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Predict the Query Transaction using Fuzzy Logic for MANETs Data Caching

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***Abstract*—In recent years, Caching technique (pull-based) in Mobile Ad hoc networks (MANETs) has become a promising technique in solving or mitigating the problems of performance, availability, scalability and resource paucity. MANETs consists of mobile nodes which communicate with each other through wireless medium without any fixed infrastructure. Mobile nodes may change rapidly and unpredictably over time. Accessing services and data over the network can be very slow and hence, the caching frequently accessed data is an effective technique for improving performance. It is used to minimize a repetitive querying of nearly stagnant data. The data can be queried once and stored in a cache, and the mobile node repeatedly accesses the cache for the data, or perhaps the cache is updated to get fresh data. There are a lot of research works going on to solve the problems of How to reduce client mobile side latency, How to maintain cache consistency between various caches and the servers and how to enable cooperation between multiple peer caches etc. In This paper presents a model to predict the data in cache operation on the mobile side by applying fuzzy logic method in order to prevent the transaction failures during execution in the mobile system that communicating across the wireless networks.**

Keywords-Mobile Ad hoc networks; Data Caching; Fuzzy Scheduler

I. INTRODUCTION

A Mobile Ad hoc Network (MANET) presents as a self configuring network of mobile routers (and associated hosts) connected by wireless links the union of which to move randomly and organize networks arbitrarily under network change rapidly, unpredictably and no master-slave relationship between mobile nodes [1,2]. Mobile ad hoc networks have several practical applications including battlefield communication, nature disaster areas, fleet in oceans or vehicular communications etc. Figure 1: Mobile Ad hoc Network (MANET) architecture is illustrated below: all terminals with relay capabilities (such as the cellular phones, laptops and PDAs) could serve as intermediate routers and help the source terminal and destination terminal to establish their communication.

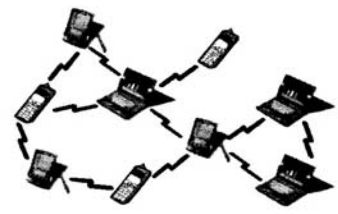

Figure 1. A Mobile Ad hoc Network (MANET) [1]

A general architecture of a mobile database environment consists of base stations (BS) and mobile hosts (MH). The mobile host moves from one cell to another, and communicates with the base stations through wireless networks. But mobile host has limited storage capability on store data items. Data Caching is used to cache some or most frequently accessed data from the base station into mobile host. The advance in data caching enable user to improve the efficiency of information access in a wireless ad hoc network by reducing the access latency and bandwidth usage. The data caching Scheme in Architecture-Based Wireless Networks is illustrate in Fig. 2.

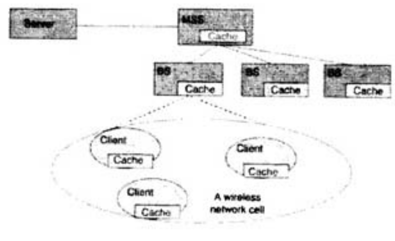

Figure 2. Cache Scheme in Architecture-Based Wireless Networks [3]

There are several requirements and discussion of mobile clients on cache-based strategies such as high data availability in mobile computing environments where frequent disconnections

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may occur because the mobile clients and server may be weakly connected, resource constraints on the mobile clients because mobile clients have limited power or processing resources and architecture-based wireless network both downstream queries (base station to mobiles) or upstream queries (mobile to base station) is expensive in terms of battery power consumption etc.

Fuzzy Scheduler [4] for improving the performance of the mobile ad-hoc networks, a scheduler can be used. The fuzzy scheduler initially proposed [5, 6], calculates the priority index of each packet as shown in the figure 3. Here important consider all the inputs, which decide the priority associated with the packet, unlike the previous scheduling schemes. The fuzzy scheduler used three input variables and one output variable. The three input variables are, the expiry time, and data rate of the packet and Queue length of the nodes.

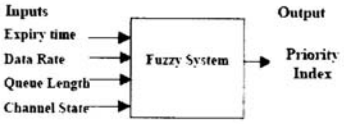


Figure 3. Fuzzy Scheduler [4]

The contribution of this paper lies in the design, analysis and evaluation on predicting the data in cache operation on the mobile side by applying fuzzy logic method. We applied a fuzzy priority scheduler for prediction data of cache in mobile units on Mobile ad hoc networks.

The rest of the paper is organized as follows: In Section 2, the related works will be reviewed. In Section 3, we will describe the characteristics of models of data caching in MANETs. Section 4 illustrates the Simulation results. Finally, Section 5 concludes with suggestions of current challenges and potential directions for future research.

II. RELATED WORKS

Significant work focused on the cache management in MANETs. Several models/solutions were proposed in the last few years, such as GloMoSim [4], DBR^{2}P [9] etc.

C.Gomathy and S.Shanmugavel improve [4], the performance of the mobile ad-hoc networks, using Scheduling algorithms. They simulation modeled a network of mobile nodes placed randomly within 1000 x 1000 meter area. Radio propagation range for each node was 250 meters and channel capacity of 2 Mb/S is chosen. There were no network partitions throughout the simulation. Each simulation is executed for 1000 seconds of simulation time. Multiple runs with different seed values were conducted for each scenario and collected data was averaged over those runs. A traffic generator was developed to simulate CBR sources and FTP items. The size of the data payload is 512 bytes. Data sessions with randomly selected sources and destinations were simulated. Each source transmits data packets at a minimum rate of 4 packets / sec. and maximum rate of 10 packets/ sec. The traffic load is varied by changing the number of data sessions and the effect is examined on scheduler with different routing protocols.

In some solutions, as Fardin M. Sagayeshi and et al. [7], focus on the mainly problem that need to retrieve information from database during the system is moving. They applied a prediction algorithm using Fuzzy logic on prediction executed when Mobile Unit (MU) sends a request while it does not have sufficient initial data to perform it. So MU sends the request to Mobile Service Station (MSS). The MSS should predict the necessary data and sends it to MU. On the prediction procedure is using Record number (RC), Table number (TC) and after wards identifying a row with maximum value of membership function. Ha Duyen Trung and Watit Benjapolakul [8] present the improvement of multiple paths location-aided routing (MLAR) method over unipath location-aided routing in terms of packet delivery, end-to-end delay through simulation using Network Simulator (ns2). They propose a method by replacing LAR with MLAR to improve performance of overall routing metrics. Location information can be used to reduce propagation of control packets, to perform controlled flooding, to maintain routes in mobility conditions and to make simplified packet forwarding decisions.

DBR^{2}P (Dynamic Backup Routes Routing Protocol) [9] was proposed by Ying-Hong Wang and at el., they focus attention on the intrinsic properties of MANETs, and the results of the simulation experiment show that DBR^{2}P has good performance. DBR^{2}P includes three phases; route discovery phase, backup node setup phase and route maintenance phase that requiring two kinds of cache: RD_request_Cache, and Backup_Routes_Cache, A source node sets a unique request identification number for each RD-request packet from a locally-maintained sequence number. The RD-request_Cache of a node is used to store temporary counters, which record how many times this node receives the RD-request packets with the same identification number, in the route discovery phase. The entity, <#RD, n>, is used to present this counter parameter, where #RD is the sequence number of the RD-request, and n is the number of times that RD-request with the same #RD has been received. The Backup_Routes_Cache is used to store backup routes. After the route discovery phase is initiated by a source node, the destination node may receive some routes, and then enter the backup node setup phase in order to analyze some backup nodes and backup routes. In backup node setup phase, the backup routes are sent to each backup node by BR-setup packets and stored in the Backup_Routes_Cache of each backup node.

III. MODELS OF DATA CACHING IN MANET

A. Cache Management

We extend our model based on DBR^{2}P and applied the fuzzy scheduler method for predicting orderly of queries transactions in mobile units. In MANETs, data caching scheme could be adopted to help reduce the use of bandwidth and the power consumption of battery. As shown in Fig. 4., [9] after Node D requests a data item (marked as d_i) from Node S, Node S will send d_i to Node D through the route *i* (marked as r_i : S > B > F > J > N > D) set up by DBR^{2}P. During the process of data transfer in data caching scheme, all nodes on the data transfer routes cache d_i. Thus, when other nodes, those not on the r_i, such as E, K, etc., want to request d_i, they do not need to rebuild a route connecting Node S to transfer d_i. They (Node E or K) could connect to the nearest neighbor node on r_i to request d_i.

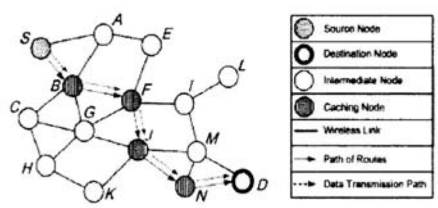


Figure 4. Example of data transmission path in a MANET [9]

For example, node E could connect to node F or node K could connect to node J to request d_i. Although using data caching scheme could shorten routes and time span to access data and raise data reusable rate to reduce the use of bandwidth, it will also cause the mass production of d_i clones in the MANET and result in additional waste of resources. The data-path caching scheme enables all nodes to cache data-path of d_i (Meanwhile data-path cache buffer will record that node S and D have d_i) during the process of data transfer. When other nodes (such as B, E, or K), except for node S and node D, also want to request d_i, they could detect which node has d_i by inquiring the data-path cache buffer of the nodes on the path. Then a route connecting node S or node D is set up to request d_i. Through the use of data-path caching scheme, bandwidth and power are reduced while caching the data-path for each data because nodes can obtain data by using few hops. However, it will increase routing overhead to map data and cache nodes.

B. Fuzzy Theory and Fuzzy Databases

Fuzzy logic starts with the concept of a fuzzy set. A fuzzy set is a set without a crisp, clearly defined boundary. It can contain elements with only a partial degree of membership [10]. A fuzzy set is an extension of a classical set. If X is the universe of discourse and its elements are denoted by x, then a fuzzy set $\tilde{A}$ in X is defined as a set of ordered pairs:

$$\tilde{A} = \{(x, \mu_{\tilde{A}}(x)) | x \in X\} \quad (1)$$

Fuzzy database is a branch of Fuzzy sets and one of its applications. On Bachles and Petri opinion a fuzzy database is a kind of database that created on relation database base and value of fields in each record is a member of universal set of fields and these values are defined with fuzzy equivalence concept. Rules, Each MU in mobile database is connected to one of MSS in order to using the data in Databases. Also it gives its request and receives essential data that are done through wireless network, the database dispatched on MSS. Each MU has some design as the main database which is used to cache the data and accepting local data. Every MSS is response for making connection with MUs. MSS is also responsible for accuracy of transaction and registration of transactions result in databases.

C. Prediction Algorithm

Prediction executed when MU sends a request while it does not have sufficient initial data to perform it. So MU sends the request to MSS. MSS should predict the necessary data and sends it to MU. Prediction procedure is using Record number (RC), Table number (TC) and after wards identifying a row with maximum value of membership function.

More accurate prediction may be accessible as:

1. If requested record or record exists in MSS, selected ones returns to MU as response.
2. If requested records do not exist, very probably MU resends similar logic request very soon, so it is preferred prediction to be performed in response to the same first request and results to be forward toward MU, to prevent later requests the formula to choose the records as shown on Table 1:

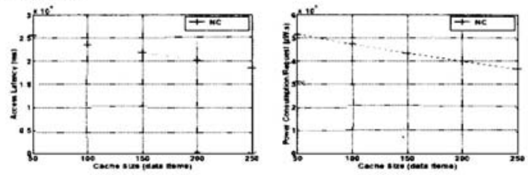
TABLE I. WEIGHT OF EACH RECORD IN MOBILE DATABASES [6,8,9]

Weight	Formulas	Conditions
Case 1	M+0	If M=1
Case 2	M+/- 0.2	If 0<M<1
Case 3	M+0.2	If M=0

M is membership value in each tuple that has been saved in table. Using above formula the most similar records are selected and would be send to MU, where they are saved in its cache memory.

IV. SIMULATION RESULTS

In the simulated experiments, we compare the performance of our proposed model in many situations as the effect of cache size and data item size etc. A simulated experiment ends when each MH generates about 10,000 requests. The performance metrics include the access latency and power consumption on communication. The access latency (a) is defined as the sum of transmission time, and the time spent (b) on waiting for required communication channels, if they are busy. Our first experiment studies the effect of cache size on system performance by varying the cache size from 50 to 250 data items.



(a) Access latency (b) Power Consumption

Figure 5. Effect of cache size

CONCLUSIONS

In this paper, we evaluated the performances of data cache management for mobile ad hoc networks in network simulator. Our goal tried to utilized response time on queries execution in disconnected environments from Mobile Units. At present a detailed operation procedure of the framework is in process of design and a simulation environment will be set up. Our future work concerns the support of federated databases and multiple heterogeneous databases environment interfaces in MANETs, and issues such as multicast and QoS. Especially, the proposed framework will be applied to real MANET environments in the near future.

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