

Mobile Agents

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INTRODUCTION

The concept of mobile agent is not new; it comes from the idea of *OS process migration* firstly presented by *Xerox* in the 1980's. The term *mobile agent* was introduced by White & Miller (1994), which supported the mobility as a new feature in their programming language called *Telescript*.

This new research topic has emerged from a successful meeting of several sub-sciences: computer networks, software engineering, object-oriented programming, artificial intelligence, human-computer interaction, distributed and concurrent systems, mobile systems, telematics, computer-supported cooperative work, control systems, mining, decision support, information retrieval and management, and electronic commerce. It is also the fruit of exceptional advances in distributed systems field (Hirano 1997; Holder, Ben-Shaul, & Gazit 1999; Lange et al., 1999).

The main idea of the mobile agent technology is to replace the old approach of the client-server Remote Procedure Call (RPC) paradigm, by a new one consisting of transporting and executing programs around

a network. The results of the programs execution are then returned back to the sending entity. Figure 1 illustrates this new approach.

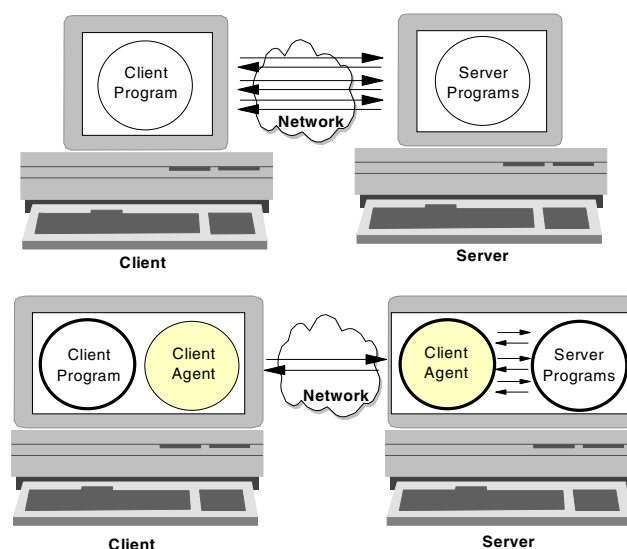
Mobile agents are dynamic, non-deterministic, unpredictable, proactive, and autonomous entities. They can decide to exercise some degree of activities without being invoked by external entities. They can watch out for their own set of internal responsibilities. Agents can interact with their environment and other entities. They can support method invocation as well as more complex degree of interaction as for example the observable events reaction within their environment. They can decide to move from one server to another in order to accomplish the system global behavior.

BACKGROUND

As the information technology moves from a focus on the individual computer system to a situation in which the real power of computers is realized through distributed, open and dynamic systems, we are faced with new technological challenges. The characteristics of dynamic and open environments in which heterogeneous systems must interact require improvements on the traditional computing models and paradigms. It is clear that these new systems need some degree of intelligence, autonomy, mobility, and so on. The mobile agent concept is one of the new system environment that has emerged from this need. Several researches have proposed a definition of mobile agents (Bradshaw, Greaves, Holmback, Jansen, Karygiannis, Silverman, Suri, & Wong, 1999; Green & Somers, 1997; White 1997). Until now, there is neither standard nor a unique consensus on a unique definition. In general, a mobile agent can be defined using its basic attributes: the mobility, the intelligence and the interactivity. Based on these attributes, we can propose the following definition:

A mobile agent is a computational entity which acts on behalf of other entities in an intelligent way

Figure 1. RPC vs. mobile agent approach



(autonomy, learning, reasoning, etc.). It performs its tasks in software open and distributed environment with some level of mobility, co-operation, proactivity, and/or reactivity.

This attributes based definition gives an abstract view of what a mobile agent does, but it doesn't present how it does it. This definition doesn't mean that mobility, interactivity, and intelligence are the unique attributes of mobile agents. Effectively, a large list of other attributes exists such as: application field, communication, delegation, and so on.

This definition shows that a mobile agent doesn't exist without a software environment called a mobile agent environment (see Figure 2).

AGENT CLASSIFICATION

According to the literature (Franklin & Graesser, 1996), agents, and especially mobile agents, can be classified using the three agent basic attributes depicted in Figure 3.

- The first agent attribute is mobility, so an agent can be static or mobile.
- The second attribute is intelligence; an agent can be characterized by its abilities of reasoning, planning, learning, and so on.
- Interaction is the third agent attribute. Agents can have different kinds of interactions. This category of agents contains the agents that: do not interact at all, interact with users, interact with applications, and interact with other agents.

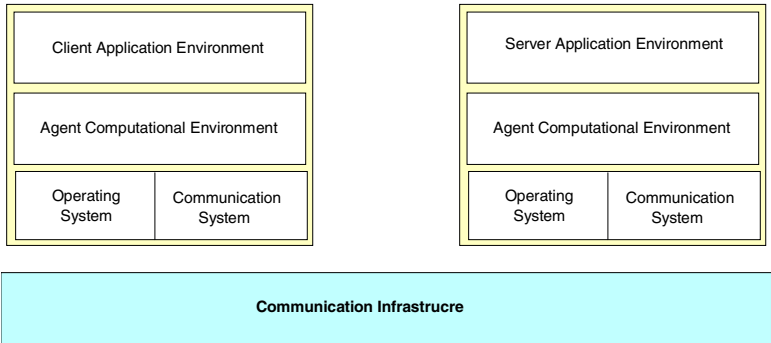
There are of course many other classification methods (Franklin & Graesser, 1996). For example, we can classify agents according to the task they perform, for example, information gathering agents or e-mail filtering agents.

MOBILE AGENT ADVANTAGES

Using mobile agents is not the unique way to solve some class of problems, alternative solutions exists. However, for some class of problems and applications, we believe that mobile agent technology is more adapted than classical methods. For example, in managing large scale intranet, where we must continuously, install, update, and customize software for different users without bringing the server down. In the following we present three types of application domains where it is better to use mobile agent technology:

- Data-intensive application where the data is remotely located. Here, agents are sent in order to process and retrieve data.
- Disconnected computing application where agents are launched by an appliance. For example, shipping an agent from a cellular phone to a remote server.
- Application where we need to extend the server behavior by sending agents that can represent permanently or not the server in different location (host or server).

Figure 2. Mobile agent environment



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