Selecting the Best Valid Scopes for Wireless Dissemination of Location-dependent Data

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ABSTRACT

Mobility of users poses new challenges to research on spatial data access. Spatial data cached in the mobile client may become invalid because of the movement of the client. To increase the reusability of the cached data, we can identify the *valid scope* of the spatial data (i.e., the spatial area within which the data is known to be valid) and save the valid scope as well as the data in the cache. In this paper, we study issues on the dissemination of spatial data and valid scopes in a wireless environment. We investigate methods for representing valid scopes and their impacts on system performance. A generic representation method, called the invalidation-efficiency-based (*IEB*) method, is proposed. Simulation experiments are conducted to compare the performance of IEB with other representation methods. Result shows that IEB is superior to the other methods because it tries to balance the precision and overhead of valid scopes.

Keywords

mobile computing, location-dependent query, spatial data, data dissemination, valid scope

1. INTRODUCTION

Location-dependent data access has received a lot of attention in the past few years due to the proliferation of mobile computing technologies. In the mobile age of the near future, a mobile user can access information anytime and anywhere. This mobility of users poses new challenges to research on spatial data access because the answers to queries may be dependent on the current locations of the users. For example, the closest bus stop to a user at Main Street may be different from the closest bus stop to the same user when she is at College Road. Moreover, the query retrieving location-dependent data is named *Location-dependent Query (LDQ)*, whose answer may become invalid due to the user's movement between the time she issues the query and the time she receives the answer. It is observed that the mobility of users has a direct impact on the validity of answers to LDQs.

In a previous work [11], we have demonstrated that the *valid scope* of a spatial data, which specifies the area for the data to remain correct for a query, is a valuable auxiliary information for validating the answer to LDQs. Valid scope has been used in cache management of location-dependent data in a mobile device. However, the issues of valid scope on wireless dissemination of spatial data in response to LDQs have not been explored. In this paper, we focus on the representation of valid scope and the trade-off between the precision and dissemination cost of the representation. We study the impact of various representations of valid scopes on the wireless dissemination performance of an on-demand location-dependent information server. A generic representation of the valid scope, called *IEB* (invalidation-efficiency-based), is proposed. IEB is devised based on a new metric called *invalidation efficiency*. Simulation experiments are conducted to compare the performance of IEB with other representation methods for valid scopes. Result shows that IEB is superior to other methods because it tries to balance the precision and overhead of valid scopes.

Location-dependent information access in mobile environments is a relatively new research area and not much existing work appeared in the literature. For data caching, data-distance-based cache replacement policies, *Manhantan Distance* and *FAR*, were proposed as cache replacement strategies for location-dependent data in [7, 1]. Prefetching was also employed to maximize the cache usage based on the user's movement in [4]. Processing of LDQs, along with some common operators, was studied in [9]. In our previous work, we proposed several solutions to address some research issues of location-dependent information access [5].

The rest of this paper is organized as follows. Section 2 formulates the problem to be addressed in this paper and provides an overview of the system model used. A generic representation of the valid scope, IEB, for efficient wireless dissemination, is introduced in Section 3. A simulation model for the system to answer LDQs is described in Section 4. Result of performance evaluation for IEB and comparisons with other representations of valid scopes are presented in Section 5. Finally, we conclude our work and depict the future directions in Section 6.

2. PROBLEM FORMULATION AND SYSTEM OVERVIEW

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In this section, we first provide the definition of location dependent data and formulate the problem to be addressed in this paper. Then, the system framework employed in this paper is described, along with the main performance evaluation metrics.

2.1 Problem Formulation

Location Dependent Data (LDD) refers to data whose value is dependent on some reference location, which in most cases is the location of the query's issuer. A *data item*, in the context of this study, refers to one type of LDD (e.g., restaurants) and usually has different instances. Each data instance is only valid in some specific region. Thus, as mentioned earlier, valid scope is introduced to represent the bounded area within which a data instance is valid. Figure 1 depicts an example. Data item o has 4 data instances, with instance o_1 valid in valid scope P_1, instance o_2 valid in valid scope P_2 and so on. For simplicity, this paper assumes that the valid scopes of the data instances of a data item are disjoint and complement.

Due to the client's mobility, the returned data should be checked in order to guarantee that the client is still within the valid scope of the answer. Consequently, valid scope is a valuable auxiliary information that could be attached to the retrieved data instance in order to facilitate validity checking. However, this auxiliary information comes with a cost. It takes longer time for the clients to download the extra information. Further, it consumes more scarce bandwidth. Thus, the main issue addressed in this paper is how to represent the valid scope in order to balance the *precision* and *dissemination cost.*

The concept of valid scope information was first proposed in our previous paper [11], in which it was used to construct a semantic cache in order to re-use the cached data. The work emphasized on cache related technologies, such as replacement schemes and invalidation strategies. The effort is to maximize the cache hit ratio using limited cache space. We are addressing different issues here in this paper. The attention is on finding a precise representation of the valid scope which does not introduce too much dissemination overhead. We find that the factors of precision and dissemination cost contribute to various results in different situations. Thus, the goal of this research is to provide a flexible scheme to make an optimal combination of these two factors.

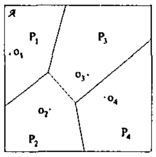


Figure 1: Data Instances and Valid Scopes

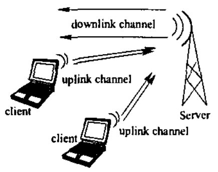


Figure 2: The System Model

2.2 System Overview

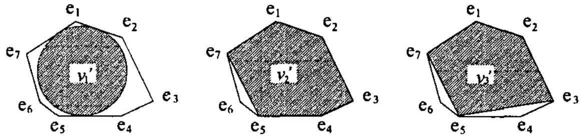
In this paper, a common client-server model is assumed for accessing location-dependent information in mobile computing environments. The server provides location-dependent service for the clients within its service area. Point-to-point, on-demand channels are utilized between the server and the clients for data transmission. The client submits a query via the uplink channel and receives the answer through the downlink channel. The server answers queries from the clients based on a first-come-first-serve (FCFS) policy. Figure 2 depicts the system model. Each client has its own uplink channel and the server uses a download channel to transfer data from the server to all the clients. The bandwidth of a uplink channel is smaller than that of the downlink channel. In addition to on-demand access mode, broadcasting is an alternative approach for wireless data dissemination, but it's outside the scope of this paper. A single-cell environment is assumed in this study and the impact caused by client's moving into other cells on the processing of LDQs deserves our further study.

As discussed earlier, the server may answer a query by returning a data instance with a valid scope. The client has a local cache and thus may cache the returned answers for later use. With the cached instances and associated valid scopes, a mobile client tries to answer a query from its cache by examining the valid scopes. If an answer cannot be found in the cache, the client issues a query to the server and waits for dissemination of the answer and associated valid scope from the downlink channel. *Probability-Area (PA)* policy is employed for cache replacement when a new data instance arrives[11]. It uses the ratio of access probability to the space cost of each record in the cache as the metric and replaces the one having the smallest cost.

Two performance metrics, namely *tuning time* and *access latency*, are used to evaluate various representation methods for valid scopes. The former is the amount of time that a client stays active for wireless transmission, including the time used for uploading a query via the uplink channel and for downloading the result via the downlink channel[1]. This metric, logically representing the client's power consumption, is tightly related to the size of a query and its answer. The latter is the time elapsed from the time the client requests data to the point when all the required data is received by the client, and thus represents the access efficiency of service.

3. VALID SCOPE BASED INVALIDATION

In general, the more precise the valid scope, the more likely a query can be answered locally. Consequently, the client issues fewer queries and consumes less battery power. Considering uplink cost alone, a more precise presentation is preferred. On the other hand, a very precise representation of the valid scope may significantly increase the bandwidth overhead and increase the access latency. Hence, an approximate representation with less overhead may be better in terms of downlink cost.



(a) v'_1=IC of v (b) v'_2=p(e_1, e_2,e_3,e_4,e_5,e_7) (c) v'_3=p(e_1, e_2,e_3,e_5,e_7)

Figure 3: An Example of Possible Candidate Valid Scopes (v=p(e_1,e_2,$\cdots$,e_7))

There are two intuitive representations of valid scope [11].

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[1] We assume that the system adopt signature techniques proposed in [3] so the clients can switch between active and doze modes. For simplicity of presentation, we do not include the time monitoring signatures in tuning time.

One is called *Polygonal Endpoints (PE)* which records all the endpoints of a valid scope. It provides a precise representation since the whole valid scope is recorded, while it consumes a large portion of the scarce bandwidth when the number of the endpoints is large. The other one is called *Approximate Circle (AC)* which uses the inscribed circle (IC) to approximate the valid scope (e.g., the shadowed area in Figure 3(a)). Since only the center and the radius information are needed, much less overhead is caused. However, this representation is less precise.

Obviously, it is impossible to use less information to present more precise valid scope information. We would like to study the problem of how to adapt these two factors and propose a generic method for balancing the overhead and the precision of valid scopes.

We first introduce a new performance criterion, *invalidation efficiency*. Suppose that the valid scope of a data instance is v, and v'_i is a sub-region contained in v. Let D be the data size, $A(v'_i)$ the area of v'_i, and $O(v'_i)$ the overhead needed to record the valid scope v'_i. The invalidation efficiency of the data instance with respect to a valid scope v'_i is defined as follows:

$$E(v'_i) = \frac{A(v'_i)/A(v)}{((D+O(v'_i))/D)^{\alpha}} = \frac{A(v'_i)D^{\alpha}}{A(v)((D+O(v'_i))^{\alpha})} \quad (1)$$

If we assume that the cache space is infinite and the probabilities of a client issuing queries at different locations are uniform, $A(v'_i)/A(v)$ means the possibility that a query is answered locally without any wireless transformation when the client issues the query within the valid scope v. v'_i is the approximated scope information stored in the client cache.

In contrast, $(D + O(v'_i))/D$ is the cost ratio for achieving such an improvement, since it has to consume bandwidth and also the cache space. The rationale behind this definition is as follows. When a valid scope is not attached to an answer, $E(v'_i)$ is 0 since the answer is almost useless (i.e., the answer is good for the exact point where the query was issued). As more precise valid scope information used, $E(v'_i)$ increases. However, if too much overhead is therefore introduced, $E(v'_i)$ would decrease again. A parameter α is introduced to denote the relative weight of representation overhead, since we observe that different systems have different preferences. Based on the invalidation efficiency, a generic method for balancing the overhead and the precision of valid scope is proposed:

> *For a data item value with a valid scope of v, given a candidate valid scope set $V' = \{v'_1, v'_2, \cdots, v'_k\}$, $v'_i \subseteq v$, $1 \leq i \leq k$, we choose v'_i that maximizes invalidation efficiency $E(v'_i)$ as the valid scope to be attached to the data instance.*

Regarding *PE* and *AC* as two extreme situations, one pays attention to the precision of the valid scope and the other gives higher weight to the overhead caused by the attached valid scope. *IEB* actually considers both factors and presents a good mix of them. *IEB* can dynamically choose an approximate representation between the precision spectrum of *PE* and *AC*. When α is set to 0, *IEB* equals to *PE*. If we continue to increase α, *IEB* will eventually become the same as *AC*.

Figure 3 illustrates an example where the valid scope of the data value is $v = p(e_1, e_2, \cdots, e_7)$, and v'_1, v'_2, and v'_3 are three different sub-regions of v, $A(v'_1)/A(v) = 0.788$, $A(v'_2)/A(v) = 0.970$, and $A(v'_3)/A(v) = 0.910$. Assuming that the data size D is 128 bytes, eight bytes are needed to represent an endpoint, and four bytes for the radius of an inscribed circle, and α is initialized to 1, we obtain $E(v) = 0.696$, $E(v'_1) = 0.721$, $E(v'_2) = 0.706$, and $E(v'_3) = 0.694$. As a result, we choose v'_1 as the valid scope to be attached to the data.

Algorithm 1 Selection of the Best Valid Scope for the *IEB* Method

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Input: valid scope $v = p(e_1, \cdots, e_n)$ of a data value;
Output: the attached valid scope $v'$, $v' \subseteq v$;
Procedure:
$v'_1$ := the inscribed circle of $p(e_1, \cdots, e_n)$; $v'$ := $v'_1$;
    $E_{max} := E(v'_1)$; $v'_i = p(e_1, \cdots, e_n)$;
for $i := 2$; $n - i \geq 1$; $i := i + 1$ do
    if $E(v'_i) > E_{max}$ then
        $v' := v'_i$; $E_{max} := E(v'_i)$;
    end if
    if $n - i > 1$ then
        $v'_{i+1}$ := the polygon that is deleted one endpoint
        from $v'_i$ and has the maximal area;
    end if
end for
output $v'$.
```

To choose the appropriate valid scope for IEB, a practical issue is to generate the candidate valid scope set, V'. There are various ways to do this. In this paper, we generate the candidate valid scope set as follows. The inscribed circle of a polygon can be obtained using the *medial axis* approach [6] and a series of candidate polygons can be generated in a greedy manner. Suppose the current candidate polygon is v'_i. We consider all polygons resulting from the deletion of one endpoint from v'_i, and choose as the next candidate v'_{i+1}, the polygon which is bounded by v and has the maximal area. The pseudo algorithm is described in Algorithm 1, where the generation of candidate valid scopes and the selection of the best valid scope are integrated.

4. SIMULATION MODEL

This section describes the simulation model used for our experiments. The discrete-time simulation package *CSIM* [8] is used to implement the model.

4.1 System Execution Model

Although a cellular mobile network consists of many cells, the network can coordinate between the clients and the cells to provide clients with a seamless service when they move across different cells. As such, the network can be considered a single, large service area within which the clients can move freely and obtain LDISs.

In our simulation, the service area is represented by a rectangle with a fixed size of *Size*. We assume a "wrapped-around" model for the service area, in which the left side is regarded as adjacent to the right side and the top side adjacent to the bottom side. In other words, when a client leaves one border of the service area, it enters the service area from the opposite border at the same velocity.

The database contains *ItemNum* items and each one has *ScopeNum* different instances. Each data instance has a size of *DataSize*. In the simulation, Voronoi diagrams of data instances serve as the scope distributions [10], which provides the region for each instance o_i that within which o_i is the nearest neighbor rather than other instances. Two different datasets are used, one contains 110 randomly distributed points and the other contains the locations of 185 hospitals in the Southern California area, which is extracted from the point dataset at [2]. Two floating-point numbers are assumed to represent a two-dimensional coordinate and one floating-point number to represent the radius. The size of a floating-point number is *FloatSize*.

The wireless network is modeled by an uplink channel and a downlink channel, having *UplinkBand* and *DownlinkBand* as available bandwidth.

4.2 Client Execution Model

The mobile client is modeled with two independent processes: *query process* and *move process*. The query process continuously generates LDQs for different data items. After the current query is completed, the client waits for an exponentially distributed time period with a mean of *QueryInterval* before the next query is issued. The client access pattern over different items follows a *Zipf* distribution with skewness parameter θ [12]. To answer a query, the client first checks its local cache. If answer is not locally available, it submits the query and its current location uplink to the server and retrieves the data through the downlink channel.

The move process controls the movement pattern of the client using the parameter *MovingInterval*. After the client keeps moving at a constant velocity for a time period of *MovingInterval*, it changes the velocity in a random way: the next moving direction is selected randomly, and the next speed is selected randomly between *MinSpeed* and *MaxSpeed*. When the value of *MovingInterval* is small, the client's movement is rather random; when the value of *MovingInterval* is large, the movement of the client behaves more like a predefined trip which consists of long straight-line segments. The client is assumed to have a cache of fixed size, which is a *CacheSizeRatio* ratio of the database size.

Parameter	**Setting**	**Parameter**	**Setting**
Size	4000*4000, 44000*27000	*QueryInterval*	50.0
		MovingInterval	1000.0
ItemNum	100	*MinSpeed*	1, 5 s^{-1}
ScopeNum	110, 185	*MaxSpeed*	2, 10 s^{-1}
DataSize	256 bytes	*CacheSizeRatio*	5%
FloatSize	4 bytes	*ParaSize*	4 bytes
UplinkBand	19.2 Kbps	θ	0.5
Downlink Band	1000 Kbps	α	0.25
ClientNum	1000		

Table 1: Default Parameter Settings for the Simulation Model

4.3 Server Execution Model

The server is modeled by a single process that services the requests from clients. With respect to the client's specified location and request, the server can detect the suitable data instance for returning to the client. Since the main concern of this paper is the cost of the wireless link, which is more expensive than the wired-link and disk *IO* costs, the overheads of request processing and service scheduling at the server are assumed to be negligible in the model. Table 1 provides the default settings of parameters. [11] presented the detailed description about the parameters and they are omitted here due to the space limitation. Similarly, some implemention issues of applying *PA* cache replacement strategy are omit and they can be found in [11].

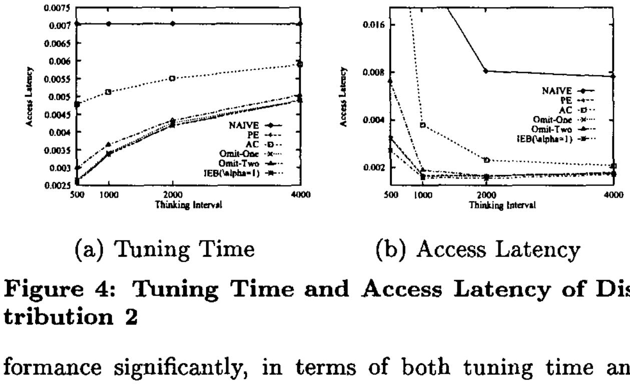
5. PERFORMANCE EVALUATION

In this section, data dissemination of LDD and valid scope represented in various approaches is evaluated using the simulation model described earlier. Default parameter settings are provided in Table 1. *QueryInterval* and *MovingInterval* use the time to download a data item as the basic unit. In our evaluation, we assume that all data items follow the same scope distribution in a single set of experiments.

5.1 Experiment #1: Improvement Brought By Valid Scopes

Without valid scope, the server only transmits the data to the client. With the assumption that the client stops moving after it submits the query, the returned answer can be guaranteed to be valid. Obviously, this *NAIVE* scheme does not introduce any overhead. However, the cached data are useless since the hit ratio is nearly 0, which makes the client upload all the recurring queries and thus increases the system load. On the other hand, the valid scope brings some overhead which increases the download time of the result. This overhead may be a worthy tradeoff since the valid scopes improve clients' cache hit ratio, i.e., a lot of queries can be answered locally, and thus lightening the system workload. Figure 4 depicts the performance of different representations of valid scopes as the *QueryInterval* varies from 500 to 4000, setting α as 1.0. *OmitOne* and *OmitTwo* mean the maximal sub-polygon containing $(n-1)$ or $(n-2)$ endpoints, given n the number of the endpoints in the exact valid scope.

One observation is that valid scopes do improve the performance significantly, in terms of both tuning time and access latency. Considering distribution 2, the improvement introduced by AC scheme is about 74.3% for latency and 40.0% for tuning time. The corresponding improvement introduced by PE is 82.1% and 56.4%, and that for Distribution 1 is similar. The other observation is that *IEB* based valid scope representation usually obtains the best performance. The improvement is described in the following sets of experiments in detail.



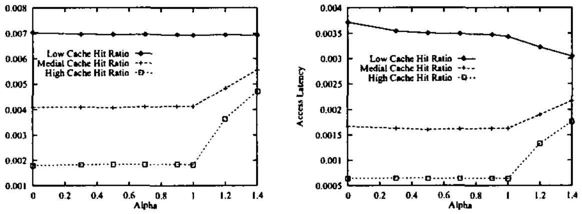
(a) Tuning Time (b) Access Latency

Figure 4: Tuning Time and Access Latency of Distribution 2

5.2 Experiment #2: Light System Workload

In this set of experiments, the workload of system is light, i.e., there is only a small number of queries waiting for service. Figure 5 depicts the simulation result. As we mention previously, *IEB* is the representation of valid scope chosen based on invalidation efficiency. IEB equals *PE* when α is 0 and it will eventually becomes *AC* as α increases. In this experiment, *IEB* becomes *AC* when α is set to 1.4, due to the small number of endpoints of the valid scope. By comparing the result, the optimal performance is achieved when α is set to 1.4 and 0.5 for the scenarios of low and medium cache hit ratio situation. While for the scenario of high cache hit ratio, *IEB* (α=0) has the shortest latency and *IEB* (α=1.0) has the shortest tuning time.

From the figure, *AC*, i.e., *IEB* ($\alpha = 1.4$), has the best performance for low cache hit ratio, and the average outperform is about 0.4% and 12.5% over that of other settings, in terms of tuning time and access latency for Distribution 2. While more and more queries can be answered locally by cache hit, the performance of *AC* decreases and others provide better performance. As the average hit ratio is around 0.4, *IEB* ($\alpha = 0.5$) is superior to others. While the hit ratio increases to 0.7, the system achieves best performance as α is 0.0, i.e., *PE* scheme.



(a) Tuning Time (b) Access Latency

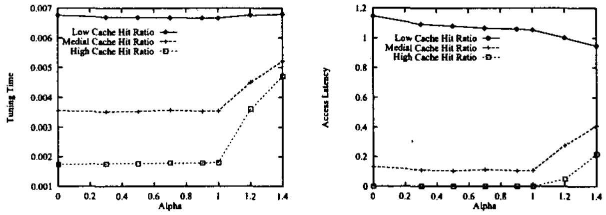
Figure 5: Performance of Distribution 2 in the Light-loaded System

In the experiment, the expected cache hit ratio is adapted via clients' moving speed. The faster the clients move, the higher the possibility that the clients leave the valid scope of the cached data and request a new data instance. Consequently, the lower the cache hit ratio. The reason that we study the system performance when the clients have different cache hit ratio is explained as follows. Since the number of the endpoints of the valid scope, which can be denoted as n, is very limited, there are at most $(n - 3)$ different ways to represent the valid scope using partial polygon, F as the whole polygon and a circum-circle as two extremes. Hence, the area difference among different representations can be computed. From our previous study, the ratio between the cached partial scope area to that of the complete valid scope area has a direct impact on the expected cache hit ratio [11]. Consequently, a rough estimation about the cache hit ratio difference can be obtained. In general, the cache hit ratio difference between complete and partial polygon representation is very small and the big difference only occurs between polygon representation and that of the circle. Comparing the hit ratio of *AC* scheme to that of *PE* scheme, the corresponding ratio is about 0.45, 0.50, and 0.49 for three situations in this set of experiments, and the average ratio of the area of the circum-circle and that of the complete valid scope is 0.48.

Based on the known estimated difference of the hit ratio, the improvement of *PE* scheme and partial polygon scheme over that of *AC* scheme can also be predicted. For low cache hit ratio, the improvement is also small in which the download cost saved by the small overhead of *AC* scheme is dominate. While for high cache hit ratio, the improvement is significant and the upload cost saved by the higher cache hit ratio of polygon or subpolygon representation is dominate. The simulation result also provides the same conclusion.

5.3 Experiment #3: Heavy System Workload

In heavy loaded system, the frequency that the clients submit the query is higher than the frequency that the server answers the queries. Therefore, the queries are queued at the server's buffer. Consequently, the client has to wait a longer time to receive the desired data. The simulation result is depicted in Figure 6. Different from the light loaded system, not a configuration can achieve the best performance for both two metrics. A reason is that in the heavy loaded system, the client's access latency is extended by the service time of the clients submitting queries before it. The amount of information contained in the answer to a client does not only decide its latency, also affects that of other clients.



(a) Tuning Time (b) Access Latency

Figure 6: Performance of Distribution 2 in the Heavy-Loaded System

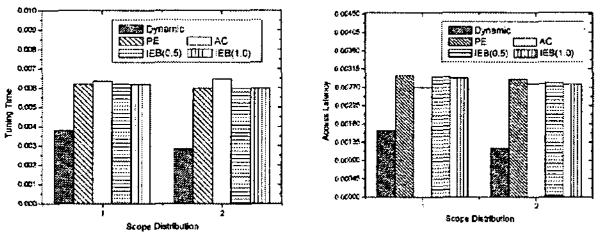
5.4 Dynamic Adaption of IEB

In order to check the advantage of dynamic decision of the value of α according to the real situation, a new set of experiments is constructed. Figure 7 depicts the simulation results. In previous experiments, the cache hit ratio of the clients is different via the changing of the clients' moving speed. In order to avoid examining the knowledge obtained from those experiments, the clients in this set of experiments change their access pattern rather than varying their velocity. The skewness parameter θ varies from 0.0 to 1.0 in the middle of the experiment. Since the skewness of the access pattern increases, the clients' hit ratio is increased. The dynamic scheme suggests that the server should adapt the value of α of the *IEB* scheme to satisfy the current situation of the system, and the clients are assumed to inform the server the change of its cache hit ratio. For dynamic settings, the server changes α from 1 to 0.5 once it finds the clients change their cache hit ratio.

5.5 Observations and Discussion

In this sections, three different sets of experiments are conducted and several observations are obtained. Firstly, the data dissemination method attaching valid scope information as invalidation achieves much better performance than the naive one, in terms of both tuning time and access latency. Secondly, *IEB* strategy combines the *PE* and the *AC* schemes and provides a more flexible way to decide the representation of the valid scope. Thirdly, the ratio of cache performance of various αs can be estimated via the computation of the attached valid scope' area. Consequently, for higher cache hit ratio, the improvement caused by the precise represent of the valid scope is also more significant.

Hence, less weight is assigned to the overhead. On the contrary, the improvement is relatively small for the low cache hit ratio situation. Consequently, more weight should be assigned to the overhead factor. Lastly, the system burden also impacts its activity. For a light-loaded system, a client's action only affects its own performance. While in a heavy-loaded system, the influence among different clients exists. Based on the above observations, a conclusion is made. As the clients' cache hit ratio decreases, the setting of α increases. *PE* is suitable for high cache hit ratio, and *AC* is the best choice for low cache hit ratio. With the cache hit ratio decreases, α increases from 0.0. Although at current study, no algorithm is devised to provide definite optimal value of α for a given system, a very useful knowledge is obtained by these sets of experiments and the analyze of the system performance.



(a) Tuning Time (b) Access Latency

Figure 7: Performance Comparison of Systems having Dynamic Actions

6. CONCLUSION

In this paper, we have explored the impact of valid scope on wireless dissemination of LDD under a geometric location model. We presented two basic representations of valid scope (i.e., *PE* and *AC*) and a generic representation, *IEB*, which chooses one of the candidate valid scopes based on the invalidation efficiency. IEB attempts to balance the overhead and the precision of the valid scope when an approximation of a valid scope has to be decided. Both observation and experiments results show that precision and dissemination cost, as two different factors, provide different contributions to the final performance in various situations. The flexible and generic metric *invalidation efficiency* gives an intelligent combination and offers nearly optimal presentation. The outperform observed from the simulation is significant, compared to other valid scope representations. As a summary, our contribution of this work is to address the validity checking for location-dependent data. Based on the point-to-point client-server model in wireless environments, valid scope information is also disseminated to the client with the requested data. A dynamic decision of the presentation of the valid scope information can be made by a generic metric *invalidation efficiency* proposed in this paper.

As for future work, we are extending our study to general queries such as "find the nearest hotel with a room rate below $100." In this work, we assume that the clients usually have similar cache hit ratio and the server makes decision of valid scopes for all the clients. We would like to study the system where the client is independent. There are some related issues, such as the dynamic decision made by the server according to specific clients.

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