# Use of mobile agents in a federated identity structure

Farah LAYOUNI and Yann POLLET
Laboratoire CEDRIC
Conservatoire National des Arts et Metiers (CNAM)

## ABSTRACT

This work will try to join two axis of research which concepts are in vogue. The first concerns the federated identity. The studies in this topic will allow the interconnection of information system, access to different resources and, above all, a secure and controlled sharing data. The implementation of such architectures required several exchanges of requests and responses which can be costly in terms of traffic data. So the second axis, namely mobile agents, intervenes to solve these problems. They offer the advantage of reducing the network load, to move the code to the data, to provide more faults tolerance...
So this work seeks to take advantage of the benefits that can offer mobiles agents to improve the architecture of federated identity.

## Keywords

Federated identity, Federated authentication, Circle of trust, Identity provider, Service provider, Mobile agents

## 1. INTRODUCTION

The individual, its digital existence, profiles, trace, avatars, blogs, social networks, pseudonyms, etc.: the question of identity in the numeric network still be one of the key topics of the coming years. Although the technologies are old, the topic has not reached maturity. Moving beyond the framework of security and the protection of privacy, "Federated Identities" approach is a way for individuals to control their own lives, and for organizations, a source of innovation and value creation. Identity federation dramatically streamlines and simplifies the process of sharing with trusted partners the identity data associated with users who share electronic access to information and resources across domains.
Using examples, digital identities allow us access to a universe of information such as:
- The different states (coordinates, consumption, invoices), which can be viewed online, which service operators (telecommunications, water, electricity, ISPs, banks, insurance) have about us,
- Different data held by retailers (loyalty systems, purchases historicization...),
- Administrative information (data held by governments or local authorities, made gradually available online) on the subject of marital status, tax information, criminal records, education,
- Medical information held by all the health professionals with whom we interact (insurance, mutual companies, hospitals, pharmacies, general practitioners, specialists, laboratories...), and with whom we are going to be required to communicate more increasingly via the Internet,
-All traces that I leave voluntarily or not online, through various accounts (messaging, forums, blogs, personal pages, professional web sites) - information ranging from marital status data to financial data (CB number) or public or private multimedia elements (photo albums..), as well as various services of Microsoft, Google and Yahoo spheres.
To share this type of information, a system of identity provides the following services: Assign an identifier (which implies usually a register, so that the identifier is unique), Authenticate the user or resource claiming to be appointed by this identifier, Serve data on that user or his resource (his name, age, Country, language), Serve external data from other resources and Serve authorizations on what the user has the right to do or not. There are various identification systems. It is hard to compare them because most do not have the same specifications and do not address the same issues.
First we eliminate centralized systems like Microsoft's Passport [1]. These systems do not fit all needs and, even if they could, it would be very dangerous to have a single identity provider. Among the decentralized systems, we note two leaders, in the freedom world, Liberty Alliance and Shibboleth : Liberty Alliance [2] is a consortium of companies, founded in 2001, has produced several specifications on the management of identities and whose primary aim was to establish a standard free federation of identities.. Shibboleth [3] is a solution-oriented universities, and reprinted by several publishers. Its primary objective is to facilitate the

sharing of online resources between different schools. Many of these systems use SAML (Security assertion markup language), OASIS standard for expressing assertions security with XML.
In the future, these solutions are likely to be an element among others in new architectures. These solutions can be mixed together to provide new architectures for future decentralized, pluralistic identification system, and allowing users to keep or regain control over their identities. This is particularly the case of Shibboleth which will serve as a basis for our work. Through this work, we will seek to propose a new model of architecture information systems taking advantage of similarities between these previous solutions and allowing a dynamic cooperation between multiple, independent and heterogeneous information systems, with different levels of involvement. This cooperation is in line with the overall provision of services for the benefit of individuals outside these SI, emergence of services already implemented on SI Premises. We will focus on cooperation involving the determination of the relevant authorizations for the use of a natural person to a particular service, or on the exchange of personal information (attributes, but generally all structured information whose semantics is shared among a certain set of systems). This will be facilitated by the use of mobile agents to convey these exchanges. This paper seeks to present the broad outlines of this new model which will be more detailed in our future work.

This paper is structured as follows. Sec. II describes the federated identity concepts. Sec. III presents mobile agent system. Sec. IV exposes our solution. Sec. V presents our conclusions and perspectives for future work.

## 2. FEDERATED IDENTITY

The notion of federated identities was arises from the need to want to share information without centralizing the data in an unique repository. In this context, it was bring to introduce the concept of ´ circles of trust ´ . Every circle represents an establishment which manages a set of users and these various circles try to interconnect their authentification services and to use common set of users attributes. This policy presents the following advantages: managing in a global and coherent way the users and their habilitations, reducing administrative costs, facilating the opening of several information systems by implementing new ways of communication and facilating secure access to digital shared resources among institutions based on user profiles. We note two key services of this solution which are the authentification delegation and the user attributes propagation.
**The authentification delegation**: consist to use the authentification service offered by the attachment institution of the user, even when the application requiring this authentification is a service outside the establishment.
**The user attributes propagation** : the latter service consists in collecting attributes relative to the user. We define two different types of attributes: those who allow customizing the service (name, e-mail, address) and those required to perform access control (user category, training, roles). Architecturally, the various solutions of federated identities like liberty alliance, Higgins[4], Infocard or Cardspace[5] regroups two fundamental elements:
**Identity provider, IdP**: it is the cornerstone of the circle of trust. It manages the numeric identity of a set of users (creation, deletion, maintenance of their identifying information). IdP offers an authentification service to its users, allowing them to authenticate on the network. When a user wants to reach a service offered within the federation, he uses the authentification service of his attachment institution. Also the IdP can define the users attributes that it auto-authorises the propagation to service provider.
**Service provider, SP**: represents the applications that require authentification, thus consuming metadata of users. This metadata is a structured set of data used to describe the user. They are descriptive metadata and management metadata. They can be held by one or more identities provider. In case of several identity provider, a protocol such as OAI (OAI-PMH = Open Archives Initiative Protocol for Metadata Harvesting) [6]centralizes metadata leaving them to their original location. So the attributes remain divided and accessible. For this, the protocol defines the conditions for the collection and transfer of metadata in the form an open archive recordings open (eg XML), produced by an identity provider, to the service provider. So the service provider collects metadata from one or more providers and assembles them to create a value-added service.

## 3. MOBILE AGENTS

The purpose of this section is to present our vision of a mobile agents system, its various components and the benefits that can be learned from. We define a mobile agent as software module that able to move from one host to another in the network; it can transport his state and its code of an environment to another in the network where it pursued his execution. A mobile agent is not related to the system in which it begins its execution. Its basic life cycle passes by three states [7] like illustrated in the following figure:
**Perception**: recognition of the objects in the environment as well as the interpretation of received messages.
**Deliberation**: expresses all the means used by the agent to accomplish its action.
**Action**: describes the operations that an agent per-

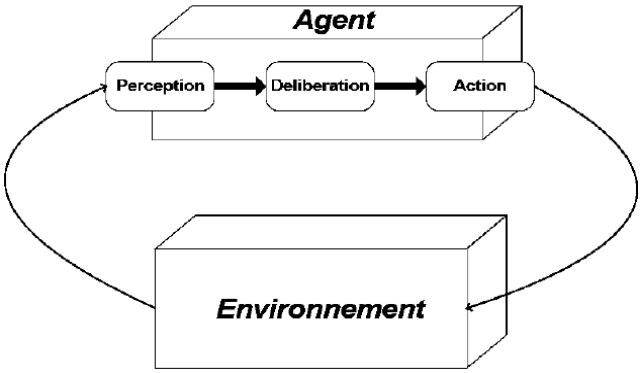


**Figure 1: Life cycle of a mobile agent**

forms as well as communications which is the issuer. These states are necessarily sequential, but the agent may repeat the cycle as many times as necessary. If in the course of its action, the agent discovered a new perception of the network, it can redo the cycle. This can be useful in cases of collaboration between agents which we will present in the following part. By passing into "action" state, the agent obtained the following characteristics[8]. First, agents are able to operate: the action is based, in a Multi-Agent system, on the fact that the agents perform tasks that are affecting the environment and subsequently modify their decision-making. Second, agents are autonomous: agents are independent and not subject to order. They are led by their individual objectives which they seek to satisfy. Each agent has the freedom to act and to respond to requests from other agents. For this, it requires a number of resources or a private local memory which makes it independent of its environment and other agents. Third, agents have a partial representation of the environment: the agents have no global vision of all the system. Moreover they are not all related. An agent knows generally only some agents who form its knowledge conscripts also relations. It is with this group of agents that it communicates and exchanges information. Such concept has several advantages[9]. We found that these benefits can be classified into four classes that we define here:

**Flexibility**: It is possible to adjust the number of agents to the size of the information system and to have trained agents according to the monitored system.

**Efficiency**: Agents affect at least the performance of each machine because they are content to work on targeted resources. It should be noted that the gain in network traffic is particularly important.

**Reliability**: If an agent is out of service, other agents can be reproduced.

**Portability**: Agents bear more easily distributed systems. Mobile agents have the ability to dynamically adapt to changes and can thus react more quickly.

We turn now to a description of the components of a model for mobile agents. Firstly, we have the agent, which is an entity that has five attributes [10]: its status, its implementation, its interface, its identification and its authority. When an agent moves through the network, it carries its attributes:

**Status**: When a travel agent, it carries with him his state, which enables him to resume his execution when it arrives at its destination. The state of an agent can be seen as a snapshot of his execution. In most programming languages, you can partition this state into a state of execution (which includes its programs and interfaces) and a statement of object (which contains the values of instance variables in an object).

**The implementation**: Like any other program, the mobile agent requires a code to run. When it moves through the network, the agent can either take its code or go to destination to see what code is available on the remote machine. The implementation of agent must be both enforceable and without risk to the host destination.

**The interface**: An agent provides an interface that allows other agents and other systems to interact with it. This interface can be a set of methods which enables agents and other applications access to methods of the agent by a messaging system.

**The identifier**: Each agent has a unique identifier during its life cycle, which enables it to be identified and located. Because the identifier is unique, it can be used as the key in transactions that require a means to reference a particular instance of agents.

Then we define the system agent. An agent (also called a server agent[9]) is an environment that is able to create, interpret, implement, and stop a transfer agent. In the same way that an agent, an agent system is associated with an authority that identifies the person or organization for which it works, like presented in the following schema:

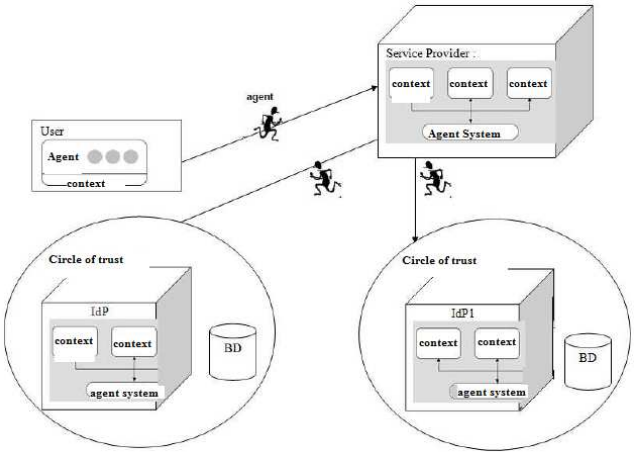


**Figure 2: Agent System**

A host machine contains an unique agent system but several contexts of agents. Four concepts play an important role in the system of agent, which can be used to identify an agent:
**The place**: A mobile agent moves from one environment to another. This environment is called "place". A place is a context within an agent system, in which an agent runs. This context can provide a uniform set of services on which the agent can count regardless of its specific location. The place of departure and place of destination can be located within the same system or different agent systems.
**The type of a system of agent**: it is used to define the profile of an agent. For example, if the type of a system officer is "AGLET" [10], then the agent system is implemented by IBM and supports Java as a programming language.
**Resources**: The agent system and the place provide controlled access to local resources and services (database, processors, memory, and disks).
**Location**: Localization is an important concept for mobile agents. It defines the location of an agent as the combination of the place in which it work and the network address of the system where an agent instead. Specifically, it is defined by the IP address and listening port of the system agent with the name of the place as an attribute. But in our case, we will add other elements to this location like the identifier of the circle of trust, the identifier of the user and also remove the listening port because it don't have any signification in our topology.

## 4. PROPOSED CHOREGRAPHY

The authentication techniques can be simple techniques where users directly provide passwords to applications or hosts, to much more complex techniques using advanced cryptographic mechanisms to protect identifiable information from user applications and potentially malicious hosts.
Provide a password in plain text to an application or a host is regarded as the most mediocre authentication technique, due to the risk of interception of the sequence of authentication. If you consider that a password must keep something secret, it is no longer really the case if the user needs to reveal this secret to all computers on the network. More effective authentication techniques can protect authentication information, so that the host or resource with which the user is authenticated does not know the information confidential. This is usually done by data cryptographic signature, with the secret password that only the user and a trusted third party (such as a domain controller Active Directory, for example) know. A computer authenticates the user via the presentation of cryptographic signature data to a trusted third party. The third compares the signature with the known data of the user and tells the computer whether it thinks the user is or isn't who he claims to be. This mechanism allows to keep the totally secret character of passwords.
There are two general categories for key-based encryption [11] symmetric and asymmetric. Symmetric encryption uses a single key to encrypt and decrypt the message. This method is easy and fast to implement but has weaknesses; for instance, if an attacker intercepts the key, they can also decrypt the messages. Asymmetric encryption, also known as Public-Key encryption, uses two different keys a public key to encrypt the message, and a private key to decrypt it. The public key can only be used to encrypt the message and the private key can only be used to decrypt it. The private key is never distributed; therefore an attacker cannot intercept a key that decrypts the message.
This choregraphy is based on this principle of asymmetric encryption [12]. The asymmetric encryption relies on a couple of keys, a public key and a private key, but in our case it will be two private keys that IdP will generate for each user. One will be send to the user, that we note Cu and the IdP will keep the other in his directory, noted Cp. Any message to be encrypted by Cu can be deciphered by Cp and vice versa. In our architecture is the user's query that would be encoded as explains the following scheme:

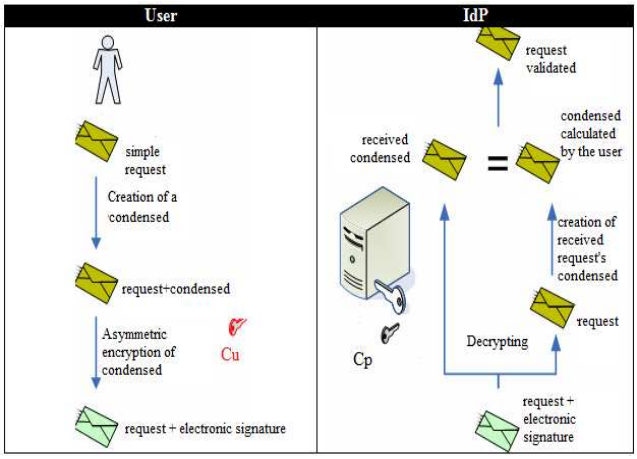


**Figure 3: Encryption technique**

The electronic signature is generated by the trust authority with personal information (such as name, e-mail address, country of the applicant, etc.) using its own private key.

### 4.1 Service Provider and identity provider in the same circle of trust

In the first case, we assume that the SP and users are part of the same circle:

1) The browser or user application sends a mobile agent whose message reflected a request encrypted with the Cu to the service provider
2) The service provider without authentication information and unable to decipher the request, will redirect it to the IdP specifying the list of attributes he needs to control access and grant access to resources
3) The IdP will decipher the request using the Cp associated with the user in question, making it possible to authenticate the user and may send the attributes necessary for the service provider who will execute the query and returns the result to user. From the viewpoint of the user like noted in the following figure, he will only send the request, which would implicitly its authentication. He did not more need to establish a session with the supplier IdP as in other architectures federation of identities.

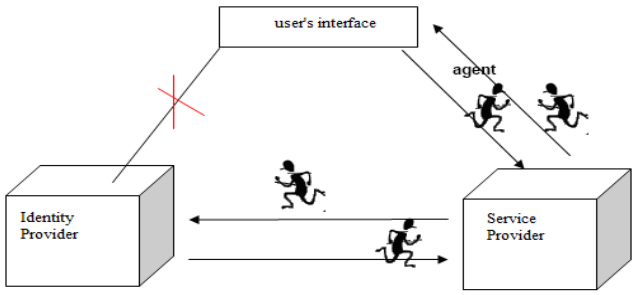


**Figure 4: SP and IdP on the same circle of trust**

For the following queries, they will be recorded in the user´ s context and also in the service provider, therefore, there will be no more need for this encryption or interaction with the IdP.

## 4.2 Interaction between different circles of trust

We now place in the event that an SP is available to users attached to different circles. The problem that arises is that the SP does not know how to redirect IdP agent for authentication. This can be solved in different ways, for example, we can use a service discovery (or Discovery Service or Where Are You From, WAYF): central component in a federation that allows a user accessing a service to select his organization to authenticate or we can clone or agents also collaborate agents to locate the IdP ...

**First request to the SP without agents' collaboration :**

To locate the IdP to which the user is connected, we will use one of the properties mobile agents namely its ability to copy itself and multiply in the network via a cloning operation. The first IdP which will decrypt the request and send back a response to the SP will be the connecting server of the user.

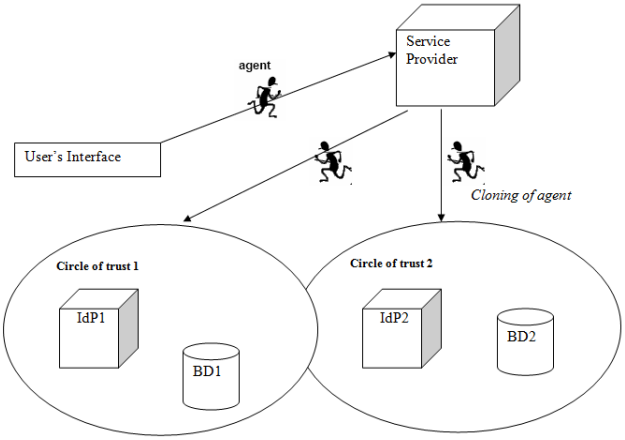


**Figure 5: SP and IdP on different circle of trust**

It is certainly impressive to have a significant number of agents generated on the network. To overcome this disadvantage, we can organize the circles of trust by neighbourly relations and choose an average number of neighbours to contact in each of cloning. Many studies [13] were performed to estimate the average number. An alternative could be gradually increases the number of clones.

**First request to the SP with agents´ collaboration :**

Agents can cooperate with each other and exchange data, which facilitates and shortens processing. In our case an agent can guide another in locating the IdP attached to the user. This exchange of information based on user´ s ID. An agent can guide another agent if the both user ID are in the same rank. Cooperation may also be extended by combining trace visitation and neighbourliness. When visiting a site, an agent may find or submit information in the memory space of the site, for example couples (pre-Id, target direction).

**First request to the SP with user choice** The user can choose from a list of possible IdP that of which he is part and make this information by the same agent at the service provider which will facilitate the forwarding agent. This can be implemented by the component WAYF used in the Shibboleth architecture. The WAYF returns an HTML form for the user to choose the preferred IdP.

## 4.3 Attribute divided among several circles of trust

The use of WAYF will greatly facilitate this task since the user can choose not only a IdP but rather a set of servers with which the agent has to move to collect the different attributes of the user. Also the system allows the user to enter one or more data sources or by

specifying a plan to guide sequencing of the agent in the removal or leave this task to load on the system of agents. This modular architecture can always keep it up to date.
To resume, all exchanges will be conveyed within the body of an agent, which offers great value and a high level of security for exchanges. Indeed, the number of queries and answers will be at least halved in comparison with other architectures of federated identities. Traditionally, other exchanges required before four pairs of queries and answers: the first pair between the user and SP for sending the request, the second pair between SP and IdP to ask for users´ authentication, a third exchange between user and IdP for authentication and then a fourth exchange between SP and IdP for the spread of attributes. So the introduction of agent will minimise the first two pairs of exchanges by removing on the one hand, the opening session between the user and IdP since authentification information will be conveyed at the beginning with the request and on the other hand the exchange between IdP and SP about sending attributes since IdP will transmit it directly by the agent which will confirm authentification. From point of view security, the encryption of the body of the agent offers a higher level of reliability.

Moreover the properties of the agents, will be used to develop this topology: portability will help them to better function in a heterogeneous environment, autonomy will foster collaboration between agents and helping to a better localisation of the IdP.

## 5. CONCLUSION AND FUTURE WORK

In this paper, we have presented a scenario in which the mobile agent would greatly reduce the management complexity and costs, as well as improve the security regarding to user´ s authentication in a federated identity topology. After outlining the three cases where the agent can intervene, we demonstrated that they offer more autonomy and adaptability.
In the future we will be working on the last case, when the attributes are divided among several circles. We have presented in this paper a centralized solution based on the WAYF but it would be interesting to avoid the involvement of the user for this task by proposing a protocol which manages the set of attributes: defining the constraints of type, a pattern of data movement between the circles of trust...
We can also define a semantic and common framework for shared attributes. The normalization or semantic standardization of data is a prerequisite for interoperability and it is primarily conceptual, in our case the data belong to a particular domain which characterizes a citizen. It is based on data dictionaries (readable form by users) that replicate the semantics (words and concepts) conceptual domain. These simple or complex data are defined in all their characteristics: type, drafting rules, values that may be assigned. However, a common and uniform comprehension of such data, their relationships and their behaviour requires a more structured representation or a modelisation faciliting their digital transcription. It can be formalized for example by using OWL, UML, XML Schema, RDF graphs or ontologies.

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