

## **The Bio-Networking Architecture Bi-weekly report #2 (June 24, 2002): Distributed Discovery**

PI: Tatsuya Suda (suda@ics.uci.edu)  
University of California, Irvine  
<http://netresearch.ics.uci.edu/bionet/>

### **Introduction:**

Networking technology is experiencing growth in peer-to-peer and wireless applications, resulting in the need for scalable, adaptable, survivable, and always-available network applications. These applications are characterized by dynamic availability and location of a variety of objects (including users, information, and applications) within the network. The PI believes that the Bio-Networking Architecture, the new network application architecture currently being investigated with support from DARPA, provides a framework capable of generating scalable, adaptable, survivable, and always-available network applications.

A key requirement for supporting objects within distributed network applications is the ability to discover the location of objects that are distributed throughout the network. The PI has developed two distinct discovery mechanisms to meet the requirements of distributed network applications. In both discovery mechanisms, objects contain relationships (links or pointers) to one another. These relationships form a network on which discovery queries are forwarded. Each object also contains a set of keywords that describe the contents of the object. Relationships of objects also include information (e.g., keywords) regarding the relationship partner, providing a mechanism to guide discovery queries.

### **New Achievements:**

In the area of discovery mechanisms, the PI has recently published works regarding the current design and efficiency of the proposed discovery mechanisms:

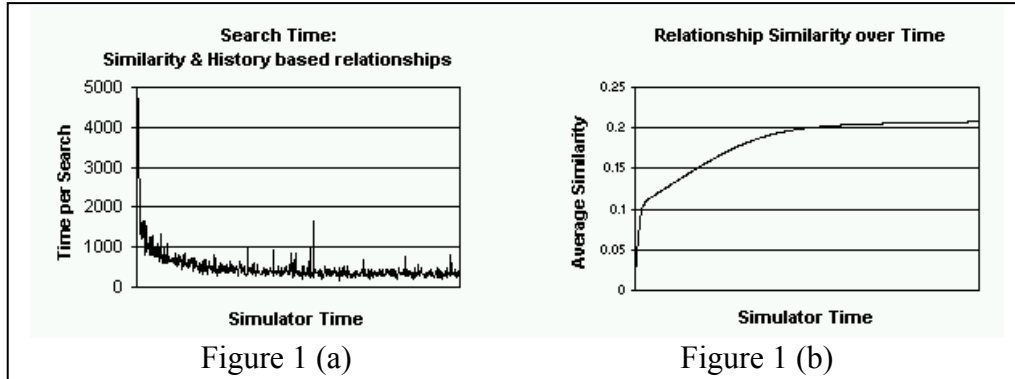
- In a paper entitled “A Decentralized and Self-organizing Discovery Mechanism” at the First Annual Symposium on Autonomous and Intelligent Networked Systems Symposium [MS02],
- In a master’s thesis entitled “Community Based Discovery in Peer to Peer Networks” [Eno02], and
- As a book chapter entitled, “Discovery In The Bio-Networking Architecture,” [TS02].

A discovery simulator has been designed and implemented, and simulations have been performed for design of the proposed discovery mechanisms and for evaluation of the characteristics and performance of the discovery mechanisms.

### **Discovery Using Strength and History**

In the first discovery mechanism, keyword-similarity and discovery history guide discovery. Keyword-similarity represents the degree of similarity between two objects and is defined as the ratio of keywords that are in common between an object and its relationship partner. Relationship history summarizes information on how a relationship partner performed in discoveries in the past and is defined as the ratio of successful discovery queries on a relationship relative to all the discovery queries forwarded on that relationship. Keyword similarity and relationship history are used at each object to determine which relationships have priority in forwarding discovery queries. A query is forwarded with greater priority to objects that are more similar to a query and for objects that are equally similar, history is used as a secondary priority.

This discovery mechanism has been evaluated through simulations. Simulations demonstrate that including both keyword similarity and discovery history in the relationships of objects improves discovery performance. Figure 1 (a) shows the improvement of search time as the time progresses, and Figure 1 (b) correlates this improvement to increased relationship similarity.

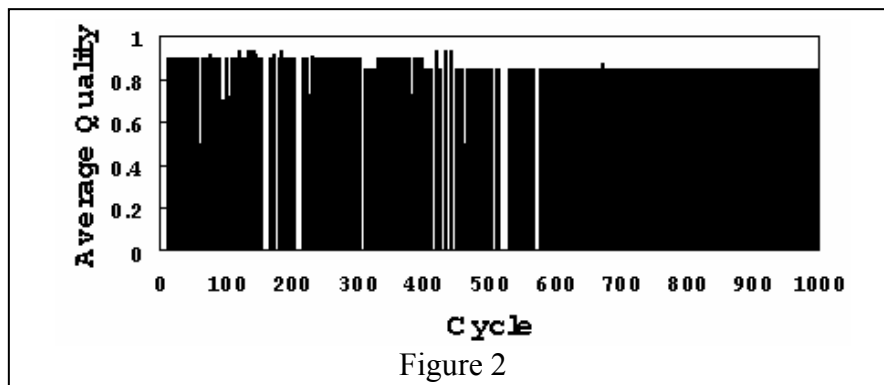


### Discovery Using User Evaluation

In addition to the discovery mechanism based on keyword similarity between objects and relationship history of objects (i.e, the discovery mechanism described in the section above), the PI has developed another discovery mechanism that guides discovery through user's (i.e., discovery originator's) evaluation of the received discovery hits. (For instance, a user may prefer discovery hits from a reputable web site to discovery hits from an unfamiliar web site.) User evaluation is defined as the user's degree of satisfaction with the returned hit, and allows the user to reward better hits from the discovery hits the user receives. This allows subsequent discoveries to obtain hits with greater user evaluation, and therefore users are likely to have greater satisfaction with these discovery hits.

In the discovery mechanism using user evaluation, each relationship is associated with one or more keywords, and for each keyword, a strength value is also associated. Keyword strength represents the usefulness of the relationship in discovering an object that contains the given keyword and satisfied many users. In the proposed discovery mechanism, both the new keywords added to relationships and the strength values of the keywords are adjusted based on user evaluation. After a user has received discovery hits, the user's evaluation is forwarded along the same path that the discovery hit returned along. Over time, the keyword strength of a relationship represents how useful the relationship was at discovering an object that contained the given keyword and also satisfied many users.

Figure 2 shows how the discovery mechanism using user evaluation improves the average user evaluation of hits over time. Currently, simulations are being conducted to further evaluate this discovery mechanism.



## Reference

- [TS02] T. Suda, T. Ito, M Matsuo, “The Bio-Networking Architecture: The Biologically Inspired Approach to the Design of Scalable, Adaptive, and Survivable/Available Network Applications,” *The Internet as a Large-Scale Complex System*, Ed. K. Park, 2002.
- [MS02] M. Moore and T. Suda, “A Decentralized and Self-organizing Discovery Mechanism,” *Proc. of the First Annual Symposium on Autonomous Intelligent Networks and Systems*, May 2002. [[netresearch.ics.uci.edu/bionet/publications/discovery\\_ains.pdf](http://netresearch.ics.uci.edu/bionet/publications/discovery_ains.pdf)]
- [Eno02] A. Enomoto, “Community Based Discovery in Peer to Peer Networks,” master thesis, Kyoto University, March 2002. [[netresearch.ics.uci.edu/bionet/publications/enomoto\\_master\\_thesis.pdf](http://netresearch.ics.uci.edu/bionet/publications/enomoto_master_thesis.pdf)].