Providing offline Workspace for Mobile Computing

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ABSTRACT
There is a tremendous growth of the mobile users everywhere which in turn leaded to high bandwidth requirements of new cellular services. But the bandwidth scenario is dependent on limited spectrum resources that have been allocated for mobile communications. Basically, three caching strategies have been discussed in this paper. An adaptive cache invalidation algorithm known as Bit Sequence for client server mobile environment; the next approaches discussed are:-

1. Asynchronous Invalidation Message technique

2. Caching using data replication from servers at the Mobile Host's Home Location Cache, abbreviated as HLC, during the network is wholly disconnected from the network & apparently, it delivers it back the invalidations details to the Mobile Host when it is reconnected; and the final approach is using the fundamentals of Data Replication for Caching strategies. Past few decades have given tremendous growth of research in caching technology of mobile computing. This particular paper is in effort to list few more techniques &particularly classify the research of this fieldin broader sense.

General Terms
Mobile Computing, Caching Methodology, Bandwidth, Mobile Hosts, Home Location Cache, Data Replication, MU abbreviated as (Mobile Units), FH abbreviated as (Fixed Hosts).

Keywords
Caching Strategies in mobile computing or portable computing devices.

1. INTRODUCTION
Mobile computing is now fully functional thanks to the converging below technologies:

The invention of super portable computers and the emerging development of fast and reliable networks. Moreover there is a lot of growth in mobile user's population coupled with the direct bandwidth requirements of new cellular spectrum services. They are in contrast to the limited spectrum resources that have been allocated for mobile wireless communications discussed in references **[7] and [8].** While development of a mobile network's infrastructure, the wastage of bandwidth should be prevented because it is highly costly and unreasonable. Hence, the main purpose is to work out and get the most out of the minimum infrastructure and resources.

Caching can minimize the bandwidth needs in wireless computing environment as well as decrease the energy consumption of wireless portable super computers. Efficient caching schemes for mobile computing should be implement the following functions: data accessing patterns and update rates, mobility usage pattern of the client,access costs and other characteristics related to the connectivity parameter and also dependency upon the location of the data. The main hurdles in mobile computing are 1. Data transfer rate and Bandwidth considerations; 2. Repeated network failures;

3. Limited battery life directly dependent on mobile network usage; 4. Expensive Wireless communications etc.Among the three techniques discussed in reference papers, one uses Bit Sequence technique–which is an adaptive cache invalidation algorithm for client/server mobile environments; the next approach is to use asynchronous invalidation messages – The AS (Asynchronous and Stately); and lastly the use of the use Data Replication for Caching is presented.

The main intention of this paper is to state the two strategies mentioned above and also mention some limitations of respective approaches. Some possible research directions on these approaches are mentioned below.The remaining paper is organized in the following sequence: Section 2 explains the bit sequence adaptive cache invalidation algorithm in brief. Section 3 explains the informal analogy of the second approach, i.e. the Asynchronous and Stately technique. Section 4 explains the caching strategy using data replication. Section 5 presents the comparison and analysis of all the three schemes. Section 6 gives the rough idea about the examples where the part of caching algorithms are being utilized. Finally the conclusions are mentioned in Section 7 following by the acknowledgement and references in sections 8, 9 respectively.

2. BIT-SEQUENCE ALGORITHM (CURRENT TECHNOLOGY)
The main perspective of this approachas discussed in references **[1], [2], [3] and [4]**is to simply optimize the workingof broadcast reports. Normally, a vast report can brief some more information and is more effective for invalidation of cache. A large report also leads to a long latency for clients while checking the report that too under provided broadcast bandwidth which is limited.The Broadcasting Timestamp (TS) is a good approach of an algorithm that sets the size of the report to a particular limit by broadcasting the timestamps and names only for the data items which is updated within a window of W seconds. Effectiveness of the report, or how authentic it is can't be guaranteed for clients as there is unpredictabledisconnection time. The following approach presents 3 optimal techniques:-

1) Foronly the applications where the cached data items are changed at minimal times on the server database, often use the

bit-sequence naming technique to refer the data items in the respective report.

2) Instead of putting up one update timestamp for every single data item, it uses update aggregation method for grouping a set with just single timestamp in the report.

3) A hierarchical architecture of bit sequence technique for linking sets of every bit sequences in order that the structure can be brought up into usage by the clients along with different disconnection times.The Bit – Sequence (BS) uses above three techniques. This algorithm is used in applications where frequently cached data iseasily predictable.The main usage of this approach include the following:

1)When bit mapping (static) scheme isbrought in implicit assumptions, the Bit Sequence technique can approach the optimal effectiveness for all known data items highlighted in the report not considering the duration of disconnection time of the clients on mobile hosts. But sometimes, such optimization is achieved only at the cost of on average 2 binary bits for every item included in the report.

2)The BS algorithm can also be used as an application to optimize other broadcast based cache invalidation techniques in which the bit mapping whether it is static or dynamic has to be included separately. This optimization reduces the size of the respective report by half of its original previous size and alsomaintains the similar level of effectiveness required for invalidation of cache.

3. THE A-S APPROACH

Here, a cache organization scheme for wireless networks that uses invalidation reports which are asynchronous famously known as call backs to maintain consistency in cache regulation is presented, which meansserver broadcasts the reports only when any kind of data changes occur and not periodically which wastes a lot of bandwidth resources. There are repeated voluntary and involuntary disconnection of client'si.e.,mobile hosts which makes this a very difficult hurdle as discussed in references **[5], [6], and [7].** Every mobile client (host) (MH) maintains its own recorded Home Location Cache (HLC) to meet the expectations with the problem of disconnections. The HLC – Home Location Cache of an MH is maintained at an already decided home Mobile Switching Station abbreviated as MSS. It consists entry for every data item which is cached by the Mobile Host and also needs to maintain only the verified time-stamp where that particular data item was last being invalidated. The main goal of the proposed scheme is to reduce the overhead load for the Mobile Hosts for validation of their cache upon reconnection regardless of the time stamps, so as to allow stateless serversand also to reduce the resourceful bandwidth requirement. The general methodology is to buffer the messages under invalidation at Home Location Cache abbreviated as HLC. The scheme for caching in the mobile environment is based on the following assumptions follows:-

1) At any span of time when data item is being updated anywhere in the network circle, an invalidation prompt message is sent out to each and every MSS through the wired network; hence, when a mobile host abbreviated as MH is in roaming mode, it gets the respective invalidation prompt message before it is disconnected.

2) The Mobile Host can find out approximately whether or not it was connected to the network.

3) The Mobile Host informs its HLC well before saving or updating any data item in its local cache or buffer.

4) The static host is nearest to the MH and it always maintains the HLC of the MH, and also sends ahead to the MH if any invalidation is received by the server.

4. CACHING USING DATA REPLICATION

Consider the architecture shown in **Figure 4.1**. The cell is assumed as coverage radio on which the MSS can easily communicate with the MU. In the figure, there are two different entities. They are Mobile units (MU) and some are fixed hosts – out of whichfew of them are Mobile Support Stations (MSS) that consists wireless interface.

If a MU - abbreviated as mobile units repeatedly reads data-item say x, and x is updated at the server's side, than it is always useful for the MU to decide or allocate a full copy of x on local level at the MU. MU will certainly receive every update of data x.If the MU reads x inconsistentlyas compared to the update rate, then a copy of x should not be stored at local level at the MU. Access of that data should be pertained on demand.The strategy of caching allocation mainly is of two types. They are either static – allocation scheme does not change over time and dynamic- allocation scheme changes over span of time. Assumptions made in this model are FH that can only request write operations where on other hand MU can request only read operations. At any point of time whether or not MU has a copy of x, either of the MU or the FH is full aware of all the relevant requests satisfying client and server. If MU has a copy of x, then everything that is read at the MU and are satisfied at local level, and everything written by FH are propagated ahead to the respective MU. If by chance the MU does not have a copy, then everything it reads is issued wholly by theMU are finally sent to FH. In general, two cases arises:

1. MU has X in the cache i.e.

   (When reads >writes.)

- If (reads >writes) then it waits for the following next operation.
- If (writes >reads) then it deallocatesa copy.
- For deallocating, the MU sends x to FH.

  Refer Figure 4.2

2. MU does not have X in the cache i.e.

   (When reads <writes.)

- If (reads < writes) then it waits for next operation
- If (writes <reads) then it allocatesa copy to MU.
- Allocation consists of sending a copy of x to MU and also an indication to save the copy in MU's cache.

  Refer Figure 4.3

The data can be replicated easily on fixed sites or the fixed hosts (FH) in the network. Now it becomes practically possible for the MU to access data even after leaving one cell and joining another cell frequently. The invalidation messages receivedby the server will reach the FH which will finally check its cache location for the data bit. If the data is found then it is updated in the FH's local cache and if the data is not found then the corresponding MU will receive the invalidation report from the FH and this process goes on simultaneously.

5. COMPARISON

This section briefs general comparison between the 2 schemes discussed in the previous sections. A possible solution to the limitations that arise in each paper was proposed in this section.

Table 1. Comparison between TS and AS

TS	AS
Server is stateless. (Information about the client cache is not maintained)	Server is stately. (HLC always maintained)
Invalidation reports sent regardless of whether clients have any data in cache.	Invalidation reports broadcast only if client have valid data in the cache.
Cache restored for sleep limited to a maximum duration of w.	Arbitrary sleep patterns can be supported.
Mobility is supported by assuming a replication of data across all stationary nodes.	Mobility can be transparently supported by using a mobility aware network layer e.g. mobile IP.

6. EXAMPLES

Small size & weight of a mobile computer means restricted memory size, low storage limit, and smaller user interface. Various methods have been tried to cope up with the problems of limited memory and storage capacity including caching strategies. General Magic's Telescript and Apple's NewtonScript are examples of some script languages which have taken a keen interest in implementing the caching techniques.

7. CONCLUSIONS

This paper concentrated on three different strategies for caching in mobile environment. One was a bit-sequence algorithm, in which a period based broadcast invalidation report is being organized as a set of binary bit sequence technique with a set of associated timestamps. In the second approach the AS technique minimizes the overhead load preserving bandwidth, reducing the number of host generating the uplink requests and also average latency. State information about the local level cache at Mobile Host with respect to data items is always maintained at the home MSS; that is by sending asynchronous call backs and buffering them till implicit acknowledgments are received, the cache still continues to be valid even after the MH is temporarily disconnected for a short span of time from the network. Maintaining this state information at the MSS can be considered as an overhead load, but it fortunately has the capability to provide various other benefits beyond this scheme, such as profiling techniques can be used by the MSS to determine what to cache at the hosts when the cache space is limited discussed in reference**[9].** It is expected to provide a platform to enable prefetching of datawhich was discussed in reference **[10]** or hoarding of files at the clients. The third approach which is the data replication strategy where in the data is simultaneously cached at the mobile host only when the number of reads is more than the number of update operations by the server.This autonomous operation is highly desirable in a mobile computer. This can be achieved only by caching i.e., using one of the mentioned three methodologies discussed in this particular paper. The limitation of all the approaches was already discussed in the comparison section.

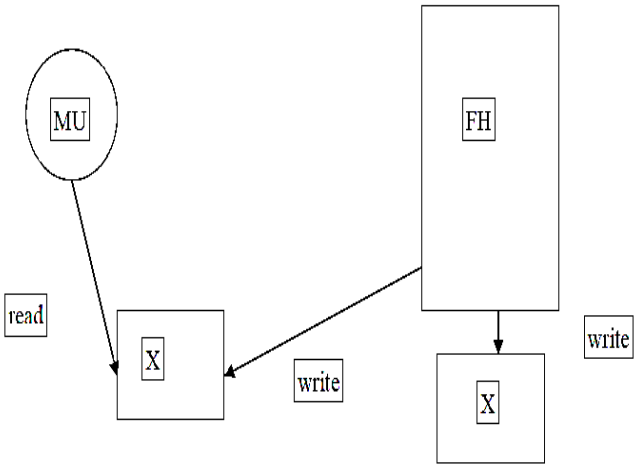

Figure 4.2 (When READS >WRITES)

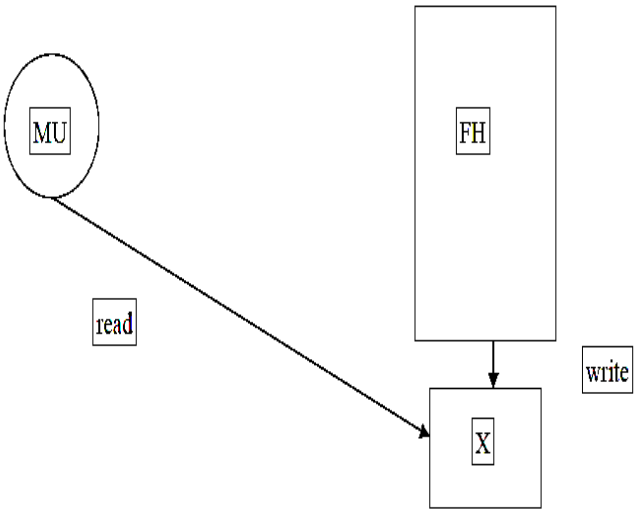

Figure 4.3 (When READS <WRITES)

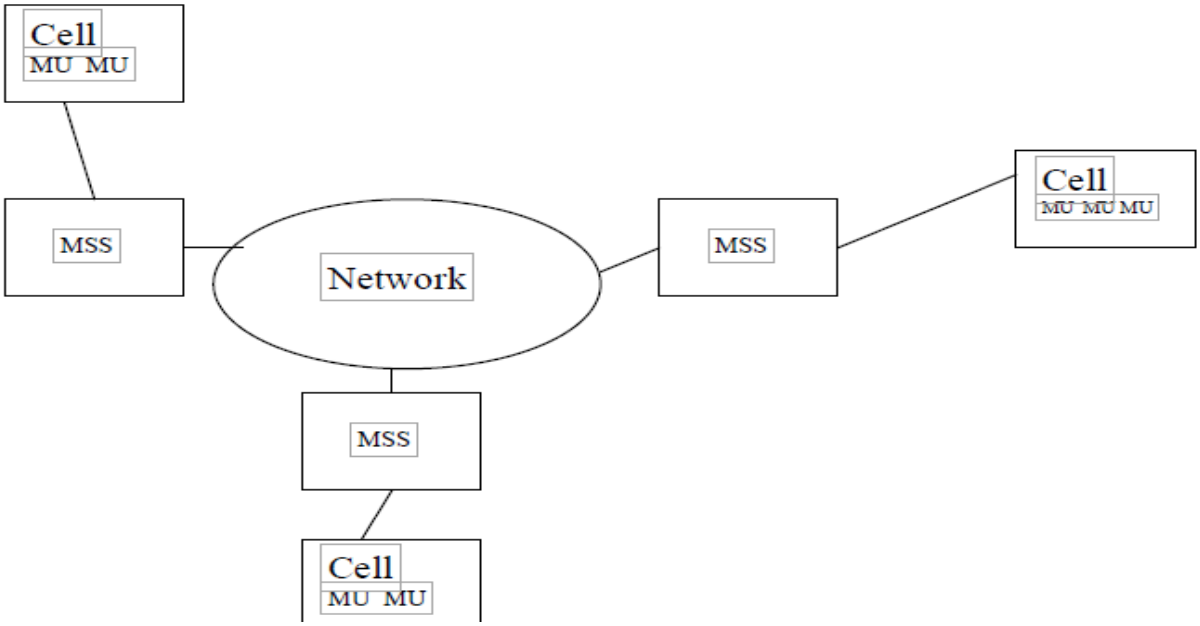

Figure 4.1(Architecture of Caching using Data Replication)

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