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NAMA-US: A Multi-Agent Community Computing Approach to Ad hoc Need Identification and Group Formation of Nomadic Community

Ohbyung Kwon, Keunho Choi

Graduate School of International Management,
KyungHee University, Korea, {obkwon, kino4u}@khu.ac.kr

ABSTRACT

Ubiquitous computing technology becomes promising to realize next generation services which work on behalf of the nomadic users whenever, wherever the users are, with any devices running on any networks. These capabilities naturally lead us to apply the ubiquitous computing technology to group decision-making support system among nomadic community. When focusing on supporting the group decision-making of relatively small sized multiple individual in a community, the following three characteristics are needed: (1) ad hoc group formation, (2) context-aware group need identification, and (3) using mobile devices working in- and out-doors. However, in community computing, research about the ad hoc group need identification is still very few. Hence, this paper aims to provide a methodology that realizes group need identification among nomadic community for ad hoc group formation. Multi-agent architecture is adopted for need identification mechanism. To show the feasibility of the idea of a prototype system, NAMA-US, is being developed.

Keywords: Community computing, group need identification, ubiquitous computing, ad hoc group formation, multi-agent system.

1. INTRODUCTION

Ubiquitous computing technology becomes promising to realize next generation services. While walking around with mobile devices, nomadic users tend to make decisions for problem solving by accessing information, communicating with others, and thinking for their education, business, research, and general entertainment. Frequently, the decisions can be made collectively. For example, a user who is on shopping and about to purchase a product may want to get advised by her/his friends or persons who already have experiences to use the product. An employee who is going to negotiate with her/his client may want to collect relevant information from others about the client on her/his way to the client's office. A doctorial candidate attending a conference may want to find a right person to appear in the job market. A jobless person wants to find an appropriate employer as soon as possible when she/he is walking around downtown. In short, a nomadic person needs persons who have complementary needs and hence will collaborate or coordinate with her/him any time, anywhere, by forming a group no matter what the group is static or dynamic.

Meanwhile, group decision support system (GDSS) or collaboration support systems have aimed to support group or team to make decisions. An excellent review of group decision support systems has already been developed since the 1980's [6, 7, 14]. Group support systems are generally classified with two dimensions: size of group and locus of participants, as shown in Figure 1.

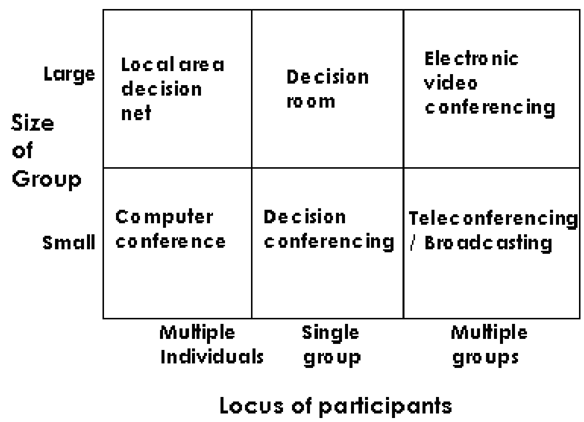

Figure 1: Classification of group support systems

To apply the classification of GDSSs shown in Figure 1 to ubiquitous computing environment settings, one more dimension is needed: characteristics of participants. The characteristics of participants consist of team, group, and community. Team and group are similar to each other in a sense that the participants have a same goal or interests. Groups are assemblages of persons gathered or located together. Teams are groups organized to work together. Comparing with group or team, community is characterized by its purpose and interaction in an anonymous manner. They do not necessarily know each other *a priori*. Community may be defined as a group of people living in a particular local area.

In this paper, we focus on decision support activity for relatively small sized multiple individual in a community. The decision support activity consists of negotiation, idea generation, voting, knowledge share, auction, and reverse auction. Comparing with typical group decision support systems, we aim to enable group to make decisions regardless of time and place. To do so, ad hoc and context-aware group formation should be supported while the community members carry mobile devices in- and out-doors. Moreover, the group members are assumed to be anonymous to each other. Figure 2 shows our focusing area among the group multiple individuals, virtual ad hoc conference is basically based on group formation from community members, rather than group or team members who are well acquainted with each other and share common goals to be together.

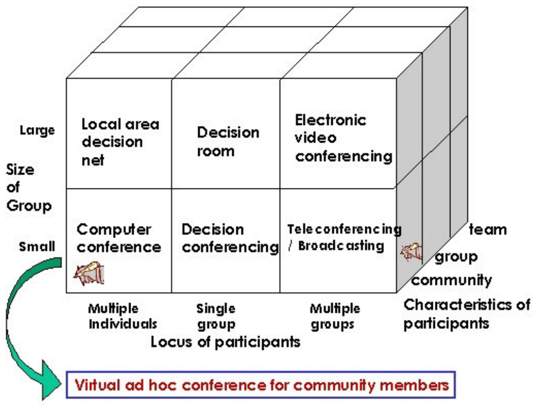

Figure 2: Locus of virtual ad hoc conference

Ad hoc group formation for any services in a community is expected to increase the problem solving abilities. To realize ad hoc group formation, how to correctly identify the nomadic group's ad hoc needs in an automated and seamless manner. However, research of ad hoc group need identification is still very few.

Hence, the purpose of this paper is to propose a community computing methodology to identify the ad hoc needs of the nomadic community. Moreover, when considering CBB (Consumer Buying Behavior) model, need identification phase, which has not been supported by legacy agent technology, is stressed in this paper because group formation is substantially related to the identification of group formation needs. Web service based multi-agent architecture is adopted for the need identification mechanism. A prototype system, NAMA-US, is being implemented to show the feasibility of the methodology proposed in this paper.

The remaining part of this paper is organized as follows. Section 2, we review the research background on need identification and community computing. In section 3, we suggest our framework and methodology for ad hoc group formation. Then, to show the feasibility of the idea proposed in this paper, a prototype system, NAMA-US, is illustrated in the section. Finally, in section 4, we summarize the research implications.

2. LITERATURE SURVEY

2.1 Need Identification

"Need" is defined as a sort of internal state to do something particular. Need is to a gap between what "is" and what "should be" [18]. Reviere mentioned that need as a gap between actual and ideal identified as community value [17]. On the other hand, McKillip interpreted need as wants or as a demand [15]. In short, need could be explained by a current condition, wants and its difference.

Need awareness originates from recognizing unfulfilled needs. CBB model is a well-known customer model which includes need identification as a main component. The CBB model proposed by He *et al.* is shown as Figure 3 [11].

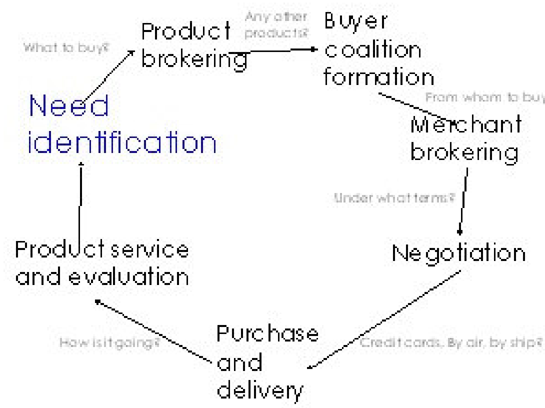

Figure 3: Basic CBB model

When focusing on buying behavior of services, the original CBB model may be amended as Figure 4. Need identification is the first step of B2C procedure that enables online customers to buy goods from the e-marketplace [1]. Since need identification is related to the customer's purchase behavior, it focuses more on predicting the future and what will be done, rather than what has been done. This results in the difficulties of deriving user need from one's past behavior.

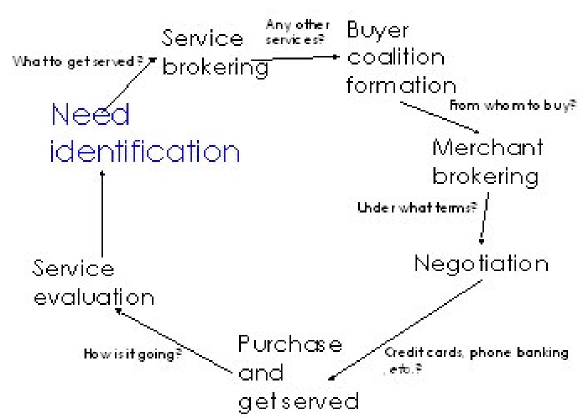

Figure 4: Service-oriented CBB for ubiquitous services

If we regard need as a set of current state, desiring state, and its differences, then the first step of CBB model, need identification, could be regarded as three detailed procedures: awareness of current condition, awareness of wants, and awareness of content; and the size of the gap between them. Awareness of the size of the gap may also cause a sort of tension to drive the need fulfillment. The identification mechanism is shown as Figure 5. However, available mechanisms of group need identification are still very few.

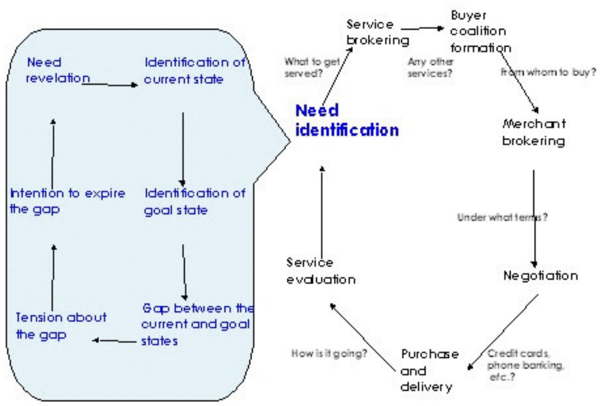

Figure 5: Need identification and service-oriented CBB model

2.2 Community Computing

Community computing began with the development of the timesharing computer in the early 1960s. The timesharing computer systems created a community by making use of network and corresponding information systems such as teleconferencing, groupware and electronic mail.

To understand community computing, the terminology community needs to be identified. The term "community" has been defined in the literature in different ways; for example Elisabeth Mynatt [16] saw community as a social grouping which exhibit in varying degrees: shared spatial relations, social conventions, a sense of membership and boundaries, and an ongoing rhythm of social interaction."

The main differences between community and group are the level of interaction between the members and the existence of shared goals and artifacts. It should be noted that there is no clear separation between these group types. Seamless transitions occur between them and groups and teams can exist inside communities.

The term community computing can be defined as the methodologies and tools for creating, maintaining, and evolving social interaction in communities [13]. Community computing is intended to support more diverse and amorphous groups of people. Community computing typically supports the process of organizing people who are willing to share some mutual understanding and experiences. In other words, compared with groupware, community computing focuses on an earlier stage of collaboration: group formation from a wide variety of people. Community computing supports different functions for encouraging social interaction.

The functionalities of community computing are (1) finding someone to collaborate with, (2) making contact with the selected people, (3) building a common understanding, (4) collaborating with others in the same community, (5) executing individual work, and (6) communicating between co-workers in order to coordinate activities and work plans.

The main usefulness of communities lays in its being a starting point for identifying a set of people one could interact with, e.g. to find some help for solving problems or to share experiences. The basic rationale for community computing, as for any computer- supported co-operative work, is that people who want to communicate and collaborate are not always in the same place at the same time [2]

2.3 Current Community Computing Systems

The Blacksburg Electronic Village (BEV; http://www.bev.net) have documented how various groups in the community organize their own activity and provide leadership to others in the community through the community network [5, 8]. The BEV provides access to a huge volume of information and services; including health information from local doctors, local bus schedules, projects by school children, the rugby football club schedule, discussion of regional power line and highway proposals, information on area museums and a string quartet, and access to the Internet. Such a service enabled the residents of Blacksburg, Virginia to build up efficiently subcomunities. However, despite its idea and actual contributions, BEV so far does not assume ubiquitous computing environment settings.

Digital City Kyoto is to make it real by establishing a strong connection to physical Kyoto, by providing an information center for everyday life for actual urban communities [12].

Communityware is intended to support more diverse and amorphous groups of people. Communityware typically supports the process of organizing people who are willing to reach some mutual understanding.

Familyware is a communication tool that provides status information about remotely located family members using peripheral displays and devices [9, 10]. By using Internet and everyday artifacts, parents an take care of their own children with less efforts, and children can communicate with their family in an easier way.

The MOOsburg project is focused on developing a community Internet resource for Blacksburg. The purpose of the project is to create a community based on-line resource modeled on the town of Blacksburg in southwest VA, USA [3, 4].

Despite several trials, full implementations of the community computing mechanism are still very few. Ad hoc group formation, which is a main purpose of community computing, is not so far based on need-awareness. To intelligently and seamlessly form a group among a community, the community members' needs should be identified in an automated and autonomous manner.

3. MULTI-AGENT COMMUNITY COMPUTING FOR AD HOC GROUP FORMATION

3.1 Framework

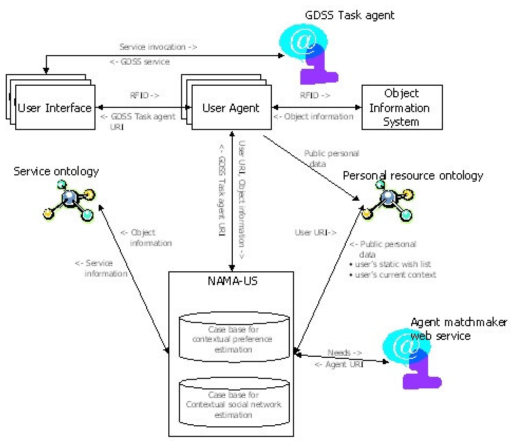

Figure 6: System framework

The proposed system framework of multi-agent system for ad hoc group formation and decision support is shown as Figure 6. User agent on behalf of the user gets RFID data from the user's currently using device with RFID reader attached. The user agent then requests object information of the entity, which contains RFID to Object Information System (OIS) by sending RFID data. The object information is regarded as context data: name of place, name of service and service URI, if any. For example, an RFID may indicate restaurants, dormitory, or train. If the place has its own service ontology, then the URI of the service ontology is delivered together as object information to NAMA-US, a group formation agent, when the user agrees to get served by NAMA-US through her/his mobile device. NAMA-US is running all the time so that group formation service request is available in an ad hoc manner. NAMA-US aims to identify group need of the users who are approximate with each other with the use of user URI and object information. To do so, the user's wish list is imported from the personal resource ontology. Moreover, to estimate remaining implicit needs which are not explicitly declared in the wish list, two case bases are used: case base for estimating contextual preference and contextual social network. A case based reasoning is performed to identify estimated needs with the corresponding case base, which contains personal profile and context data as conditions and revealed needs as results. The contextual need is estimated by the following equation:

$$Contextual\_need_{i,j} = f(s_1, s_2, \ldots, s_n \mid c_1, c_2, \ldots, c_m) \quad (1)$$

where i and j indicates ith user and jth need, respectively. C_k is the kth contextual feature; S_l is the lth static feature. Static feature is characterized by the user's profile which comes from personal resource ontology. Contextual feature is represented as social context and context model.

Case base for contextual social context is adopted to selectively identify group needs that can be revealed a specific type of social context. For example, if the profile of the users in vicinity is their parents or their children, they may not want to buy and sell books or any other items. If the users are professor and students, they will not share information about anticipated questions and answers that will be appear in the upcoming exam. As a result, case based reasoning of contextual social context will narrow down the group needs which are derived from the estimated needs that are recommended by the contextual preference estimation phase and also from the declared needs of wish list. The group needs are intersection of needs of the users in the vicinity based on the RFID-attached place.

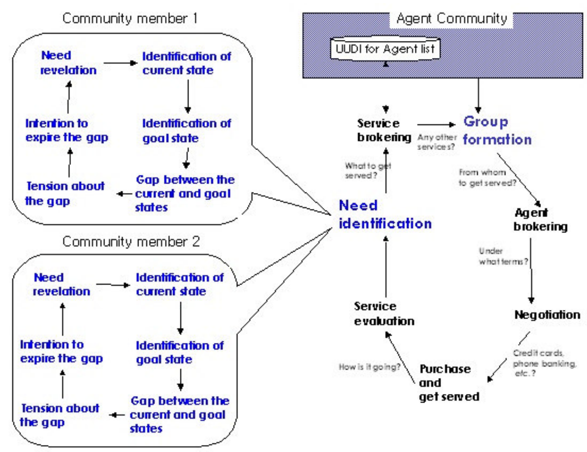

Figure 7: Group need identification and service-oriented CBB model for group works

With the identified group needs, NAMA-US then invokes agent matchmaker web service, which is an agent-oriented web service. Agent-oriented web service is an agent that communicates with other agents or computer resources over web service protocol, SOAP. Hence, agent-oriented web service makes use of web service functionalities such as easy service deployment and discovery and standardized communication method.

The agent URI is returned to the NAMA-US, so that NAMA-US may inform available GDSS task agent to each user agent. The user agent then generates a dynamic web document and transmits it to the user interface. The user can invoke the selected GDSS task agent to get group service served.

The core of the system framework follows the service-oriented CBB model with need identification model as shown in Figure 7. Each step of need identification model generates static and contextual content that might be useful for automated identification of group member’s explicit and/or implicit needs as listed in Table 1.

Table 1. Steps in identifying group member's needs

Steps	Static content	Contextual content
Identification of current state	User profile	Current location Current time Current activity Current identity
Identification of goal state	Wish list To get served list	
Gap between the current and goal states		
Tension about the gap	Perceived sensitivity of contextual pressure	Contextual pressure Due duration of get served
Intention to expire the gap	Eagerness to get served	Social context Availability of services
Need revelation		Users' commitment to get served

Static content is imported from personal ontology or manual input. Contextual content is imported from sensors such as RFID and partially from E-Wallet.

3.2 Implementation

Currently, since NAMA-US is an on-going project, the prototype system is not fully implemented. NAMA-US is a next-generation system of NAMA and NAMA-RFID. NAMA applies both Bluetooth and semantic web technologies to enhance context through user location tracking. To control the JSR-82 of Bluetooth, we use a JCP Linux-based Bluetooth controller API from Rococosoft Company, Impronto DK for Linux v1.1, the Windows operating system for the Pocket PC, and Atinav Company's aveLink Bluetooth Protocol Stack and SDK. To create the ontology, we used Protégé-2000; this was managed by an e-wallet web service using JENA 2.0 API. Pointbase was used to as the database running on the user's mobile device. For the Java virtual machine, Sun's JAVA SE 1.4.1 was used. For the Pocket PC virtual machine, EVM from Jeobe was applied. As a platform environment, Windows XP Professional and Linux-based Red Hat 9.0 was used. The mobile device operating system (in this case, two PDAs: HP's iPAQ 2100 and iPAQ 5400) is Microsoft Pocket PC 2003. We used a Bluetooth USB dongle with the Bluetooth v1.1 standard (PROMI-USB (Initium)).

NAMA-RFID uses RFID and semantic web based location-tracking method. To do so, ontology is managed by Protégé-2000 and parsed by JENA 2.0. For PDA-based data management, a DB engine, Pointbase, is adopted. Figure 8 show the RFID tag, reader and PDA used in the implementation.

Figure 8: RFID and PDA used in NAMA-US

4. CONCLUSION

This paper aims to illustrate how community computing technology and multi-agent-based web services can jointly contribute to a ubiquitous group support. We selected and implemented an ad-hoc group formation system as an example service. A full-fledged context-aware service is considered: not only a location-based service but a service that considers time, identity, and entity.

To reveal the feasibility of the ideas in this paper, we proposed a RFID-based multi-agent-based group formation service called NAMA-US, which will run on the user's mobile device, such as a PDA. To automate the ad hoc group formation with user agent and GDSS task agent, we adopted semantic web with ontology. Full implementation will be done by the end of 2005.

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REFERENCES

[1] Blake M.B., The Business of e-Commerce Systems: Business Models and XML, available from http://www.cs.georgetown.edu/~blakeb/Spring2002/COSC545/HTML_Pages/COSC545_Lecture5.pdf (2002).

[2] Carroll, J.M., Community computing as human-computer interaction, Behavior and Information technology, Vol.20, No.5, pp.307-314 (2001).

[3] Carroll, J.M., Rosson, M.B.Isenhour, P.L.Ganoe, C.H.Dunlap, D.R., Fogarty, J., Schafer, W.A. and Van Metre, C.A., Designing Our Town: MOOsburg, International Journal of Human-Computer Studies, Vol.54 (2001).

[4] Carroll, J.M., Rosson, M.B.Isenhour, P.L.Van Metre, C.Schaefer, W.A. and Ganoe, C.H., MOOsburg: multi-user domain support for a community network, Internet Research, Vol.11, pp.65-73 (2001).

[5] Carroll, J.M. and Rosson, M.B., Developing the Blacksburg Electronic Village, Communications of the ACM, Vol.39, No.12, pp.69-74 (1996).
[6] Chun, K.J. and Park, H.K., Examining the conflicting results of GDSS research, Information & Management, Vol.33, pp.313-325 (1998).
[7] DeSantis, G. and Gallupe, R.B., A foundation for the study of group decision support systems, Management Science, Vol.33, pp.589-609 (1987).
[8] Farrington, C. and Pine, E., Community memory: a case study in community communication, In P. Agre and D. Schuler (eds), Reinventing Technology, Rediscovering Community (Mahwah, NJ: Ablex) (1997).
[9] Go, K. and Carroll, J.M., Scenario-Based Task Analysis, In Dan Diaper and Neville Stanton (Eds.), Handbook of Task Analysis for Human-Computer Interaction (2003).
[10] Go, K., Carroll, J.M. and Imamiya, A., Familyware: communicating with someone you love, IFIP Conference on Information Technology at Home, Wolverhampton, UK, 28 - 30 June. In A. Sloane and F. van Rijn (eds), Home Informatics and Telematics: Information, Technology and Society (Boston, MA: Kluwer Academic), pp.125-140 (2000).
[11] He, M., Jennings, N.R. and Leung, H.F., On Agent-Mediated Electronic Commerce, available from http://citeseer.nj.nec.com/567141.html (2004).
[12] Ishida, T., Digital City Kyoto: Social Information Infrastructure for Everyday Life, Communications of the ACM, Vol.45, No.7, pp.76-81 (2002).
[13] Ishida, T., Towards Communityware, International Conference and Exhibition on the Practical Application of Intelligent Agents and Multi-Agent Technology (PAAM-97), Invited Talk, pp.7-21 (1997).
[14] Kraemer, K.L. and King, J.L., Computer-based systems for cooperative work and group decisionmaking, ACM Computing Surveys, Vol.20, pp.115-146 (1988).
[15] McKillip, J., Need analysis: Tools for the human service and education, Applied Social Research Methods Series, Vol.10 (1987).
[16] Mynatt, E. D., Adler, A.Ito, M. and O'Day, V. L., Design for network communities, Proceedings of the ACM SIGCHI Confernece on Human Factors in Computer System (1997).
[17] Reviere, R., Berkowitz, S.Carter, C.C. and Gergusan, C.G., Needs Assessment: A Creative and Practical Guide for Social Scientists, Taylor and Francis: Washington, DC (1996).
[18] Witkin, B.R. and Altschuld, J.W., Planning and Conducting Needs Assessments: A Practical Guide, Sage Publications: Thousand Oaks, CA (1995).