A distributed system for mobile information communications

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Abstract

In this paper, we present a distributed system for mobile agent communication that integrates non interactive mobile systems and is based on a mailbox scheme. To describe the system, the authors have used a structured model that permits the evaluation of the meeting level of the system’s requirements. This scheme characterised the mobile protocols and applications using 3D space, the properties used are: mailbox migrating frequency, operation executed for message delivering and kind of synchronization made to avoid the message loss. Nowadays, the system is working in a context of an intelligent system for public transport by road and it plays a main role in the administration and maintenance of its mobile stations.

1 Introduction

This work belongs to the mobile distributed systems field, in which users and systems, in various locations, can work using common geographically dispersed resources. In this context, new research areas and technologies of distributed computing arise such as: peer-to-peer, pervasive and nomadic computing [1]. Nowadays, it is very common to meet systems that use mobile agents. Fields such as e-commerce, telecommunications, public information systems, network managements, etc, use this type of agents. In general we can, affirm that the mobile agents began to play a key role in networking and distributed systems. We define a mobile agent ass an autonomous element that moves between locations in an information system. This information system must provide all the
necessary resources for mobility and communications. Some authors identify these resources as a distributed abstraction layer named mobile agent system [2]. The communication protocols are an important element in this kind of systems because they ensure the communication between agents. In recent years, researches have provide a wide range of schemes for mobile communications, but in general, these schemes have particular assumptions and methodology, as a consequence, there is no uniform or structured paradigm to analyse the effectiveness and performance of protocols and applications in the context of the mobile agents system [3], [4], [5]. Therefore we have used a structured scheme to design our distributed system for mobile agents administration. This scheme is based on use of a mailbox to buffer messages in each mobile agent, permitting that agent and mailbox reside in different host migrating separately. The system that we have developed permits us transferring data and commands between mobile agent systems in order to administrate and maintain a corporative information system that integrates a set of mobile information platforms in an automatic and remote way.

2 The problem to solve: objectives and requirements

The general context of our problem can be described as follows: we have a corporative information system that integrates mobile and no mobile platforms. The mobile platforms move around a large geographic area. They are systems that have no human interactivity and they are not permanently connected to the corporative network. In our case, the corporative information system is the information system of a public transport company of passengers that has 350 buses and a mobile platform is installed on each bus and it achieves the following functionalities: the control of the time tables fulfilment, the hardware and software exceptions produced in on board devices, the registration and automatic transferring of data which represent the activity produced on board. These functionalities must be achieved without a periodic communication with any control centre, using the communications resources in an efficient way. To fulfil this requirement, it is necessary that the mobile platforms have all the hardware and software components needed to work in an autonomous way. To guarantee the software resources availability, it is necessary to use a tool that permits us the transference of these software elements to the mobile systems installed on the buses. The availability of this tool facilitates the administration and maintenance of this type of systems, moreover developing this tool in a suitable way the administration and maintenance can be performed in an automatic and no supervised way, an important practical aspect of this kind of corporation information system based on mobile information system.

To achieve this main objective, additionally, it is necessary that the communication protocol used by the system fulfils the following requirements:

Location transparency. Mobile systems (mobile agent) are sporadically integrated in the corporative network using mobile stations, so the system must
support the mobile agent location, allowing to send and receive messages not taking into account the physical location.

- **Asynchrony.** To guarantee reliable message delivery, the messages forwarding and the agent migration must be coordinated by the system. This coordination must not constrain the agent mobility
- **Reliability.** The system must ensure that all messages are routed to the target agent, independently how it migrates.
- **Efficiency.** The cost of the communication must be minimized performing two operations: agent migration to new sites and messages delivery. The cost includes aspects such us: distance, number of messages, sizes of messages, etc.

![General vision of the system.](image)

**Figure 1:** General vision of the system.

### 3 Scheme based on mailbox

In that scheme, there are three components: the mobile agents, the mailboxes and the mobile agent platform. We have assumed that each mobile agent has a mailbox that buffers the messages received. The agents are autonomous and mobile and the mailbox are mobile but not autonomous because they can not determine migration paths. The agent can send messages to the mailbox of another agent. To obtain the messages from its mailbox, the agent can execute the pull operation or the push operation, so the communication between agents has two steps: first, sending the messages to the receiver mailbox, and, second, delivering the message from the mailbox to its agent.

To apply this general scheme to our problem, we have the following settings: the mobile information systems of the buses play the role of the mobile agent platform, the applications that can send or receive messages are the agents. When the agents are being executed in a mobile platform, then they are mobile agents.
Finally, the mailboxes are objects that are not in mobile agent platforms. In order to guarantee that messages are not lost during the transmission and deliverance of messages, our system uses a high level of reliable network communication. Figure 1 represents a general vision of the system, the mobile agents execute in mobile platform installed on buses, and these are sporadically integrated by no mobile agents. Mailboxes of the mobile agents are installed in the home server.

4 System description

In order to explain in a systematic way the more relevant aspects of the system, our description will be base on the general model proposed by Cao et al. [6]. In this model three key parameters are defined in every mobile communication application: mailbox migration frequency, messages delivery from mailbox to the agent and synchronization between migration and delivery.

- **Mail box migration frequency.** It consists of the number of migrations that occur during the mobile agent working. In general we can find three basic options:
  - **No migration (NM).** The mailbox permanently stays in the same agent platform generally named home. It means that the mobile agent can migrate to different agent platforms. All the messages must be sent to the same home but these messages must be forwarded from the home to the mobile agent.
  - **Full migration (FM).** The mailbox is considered part of the mobile agent and so it migrates with the mobile agent.
  - **Jump Migration (JP).** The mailbox and the agent can migrate dynamically. The mobile agent determines where to establish its mailbox considering factors such as distance, number of messages, etc.

  Our system uses NM mode because the tracking of mailbox produces no cost and it is simpler from the point of view of design. Moreover, generally, NM mode works well with small and medium systems with a few mobile agents and this is our case.

- **Message delivery.** The messages to the mobile agent must be sent first to the mailbox and next the messages must be delivered from the mailbox to the mobile agent. To achieve the second communication step, we can execute two alternative operations: push operation (PS) or pull operation (PL).
  - **Push operation (PS).** By this operation, the messages are forwarded from the mailbox to the mobile agent and so the mailbox must know the mobile agent location every time. This means that every migration of the mobile agent must be communicated to the mailbox.
  - **Pull operation (PL).** By this operation, the messages are retrieved by the mobile agent only when the messages are
needed. This means that the mailbox does not know the location of the mobile agent, so the mobile agent must query its mailbox for messages.

In our system, we have selected the push operation for two reasons: first, in some situations we need that the information arrives to the mobile information system on the buses as soon as possible (real-time delivery), and second, the pull operation would produce an increment of the message delivery cost.

- **Synchronization between migration and delivery.** This aspect refers to the reliability of the system. In order to avoid the message loss, the system can act as follows:
  
  No synchronization actions (NS).
  Synchronization between host’s message forwarding and mailbox’s migration (SMH).
  Synchronization between mailbox’s messages forwarding and agent’s migration (SMA).
  Full synchronization (FS) that covers the two previous synchronization actions.

In our system we use SMA synchronization; the no mobile agents are synchronized with the mobile agents. When a mobile agent contacts with a no mobile agent, it sends register message and waits for an acknowledge message. Then the messages can be forwarded and for each message forwarded to the mobile agent, it sends an acknowledge message indicating that the message has been received. In the opposite case, before each mobile agent migrating send a deregister message to the agent server that can forward pending messages or not.

![Figure 2: 3D dimensional model.](image-url)
Resuming, this scheme can be expressed as a three dimensional model that can be used to develop and evaluate protocols and applications in the field of the mobile communications. Using this vision of the scheme, the protocol used by our system can be characterized as a (SMA, NM, PS) protocol. For example: mobile IP is represented by (NS, NM, PS), so our (SMA, NM, PS) protocol is similar to mobile IP with synchronization and Forwarding-pointer-based protocols are represented by (NS, *, FM).

5 Conclusions

In this paper we have explained in a structured way a distributed system for non interactive mobile information system communication. With this tool we can solve a critic problem in mobile information systems that integrate a fleet of non interactive mobile systems: to administrate and to maintain the non interactive mobile systems in an automatic and none supervised way. The method used in the explanation can help to design new protocols and applications in the mobile communications and it can be also used to evaluate existing protocols and applications in this communication field. Our future work will be to reduce the protocol communication cost, using jump migration (JM), with this new characteristic our system will be more flexible and it should be used in other communication mobile contexts. Another important reason to improve the system using jump migration is that the integration of the mobile platform in the corporative network is not permanent and that connectivity between two mobile platforms could be possible.

References