A Prototype for Active Service System *

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Abstract

Active Services is a promising technology and notion in relieving user from burdensome search for meaningful information, which is a problem becoming more serious for the information explosion on Internet and increasingly popular usage of wireless networks terminals. This paper presents a smart prototype for active service system which has a novel Index Tree-Trace Map model centralized, wireless networks environment based architecture. The prototype can automatically perceive user requirement by analyzing environment parameters and user information basing on preset rules and system knowledge of operation history, forwardly provide customized service for user. A well-operated experimental system is introduced here as well.

1. Introduction

Mobility is becoming a sine qua non characteristic of current information and communication technologies scenarios, and several efforts are being spent to support mobility in different areas [1]. The amount of information available via networks and databases has rapidly increased and continues to increase. Existing search and retrieval engines provide limited assistance to users in locating the relevant information that they need [2]. The inconvenience mobile terminals bring to input make an effective solution to this problem imperative. And then on the one hand the characteristic that the Internet has no state makes itself extremely powerful, but at the same time it cannot provide customized service because they cannot exploit detailed knowledge of the involved environment and user preference to enhance their performance [3].

To mitigate the problem above, with active services notion in mind [4], we present a smart prototype for active service system based on wireless networks environment (PASS).

This prototype is built on a novel computer-active service model, where computers not only take the job of resource maintenance and machine interface provision, but also help user locate desired customized information by analyzing environment parameters, user preference and any other information helpful in fulfilling this job such as system log files etc. This make the service content customized, location based and time dependent.

Some researchers have done a lot of work in active services field, Anne Ren and his colleagues invented a CKB model [5], I. W. Marshall and his team advanced ALAN [6], Habib Bakour and his collaborators brought up VAN [7]. All these tasks have promoted active services to a high level. The distinctive character of our work is that we introduce intelligent analysis of user requirement into active services. This analysis is supported by service content organization, environment awareness, user preference gathering and an Index Tree-Trace Map model (IT-TM model). The whole process of service provision can be covered under system's guide so that user requirement can be obtained instantaneously, which will release user from troublesome interaction while enjoying service.

Otherwise, because of the severe computer networks security problem and information garbage, security protection is also taken into account in PASS to protect both the system and user [8]. PASS is a WLAN-based application, but it can establish connection to the Internet, which enables instant

update of system and resource share and interaction between PASSes. PASS also provides service in the ordinary user-active and machine-passive model to be downward compatible.

The rest of the paper is organized as follow: Section 2 is about the architecture of PASS. Section 3 is introduction to IT-TM model. Section 4 presents an experimental system to prove the feasibility of PASS. Finally, the concluding remarks are given in Section 5.

2. The Architecture of PASS

PASS consists of User Terminals Unit, Logic Ratiocinate Unit and Resource Maintenance Unit. They cooperate in data transportation and system control. Every Unit is further divided into several smaller components, which are called modules. The architecture of PASS is shown as Figure1.
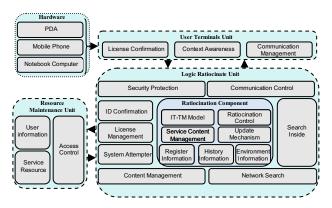

Figure 1. Architecture of PASS

2.1 User Terminals Unit

Besides common human-machine interaction terminals, Environment Awareness Module (context awareness), Security Module (License Confirmation) and Communication Management Module are also included in User Terminals Unit. Environment Awareness Module gathers context information including location, situation, and time and so on from GPS, RFID, thermometer, system clock and wireless networks sensor [9]. Security Module gives licenses to service providers and examines the legality of license when a connection is being established to a service provider. The license mechanism can ensure mobile terminals receive data from only those licensed provider and shield off garbage information. Communication Management Module manages the

communication between user terminals and service providers.

2.2 Logic Ratiocinate Unit

Logic Ratiocinate Unit is the core of this architecture. The Ratiocinate Component maintenances the IT-TM model and preset comparison rules IT-TM model uses and other useful information including register information, history information and Environment information. This component undertakes the work of user requirement analysis using IT-TM model, and provides service to user according to the result of analysis. The details of IT-TM model is going to be discussed in next section. Search Inside Module provides service in an ordinary-compatible model, which serves as a search engine for this system. Service Content Management Module maps service identifier IT-TM model recognizes to concrete service content. The purpose of Networks Search Module is that PASS can search on the Internet to find user-desired service content to update the system when no service in current system answers to user's demand or connect to other PASSes through Internet to support large scale general application.

2.3 Resource Maintenance Unit

Resource Maintenance Unit is similar to the Enterprise Information System (EIS), or more concrete, a database. User Information Module records basic user information and preference. Service content of the system is stored in Service Resource Module. Access Control Module keeps the system database running properly and ensures the security, data sharing, data recovery and integrality of data [10].
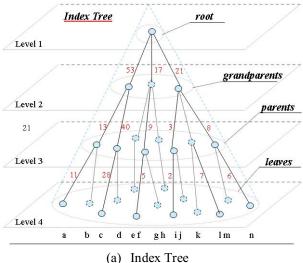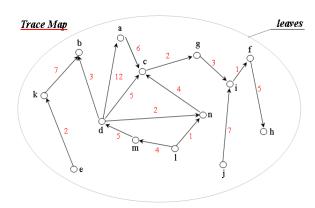
2.4 Relationship among Units

As Figure 1 shows, User Terminals Unit sends all the information including user identification, context parameters from Context Awareness Module and license from License Confirmation Module to Logic Ratiocinate Unit through Communication Management Module. Then Logic Ratiocinate Unit stores license information in it and at the same time gets user information and system records of this user from Resource Maintenance Unit. Ratiocination Component uses all these information to analyze user requirement and sends concrete service which is transferred from the user requirement by Service Content Management

Module together with license information in License Management Module to user through ID Confirmation Module. If desired service content doesn't exist in Service Content Management Module after user requirement is worked out, Networks Search Module and Content control Module are invoked to search required service content in the Internet and other connected PASSes. And then the service content is updated through Update Mechanism Module if the result is found.

3. Discussion on IT-TM Model

As a key technology, IT-TM model works out user requirement through programming decision using preset comparison rules(information including user preference, user use and environment information weight) and passes the result to Content Management Module, which then translates the service identifier to concrete service content and provides it to user. It is shown as Figure 2.

(a) Index Tree

(b) Trace Map
Figure 2. IT-TM Model

3.1 Structure of IT-TM

The structure of IT-TM depicts the organization of service content. IT-TM model is a cone in 3 dimensions; its vertical view is a rooted tree, which is called Index Tree; its horizontal view is a weighted directed simple map, we call it Trace Map. Index Tree manages classified service content and is similar to decision tree in function and has the same hierarchy with service content index in structure [11]. Trace Map is the horizontal cross-section of IT-TM model. It is introduced to solve the inefficient problem of back-trace in a tree. All points of a Trace Map are content-related for the truth that they have a same ancestor in the Index Tree, great-grandfather for example. Each point in Trace Map is a service identifier representing a kind of service, and the weight of its edge between two points is the frequencies of swift from one ender to the other representing the possibility of a state transfer.

When new service content is added in system, corresponding service node is added in the Index Tree or Trace Map at the same time. To keep nodes in IT-TM model active, if a node is never visited in a long period, a message will be sent to system manager to determine whether to delete this node and its service content or not. The nodes of IT-TM model are dynamically adjusted to keep Trace map on a proper scale to ensure that all the nodes in it are content-related in an appropriate degree as the service content change. As a process of system study the weight of its edges is constantly updated when PASS is in operation which will make the analysis of user requirement more and more accurate.

3.2 Working Process of IT-TM

The process of user requirement analysis starts from the root node of the Index Tree; a decision is made after calculate on the environment parameters, basic user information and preference and the weight of the current node to determine which edge to go down. By this way, every node chosen by PASS is the node most likely to answer user requirement in the largest extent. The initiation of the service location is finished after the bottom of the Index Tree (a leaf node) is arrived, then the result node can transfer from node to node in the Trace Map to locate next service if the service content at the current location is finished or no longer fulfills user's demand. Search for desired service node is limited in a Trace Map till a conclusion is made that all desired service in current map is already finished by user and no node in this map can answer user's demand any longer, and then a back-trace in Index Tree is made to move our focus onto another Trace Map in which exist the service node on user's demand.

As each node of Trace Map represents concrete service content, they are leaves of the Index Tree. The next is the discussion of the problem how many nodes should a Trace Maps include. See Figure 2, we can put nodes from a to h into a Trace Map for they have a same great-grandfather which is the root, but we can also put nodes from d to h into another Trace Map for they have a common grandfather which is the second node in level 2. The larger a Trace Map is the less back-trace is made in locating desired service node but at the same time the more difficulty lies in maintaining the Trace Map. So it's just a matter of trade-off.

3.3 User Preference Gathering of IT-TM

IT-TM needs a study mechanism to make its decision increasingly more accurate while in operation. This is achieved by a user preference gathering process. Every time a user preferred service locating is made, its trace in Index Tree is recorded. Take advantage of its tree structure and the truth that every pass starts from the root and each step goes deeper; this can be done by simply maintaining an integer value for every node in the tree for a customer. But the trace of Index Tree may not point to the right user desired service if one or more no stop transfers are made in the Trace Map as soon as arriving the bottom of the tree. This can be amended by decreasing the integers in the coming path and increasing the integers in the path ending at the target node. It is easy because only one path exists heading a given leaf node in Index Tree.

The user preference can be predicted both in person and in public. Under a certain circumstance, it is most likely for man to do things he did most and things the public did most. While the Index Tree embodies the personal user preference, the Trace Map indicates the public user preference. The node with the largest net income count in the Trace Map presents the hottest service; net income count equals subtract the count of all outgo links from the count of all income links. It is straightforward that a hotter service has a higher probability in decision making. Critical environment factors often affect the public preference, this is right the place where environment awareness helps in an efficient and correct service decision.

4. Validation of PASS

Supermarket is chosen as scenario and a supermarket active guide system is developed to prove the feasibility of PASS. System forwardly recommend commodity in demand to user by analyzing user requirement using preset assume rules and information such as location, situation, time from user's mobile terminals and user preference, user records from database which in turn assist custom finish the shopping process.

4.1 Deployment of PASS in the Scenario

PASS consists of user terminals, an active services content server and a resource server. It is shown as Figure 3. User terminals are the context awareness devices and human-machine interface which enable interaction between user and system. The resource server stores and maintains the service content, user preference and user records. The active service server has IT-TM model run in it and takes the responsibility of service content organization, update and security protection. The Internet connection among PASSes is for communication among PASSes, share of user information and service resource, and update of system.
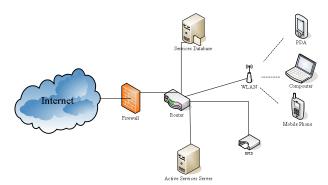

Figure 3. Deployment of PASS in the Scenario

4.2 The Process of PASS in the Scenario

The whole process from the moment user enters the wireless networks environment to the end of the service consuming is given in detail as shown in Figure 4:
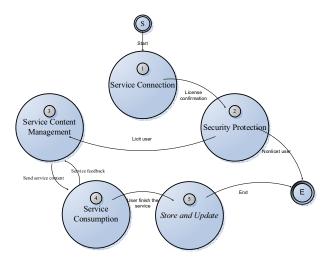

Figure 4. Process of PASS

The main steps of process are as follows:

Step 1: when user's mobile terminal enters the area WLAN covers, the user identity must be validated to go ahead.

Step 2: a assuring message is sent to user to check whether active services is permitted, go next if an affirmative feedback is received or else exit the system.

Step 3: the active services server works out user requirement and sends the service content getting from service database to user along with a license.

Step 4: the validity of the license is checked by user terminal to determine whether current service content is to be accepted and displayed to user. Then the active services suspend until user response is received. Go to the fifth step if user asks for quit and else after the environment information user terminal collect is pass to active services server the process goes back to the third step if user chooses continue.

Step 5: store the record of this process in service database and update the active service server.

5. Conclusion

PASS transfers the work of search for desired service content from human to machine, lightens the burden of user and enables the wireless networks user enjoy the whole process of service by only a little interaction, improve the human-machine relationship by making user complete consumers. The analysis of context parameters and user information and preference makes the service provided to user customized. In addition, more maintain work is undertaken by computers and the collected information can be very useful resource for data-mining and further improvement of system.

We are going further to improve the system and focus our energy on the goal of improving the efficiency of PASS and advancing the accuracy of user requirement analysis by work out quantitative result of the spending of the active analysis.

6. Acknowledge

7. References

[1] Cabri G., Leonardi L., Mamei M., Zambonelli F., "Location-Dependent Services for Mobile Users", Systems, Man and Cybernetics, Part A, IEEE Transactions on Volume 33, Issue 6, Nov. 2003 pp.667 - 681

[2] James Jansen, "Using an Intelligent Agent to Enhance Search Engine Performance", First Monday, 1997 – firstmonday.dk, http://www.firstmonday.dk/issues/issue2_3/jansen/
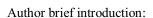
[3] Elan Amir, Steven McCanne, Randy Katz, "An active service framework and its application to real-time multimedia transcoding",ACM SIGCOMM '98 conference on Applications, technologies, architectures, and protocols for computer communication, Oct. 1998 pp.178-189

[4] M. Fry, A. Ghosh, "Application Layer Active Networking" Computer Networks, 31, 7, pp. 655-667, 1999.

[5] Anne Ren, Gerald Q. Maguire Jr，"A smart network with active services for wireless context-aware multimedia communications", Wireless Communications and Systems, 1999 Emerging Technologies Symposium，12-13 April 1999 pp. 17.1 - 17.5.

[6] I. W. Marshall, H. Gharib, J. Hardwicke and C. Roadknight, "A novel architecture for active service management" Integrated Network Management Proceedings, 2001 IEEE/IFIP International Symposium on 14-18 May 2001 pp.795 – 810.

[7] Habib Bakour, Nadia Boukhatem，"Provisioning virtual active networks for dynamic active service deployment", Computers and Communications, 2004. Proceedings. ISCC 2004. Ninth International Symposium on, Volume 2, 28 June-1 July 2004 pp.1104 - 1109 Vol.2.

[8] Vipul Gupta, and Sumit Gupta, "Experiments in Wireless Internet Security", Wireless Communications and Networking Conference, 2002,IEEE. Volume 2, 17-21 March 2002 pp.860 - 864 vol.2.

[9] William J. Fleming," Overview of Automotive Sensors", Sensors Journal, IEEE Volume 1, Issue 4, Dec. 2001 pp.296 – 308.

[10] Zuji Mao,Douligeris, C, "A distributed database architecture for global roaming in next-generation mobile networks", Networking, IEEE/ACM Transactions on Volume 12, Issue 1, Feb. 2004 pp.146 - 160.

[11] Richard Johnsonbaugh, "Discrete Mathematics, Fifth Edition", 2001, Person Education, Inc., publishing as Prentice Hall

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