An Agent System for Recovering Disabilities in the Ubiquitous Environment

Sang-Bin Park[†], Won-hyuk Lee[††], Byeong-Yeon Park[††] ,Sung-jin Ahn[†], and Jin-wook Chung[†††]

[†] Dept. of Computer Eng., Sungkyunkwan Univ., Korea
[††]R&D Network Management, KISTI, Korea
[†††]School of Infor. and Comm Eng., Sungkyunkwan Univ., Korea

Summary
The network is gradually becoming more sophisticated as the ubiquitous computing technology allows one to freely access or to create a network regardless of time and place. Given such environment, there is a need for a system that can prove the quality of self-management/administration for network disabilities by installing an agent that can take measures against network disabilities to each digital device in order to apply the quality of self-management/administration that does not require human intervention by attempting to identify the status that varies according to time and place through sensing and tracking as computers are present in every aspect of our lives.
Since the existing systems perform each procedure in a sequential manner, it is difficult to detect the characteristics of disabilities and therefore the consequent diagnosis and recovery are very difficult. Also, there are constraints when a system tries to determine the network organizational disabilities of its own. In other words, it is difficult for a system to determine its own internal or external network status. Therefore, communications between various agents that are scattered in the network are required in order to accurately identify the causes of such disabilities so that these network organizational disabilities can be recovered.
Hence, this research paper proposes a method that not only diagnoses disabilities but also a system that effectively recovers them by accurately identifying the status of the internal or external network that cannot be identified by the system itself through an organic collaboration with all available agents at any place and any time, supported by the ubiquitous computing technology..

Key words:
Network Disability Diagnosis System, Self-Recovery. Network Disability Diagnosis System, LODES,

1. Introduction

The term ‘ubiquitous’, first used in 1988 by Mark Weiser of American office photocopier producer Xerox, is a Latin word for ‘existing everywhere at every time’, which is a modern term for an environment in which a user is able to freely connect to any network with any computer regardless of where he is or when it is.

The ubiquitous computing technology that allows anyone to access any form of network from any place at any time has emerged into the spotlight. [1] In the ubiquitous computing environment, computers, integrated with digital devices, use sensing and tracking to identify the status that changes according to time or place so that they self-manage and restore without human intervention. [2] As the network becomes vaster and more sophisticated, it would heavily burden network service providers or companies with large networks in terms of management costs and personnel supply if all disabilities of the network had to be monitored and repaired entirely by a human administrator. As of current, expert systems, which have an accumulated professional knowledge regarding disability management, detection, and repair, provide such services. [3]. However, not only is this method unable to satisfy the characteristics of the ubiquitous computing environment but it also possesses restrictions when it comes to identifying every status details of professional systems or networks thereby limiting its own roles. [3, 6, 7, 8]

Furthermore, it is even more difficult to accurately detect the causes of network organizational disabilities of a system. This is because for a system’s network organizational disability, it may have a variety of causes but its symptoms may be identical to some other disability. For instance, one cannot claim that a system’s network organizational disability is accountable when the Internet does not work. This is because such disability may be caused by many different causes such as network failure,

Manuscript received August 5, 2007
Manuscript revised August 20, 2007

system's network interface error, or failure of the network device that collectively forms the network. [5]

Therefore, there are constraints when a system tries to self-detect its own network organizational disability. Consequently, it is difficult for a system to determine, by itself, the status of an internal or external network. With this said, there needs to be collaborative communications between various agents spread around the network in order to accurately identify and recover such network's organizational disabilities.

Hence, this research paper would like to propose a method that not only diagnoses disabilities but also a system that effectively recovers them by accurately identifying the status of the internal or external network that cannot be identified by the system itself through an organic collaboration with all available agents at any place and any time, supported by the ubiquitous computing technology
Chapter 2 of this paper introduces the LODES system, which is a prime example of the existing network issue analysis systems. Chapter 3 introduces a collaborative model between agents in the ubiquitous environment and the network disability recovery regulation model. Finally, Chapter 4 summarizes the system proposed in this paper and discusses prospective plans.

2. Related Studies

2.1 Network Disability Diagnosis System

There is a need for a self-recovery system that can diagnose and recover, on its own, network disabilities in each configured network. Such self-recovery technology identifies and analyzes the current status information such as the current location, time, surrounding network status, and user activity and task history to self-detect and recover errors. Currently, there are professional disability diagnosis systems that automatically and efficiently support network management. Professional disability diagnosis systems analyze a disability that occurs in a system and perform an automatic diagnosis and recovery of the disability by using the database containing accumulated knowledge of skilled network administrators.

2.2 LODES (Large Internetwork Observation and Diagnostic Expert System)

The LODES (Large Internetwork Observation and Diagnostic Expert System) is a professional disability diagnosis system that diagnoses disabilities within vast internetworks. This is a system that diagnoses disabilities that occur in complex and irrational network environments based on the professional knowledge of TCP/IP-related problem solving.

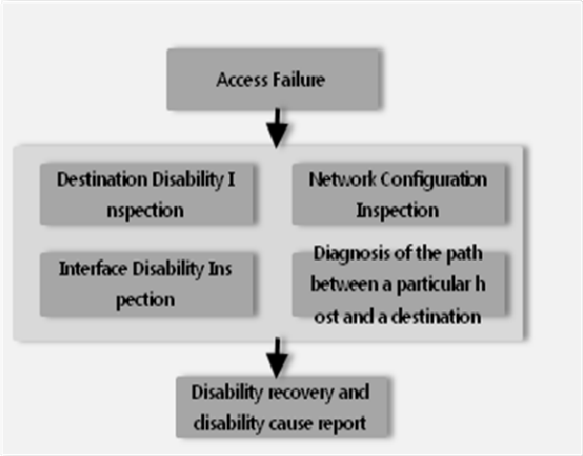
Unlike other typical systems, this system pursues active diagnosis. However, one of its drawbacks is that the network administrator has to directly access the equipments when a problem arises in the host. [6]

3. Disability recovery among agents in the Ubiquitous Environment

In ubiquitous computing, every device can analyze and identify the information extracted from the many devices within the sensor network. Here, the professional disability diagnosis system is installed to each device so it can perform the self-recovery function. However, most network issues are generated by the environmental elements of the network rather than issues with the system itself. Therefore, the existing professional disability management systems such as LODES cannot effectively perform self-recovery. Thus, this research aims to analyze the causes of and repair network disabilities through collaboration with the many devices within a network as it is the strength of ubiquitous computing. Such method can enhance the credibility of network disability analysis and it can help concentrate on solving network disabilities by allowing room for device control. For example, when a device finds itself unable to communication with a device in another network through a router, it can request its nearby devices to test if they can communicate with the particular device at the other end so that it can determine if the communication failure is its problem or if there's a problem with an element in the network. Such acquired status information can be utilized in recovering network disabilities.

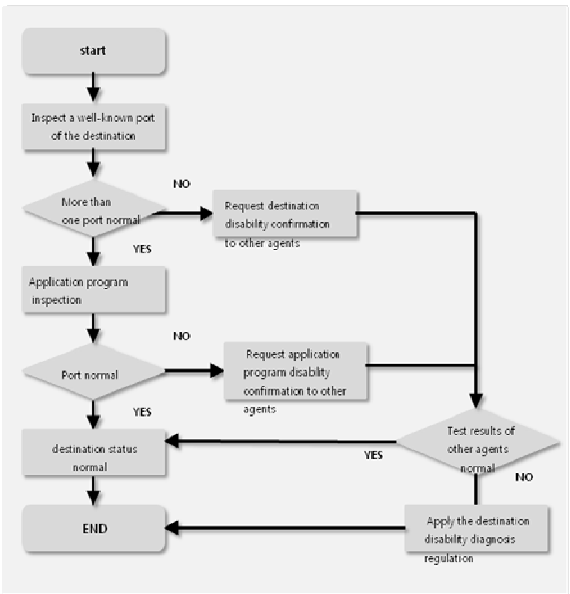
3.1 Agent Disability Inspection Module

An agent is installed in all digital devices to detect any malfunctioning of the system, monitor the status of the LAN that the system is a part of, and regularly send back and forth information with other agents in order to verify that the network connection is in normal operation.
Detecting an agent's disability is triggered when access to an arbitrary sector of the network fails and the orientation of the entire model is as follows.



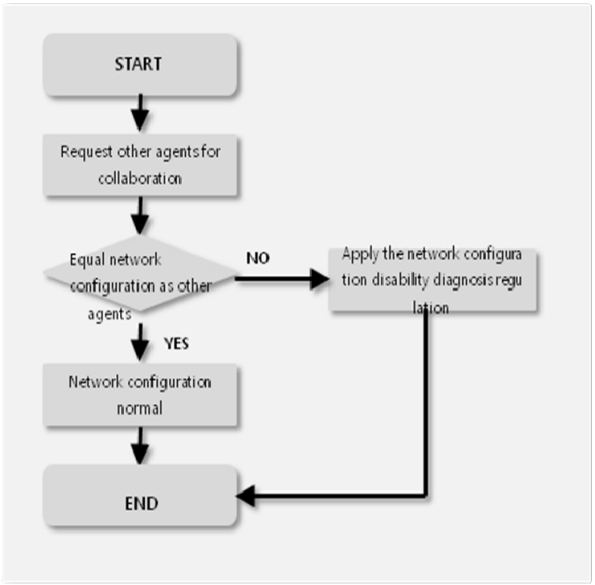
[Figure 3.1] Orientation of the Entire Module

A) Destination Disability Inspection
A common cause of destination disabilities, destination failure, is diagnosed with a well-known port and the application program of the destination is diagnosed by the port that the particular application program uses. The local agent's host first tests the functionality of each well-known port excluding the application program port and when no abnormalities are detected, it then inspects the application program port. When there is a problem in the test results, other agents provide help and the diagnosis regulation is applied to recover the disability according to the feedbacks of the other agents.



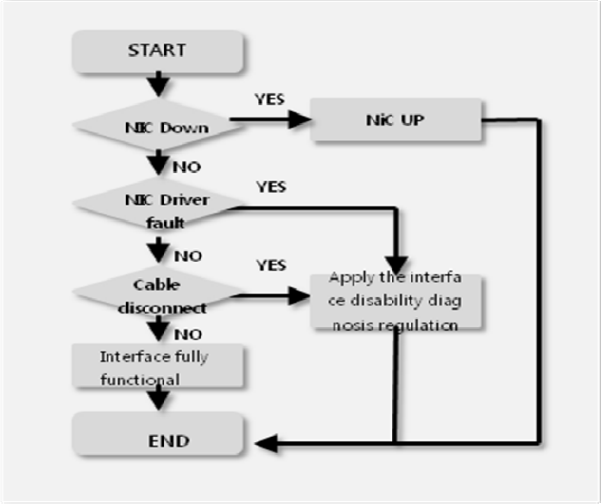
[Figure 3.2] Destination Disability Diagnosis Algorithm

B) Network Configuration Inspection
Network configuration issues commonly occur due to network configuration errors in the IP, Subnet Mask, DNS, or Default Gateway. Such network configuration errors are detected by requesting help to other agents within the same network and comparing the network configuration with that of a fully operational agent and then applying the appropriate diagnosis regulation for recovery.



[Figure3.3] Network configuration disability diagnosis algorithm

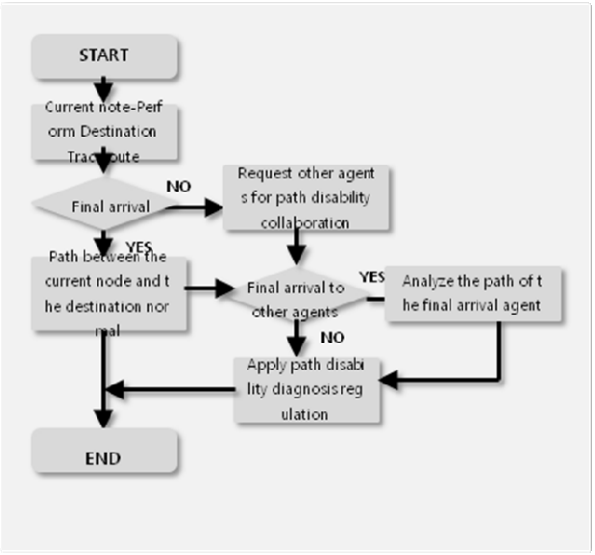
C) Interface Disability Inspection
Problems occur in an interface due to malfunctioning network devices or a connection failure of the interface. When an interface disability occurs, it must be reported to the network administrator or the user for a prompt recovery.



[Figure 3.4] Interface disability diagnosis algorithm

D) Diagnosis of the path between a particular host and a destination

Path disability between a host and a destination may occur due to a malfunctioning circuit of the network, a malfunctioning network device that lies in the path such as a switch or router, or a failure along the path caused by the routing protocol. When a disability occurs between the two, the sector with the disability must be reported to the network administrator for a prompt recovery.



[Figure 3.5] Path disability diagnosis algorithm

4. Conclusion

This research paper proposed a regulation-based disability recovery agent that self-diagnoses and recovers network disabilities according to the nature of self-regulation of each device in the ubiquitous environment. Also, since it is difficult for a single agent to resolve external issues such as network organizational disability, a collaborative disability recovery model that cooperates with other agents has been proposed.

Network disabilities such as network device failures or internal issues that could not be fixed by the existing systems can now be diagnosed and recovered through this method. Also, through collaborative efforts between each agent, the system can flexibly respond to various network disabilities and actively adapt to changing network environments.

However, devices in the ubiquitous environment, mostly small, have weak processing abilities along with a relatively smaller memory size. Based on this, there is a need for a method that can effectively diagnose and recover network disabilities. Therefore, post to this research, we plan on conducting a research on how to maximize the efficiency of collaboration between agents and on how to effectively apply the network disability diagnoses regulation.

References

[1].B. N. Schilit, “Context-aware Computing Applications,” in Proc. of IEEE Workshop on Mobile Computing Systems and Applications, 1994.

[2].The ubiquitous service-oriented network (USON)-an approach for a ubiquitous world based on P2P technology Takemoto, M.; Sunaga, H.; Tanaka, K.; Matsumura, H.; Shinohara, E.; Peer -to-Peer Computing, 2002. (P2P 2002). Proceedings. Second International Conference on 5-7Sept. 2002

[3].Kang Hong Cho, Seongjin Ahn, Jin Wook Chung, Rule-based Agent system for Fault Detection and Location on LAN, KIPS, vol. 7-7 pp.2169-2178, 2000

[4].Kohei Ohta, Takumi Mori, Nei Kato, Hideaki Sone, Glenn Mansfield, Yoshiaki Nemoto, Divide and Conguer Technique for network Fault Management, Proceedings of ISINM97, 1997

[5].Taein Hwang, Seongjin Ahn, Jin Wook Chung, A study on the rules and algorithm for the diagnosis and recovery of routing configuration, SCI 2000, World Multiconference on Systemics, Cybernetics and Informatics 4(2000) 137-141

[6].T. Sugawara, Acooperative LAN diagnosistic and observation expert system, computers and communications, Proceeding of the Ninth Annual International Phoenix Conference, 1990, pp. 667-674.

[7].Taein Hwang, Seongjin Ahn, Jin Wook Chung, Design and Implementation of Rule-Based network Configuration Fault Management System, Thesis of master's course, Sungkyunkwan Univ.
[8].J.-M. Yun,, S.-J. Ahn, J.-W. Chung, Web Server Fault Diagnosis and Recovery Mechanism Using INBANCA, 2000, PP. 2467-2504.
[9].K. Ohta, T.Mori, N.Kato, H.Sone, G.Mansfield, Y.Nemoto, Divideand Conquer Technique for network Fault Management, Proceedings of ISINM97, 1997
[10].Yunseok jang, Seongjin Ahn, Jin Wook Chung, RBR Based network Fault Detection and Recovery System using Agent Collaboration, ICOIN, 2003
[11].Kwang Jong Cho, Seongjin Ahn, Jin Wook Chung, RBR Based network Configuration Fault Diagnosis Algorithm using Agent Collaboration, Thesis of master's course, Sungkyunkwan Univ.
[12].Zheng, S.Q.; Sun,M.; Constructing Optimal Search Trees in Optimal Time; Computers, IEEE Transactions on , Volume: 48 , Issue: 7 , July 1999, Pages:738-748
[13].Kato, K., Persistently Cashed B-trees, IEEE Transactions on, Volume: 15, Issue: 3, May-June 2003, Pages 706-720.
[14].Pan Aihuam, Lku Chuntu, Real Time Analysis on Expert Systems, Proceeding of the 3rd World Congress on Intelligent Control and Automation, 2000
[15].H. Weatherspoon, T. Moscovitz, J. Kubiatowicz. “Introspective Failure Analysis:voiding Correlated Failures in Peer-to-Peer Systems”, Proceedings of International Workshop on Reliable Peer-to-Peer Distributed Systems, Oct 2002.
[16].G.M. Lohman, S.S. Lighstone, “SMART: Making DB2 (More) Autonomic”, Proc. 28th VLDB Conf., Hong Kong, China, 2002.
[17].R. Sterritt, “Towards Autonomic Computing: Effective Event Management”, Proceedings of the 27th Annual IEEE/NASA Software Engineering Workshop, Greenbelt, MD, Dec. 2002.
[18].L.D. Paulson, "IBM Begins Autonomic Computing Project", IEEE Computer, Feb., p25, 2002.
[19].A. Wolfe, "IBM sets its sights on ' Autonomic Computing' ", IEEE Spectrum, Jan., p18- 19, 2002
[20].E. Mainsah, "Autonomic computing: the next era of computing", IEE Electronics Communication Engineering Journal, Vol. 14, No. 1 (Feb), pp2-3, 2002