Decentralized Grid Resource Locating Protocol Based on Grid Resource Space Model

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Abstract. This paper focuses on how to model grid resource and locate grid resource using efficient and scaleable protocol under a grid environment. A mathematic model of grid physical resource space and logical resource space is built based concept of virtual organization. Then, a mathematical method based the binary equivalent relation is presented to divide grid physical resource space. Then, this paper proposes the concept of grid resource domain, and introduce a fully decentralized grid resource locating protocol based it from aspects of the overlay network of grid resource domains and query routing protocol among different grid resource domains. On the other hand, in order to propagate query among information nodes within given grid resource domain, this paper presents informed search protocol based bloom filters. Our resource locating protocol can enhance the query success rate and recall rate, and avoid too much unnecessary query messages.

1 Introduction

As an important information technology solving distributed complex problem cooperatively, grid aims to congregate, share and integrate large-scale, heterogeneous, distributed resources across dynamic resource organization and management domain. In the small-scale and tight-coupled environment, resource space model may be not necessary. But if we hope to deploy grid application successfully under the environment in which resources is widely distributed and heterogeneous, the issues that how to model and organize resources will become more significant. Moreover, successful large–scale grid applications always need efficient and scaleable grid resource locating mechanism without centralized management and control.

Research institutes and enterprises have done lots of work on grid resource model and grid resource space model. The representative achievements of grid resource model include Web service, Service Domain, OGSA, WS-Resource and so on. The research work about grid resource space model in homeland is developed from aspects of service grid, information grid and knowledge grid by the researcher group coming from institution of computing technology, Chinese academy of science. The EVP grid resource space model [1] and resource space grid [2] are two kinds of

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representative production. On the other hands, researchers have proposed many solutions for resource locating problem in the fields of web services and grid, but the foundation or basic idea of those solutions can derive from related research result of peer-to-peer network.

The available decentralized resource locating and sharing protocol can be classified as unstructured, loosely structured, and highly structured peer-to-peer network according the control mechanism over data location and overlay topology [3]. In an unstructured p2p network such as Gnutella [4], no rule exists which defines where data is stored and the overlay topology is arbitrary. In a loosely structured network such as Freenet[5], both the overlay structure and the data location are not precisely determined. In a highly structured P2P network such as CAN [6] and Chord [7], both the overlay topology and the data placement are precisely specified. Searching in unstructured P2P network covers both blind search schemes and informed search schemes. Blind searches include iterative deepening [8], k-walker random walk [9] and so on. Informed searches include local indices [10], adaptive probabilistic search [11] and so on.

This paper doesn't research concrete grid resource model, it should be the work of related standardization organization, such as W3C, GGF and so on. The major contribution of this paper includes:

1. Proposes a mathematical model of grid physical resource space and logical resource space.
2. Presents the mathematical method used to partition grid physical resource space based on the binary equivalent relation, and the method used to partition grid logical resource space based on the concept of content similarity.
3. Defines the concept of grid resource domain, and design the grid resource locating protocol based on grid resource space division from aspects of overlay topology, bootstrap system, and query routing protocol among grid resource domains.
4. Presents one informed search protocol based bloom filters, and use it to forward query within the same grid resource domain.

The rest of this paper is organized as follows. Section 2 proposes grid resource space model. Section 3 presents grid resource locating protocol based on grid resource domain from aspects of overlay topology, bootstrap system and query routing mechanism among different grid resources domains. Section 4 presents one informed search protocol based bloom filters used to route query within a grid resource domain. Section 5 concludes this paper.

2 Grid Resource Space Model

Grid can utilize idle or dedicated large-scale, heterogeneous, distributed resources delivered by different persons or organizations to realize goal of resource sharing and problem solving cooperatively across different manage domains. Grid also is viewed as an infrastructure which provides necessary resources and services with high QOS for certain applications and users. Grid systems and applications are often associated with the concept of virtual organization (VO). Each independent resource organization would like to contribute its idle or dedicated kernel resources and services to one or several virtual organizations according to common goal. In fact, virtual organization is one kinds of basic conceptual model of grid system and application. In this section, we try to establish the grid resources space model based the concept of virtual organization.

2.1 Physical Resource Space Model

Definition 1. A network can be denoted as (O,E) satisfying $E \subseteq [O]^2$; thus the elements of E are 2-element subsets of O. The elements of O are all kinds of resource organization providing resources; the elements of E are the links among elements of O. The resource organization is a pair $o=(r,lacl)$ of sets. The elements of r are local physical resource; the elements of $lacl$ are corresponding resource access control rules for r.

Definition 2. Virtual organization is consisted of the resources provided by each resource organization for the identical global goal. For virtual organization vo_j, it can be denoted as $VO_j = \bigcup_{k=1}^{|O|} (w_{kj} \times o_k)$.

Each resource organization need provide a resource sharing vector to indicate their contribution degree and access control method of owned resources for given virtual organization. Let l denote the number of resources owned by resource organization O_k, resource sharing vector provided by O_k for virtual organization vo_j can be denoted as $w_{kj}=\{w_{kj1},f_{kj1},w_{kj2},f_{kj2},\ldots,w_{kjl},f_{kjl}\}$. w_{kjl} is denote the quality and quantity of resource r_{kl} delivered to vo_j. f_{kjl} is used to denote the mapping relation between access control of resource r_{kl} for local application and that for virtual organization vo_j.

Definition 3. Let vo denotes a concept model of given grid system or application G. The physical resource space of G is the projection of resource space of all resource organization based on *goal* of corresponding vo_j, and also is identical with the physical resource space of corresponding virtual organization.

2.2 Logical Resource Space Model

The kernel resources and services provided to corresponding *vo* by each resource organization display similarity on the type and function. There are at least two reasons for these phenomena. First, the type of all resources which can be accessed through Internet is limited and confirmable for each application filed, and this can results in many similar resource instances hosting in the same grid physical resource space. Second, the interface of web service trend to become uniform and standard in many application fields, and there are many similar services instances deployed in the same grid physical resource space.

In reference [1], authors proposed the “homogeneous” binary relation on the grid physical resource space and divide it into the no-overlapping subsets. But they didn’t present a rigorous and explicit definition for the conception of the “homogeneous physical resource”. In this section, we will design the binary “equivalent” relation on the grid physical resource from the point of service function characteristic, and uses this binary equivalent relation to divide the grid physical resource space.

Definition 4. Let assume R is a binary relation on the grid physical resource space R_{grid}, and there is a corresponding elementary set called the base of binary relation R. R can be defined as following statement: $\forall x, y \in R_{grid}, (x, y) \in R,\ \exists z \in Base$, and the resource type, metadata model and derived functions of x and y are both the same z.

Definition 5. S is a division of a grid physical resource space R_{grid}. Only if it satisfies those three conditions, we call S a division about binary equivalence R on R_{grid}, and there is a one by one mapping *f: Base—>S.*

(1) $|S| = |Base|$; (2) If $\forall x, y \in T_1, T_1 \in S$, then $(x, y) \in R$;

(3)If $\forall x \in T_1, T_1 \in S$ and $y \in T_2, T_2 \in S$, then can't deduce that $(x, y) \in R$.

Definition 5 proposes the method used to divide grid physical resource space R_{grid} based on the binary equivalent relation R. At the same time, it also can be used to judge whether a division of a grid physical space satisfies the binary equivalent relation R. The elementary work before applying definition 5 is to identify the base of the binary equivalent relation R.

Definition 6. The grid logical resource space R_{vgrid} is the base of binary equivalent relation R on the grid physical resource space R_{grid}. Each grid logical resource is one element of *Base*, and $|R_{vgrid}| = |Base|$. There is a scheduling function g between each grid logical resource and the most suitable physical resource, which use to discover, select and invoke most suitable physical resource according to given logical resource.

Grid applications are established on open and dynamic environment, this leads to the uncertainty of the reliability and usability of resources or services instance involved by application at the running phase. Therefore, grid application should be established on logical resource rather than concrete physical resource. Grid application realizes the initialization of various logical resources at the compiling phase, and dynamically instead logical resource with most suitable resource instance at the running phase, and guarantee application possess excellent fault-tolerant and loading balance capability.

2.3 Division of Grid Logical Resource Space

As mentioned above, grid application should be established on logical resource instead of physical resource instance directly. Thus it is need to pay more attention to the organization and management methods of grid logical resource. We will study the division methods used to cluster elements of grid logical resource space.

Definition 7. Let M denote the size of R_{vgrid}, R_{vgrid} is organized as a tree called grid logical resource tree (GLRT), and the depth of GLRT is denoted as N. For any x and y belonged to R_{vgrid}, the degree of similarity between them is denoted as *Similarity(x, y).* $leaf_x$ and $leaf_y$ are the corresponding leaf node of that GLRT. If $Similarity(x, y) = \infty$, we can say that x and y are not accessible each other; otherwise, they are accessible.

The similarity between any two grid logical resources can be computed according following steps: (1) $Similarity(x, x) = 1$;(2) Find the corresponding path from $leaf_x$ and $leaf_y$ to the root node of GLRT, and denoted as $route_x$ and $route_y$;(3) If the length of *route*$_x$ and *route*$_y$ are one, *Similarity(x, y) =1*.Otherwise, it is need to compute the first overlap node of *route*$_x$ and *route*$_y$; (4) If the first overlap node is the root node of GLRT, *then Similarity(x, y)* =∞. Otherwise, compute the length *length*$_x$, *length*$_y$ from *leaf*$_x$, *leaf*$_y$ to the first overlap node, and *Similarity(x, y) =Max (length*$_x$*, length*$_y$*)*.

The algorithm based content similarity to divide grid logical resource space is embodied by algorithm1. The parameter Q has influence on the granularity of division result for same grid logical resource space. This paper does not focus on this problem.

Algorithm 1. DivideLogicalGridResourceSpace (Rvgrid Base, Similarity *Q*)

```
1. Let the size of Base be M. Let the element of Base be base1,
base2,…,baseM , sorted by the order of leaf when traversing the tree
from left to right.
2. Let Grd denote the result after dividing up the Base, the initial-
ized value is null.
3. For i=1 to M do
4.   If basei has been in Grd then continue Else
5.       Create Set named answer, initialized value of answer is null
6.       For j=i to M do
7.          If basej has been in Grd then continue
8.          Else If Similarity (basei, basej) is less than Q then
9.             answer= answer Union {basei , basej }
10.         End if
11.      End for
12.      Add answer to Grd
13.   End if
14. End for
15. Return Grd
```

We will give an example to embody this algorithm. We assume parameter *Q* is one, *Base= {K, L, F, G, M, I, J},* and the corresponding grid logical resource tree is illustrated by figure1, the set of leaf node of this GLRT equals to R_{vgrid}. According to this configuration, algorithem1 can response such a division result *Grd*={{R,S}, {N,O}, {F,G},{H,I},{T,V},{Q},{K,L}}.

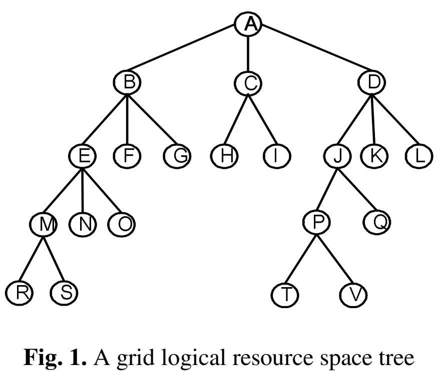

Fig. 1. A grid logical resource space tree

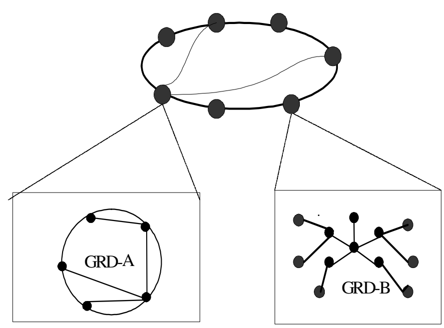

Fig. 2. The overlay of grid resource domain

3 Resource Locating Protocol Based Resource Space Model

Definition 8. Grid Resource Domain *(GRD*) is comprised of its resource entity and inner overlay network, and is denoted as *(T, G).T* is an element of one division result G*rd* of given grid logical resource space. The inner overlay network of given grid resource domain is modeled as a graph *G= (N, E)*, and *N* is the information node set of this *GRD*, *E* is the edge set among the nodes. The responsibility of each information node is limited by *T*. They only are willing to store information of grid physical resources which corresponding grid logical resources belong to *T*. For any two different grid resource domains GRD_x and GRD_y, *x* is a random element of $GRD_x.T$, and *y* is a random element of $GRD_y.T$, if $Similarity(x, y) = \infty$, GRD_x and GRD_y are not accessible each other, otherwise they are accessible.

We will present a new grid resource locating protocol based grid resource domain. At its heart, it can be viewed as a two-tier structure as shown in figure 2. The top tier structure means the overlay network of grid resource domains, and second tier means the inner overlay network of each grid resource domain. Note that the interconnection of domains shown in the figure2 is only conceptual, and is actually realized as part of the interconnecting information nodes.

3.1 Bootstrap System

To join this peer-to-peer system, a new information node with responsibility of given grid logical resource must look up some or all information nodes within corresponding grid resource domain in order to set its intra-domain links, at the same time it also need discovery some or all information nodes within other grid resource domains in order to build its inter-domain links. Thus, there should be a bootstrap system to store and maintain grid logical resource tree, division result of grid logical resource space and all grid resource domains of given grid application. Whether this system is centralized or decentralized, it must provide standard and open interface to deliver those information to new information node, grid resource provider, and resource consumer. On the other hand, it allows these kinds of user to pull or cache information on-demand. We don't focus detail about this bootstrap system and assume it has been deployed successfully, but prefer structured peer-to-peer protocol to other protocols, and it will better if nodes within bootstrap system are stable and powerful.

3.2 Overlay of Grid Resource Domains

We now describe the desired overlay of grid resource domains. The desired overlay can guarantee these characteristics: (1) a query and publication message with given grid logical resource issued by any information node can be forwarded to correct grid resource domain within log (k) hops, k is the number of grid resource domains; (2) a query message without any grid logical resource issued by any information node can be forwarded to all grid resource domains;(3) a query message with multiple grid logical resources, distributed among multiple grid resource domains which are reachable each other, can be forwarded to any one corresponding grid resource domain within (k) hops, and then forward to other grid resources domain within one hop.

In order to guarantee those characteristics mentioned above and avoid the disadvantage of centralized system, we will use the Chord-like structure [7] as a conceptual interconnection network of grid resource domains, other structured p2p structure maybe also suitable. First, a conceptual link between any two grid resource domains means, for any information node n1 belonged to one domain, there exists some node n2 belonged to another domain, such that node n1 links to node n2. Second, each grid resource domain need make sure it's identifier in order to define inter-domain structure. The identifier can be a hashing code of the uniform name of each grid resource domain, and can also be a bloom filters of the set consisted of all grid logical resource name within each grid resource domain. Third, grid resources domains are then arranged in a circular space using their domain identifier, and are interconnected obeyed Chord protocol. Finally, grid resources domains which are reachable each others are interconnected each other. Each link from one grid resource domain to another is implemented by a set of inter-node links, as described above. The neighbor relationship among domains should be defined once the whole grid logical resource was divided according method mentioned at section 2, and should be stored by bootstrap system. Of course, once a new grid logical resource appears, the neighbor relationship should be redefined, and then update related information stored by bootstrap system.

After outline the desired overlay of grid resource domains, we present solutions to information node arrival and grid resource registration problem. New information node arrival operation can be processed by following steps: (1)A new information node publishes its grid logical resource and its description information to the bootstrap system, and that information would be appended to the entry for its hosting grid resource domain in bootstrap system; (2)The new information node retrieves some or all candidate nodes within its hosting grid resource domain, then sets link to those nodes obeyed to the protocol used by this grid resource domain;(3)The new information node retrieves one information nodes for every neighbor grid resource domains of its hosting grid resource domain by accessing the bootstrap system, and then sets link to those nodes obeyed to the protocol mentioned above.

We assume that grid resource provider can identify the name of logical resource which corresponding physical resource will be published to the peer-to-peer registration system, and has knowledge about one information node within system. The registration message can be first submitted to that information node and enter one grid resource domain, the information node will retrieve the identifier of desired grid resource domain from bootstrap system. If current grid resource domain is not the desired one, the message will be forwarded to the desired grid resource domain within log (k) hops according to local routing table (include routing entries obeyed chord protocol and the obeyed the reachable rule of grid resource domains). Furthermore, the message will be redistribution among the desired domain according to related load balance protocol.

3.3 Inter-GRD Search Protocol

After discussing the overlay network of grid resource domains and two major problems (information node arrival and grid resource registration), it is time to focus on grid resource discover problem at the level of grid resource domains, the same problem within one grid resource domain will be discussed at following section.

For a query without payload about grid logical resource information, it will be submitted to any information node within any grid resource domain, and then the information node first finds all answers to the query within its own grid resource domain. If the number of answers proves insufficient, it attempt to find answers from one additional grid resource domain. While the number of answers still insufficient, it will propagate the query to more grid resource domain until either a sufficient number of answers are discovered, or all the grid resource domains have been searched. Detail about query broadcast algorithms can be found from literature [12].

On the other hand, we assumed that the grid resource consumer has knowledge about the desired logical resource used as part of query payload. For this kind of query, it will be submitted to any information node within any grid resource domain, and then the information node obtain the desired grid resource domains through the bootstrap system using the desired grid logical resource as input parameter. If its own domain is the only desired domain, then it just need find all answers to the query among its own domain according the query protocol used by this domain. Otherwise, it will forward the query to the only desired grid resource domain or other desired grid resource domains. In fact, the forward decision is first made by taking care of the local routing entries defined according the reachable rule of grid resource domains, then made according the local routing entries obeyed chord protocol.

After the deployment of grid resource domains network, if grid resource consumer appends desired grid logical resource in the query message, resource locating protocol mentioned above can enhance the query success rate and recall rate, at the same time it can avoid too much unnecessary query messages.

4 Intra-GRD Informed Search Protocol Based Bloom Filters

In this section, we focus on how to route query among different information nodes within the same grid resource domain. The overlay and search protocol for given grid resource domain should not be imposed. The candidate overlay can be classified as three categories: unstructured, loosely structured, and highly structured based on the control mechanism over data location and network topology. In this section, we will introduce a new informed search protocol based bloom filters for unstructured peer-to-peer, and make use it to forward query among the same grid resource domain.

4.1 Preliminary Introduction of Bloom Filters

A bloom filter is a compact data structures for probabilistic representation of a set in order to support membership queries. A bloom filter for representing a set $S = \{s_1, s_2, ..., s_n\}$ of n elements is described by an vector of m bits, initially all bits are set to 0. A bloom filter uses k independent hash functions $h_1, h_2, \ldots, h_k$ with range $\{1, \ldots, m\}$. These hash functions map each item in the universe to a random number uniform over the range $\{1, \ldots, m\}$. For each element *x* of *S*, the bits $h_i(x)$ are set to 1 for $1 \leq i \leq k$.To check whether an element *x* belongs to *S*, one just need to check whether all the *hi(x)* bits of the vector are set to 1. If not, then *x* is not a member of *S*. Otherwise, we assume that *x* is a member of *S*, although we are wrong with some probability. Hence a bloom filter may yield a *false positive*, for which it suggests that an element *x* is in *S* even though it is not. Each false positive is due to a filter collision, in which all bits indexed were set to 1 by other elements previously [13].

4.2 Informed Search Protocol Based Bloom Filters

In nature, informed search protocol is one kind of forward-based routing protocol. It has two major components, the construction and maintenance mechanism of routing table, and a query forward mechanism using the routing table. In our informed protocol, the routing table is a set of bloom filters, each corresponding to a link. When a peer needs to forward a query, bloom filters corresponding to each link will be scanned and desired links will be filtered out as the forwarding directions.

In order to construct a routing table, A. Kumar has presented an interesting method in [14]. Each peer must construct local bloom filter and send a routing advertisement (in the form of bloom filter) to the neighbor at a connection setup. Then the neighbor can construct a routing entry for the link from itself to the new peer. The initial advertisement is created by taking the decay union of all advertisements received from neighbors other than the target neighbors, allowing this combined advertisement to decay by the decay factor d. We believe that it should adopt gossiping protocol [15] to exchange advertisement between sources and sink peer instead of push or pull. The experiment according to algorithem2 shows that the convergent speed of gossiping protocol is faster than in a single push protocol.

Only this kind of mechanism is not enough to make sure that each routing entry contains whole summary information of the reachable data along the corresponding link direction. In fact, the majority of early arriving peers have little information about the later peers, although the later peers have enough information about the early peers. Thus, we should pay more attention to routing table update and maintenance mechanism. A. Kumar has presented a push protocol in which each peer constructs and pushes the update advertisement for each neighbor in a given interval. In our experiment, we found that it is not necessary to update for all link directions. We also adopt asynchronous gossiping update protocol, and each peer creates an update advertisement for a random link direction at each gossiping round, and exchanges update advertisements in that direction. Please refer algorithem2 for details.

Algorithm 2. Gossip (node *i*)

```
1. Obtain local bloom filters for node i and its neighbors;
2. Select a node j from neighbors of node i randomly
3. Create Update (node i, node j);
4. Create Update (node j, node i);
Create Update (node i, node j)
1. Obtain local bloom filters A_i of node i;
2. U_j=A_i;
3. While (x belongs to neighbors of node i)
4. For r=1 to m
5.   If A_x[r] ==1
6.     U_j[r] =1;
7.   End if
8. End for
9. End while
10. Node i send U_j to node j;
11. Node j constructs routing entry for link j-->i with U_j.
```

The query forward mechanism is tightly associated with the bloom filters corresponding to each link. It is easy to know that queries about data hosted at given peers may be issued at any time from any peer, before the corresponding bloom filters of one given peer propagate over whole p2p network without any information loss. In fact, the protocol may be design to make the information of given source peer decay during the propagate process in order to save bandwidth and make protocol become more scalable, such as [14]. In order to overcome these kinds of information uncertainty, we combine informed forward based bloom filters with random walker. First, current peer make forward decision according to route table. If it works well, it is not need any more compensation. Others, it needs random walker protocol as the assistant forward mechanism. Please refer algorithm3 for detail.

Algorithm 3. Forward Query (node *i*, query *y*):

```
For each neighbor j of node i
  obtain the routing entry A_j for link i-->j;
  If all hash_l[y] bits of A_j equals one,for 0<l<=k
     Deliver Query(Y, i);
End for
If there isn't any neighbor satisfied above condition
  Deliver Query(Y, random neighbor i);
```

4.3 Simulation of Intra-GRD Search Protocol

We use the PeerSim p2p simulator to design and implement our experiments. Peersim was delievered by BISON project[16], and is an open source, Java based, P2P simulation framework aimed to develop and test any kind of P2P algorithm in a dynamic environment.

In this section, we will simulate Gnutella0.4, Random walk, and informed search protocol based bloom filters under random overlay with 5000 nodes. There are multiple instances of the same object at different locations. The model we use for replication of content is based on the zipf distribution, frequently used to model the replication of objects on the web. The ith most popular elementary object of a space will has $1/i^a$ times as many replicas as the most replicated object. In our experiment, the whole the size object space is 50000, the size of elementary object space is 5000, and the parameter *a* used by zipf law is set to be 0.5. The whole queries is 10000, and the distribution of query's payload is also obeyed the zipf law, and the parameter *a* is set to be 0.5. In order to model the data and query distribution among all peers, we use zipf law to model this and embody the popularity distribution of peer.

Performance issues in real p2p systems are extremely complicated. In addition to issues such as load on the network, load on network participants, decay and success rate of query, there are a host of other criteria. In our experiment, we focus on efficiency aspects of algorithms, and use the following simple metrics.

Pr (success): the probability of finding the queried object before the search terminates. Different algorithms have different criteria for terminating the search; it depends on the search semantics. Recall: the ratio between numbers of relevant documents presented to the user to total number of relevant documents in the p2p network. Nodes visited: the number of p2p network participants that a query's search messages travel through. This is an indirect measure of the impact that a query generates on the whole network.

The simulation result of search for all copy (get all the copies of given elementary object) under protocol Gnutella0.4 and our informed search based on bloom filters is illustrated by figure 3. For any query, informed search protocol can obtain high recall without visit large portion of whole peers in order to process the query, while Gnutella-like protocol can obtain relative lower recall with cost of visit large portion of whole p2p network. It is show that informed search based bloom filters can avoid bring huge message copies and blind forward.

The simulation result of search for one copy (get at least one copy of given elementary object) under protocol random walker (the number of walker can be lager upon the degree of peer issued the query) and our informed search based on bloom filters is illustrated by figure 4. For any query, informed search protocol can obtain high Pr (success) compare to random walker with the same ration of visited peers to whole network. When there are multiple instances distributed randomly among whole

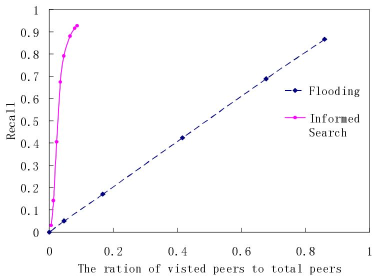

Fig. 3. The ration of visted peers for one query to total peers vs. recall

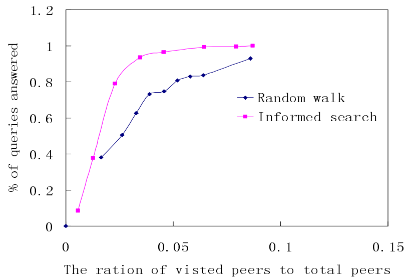

Fig. 4. The ration of visted peers to total peers vs. % of queries

peers for any elementary object, the Pr (success) of both kinds of protocol cans almost 1 after visiting peer less than 10% of whole network. It is also explained that informed search based bloom filters possesses advantage than blind search.

The overhead of our informed search protocol is the need to exchange information between peers at given gossiping rate. This operation can merge with the stabilize operation of neighbor ship. Furthermore, the transmit size can become small by adopting bloom filters and compressed bloom filters.

5 Conclusion

During the research process of the grid resource space model, we find that it is difficult to keep the availability of the grid physical resources during the running phase, and grid application should build on the logical resources other than the physical resources. The grid resource space model presented in this paper can deal with that problem mentioned above, and can be used to realized the service virtualization model. The basic idea of our resource locating protocol, which based on the grid resource space division and grid resource domain, is to control the topology of the grid resource locating system and the distribution of resources registration information. Our protocol try to instruct any query messages with information about grid logical resource to be forwarded to corresponding grid resource domain without unnecessary message, and also present a informed search protocol based bloom filters used to locate grid resources within any grid resource domain. The grid resource locating mechanism possesses good expansibility and robustness. If it is companied with proper guide for the action of resource registration, it can respond the query message using grid logical resource as part of payload more quickly. The information service of Spatial Information Grid (SIG) [17] adopts the resource locating protocol based on the grid resource space model. The information service has been applied and popularized in National Geography Grid (NGG) project [18].

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