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PERFORMANCE EVALUATION OF UNIFIED INDEX HUB USING INTEGRATED SIGNATURE

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Abstract: Due to its widespread application mobile computing has become reality. In real time broadcast, data management research community faces challenge from battery power and delay in data retrieval. The increasing populations of broadcast operator without widening the available electromagnetic spectrum worsen the situation. Index tree and signature techniques are generally employed to manage data in mobile environment. When similar type of data has broadcasted than signature technique is preferred over index tree technique for better data retrieval time. Lee and Lee model of integrated signature is effective in reducing access time. With many number of broadcast operators, the unification of operators is alternative way to manage data. The UIH developed by Verma S. et.al. is a way to unify the broadcast operators. This research work intends to propose a new model by applying integrated signature to UIH and compare the performance to state of art Lee and Lee model. The proposed model is simulated using Matlab7.4. The simulation result shows the proposed model out perform the existing state of art Lee & Lee model.

Key word: Data broadcast, integrated signature, mobile client, mobile computing, Unified Index Hub

I.INTRODUCTION

In recent years, the use of wireless technology devices has been growing at an exponential rate and the standard for timely access of global information is also changing [5, 6]. The current advancement in mobile network, data dissemination and retrieval strategies, server and client architecture, services and applications has spurred an unprecedented emergence of various techniques that de facto give a new generation wireless environment. Now many people are able to access information system located in wired network anywhere and anytime using portable size wireless computing devices like notebooks, tablet PCs, personal digital assistants (PDAs) and GPRS-enabled cellular phones, laptops, palmtops which are powered by small battery. These portable computing devices communicate with a central stationary server via a wireless channel and become the integral part of the existing distributed computing environment. These mobile clients can have access the database information systems located at the static network while they are traveling and this type of computing is known as wireless computing or mobile computing [6].

Wireless computing provides database applications with useful aspects of wireless technology and subset of mobile computing that focus on querying central database server is referred as to wireless databases. Mobile service providers have establishing a number of information services including weather information or weather forecast services, news, stock indices information, foreign exchange rates, election results, tourist services, airlines, railways schedules etc[7]. With the introduction of mobile computing, the mobile clients (MC) have higher flexibility in accessing the information from different locations with varying networks connectivity. Also, air channel can act as storage medium for broadcast data [8].

The major shortcoming with broadcast data items in a wireless environment is that data are accessed sequentially. The increasing number of broadcast items causes mobile clients to wait for a long time before receiving desired data item. Consequently, dependence of mobile devices on rechargeable battery, which has limited capacity, is also another drawback of wireless data retrieval. The rate of increase in the chip density is much higher than the rate of increase of battery capacity. The battery capacity is expected to increase mere by 20% in every 10 years [9]. So the energy consumption greatly impacts on system performance. Also, due to ever increasing demand for mobile information services many numbers of operators are providing services, that comes in to fray which cause large data broadcast rate causing deterioration in quality of services. In order to curb these drawbacks and improve system performance, it is necessary to visualize following two performance matrices [10]:

Access time: Time elapse from the moment a request is initiated until all data item of interest are received.

Tuning time: The amount of time spent by the client to actively listen for the desired broadcast data items.

The access time is related to data retrieve delay from channel and tune time gives the time for which client remains in active mode to tune the channel. The architectural enhancement of mobile client allows two modes: *active mode* and *doze mode*, former consume more power and later is sleeping mode with minimum power consumption. The power consumption must be minimized to retain effective battery usage and access time must be reduced for early retrieval of desired information. Since these parameters are contradictory to each other so can not be reduced to great extent simultaneously, but a trade off between two can be set for better system performance.

In a mobile environment queries can be classified into two categories traditional queries and location-dependent queries. The queries invoke in traditional wired environment are traditional queries, while when these are transmitted over a wireless communication network, called location-dependent queries. However, queries on wireless database have more complexity, which does not exist in traditional wired databases. It is realized that location-dependent queries are becoming more common and of great interest. Consequently, to provide efficient and effective mobile information services that cover both traditional queries and location-dependent queries will be highly desirable.

The retrieval process of queries in wireless environment can be performed in two ways (i) pull or on demand mode and (ii) push or broadcast mode. On-demand queries are those where the client initiates the query and sends it to the server. The server processes the query and sends the result back to the client. In the broadcast-based queries the server broadcast the data items periodically over one or more broadcast channels. Mobile clients tune to it and select data items of interest and capture it. With broadcast-based queries, a mobile client is able to retrieve information without wasting power to transmit a request to the server. Also, it supports a large number of users at a time and the number of users in a cell or high information downloading rate does not affect query performance. It is effective, despite a large no of users retrieving data simultaneously. The behavior of the broadcast-based information system is unidirectional which means the server disseminates a set of data periodically to the multiple number of users. With this mechanism, the requests from the clients are not known a priori. These novel features of broadcast approach makes it popular among professionals engaged in data management.

The emergence of ubiquitous and small mobile devices along with the development of fast, reliable and accessible network has helped to advance research in pervasive computing area. The various data broadcast management techniques like indexing; scheduling and broadcasting along parallel channels pivot this development. Broadcast data can be managed in various ways. The broadcast in which a single data item is placed once in a single broadcast channel is called *flat broadcast* and a broadcast in which a single data item appear more than once is called *skewed broadcast*. To adjust optimal trade off between access and tune latency skewed broadcast is preferred. Owing to various constraints of business, economy and technical reasons mobile service provider generally use combination of low bandwidth to obtain high combined bandwidth instead of single high bandwidth channel.

The behavior of broadcast system is unidirectional and cyclic hence, mobile clients need only tune-in to channels. For effective data broadcast tree based [11] and signature based [1], approach are used. Tree based approach gives the exact time of arrival of data so that MC can go to doze mode and save considerable amount of battery power; while signature based approach uses signature to examine data object, which result in saving access time. The real time broadcast environment is asymmetric and heterogeneous. As a result of many number of operators in field and several numbers of channels are available on air to disseminate data; to handle these enormous number of channels is a tedious job. In order to find data of interest the Mobile Client (MC) has to remain in active mode for long time to filter data, which cause MC to have large tune time. With similar type of data items signature technique is effective in data management. Due to high population of mobile operators the data density is much high on the air. To manage effectively, clubbing of these data of an operator in a group is effective. Here, we study the different aspect of data management; a Unified Index Hub (UIH) is developed to make the searching process easy. The UIH is like search engine of operators and analogue to google or yahoo search of these channels to make search. In spite of that UIH is combination of indexing and signature technique.

This paper proposes and develops UIH with integrated signature. Basically it is expansion of work done by same authors in [2, 3, 4] with application of integrated signature over it. We will least describe the work already done in literature, for such work references within can be referred. The rest of this paper is organized as follows. Section 2, introduces the background and gives related work on topic. Architecture of AHME and signature indexing model (SIM) to reduce the access time and battery power use in searching data on multiple channels is discussed in section 3; it also describes the architecture of two level signature index model (TLSIM). Section 4, proposes new model, and evaluate its performance theoretically as well as present simulation results carried out on Matlab7.4 simulator at different parameters. Section 5, finally concludes the paper and mention direction for further research in this field.

II. BACKGROUND

The propose of broadcast disks by Acharya et. al. [5] in which hot data items are allocated more frequently than cold data items from which average access time decrease; enunciate new paradigm in mobile computing. Discriminate tuning is best possible way to reduce power consumption in single channel environment. Distributed indexing was developed to efficiently replicate and distributed the index tree in broadcast by Imielinski, Vishwanathan and Badrinath [8]. Lee, Zheng and Lee [12] suggest indexing structure for multiple broadcast channels. Amarmend et.al. [13] enhances index allocation over multichannel for reducing access latency and tuning time. Lee, Chen and Lo [14] examined the data allocation for sufficient and insufficient channels and develop algorithms for allocating data over insufficient channels. Various Indexing and scheduling techniques to effectively manage data have been discussed in literature [2, 8, 10, 11, 13, 14, 15, 16, 17, 18, 19].

The signature and index tree technique describe two different classes of data organization. The papers in literature based on index tree are for clustered data, while signature technique based papers consider non clustered data. The effect of signature size, number of signature, true / false drop probability is studied by Lee and Lee [1]. The concept of CIS is proposed by Ho and Lee [15]. Verma, Rakhee and Savita [2] developed UIH which is further extended to be able for dynamic updating in [3, 4]. Our work is to propose a new model on the line of [2, 3, 4] and compare its performance with state of art Lee and Lee model [1] to find alternative means of data administration with huge population of operators.

III. AHME

By reason of lenient spectrum allotment policy the number of broadcast agents has been increasing many fold in recent years and expected to grow at much higher rate recently. In real time mobile environment Asymmetric data retrieval in Heterogeneous Multichannel Environment (AHME) is done through many techniques. Today, in mobile computing the research community is going through single problem and infinite solution without anybody best. But best depends on situation. The futuristic approach of wireless data organization is unification of broadcast operator. The model of AHME is shown in figure 1 and its subsequent components are explained in section 3.1, 3.2 and 3.3.

A. Unified Index Hub (UIH)

It may be defined as combined index for all broadcast operators. Here, we define the broadcast agent (BA) as any individual operator, which has data to broadcast on the channels. Each BA is connected to the UIH and Broadcast Transmitter (BT), which put data of BA on its subscribed channels, through a wired network [16]. The UIH is responsible for broadcasting index information on a dedicated wireless channel for the whole broadcast, while the BT is only responsible for broadcasting a data message (DM) on its own wireless channels for BAs who subscribe to it.

When a BA has to broadcast the data then at first it will send a “data-to-broadcast” notification (DTB) to the UIH through the wired network. The content of the DTB are in standard format as prescribed by the UIH. The major contents of DTB are BA’s ID, the channel ID that the BA has subscribed to, the message ID, a list of key attributes describing the data and data type ID. When the UIH receives the DTB, it extracts the information from the DTB and converts it into the index message (IM) format, which contains information on BA’s ID, channel ID, message ID, the IM size, the information of attribute list keys, and pointer to the starting of data. Next, the UIH puts the IM into the broadcast queue for index broadcast. Once the UIH receives the DTB, it will reply to the BA so that it can broadcast its data. This replied message is called the “earliest-send” notification (ES). The ES can have maximum value equal to end time of IM of BA, which guide BA that in how much time it has to place its data on its subscribed channel so that MC will be able to receive data. When BA upgrades information on its channel it informs the UIH through message so that it can update its index.

The key point in data retrieval on AHME is the Unified Indexing Hub (UIH), which manage and broadcast index information about the data being broadcast on all of the broadcasting channels. Figure 1, shows the architecture of AHME and position of UIH.

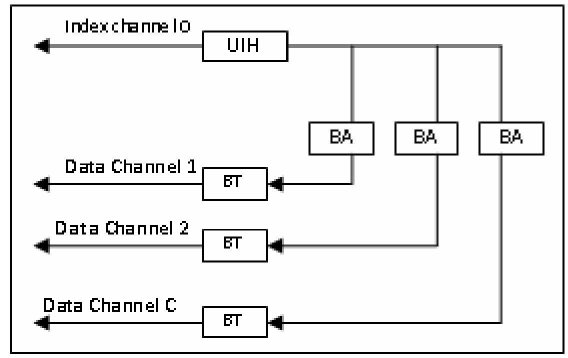

Figure 1.Architecture of AHME

B. Signature Indexing Model

The signature model described here is helpful to construct indices when there is large number of BA and all are sending DTB simultaneously with their attribute list. In such situation, it will take long time for UIH to broadcast all IM on dedicated index channel. To avoid long queuing, Signature Index Model (SIM) use signature of attribute instead of attribute itself. A signature S_i of a data item is basically a bit vector generated by first hashing each data value into a bit string and then superimposing the bit strings together [1]. Figure 2 illustrate the construction of attribute list signature on SIM. Each DTB which actually contains a list of attributes to identify channel, message and data to be broadcasted. This Attribute List (AL) is hashed to form bit string for each attribute and these bit strings are superimposed through logical OR operation to get attribute list signature (ALS). Generally, the UIH has two-signature lists, one is used to contain the channel signature (CS) of all channels and other have an ordered array to store the broadcast order and time for each entry in the CS list. When MC tune into UIH to filter desired data a query signature (QS) is constructed in the same way in the ALS. The QS is superimposed over ALS to match the channel ID that contains data of interest and pointer directs the MC to channel containing desired data.

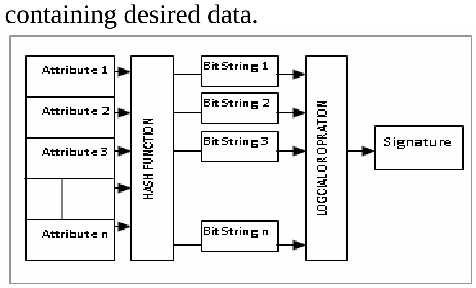

Figure 2. Attribute Signature Development

When DTB reaches to UIH from a BA, it extract channel ID and ALS from it. The ALS is superimposed to CS of all channels one by one. When ALS match with CS then UIH will inform the referring BA by "earliest transmit" notification (ET). The ET contains the information about channel used for broadcast. The ET is also in standard format prescribed by BAs. Here all BA's are required to send an AL with each data item so that BT can broadcast it.

Sometimes when there is large number of BAs then DTB received by UIH is very large. The IM are generated just after matching the signature and UIH will send ET notification to BA to broadcast its data on its committed channel but because of long queue, it fails to put IM on index channel within time. In such situation, when IM is broadcasted over index channel the data indicated by IM may have gone, on channel for this data, so MC will not find data at prescribed place. So some time a false drop will create. To avoid this MC should get detuned to channel after a fixed interval to save power.

C. Two Level Signature Index Model

For UIH multichannel data we will consider following assumptions:-

1. All BA's are transmitting data at equal rate i.e. channel load of all channels is equal.
2. There is negligible switching time for MC while accessing data between UIH and channels.
3. All BA's have their separate dedicated channels but common channel for index.
4. All data frames, simple signatures and integrated signatures are of equal size within each other i.e. all similar units contains equal number packets but may differ from each other.

For reducing energy consumption two level signatures viz. simple signatures and integrated signatures are used. Simple signature contains information about particular data frame only and placed just before data frame start while integrated signature is abstraction of frame group i.e. it is an index for group of frames and placed on individual channel. Figure 3, shows architecture of TLSIM. In this design, index channel has simple signature of BA while dedicated channels contain data along with their integrated signature.

When MC has to filter data from broadcast channel it creates Query Signature (QS). Signature may be simple signature or integrated signature it is technically an Attribute List Signature (ALS). These QS are first matched to Simple ALS (SALS). Let 1 denotes relevant signature and 0 denotes the irrelevant signature then if Query Signature and SALS both are relevant to MC and broadcast, only then SALS will direct the MC to channel containing data of relevant BA, if either of them is irrelevant then that signature will be skipped as mentioned in table 1.

Table I. Matching QS with ALS

QS	***ALS***	Corresponding Operation
0	0	Skip
0	1	Skip
1	0	Skip
1	1	Directed to Simple Signature

The Query Signature for Integrated ALS (IALS) on dedicated channel are also created in the same way as the SALS and compared to IALS. When QS does not match the ALS, there is no match and MC goes to doze mode. When QS match with ALS and data also found there, it is true match and MC remains active to download the data. When QS match with ALS and data does not found there it is false drop. False drop causes energy consumption without purpose. It is a challenge to research community to reduce false drop possibility to negligible.

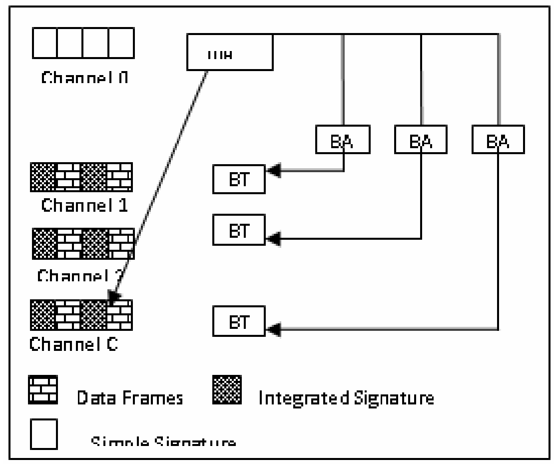

Figure 3. Architecture of Two Levels Signature Index Model (TLSIM)

IV. PROPOSED MODEL

In this section we briefly introduce our model. This section presents the performance analysis and simulation results. Here large numbers of BA are supposed to broadcast data simultaneously. These data may be with one or more same attribute. The available bandwidth is partitioned in to channels. If there are C operators then total number of channels on system is $C+1$. This will form a $I.k*C$ grid where data are filled according to vector format without gap such that one channel contains data of only one BA. Here BA's unique ID is considered as attribute for data allocation. For simplicity, we consider that all BA have equal number of information to broadcast.

The architecture of this model is similar to TLSIM shown in figure 3. The first channel on broadcast is index channel containing simple signature ID of BA in sequential order of their attribute, it is Unified Index Hub (UIH) for all BA/channels. Initially, MC tune in to UIH and get information about channel where desired data is available. The dedicated channels for BA contain data along with integrated signatures. Rest process of data filtering is similar to TLSIM.

The access time and tune in time for data filtering can be calculated on the pattern of [1]. Performance evaluation and simulation results are followings.

D. Performance Analysis

Section is devoted to analyze the performance of proposed model for data broadcast over multichannel environment. The performance is analyzed in term of number of packets which is physical unit of data transfer in broadcast. Various factors including signature size, number of signature, filtering capability, initial probe time and false drop probability affect the system performance. While evaluating two performance matrices due weight is paid to these factors. Here we consider that all frames contain same number of packets and each channel consists of same number of data items. Also the distance of MC from BT does not affect the system energy requirement.

Symbols for performance analysis model

- A: number of information frames in broadcast cycle
- A_t: number of information frames received due to true drop
- A_f: number of information frames received due to false drop
- C: number of channels / Number of operators indexed by UIH
- n: the average number of packets in information frame
- k: number of information frame indexed by an integrated signature
- r: the number of packets in a signature ($r=m/p$)
- I: number of integrated signature in bcast cycle
- I_t: number of integrated signature received as true drop.
- I_f: number of integrated signature received as false drop.
- l: average number of true drop in a frame group
- m: length of signature in bits
- Ps: selectivity of a query
- P_f^i: false drop probability for integrated signature
- s_i: number of bit string superimposed to form the integrated signature

The false drop probability P_f according to Lee & Lee [1] is

$$Pf=\frac{Af}{A-A_t}$$

And false drop probability for integrated signature is given as

$$P^i_f = 0.5^{m \ln 2 / s_i}$$

In UIH model we consider only the dedicated channel as the broadcast cycle for related operator because operator can only send data over it for its client. The broadcast cycle length for UIH comprise of signature and data over channels.

Therefore, total number of data (D) on a dedicated channel of an operator is

$$D=\frac{An}{C}$$

Unified index channel contains number of simple signature equal to the number of BA. Each dedicated channel contains data frame along with their group integrated signature placed just before the group of data frames.

Total number of integrated signature in a broadcast is given as

$$IS=I.r=\frac{Ar}{Ck}$$

The broadcast cycle length comprises of integrated signature and data over one of the ‘C’ dedicated channel. Broadcast cycle length is

$$Cyc=IS+D$$

Average initial probe time is time elapsed from the moment a query is initiated by MC to the moment when first information of data is received.

Average Initial Probe Time is

$$IPT=Cr/2$$

Hence, Access Time for UIH with integrated signature is

$$AT=\frac{Ar}{Ck}+\frac{An}{C}+\frac{Cr}{2}$$

On UIH the MC get information about arrival of its demanded data just by tuning to single signature on unified index. So, the time for which MC remains in active mode during initial probe time is r .i.e.

$$\Pr obeTuneTime=r$$

The MC after initial probe has to remain in active mode to tune all integrated signature, the data frame received under the integrated signature qualified as true drop and also all data frame received under the integrated signature qualified as false drop. The tune time for UIH comprises all the above time for which MC remain in active mode. Therefore, tune time for UIH is

$$TT = \Pr obeTuneTime + IS + I_t.n.k + I_f.n.k$$

The number of integrated signature received as true drop is

$$I_t=A.P_s/Cl$$

And the number of integrated signature received as false drop is

$$I_f = P_f^i.I = P_f^i \frac{An}{c}$$

Thus, tune in time for UIH is

$$TT=r+\frac{Ar}{Ck}+\frac{AP_s}{Cl}.n.k+\frac{P_f^i A.n}{C}$$

The access time and tune in time calculated here is used to compare with integrated signature calculated by Lee and Lee [1] with single channel for all BA’s. In [1] data transmitted over single channel create a plethora and the broadcast cycle get lengthen resulting in high access time but propose model shorten broadcast cycle length resulting in smaller access time.

The access time and tune in time for single channel data broadcast using integrated signature respectively are [1].

$$ACCESS\ TIME=\frac{r+k.n}{2}+\frac{A.r}{k}+A.n$$

$$TUNE\quad TIME=\frac{r^2+n^2.k}{2(r+n.k)}+\frac{A.r}{k}+\frac{P_s.k}{l}.D+P_f^i.D$$

The comparison results of proposed model and Lee and Lee models are shown in next section, which shows it’s over performance above the existing techniques.

E. Simulation Results:

The performance of proposed model is analyzed using Matlab7.4 simulator. For performance analyses following simulation parameters are used.

Table II. System Performance setting parameters

Parameter	***Value***	***Parameter***	Value
A	10000	l	3
N	1000	Ps	0.01
P	128	m	1 - 30
K	4	C	2 - 8

The calculated false drop probability for integrated signature (s_i = 280) is used for further calculations. The comparison of access time with different values of signature length for broadcast with UIH and without UIH is shown in figure 4, which show much reduced access time for UIH than non-UIH scheme at all values of signature length.

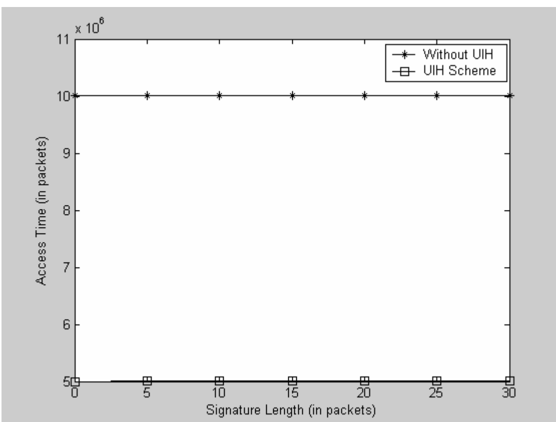

Figure 4. Access Time with signature length

Similarly, the comparison of tune time with different values of signature length for broadcast with UIH and without UIH is shown in figure 5, which shows slight reduction in tune time on UIH at all values of m. Tune time get increases with rise in signature length. The variation of access and tune time together with increase in number of channel is shown in figure 6.

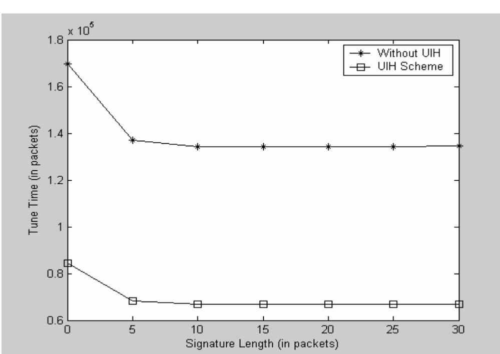

Fig 5. Tune time with signature length

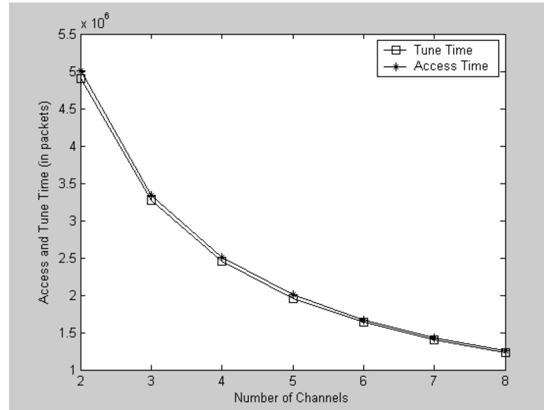

Figure 6. Access and tune time with numbers of channels (m=10)

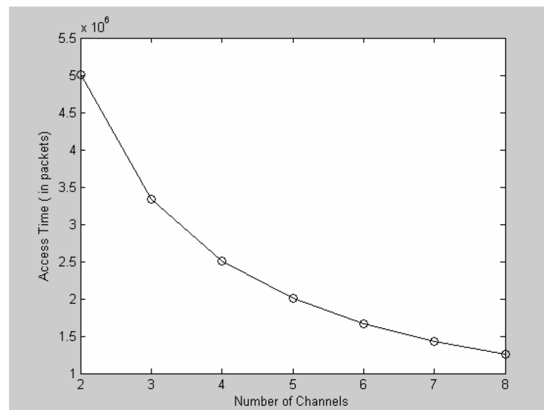

Figure 7. Access Time with number of Channels (m=10)

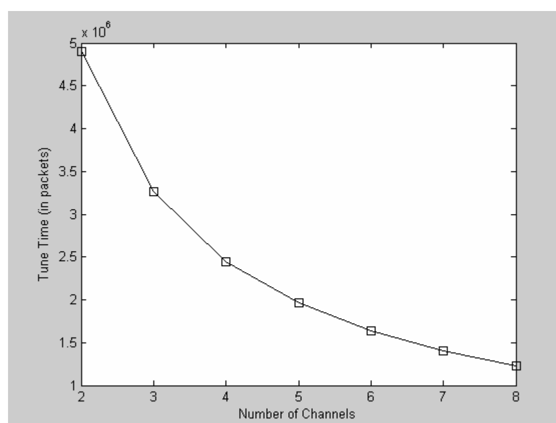

Figure 8. Tune Time with number of Channels (m=10)

Access time reduces considerably and tune time reduces slightly with increase in number of channels. The variation of access time with number of channels on UIH at m=10 is shown in figure 7 and variation of tune time for same parameter with number of channels is shown in figure 8.As the number of channels corresponding to number of BA in system. We have simulated the system for eight BA's.

V. CONCLUSION

Signature techniques have been widely used for information retrieval in wireless environment. The purpose of ideal index technique is to keep both access and tune time optimal. In this paper we have evaluated both in unique scenario, having combination of index tree and signature technique called UIH. Simulation results show that UIH with two level signatures have advantage over state in art signature technique.

The simulation results presented in section 4.2 clearly envisage that for different signature length access time and tune time, both have reduced in proposed model; which can yield a new paradigm in energy versus access latency trade off for multichannel mobile computing. The increasing channel numbers can cause considerable decrease in access time and tune time. Since, the number of BA is increasing by leap and bounds so UIH with TLSIM is over performing to substitute over existing data broadcast management techniques.

This research has an impulsive future. Here we have considered all BA with equal data items. In practice BA can have data according to its business value. The concept needs to be extended up to such environment. In future, we are planning to apply data caching techniques and develop dynamic data replacement policy for UIH with TLSIM.

VI. ACKNOWLEDGEMENT

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