MULTI-AGENTS CONCEPTION OF LOGISTIC NETWORK

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Abstract

A logistic network is a favorable environment for companies to collaborate together in order to improve the quality of a service or a product and to surmount some problems.

In this paper, we present a logistic network conception which is based on multi-agents systems and which takes into account security aspects.

Keywords: logistic network, multi-agents system, conception, security.

1. Introduction

Riane and Pirard [15] define the logistic network as a set of entities having each one a specific activity (or a role) consisting in supplying, producing, transforming or distributing the final product. A logistic network can be represented by nodes and edges. Nodes correspond to entities (activities: (supply, production, distribution and sale) and edges correspond to the complex flow of products and information.

These networks have to react to a dynamic environment and to collaborate. In fact, traditionally firms have acted as sole economics entities in the market. But, now days, firms have to form strategic alliance with other firms. They have to coordinate with their customers and their suppliers.

Agent technology is suitable to manage the collaboration in the logistic network since entities can be seen as agent and the logistic networks as a multi-agent system.

The primary goal of this work is to present a muli-agent conception for the logistic network.

To collaborate, agents have to share and to exchange private information. Since these agents evolve in a high competitive economic environment, a specific attention must be given to the security of the logistic network. Thus our multi-agent conception for logistic networks takes into account the security aspects.

The reminder of the paper is organized as follow: section 2 deals with various modeling of the logistic network. Section 3 describes the proposed multi-agent conception of the logistic networks that integrates security aspects. Finally section 4, concludes the paper.

2. Modeling of the logistic network

Many models of the logistic network are presented in the literature. They are classified into three categories [11]:

- Organizational models: represent the logistic network from its entities, its activities, its processes, its functions, its structure and its behavior.

- Analytical models: the logistic network is seen according to a quantitative perspective. The works stemming from the operational research confirm this vision. They generally base themselves on the statistics, the optimization theories, etc.

- Simulation models: they overcome the conveniences of the previous models which consider the logistic network as a static structure which does not evolve during time. The simulations approaches are essentially based on two programming approaches: objects and agents. According to different authors ([11], [12]), a logistic network can be seen as a multi-agent system. In fact, agents are autonomous, they have the ability to react, to communicate with each others and they are proactive. One (or some) agent (s) represents an actor of the logistic network (supplier, company, etc.). In this way, the characteristics of its behavior will be taken into account: an actor executes tasks by itself without external intervention (autonomy). An agent can communicate with other agents to place an order of products or services (authorized social) for example. An actor modifies his behavior if the market or the competition increases (ability to react). An agent can decide for example to launch a new product on the market (pro-activity). Some multi-agents conceptions are listed in the following paragraphs.

Sardinha et al. [16] use a multi-agent system which is composed of the following agents: the customer agents, the supplier agents, the sales representative agent, the marketing manager agent, the production scheduler agent, the delivery scheduler agent, the

procurement buyer agent and the procurement manager agent. These agents use a corporate knowledge base to exchange information for decision making purpose.

Swaminathan et al. [17] define a generic agent which is then specialized to perform different activities within a supply chain. Agents in this framework communicate with each other through messages. Incoming messages are selected by each agent based on an event selection mechanism such as first come first served.

Most works which are interested in the logistic network multi-agents conception, (such as [7], [8], [16], [17]), do not handle a fundamental notion which is the logistic network security. In what follows, we present a multi-agent conception of a logistic network based on security.

3. Multi-agent conception of logistic network

Various methods and language for multi-agents systems conception still exist. These methods are inspired by knowledge engineering such as the method KADMS, or by oriented objects methods such as Multi agent System Engineering (MaSE) ([5], [6]). However, UML remains the most popular modeling language. UML provides structural diagrams to model state properties and behavioral diagrams to model dynamic systems behaviors. That's why UML is the best tool for the system design [10].

Several extensions were proposed to the versions UML 1.x to take into account the agents concepts ([2], [9], [13]). UML2 is adopted to design multi-agent systems since it is inspired by the Agent UML language [3]. Semantics of diagrams in UML 2, as well as semantics of the action was improved [4]. In this paper; we use UML 2 for multi-agents conception of logistic network.

2.1. Logistic network composition

The logistic network is formed by a company, its customers and its suppliers. Each company is seen as an intelligent agent. The company itself is composed of many activities (scheduling, logistics, production, distribution and security). Each activity is considered as one or several agents. An agent can be classified whether external or internal to the company.

The external agents are:

- a provider agent : provides raw materials
- a client agent : places orders for finished products.
- a certification Authority and Registration agent (CAR) : manages security credentials and public keys for message and verify information provided by the requestor of a digital certificate.

The internal agents are:

- a brocker agent courtier : sends and receives messages to the company. It plays the role of an order office.
- a transporter agent : transports raw materials from suppliers and distribute finished products to the customers.
- a resource agent : makes the stock inventory and places orders of raw materials.
- a scheduler agent : generates the production plan. In case of breakdown or of delay of raw materials, it proposes a rescheduling of the current production plan.
- a controller agent : distributes the tasks to the workers agents according to the planning of the scheduler agent.
- a worker agents : realizes the production orders of the controller agent.
- a logistics Agent : fixes the prices and the delays according to some constraints. These constraints have to be respected by the scheduler agent.
- an administrator agent : it is the administrator of the security. In case of intrusion detection in logistic network, it takes the measures necessary to arrest the intrusion.
- a Manager Security Policy agent (or MSP) : defines the security policies.
- an audit agent : listens to the streams which circulate in the network and analyzes them.

2.2. *Conception*

a) Class diagram

The class diagrams permits to represent the agent roles and the relations between these roles [8]. So, figure 1 presents the various agents that we have mentioned below as well as the relations between them.

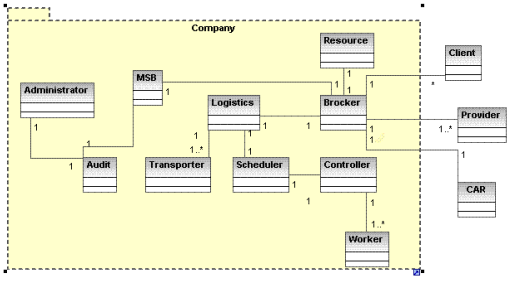

Fig 1. Class diagram for logistic network

b) Use case diagram

Use cases are a means for specifying required usages of a system. Typically, they are used to capture the requirements of a system, that is, what a system is

supposed to do [14]. They capture the behavior of a system, a sub-system, a class or a component such as an outside user sees it [1].

Figure 2 gives an example of a use case for the audit agent. The actor is the audit agent and the use cases are the listening to the streams which circulate in the network and the events analysis. The listening of the network allows the audit agent to collect the events, to analyze them and to filter the suspect events.

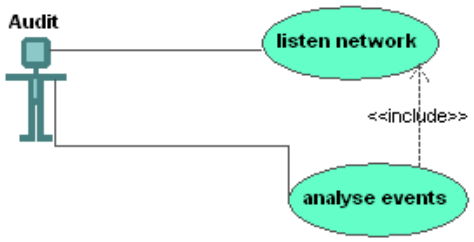

Fig 2. Use case diagram for audit agent

c) Sequence diagram

The sequence diagram describes the messages exchanged between the logistic network actors. It is one of the most interesting diagrams in the multi-agents systems conception.

Several diagrams can be elaborated such as the product order, the raw materials supply, the intrusion detection, etc.

Figure 3 gives an example of a sequence diagram. The diagram for raw materials supply is composed by four agents who are: the resource agent, the broker agent, the supplier agent and the certification Authority and Registration agent (CAR). The resource agent announces an order for buying raw materials according to a stock security threshold. This order will be transferred by the broker agent to the corresponding supplier agents, who can accept or refuse the order. When receiving the reply, the broker agent verifies the coherence of the received certificate and if it is revoked or not with the certification and registration authority agent. Two cases appear:

- The supplier is not authenticated: this implies that there is an intrusion. The alert reference indicates that the broker agent transmits an alert message to the audit agent. The latter alerts the administrator. The operator "Loop" is used to describe a set of interaction that can be repeated. Indeed, when the supplier is authenticated, the order will be again dismissed to the supplier.
- The supplier is authenticated: the broker agent transmits the acceptance or rejection message from the supplier to the resource agent. The latter answers by an acquitement message.

d) Activity diagram

The activity diagram demonstrates the operations and the events which activate them. It is useful in the complicated interaction protocols [13]. An example related to the logistic network is given in figure 4.

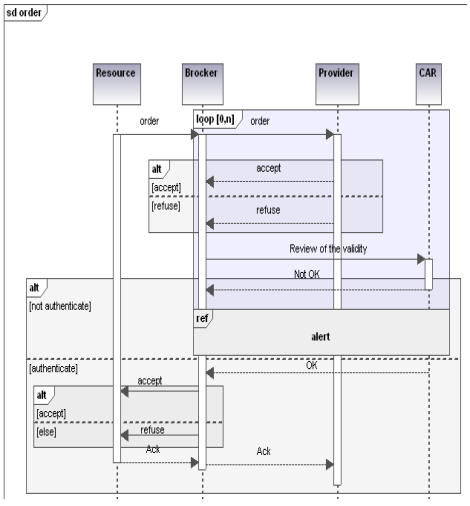

Fig 3. Sequence diagram for the raw materials supply

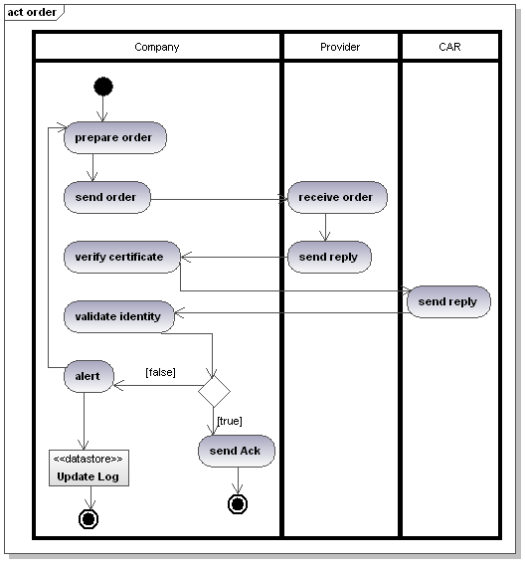

Fig 4. Activity diagram for order treatment

4. Conclusion

The aim of the paper is to present our logistic network conception taking into account security aspects. Numerous perspectives of research are possible. Our first direction is to specify how the Manager Security Policy agent defines the security policies inside and outside the network and how it distinguishes between the normal users and the intruders which is a difficult task in the logistic networks.

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