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# Energy-QoS Aware Routing Protocol for DTMANET

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## Abstract:

Delay/Disruption Tolerant Network is established in the extreme and challenged environments. One of the main characteristics of this type of network is intermittent connections i.e, no end to end path exists all the time. The major challenging task in this kind of network is its limited resources. Since most of the resources of each node is used for the data delivery of other nodes. In this paper we designed a routing protocol which balances the node's resource 'Energy' and the Quality of the Service.

*Keywords* — **Delay/Disruption Tolerant Network, Energy Cost, Node Density.**

## I. INTRODUCTION

Wireless Communication has made its journey thriving for the reason that it provides mobility and expediency to the users. Handheld devices make the life comfortable and keep the users updated by connecting the people anywhere and at anytime. Amongst that, a successful mode of communication in extreme conditions is Delay Tolerant Networks (DTN). Efficient utilization of battery of the handheld devices is a challenge in such extreme scenarios. We are interested in prolonging the lifetime of the battery and to extend network lifetime by considering the energy conservation techniques. The Delay Tolerant Mobile Ad Hoc Networks (DTMANETs) have numerous applications now-a-days and hence it attracted many researchers. Not quite same as the traditional wireless network, DTMANETs are utilized in outrageous network conditions where end-to-end route does not exist at all the time due to the mobility of nodes. DTN find its application in such circumstances where infrastructured network is unviable for e.g., Emergency and rescue areas. In extreme conditions, frequent recharging or replacing of the batteries are unfavourable and so any algorithm developed ought to be designed with Energy awareness so as to achieve energy efficient wireless networking.

## II. RELATED WORK

The Routing protocols for DTN are categorized into two types namely, Single copy routing and Multi copy routing. Single copy routing protocols saves the resources of the node and network. But it does not guarantee the Quality of Service (QoS). It may introduce unexpected latency and poor data delivery of data which make the network loses its reliability. If energy of each node is not considered, then nodes get exhausted very soon and start to get switched off which is a failure to this type of networks. So prolonging the network life time is the most important issue to be considered along with the QoS. Many protocols have been developed to focus on this issue. Some of them are discussed here for better understanding and to understand where we are in this research.

Recently, in 2017 Min Wook Kang developed a routing protocol with novel energy aware technique for DTN [1]. The Authors of this work considered DTN type of network used in Wireless Sensor Networking which deployed static nodes for better performance. Most of the load is given to the static node with more resources thereby saving the energy of the mobile node. But in this paper, only mobile nodes are deployed and all nodes are designed with the same energy level. So distribution of the load is essential so that nodes will not die out very soon thereby avoiding the nodes from malfunction.

In 2017, Bhed.B.Bista suggested a protocol called Restricted Epidemic Based routing for DTN [2].

Epidemic routing protocol is the first routing protocol designed for intermittent network which floods the network and consumes the resources of all nodes and makes the network fail at the earliest. To avoid such situations, energy aware QoS routing protocol has been proposed in this paper.

En Wang Et al in 2013 proposed a routing protocol for DTN based on the time duration needed to meet the destination node [3]. Spray and Wait style of routing has been proposed. In this paper, no focus has been given on the Residual Battery Energy and so the network lifetime closes very earlier.

## III. PROPOSED ENERGY-QOS AWARE ROUTING PROTOCOL

### A. *Data Delivery Prediction*

The Data Delivery Prediction follows the Probabilistic Routing Protocol using History of Encounters and Transitivity (PRoPHET) [4] means of routing in which the future encounter is predicted with the knowledge of the past encounter experienced by the nodes.

$$D(A,B) = (\alpha + 1) * D(A,B)_{old} * e^{-\Delta t} \quad (1)$$

***D (A, B)*** – Equation to calculate Data Delivery Prediction between two node A and B

$\alpha$ – Number of encounters

***D (A, B)$_{old}$*** – Past calculation of Data Delivery Prediction between the same two nodes A and B.

e - Mathematical constant (Euler's constant).

$\Delta t = (t2 - t1)$ – inter contact duration between the nodes A and B

### B. *Energy Cost*

Selection of forwarding node based on the residual energy of the encountered node. If the residual energy is too low, those are not suitable for storing, carrying and forwarding the data. The reasons for non-suitability for forwarding the data are twofold.

1) Since the residual energy is too low, it will get drained off and the forwarded data will be dropped without reaching the destination.
2) If the residual energy is too low, it is not advisable to be an intermediate node. It acts only as a source node or destination node. Otherwise the node will become dead and it could not transmit/receive data that are destined for it.

$$EC = EC_{tx} + EC_{rx} \quad (2)$$

*EC* – Energy Cost
$EC_{tx}$ – Transmission Energy Cost
$EC_{rx}$ – Receiver Energy Cost

$$EC_{tx} = \frac{\delta * E_{tx}}{C * E_R} \quad (3)$$

$E_R$ – Residual Energy
$\delta$ - size of the message
C - Channel Capacity

$$EC_{rx} = \frac{\delta * E_{rx}}{C * E_R} \quad (4)$$

### C. *Calculating Neighbour Node Density*

$$\rho = \frac{(S_i(n)\pi R^2)}{A} \quad (5)$$

$\rho$ - neighbour node density
***Si(n)*** - number of neighbour nodes in area A.
***R*** - Radio Transmission Range

### D. *The Forwarding Rule*

1) If the address of the destination nodes is available in the Data Delivery Prediction table with the value required for forwarding the message, then the sender node hand over the message to the encountered node.
2) Before the expiring time of the data for the destination node, sender node search for the opportunity to forward the data towards the destination. If the Suitable forwarder is

unavailable then in order to deliver the message towards the destination, the sender comes to the conclusion of choosing the forwarder based on the node with more node density in its neighbourhood.

### *E. Performance Analysis*

The performance is analysed with the NS3 Simulation. 20 nodes are considered for the network. Random WayPoint Mobility model was used for the moving pattern of the nodes.

The area taken for the movement of the mobile nodes are 1000 m x 1000m. The transmission range of the nodes is taken as 50m.

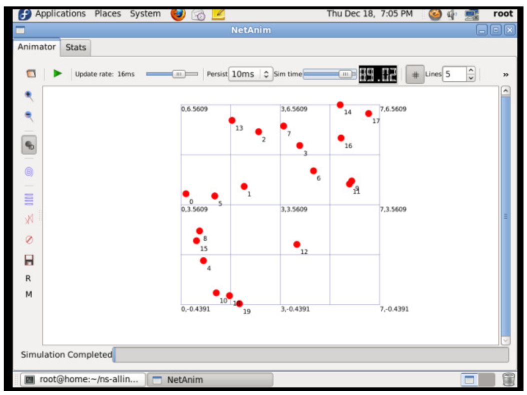


Fig.1: Simulation Scenario

The proposed protocol is compared with the standard existing protocol namely PRoPHET routing protocol.

PRoPHET – D stands for PROPHRT routing protocol with data forwarding rule based on neighbour node density

PRoPHET – DEM stands for PRoPHET-D routing protocol along with Energy Cost Calculation.

The performance of the existing and the proposed protocols are compared in terms of delivered messages, Data delivery delay and Network Life time.

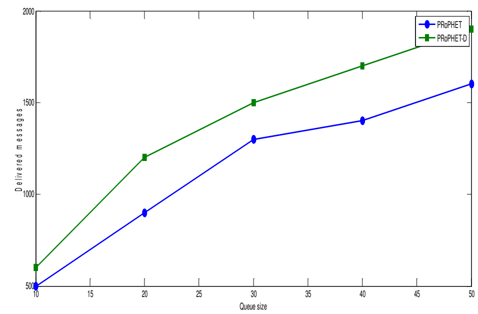


Fig 2: Queue Size Vs. Delivered Messages

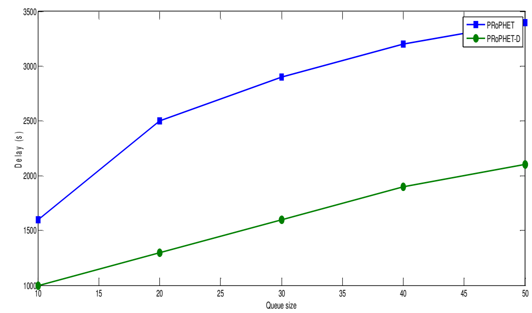


Fig 3: Queue Size Vs. Delay

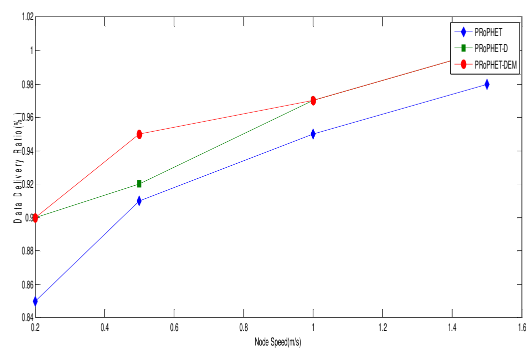


Fig.4 : Node Speed Vs. Data Delivery Ratio

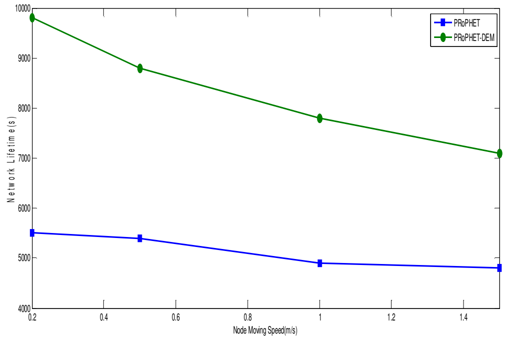


Fig.5: Node Moving Speed Vs. Network Life Time

## IV. CONCLUSIONS

The proposed routing protocol optimizes the performance of existing routing protocol in terms of the energy consumption and also the performance. In future, real world scenarios and parameters are to be considered to get more realistic outputs. Also the idea of Overhead generated as the control packet overhead gives the actual performance of the routing protocol.

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