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EFFICIENT DISCOVERY PROTOCOL FOR UBIQUITOUS COMMUNICATION IN WIRELESS ENVIRONMENT

JAVAD ZARRIN

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EFFICIENT DISCOVERY PROTOCOL FOR UBIQUITOUS COMMUNICATION IN WIRELESS ENVIRONMENT

By

JAVAD ZARRIN

Thesis Submitted to the School of Graduate Studies, University Putra Malaysia, in

Fulfillment of the Requirement for the Degree of Master of Science

June 2009

UPM

To

My beloved father and mother

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

EFFICIENT DISCOVERY PROTOCOL FOR UBIQUITOUS COMMUNICATION IN WIRELESS ENVIRONMENT

By

JAVAD ZARRIN

June 2009

Chairman: Mohd Fadlee A Rasid, PhD

Faculty: Engineering

Nowadays, according to the advances of the wireless network technologies and also mobile computing devices the concept of ubiquitous computing environments has become a considerable research area. Ubiquitous computing environment means an environment which is saturated by elements or devices with capacities of computing and communication. So, there are a lot of ways to develop and employ applications in such environment as infrastructure, but the most effective and general one is using service advertisements, service discovery and service remote invocation.

In an Ad-hoc network which its devices make an ubiquitous computing environment, every device as a server node can announce various applications as services in the environment and at the same time every device is able to listen to the network interface and be aware of surrounding services and invoke the remote services.

A mechanism which is needed to recognize surrounding services is called service discovery, this mechanism also clears how to advertise services, and invoke them. Type and method of discovery procedures play the critical role in quality and efficiency of services in ubiquitous environments. Because of these properties (small and mobile) there is a serious limitation for the resources of devices specially power resource. The problem is that the most of service discovery protocols are not effective for wireless Ad-Hoc networks and ubiquities environments, efficiency in case of service quality and power consumption.

In this research a new mechanism and algorithm is designed to improve current wireless service discovery protocols. Analysis of the results has shown that the designed mechanism in most of the comparative parameters such as speed of service delivery, power consumption, and coverage of the services will act much better than the current discovery protocols.

The proposed solution is compared with (directory based and directory-less based) of discovery protocols in ubiquitous environment in three states: mobile nodes, mobile and static nodes, and static nodes. It can be derived that the proposed model obtains fewer messages around 52% while maintain the same rate of service discovery and false rate of service discovery. The reduction of the number of posts per request coupled with the fact that devices with greater time availability transmit more responses in the proposed model, it can be concluded that energy consumption in devices with more restrictions will be decreased.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

PENEMUAN PROTOKOL YANG BERKESAN UNTUK KOMUNIKASI TANPA HAD DALAM PERSEKITARAN WAYARLES

Oleh

JAVAD ZARRIN

Jun 2009

Pengerusi: Mohd Fadlee A Rasid, PhD

Fakulti: Kejuruteraan

Pada masa kini, konsep perkembangan teknologi jaringan tanpa wayar dan peranti perkomputeran mudah alih di dalam persekitaran perkomputeran biasa berkembang di dalam bidang penyelidikan. Persekitaran perkomputeran biasa bermaksud persekitaran yang tepu dengan elemen atau peranti yang berkapasiti untuk perkomputeran dan komunikasi.

Oleh itu, terdapat berbagai cara untuk membangun dan mengguna aplikasi di dalam persekitaran ini sebagai infrastruktur, tetapi yang paling efektif dan umum adalah penggunaaan dalam perkhidmatan pengiklanan, penemuan baru dan bantuan jarak jauh. Di dalam jaringan ad-hoc dimana perantinya adalah biasa di dalam persekitaran perkomputeran, setiap peranti bertindak sebagai nod server boleh menyiarkan berbagai bentuk aplikasi sebagai persekitaran di dalam servis dan pada masa yang sama setiap

peranti boleh berinteraksi dengan jaringan antara fasa dan prihatin dengan perkhidmatan persekitaran dan membantu perkhidmatan mudah alih.

Mekanisma yang diperlukan untuk mengenali perkhidmatan persekitaran di namakan penemuan perkhidmatan, dan mekanisma ini juga memperjelaskan bagaimana untuk mengiklan perkhidmatan dan membantu mereka. Jenis dan kaedah prosedur penemuan memainkan peranan penting di dalm kualiti dan kecekapan perkhidmatan di dalam persekitaran umum. Walaubagaimanapun, kebanyakan peranti di dalam persekitaran perkomputeran adalah kecil dan mudah alih dan kerana ini terdapat had di dalam sumber peranti terutamanya sumber kuasa tenaga.

Pada masa ini, terdapat berbagai teknik dan protokol berbeza untuk perkhidmatan penemuan dimana pada umumnya adalah mekanisma tolak dan tarik. Walaubagaimanapun, masaalah kebanyakan protokol adalah ianya tidak berkesan untuk jaringan Ad-Hoc tanpa wayar dan persekitaran biasa, protokol ini adalah cekap dan sesuai untuk jaringan tetap, dan sebilangan kecil protokol yang sedia ada untuk jaringan mudah alih seperti Service Location Protocol atau protokol tolak dan tarik, masih tiada protokol yang berkesan untuk kualiti perkhidmatan dan penggunaan kuasa tenaga. Di dalam penyelidikan ini, satu mekanisme baru dan algoritma telah di reka untuk menaiktaraf protokol perkhidmatan penemuan mudah alih yang sedia ada.

Penyelesaian yang disyorkan adalah kombinasi berasas protokol tolak dan tarik. Hasil analisa keputusan yang diperolehi menunjukkan mekanisme yang di reka di dalam perbandingan parameter seperti kelajuan perkhidmatan pemberian, penggunaan kuasa tenaga dan liputan perkhidmatan akan bertindak lebih baik daripada protokol penemuan semasa.

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APPROVAL

I certify that an Examination Committee has met on **22/06/2009** to conduct the final examination of **Javad Zarrin** on his **Master of Science** thesis entitled "EFFICIENT DISCOVERY PROTOCOL FOR UBIQUITOUS COMMUNICATION IN WIRELESS ENVIRONMENT" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Sabira Khatun, PhD
Faculty of Engineering
Associate Professor
Universiti Putra Malaysia
(Chairman)

Abdul Rahman b. Ramli, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Rusli Abdullah, PhD
Faculty of Computer Science and Information Technology
Universiti Putra Malaysia
(Internal Examiner)

Ismaeil Sulaiman, PhD
Associate Professor
Faculty of Engineering
Universiti Technology Malaysia (UTM)
(External Examiner)

_____

BUJANG KIM HUAT, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia
Date:

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirements for the degree of Master of Science. Members of the Supervisory Committee are as follows:

Mohd Fadlee A Rasid, PhD
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Nor Kamariah bt. Noordin, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

HASANAH MOHD GHAZALI, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 16 October 2009

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

_____

Javad Zarrin

Date:

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LIST OF ABBREVIATION

AFH	Adaptive Frequency Hopping
AWT	Abstract Window Toolkit
CCK	Complementary Code Keying
CDC	Connected Device Configuration
CDMA	Code Division Multiple Access
CLDC	Connected Limited Device Configuration
DSSS	Direct Sequence Spread Spectrum
EDGE	Enhanced Data Rates For GSM Evolution
FHSS	Frequency Hopping Spread Spectrum
GERAN	GSM/EDGE Radio Access Network
GPRS	General Packet Radio Service
GSM	Global System For Mobile
IAS	Information Access Service
IETF	Internet Engineering Task Force
IMT-2000	International Mobile Telecommunication -2000
IRDA	Infrared Data Association
ISM	Industrial , Scientific and Medical
ITU	International Telecommunication Union

J2ME	Java Platform , Version 2 Micro Edition
JSDP	J Service Discovery Protocol
JSDPSCM	JSDP Service Centre Mode
JSDPUM	JSDP User Mode
LAN	Local Area Network
NS2	Network Simulator 2
GSN	GPRS Support Nodes
OFDM	Orthogonal Frequency Division Multiplexing
SCM	Service Centre Mode
SGSN	Service GPRS Support Node
SLP	Service Location Protocol
SSDP	Simple Service Discovery Protocol
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
UM	User Mode
UPNP	Universal Plug and Play
USN	Unique Service Name
UTRAN	UMTS Terrestrial Radio Access Network
WLAN	Wireless Local Area Network

WPAN	Wireless Personal Area Network
WSN	Wireless Sensor Network

CHAPTER 1

INTRODUCTION

1.1 Background

Today, along with the enhancement of the wireless network technology and advances of the various types of the mobile devices the concept of ubiquitous environment is going to be the most considerable field in network researchers. The concept of ubiquitous environment which first time introduced in 1991 [1], defines an environment saturated with computation and communication of elements abilities, fully integrated into people lives and provides them with information and services associated with their needs and the environment where they are at every moment.

The ideal for such environment is providing real time for all kinds of possible services at anytime and anywhere. Currently by enhancement in wireless network infrastructures and protocols such as GPRS [2], UMTS [3], WLAN [4], Bluetooth [5], etc the ubiquitous environment is going to be real.

Ad-hoc networks with the ability of setting up spontaneous network without need of pre configuration are so close to the concept of ubiquitous environment. However, in the real case an environment with mobile and fixed devices which all of the devices communicate together via wireless is considerable.

The ubiquitous environment provides more facilities for the people's lives for example, by a mobile phone can not only have a telephone conversation, but also see the weather information, location of the nearest pharmacy, and schedule of the washing machine [6].

Another example is using the sensors which allow people to execute actions remotely on physical elements (doors, switches, etc), household appliances (washers, refrigerators, etc) or offices (printers, fax machines, air-conditioners, overhead projectors, etc), and transportation systems (cars, buses, etc).

To offer and discover services in such environment, today there are many kinds of services discovery protocols, but the problem is that these protocols are not most adapted and customized for the wireless ubiquitous area.

The majority of devices which are present in ubiquitous environments such as mobile phones and sensors use the restricted resource in terms of capacity, battery, and processors. So, there is a challenge to provide a mechanism of discovery to minimize use of the resources with the ability to do high quality service discovery.

1.2 Problem Statement

Lack of an efficient and smart adapted mechanism of service discovery for ubiquitous environment is a problem which has not been considered in the current discovery solutions.

In the ubiquitous environments users continually need to look around for services, discover the required services and invoke them. So, these are needed to provide an appropriate service discovery mechanism for the environment to support it by fast and smart adapted service discovery protocol based on the users' demands.

Current solutions are based on Pull, Push [7], and Directory and operate as centralized or diffusive architecture [8], [9]. Each of these solutions has advantages and weaknesses. This thesis did not consider on the mixed service discovery mechanism related on routing protocols. [10]

There is a tradeoff between pull and push mechanism. For the pull mechanism the weakness is producing more traffic load on the network and more resource consumption. And for the push mechanism the problem is increasing the number of unconverted services (unavailable services) and decreasing the percentage of service discovery many available services at the time are not recognized). Directory also is not possible to implement in any ad-hoc networks, since in this solution some specified nodes must be pre-configured as the directory agent. By considering these basic mechanisms for discovery of the other available protocols such as SLP, SSDP, etc which all are depends on these mechanisms, they are not fully efficient especially for ad-hoc networks.

To address these problems, the proposed model which is general extension on the current models is going to define a discovery model to solve the trade off problem by combining the advantages of the mentioned mechanisms in order to overcome the

weakness and take the special features of the ubiquitous environment into account. Also, the proposed model will provide a smart adaptation for this environment to support small devices to save the resource and decrease the power consumption.

1.3 Research Aim and Objectives

Service discovery performance in ubiquitous environment especially in ad-hoc networks will be investigated in this research. The main aim of the research is to decrease the traffic load and resource consumption on the operation of service discovery mechanism in the network. To do that the objectives are:

- To reduce the number of messages transmitted per query
- To minimize the rate of false service discovery (unavailable services)
- To increase the percentage of service discovery this means increasing the ability of service discovery mechanism to recognize all the services in the network.

1.4 Research Scope

The scope of this research is focusing on the service discovery mechanisms based on Pull, Push, and Directory, and also discovery protocols based on centralized or distributed architecture in ad-hoc networks and mixed ad-hock networks with fixed devices.

In this research a study has been conducted to propose a discovery model to improve the current service discovery solutions.

1.5 Overview of Thesis

Figure 1.1 indicates an overview of the thesis which contains process of finding problem, reviewing previous literatures, methodology and simulation in order to get results.