Proceedings of
the 2nd International Workshop on
Autonomous Decentralized System

Autonomous Synchronization Technology for Achieving Real Time Property in Service Oriented Community System

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Abstract

The advancement of wireless communication and mobile telecommunication has made mobile commerce possible. In the retail business under the evolving market, the users would like to utilize the appropriate services based on their preference and situation. The service providers need to grasp the current requirements of the majority of the users in the local service area in order to provide the effective service for the current local majority of the service area.

The Service Oriented Community is proposed in order to satisfy both users' and service providers' requirements. In the Community, the members cooperate with each other in order to get mutual benefits like social community. The users provide their requirements to service providers while utilizing the services, and service providers utilize the users marketing information the services while proving the services. This marketing information should be collected in the flexible area based on services in real time. Hence flexibility and real-time property are required.

Time Distance Oriented Information Service System has been proposed to achieve flexibility to provide and utilize the users' marketing information in the area based on services. But this system does not collect the users' marketing information in real time.

In this paper, Autonomous Synchronization Technology is proposed to satisfy real time property. Each node in the community waits for the multiple messages sent asynchronously and continuously, and integrates them. In this way, all the nodes in the community cooperate with each other and as the result real time property is achieved. The effectiveness of this technology is shown at the end.

1. Introduction

The advancement of wireless communication and mobile telecommunication has made it for users possible to access information services with a mobile device anytime and anywhere. Mobile devices have been pervasive. In Japan more than 50 million users access the Internet with mobile phones like I-mode. The market of mobile commerce has been broadened.

Under the evolving market, it has been increasing even more than the requirement for mobile commerce to provide the situation-aware appropriate services. It means not only location-aware but also timely services and the service reflecting the users' preference, which cannot be satisfied through the global information services such as e-commerce on the Internet.

In order to provide and utilize the appropriate services which are timely and reflecting the users' preference in the local area, the mutual cooperation between users and service providers is required, where users provide their preference information and meanwhile service providers utilized the marketing information in the local area at the moment. This mutual cooperation should be done among service providers and users in the dynamic area based on each service and at the moment under the evolving market. Therefore flexibility and real-time property is necessary for the system.

Systems using a service accelerator system and an autonomous decentralized service system to provide personal service have been reported. [2, 3] These systems mediate between service providers and users and provide individual user with services based on their profiles. However, these services cannot satisfy the local majority in the temporary occasion. Conventional location awareness systems using mobile terminal can provide services based on the users location. [4, 5, 6] These technologies describe a basic concept of service mediation platform, but they assumed that each service is

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provided to static area. Provision to the dynamic area cannot be realized.

Time Distance Oriented Information Service System [7] has been proposed to achieve flexibility in providing the information in the dynamic area based on each service. But in this system, real-time property in collecting the users' marketing information is not achieved.

This paper shows the proposition of Autonomous Synchronization Technology to achieve real-time property. Each node waits for the messages sent asynchronously and integrates them over and over, and as the result, real-time property can be achieved.

This paper is structured as follows. Next section presents the application and system requirements. Section3 discusses Service Oriented Community System. Section4 exposes our proposed Autonomous Synchronization Technology. Section5 shows the effectiveness of our proposed technology. Last section concludes the paper.

2. Requirements

2.1. Application Requirements

2.1.1. Users Requirements

The circumstances surrounding users are constantly changing and so are their requirements. Users require the utilization of appropriate services based on their current situations and preferences.

Users would like to reduce the price of goods that they would like to buy. If many users in the neighborhood temporarily have the same requirement, they make the pressure group and it can reduce the price. Users would like to cooperate with each other by sharing their requirements.

2.1.2. Service Providers Requirements

Service Providers (SP) would like to increase sales constantly in the evolving market. In the retail business SP has provided services for the users in not the global but the local area around it. In order to increase sales SP would like to provide the effective service to the users in the local service area. Therefore SP would like to grasp the users' marketing information at the moment and to determine the most effective service for them.

The service areas differ according to each service. For example, inexpensive goods like bread and vegetables are bought by users near the SP, and expensive goods like electric devices and PC are bought also by users far from the SP. Therefore SP would like to change the area where it grasps the users' marketing information.

And users in the service area are changing at every moment because they are moving. Therefore SP would like to grasp the users' marketing information at the moment to create the service in real time.

2.2. Service Oriented Community

The Service Oriented Community is proposed in order to satisfy both the requirements of the users and that of SP. The Community consists of members such as the users and SP in the specified area based on services.

In the Community, the members cooperate with each other in order to get mutual benefits like social community. The users provide their requirements to SP as well as utilize the services, and SP utilize the users marketing information as well as provide the services.

As the result, SP can grasp the current majority requirement in the community by collecting the users' marketing information, and determine the most appropriate service based on it.

2.3. System Requirements

In order to satisfy these users' and SP's requirements, the system that provides and utilizes the users' marketing information based on the service in real time is asked for the following requirements.

Flexibility

Users would like to utilize the appropriate service based on their preference and situation like their location and time from SP in each user's accessible area, and SP would like to provide the effective service for users in the service area based on service. In order to satisfy both users and SP, to collect the users' marketing information in the service area is necessary. And the service areas differ according to each service. Therefore flexibility to change the community area to provide and utilize the information based on service itself is required for the system.

Real-time property

Users would like to utilize the appropriate service at the moment, and SP would like to grasp the marketing information that consists of the users around SP at the moment. Users around SP are constantly changing because users are moving, and users' requirements change constantly as the current situation changes. There are a number of users in the community and it is necessary to collect the large amount of the users marketing information and to send the result to SP in real time. Therefore real time property to the dynamic situation is required for the system.

3. Service Oriented Community System

Service Oriented Community System called Time Distance Oriented Information Service System has been proposed, which achieves flexibility described previously.

3.1. Time Distance

Time Distance is a logical distance that is defined by user's physical moving time, and an efficient measure to determine the appropriate community areas. Because user's access time is different based on the physical condition, like a river or some physical obstacles, and the

condition like traffic jam even if physical straight distance is the same, the community area which means the user's accessible area based on service cannot be defined by physical distance. Hence, Time Distance has been proposed to measure the community area based on services.

3.2. System Architecture

The system is structured based on Autonomous Decentralized Systems. [1] It consists of the autonomous subsystems, which are nodes, SP and users with mobile devices.

Nodes are base stations of the wireless network. They transmit data between physically neighboring nodes, and broadcast messages to the users within the sphere of the cell. Each node has a time distance table, in which time distances are registered from neighboring nodes.

SP communicates with the physically nearest node and it has its own services that change dynamically in the evolving situation. SP determines the lifetime for each service.

The users have a wireless connection to the nearest node. Each user has his preference that contains his demand information.

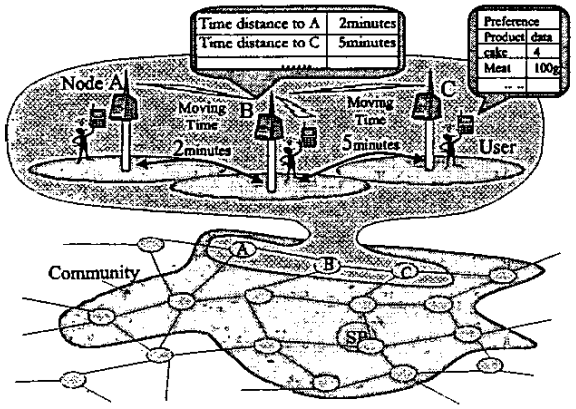

Figure 1: System Architecture

3.3. Autonomous Information Provision

Autonomous Information Provision Technology has been proposed to achieve flexibility of the information provision based on services. It makes the request message for collecting users' requirement information provided in the community based on the lifetime of the service.

The request message contains the Content Code (CC), the Service Lifetime (SLT), the Cumulative Time Distance (CTD), Service ID (SID) and the service's information. CC shows that this message is a request message. SLT means the service area, which is defined by time distances, of the service that SP can describe based on each service. To CTD each node adds the time distance. SID shows the unique identifier of the message.

SP sends the request message attached the SLT to the nearest nodes. This request message is provided in the community of SLT in the following way.

When the node receives the request message directly from SP, it attaches CTD=0 in the message and sends it to all the neighbor nodes. Each node receiving the request message updates CTD by adding the time distance from former node. The node autonomously judges whether the request is valid or not based on updated CTD. If the CTD is larger than SLT, the node disposes of it. Otherwise, the node sends the message to all the neighbor nodes without the sending node.

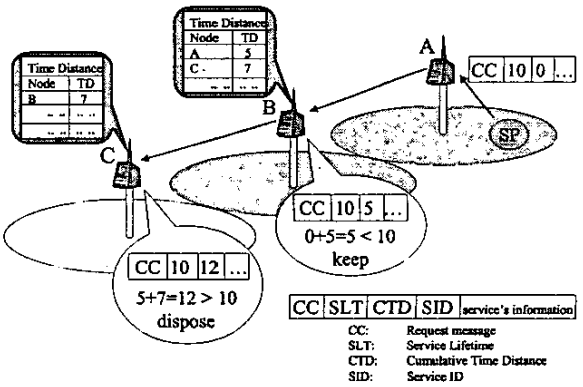

Figure 2: Autonomous Information Provision

In case that the node receives the same request message, which is shown by the same SID, if CTD of the latter message is not smaller than that of the former, the node disposes of it. Otherwise, the node processes it in the same way of the first receiving.

Thus the request message from SP can be provided to all the nodes in the community based on the property of the service lifetime flexibly. In this way, flexibility to provide the information based on service is achieved.

3.4. Process of Collecting Users' Marketing Information

After providing the request message to the nodes in the community based on the service by autonomous information provision technology, the nodes broadcast the request message to the users in cell.

All the messages from users are sent to SP in the following way. Each user sends his demand information containing SID of the request message to the nearest node, and the node sends it to the upper node that sent the request message containing the smallest time distance of all the neighbor nodes that sent the same SID. The message is sent to the upper node over and over, and by this means the return path is autonomously judged by each node and all the messages from the users are sent to SP in this system.

3.5. Problem in collecting process

In order to finish collecting all the users' information

in the community in real time, there are two necessities. SP must receive the users' information soon, and counting process of that must be finished soon.

It takes little time for SP to receive all the users' information by the primitive way that each node receiving the information from users only sends the information to the upper node without any processing as soon as it receives. But that only SP does counting process costs much time because there are so many users in the community.

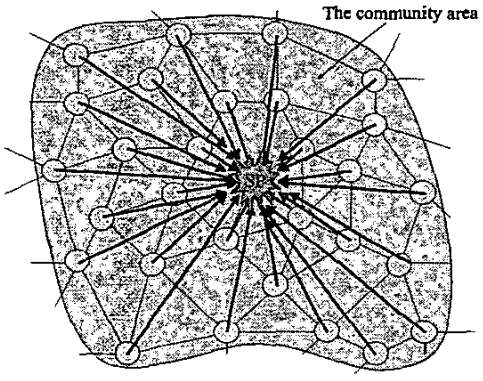

Figure 3: Problem in Collecting Process

In this centralized way, real-time property cannot be achieved.

4. Autonomous Synchronization

In order to achieve real-time property in counting all the users' marketing information in the community, Autonomous Synchronization Technology is proposed.

If only SP does counting process of users' demand information, even if SP receives them as soon as possible, it takes much time. Hence, load sharing among the nodes in the community is necessary to achieve real time property. In order to decrease SP's load, not only SP but also each node in the community has to do collecting process of the users' requirement information. If each node collects the messages of the requirement information and integrates them before sending them to the upper node, the messages received by SP decrease and processing time are both decreased. The messages of user's marketing information are sent asynchronously and continuously from user's mobile devices to the nearest node through the wireless connection. Therefore, each node can get the multiple messages by waiting in a certain period of time and synchronizing them.

When each node receives the message from a user or a neighboring node, it begins to wait in the synchronizing time to receive the other marketing information. Each node does not need to know which node sends the messages. If the node receives the other messages containing the same SID from the other users or the other neighbor lower nodes in this time, it integrates these messages into one message. It forwards the integrated message to the upper node when the synchronizing time is expired. Each node does not know when a node sends the messages. If the message is received after forwarding the integrated message, the node waits, synchronizes and integrates it with the next receiving messages, and forwards it to the upper node.

The asynchronous messages are synchronized and integrated continuously by each node, and the messages received by the upper nodes including SP are decreased. As the result, the response time that SP finishes collecting process of all the users' demand information is decreased.

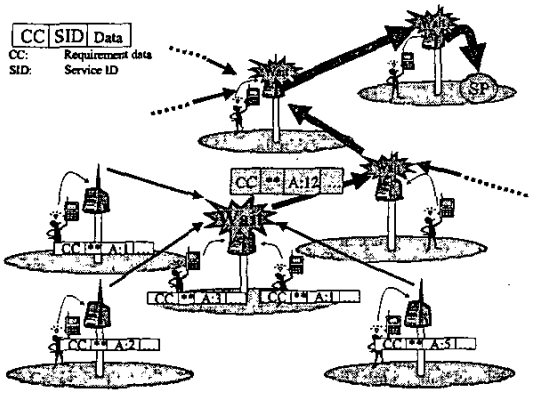

Figure 4: Autonomous Synchronization Technology

5. Evaluation

Proposed technology is evaluated with the following model, and the effectiveness is clarified.

5.1. Evaluation Model

To evaluate the effectiveness of the proposed technology, the response time, which is defined as the time from when SP sends the request message until when SP gets the result of the information collected from all the users' marketing information, is compared with the centralized way that only SP does collecting process.

The assumption of the simulation environment is shown as following.

There is one SP in the network, and a certain number of users distributed equally. Each node has the same capacity and each node can process 500 users' data per second. Each node has 6 neighbor nodes and 250 users in each cell. Each user sends the information randomly within 1 second. The community area changes like a concentric circle and the number of the users in the community changes as the community area is changing.

5.2. Results

By this model, we compare the response time of the proposed technology with that of the centralized one under the condition that the community area changes

from 1 layer (1 node, 250 users) to 10 layers (54 nodes, 67750 users).

The result is shown in Figure 5.

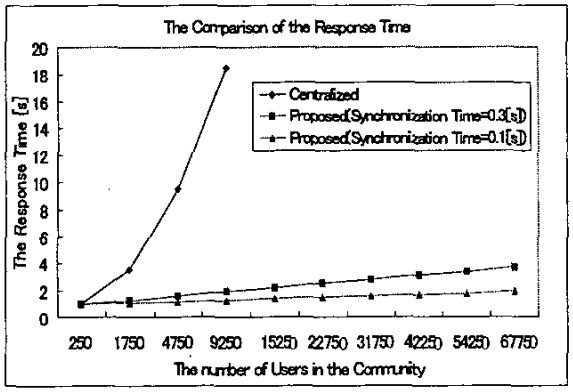

Figure 5: Simulation Results (1)

Figure 5 describes the effectiveness of the proposed technology. The proposed technology costs less time than the centralized one. Even under the condition when the number of users is large, response time is small with the proposed technology, so real-time property is assured.

In Figure 5 there are two cases of the proposed technology where synchronizing time (ST) is 0.3 [s] and 0.1 [s]. The case of ST=0.1 is better than that of ST=0.3. This shows that there exists a relation between synchronizing time and response time. If synchronizing time is small, it takes little time for SP to receive messages but the number of messages received by SP is large and collecting process of SP costs much time. But on the other hand, synchronizing time is large, it takes much time for SP to receive messages but the number of messages received by SP is small and collecting process of SP costs little time.

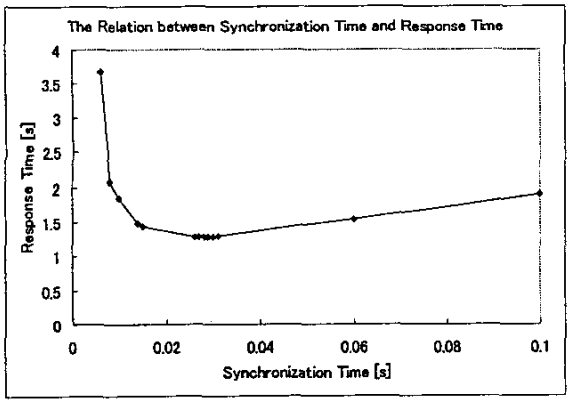

Figure6: Simulation Results (2)

Figure 6 shows the relation between synchronizing time and response time under the condition that the community has 10 layers, 54 nodes and 67750 users.

It describes that there is an optimal synchronizing time (OST) and it is 0.027 [s]. In the case that ST is less than OST, the response time is increasing rapidly because of load concentration in some nodes. In the case that ST is more than OST, the response time is increasing gradually because of the overhead of waiting time.

6. Conclusion

It has been increasing even more that the requirement for mobile commerce to provide the timely services reflecting the users' preference under the evolving market. Users would like to utilize the appropriate services reflecting their location, time and preference. SP would like to grasp the current users' requirements in the area based on each service at the moment to determine the effective service.

In order to satisfy both the users and SP's requirements, Service Oriented Community is proposed. In the Community, the members cooperate with each other in order to get mutual benefits like a social community. SP grasps the current requirements by collecting users' marketing information in the community area based on services in real time.

Time Distance has been proposed as the efficient measure of the community area, and Time Distance Oriented Service System has been proposed to achieve flexibility to provide users' marketing information based on each service. But real-time property in collecting the large amount of users' marketing information in the community is not achieved.

Autonomous Synchronizing Technology is proposed to achieve real-time property. Each node waits for the multiple messages from users in the cell and neighboring nodes, integrates them into one message, and forwards to the upper node over and over. As a result, the number of messages received by SP is decreased, as the result the time to finish collecting process at SP is decreased.

Effectiveness of the proposed technology is clarified. It assures real-time property even in the case of increasing the number of users.

References

[1] K. Mori, "Autonomous Decentralized System: Concept, Data Field Architecture and Future Trends", Proc. of ISADS93, pp28-34, March 1993.

[2] K. Mori, S. Yamashita, H. Nakanishi, et al., "Service Accelerator (SEA) System for Supplying Demand Oriented Information Services", Proc. of IEEE 3rd ISADS, pp.129-136, April 1997.

[3] ADSS DSIG (Autonomous Decentralized Service Systems, Domain Special Interest Group), White Paper for ADDS, ads/98-12-01, OMG, 1997, http://www.omg.org/

[4] J. Hightower and G. Borriello, "Location Systems for Ubiquitous Computing," IEEE Computer, vol.34, no.8, pp.57-66, 2001.

[5] N. Marmasse and C. Schmandt, "Location-Aware Information Delivery with ComMotion," HUC2000, LNCS1927, pp.157-171, 2000.

[6] Y-C. Tseng, W-H. Liao and C-M. Chao, "Location Awareness in Ad-Hoc Wireless Mobile Networks," IEEE Computer, vol.34, no.6, pp.46-52, 2001.

[7] Takanori Ono, Khaled Ragab, Naohiro Kaji and Kinji Mori, "Service Oriented Communication Technology for Achieving Assurance," 1st International Workshop on Assurance in Distributed Systems and Networks, 2002.