International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 08 | Aug-2016 www.irjet.net p-ISSN: 2395-0072

Replication Based File Sharing for Enhanced File Access Availability in MANET

K.V.Bhavani, S.Venu Gopal

Dept. of CSE, Vardhaman College of Engineering Affiliated to JNTUH, Hyd
venkatabhavani.19@gmail.com
Associate Professor, Dept. of CSE
Vardhaman College of Engineering, Affiliated to JNTUH, Hyd
s.venugopal@vardhaman.org

Abstract - *Mobile Ad Hoc Network (MANET), of late, is also used for file sharing applications. The file access availability is to be given importance for good performance. However there are certain issues in the MANET as the nodes exhibit mobility and contain limited transmission range and constrained resources. A simple method to ensure high file access availability is to make replicas and promoting availability. However, usage of replicas without a proper approach can cause other problems like memory overhead. To overcome this problem in this paper we proposed a methodology that ensures optimal replication which maximizes query performance besides reducing query delay significantly. The methodology takes care of storage capacity of nodes and the meeting frequency. The impact of resource allocation on the query delay is explored with an optimal resource allocation rule. We built a prototype application that demonstrates the proof of concept. The empirical results revealed that the proposed system is able to improve file access availability in MANET.*

Key Words: Mobile Ad Hoc Network, file availability, files sharing, replication

1. INTRODUCTION

The term MANET (Mobile Ad hoc Network) refers to a multichip packet based wireless network composed of a set of mobile nodes that can communicate and move at the same time, without using any kind of fixed wired infrastructure. MANET is actually self organizing and adaptive networks that can be formed and deformed on-the-fly without the need of any centralized administration. A MANET is a type of ad hoc network that can change locations and configure itself on the fly. Because MANETS are mobile, they use wireless connections to connect to various networks. This can be a standard Wi-Fi connection, or another medium, such as a cellular or satellite transmission.

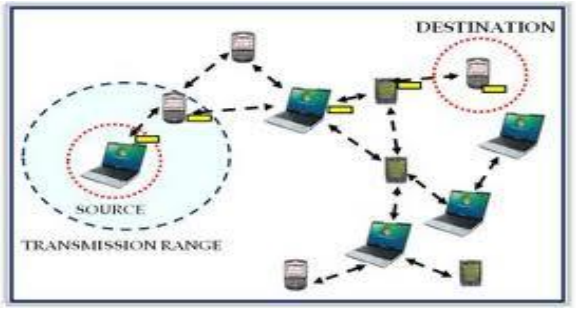

Fig -1: Structure of MANET

The purpose of the MANET working group is to standardize IP routing protocol functionality suitable for wireless routing application within both static and dynamic topologies with increased dynamics due to node motion and other factors. Approaches are intended to be relatively lightweight in nature, suitable for multiple hardware and wireless environments, and address scenarios where MANETs are deployed at the edges of an IP infrastructure. Hybrid mesh infrastructures (e.g., a mixture of fixed and mobile routers) should also be supported by MANET specifications and management features. Recently MANET is being used for file sharing applications. In this context, there are many issues when file replicas are used in the network. Especially it causes overhead in terms of memory. To overcome this drawback, in this paper, we implemented a methodology that provides high availability of files besides reducing overhead.

The remainder of the paper is structured as follows. Section II provides review of literature. Section III presents the proposed system in detail. Section IV provides implementation details. Section V presents experimental results while section VI concludes the paper.

2. Related Work

This section provides review of literature on the file sharing and file access availability in MANET. The research of file sharing in MANET is relatively new in MANET. Efficient file sharing in MANET can serve users to gain maximum benefits. File replication techniques have been

around as explored in [5], [4] and [3]. According to these techniques a general approach followed is described here. An individual node or a set of nodes consider file querying frequency and determine the node replication decisions. Three file replication methods were proposed in [3]. They are known as Dynamic Connectivity Based Grouping (DCG), Dynamic Access Frequency and Neighborhood (DAFN) and Static Access Frequency (SAF). With respect to SAF, each node in MANET determines the replication of files that are queried frequently based on the available storage. This technique may results in many replicas in the neighborhood based on their preferences common. This will cause memory overhead.

In case of ADFN, the duplicates in replicas are avoided in the neighborhood. DCG is stricter on eliminating replicas which are duplicates. It further reduces duplicates in the replicas among a set of nodes grouped together and maintain replicas based on the frequency of queries made to files. Both DCG and DAFN eliminate unnecessary replicas from the neighboring nodes. However, they have got issues with node mobility. They also cause more traffic while identifying duplicate replicas and managing group of nodes. Zheng et al. [4] followed different approach. According to this each node involves in the collection of data access statistics from neighbors and then makes decisions in terms of relinquishment or creation of replicas.

Duong and Demeure [5] grouped nodes together based on stable connections. Then each node is allowed to check the possibility of neighbors to request a file and the status of the storage while making replication decisions. Later on Yin and Cao [2] used caching concept in order to cache files that are understood as popular they used file retrieval paths and identified intersection nodes for file replications. It is an effective method for popular files. However, it results in wastage of storage space on nodes. The concept of probability of acquiring files is explored in [6] to maintain n number of replicas in the network which is potentially partitioned. The retrieval performance is studied by the researcher besides exploring ensures coding for better performance. Chen [7] focused on finding a techniques which enables to use minimal number of servers in order to ensure that there will be maximal file access availability. Moussaoui et al. [1] studied and proposed a replication procedure which has two steps in it. The first steps take care of primary replication while the second step is to take care of dynamic replication. Thus file replicas are used to disseminate the required content in the network to satisfy end users and ensure the data loss is prevented in the context of network partition.

3. Proposed Methodology

The proposed methodology is described here. Random Waypoint (RWP) model is used for optimal file replication. Community based mobility model is used to handle mobility in MANET with respect to file access availability and file replication problems. Meeting ability distribution is considered for file replication decisions. The design of file replication guidelines helped to achieve the optimal file sharing capabilities to the nodes in the application.

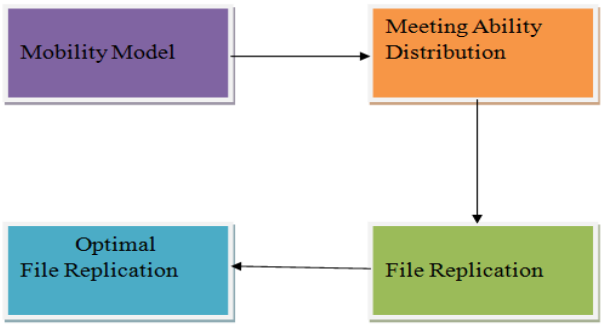

Fig -2: Overview of methodology

Optimal File Replication

- In the Random Waypoint (RWP) model, we can assume that the inter-meeting time among nodes follows exponential distribution. The probability of meeting a node is independent with the previous encountered node. Therefore, we define the meeting ability of a node as the average number of nodes it meets in a unit time and use it to investigate the optimal file replication. Specifically, if a node is able to meet more nodes, it has higher probability of being encountered by other nodes later on.

- A node's probability of being encountered by other nodes is proportional to the meeting ability of the node. It indicates that files residing in nodes with higher meeting ability have higher availability than files in nodes with lower meeting ability. So we take into account both meeting ability and storage in measuring a node's resource. When a replica is created on a node, it occupies the memory on the node. Also, its probability of being met by others is decided by the node's meeting ability. This means that the replica naturally consumes both the meeting ability and the storage resource of the node.

Community-Based Mobility Model

- In this module, we conduct the analysis under the community-based mobility model. We consider each node's satisfying ability. It is defined as a node's ability to satisfy queries in the system and is calculated based on the node's capacity to satisfy queries in each community.

- In this model, since nodes' file interests are stable during a certain time period, we assume that each node's file querying pattern (i.e., querying rates for

different files) remains stable in the considered period of time. The number of nodes in a community represents the number of queries for a given file generated in this community. As a result, a file holder has low ability to satisfy queries from a small community.

- We integrate each community's fraction of nodes into the calculation of the satisfying ability.

Meeting Ability Distribution

- We measured the meeting ability distribution from real traces to confirm the necessity to consider node meeting ability as an important factor in the resource allocation in our design.

- For each trace, we measured the meeting abilities of all nodes and they are in decreasing order. We see that in all traces, node meeting ability is distributed in a wide range. It matches with our previous claim that nodes usually have different meeting abilities. Also, it verifies the necessity of considering node meeting ability as a resource in file replication since if all nodes have similar meeting ability, replicas on different nodes have similar probability to meet requesters, and hence there is no need to consider meeting ability in the resource allocation.

File Replication Protocol

- We propose the priority competition and split file replication protocol (PCS). We first introduce how a node retrieves the parameters needed in PCS and then present the detail of PCS.

- In priority competition and split, each node dynamically updates its meeting ability and the average meeting ability of all nodes in the system. Such information is exchanged among neighbor nodes.

- We introduce the process of the replication of a file in PCS. Based on OFRR, since a file with a higher P should receive more resources, a node should assign the higher priority to its files with higher P to compete resource with other nodes. Thus, each node orders all of its files in descending order of their Ps and creates replicas for the files in a top-down manner periodically.

- The file replication stops when the communication session of the two involved nodes ends. Then, each node continues the replication process for its files after excluding the disconnected node from the neighbor node list. Since file popularity, Ps, and available system resources change as time goes on, each node periodically executes PCS to dynamically handle these time-varying factors. Each node also periodically calculates the popularity of its files to reflect the changes on file popularity in different time periods. The periodical file popularity update can automatically handle file dynamism.

4. IMPLEMENTATION

The prototype application is implemented using Java programming language. Java swing API is used to design user interface and functionality is implemented using networking and IO API available in JDK. The application demonstrates peer to peer concept where file sharing and replication are demonstrated with the custom simulation application.

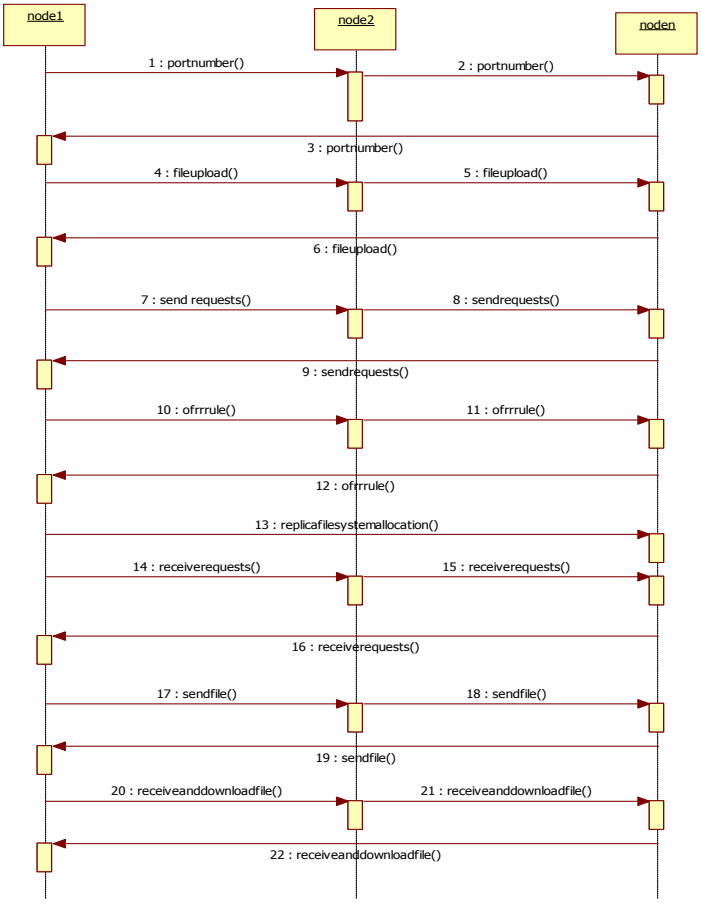

Fig -3: Shows the communication process between nodes

As shown in Figure 3, it is evident that there are formal communications among the nodes deployed in the network. The communications are related to file sharing, file search and the file replication.

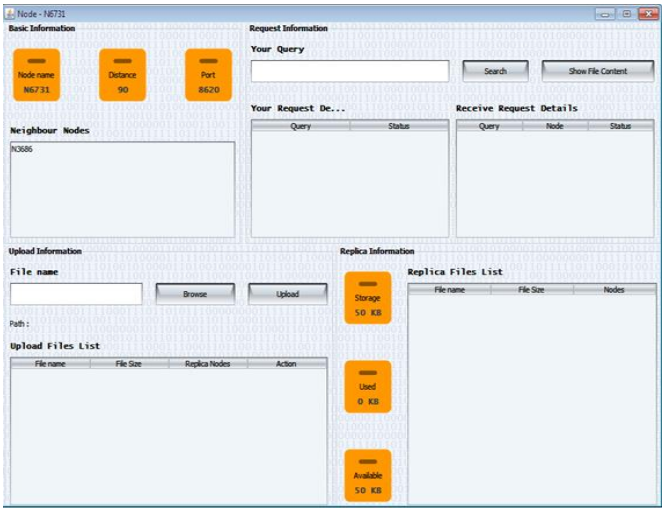

Fig -4: A peer node and its typical UI

As shown in Figure 4, it is evident that the node is represented a GUI program which contains the features of file sharing applications. In fact a file sharing protocol is used as underlying mechanism. There are provisions for querying, searching, viewing files, uploading files for sharing and memory usage information.

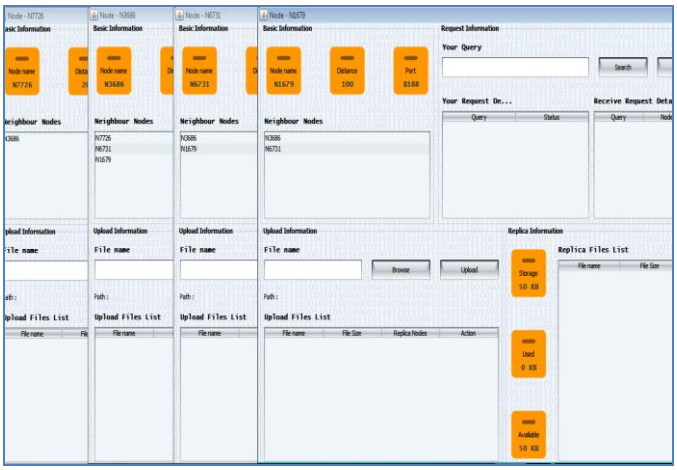

Fig -5: Shows multiple nodes in action

As can be seen in Figure 5, there are multiple nodes containing same capabilities are in action. These nodes can perform two operations. They are file sharing and file searching. These are two important activities used in the file sharing applications in the real world. In the same fashion, this application supports those two operations. Moreover, there is a mechanism for replication which is implemented in every node in the network. The replication methodology ensures that the file sharing efficiency is improved besides reducing memory usage.

5. EXPERIMENTAL RESULTS

Experiments are made with a prototype application which demonstrated the proof of concept. The results are presented here. The results reveal the efficiency of the proposed system when compared with various existing methods.

Dartmouth Trace	25	24	23	23	21	21	16

Table -1: Shows Dartmouth trace

Mit Reality trace	18	13	11	8	7	3	2	1	0
Haggle trace	8	7	6	5	4	4	3	2	1

Table -2: Shows mit reality trace and haggle trace

OPTM	RANDOM	CACHE-DTN	DCG	PCS
0.66	0.65	0.66	0.67	0.67
0.63	0.63	0.63	0.64	0.65
0.62	0.61	0.61	0.59	0.6
0.59	0.58	0.57	0.56	0.56
0.52	**0.52**	**0.53**	**0.53**	**0.52**

Table -3: Shows performance of different methods

PCS	DCG	CACHE-DTN	RANDOM	OPTM
34	35	34	36	35
33	32.5	32	32	31.5
29	31	30	30	31
28	28.5	28.75	29	30
28	27	27.5	27.75	28

Table -4: Shows performance of different methods

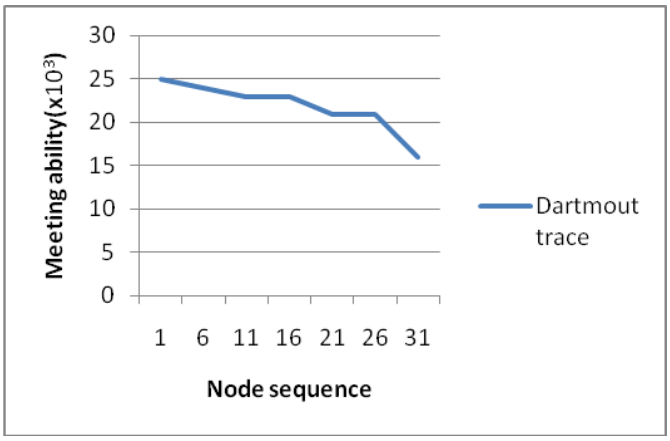

Chart -1: Meeting ability vs. node sequence

As can be seen in Chart 1, Dartmouth trace is used for experiments. The horizontal axis represents node sequence while the vertical axis represents the meeting ability. As the node sequence is increased meeting ability is decreased.

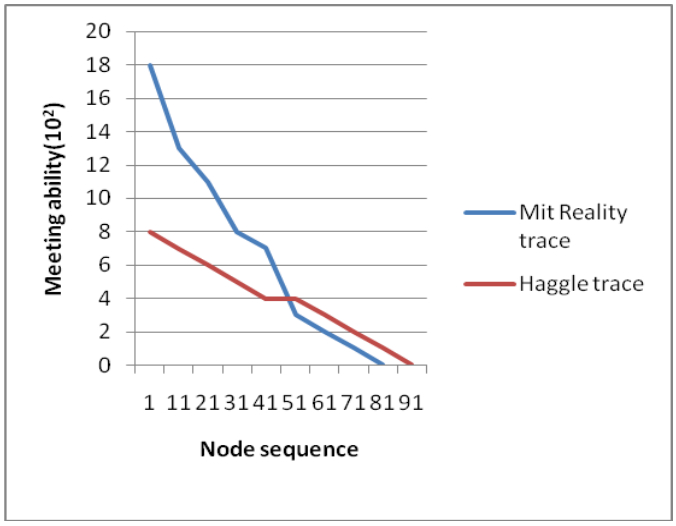

Chart 2: Meeting ability vs. node sequence

As can be seen in Chart 2, mit reality trace and haggle trace are used for experiments. The horizontal axis represents node sequence while the vertical axis represents the meeting ability. As the node sequence is increased meeting ability is decreased.

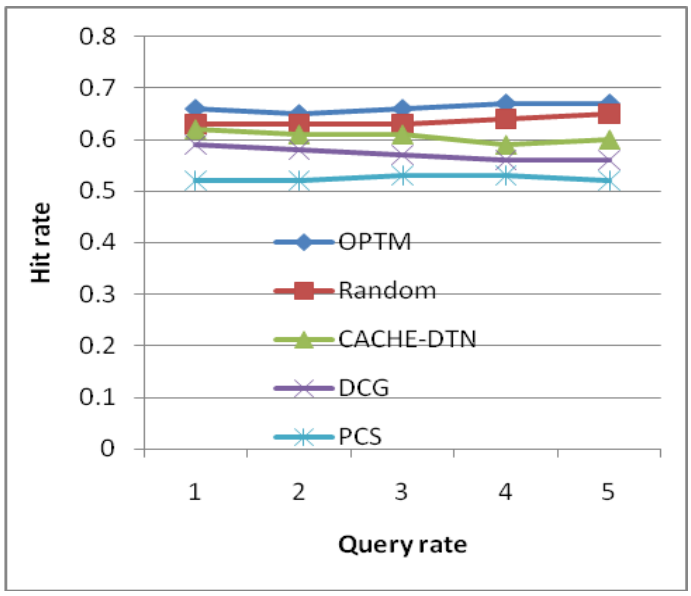

Chart -3: Hit rate vs. query rate

As can be seen in Chart 3, different techniques are used to compare performance. The horizontal axis represents query rate while the vertical axis represents hit rate. The results reveal difference performance levels based on the technique used.

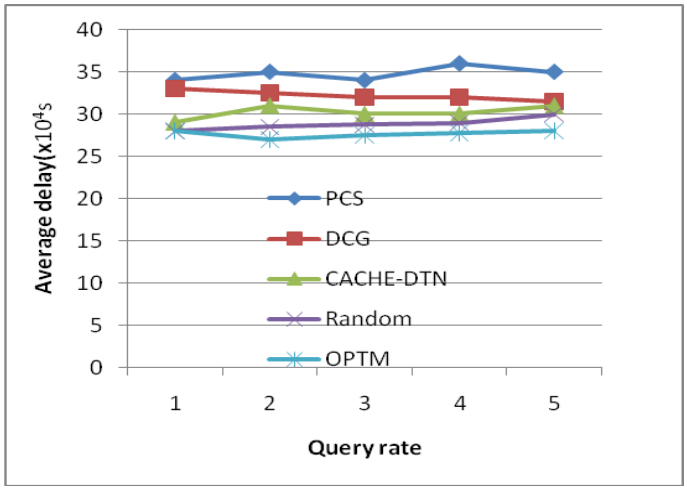

Chart -4: Average delay vs. query rate

As can be seen in Chart 4, different techniques are used to compare performance. The horizontal axis represents query rate while the vertical axis represents average delay. The results reveal difference performance levels based on the technique used.

6. CONCLUSIONS

In this paper we studied the problem of file access availability in file sharing applications that run on MANET devices. We investigate on the file replicas as means of improve file access availability. In the process we came to know the issues pertaining to limited resources and mobility of MANET. We proposed a methodology that could reduce the burden on network by carefully using a replication method that optimizes the file access availability and resource consumption. We investigated the impact of optimal replica distributed in order to reduce delay in querying and improve the file access availability. We also built a prototype application which demonstrates the proof of concept. This research can be extended further by investigating the tradeoffs between the resource utilization and file access availability when replication technique is used.

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