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Development of Energy Based Dynamic Routing Scheme (EBDRS) for Delay Tolerant Sensor Networks

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Abstract: Delay Tolerant Network (DTN) a heterogeneous network designed to withstand long delays with the capability of storing packets in intermediate nodes until an end to end route can are found. Delay Tolerant Sensor Networks (DTSNs) are a collection of sensor nodes and transceiver nodes without peer to peer points. DTSN is mainly used for traffic monitoring between nodes in the network for surveillance applications need to bother on energy efficiency in order to away from break of transaction. The traditional energy routing protocols existing are only based on fixed network in terms of nodes mobility resulting failure in data transmission. Especially in congestive environments, the packets are used to collide often owing to lack of energy in the unaware intermediate nodes during instant routing. Therefore, a protocol is needed based on the consistency energy monitoring of nodes in the network for identifying and forwarding the packets through the better nodes path to resume the transmission without fail. Earlier many routing protocols implemented and none of them bothered on energy based on Dynamic Cluster Method. In this study, researchers aim at proposing Energy Based Dynamic Routing Scheme (EBDRS) to reduce the energy consumption and thus maximize the network lifetime. The objective of this study is two folded with the formation of DTSN and EBDRS to provide reliable security among nodes in the network. Comparative analysis has also been done and the proposed routing procedure outperforms the earlier methods in terms of delivery ratio and throughput.

Key words: Delay tolerant network, delay tolerant sensor networks, energy routing protocols, energy based dynamic routing scheme, traffic monitoring, reliable security

INTRODUCTION

Transmission in Delay Tolerant Network (DTN) are not guaranteed owing to its characterization of disobedient connectivity, high data loss and propagation delays currently research scopes in DTN are unlimited particularly in routing of nodes that do not have end to end path (Elwhishi and Ho, 2009). To improve routing in DTN there were many research articles published based on energy consumption and one attractive algorithm called epidemic routing algorithm that does not look after the relationship among nodes and with the concepts of static energy hold by the clusters to forward the message (Mundur *et al*., 2008). The objective of this study is to introduce Energy Based Dynamic Routing Scheme (EBDRS) for assuring the data to be forwarded to the successive nodes) to enhance the reliability. The proposed EBSR protocol aims at attaining high delivery ratio, throughput and transmission time and reduced packet loss.

On the other hand, the applications area of WSNs in adhoc environment vary from civil, healthcare and environmental to military applications include target tracking in battlefields, habitat monitoring, civil structure monitoring, forest fire detection and factory maintenance. However, with the unique properties of sensor networks such limited power, stringent bandwidth, dynamic topology, high network density and large scale deployments have been creating many tough tasks in the design and management of sensor nodes in DTN (Conan *et al*., 2008). These challenges have demanded energy awareness and robust protocol designs at all layers of the networking protocol stack. Because of mobility of nodes and difficulty of connection of power station, the nodes in DTSN are usually lack of energy during the message routing and however lots of energy should be consumed for sending, receiving and storing messages as well as performing computation. Therefore the energy efficient design is of importance (Fall, 2003).

Already many research works have been underway in forwarding data in DTN. Strategies in the flooding family deliver multiple copies of each message to a set of nodes, called relays which store the messages until they get connected with the destination by the time message is delivered. The earliest research in the area of DTN routing falls into these family (Cerf *et al*., 2007).

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Tree-Based Flooding (TBF) strategies are the other type to extend two hop relay by distributing the task of making copies to other nodes. When a message is copied to a relay, there an indication of how many copies the relay should make. Epidemic Routing (ER) represents the extreme end of the flooding family because it tries to send each message over all paths in the network (Scott and Burleigh, 2007). To maximize the message delivery makes the network reliable, the following issues are identified:

- Since, the DTN is always in mobile environment, the nodes need to be operated only with the available energy. So, it is imperative that the limited energy within the node is to be utilized effectively
- The bandwidth utilization also plays a vital role to increase the efficiency since there is no end to end communication in DTN
- Some applications require the involvement of unlimited nodes that creates the discontinuity in delivery of packets due to the lack of energy

Motivation: The limitations in the design of WSNs are those concerning the minimum energy consumption required to drive the networks (Pentland *et al*., 2004). Since, the sensors do sampling, processing and data communication, the handling of power is an important issue for the effective utilization in DTN environment (Daly and Haahr, 2009). Sensor nodes can use up their limited supply of energy performing the mentioned parameters in a wireless environment. As such energy-conserving forms of communication and computation are essential. Therefore, sensor node lifetime is highly dependent on battery lifetime (Burgess *et al*., 2006). In a multi-hop WSN, each node plays a dual role as data sender and data router. Moreover, the malfunctioning of some sensor nodes because of power failure can cause significant topological changes and might require rerouting packets and reorganizing the network (Nelson *et al*., 2009). Thus, the key challenge in data routing is conserving the sensor energy so as to maximize their lifetime with a need of better energy efficient routing method and such method is the proposed EBDRS.

LITERATURE REVIEW

Lo and Liou (2012) proposed new routing schemes which can dynamically adjust quota values of the network loads. The two shortcomings of their proposal are weakness in the setting of quota values and among non cooperation among neighbouring nodes to reduce severe traffic congestion in DTN. Komnios *et al*. (2009) proposed routing protocols for DTN epidemic, prophet and contact graph routing in space environment. The shortcomings of these protocols are none of them is not energy efficient and also not providing Quality of Service (QoS). Bulut and Szymanski (2010) introduced a new metric for detecting the quality of friendships accurately. The drawback of this study is that information requested done from only close friend's nodes with small sizes and it cannot access information beyond that friendship groups and thus security beyond the friendship group is risky.

Bulut *et al*. (2010) proposed to improve the routing protocols prophet. The disadvantage ofthis study is that the energy of different nodes in the environment seemed very less due to low density of nodes, node mobility and energy failure. Narmawala and Srivastava (2009) proposed a multicopy routing protocol for multicasting in DTN. The issue of those studies is wastage of buffer space by using multi copy of routing.

Henrikson *et al*. (2007) offered a new perspective by making an analogy between routing and routing table constructions in DTNs. The limitation is that developed caching based routing strategies are not specifically tailored towards DTN's. Spyropoulos *et al*. (2005) presented a tree based routing algorithm based on the knowledge about motion and availability patterns of mobile nodes. In the Epidemic Routing scheme, the node receiving a message, forwards a copy of it to all nodes it encounters. Prophet is probabilistic routing protocol developed by Lindgren and the basic assumption in the prophet is that mobility of nodes is not purely random but with the number of repeating behaviour. In source routing Wu and Wang (2012) the complete path of a message is determined at the source node and encoded in the message. The route is therefore determined once and does not change as the message traverses the network. In contrast, in per-hop routing, the next-hop of a message is determined at each hop along its forwarding path. Per-hop routing allows a message to utilize local information about available contacts and queues at each hop which is typically unavailable at the source (Lo *et al*., 2011).

PROPOSED RESEARCH

The proposed DTSN is shown in Fig. 1. It is assumed that the static node type network, the nodes are in fixed position and in the dynamic network the nodes are movable within its communication range. The nodes in the proposed DTN are arranged in a hierarchical manner based on tree topology with the relationship. All nodes connected in the network have been embedded by means of wireless module.

The nodes also have been placed in a clustered way so as to transfer message through the cluster heads only. In the proposed approach while the nodes moving in the surrounding environment are being updated at every

point of time during transmission by route tables. The route table contains the energy of the individual nodes among the cluster and the energy variation is also updated and ranked for every instance. Initially all nodes including cluster heads have been assigned by energy in joules and are updated after every events happen in the route table in order to let the nodes knowledge. By using this mechanism, sensor nodes in DTN always transmit the updated information to the mobile sink which makes it aware about the current distribution of the nodes.

Energy calculation for DTSN: The combination of energy efficiency and QOS are the backbone of the proposed Energy Based Dynamic Routing Scheme (EBDRS) for the purpose of enhancing the network lifetime through balancing energy consumption across multiple nodes that reduces the end to end delay through spreading out traffic across multiple paths. EBDRS handles both real-time and non real time traffics among the nodes in the network. The proposed protocol uses the multi path paradigm together with Forward Error Correction (FEC) technique to recover from node failures without invoking network wide flooding path discovery which is essential in DTSN since flooding consumes energy and consequently reduces network life time. EBDRS protocol uses residual energy and node available buffer size which splits up the transmitted messages in to number of segments of equal size then transmit over multipath simultaneously to increase the probability that an essential portion of the packet is received at the destination without any delay (McMahon and Farrell, 2009). The energy of a node is calculated using the equation (Pentland *et al*., 2004):

$$CE = \frac{\left(E_{node\text{-}res}\right)_j}{\left(1-\left(\frac{dis(j)}{100}\right)\right)^2} \quad (1)$$

Where:

$(Enode\text{-}res)_j$ = The current residual energy of node j

dis(j) = Calculated by equation

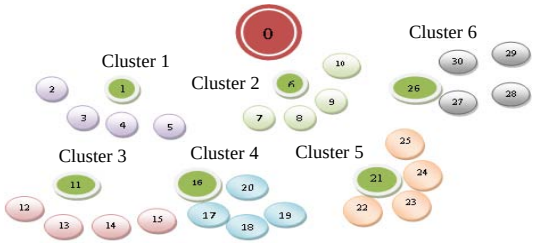

Fig. 1: Proposed DTSN

$$dis(j) = \left(\sum_{i=1}^{1}\left(|D_{db}(j)-D_{db}(i)|\right)\times t_{p\times k}\right) \quad (2)$$

Where:

D_{db} = Node distance to sink and it is assumed that the number of bits k = 1

t_p = The transmission power and transmission power, tp = 1

The proposed EBDRS algorithm is illustrated in the Fig. 2. The advantages in the proposed algorithm are two folded namely the path selection of nodes can be found out by hierarchical nodes as well as the energy of nodes even the same condition is applicable to cluster heads in each cluster results a great amount of reliability in less transmission time, packet loss and flexible mobility.

EBDRS algorithm:

- Data transfer starts: nodes in the network are to be initialized and the node has to be searched
- E is the Energy of the node
  - If E = 50 joule then it automatically transmission takes place through that node
  - If E>50 joule then the nodes chooses the shortest path routing and ends the transmission
- If E<50 joule then ideal node searching results in fixed and movable node separation
- Path selection based on the energy level among relationships taking three conditions namely N = 1, N<1 and N>1
- Fixed nodes uses immediate parent for sending the data
- Movable nodes uses high energy node for sending the data
- Finally, the data has to be send in a more secure way

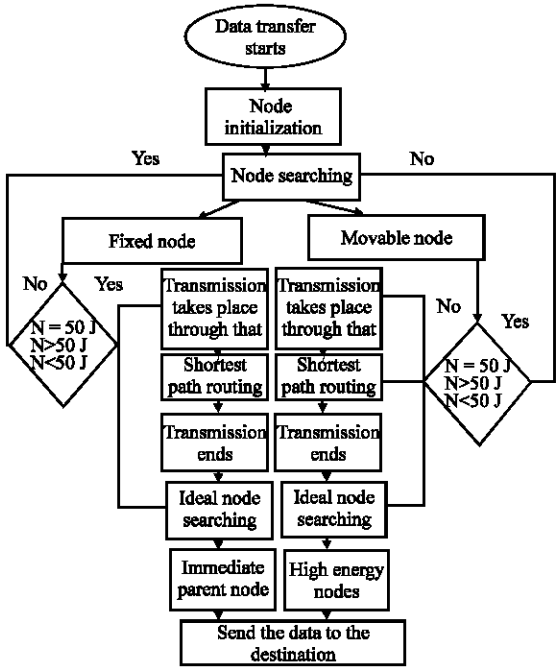

Fig. 2: Communication flow for EBDRS algorithm

EXPERIMENTAL ENVIRONMENT AND OUTPUT

The proposed DTSN has been experimented with the EBDRS algorithm using Network Simulator (NS2). The experiment was tested initially 31 with nodes for static and dynamic environments. Figure 3 shows the overall structure of the proposed DTSN with 6 cluster head and each carries 4 cluster nodes. Base station here is named the node 0. The packet transfer happens from source to destination through the cluster head only. The data can be transferred between nodes called 16, 11, 21 and 26 a as cluster heads in the network through wireless module.

Figure 4 shows the data transfer between the base station 0 and node 18 without applying the proposed EBDRS Method. The packet has been transferred from node 18-0 through the node 1 in the cluster head 4. The energy allotted for all the nodes in the proposed network has been 100 J since the aim for attaining energy efficiency to find out the better routing nodes based on the energy retain on every transaction.

The idea is to use the reliable nodes in the network with the required minimum energy to fulfill the successful transmission of packets without fail. So, even a node that is located far away from the source node in distance but at the same time having got the minimum required energy to forward the data to the destination. In that way, the proposed EBDRS algorithm takes an advantage over the existing algorithm in order to reduce the packet loss and simultaneously enhancing the life time of the network. Figure 5 shows the initial node allocation for being

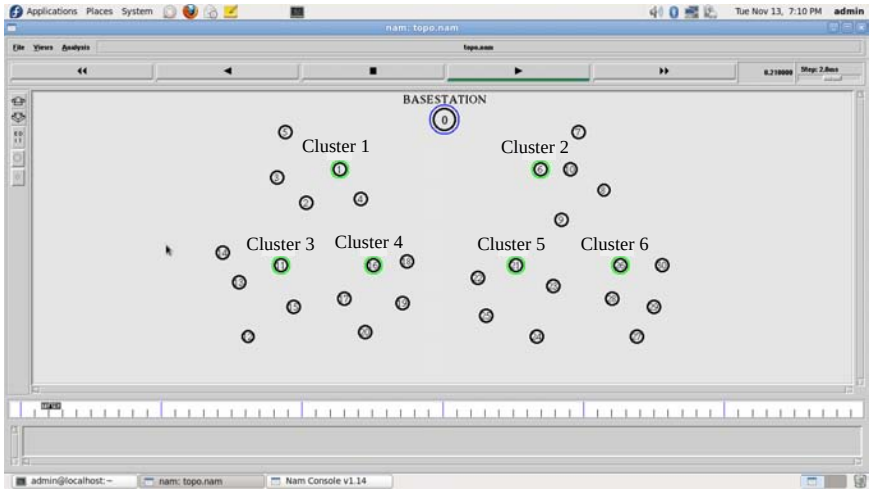

Fig. 3: Proposed DTSN in simulation

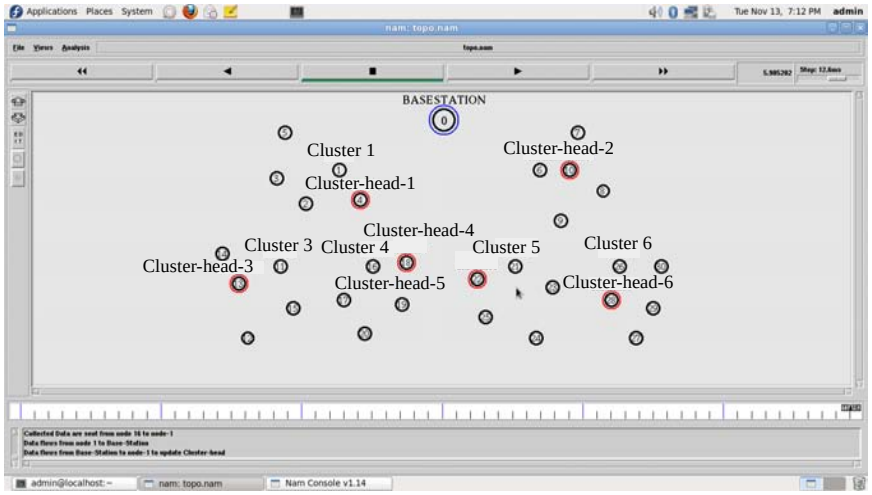

Fig. 4: Data transfer among nodes without EBDRS Method

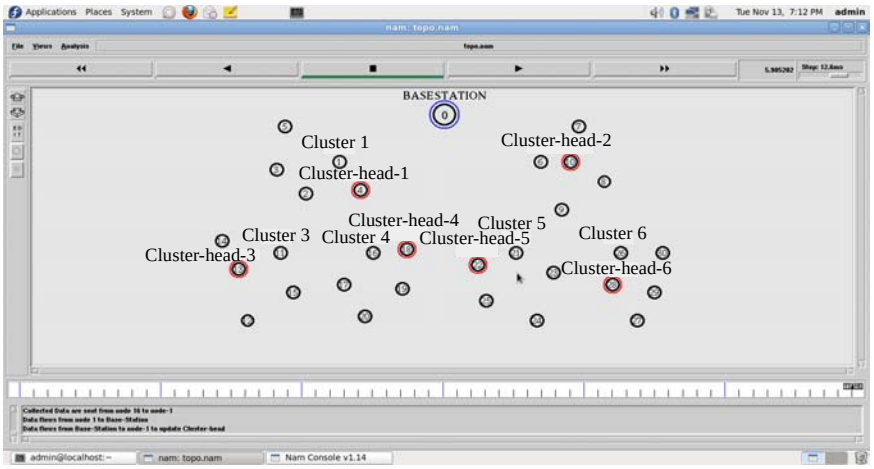

Fig. 5: The cluster head changes in the EBDRS Method

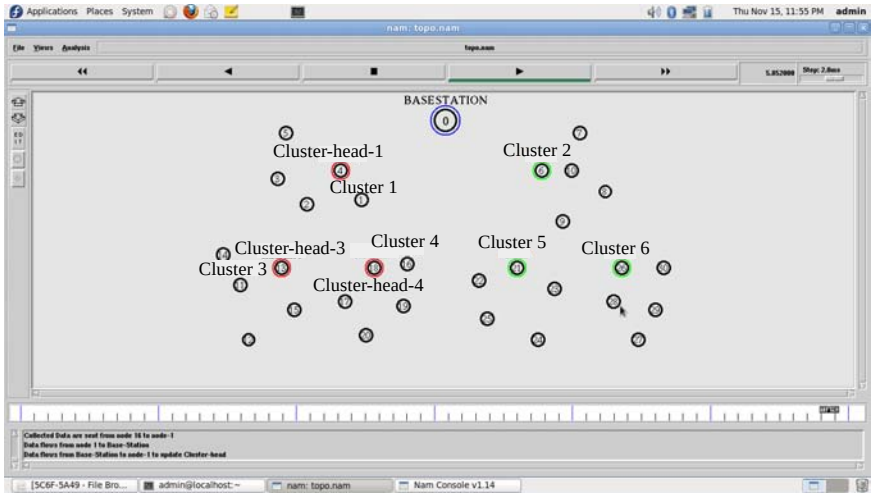

Fig. 6: EBDRS uses high energy nodes for transaction in a network

the normal cluster nodes and the change of cluster head. The energy variance for every time period could be easily identified from the route table of individual nodes in the network.

Figure 6 shows the packet is being transmitted from node 1 to base station 0. The node which has been selected as a routing node depending on the energy in which the nodes contain at that time. The change of cluster head done here in this EBDRS Method only after transaction and being updated in the route table of every node which is not fixed.

The proposed network chooses transfer nodes in every time based on the energy and such node can be called as cluster head rather than the fixed node as cluster head so as to minimize the packet loss due to the lack of energy headed in nodes.

Table 1: Comparative analysis between the proposed EBDRS and Epidemic Method

Parameters (31 nodes)	Epidemic Method	EBSR Method*
Transmission time (msec)	10	5
Latency (msec)	15	10
Delivery ratio (msec)	20	15
Throughput (msec)	25	18
Packet loss (msec)	20	10

COMPARATIVE ANALYSIS

The comparative analysis has been done between the existing Epidemic Routing (Elwhishi and Ho, 2009) and the proposed EBDRS Routing Method is shown in Table 1. From the Table 1, it is clearly inferred that the proposed EBDRS Method outperforms the existing method in terms of less transmission time, good delivery ratio, minimum packet loss and thus the life time of the DTSN could be highly improved.

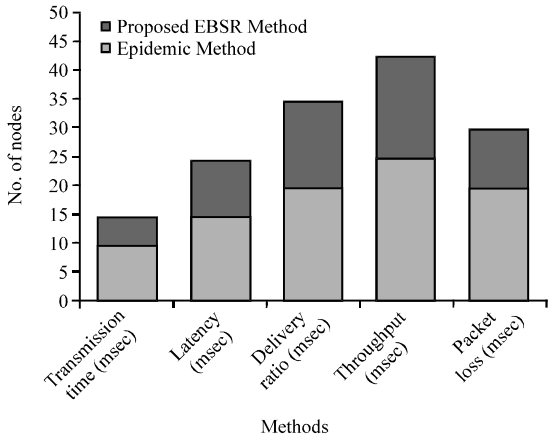

Fig. 7: Comparative analysis between the proposed EBSR and Epidemic Method

Figure 7 also indicates clearly by selecting the routing nodes based on the energy of nodes at every instant of transaction in cluster-heads and members results an enhancement of lifetime of the DTN reliability and efficiency by ennergy efficeient routes rather that the conventional shortest path.

CONCLUSION

Energy Based Dynamic Routing Scheme (EBDRS) has been proposed in this study with the aim of maximizing the lifetime of the DTN by taking the resource parameters as latency, throughput, delivery ratio and transmission time. In addition, a DTSN Architecture Model also has been framed based on hierarchical arrangements of nodes. Here, nodes reliability could be increased in the DTN environment on par with the energy efficiency due to the concept of dynamic selection of nodes based on energy. In the proposed routing method, the node with the highest energy level is chosen for the message to be forwarded and there is no permanent cluster head all the time. The comparative analysis also has been done with the proposed EBDRS and the results are so attractive in terms of reliability. In the future research, the algorithm can be applied in different applications with specific QoS parameters related to security environment.

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