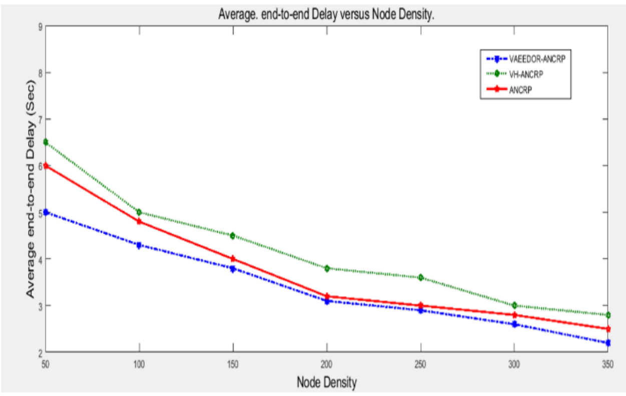

Figure 4. Performance analysis of the end-to-end delay against various routing protocols

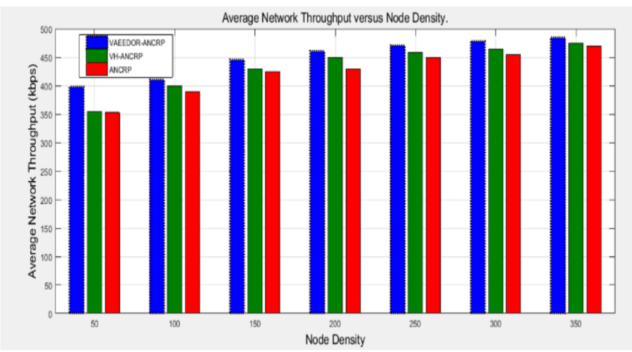

Figure 5. Performance analysis of the throughput against various routing protocols

Network lifetime of the routing protocols has been analysed on various aspects especially it Increase the energy of the node for data transmission. Proposed protocol consumes less energy and reduced time for packet transmission from source to destination. Figure 7 provides the performance analysis of the routing protocol with respect to the network lifetime. Routing protocol is highly efficient in handling the node failure. Node density is determined across the network in order to avoid the fault in the network.

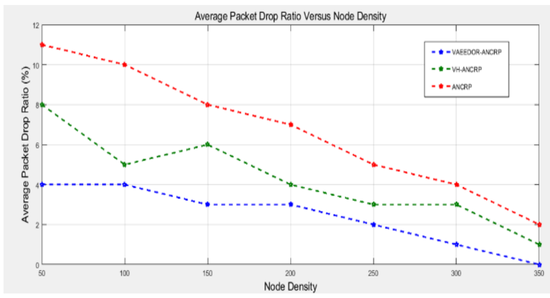

Figure 6. Performance analysis of the packet drop against various routing protocols

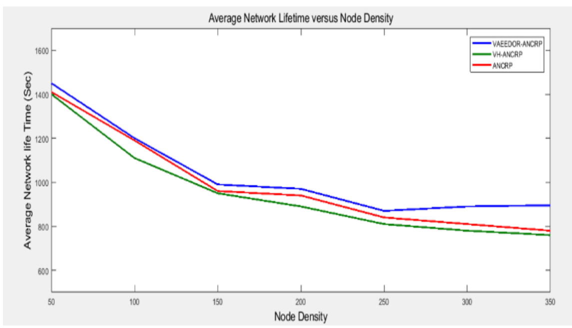

Figure 7. Performance analysis of the routing protocols on basis of network lifetime

Simulation analysis has demonstrated that the utilization of energy and maximization of throughput are enhanced through the implementation of an optimal solution for channel access, compared to the state of the routing protocol. Furthermore, performance evaluation indicates the scalability and reliability of the evaluated framework.

5. CONCLUSIONS

We design and implemented on Vector Assisted Energy Efficient Dynamic Opportunistic through Cluster Based routing protocol. Model partitions the network into clusters on selection of the cluster head for the optimal data transmission and to enhance the lifetime of the network by gathering the mobile nodes on basis of the adaptive Negotiations strategies modelling. Especially reactive opportunistic routing protocol is high capable in producing the high data scalability on the data transmission from source to destination node on the dynamic updates of the data traffic among the intermediate nodes in the densely populated cluster region of the network. Further, packet forwarding is carried out using the negotiated nodes as it is organized into vector. Packet scheduling and forwarding is enabled through the optimal routing paths on basis of packet represented in the vector to reduce the network energy and bandwidth. Performance of the proposed model is evaluated against the conventional routing protocols in terms of Throughput, Packet delivery ration, Average end to end delay and Network lifetime and packet drop.

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