A Multi-Agent Architecture For a Transport's Multi-Modal Information System.

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Abstract: A wide and growing variety of transport's useful information and services become available daily, but technical supports for discovering, selecting and integrating these resources still limited. This is due to several reasons of different types: organizational, economical, juridical, technical and quality reasons. The purpose of this study was, first, to analyze the existing works in terms of Multi-modal Information Systems adapted with the transport's context. Then we propose a Multi-modal Information System modeling based on Multi-Agent concept. Finally we present some implementation results.

Key-Words: Multi-agent system, Mobile agent, Transport's information, Multi-modal transport, Information system.

1. Introduction

At present there is considerable activity associated with the development of public transport information systems. Some developments are to assist the efficient and effective operation of services; others are centered on the delivery of improved information to the customer. The aim is finally to give a precise and optimized description of the passenger route, with other services that corresponds to the traveler information requests.

These new multi-modal information services presuppose to cross data from networks and services, to organize them and finally to disseminate information through different multimedia means [1]. They involve an efficient co-ordination between different actors (Government, regional authorities, transport operators, industry, service companies, researchers, etc.). However, to produce multi modal information, this –ordination should be realized by a multi-servers integrating platform, allowing exchange of information and cooperation among network-wide distributed and heterogeneous actors' applications.

2. What exists really in terms of Transport's Multi-modal Information System (MIS)?

2.1. National projects (France)

The majority of the implemented transport's information systems are mono modal, dealing with only one means of transport. Many web sites can be classified in this category of mono modal systems such as Phebus [2]: Versailles company of transport; or Solea [3] For transports of Mulhouse and its suburbs. Other information systems are multi-modal, concerning several means of transport, but they always concern one transport operator, such as Transpole [4], for Lille and its suburbs, Pilote [5] for Marseille and its suburbs, or RATP [6] for Paris and its suburbs. Because they belong, each one to an only one transport operator, these last-mentioned systems still geographically limited.

To federate the latter projects and to capitalize the transport's research experiences in terms of multi-modal information, the PREDIT- National program of research [7], experimentation and innovation in land transport- has recently created the PREDIM [8]- the research and experimental platform for

the development of multi-modal travel information.

2.2. European projects

Two projects should be mentioned. Firstly, The INFOPOLIS project which aims essentially to ameliorate the quality of transport information produced by the existed systems. And secondly, the ISCOM project dealing with the development of new multimedia techniques of information diffusion [9].

2.3. Others issues: Personalization

As a recent research issue, the information personalization is trying to adapt the transport's information with users profiles, using a multi agent architecture to collect, to filter and to present information [10].

3. Problematic

Because there are many private organizations in the passenger transport industry, the complexity of information flows has increased with a multitude of different information systems serving different tasks, dealing with different data formats from different private sources. Therefore, unfortunately, till now, there is no coherent transport's multi-modal system, giving satisfying information for customers [11]. This is caused by several reasons, such as:

- *Organizational reasons*: several transport actors and operators contribute in producing transport information which complicates any coordination attempts between them to produce multi-modal information;

- *Economical reasons:* the transport information coasts much to the operators. And more over, in the concurrence context, to be more competitive, transport operators are obliged to protect their information.

- *Juridical reasons:* providing and using this transport information requires a real reflection, not only about the property of this information, but also about the responsibility which is attached to its use.

- *Technical reasons:* There are multiple data sources, dispersed on different servers, presented in several formats, and diffused by different technologies which are besides in a continuous evolution. As a matter of fact, managing multi-modal information become more and more complicated.

- *Quality reasons:* Updating the multi-modal information, considering the eventual transport perturbations, responding in real time to users' requests, and giving precise and personalized information to customers, constitute the more important challenges to produce information of quality.

4. Problem solution: An UML model of a multi-agent architecture for transport multi-modal information system.

4.1. Multi-Agent Systems

Software Agents and their use in various applications areas such as electronic commerce have been studied extensively in the literature [12-16]. These agents are personalized, continuously running and semi autonomous programs to which people or other programs may delegate a task automating part of a business process of varying complexities and application domains. They can also be mobile agents, moving from server to server to execute several tasks.

In this work we use the agent concept. The use of such a concept facilitates the conception of the distributed multi-modal information system, and makes more flexible the different system's tasks, such as :

- gathering data,
- treating different formats,
- producing the requested information
- diffusion of the transport's information.

4.2. UML modeling in brief

The UML is a software industry standard modeling language for visualizing, specifying, constructing, and documenting the elements of

systems in general, and software systems in particular.

In UML, systems can be modeled by considering three aspects, namely, behavioral, structural and architectural aspects [16-17]. Each aspect is concerned with both the static and dynamic views of the system. The static view represents a projection onto the static structures of the complete system description. However, the dynamic view represents a projection onto the dynamical behavior of the system. Finally, views are communicated using a number of diagrams containing information emphasizing a particular aspect of the system.

The growing use of agents and mobile agents necessitated the introduction of tools for modeling and developing mobile agent Application. A recent work was done to define an extension to UML for the modeling of mobile agent-based software systems: M-UML [18].

In the following, we will limit our UML diagrams on the use of the Use case diagram, the class diagram, and interaction diagram.

4.3. System Modeling

4.3.1. The context of use

Public transport users are often concerned with getting from their origin to their destination as conveniently as possible. Convenience includes the acquisition of different possible itineraries, destination area plan, meteo information etc, to plan the travel. It includes also the accessibility of information from any multimedia service: internet, mobile SMS, PDA…[19].To answer these users requests, the Multimodal Information System may ask different operators servers, or different mono-modal information systems. This is illustrated on the following UML Use Case Diagram (Fig 1).

We can suppose that we will add a federative level: an integration platform to federate the existing mono-modal systems, and to do well with the existing databases.

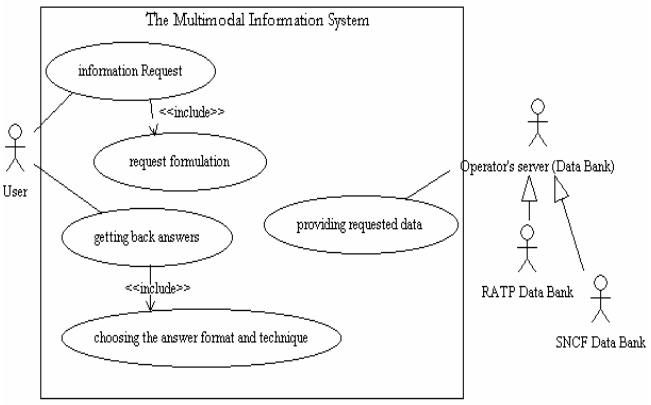

Fig1 : UML Use Case Diagram

The system will be an internet service, available at a net address, or it can be accessible from other multimedia support such as PDA, mobile phone, transport's tickets distributor….etc. It provides the user with requested multi-modal information.

4.3.2. The system's structure

The concept we propose is to associate to each operator's data source, a data provider agent **(DPA)**. We associate in addition to each user a user's informer agent **(UIA)** which helps the user to formulate his request then presents him the answers, and we use a data transporter mobile agent **(DTMA)** to transport data, requests and answers on the net . Finally an optimizer agent **(OA)** is used to steer the data transporter mobile agent on the network.

Since the major communications between agents are data blocs, the chosen method is to use Extensible Markup Language (XML) to formulate requests and to describe answers. The used form of XML is called here TML, Transport Markup Language, it contains a general format which permit the representation of any transport's information (multi-modal itinerary, area plans, meteo information,….). A recent research made in Singapore University is trying to integrate Spatio-temporal information in XML. That is useful to describe precisely itineraries [20].

The UML class diagram illustrating the latter multi-agent information system is illustrated by (Fig2).

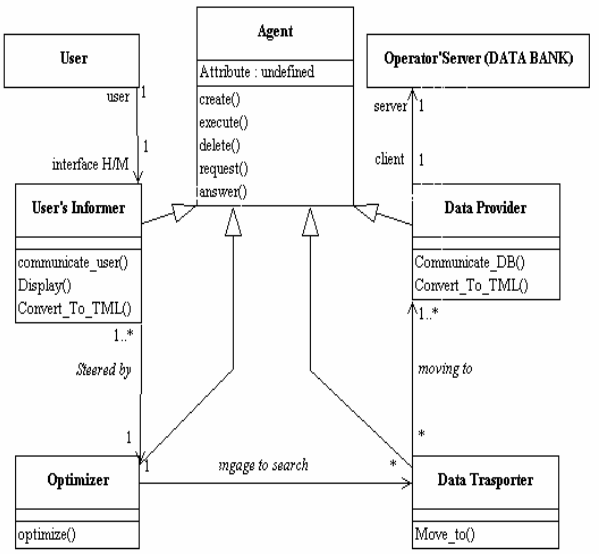

Fig2 : UML Class Diagram

All the system's agents are autonomous; they can create, execute and delete them selves. They are able to communicate TML data with each others, and, the more interesting ability they have, is to appeal each others competences.

In the following, we define the competences associated to each agent as:

User's Informer Agent (UIA): It is the Human/Machine interface of our system, it helps the user to formulate his request step by step, by presenting different forms. It helps the user also to choose the form of his answer, and the way it will communicated to him, by internet.

Its special competence is to convert the user's requests into TML specification: a request that will be addressed to the optimizer Agent.

Optimizer Agent (OA): This agent receives the request from the UIA, analyze it using his Information Distribution Database; divide it into several sub-requests. Then, it determine to which server should the data transporter mobile agent accede to respond to each sub-request. Finally, it provides the data transporter mobile agent a "work plan", indicating the route on the network, and the data to get.

The latter database is a static description of the multi-modal transport network. It can be an instance of the following class diagram (Fig3).

This diagrams shows, for example, that any information dealing with the passage of a means of transport by a station can be reached on a certain server. This association "information type"-server, allows the optimizer Agent to have a cartography précising the placement of each type of information on the servers network.

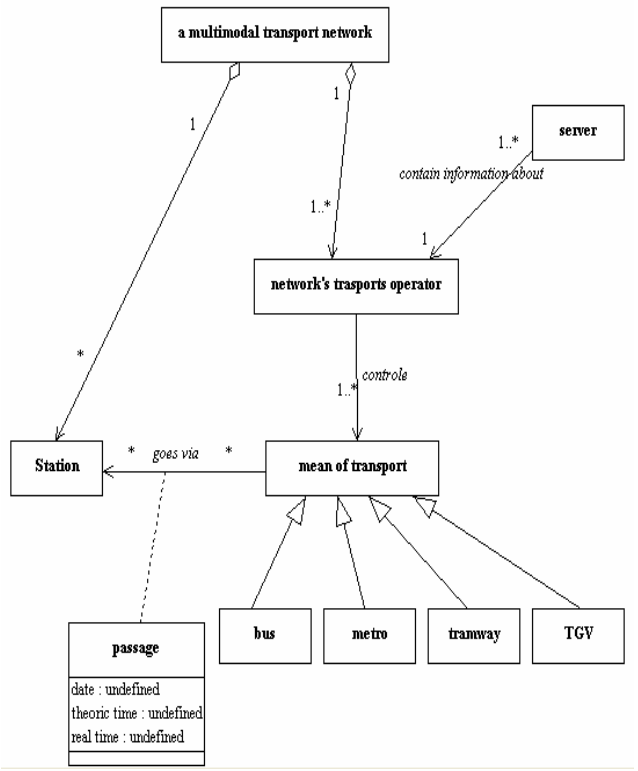

Fig3 : UML Class Diagram

Otherwise, when the instance of such a data-base meta-model, will be determined for each area, it will be possible to deduce the DTD (Document Type Definition) related to the TML language.

Data Transporter Mobile Agent (DTMA): Given the "work plan" précising what data asking and from what server. The DTMA moves from server to server requesting for the needed data. It addresses its request to the data provider agent present in each server.

Data Provider Agent (DPA): The DPA has for **role** to convert the TML DTMA request into a specific request recognizable by the present operator's database, and then to convert the answer given into TML. It finally provides the DTMA with the needed data in the needed format.

The agents interactions can be summarized by the next diagram (Fig4).

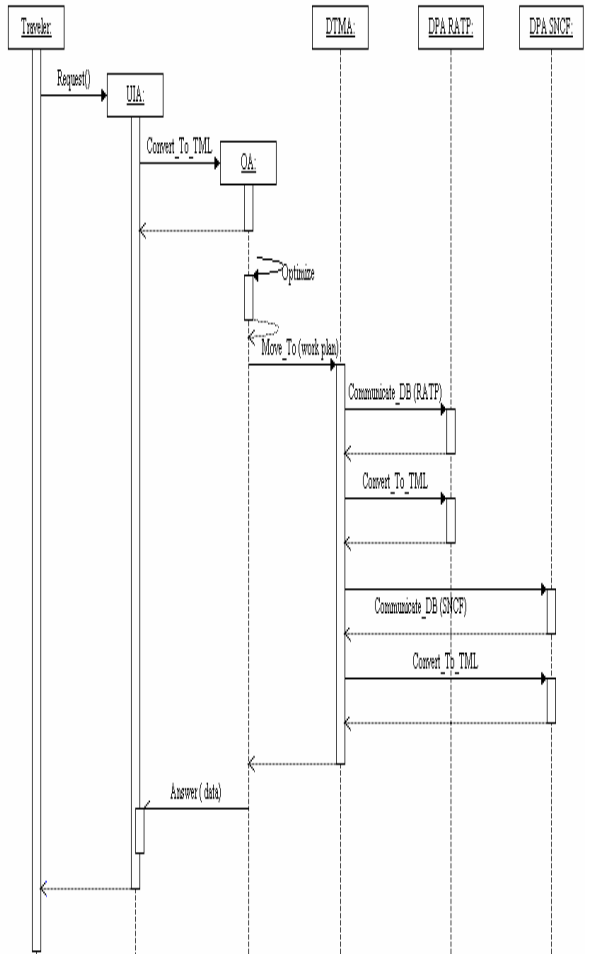

Fig4 : UML Interaction Diagram

4.4. Implementation difficulties

When we proceeded to the concretization, we have faced many difficulties. In fact, the operator's data bases are not freely accessible, so certain works have tried to simulate data banks, others tried to use directly the available mono-modal information systems [7]. We have chosen, the second alternative, and we have implemented as a first step, the Data Agent Providers.

4.5. Data Agent Provider Implementation

The idea is to realize an agent which is able to communicate with an Operator's mono-modal system interface by filling the concerned web forms. The agent pick up then the needed data from the web result page. Finally, it is a program to which we delegate, the surfer's research activity and particularly the information extraction.

To fill automatically the web Forms, the chosen method is to use the "Atomate "software [21]. This software permits the automation of any computer tacks, and particularly the interactive tasks. Before the automation, it is necessary to define precisely the tasks to automate. This is précised in the next UML Diagram Activity (Fig7).

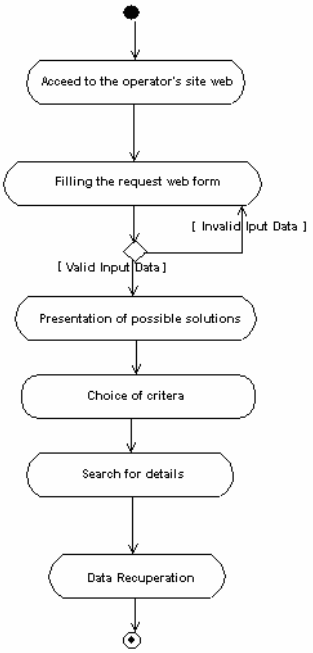

Fig5: The Data Provider Agent Diagram Activity.

The results were satisfying in efficiency terms; we could extract the desired data. Unfortunately, the response time was around 10 seconds for each operator's web form. More over it depends not only of the options presented by the forms, but also of the technical quality of the web connection.

This Data Agent Provider, to be correctly used, should be updated to be adapted to any web forms changes. There, although it respects all juridical constraints, this technical solution still limited.

5. Conclusion

The transport's multimodal information systems development still obstructed by juridical and by organizational constraints. But even if we suppose that there is a freely accessibility to transports operators servers, managing the data flows between the operators computer technical supports, still daily too complicated. The appeal of multi-agent techniques makes the problem more flexible.

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