LOCATION SENSITIVE SERVICE DISCOVERY PROTOCOL FOR MOBILITY SUPPORT IN UBIQUITOUS COMPUTING ENVIRONMENT

Sunil Kumar Nandal, Yogesh Chaba
Guru Jambheshwar University of Science & Technology, Hisar, India

ABSTRACT

Ubiquitous computing environment envisions computing devices assisting human beings in their day to day routine life activities, staying invisible from their attention. To fulfill this basic requirement of hindrance free environment, users of the system should be able to move from one place to other. So, user mobility, without any break in service, is the fundamental assumption of Ubiquitous Computing Environment. In this paper, a location sensitive service discovery protocol for mobility support has been proposed. As existing network protocols requires users to be identified by the network address of device on which service is to be accessed. The proposed protocol works on middleware layer to support user mobility without any break in service.

1. INTRODUCTION

Ubiquitous Computing [1] aims to provide continual service to the users without any break, along with user mobility support. Thus the infrastructure for ubiquitous computing environment shall contain large number computers supporting transparency in service access, as in distributed computing systems, and user mobility, as in cellular systems.

Internet and cellular systems are most successfully implemented infrastructures. Both of these systems provide services to user over a large area, distributed over globe. However, these systems are differ at the level of basic architecture. Cellular systems are designed to provide the facility of voice communication to the mobile users. Cellular system divides service coverage area into different cells. Each one of these cells have a wireless transceiver to provide wireless connectivity to its users, any where in that cell. The communication in between user and transceiver is controlled and monitored by Base Station Subsystem (BSS). There is one Mobile Switching Centre controlling the functioning of many BSS. Different MSCs are connected to provide service coverage in a large area. Contrary to this Internet consist of connection of computer LANs. Most of these computers, in Internet infrastructure are non-portable. But due to collection of large number of high speed computer, Internet infrastructure provides faster communication and processing speed.

In this paper, features of these systems are combined to implement location sensitive service discovery protocol for mobility support in ubiquitous computing environment. This paper is organized into four sections. Section 2 introduces to Structure of Ubiquitous Computing Environment. Section 3 introduces User Mobility Tracking and section 4 discusses Design of Protocol for Continual Service Provision for Mobile User. Section 5 concludes this paper.

2. STRUCTURE OF UBIQUITOUS COMPUTING ENVIRONMENT

On the basis of utility of ubiquitous computing environment to its users, it may be divided in three sections as mentioned below-

(i) Service Infrastructure and
(ii) User Mobility
(iii) Ubiquitous Computing Infrastructure Scenario

2.1 Service Infrastructure

Ubiquitous infrastructure contains fixed or portable computing devices which forms the part of service rendering system. The complete area of user mobility is to be covered by these devices. So this area has to be divided into different sections called active areas. All the devices in any particular active area are considered to be connected in wired or wireless LAN forming a distributed system of services with the help of middleware layer.

2.2 User Mobility

Users in ubiquitous computing environment may move freely from one place to another. Sufficient number of ubiquitous system devices along path of movement provides service without any break. Unique identification technique like RFID [2][3] may help to automatically detect user device and process without any explicit network setting.

2.2.1 Mobility Support in Internet Infrastructure

Internet is a worldwide connection of computers on basis of client server architecture, connected through a series of proxy servers called Internet Service Provider (ISPs). The World Wide Web is further divided into small group of computes in the form of LAN, each LAN having one server which is directly connected to some ISP or some other proxy server. So, Internet forms a hierarchical connection of LANs. Every computing device in this World Wide Web must be a part of any LAN with unique IP address. If a computing device moves from one LAN to another, then need to acquire new IP address from server of the LAN before it may communicate with any system. However Internet may provide connection between any two computers, but they have to be bound to a LAN to access any services [4].

2.2.2 Cellular System

A cellular system has been designed to support mobility of users' mobile phones, also called Mobile Stations (MS). In a cellular system the complete area of coverage is divided into various hexagonal cells each managed by a Base Station Subsystem (BSS). BSS contain a base transceiver (BTS) for providing wireless connection to the MS and Base Switching Centre (BSC). Many BSCs are further connected to a Mobile Switching Centre (MSC). MSC forms main entity of cellular system. Every mobile phone (MS) user have one home MSC, where user is registered and identified by global unique identifications called Subscriber Identity Module and International Mobile Equipment Identity(IMEI) [5]. These unique identification of MS does not change with movement from one MSC to another and MS need not re-establish the identity in new BSS. Cellular systems provide very good provision for subscriber mobility. Due to limited number of computing devices dedicated for voice calls in each BSS, it does not provide the same type of service access as Internet infrastructure.

2.3 Ubiquitous Computing Infrastructure Scenario

The following basic requirements of ubiquitous computing system

(i) Access to large number of services available throughout the system
(ii) Access to service from anywhere in the system
(iii) Continuity in service access while user moves from one place of connectivity to another

may be fulfilled by combining the features of Internet (behaving as a distributed system with the help of middleware layer) and cellular system. Computing devices may be arranged in the form of cells (coverage area of one BSS), with each cell having one transceiver to cover the user devices in the cell. These cells may be called Active Areas (AA) in ubiquitous system. For mobility support each user device must have a consistent global unique identification, which does not change when user moves from one LAN/ BSS/ AA to another.

3. USER MOBILITY TRACKING

Like every mobile phone/ mobile station user in cellular system have one home MSC, every user in ubiquitous computing system may also be assigned to one home active area. The home active area may keep movement track of the users registered with it. All the user's devices have unique identification tags like RFID to track their location. Whenever a user device is detected in an active area other than its home, it will be identified by its unique identification tag. The activity status of the

roaming user need to be passed to new active area, user is going to visit (Fig1). This may be implemented using following handoff strategies

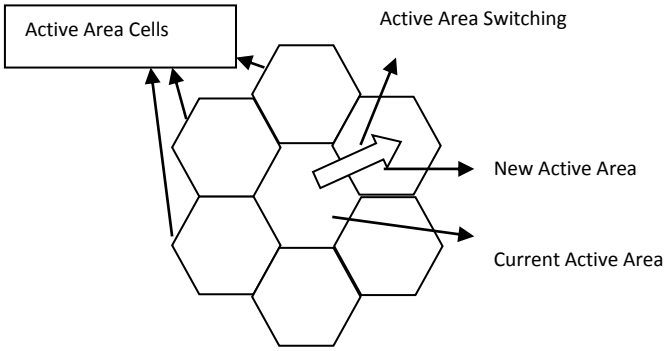

Fig 1: Active Area Cells for user tracking

(i) On detection of a roaming device the active area mobility manager (server keeping track of incoming and outgoing users), passes this information to its parent active area mobility manager and receives its activity status. In this case activity status, containing information status of various services being accessed by user, is maintained at home active area of the user

(ii) An alternate of previous policy may be that the information about activity status of every user is kept by current active area. When a user migrates from one active area to another, the activity status of the visitor user is passed to new active area manager by last visited active area manager. The mobility manager stores links to new location of user for link based tracking.

(iii) A combination of above mentioned tracking scheme may be used to recover status information of any user from home active area in case connectivity may be lost at the time of switching from one active area to another.

4. DESIGN OF PROTOCOL FOR CONTINUAL SERVICE PROVISION FOR MOBILE USER

This part includes four phases of a service namely creation and naming of a service, registration with a lookup service, lookup & binding of service and ubiquitous availability of service. To provide break free service to mobile users, following service semantics need to be implemented.

4.1 Creation & Naming of Service

Life of a service starts with creation of a service and making it available for access by various client processes on the user machine or by other services ubiquitous infrastructure. Name of a service should be such that it may uniquely identified in the complete ubiquitous system. Name of service should contain identification of its developer and version number of the service. This information may be helpful for the user to decide about the selection from similar types of services on the basis of trust credential of the service and service developer with the user. Name of the service and service parameters should signify the purpose of the service. Fig 2. shows the general prototype of a ubiquitous service.

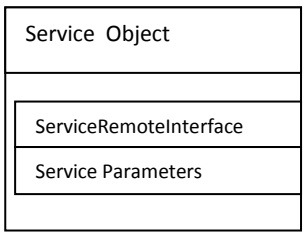

Fig 2: Prototype of a Service

4.2 Service Registration

Every service in ubiquitous system must be registered with directory server(s) in their respective active areas. The directory server provides user process link to service in ubiquitous environment. The directory server stores the updated location information of the service to be accessed. There have to be at least one directory server in each active area. However, there should be distributed set of directory servers for reliable and efficient service detection process.

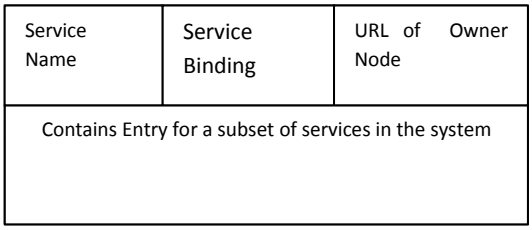

Fig 3.Distributed Directory Server (Entries of all N services divided among M designated nodes)

Fig3 shows the implementation structure of distributed directory servers containing information about a subset of services. This organization of directory server have a single point of failure. To enhance reliability every server database need to be replicated and updated periodically. In this scenario of directory server, on addition of new service, entries of one server and its replica(s) need to be updated.

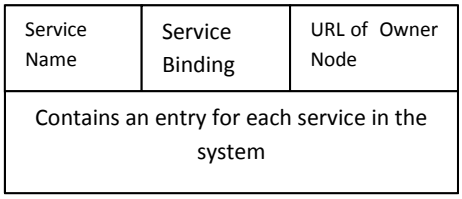

Fig 4. Dynamically Distributed Directory Servers (Every server in active area maintain entry of all services)

In dynamically distributed set of server (Fig 4) each server contains one entry for every service. This scenario provides a better degree failure handling and faster service discovery. However, entries on all servers need to be updated on addition of a new service and migration of a existing service.

4.3 Service Lookup &Binding

When a user process needs to activate a service, it contacts directory server of the active area in which it is present (Fig5). Every user device has a inbuilt interface process for detection of services. This interface is called lookup service. Infrastructure computing device, directly connected to user device, fetches list of services from directory servers along with handle to the services. User may select appropriate service, out of the available services.

After the selection of appropriate service by the client user process, the lookup service returns a handle to the service and thus execution of the service may be started by client process. There may or may not be nested calls of services to fulfill any task.

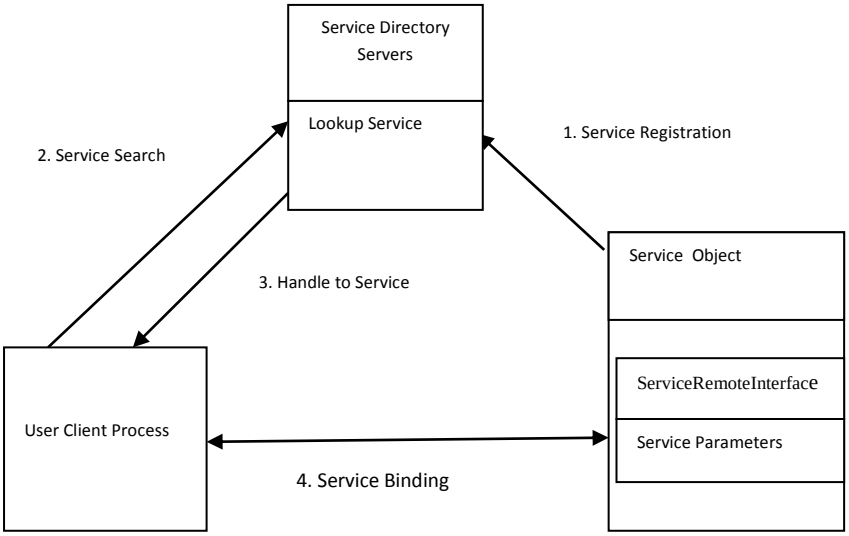

Fig 5 : Service Access Model in Ubiquitous Computing Environment

4.4 Ubiquity of Service

The device, on which user process runs, should be free to move from one point to another in the ubiquitous system infrastructure. The services once registered with the lookup service of the ubiquitous system infrastructure should be accessible to the user processes without any break. The user mobility tracking module keeps the system updated about the current location of user. Whenever service need to interact with the user, it may request user mobility tracking module to provide the current location of user. The remote service interface sends required information on user device in new migrated location of the user, making user realize the freedom to access service on move.

5. CONCLUSION

Combining the features of cellular system and Internet, a ubiquitous architecture is designed to support user mobility. Location transparency is one of the basic requirements of ubiquitous computing. Location transparency in Internet infrastructure may be achieved by creating a distributed middleware layer. The area for coverage of users' movement is divided into different active areas, which based on concept of cell in a cellular system. Cellular system based unique identification of user devices helps in tracking the movement of user.

With the help of distributed service directory, services may be located from any place it the system. The middleware layer components provide service access to user devices anywhere in the ubiquitous computing environment. Designs proposed in systems like Jini, UPnP are distributed in nature, but does not support user mobility.

REFERENCES

[1] Mark Weiser, "The Computer for the 21st Century," *Scientific American*, pp. 94–104, Sep 1991

[2] European Union (2007) European policy outlook RFID (draft version). Working document, German Federal Ministry of Economics and Technology, June 2007.
http://www.nextgenerationmedia.de/Nextgenerationmedia/Navigation/en/rfid-conference.html.

[3] Jong Hee Kang, Gaetano Borriello, "Ubiquitous Computing using Wireless Broadcast", *Proc Sixth IEEE Workshop on Mobile Computing Systems and Applications (WMCSA 2004)* pp. 72-81 1550-6193/04 © 2004 IEEE

[4] Tatsuo Nakajima, Hiro Ishik awa, Eiji Tokunaga, "Technology Challenges for Building Internet-Scale Ubiquitous Computing" *Proc. Seventh International Workshop on Object-Oriented Real-Time Dependable Systems (WORDS 2002)* 1530-1443/02 © 2002 IEEE

[5] *http://ej.iop.org/links/rqPN3A4,P/Pj0p_COG2xG-BuLSav5vpA/joa4_4_003.pdf*

[6] G. KUNITO, K. SAKAMOTO, N. YAMADA, T. TAKAKASHI, S. TANAKA "Architecture for Providing Services in the Ubiquitous Computing Environment", *Proc 26th IEEE International Conference on Distributed Computing Systems Workshops (ICDCSW'06)* pp. 60-65 0-7695-2541-5 /06 © 2006 IEEE
[7] M. MINAMI, H. MORIKAWA, T. AOYAMA, "The Design of Naming-based Service Composition System for Ubiquitous Computing Applications", *Proc. 2004 International Symposium on Applications and the Internet Workshops (SAINTW'04)* pp. 304-312 0-7695-2050-2/04 © 2004 IEEE
[8] Keonsoo Lee, Minkoo Kim, "Service Selection for Ubiquitous Computing Environment using Situation Awareness", *Proc. Fourth IEEE Workshop on Software Technologies for Future Embedded and Ubiquitous Systems and Second International Workshop on Collaborative Computing, Integration, and Assurance (SEUS-WCCIA'06)* 0-7695-2560-1/06 © 2006 IEEE