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Efficient Caching of Data Using Fast Wireless Data Access Scheme

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***Abstract*—** In Wireless Data Access Applications where objects are frequently updated and fast access to objects is required and it is essential to reduce both access latency and the wireless traffic. So in this project we propose FW-DAS (Fast Wireless Data Access Scheme). This extends Poll-Every-Read and Call Back Scheme in Combination. Fast Wireless Data access Scheme (FWDAS) is used to improve performance by caching the data at user level and server level. Caching of data is done based on data popularity. In FWDAS three data models are defined and used based on data popularity of the data object. FWDAS uses different operations on the data based on data popularity of the data object. Only popular object are proactively pushed to the servers thus reducing the access latency while mitigating the traffic load over the network.

***Keywords*—**Cloud Computing, Caching, Cache Replacement.

I. INTRODUCTION

With expanding popularity of mobile and hand held devices applications for these devices are also growing exponentially. With these applications there is a huge increase in the use of wireless network. The world today is moving from simple client-server systems to cloud Computing. Cloud Computing stores data and other user information in remote server known as cloud. Cloud Computing allows the storage of data, Computational capacity to the applications. Using Cloud computing the data can be accessed from any part of the world using web application. Web application connects to cloud to retrieve the data from cloud and exchange the information between cloud and client. To reduce the data accessed from the cloud some intermediate storage is used [1].

Caching is a technique which stores a copy of the data in local memory. This increases the performance of application and improves the time required to access that data. This cache resides in temporary storage i.e. when data is no longer required or used the data can be expired. Cache is a method employed to store the data retrieved from web Server. The time required to fetch the information from the servers is reduced by using cache this also reduces the information being transmitted through the network. This reduces the processing and load on servers thus increasing the responsiveness of the web server [2].

With applications accessing data through internet the speed of data retrieval becomes important. Since a large number of applications are accessing the servers continuously there are delays in the system. If same data is being accessed multiple times retrieving data from server increases accesses time and load on the servers. This problem can be countered with data caching. When data is being accessed and changed at a constant rate. Cache freshness and validity becomes an issue hence when cache is not fresh or valid time take to access the data increases due to decrease in ‘HIT’ to ‘MISS’ ratio. To reduce this some replacement policies have been used. Such as “Poll Each-Read (PER)” and “Call Back (CB)”.

Poll Each Read (PER) Scheme is a data caching method. In this scheme Mobile Node Caches the data which is checked when same data is requested. Here the Cached Data is validated in Application Server. If the Cache Object is up to date then the Consistent Data is noted and AS Server sends a validation message to the Mobile Node. If the data in the Application Server is different, then AS sends new data to the mobile node to MN. MN then saves the new data along with timestamp in its local cache.

In Call Back (CB) scheme the Application Server sends invalidation message to Mobile Node (MN) then MN removes the cache in its local store thus data in MN is always consistent. When data is searched it data object is searched in cache, if the data object is found then data is directly displayed. Hence there is reduced latency in data accessed if data is found in the cache.

In both the schemes there are pros and cons. CB reduces the latency and PER the Data traffic. The disadvantage of these methods are either it reduces data latency or reduces the data

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traffic by sacrificing the other. Here FW-DAS (Fast Wireless Data Access Scheme) is proposed which reduces both data traffic and access latency of the network by finding an agreeable balance between the two schemes. It is critical for network traffic to be reduced in a wireless link and network cache can be used at Access Point (AP)/Base Station (BS) to reduce the access latency.

This algorithm uses a two tiered architecture in which first tier is between MN and AP/BS and second tier is between AP/BS and AS. For the first tier between AP/BS and MN "Poll Each Read" Scheme is used and for second tier is in between AP/BS and Application Server (AS) along with data popularity technique for increased efficiency of data invalidated. Data popularity is a check used to perform three main operations on AP/BS.

A. *Invalidation and Push Method:* In this method when data is changed in the application server, application server forces the connected Base Station to invalidate that cache and replace it with newly changed data. This method being used is dependent on whether the data is popular in application server or not.

B. *Invalidation and Pull Method*: In this method application server just informs the base station that data have been changed, if the data object is popular in base station it acquires the data from application server and saves the data.

C. *Invalidation only Method:* In this method application server just informs the base station that data have been changed, if the data object is not popular in the base station then data is removed or invalidated from the local cache.

Data in the cache resides in the cache infinitely. If data is extensively for a short duration of time and is no longer used then the space in the cache is wasted. Thus to remove these unused data is critical hence in this scheme data is checked for usage at every given interval.

Main Contributions is FWDAS addresses fundamental problem in wireless data access i.e. joint reduction of data access Latency and the wireless network traffic hence is ideal for mobile communication

The organization of the paper is as follows. Section 2 provides information about the related work. Section 3 and Section 4 describes the System Model and algorithm. Performance analysis is done in Section 5 and finally the conclusion is summarized in Section 6.

II. RELATED WORK

The New pattern of Infrastructure is in IT area is "Cloud computing". This permits the clients to get to the Information and in addition programming forever stored in the cloud. Here expansive exploratory information sets of different controls, for example, geophysical information acquires confidence since they are seen and questioned and gathered by vast gatherings of researchers. This expands the need that distributed computing can be utilized at a conservative expense [1]. At the point when clients of the cloud utilize the information and inquiry the information they pay for what they are utilizing. This paper proposes and self-tuned monetary for administration logical information. This suggests (i) singular inquiry administration, (ii) expanding general nature of question administrations, and (iii) Cloud benefit [3].

Reserving is a strategy used to briefly store the information. Reserve information can be gotten to from the framework with framework's fundamental memory and in this manner build the information access rate. At the point when required information is found the reserve put away then it is consider a hit, and when not discovered it is a miss. At the point when Cache is full then LRU (Least Recently Used) Policy is utilized for reserve substitution. This paper is impacted be ICN (Information Centric Network) which gives clients content a name as opposed to unclear information lumps. This gives piece information addresses by-name this permits the reserving to done methodically and on-the-fly into any hub this expels the utilization of bulky HTTP header parsing [4].

In the midst of Wireless transmission the Capacity of the remote association is obliged. Since most application territory based servers for data get to therefore Cache Mechanism can be worked for this system for upgraded execution for data access. In this regularly used data article is padded for further use. When data is balanced an unequivocally unsurprising count is used to ensure exactness of the data. Here LRU (Least Recently Used) computation is used for User Cache. This framework shows that it can assemble the store hit rate considerably and diminish the data movement in the Network [5].

The progression of interactive media able frameworks at sparing expense has set off the development remote activity at a remarkable rate subsequently a higher information access is required, at a practical way for this end neighborhood storing is the most well known procedure utilized as a part of most little cell Base Station BS(intermediate server, for example, switch and Gateways)][6]. This work considers the heterogeneous cell systems, and utilizations Transfer Learning (TL) to enhance the estimation precision of Cache.

Present day versatile specialized gadgets, for example, advanced mobile phones have capable universally useful figuring gadgets with correspondence abilities. These gadgets shape a correspondence stage and gets to information from any part of the world. Messages, recordings and other correspondence are made accessible by loading the correspondence system. In Mobile Information System Data

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is put away far in a remote server along these lines putting strain on the system this can be decreased by fusing Cache into the system. With reserve the information sending can be decreased the principle utilization of this are (1)This diminishes the information access time and dormancy (2) if Cache is not Used these information should be gotten from information server. (3) Without the reserve all information must be taken care of by the server. This paper gives a solid information mindful storing instrument. Firstly Proactive Access Policy (PAP), and Reactive Access Policy(RAP). This paper presents an Update-situated Replacement Policy (URP) [7]

The principle objective of this paper is (1) to expand the compelling hit proportion and (2) to diminish transmission cost by the applications At the point when a site gets to be mainstream because of immense convergence of information there is going to idleness and database might be notable manage stack henceforth the sites must enhance end-end inertness. For enhancing the inertness the database reserving is presented here when something is questioned the outcome is put away in a cradle. Despite the fact that this is accessible in MySQL and different databases decoupling of this gives more prominent advantages and enhances idleness [8]. For this another Cloud Caching system is presented. SC2 bolsters a basic administration model permitting the clients to express their prerequisites as a mix of nature of administration assurances and unequivocal inhabitancies bounds. SC2 likewise presents another method for profiling and apportioning the reserve space utilization and conforms the experience appropriately Hui *et al.*, [9] proposed Collaborative Hierarchical caching with dynamic request routing for massive content distribution. The major issue in content distribution is analyzing the capacity of caching in the network.

Pack *et al.*, [10] suggested “Proxy based Wireless Data Access Algorithms in Mobile Hotspots”. Efficient wireless data access algorithms in mobile hot spots are considered. A proxy cache (PC), PC based poll each read (P-PER) and PC based call back (P-CB) data access algorithms is proposed to minimize the cost of the transmission over wireless links in mobile hot spots. A systematic model is developed and simulation results are carried out to evaluate the performance of the P-PER and P-CB.

III. SYSTEM MODEL

FW-DAS [11] system model is shown in the Figure 1. In this system Mobile Node (MN) is connected to Access point/Base Station via a wireless link, Application Server (AS) is linked to BS through a TCP wired link. We assume that MN node has a limited cache storage capacity referred to as Kmn and Base station has cache which can be considered as network cache a network has a capacity referred to as KNC. Since there can be multiple MN connected to network we assume that KNC has memory much larger than a MN.

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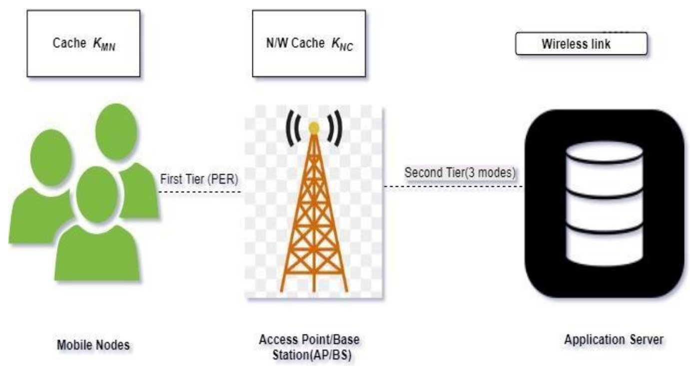

Figure 1. System Model of FWDAS

Communication in the network takes place using four

1. Access (j, t): This is the message used to access the data from server or application server here “j” is the data and “t” is the timestamp of the data j.

2. Send (j, t, F): This is a message used to send data from server to MN or AS to AP/BS. This is also used to send verification message, here “j” is the data, “t” is the timestamp of data j and F indicates the data flag. If F is 1 then data is being sent else, it a verification message.

3. Update (j, F): This message is used when updating takes place for data in AP/BS from AS. Here “j” is the data and F is the flag indicating if data is present. If F is 1 then AS sends updated data invalidation message and if F is zero it sends a invalidation message from AS.

4. Ack (j, R): This message is used to acknowledge the update request sent by application Server. This message may also contain a request for the object. Here “j” is the data, R is the Flag that indicates whether the object is requested by the base station or not. That is if R is set then base station is requesting application server to send the data j.

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IV. FAST WIRELESS DATA ACCESS SCHEME

A. Overview of PER and CB

PER Scheme: PER scheme is a scheme which is used to reduce the traffic load in the network. In the PER scheme when a data object is searched in the mobile node the mobile node searches its cache if the data is found it tries to validate the consistency of the data object with servers. If the data is validated then it displays the result otherwise new data object is retrieved cached and displayed.

In Figure 2 the PER scheme flow is shown. In the beginning of the system's time if the data is searched the data is not present in the user cache hence it sends an access message Access (i, 0) data object with a timestamp of 0 indicating that cache not available. The request is forwarded to application server.

In application server the data object is searched and replay is sent back to the mobile node. Which is stored in the mobile node as cache, when same data object is searched again then the mobile node checks weather the data present in its cache is valid and correct by sending the Access(i, t). if the data is correct and valid the application server replays with send(i, t,0) which indicates that the data is correct and valid.

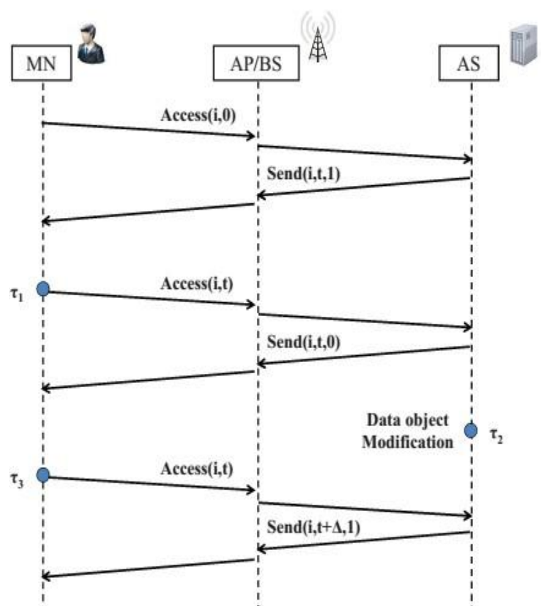

Figure 2. PER Schema

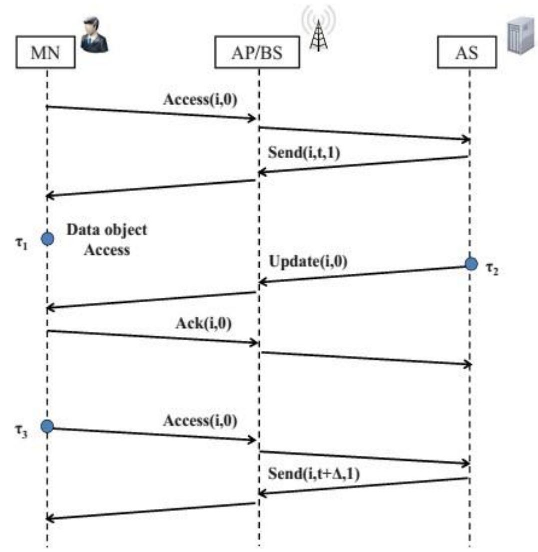

Figure 3. CB Scheme

CB Scheme: CB scheme reduces the access latency of the data objects being accessed. When a data object is accessed by a mobile node that data object is stored as a cache in the mobile node. In CB scheme when same data is searched and that data object is available in cache then they are displayed without a need for validation. In CB scheme when a data object is modified then an invalidation message is sent to all connected mobile node to invalidate their cache thus cache in the mobile node is always valid.

In Figure 3 CB Scheme is shown. When a data object "i" is searched the mobile node sends a Access (i, 0) message is sent to the base station here 0 indicating that no cache is present. Application server searches the data and sends the data back to mobile node using send (i, t, 1) this data object is stored in the Mobile nodes cache. When same data is searched again in the mobile node then the Mobile Node retrieves data from its cache and displays the data. At some time t+x the data object "i" is modified in the application server, AS sends the update message update(i,0) to mobile note indicating to mobile node to invalidate and delete the data object "i". Mobile node deletes the object "i" and sends a acknowledge ack(i,0) message to the server acknowledging that invalidation message is received. When the same data object "i" is searched the mobile node searches its cache and doesn't find the object since that object was invalidated. Mobile node sends an Access (i, 0) to application server. Application server searches for data and returns a message send (i,t+x,1) back to the mobile node. After some time say t + x then data object is modified when mobile node tries to validate the data application server sends send (i, t+x, 1) indicating data object "i" was changed at t+x and the new data is being sent. Flag 1 indicates that data is present in the message

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B. First Tier Operation of FW-DAS

At First Tier of the FWDAS the orthodox PER scheme is utilized. In first tier the mobile node always checks the validity of the data object from Base Station. Cache at base station is always valid as the connection between AP/BS and AS uses the CB scheme hence the data in AP/BS is always true and valid.

The flow of data is shown in Figure 4 and Figure 5 initially mobile node tries to access the data object “i” mobile node searches its cache since data is not present in the cache it sends an Access (i, 0) AP/BS sends the request to the applications server, application server searches its and sends the data back to the base station, base station saves the data in its cache then sends the data to mobile node. Mobile node displays the data and saves the data to the local cache. When the same data is searched again the cache is found in the local cache then the mobile node tries to validate the data by sending Access (i, t) where t is the timestamp of the data. AP/BS checks if data is present in its cache and replays with validation or invalidation message. It is assumed that if data is present in BS then data is valid and consistent as link between AS and BS is based on CB scheme.

C. Second Tier Operation of FW-DAS

In wireless network data is actively cached by BS if the data is popular in the network. i.e. if data is being accessed or used frequently then it is paramount that this data object “i” must be cached for faster data access. Based on data popularity a decision can be made weather a cache to be saved or disregarded. Based on data popularity mechanism FW-DAS proposes three main modules in the second tier of the operation.

1. Invalidation and Push
2. Invalidation and Pull
3. Invalidation Only

Invalidation and push methods are for those objects which are popular throughout the application and “Invalidation and pull” is used for data objects that are popular in the server but not throughout the application. “Invalidation only” is for cache items which are sparing used by used.

Invalidation and Push: In Figure 5 we see 2 steps between AP/BS and AS this step is done if the data is globally popular First data is accesses from MN and Cache is saved in BS. When an data change is done to data in the AS it notifies the BS and Sends the data for replacement in BS based on data popularity.BS replaces this data object.

Invalidation and Pull: In Figure 6 we see two steps between AP/BS and AS this step are done if the data is popular in BS but not in AS. First data is accesses from MN and Cache is saved in BS. When a data change is done to data in the AS it notifies the BS If the data is popular in the BS then It requests for data object and Replaces the data object.

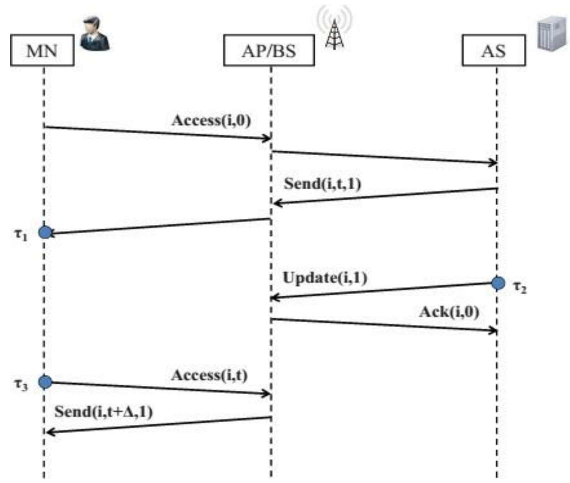

Figure 4. First Tier Operation

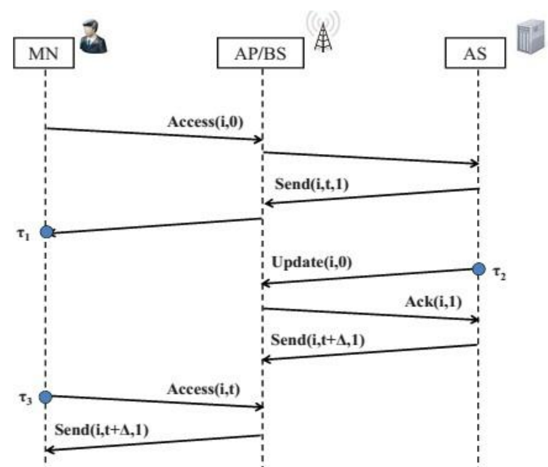

Figure 5. Invalidation and Push

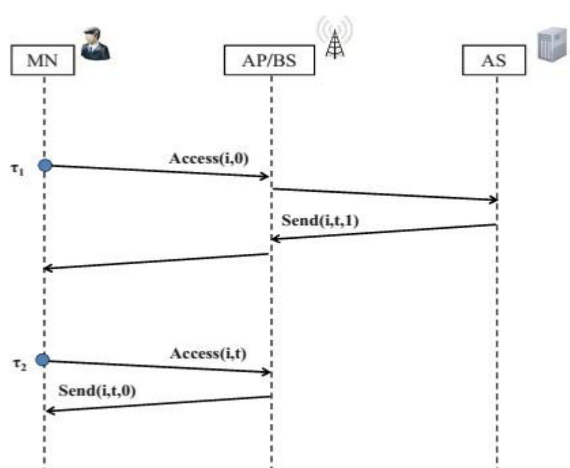

Figure 6. Invalidation and pull

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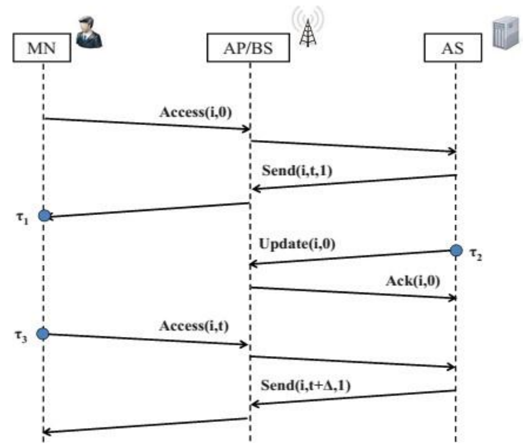
Invalidation only: In Figure 7 we see 2 steps between AP/BS and AS. First data is accesses from MN and Cache is saved in BS. When a data change is done to data in the AS it notifies the BS. If data is not popular in BS then it just removes the Data object.

Figure 7.Invalidation Only



V. ALGORITHM

ALGORITHM 1: FWDAS ALGORITHM

1. Assign data object index *i* to data objects in a descending order depending on the global popularity in the AS.
2. K_{BS} be Cache Size of Base Station and β be size already filled with Cache
3. K_{AS} be Cloud Size of Application Server and λ be size already filled with Cache
4. $x \leftarrow \kappa * \rho * K_{AS} / \lambda;$
5. $y \leftarrow \kappa * K_{BS} / \beta;$
6. **for** each data object *i* **do**
7.   **if** $i/N \leq x$ then
   Use the invalidation and push
   Mode for data Object *i*
8.   **end if**
9. **end for**
10. Assign data object index *j* to unselected data objects in a descending order depending on the local popularity in the AP/BS.
11. **for** each data object *j* **do**
12.   **if** $j/N \leq y$ **then**
    Use the invalidation & pull
    For mode data object *j*
13.   **Else**
    Use the invalidation only
    Mode for data object *j*
14. **end if**
15. **end for**

In FWDAS algorithm we see that the maximum size of the Base Station cache to be KBS and the size of cache to be β. And Size of the data base in the Application server to be KAS and the size of the records present to be λ.

The Skew factor (κ) is the importance of the data popularity. If κ is 0 then data popularity is not important as all the data are being accessed equally. If κ is 1 then the same data is being accessed continuously. The Ro factor (ρ) is the ratio of access vs update i.e number of records being updated to number of records being accessed. If ρ is 1 then for each data accessed a record is being updated.

ALGORITHM 2: PERIODIC DATA REMOVAL ALGORITHM

1. Wait for given period of time
2. Check if the server list has object not accessed for period of time
3. If Found
   Set Data popularity index to 0
4. Else
   Go back to step 1

In the Periodic Data removal algorithm is like a garbage collection algorithm which runs at a given time interval we assumed this to be 20 minutes this algorithm checks if the given data object has gone unused for more than a certain period of time. If the object is not used in certain period of time the popularity of the object is reduced to zero.

VI. RESULTS

A. Performance based on cache size (Size of Server Cache).

In Figure 8 shows this evaluation we check the access latency based on the size of the server cache using .FWDAS algorithm in this evaluation we check the access latency by varying the cache Length of the server cache. From 25 to 50 to 75 records. We see that when the size of the sever cache increases the records access time decreases.

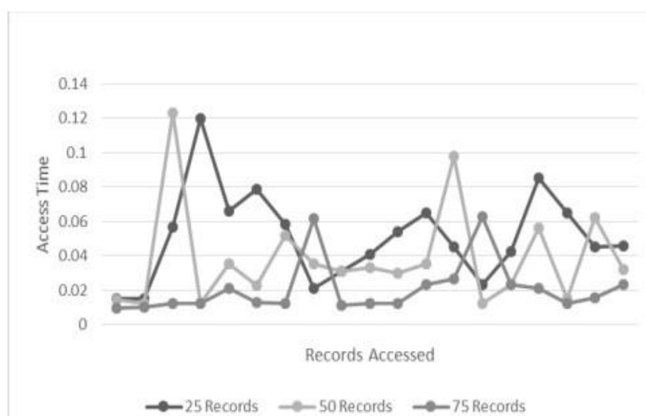


Figure 8. Evaluation Using Server Cache

B. Caching with changes in Due to Skew factor

In Figure 9 we shows check access latency based on (κ). Here we see that as the importance of the data popularity is increased i.e. if random data is being used and if we increase the weightage to data popularity index we see that time taken to access the data is significantly reduced.

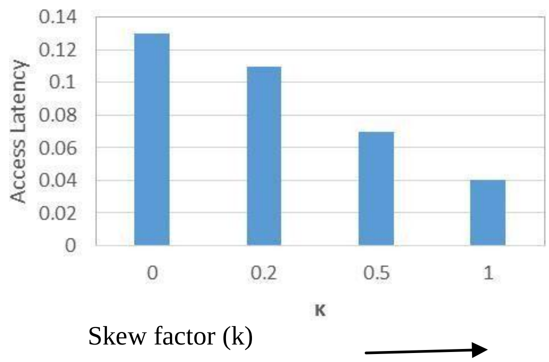


Figure 5. Skew Factor vs Access Latency

VII. CONCLUSIONS

For applications which have a high requirement for fast data transfer and less network traffic load a fast wireless data access scheme is proposed. This system not only needs to reduce the latency of the data accessed but must also reduce the traffic load in a wireless network. FWDAS performs various operations on the system data based on data popularity. Only frequently used and famous data is pushed in to the server aggressively to reduce the time taken to retrieve frequently used data thus reducing the access latency. FWDAS also reduces the traffic load on a wireless network by reducing the amount of data transmuted between the MN and Base station server.

A periodic cache invalidation mechanism was included to reduce the space requirement and reducing the replacement of cache data due to cache overflow. For our future work, we will try to improve FW-DAS performance by means of Node cooperation. We can also improve the security of the cache replacement messages by including a security certificate.

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