Chapter 13

A Cache Replacement Policy for Location Dependent Data in Mobile Environments

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ABSTRACT

Data caching at mobile clients is an efficient mechanism to enhance data accessibility and reduce access cost. The issues of cache replacement for location-dependent data have been studied under a geometric location model, and a new cache replacement policy has been proposed by taking into account the spatial and temporal factors.

Cache hit ratio is employed as the primary performance metric where the higher the cache hit ratio, the higher the local data availability, lower uplink and downlink costs and less battery consumption. The experimental results show that the proposed replacement scheme is effective when the user preference is considered and the policy significantly outperforms the conventional replacement policies.

1. INTRODUCTION

Advances in wireless networking and the proliferation of portable devices have engendered a new computing scenario, called mobile computing, in which users with power-limited mobile devices can access database information systems located at the static network while they move. Lot of research has gone into improving the functionality, computational power, size and power constraints of mobile devices such as personal digital assistants, cell phones etc. Also, there has been considerable work on improving the communication capabilities through increase in bandwidth and...
development of protocols that are fault tolerant and resilient to the error prone wireless media.

In the last few decades, LBS have created lot of hype where the geographic data helps in providing location based information. Wireless communication helps in providing the location of the service requester i.e. the user. Hence to exploit the benefits of location-based services these two technologies should go hand in hand, which requires integration. The integration of these two technologies should also help in a time critical situations where quick and efficient response could help the user. Though users can access information anytime, anywhere, even while on the move, the performance of a wireless link will always be several orders lower when compared to a wired network.

While technology has been rapidly advancing, various limitations of wireless communication and mobile devices like limited bandwidth, client power and intermittent connectivity remain primary challenges in design and implementation of location based applications.

Client side data caching is considered as one of the important techniques to relieve bandwidth constraint imposed on wireless mobile systems. The importance of data caching has been observed early and could be seen in works (Acharya, 1995) and (Barbara, 1999). Data caching is a mechanism where copies of remote data can be kept in the local memory of mobile devices to substantially reduce data retrievals from the original server. This not only reduces the uplink and downlink bandwidth consumption but also improves the latency in data access. In a majority of mobile devices like laptops, palmtops and cellular phones, wireless communication is one of the major sources of energy consumption that reduces battery life. Thus, caching frequently accessed data in mobile devices can potentially minimize communication and hence conserve battery power. In data-caching method, data is cached at the mobile client. When the client receives a query, it first searches its cache. If there is a valid copy in the cache, it returns an answer immediately. If not, the client attempts to obtain the data item from the server through on-demand access or broadcast. Client data caching is particularly important in mobile environments. The following features of caching make it attractive to all participants, including location dependent service providers, users and network managers.

- Caching reduces network bandwidth usage and load on server as a result improves the system throughput.
- Caching reduces user-perceived delays and improves data access performance, since a portion of the queries could be satisfied locally.
- Caching improves data availability in circumstances where the clients are weakly connected or totally disconnected.
- Caching reduces energy consumption since wireless communication not required for cache hits.

Figure 1 depicts a generic architecture of the wireless data dissemination systems studied. We assume that the system assumes point-to-point access for data dissemination. A cache management mechanism exists in the client. Whenever an application issues a query, the local cache manager first checks whether the desired data item is in the cache. If it is cache hit, the cache manager still needs to validate the spatial consistency of the cached item with the master copy at the server. If the item is valid, it is returned to the application immediately. When a cache miss occurs, the cache manager sends a query request to the server. When the result arrives, the cache manager returns it to the user and retains a copy in the cache. The issue of cache replacement arises when the free cache space is not enough to accommodate a data item to be cached. Replacement schemes decide which data items are to be evicted from the cache to make room for incoming items. There are three main issues involved in the design of caches for mobile devices.