TOWARDS AN AGENT FRAMEWORK FOR A PASSENGER TRANSPORTATION VIRTUAL ENTERPRISE

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Keywords: AOSE, Virtual Enterprise, Agent Framework, PASSI.

Abstract: This work presents the first approach for obtaining a framework based on the agent technology for the passenger transportation problem, considering a virtual enterprise domain. The agent architecture obtained provides a baseline for the integration between end-users of the transport service and multiple transport operators affiliated to a virtual enterprise, which provides flexibility in the incorporation and leaving of transport operators. The participation of governmental organizations and active destinations within the system allows the virtual enterprise having additional information on potencial opportunities of business and assures to the users of the transport system a wider and more complete service search. The PASSI methodology has been used as base modelling methodology for leveraging the multiagent architecture.

1 INTRODUCTION

Passenger transportation in urban areas constitutes an increasingly important problem in our society. Geographical coverage problems among transport operators services, difference in the volume and quality of handled information, among other, gives origin to problems that range from wrong evaluations comming from state-regulatory entities, up to direct problems with the system final users, which definitively results in a poor quality of service. Therefore, the existence of a group of transport operators, partial or totally disconnected among them, must move towards the conformation of a unified transport service, sustained by a virtual enterprise for passenger transportation.

The obtention of a software framework for the passengers transportation problem will allow to adapt this architecture according to concrete required characteristics, reducing in a important way the development cost, and not less important, while using part of a solution that already has been used in the past and therefore with the necessary maturity and reliability.The framework development has been realized based on the utilization of PASSI (Burrafato, 2002), an agent-oriented methodology for systems development. This work represents the continuity of a past reseach in this transport domain (Cubillos and Gaete, 2007), concerning the development of an agent system for passenger transportation for a single operator under a demand-responsive scenario.

2 PASSENGER TRANSPORTATION

The Intelligent Transport Systems (ITS) have been attracting interest of the transport professionals, the automotive industry and governments around the world. The ITS aim at development of the road infraestructure (for example, ways) and to integrate them together with the persons and vehicles by means of advanced technologies of integration, from several research areas.

On the other hand, in the last years, the Demand Responsive Transport Services (DRTS) have risen in popularity for several reasons, among them, strong incorporation of information and communications technologies, increasing the efficiency and diminishing the operations cost. A DRT is understandable as a component of a long chain of inter modal service, delivering local and complementary mobility to other conventional transportation alternatives, such as the bus or train.

Cubillos C. and Cabrera D. (2008).
TOWARDS AN AGENT FRAMEWORK FOR A PASSENGER TRANSPORTATION VIRTUAL ENTERPRISE.
In *Proceedings of the Fourth International Conference on Web Information Systems and Technologies*, pages 292-295
DOI: 10.5220/0001528602920295

2.1 Virtual Enterprise

A virtual enterprise is a cooperation network of legally independent companies, which quickly constitute a whole and contribute mainly their core competences in order to exploit a specific business opportunity. In general terms, the life cycle of a virtual enterprise is marked by four phases, that go from the identification, evaluation and selection of business opportunities, to the selection of partners for conforming the virtual enterprise; later, a phase of operation, where the business opportunity is exploited and a phase associated to the end of the virtual enterprise, with the corresponding separation of assets.

2.2 Transport Requirements

In the DRTS, is identified a set of actors, who interact in different ways. In general terms and by considering any service, a normal way to understand the term "users" is to only associate it to the "end users", that is to say, to the people that actually use the service. However, in a complex system like this one of passengers transportation, there are many other users or actors who have a direct interest in the commercial, social and infraestructure impacts. According to the present development, the actors considered in a DRTS correspond to:

User. Represents the end user of the passengers transport system. The user has the faculty to make transport requests (with their respective conditions), as well as to indicate any problem that may affect him and that can has incidence in the concretion of the requested trip.

Transport Operator. Represents a transport company within the system. A transport operator can correspond to a single person (who is performing the roles of operator and driver at the same time), or can also correspond to a company composed by multiple vehicles (fleet of vehicles). The virtual transportation enterprise is conformed by heterogeneous operators.

Government Entity. Represents a government party with regulation or control faculties, which guard current legislation and the correct service contracts fulfillment.

Active Destination. Represents a frequent destination within the total of existing destinations. An active destination can make the virtual transportation enterprise to realize a necessity or a business opportunity available, as well as to indicate problems associated to the transport services offered, such as a loss in the quality of service, or restrictions on the operation.

Traffic Information System. Represents an external information system which gives information on present traffic conditions, collisions, traffic jams, alterations due to streets repair, among others.

Virtual Enterprise Information System. Contains a transaction system and a management system of affiliated enterprises. The first system controls all satisfied transportation requests and those in course of action, including all the information of the transport request and of the transportation service characteristics offered through the virtual transportation enterprise. The second system administers the virtual enterprise lifecycle, from the affiliation of a transport operator, to the separation among the operators and the virtual transportation enterprise.

Transport Operator Information System. It is made up of a Fleet Management System and a Solver System. The first system manages at internal level, within the transport operator, all its fleets and/or vehicles affiliated to the virtual transportation enterprise. The second system optimizes the operations of transport by means of a solver of heuristic nature.

3 AGENT TECHNOLOGY

In the last years an emergent paradigm has been increasingly consolidating incide diverse study areas related to the Artificial Intelligence filed. It corresponds to the Agent paradigm, which approaches the development of entities that could act in an autonomous and reasoned way. Considering that consensus does not exist on a single definition for the term Agent, such term will be understood according to what described in (Weiss, 1999): “An agent is a computer system that is situated in some environment, and that is capable of autonomous action in this environment in order to meet its design objetives”.

The need to develop complex applications compound by multiple subsystems that interact with each other does leverage the need to distribute the responsabilities among different agents, moving us to Multiagent Systems (in ahead MAS). Is generally accepted that coordination is a key and distinguishing characteristic in a MAS (Mas, 2005).

4 TOWARDS A FRAMEWORK USING AGENT TECHNOLOGY

The Figure 1 shows a extract of the Agents Identification Diagram, which takes as starting point the description of UML use-cases, offering a general view of all the functionality provided by the system and in addition, it incorporates a grouping of use-cases for each agent identified within the system in order to visualize the responsability level that each of the agents has regarding the system. It is possible to indicate that the generation of diagrams is given on the basis of the use of a graphical tool available for PASSI, denominated PASSI Toolkit (PTK, 2007).

The VirtualEnterpriseAgent receives the transport request and initiates a search of alternatives to satisfy it, registering in the transaction system the received transport request and the identifier of the assigned vehicle. It handles information on all the existing events. Considering the nature of the triggered events, it can carry out changes and/or apply countermeasures to the transport operators. Furthermore, it can receive an affiliation request to the virtual enterprise comming from a transport operator and activates the mechanism to verify its validity and feasibility. It can also drop from the virtual transportation enterprise a specific operator.

The OperatorManagerAgent receives transport requests from users and possible indications on events caused by organizations external to the virtual transport company. At any moment, it knows the total number of vehicles available and the vehicles that are in operation, and obtains the proposals to the received requests of transport.

The ScheduleAgent verifies for a vehicle in particular if it fulfills the conditions specified on a requested trip (user conditions, conditions of the virtual enterprise, or conditions caused by external events), checking its itinerary obtained from the information system of the transport operator. Considering the feasibility verification, a proposal or a declination takes place. For more details on the underlying scheduling and optimization problem please refer to (Cubillos et al. 2007)

A deployment/component hybrid diagram of the general framework architecture is included (see Figure 2). This initiative constitutes a first approach in the conformation of a configurable and adaptable architecture, based on object oriented and agent-oriented technology together with considering the virtual enterprise concept.

Inside each package a set of software components are identified, those of which can correspond to agents (as is the case of the package with the <<Virtual Enterprise Terminal>> stereotype) or to

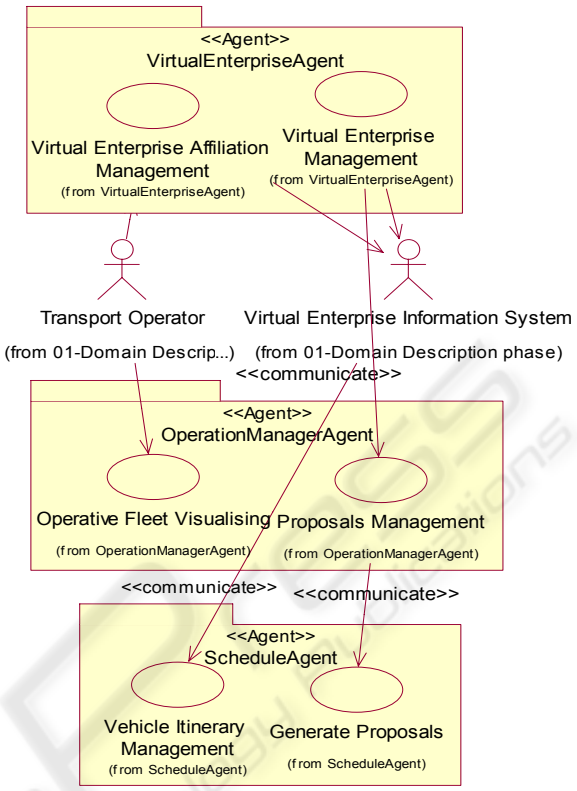

Figure 1: Agent Identification Diagram for the Job-shop scheduling system.

independent systems (as in the "Virtual Enterprise Information System" package) or to a mixture of both, agents with applications and managements systems, as it happens in the case of the remaining packages.

This architecture allows each transport operator affiliated to the virtual transportation enterprise to control at any moment the status of its operative fleets, as well as to administer, if they wish, all the information of their own information systems, in such a way that independence between the different operators of transport stays in the operative scope.

Each transport operator has his own mechanism for allocation and control of the itineraries for the different vehicles that conform his fleets, having the virtual transportation enterprise the responsibility of only receiving trip requests and the assignment of these requests to the vehicle that constituted the most attractive provider for the service user.

Anyway, the virtual transportation enterprise maintains an own transaction system, in order to register its daily tasks, satisfied requests, aborted trip requests, information and/or alerts from government organizations or active destinations, among other things.

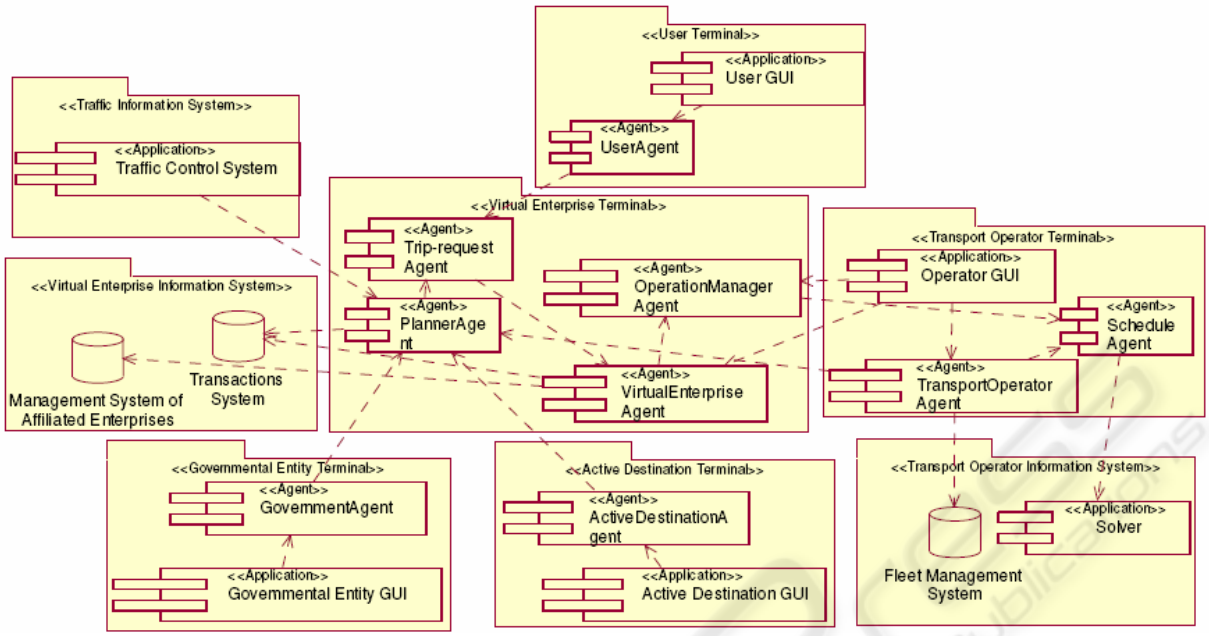

Figure 2: Deployment/Component hybrid diagram of the virtual enterprise framework.

5 CONCLUSIONS

The first version of a framework architecture for a virtual enterprise devoted to passengers transportation has been reached. The domain context and their involved actors have been defined, which can correspond to information systems or people.

The architecture includes a set of identified agents which conform a society of agents and that interact with both, the final user of the transport system, and information systems and applications external to it.

The future work will led to the refinement of the software framework, verifying the points of variability and the mechanisms of reusability.

ACKNOWLEDGEMENTS

Partially funded by Project No. 209.746/2007 of the Pontifical Catholic University of Valparaíso (www.pucv.cl).

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