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Competition of Efficient Data Access in Disruption Tolerant Networks

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Abstract: Disruption tolerant networks (DTNs) are characterized by low node density, unpredictable node mobility, and lack of global network information. Most of current research efforts in DTNs focus on data forwarding, but only limited work has been done on providing efficient data access to mobile users. In this paper, we propose a novel approach to support cooperative caching in DTNs, which enables the sharing and coordination of cached data among multiple nodes and reduces data access delay. Our basic idea is to intentionally cache data at a set of network central locations (NCLs), which can be easily accessed by other nodes in the network. We propose an efficient scheme that ensures appropriate NCL selection based on a probabilistic selection metric and coordinates multiple caching nodes to optimize the tradeoff between data accessibility and caching overhead. Extensive trace-driven simulations show that our approach significantly improves data access performance compared to existing schemes.

Keywords: Disruption Tolerant Networks (DTNs), Network Central Locations (NCLs).

I. INTRODUCTION

Disruption tolerant networks (DTNs) consist of mobile devices that contact each other opportunistically. Due to the low node density and unpredictable node mobility, only intermittent network connectivity exists in DTNs, and the subsequent difficulty of maintaining end-to end communication links makes it necessary to use "carry and-forward" methods for data transmission. Examples of such networks include groups of individuals moving in disaster recovery areas, military battlefields, or urban sensing applications. In such networks, node mobility is exploited to let mobile nodes carry data as relays and forward data opportunistically when contacting others. The key problem is, therefore, how to determine the appropriate relay selection strategy. Although forwarding schemes have been proposed in DTNs, there is limited research on providing efficient data access to mobile users, despite the importance of data accessibility in many mobile applications. For example, it is desirable that smart phones users can find interesting digital content from their nearby peers. In vehicular ad-hoc networks (VANETs), the availability of live traffic information will be beneficial for vehicles to avoid traffic delays. In these applications, data are only requested by mobile users whenever needed, and requesters do not know data locations in advance.

The destination of data is, hence, unknown when data are generated. This communication paradigm differs from publish/subscribe systems in which data are forwarded by broker nodes to users according to their data subscriptions. Appropriate network design is needed to ensure that data can be promptly accessed by requesters in such cases. A common technique used to improve data access performance is caching, i.e., to cache data at appropriate network locations based on query history, so that queries in the future can be responded with less delay. Although cooperative caching has been studied for both web-based applications and wireless ad hoc networks to allow sharing and coordination among multiple caching nodes, it is difficult to be realized in DTNs due to the lack of persistent network connectivity. First, the opportunistic network connectivity complicates the estimation of data transmission delay, and furthermore makes it difficult to determine appropriate caching locations for reducing data access delay. This difficulty is also raised by the incomplete information at individual nodes about query history. Second, due to the uncertainty of data transmission, multiple data copies need to be coached at different locations to ensure data accessibility. The difficulty in coordinating multiple caching nodes makes it hard to optimize the tradeoff between data accessibility and caching overhead. In this paper, we propose a novel scheme to address the aforementioned challenges and to efficiently support cooperative caching in DTNs. Our basic idea is to intentionally cache data at a set of network central locations (NCLs), each of which corresponds to a group of mobile nodes being easily accessed by other nodes in the network. Each NCL is represented by a central node, which has high popularity in the network and is prioritized for caching data. Due to the limited caching buffer of central nodes, multiple nodes near a central node may be involved for caching, and we ensure that popular data are always cached nearer to the central nodes via dynamic cache replacement based on query history. Our detailed contributions are listed as follows:

- We develop an efficient approach to NCL selection in DTNs based on a probabilistic selection metric. The selected NCLs achieve high chances for prompt response to user queries with low overhead in network storage and transmission.
- We propose a data access scheme to probabilistically coordinate multiple caching nodes for responding to user queries. We furthermore optimize the tradeoff between data accessibility and caching overhead, to minimize the average number of cached data copies in the network.
- We propose a utility-based cache replacement scheme to dynamically adjust cache locations based on query history, and our scheme achieves good tradeoff between the data accessibility and access delay.

II. EXISTING SYSTEM

In the existing system, research on data forwarding in DTNs originates from Epidemic routing], which floods the entire network. Some later studies focus on proposing efficient relay selection metrics to approach the performance of Epidemic routing with lower forwarding cost, based on prediction of node contacts in the future. Some schemes do such prediction based on their mobility patterns, which are characterized by Kalman filter or semi-Markov chains. In some other schemes, node contact pattern is exploited as abstraction of node mobility pattern for better prediction accuracy, based on the

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experimental and theoretical analysis of the node contact characteristics. The social network properties of node contact patterns, such as the centrality and community structures, have also been also exploited for relay selection in recent social-based data forwarding schemes.

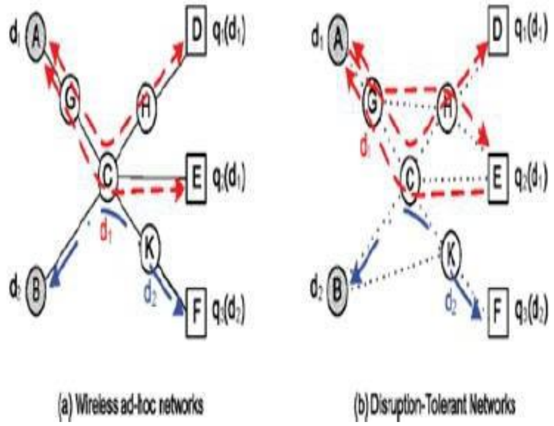

Fig 1: Caching strategies in different network environments. Data d1 generated by node A are requested by nodes D and E, and d2 generated by node B are requested by node F. A solid line in (a) between nodes indicates a wireless link, and a dotted line(b) indicates that two nodes opportunistically contact each other.

III. PROPOSED SYSTEM

In the proposed system, we propose a novel scheme to address the aforementioned challenges and to efficiently support cooperative caching in DTNs. Our basic idea is to intentionally cache data at a set of network central locations (NCLs), each of which corresponds to a group of mobile nodes being easily accessed by other nodes in the network. Each NCL is represented by a central node, which has high popularity in the network and is prioritized for caching data. Due to the limited caching buffer of central nodes, multiple nodes near a central node may be involved for caching, and we ensure that popular data are always cached nearer to the central nodes via dynamic cache replacement based on query history. Our proposed cache replacement strategy in Cache Replacement is compared with the traditional replacement strategies including FIFO and LRU. It is also compared with Greedy-Dual-Size, which is widely used in web caching. We use MIT Reality trace for such evaluation, and set T as one week. The results are shown. FIFO and LRU leads to poor data access performance due to improper consideration of data popularity. In Fig. 1a, when data size is small and node buffer constraint is not tight, cache replacement will not be frequently

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conducted. Hence, the successful ratio of traditional strategies is only 10-20 percent lower than that of our scheme. However, when data size becomes larger, these strategies do not always select the most appropriate data to cache, and the advantage of our scheme rises to over 100 percent when savg ¼ 200 Mb. Data access delay of FIFO and LRU also becomes much longer when savg increases as shown. Greedy-Dual-Size performs better than FIFO and LRU due to consideration of data popularity and size, but it is unable to ensure optimal cache replacement decision, we also compared the overhead of those strategies, which is the amount of data exchanged for cache replacement. Since cache replacement is only conducted locally between mobile nodes in contact, there are only slight differences of this overhead among different strategies. Greedy-Dual-Size makes the caching nodes exchange a bit more data, but this difference is generally negligible.

IV. IMPLEMENTATION

A. Service Provider

In this module, the Service Provider sends their file to the particular receivers. For the security purpose the Service Provider encrypts the data file and then store in the network central locations (NCL 1, NCL 2 and NCL 3). The Service Provider can have capable of manipulating the encrypted data file. The service provider will send the file to particular receivers.

B. Router

The Router manages a multiple nodes to provide data storage service. In Router n-number of nodes are present, before sending any file to receiver energy will be generate in a router and then select a smallest energy path and send to particular receivers. Service Provider encrypts the data files and stores them in the network central locations for sharing with data receivers. To access the shared data files, data receivers download encrypted data files of their interest from the Network Central Location and then decrypt them.

C. Network Central Location

All uploaded files are stored in Network Central Locations (NCL 1, NCL 2 and NCL 3), via network central locations file will send to particular receivers. Receiver has request the file to router, then it will connect to NCL and check the file in network central

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locations & then send to receiver. If the requested file is not present in network central locations then response (file is not exist) will send to receiver. The receivers receive the file by without changing the File Contents. **D. Receiver (End User)**

In this module, the receiver can receive the data file with the encrypted key to access the file. The Receiver has request the file to router, it will connect to NCL and check the file in all network central locations & then send to receiver. If receiver enters file name is not present in all network central locations then the receiver is getting the file response from the router and also shows delay of time in router. The receivers receive the file by without changing the File Contents. Users may try to access data files within the network only.

V. NETWORK CENTRAL LOCATIONS

In this section, we describe how to select NCLs based on a probabilistic metric evaluating the data transmission delay among nodes in DTNs; we validate the applicability of such metric in practice based on the heterogeneity of node contact pattern in realistic DTN traces. Furthermore, we propose detailed methods for selecting NCLs in practice based on different availability of network information.

A. Trace-Based Validation:

The practical applicability of the aforementioned NCL selection metric is based on the heterogeneity of node contact patterns, such that nodes in DTNs differ in their popularity and few nodes contact many others frequently. In this section, we validate this applicability using realistic DTN traces. These traces record contacts among users carrying mobile devices in conference sites and university campuses. The mobile devices, including Mica2 sensors or smartphones, are distributed to users being participated into the experiment. Devices equipped with Bluetooth interface periodically detect their peers nearby, and a contact is recorded when two devices move close to each other. Devices equipped with WiFi interface search for nearby WiFi APs and associate themselves to APs with the best signal strength. A contact is recorded when two devices are associated with the same AP. The detected contacts are recorded in the local storage of mobile devices. After the experiment ends, these devices are called back so that the recorded contacts are processed and analyzed.

B. Practical NCL Selection

In general, network information about the pair wise node contact rates and shortest opportunistic paths among mobile nodes are required to calculate the metric values of mobile nodes according to (3). However, the maintenance of such network information is expensive in DTNs due to the lack of persistent end-to-end network connectivity. As a result, we will first focus on selecting NCLs with the assumption of complete network information from the global perspective. Afterwards, we propose distributed NCL selection methods that efficiently approximate global selection results and can operate on individual nodes in an autonomous manner.

C. Caching Scheme

In this section, we present our cooperative caching scheme. Our basic idea is to intentionally cache data at a set of NCLs, which can be promptly accessed by other nodes. Our scheme consists of the following three components:

1. When a data source generates data, it pushes data to central nodes of NCLs, which are prioritized to cache data. One copy of data is cached at each NCL. If the caching buffer of a central node is full, another node near the central node will cache the data. Such decisions are automatically made based on buffer conditions of nodes involved in the pushing process.
2. A requester multicasts a query to central nodes of NCLs to pull data, and a central node forwards the query to the caching nodes. Multiple data copies are returned to the requester, and we optimize the tradeoff between data accessibility and transmission overhead by controlling the number of returned data copies.
3. Utility-based cache replacement is conducted whenever two caching nodes contact and ensures that popular data are cached nearer to central nodes. We generally cache more copies of popular data to optimize the cumulative data access delay. We also probabilistically cache less popular data to ensure the overall data accessibility.

VI. CONCLUSION

In this paper, we propose a novel scheme to support cooperative caching in DTNs. Our basic idea is to intentionally cache data at a set of NCLs, which can be easily accessed by other nodes. We ensure appropriate NCL selection based on a probabilistic metric; our approach coordinates caching nodes to optimize the tradeoff between data accessibility and caching overhead. Extensive simulations show that our scheme greatly improves the ratio of queries satisfied and reduces data access delay, when being compared with existing schemes.

VII. REFFRENCES

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