



Trial manufacture of sales supporting system using mobile agent technology

Kiyotaka Seki

Railway Technical Research Institute, Japan.

Abstract

We have developed a system for sales staff to access database systems which contain the information on customers and travel plans through mobile terminals such as a notebook PC from their location. This system uses a Java-based mobile agent system, in that the "login agent" is first activated at the mobile terminal and moves to an authentication server with user ID and password information. When the authentication succeeds, the "information retrieval agent" is activated at the authentication server, and moves to the mobile terminal. The information retrieval agent communicates with "database management agents" which reside at database servers, retrieves the information on customers and travel plans for reservation. Merits of this system are as follows.

- 1) As the agent for the process moves to the mobile terminal from the server at the execution time, it is not necessary to upgrade the program of any mobile terminal.
- 2) There is no data or program at the mobile terminal except the login agent, so the possibility of leaking information is very low even if the mobile terminal is lost or stolen.
- 3) The agent can access multiple database systems with only one communication protocol because the differences between specifications of database systems are absorbed by database management agents.

We measured the quantity of transferred data and response time required for the agent to move. Although it takes a comparatively long time for the first retrieval because the agent has to move to the mobile terminal, it is still about 10-15 seconds at the transmission rate of about 28.8kb/s, which is allowable for practical use. After the first retrieval, only data is transmitted, so the communication time is nearly equal to the time for data transmission.



1 Introduction

The agent technology is becoming increasingly important in these years. The mobile agent is an agent focused on the mobility over the network that can move from one computer to another for execution. The mobile agent technology is thought as one of the core technologies for distributed systems in the next generation, and a number of development tools are provided from various organizations and companies. Many of the tools are JavaTM-based ([1][2]), of which some provide not only the mobility function but also the communication function between agents and function to reproduce its own schedule according to the environments to be visited.

One of the examples of the mobile agent technologies adopted for travel-related system is "TabiCan", which is an electronic marketplace implemented by the AgletsTM system developed by IBM Japan ([3][4]). In this system, a consumer agent communicates with shop agents, and retrieves and reserves travel plans such as air tickets and package tours. Foundation for Intelligent Physical Agent (FIPA), which sets various specifications of agent technology, specifies the "Personal Travel Assistance"[5] system which can provide assistance in the pre-trip planning phase as well as during the on-trip execution phase. FIPA Agent Communications Technologies and Services (FACTS) project performed experiments in order to certify the FIPA specifications[6].

As the wireless telecommunication technology and electronic devices technology progress on the other hand, mobile computing which enables us to process information anytime and anywhere is now being realized. Examples of media which provide advanced wireless telecommunications are Personal Digital Cellular System (PDC), Personal Handy-phone System (PHS) which provides digital micro cellular phone services, Wireless LAN, and International Mobile Communication-2000 (IMT-2000) in the near future.

To realize of advanced information processing systems of railway, it is essential to consider communications and collaborations between mobile entities such as trains, crews, station staffs, trackside workers, and fixed entities such as dispatchers, host computers and so on. As the communication link can be established with the wireless technology described above, we consider that advanced systems can be constructed effectively by combining the agent technology and the mobile communication technology. Thus, it is possible to construct a more advantageous system than by traditional technologies where communication costs are not negligible or communication links such as the train radio system are unstable, because it is necessary to set up communication links when agent moves or communicates to other agents. An example of these applications is a system which requires vast processing on servers. Another merit is that the destination computer doesn't need resources such as CPU and memory except for execution time and a hard disk drive to store programs. As a result, it is possible to simplify mobile terminals and omit its program maintenance work.

We have developed a system for a sales staff to access database systems which contain the information on customers and travel plans through mobile

terminals such as a notebook PC from their location. In this paper, we describe the specification of this system and the results of experiments.

2 Specification

In this section, we introduce the specification of this system.

2.1 Configuration

Figure 1 shows the configuration of the system. The sales staff who possesses a mobile terminal accesses the database system for information on customers and travel plans from his location or at tentative windows of busy seasons. A database maintenance staff adds, updates or removes information on travel plans and sales staff.

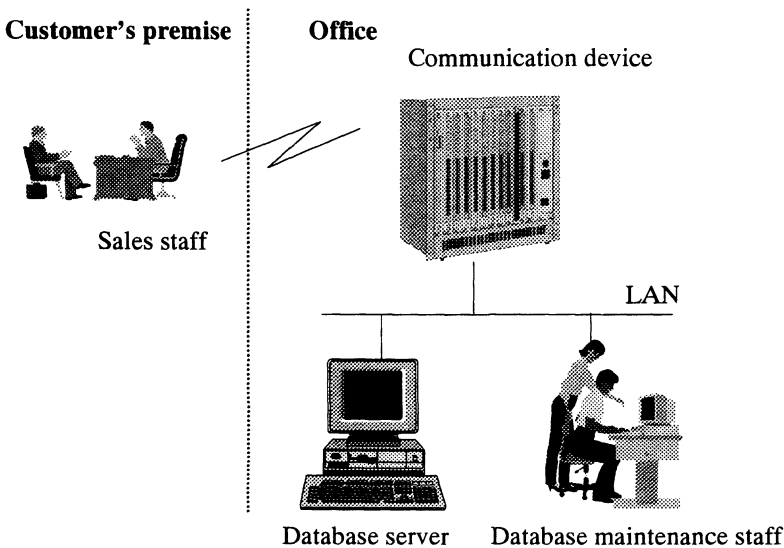


Figure 1: Configuration of the mobile sales system

2.2 Overview of processing

Table 1 summarizes the implemented functions. This system is implemented with Aglets as the mobile agent system. We use package tours as travel plans.

2.2.1 Mobile information retrieval function

Figure 2 illustrates an overview of processing for the mobile information retrieval function.

2.2.1.1 Authentication When designated, a login agent is activated at a mobile



terminal and displays a login menu for which the sales staff inputs a user ID and password.

The login agent is dispatched to an authentication server with input data and creates an authentication agent. The authentication agent accesses a sales staff database and notices the result of the authentication via communication between agents.

Table 1: Summary of functions

Function name	Description
Mobile information retrieval	Sales staff with mobile terminal retrieves customer information and travel plan information and makes reservation
System Environment setting	Database maintenance staff sets the operational environment of database servers and registers, modifies or deletes the sales staff information
Travel plan maintenance	Database maintenance staff registers, modifies or delete travel plans and hotel information

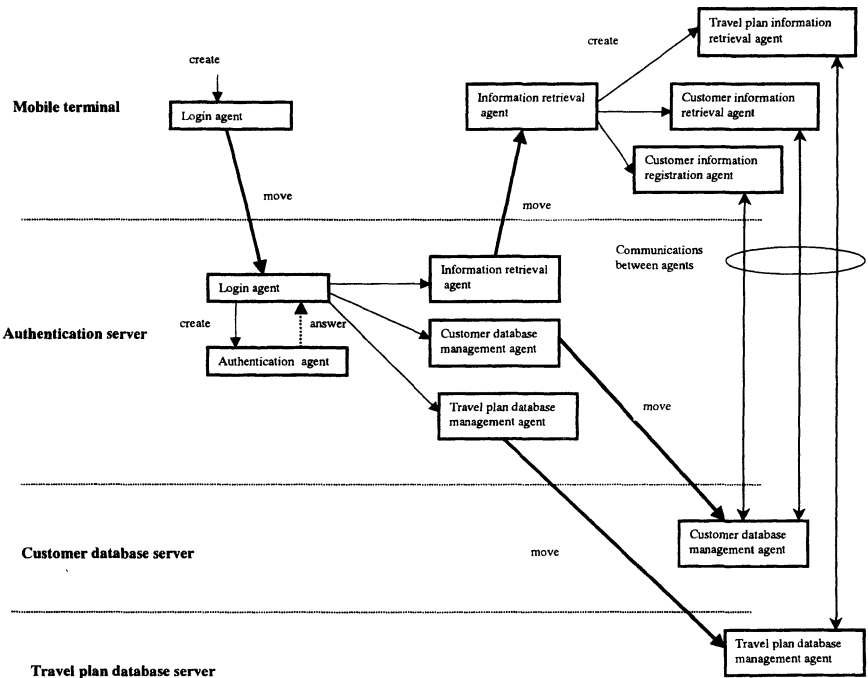


Figure 2: Overview of processing for the mobile information retrieval function.



When the authentication succeeds, the login agent creates an information retrieval agent, a customer database management agent, and a travel plan database management agent and becomes extinct. The three created agents are dispatched to the appropriate machines (the mobile terminal, database servers).

The information retrieval agent displays a menu from which the sales staff can select customer information retrieval, travel plan information retrieval or customer registration.

2.2.1.2 Customer information retrieval When selected, a customer information retrieval agent is created and requests input of retrieval conditions (customer's name, customer ID or customer's telephone number). The customer information retrieval agent then asks the customer database management agent about a list of the customers who satisfy the conditions via communications between agents and displays it. The customer database management agent creates SQL sentences and performs information retrieval.

When the sales staff selects a customer from the list, the detailed information is displayed (Figure 3). The staff can edit or delete the customer information including his name and address in the left half of this display. The right half shows the customer's history of purchase

After that, the sales staff can select the travel plans information retrieval.

旅行計画一覧	出発日	出発地	乗車区間	乗車回数	乗車料	乗車料(円)	乗車料(円)	乗車料(円)
東京-大阪	2000/09/15	74,200	東京-大阪	1	74,200	74,200	74,200	74,200
小樽-札幌	2000/07/18	178,800	小樽-札幌	1	178,800	178,800	178,800	178,800

Figure 3: Examples of the display of the customer's detailed information

2.2.1.3 Travel plan information retrieval and reservation When selected, a travel plan retrieval agent is created and requests input of retrieval conditions (Figure 4). The travel plan retrieval agent then asks the travel plan database

management agent about a list of the retrieved travel plans and displays it (Figure 5). The travel plan database management agent calculates scores of the travel plans according to the designated conditions and answers the travel plans with high scores. Section 2.3 describes the retrieval conditions and how to assign the score to each travel plan.

When the sales staff selects a travel plan from the list, the detailed information of the travel plan is displayed. After the input of departure date, the reservation of the travel plan completes.

2.2.1.4 Customer registration When selected, a customer registration agent is created and requests input of the customer's information (customer's name, customer's telephone number, etc. which displayed on the left half of Figure 3). The customer registration agent then asks the customer database management agent about the registration of the customer via communications between agents.

Merits of this configuration are as follows.

- 1) As the agent for the process moves to the mobile terminal from the server at the execution time, it is not necessary to upgrade the program of any mobile terminal.
- 2) There is no data or program at the mobile terminal except the login agent, so the possibility of leaking information is very low even if the mobile terminal is lost or stolen.

Figure 4: Example of travel plan retrieval request

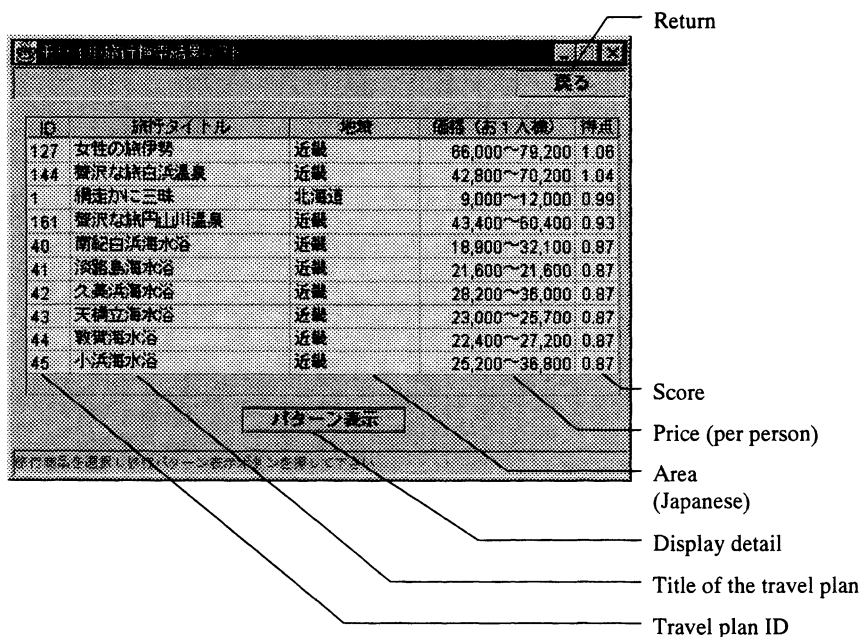


Figure 5: Example of result of travel plan retrieval

3) The agent can access multiple database systems with only one communication protocol because the differences between specifications of database systems are absorbed by database management agents.

2.2.2 System environment setting and travel plans maintenance functions

Although these two functions are usually performed from terminals on the same local area network as database servers, they are implemented by using mobile agent in order match the mobile information retrieval function. The authentication process is the same as that of the mobile information retrieval function. In these functions, however, an agent corresponding to the selected process is created on the server instead of the terminal, because the communication capacity between the terminal and the servers is very large.

In the system environment setting and travel plans maintenance functions, the processes listed in Table 2 and Table 3, respectively, are implemented

2.3 Scoring

When travel plans are retrieved, the score is calculated for each travel plan, and travel plans are listed in the descending order of their scores. We adopt the following formula to calculate the score.



Table 2: Processes provided by the system environment setting

Name	Description
Servers environment setting	Set servers' name, port numbers, etc.
Scoring function setting	Set the default value of the scoring function(see 2.3).
Sales staff maintenance	Register, update or delete sales staff information

Table 3: Processes provided by the travel plan maintenance function

Name	Description
Travel plan maintenance	Register, update or delete travel plan information.
Hotel maintenance	Register, update or delete hotel information.

$$R(x) = \sum_{i=1}^n \alpha_i * S_i(x) \quad (1)$$

where $R(x)$ = Score of travel plan x

$S_i(x)$ = Score contributed by criterion i

α_i = Weight for criterion i

n = Number of criteria

That is, we think the score of a travel plan is given by the weighted sum of scores contributed by some criteria. In this trial manufacture, we adopt the following four criteria (i.e., $n=4$).

1) $S_1(x)$:Adaptation to designated conditions

This criterion evaluates the conditions requested by a customer. $S_1(x)$ is calculated by eqn (2).

$$S_1(x) = \sum_{j=1}^m \beta_j * C_j(x) \quad (2)$$

where $C_j(x)$ = Score contributed by condition j

β_j = Weight for condition j

m = Number of conditions

In this trial manufacture, we adopt four conditions (i.e., $m=4$); area, price, departure date and keyword. The values of α s and β s can be set by slide bars (see Figure 4).

2) $S_2(x)$:Similarity to other customers

A high score is given to the travel plans which other customers who have the similar interest in the target customer have purchased. The similarity of interest is thought to be measured by how many travel plans of the same contents were purchased by two customers.

$$S_3(x) = \sum_{k=1}^p D_k(x) \quad (3)$$



where $D_k(x)$ =Degree of the similarity of interest with the
target customer and another customer k who purchased x
p=Number of customers who purchased x

3) $S_3(x)$:Coincidence with the history of purchase

The customer's interest is extracted from his history of purchases. The travel plans which are thought to match his interest are given high scores.

$$S_3(x) = \sum_{j=1}^m E_j(x) \quad (4)$$

where $E_j(x)$ =Degree of the customer's interest about condition j
m=Number of conditions (same as (1))

4) $S_4(x)$:Promotion to travel plan

The database maintenance staff gives this score when he registers the travel plan according to the sales policy.

3 Experiments

We measured the amount of transferred data between mobile terminal and servers, and evaluated the behavior of the system where the telecommunication environment was unstable.

In these experiments, we used PHS private mode as the wireless communication channel.

3.1 Amount of transferred data

We performed a series of nformation retrieval processes from a mobile terminal twice and measured the total frame length transferred over the PHS channel and elapsed time between the first frame and the last frame transmitted for each process unit.

Table 4 shows these values and the estimated transfer time which was calculated from the total frame length divided by the transmission rate (28.8kbps) for the processes of customer detailed information display and travel plans retrieval. As class libraries necessary to perform the process are transmitted from the server at the first time, the total frame is rather long, but it is thought to be allowable for practical use. At the second time or later, only the designated conditions for the retrieval and its results are transmitted, so the total time is very short. The difference between the estimated transfer time and elapsed time is thought to be the database access time.

3.2 Behavior in unstable environment

Even in the environment where frame errors occur frequently (about 4% of the frames were damaged) due to very weak radio power, this system could operate correctly.



Table 4: Amount of transferred data

		First time	Second time
Customer information retrieval	Total frame length (Kbyte)	41.6	5.9
	Estimated transfer time(sec)	11.5	1.7
	Elapsed time(sec)	17.5	3.2
Travel plan retrieval	Total frame length (byte)	29.5	4.0
	Estimated transfer time(sec)	8.2	1.1
	Total time(sec)	15.7	3.1

4 Conclusion

Through the trial manufacture of sales supporting system by the mobile agent technology, we can obtain prospect of realizing practical systems. We will continue to study the intelligence in particular, as explained below.

- 1) To reduce the amount of transferred data over the wireless link by operating autonomously. For example, the agent changes retrieval conditions to squeeze the result of retrieval, or reserves a travel plan which is available.
- 2) To acquire the customer profile or customize the process according to the profile autonomously.
- 3) To enable retrieval by ambiguous conditions or associated information as well as keyword or travel plan title.
- 4) To enable adding a new criterion and modifying the existing criteria, etc.

Moreover, we will study adaptation to other applications as well as the sales supporting system. For example, by adapting it to systems which control or monitor on-board devices from the ground (dispatcher or train depot), it is possible to simplify on-board devices by dispatching an agent which corresponds to the running line or section.

References

- [1] Wong,D., Paciorek,N., Moore,D. Java-based Mobile Agents, Communications of the ACM, 42(3), pp.92-102, 1999.
- [2] Kiniry,J., Zimmerman,D. A hands-on look at Java mobile agents, IEEE Internet Computing, 4(1), IEEE, 1997.
- [3] Lange,D.B., Oshima,M. Programming and Deploying JavaTM Mobile Agents with AgletsTM, Addison-Wesley, 1998.
- [4] Yamamoto,G., Nakamura,Y. Architecture and Performance Evaluation of a Massive Multi-Agent System, Research Report,RT-0272, Tokyo Research Laboratory of IBM Japan Inc., 1998.
- [5] Foundation for Intelligent Physical Agents. Personal Travel Assistance, FIPA 97 Draft Specification Part 4, 1997.
- [6] WP3 partners: BT, CNET/ONERA, KPN, BROADCOM. Phase I Demonstrator (Personal Travel Market), FACTS, 1999.