International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 2, February 2014)

Enhanced Data Replication based on Demand to Improve Data Availability in MANETs

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***Abstract*—The mobile ad hoc network is a wide research area as it exploits a variety of applications. Manet is mainly used for specific type of applications. The network is formed without any infrastructure and it has the ability to configure itself. The topology changes dynamically as the nodes move frequently and it may leads to the network partitions. The data's available on one node cannot be accessed from another node if it is on another partition. The data availability can be increased by applying data replication since the possibility of finding one copy of data item is higher. The data items are replicated on to the mobile node according to the data accessibility. In this paper the availability can be further increased by using the shortest path algorithm for finding the data item.**

***Keywords*—access frequency, data availability, data replication, MANET, network partition.**

I. INTRODUCTION

One of the most interesting research areas in mobile computing environment is ad hoc networking [3]. The ad hoc network consists of self configuring nodes. The Nodes change locations erratically and the network is formed without any fixed pattern. When the infrastructure is wiped out, we can easily deploy the ad hoc network. This type of network does no need a central administrator as shown in Fig.1. Different devices are connected and the network is formed on the fly. These nodes are capable of both single and multi-hop communication.

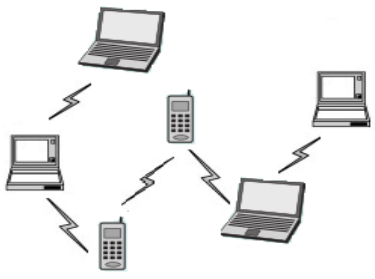

Fig. 1 Mobile ad hoc network

The mobile nodes move very freely and it may cause frequent network partitions. When the node is moved from one area to another and if other nodes cannot access the moved node may leads to a network partition. The mobile node in one of the partition cannot access data item hosted by mobile node in another partition and, hence decrease the accessibility of data items.

To increase the data availability, the data item can be replicated on nodes. Various methods are available for data replication.

As a solution to maintain the data availability, we need to consider data replication techniques. To make replica depends on several factors, like storage space, since the mobile nodes are equipped with a small storage space, the demand of data item etc. Replicating data everywhere is not a good solution due to several factors. The power consumption, huge bandwidth requirement are also vital factors when considering the replication.

Three nodes A, B, C form a network as in Fig. 2, and each node possess a data item, D1, D2 & D3 respectively. The node A can access data item D3 from node C as long as link between node A and node C exists via node B. When a disconnection occurs between node B and node C, the data items are not accessible. Then the network is partitioned into two. One solution to improve data accessibility is replicating data items at mobile node. Various factors can be included during replication.

- It is better to avoid replicate the same data item that the neighbouring nodes already have for saving the storage space.
- Not to replicate the huge data item for saving the storage space.
- It is better to replicate the most wanted data item.

The replication will improve the delay time since the data access from neighbouring node is shorter than from the original owner.

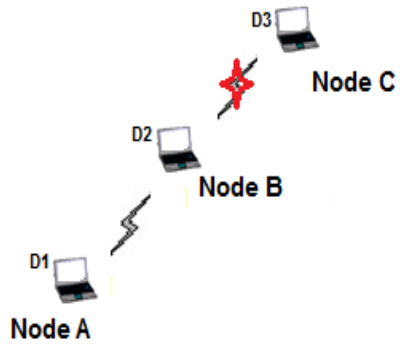

Fig. 2 Network Partition

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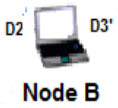

Fig. 3 Data Replication

If the data item D3 is replicated at node B, D3', before the disconnection, the network partition does not affect the data accessibility since the mobile node can obtain the replica of data item from its neighbor as shown in Fig. 3. But if the node B does not have enough storage to hold the data item, then we go for other solutions. Even though the replication is a better remedy to improve data availability and query delay, a node cannot gather and hold all data items considering the constraints storage space, bandwidth and power consumption.

The remainder of this paper is organized as follows, some related works presented in the section 2. Section 3, describes proposed data replication methods. A comparison is made in section 4 and finally a conclusion is made in Section 5.

II. Related Work

There are many techniques has been found for data replication. Some of the techniques are concentrating on improving the data availability [1] only and some are with query delay also [2]. Data replication are widely used in distributed database systems [4] for curbing the response time for database operations and in web server environment for replicating the web servers in several locations [9].

T. Hara [5] proposed some improvements on replication techniques called Dynamic Access Frequency and Neighbourhood (DAFN). In DAFN scheme, duplicated data items are not considered for replication to save the storage space to some extent. But DAFN does not consider the link stability between mobile nodes and the query delay. T. Hara [7] *et al.* timely introduced modified approaches for improving data availability. Robust data replication algorithm (RRA) [11] for MANET ensures data availability by duplicating data over mobile nodes while considering node failures and radio obstacles.

Network partition is another interesting issue for researchers. Mobility is a very important factor for data replication. The group mobility of hosts is discussed in [8]. Replication can be based on location of the mobile host [10]. In DREAM [12] data accessibility can be improved while addressing the issue of power limitation by replicating hot data items before cold data items at servers that have high remaining power.

Most of the replication techniques do not consider the data update while data replication. Sometimes data items are frequently updated and it must be taking into account while replicating it [13]. Since mobile host's mobility causes frequent network partitions, consistency management becomes a critical issue. New consistency maintenance based on local conditions such as location, time etc. are discussed in [14].

In One-To-One Optimization (OTOO) Scheme [2], each mobile node only cooperates with at most one neighbour to decide which data to replicate. To further increase the performance, a Reliable-Neighbour scheme which contributes more memory to replicate data for neighbouring nodes and a Reliable-Grouping scheme which shares replicas in large and reliable groups of nodes are also introduced. The Greedy scheme does not consider the data size while replicating data items. Greedy-S is an improved method, which considers access frequency and data size.

Most of the data replication schemes in the existing system talks about replication schemes based on some constraints and none of them consider the demand of the data item and the shortest path for the data access. The proposed scheme considers different schemes to improve data availability in MANET.

III. Proposed Replication Technique

The new technique consists of three main parts. The first part considers the node and its next neighbour to replicate the data item. It also considers the demand for the data item. The second part determines the reliable neighbours for replication and the third part considers the reliable group in the network and the shortest path for replicating the data item. Since some applications need to store huge amount of data, the data items in MANETs are shared among nodes. The network is considered to be a mesoscale network as in [5], which broadcast small messages such as access requests, access frequencies etc.

Let the projected network N consists of m mobile nodes N_1, N_2 ... N_m and D denote a collection of n data items, d_1, d_2 ... d_n. Storage Capacity of each node is used to store both original data as well as the replicas. The size of the data item, memory capacity of each node, access frequency of each data item, link failure probability between nodes, reliability of neighbouring nodes etc. are different factors to be considered in the network N.

A. *Demand Based Data Replication*

In this method each mobile node only cooperates with at most one neighbour to decide which data to replicate. Let the access frequency of each data item is known and which is normalized against its size.

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The link failure probability (l_{ij}) between the nodes is calculated by considering the distance between the nodes and the radio range. A threshold value has been set for evaluating the link stability. If l_{ij} is greater than the threshold, the data item is replicated. Otherwise we checks whether the data item is important or not, by calculating the access frequency of data items. The selected data item for replication depends on the demand for that data item to that particular node. When the data item has the highest access frequency to that particular node, we go for replication.

B. *Replication with Reliable Neighbors*

In the above scheme at most one neighbour is considered for the process. To further increase the degree of cooperation, all reliable neighbours are taking into account and which contributes more memory to replicate data. The reliability can be checked by calculating ($1-f_{ij}$)>threshold. A set of reliable neighbours is formed and the total contributed memory space is determined. The memory space is allotted according to the priority of the data item and the priority can be resolved with the help of access frequency, size of the data item, link failure probability etc.

C. *Replication among Reliable Group*

The access frequency of the data item in the network is known. The reliability of a node can be checked as in the previous scheme. The set of reliable neighbors can be formed by not only considering one hop neighbors but the entire connected component. The priority of data item can be resolved with the help of access frequency, size of the data item and number of nodes in the group. Then the access delay to data item from each node can also be calculated. By doing so, we can pick up the most suitable data item for replication on the best node to maximize the data availability and minimize the data access delay within the group. If the node is running out of memory space, then we choose another node with the next lower delay.

D. *Data Access using Shortest Path*

In addition to the data replication, the network also supports shortest path calculation for data transfer. The data availability can be enhanced by using the shortest path algorithm for finding the data item. When a data item is requested, the shortest path to the node at which the data item resides can be found. Then the data item is transferred through that path. It will help to faster the data transfer.

IV. COMPARISON

From the analysis, it can be shown that the data availability has improved by replication. The transfer time of data item from one node to another in the network has found and which is compared with the transfer time of the same with replication. The transfer time is again decreased by using the shortest path calculation. The comparison chart is sown in Fig. 4.

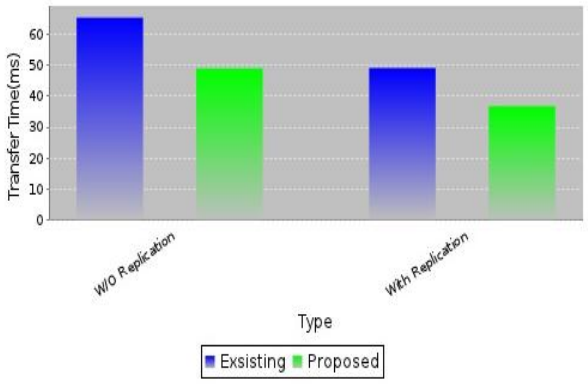

Fig. 4 Comparison chart for data replication

V. CONCLUSION

In MANET, the network partitions are common due to link failure. A node cannot access data from a node when the link fails and create another partition. Data replication is a good solution to enhance the data availability in MANETs. The proposed scheme is more suitable where the network partitions are more common. The replicas of data items are created according to the access frequency, link failure probability, the demand for a data item, transmission delay, and reliability of a node. The memory allocation is also done as per the demand. Thus the data availability can be improved since a node can access the data item from its neighbouring node itself. The proposed scheme also ensures a fast data transfer by including the shortest path calculation for finding the data item.

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