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CLUSTERING IN ADHOC NETWORKS BASED ON LOAD BALANCING FOR DELAY-TOLERANT APPLICATIONS

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Abstract:

Delay-tolerant networking (DTN) is an approach to computer network architecture that seeks to address the technical issues in heterogeneous networks that may lack continuous network connectivity. Due to the lack of continuous communications among mobile nodes and possible errors in the estimation of nodal contact probability, convergence and stability become major challenges in distributed clustering in DTMN. Clustering significantly reduces the energy consumption of a cluster. In this paper, a cluster based routing protocol for Delay-Tolerant Mobile Networks (DTMNs) is used. Exponentially weighted moving average (EWMA) scheme is employed for on-line updating nodal contact probability, with its mean proven to converge to the true contact probability. Based on nodal contact probabilities, a set of functions including sync ( ),leave ( ), and join ( ) are devised for cluster formation and gateway selection. The gateway nodes exchange network information and perform routing. It uses clustering's structure to decrease overhead, average end-to-end delay and improve the average packet delivery ratio.

Keywords: **Delay Tolerant Mobile Network (DTMN), Exponential weighted moving average (EWMA).**

1. INTRODUCTION:

Delay tolerant Mobile Network (DTMN), fundamentally opportunistic communication system, where communication links only exist temporally rendering. It is impossible to establish end to end connection for data delivery. Delay-tolerant networking (DTN) is an approach to computer network architecture that seeks to address the technical issues in heterogeneous networks that may lack continuous network connectivity. The Delay-Tolerant Network (DTN) is an occasionally [2] connected network that may suffer from frequent partitions and that may be composed of more than one divergent set of protocol families. Examples of such networks are those operating in mobile or extreme terrestrial environments, or planned networks in space. DTNs span very challenging application scenarios where nodes (e.g., people and wild animals) move around in environments where infrastructures cannot be installed (e.g., military grounds and protected environments).

Some solutions to routing have been presented also for these cases, starting from the basic epidemic routing, where messages are blindly stored and forwarded to all neighboring nodes, generating a flood of messages. Existing routing protocols (AODV)]9\ are must take to a "store and forward" approach, where data is incrementally moved and stored throughout the network in hopes that it will eventually reach its destination. A common technique used to maximize the probability of a message being successfully transferred is to replicate many copies of the message in the hope that one will succeed in reaching its destination. This is feasible only on networks with large amounts of local storage and internodes bandwidth relative to the expected traffic. The drawbacks that are encountered in Delay-Tolerant Mobile Networking are [5]

1. Lack of Connectivity.

2. Lack of Instantaneous End-To-End Paths

3. Very High Number of Messages that are needed to obtain a successful delivery to the right recipient.

2. PROBLEM DEFINITION:

Clustering in DTMN is unique, because the network is not fully connected. Due to the Lack of continuous communication among mobile nodes and possible errors in the estimation of nodal contact probability, convergence and stability becomes a major problem in the Delay-Tolerant Mobile Network (DTMN) [1]. In non clustered Delay –Tolerant Mobile network any node in the network may not able to get contact with the other neighboring node this is because of the nodes will not be having a correct updating in their nodal contact probability and the gateway information therefore they lack communication. As a result the nodes cannot provide end to end delivery of the information. At the same time nodes break up their communication if they move out of the coverage area.

3. CLUSTERING:

Clustering is a process that divides the network into interconnected substructures [9], called clusters. Each cluster has a cluster head (CH) as coordinator within the substructure. Each CH acts as a temporary base station within its zone or cluster and communicates with other CHs.

In our protocol, there are three possible states for the node: NORMAL, CLUSTERHEAD and GATEWAY. Initially all nodes are in the state of isolated. All nodes maintain the NEIGHBOR table wherein the information about the other neighbor nodes is stored CHs [9].

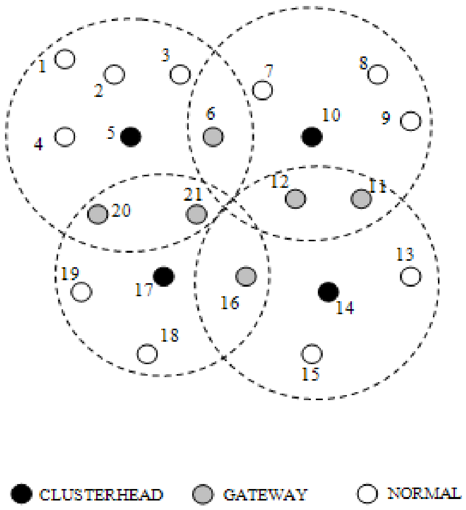

Fig 1: cluster formation

4. DISTRIBUTED CLUSTERING ALGORITHM:

Distributed clustering algorithm used to form a cluster in delay tolerant mobile network. The algorithm is event-driven, where the key part lies on the meeting event between any pair of nodes[6]. The set of functions in the algorithm including Sync, Leave, and Join is outlined below. The Methodology will give out an idea how the algorithm performs its function

METHODOLOGY:

a. In our protocol, an exponentially weighted moving average (EWMA) scheme is employed for on-line updating nodal contact probability.

b. Weighting factors which decrease exponentially. The weighting for each older data point decreases exponentially, giving much more importance to recent observations while still not discarding older observations entirely.

c. True contact probability. Subsequently, a set of functions including *Sync ()*, *Leave ()*, and *Join ()* are devised to form clusters and select gateway nodes based on nodal contact probabilities.

d. Cluster table consists of four fields: Node ID, Contact Probability, Cluster ID, and Time Stamp.

e. Each entry in the table is inserted/updated upon meeting with another node, by using the aforementioned online updating scheme.

f. Gateway table consists of four fields: Cluster ID, Gateway, Contact Probability, and Time Stamp.

NODAL CONTACT PROBABILITY:

The delivery probability indicates the likelihood that r can deliver data messages to the sink. The delivery probability of a power *i*, is updated as follows,

$$\xi_i = \begin{cases} (1-\alpha)[\xi_i] + \alpha\xi_k, & \textit{Transmission} \\ (1-\alpha)[\xi_i], & \textit{Timeout}, \end{cases}$$

where is the delivery probability of power *i* before it is updated, is the delivery probability of node *k* (a neighbor of node *i*), and is a constant employed to keep partial memory of historic status.

A.SYNC

The *Sync ()* process is invoked when two cluster members meet and both pass the membership check. It is designed to exchange and synchronize two local tables. The synchronization process is necessary because each node separately learns network parameters, which may differ from nodes to nodes. The Time Stamp field is used for the "better" knowledge of the network to deal with any conflict.

B.LEAVE

The node with lower stability must leave the cluster. The stability of a node is defined to be its minimum contact probability with cluster members. It indicates the likelihood that the node will be excluded from the cluster due to low contact probability. The leaving node then empties its gateway table and reset its Cluster ID.

C.JOIN

The *Join ()* procedure is employed for a node to join a "better" cluster or to merge two separate clusters. A node will join the other's cluster if, it passes membership check of all current members. Its stability is going to be improved with the new cluster. By joining new cluster, it will copy the gateway table from the other node and update its cluster ID accordingly. Thus the distributed clustering algorithm is used to form a cluster in DTMN.

CLUSTER BASED ROUTING:

The cluster based routing protocol used to perform a routing in delay tolerant mobile network. We consider the Node i has a data message to Node j, the cluster based routing protocol is given below.

A. INTRA-CLUSTER ROUTING

If Nodes i and j are in the same cluster, they have high chance to meet each other, thus Node i will transmit the data message to Node j directly upon their meeting. No relay node is necessarily involved.

B. ONE-HOP INTER-CLUSTER ROUTING

If they are not in the same cluster, Node i look up gateway information to Node j's cluster in its gateway table. If an entry is found, Node i send the data message to that gateway. Upon receiving the data message, the gateway will forward it to *any* node.e.g. Node *k*, in node j's clusters. Node *k*, which in sum delivers the data message to node j via Intra-cluster Routing. If no gateway entry is found, node i precede the Multi-hop Inter-cluster Routing as to be discussed next.

C. MULTI-HOP INTRA CLUSTER ROUTING

If node i does not have any information about node j, the data transmission needs a multi-cluster routing scheme. Given the low connectivity environment, on-demand routing protocols, with extremely high packet dropping probability, will not work effectively here. However, any table-driven routing algorithm such as the following link-state-like protocol can be employed. In the protocol, every gateway node builds a *Cluster Connectivity Packet (CCP)*, and distributes it to other gateways in the network.

1. The CCP of a Gateway comprises its cluster ID and a list of clusters to which it serves as gateway along with corresponding contact probabilities. Such information can be readily obtained from the gateway table.
2. Once a gateway node accumulates a sufficient set of CCP's, it constructs a network graph. Each vertex in the graph stands for a cluster. A link connects two vertices if there are gateways between these two clusters.
3. The weight of the link is the contact probability of the corresponding gateway nodes. Based on the network graph, the shortest path algorithm is employed to establish the routing table. Each entry in the routing table consists of the ID of a destination cluster and the next-hop cluster ID.
4. Once the routing table is obtained, the routing is performed from a cluster to another cluster via One-hop Inter-cluster Routing and Intra cluster Routing. The diagram for cluster based routing protocols is given below.

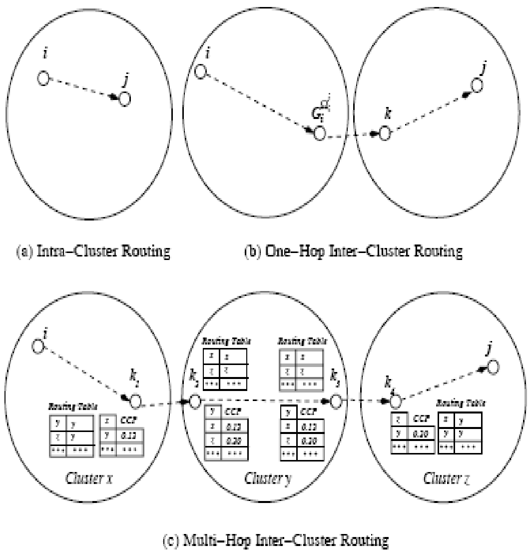

Fig 2.Cluster based routing protocol

By using the above mentioned concepts with the block diagram and the flow control the construction of Exponential Weighted Moving Average become simple. Thus the distributed clustering algorithm used to form a cluster in delay tolerant mobile networks and the cluster based routing protocol used to perform routing in delay tolerant mobile networks.

5. EXPERIMENTAL SETUP:

The performance of power balanced communication scheme is evaluated using Network simulator -2, which simulate node mobility [5], realistic physical layer radio network interface and AODV protocol. Evaluation is based on the simulation of 50 nodes located in the area of 1500 x 300 m^2. The traffic simulator is constant bit rate (CVR). The three different scheme non cluster method, EWMA, and power balanced communication are used for comparison.

PERFORMANCE METRICS

The performance metric used in this project are throughput packet delivery ratio bandwidth end to end delay, energy construction and routing overhead. The measures and details of the various parameters are given below.

A.PACKET DELIVERY RATIO

It is defined to be the percentage of the ratio of number of packets received to the number of packets sent.

$$PDR = \frac{\text{Number of packets received}}{\text{Number of packets sent}} \times 100\%$$

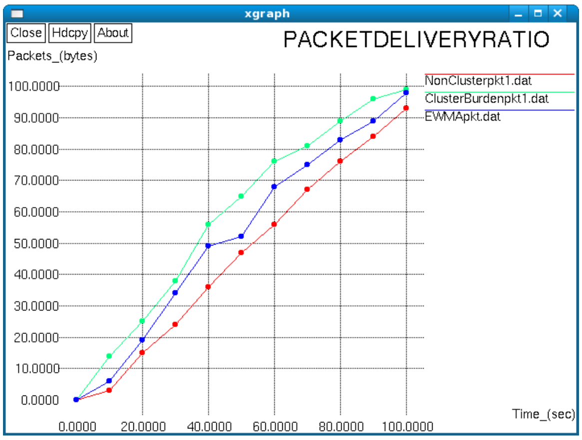

Fig2. Performance comparison using Packet delivery ratio

The X graph shows the variation of Packets (bytes) received based on the time when three different routing schemes are implemented.

C.END TO END DELAY:

The time interval between the first packet and second packet. Here the total delay takes 1.3 in non-cluster method and 0.9 in EWMA and power balanced communication have 0.4.

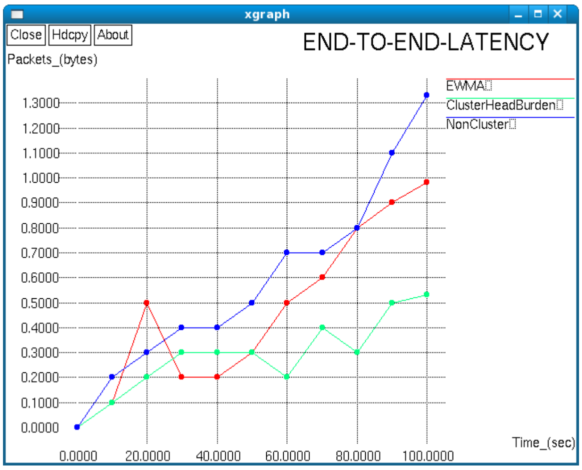

Fig3. Performance comparison using end to end latency

From the X graph shows the proposed power balance communication system achieves low end to end delay.

C. ROUTING OVERHEAD

Total number of route request and the route reply at the time

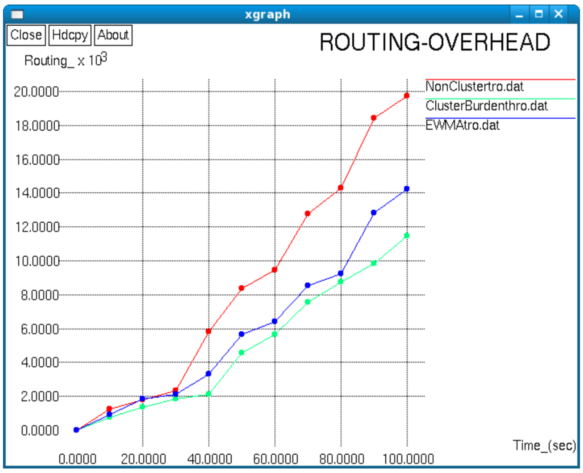

Fig4.Performance using routing overhead

From the X graph shows the routing over head has low in power balanced communication when compare to other existing methods.

D.TRHOUGHPUT:

Throughput is the ratio of number of packets received to the time seconds.

$$\text{Throughput} = \frac{\text{Number of packets received}}{\text{Time (sec)}}$$

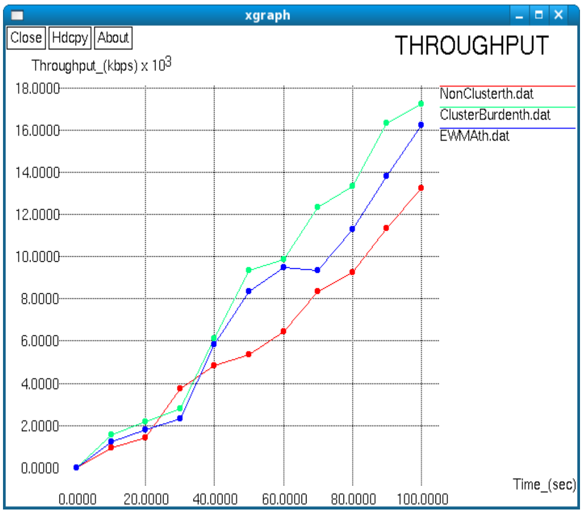

Fig5. Performance comparison using throughput

From the X graph shows the throughput high value to the Power balanced communication when compare to other existing methods.

6. CONCLUSION:

Establishing end-to-end connections for data delivery among Delay-Tolerant Mobile Networks becomes impossible as communication links only exist temporarily. In such networks, routing is largely based on nodal contact probabilities. To solve this problem, an exponentially weighted moving average (EWMA) scheme is employed for on-line updating nodal contact probability. A set of functions including sync (), leave (), and join () are devised for cluster formation and gateway selection. Finally the gateway nodes exchange network information and perform routing. The results have shown that it achieves higher delivery ratio and significantly lower overhead and end-to-end delay, compared with its non-EWMA.

7. REFERENCES:

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