Improved Network Navigability and Service Search in Social Internet of Things (SIoT)

A.Meena Kowshalya, Dr. M. L. Valarmathi

Department of Computer Science and Engineering, Government College of Technology, Coimbatore

***Abstract*: The Internet of Things is populated by huge number of objects requiring extreme heterogeneous communication solutions. The Paradigm of combining Social Networks into the Internet of Things has led to what is known as Social Internet of Things (SIoT). Though very little research has been done in SIoT, this area has opened numerous applications possible such as smart city, intelligent transportation and Smart grids. This paper introduces the Social Internet of Things and addresses strategies for network navigability. The basic network properties like average path length, clustering coefficient and average degree of connections are analyzed for analyzing the overall network navigability. The experimental results shows that the SIoT network is navigable how much ever huge the network is.**

Keywords: Internet of Things (IoT), Social Internet of Things (SIoT), Network Navigability, service selection

I. INTRODUCTION

The Internet of Things integrates large number of objects together to achieve desired task about the physical worlds. IoT has many visions and one such revolutionary concept is integrating Social Networks into IoT. The IoT and Social Networks put together is known as Social Internet of Things (SIoT). In a Slot environment, objects are not only smarter but also socially conscious and socially aware. Slot is defined as collection of socially aware smarter objects [1]. the main challenge in Slot environments is searching for a specified service with increased number of objects. The network traffic, number of queries and the search space are increasing enormously [2]. A Slot environment is the first shift from human to object interaction to object to object interaction. [3] proposes the mechanisms about how objects in SIoT communicate with each other. Numerous researches have been proposed for search of service in IoT [4,5] but these are centralized in nature. With the highly distributive nature of IoT and Slot these approaches cannot be directly used. A SIoT network possesses objects that discover service from other objects using its relationships in a distributed manner. The main idea of navigation was from [6]. and [7] concluded that humans can find shortest path without knowledge of global network. Every object in Slot network need to store and manage its own information, its friends and friends of friends for efficient communication. [1, 8] addressed many issues related to network navigability and friendship selection. Objects can also be clustered according to their behaviors. [14] presented various ways to cluster heterogeneous WSN The same approach in an extended manner can be used in SIoT. The number of relationships and the usefulness of a service or friendship vary from object to object. Which friend to trust is another important parameter for reliability of communications? The main contributions of the paper are the following:

1. Using three heuristics namely average path length, clustering coefficient and average degree of connections based on network properties to rank nodes in descending order and analyze network performance
.
2. Checking and estimating for the navigability of the network.

The rest of the paper is organized as follows: Section 2 presents the related work, Section 3 presents the heuristics for analyzing SIoT network performance, Section 4 checks whether the network is navigable, Section 5 presents the experimental results followed by Conclusion.

II. RELATED WORK

In SIoT many forms of socialization of objects occur and many types of smart objects exists [3]. In [3], the authors classify smart objects as

- Activity aware smart objects
- Policy aware smart objects
- Process aware smart objects

Activity aware smart objects can record information about work activities and its own use. Policy aware smart objects interpret events and activities with respect to predefined organizational policies. Process aware smart objects understand the organizational processes and provide workers with context-aware guidance about tasks, deadlines, and decisions. Any object simply connected to the Internet need not be a smart object. [1] achieve network navigability of a SIoT network where objects inherit some capacities of humans and mimic their behavior. This paper derives the foundational aspects of network navigability from [1]. [8] presents the methodology to efficiently discover and search services from neighboring objects. Very few works have been done for service search and discovery.

[11, 12] showed that relationship devised for SIoT follow the ones studied in sociological fields. The objects thus create and manage several kinds of relationships and use them to navigate a network. The aspects of network navigability were studied years ago. [9, 10] showed the conditions for network navigability stating the existing of a giant component and low effective diameter. In general, the largest distance between any pair of nodes should not be > log (N) where N is the number of nodes in the network.
Selection criteria of network links:

1. A nodes accpects all the requests it eceives until a maximum threhold NH.
2. A node sorts its friends according to its degree and computes friends with the lowest and highest degree inorder to maximize and minimize average degree of friends.
3. A node sorts its according to the number of their common friends and compute nodes that possess minimum and maximum frinds inorder to adjust its local clustering coefficient.

Based on these startegies a node computes its friends and selects neighbouring paths.

III. EXPERIMENTAL RESULTS

To simulate a SIoT environment, SWIM (Small Worls in Motion) simulator was used. In order to predict human behaviour since in SIoT objects mimic human behaviour the Epinions dataset were modified to produce events. The Epinions dataset consiting of 3999 nodes were used for simulaion purposes. Table 1 shows the parameters for Epinions dataset. To dervice the properties of the social network for the Epinions dataset Node XL was used.

Description	Epinions dataset	Brightkite dataset
Nodes	3999	2999
Number of edges	13456	11786
Average Path Length	4.243	3.124
Average Clustering Coeeficient	0.213	0.202
Average degree	5.97	4.89
Giant component	85.67%	83.45%

Table 1 Properites of Epinions and Brightkite dataset

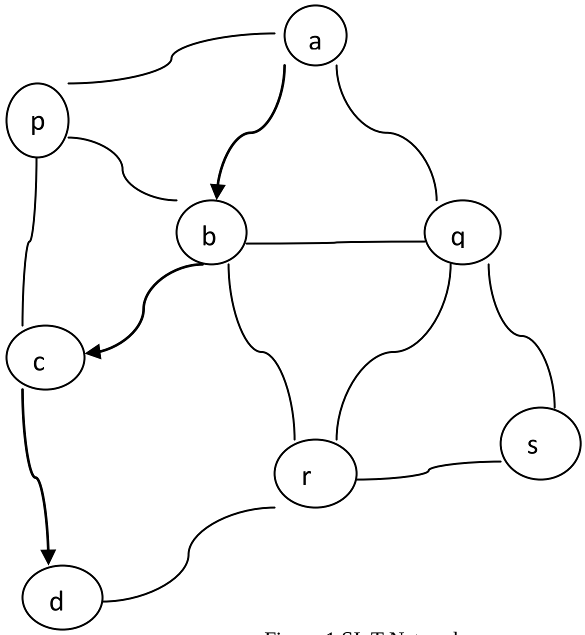

Figure 1 SIoT Network

Figure 1 provides a simple example of a SIoT network, where links represent friendship ties while the pointed arrow line is the best route for node ‘a’ to reach the requested service ‘d’. In this network, when node ‘a’ needs a particular service, it does not send a request to a centralized search engine, but it uses its own friendships to look for, in a decentralized manner, a node with the desired service, by contacting its friends and the friends of its friends. In this scenario, we aim to evaluate the impact of several strategies for link selection in order to select an optimal set of friendships to limit the use of computational resources needed for the search operations.

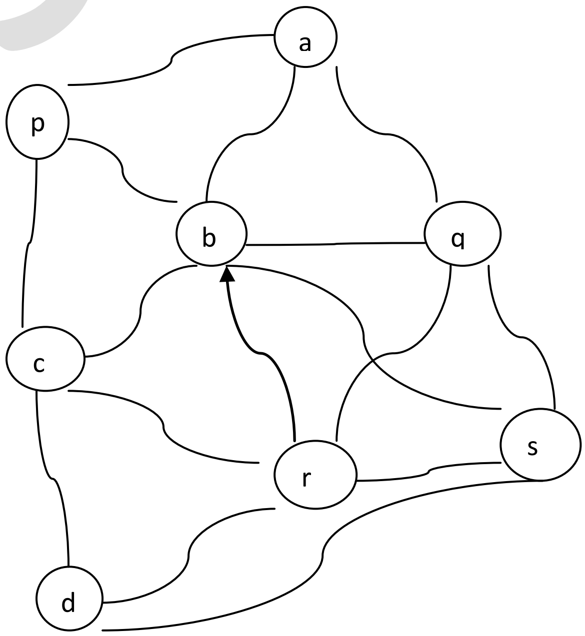

Figure 2 Service search and selection

Let us consider a network example, as shown in Figure 2, where the maximum number of connections is set to N_{max} = 4 and let us suppose that node ‘r’ sends a friendship request to node 'b' Since node 'b' has already reached N_{max} connections, the decision on this request will depend on the implemented strategy. If node 'b' implements strategy 1, it will simply refuse the request; with strategy 2, node 'b' checks the degree of all its friends and of node 'r' and then it terminates the relationship with node 'p', which has only one more friend, in order to accept the request from node 'r' (4 friends). In the same way, using strategy 3, node 'r' terminates the relation with node 's', which has N_{max} connections, and accepts the request.

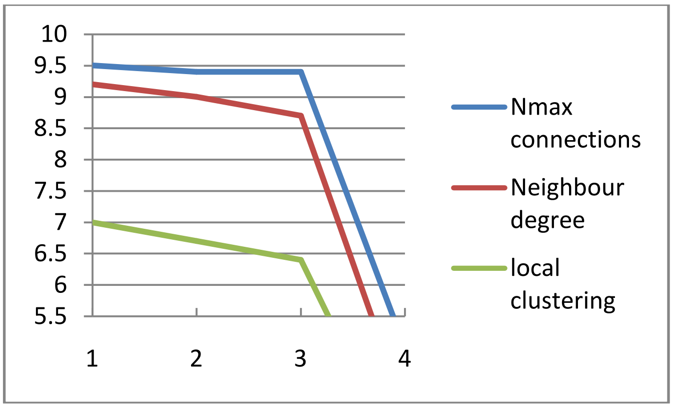

Figure 3 Average degree

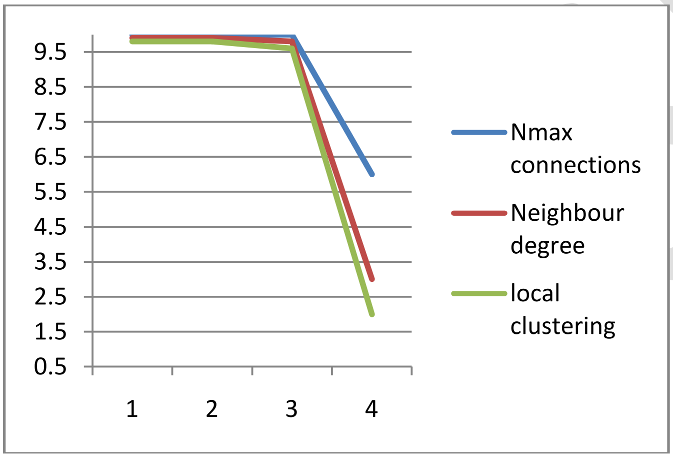

Figure 4 Giant Component

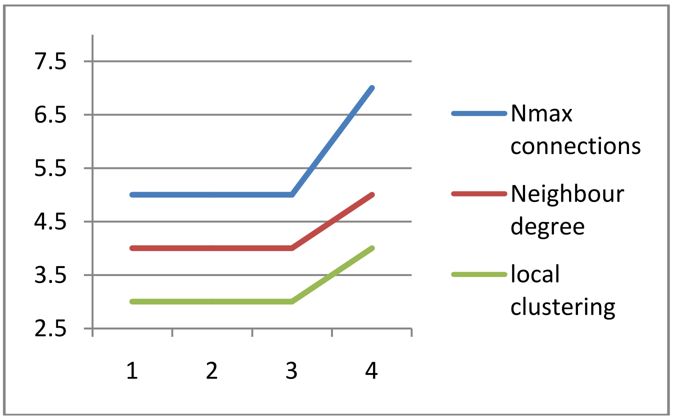

Figure 5 Local Clustering Coefficient

The simulation results shows that the SIoT network is completely navigable and efficient service search and selection is assured by using the three selection criteria discussed.

IV. CONCLUSION

This paper has addressed link selection and network navigability in SIoT. Three strategies namely average path length, clustering coefficient and average degree were used as heuristics for link selection as they have primary impact on network navigability. All these approaches have a better local navigability and in the future more powerful friendship selection strategies can be used.

REFERENCES

[1]. M. Nitti, L. Atzori, and I. P. Cvijikj, "Network navigability in the social internet of things," in Internet of Things (WF-IoT), 2014 IEEE World Forum on , March 2014, pp. 405–410

[2]. D. Zhang, L. Yang, and H. Huang, "Searching in internet of things: Vision and challenges," in Parallel and Distributed Processing with Applications (ISPA), 2011 IEEE 9th International Symposium on , 2011, pp. 201–206.

[3]. L. Atzori, A. Iera, G. Morabito, and M. Nitti, "The social internet of things (siot)–when social networks meet the internet of things: Concept, architecture and network characterization," Computer Networks , vol. 56, no. 16, pp. 3594–3608, 2012

[4]. B. Ostermaier, K. Romer, F. Mattern, M. Fahrmair, and W. K ellerer, "A real-time search engine for the web of things," in Internet of Things (IOT), 2010, pp. 1–8.

[5]. K.-K. Yap, V. Srinivasan, and M. Motani, "Max: human-centric search of the physical world." in SenSys ACM, 2005, pp. 166–179

[6]. J.Travers, S. Milgram, J. Travers, and S. Milgram, "An experimental study of the small world problem," Sociometry , vol. 32, pp. 425–443,1969.

[7]. J. Kleinberg, "Navigation in a small world," Nature , vol. 406, p. 845, 2000.

[8]. M. Nitti, L. Atzori, and I. P. Cvijikj," Frienship Selection in the Social Interent of Things: challenges and possible strtegies", IEEE Interent of Things, Vol 2, Issue: 3, pp:240-247, 2015.

[9]. M. Bogu, D. Krioukov, and k. claffy, "Navigability of Complex Networks," Nature Physics, vol. 5, no. 1, pp. 74–80, Jan 2009.

[10]. L. A. N. Amaral and J. M. Ottino, "Complex networks. Augmenting the framework for the study of complex systems," European Physical Journal B, vol. 38, pp. 147–162, March 2004.

[11]. L. E. Holmquist, F. Mattern, B. Schiele, P. Alahuhta, M. Beigl, and H.-W. Gellersen, "Smart-its friends: A technique for users to easily establish connections between smart artefacts," in Proceedings of the 3rd international conference on Ubiquitous Computing, ser. UbiComp '01. Springer-Verlag, 2001, pp. 116–122.

[12]. J. Kleinberg, "Small-world phenomena and the dynamics of information," in In Advances in Neural Information Processing Systems (NIPS) 14. MIT Press, 2001, p. 2001.

[13]. A.MeenaKowshalya, Dr.M.L.Valarmathi, "Secure and Efficient Ciphertext Policy Attribute Based Encryption without key Escrow Problem", International Journal of Emerging Engineering Research and Technology, vol.2, no.2, pp:126 - 130, 2014.

[14]. A.MeenaKowshalya, A.Sukanya, "Clustering Algorithms for Heterogeneous Wireless Sensor Networks–A Brief Survey", International Journal of Ad hoc, Sensor & Ubiquitous Computing (IJASUC),vol.2, 2011.