The Italian *e*-Government Service Oriented Architecture. Strategic Vision and Technical Solutions

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Abstract. The paper describes the currently ongoing effort for defining and developing a nationwide *e*-Government Service Oriented Architecture, in order to guarantee a flexible approach for integrated application services, respecting local and central administrations' autonomy. An appropriate mixture of organizational initiatives, together with the promulgation of appropriate laws, and the development of innovative technical rules, seems to be the success factor of the approach. From a more technical point of view, the definition *(i)* of semantically-rich service agreements, *(ii)* of a repository more complex than a simple UDDI registry, and *(iii)* of complementary components for dealing with QoS and security, represent the core elements of the infrastructure. To the best of our knowledge, this is one the hugest and most comprehensive *e*-Government initiatives currently undertaken in Europe.

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1 Introduction

Before 1999, the scenario of the ICT in the Italian public administrations (PAs) was quite disomogeneous: there were sectors of excellence in some central PAs as far as basic and advanced interoperability is concerned, and other central or regional PAs that acted as almost isolated systems. Basic network services (not necessarily Internet-based) were outsourced by each PA to external providers with an explosion of costs and possibly lack of interoperability between basic services of different PAs. In this context, the "Nationwide Cooperative Network" (referred to as RUPA [1]) was established in order to provide security and basic interoperability services (e.g., directory, e-mail, WWW) to the central PAs. But, even if from one hand RUPA created a system's vision (about interoperability)

and generated big savings for the central administrations, on the other hand, during the years it became clearer and clearer that basic interoperability is not sufficient, and there was a real need for advanced interoperability and application cooperation/integration between back offices.

The heterogeneity of procedures, data and infrastructures among local and central PAs has been exacerbated from the political viewpoint. The reform of the Italian Constitution in 2001 attributed indeed new possibilities for action to local authorities. Since then, the right to pass laws autonomously represented an increasingly effective means for decentralization with respect to administrative, organizational and also technical aspects. But from an ICT management point of view, this decentralization generated different points of decision, possibly leading to different ICT choices as well as different organizational processes. This can bring rapidly to the proliferation of different interoperability infrastructures (a sort of "spaghetti" connections/middlewares) with the consequent high risk of inefficiency.

Even though this process of decentralization of competencies and diversification of ICT solutions can help in defining and actuating in a rapid way political objectives (defined by laws) at the regional or local level, it will make tremendously difficult the implementation of political objectives at the inter-regional or national level sharing local and central competencies. Many examples of such strategic objectives can be found in the areas of healthcare, employment, register offices, tax offices, etc. If not mastered properly, therefore this process of decentralization, instead of turning out in an advantage for the country, can lead to a lack of interoperability among the PAs.

Given this context, the issue was to set-up an organizational process, together with technical solutions, that would allow the development of nationwide application cooperation/integration between back offices. Even if Web services are the technological instrument enabling the solution, such a solution requires *(i)* a strategic vision, based on a bottom-up process for reaching a shared PA-wide Service Oriented Architecture (SOA), and for maintaining it, and *(ii)* a deep and comprehensive technical specification of such an *e*-Government SOA.

The aim of this paper is to outline both *(i)* the strategic actions, that at the level of overall governance of the Italian *e*-Government process, have been undertaken, and *(ii)* the architecture and the innovative technological solutions that have been proposed for the realization of such a nationwide SOA, referred to as SPCoop - *Sistema Pubblico di Cooperazione* [Public Cooperative System] [3]. We argue that such experience and the proposed solutions are not limited to

[3] Such contributions have been developed by CNIPA– the name is hidden for blind review purposes – together with the industrial and academic/research community. CNIPA is a Government Agency that supports and implements policies delivered by the Ministry for Reformation and Innovation in the Public Administration. In particular it *(i)* establishes the strategies of the ICT innovation, *(ii)* proposes and supports the drafting of laws, and related technical rules, for the use of ICT technologies, *(iii)* organizes "call for projects" to innovate ICT infrastructures in the PAs and then funds and reviews selected projects, and *(iv)* promotes best practices and coordinates the planning process. Moreover, it monitors (by providing technical/economical congru-

the Italian scenario, but can be reproduced and enhanced in may other contexts (European in particular) in which the implementation of *e*-Government should face with a concurrent decentralization process; moreover, the Web service-based technical solution represent an impressive "real world" experience in the design and deployment of large scale SOAs, thus contributing to the research in this specific field. The contribution of this paper is therefore twofold: to be an effective governance and strategic experiment in the implementation of *e*-Government, and to present a novel nationwide SOA in which many novel solutions have been incorporated.

The paper is structured as follows. In Section 2, the strategic and governance actions that were undertaken in the last years are presented, then Section 3 presents SPCoop, by introducing the main conceptual components. Finally Section 4 concludes the paper, by discussing the schedule for the realization of the system.

2 Strategic and Governance Actions

In 2003, CNIPA started the coordination of a nationwide bottom-up consensus operation, from basic telecommunication services to advanced application cooperation. Different working groups were started with the participation of over 300 representatives of central and local PAs, universities and research centers and Italian ICT companies. The outcome has been a set of about 30 documents describing a technical and organizational nationwide system for network, communication, basic interoperability, cooperation and security services among administrations. This system consists of SPC - *Sistema Pubblico di Connettività* [Public Internetworking System] and, on top of it, of SPCoop for the application cooperation among PAs.

In parallel to the bottom-up process for the definition of SPC and SPCoop, the Government issued a Law Decree, approved by the local governments, that defined the legal framework of the whole initiative. The Law Decree n. 42 (February 2005) establishes the scope, the sectors of interest, the technical rules, the concept and the scope of a national shared infrastructure, the governance, the management and the governing board. The board is composed of 17 people, from central and local governments, who approves the technical rules, the guidelines, the areas of evolution, the condition for participating. CNIPA provides "compliant services" for the central PAs and, following the guidelines of the board, CNIPA manages the overall national shared infrastructure; in both tasks, CNIPA is supported by technological partners selected through public tenders.

In particular the Law Decree n. 42 establishes two important principles:

– the cooperation among administrations is exclusively carried out on SPCoop, with its tools and according to its technical rules; it has *legal* value

ence opinions) procurement of ICT services. Finally, it is responsible for the ICT training of PA managers.

and no further decree or official publication (e.g., on the Gazette) is needed (e.g., when defining standard XML formats for data exchange);
– the public ICT managers need to organize their information systems, including organizational and management aspects, in order to accommodate SPCoop rules.

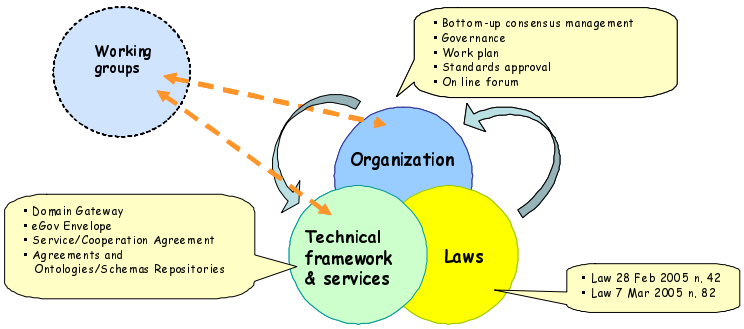

Fig. 1. The interplay of organizational, legal and technical aspects in SPCoop

SPCoop is not only a software framework, but also a technical and organizational platform whose aim is to create the conditions for a long-lived *legally valid* cooperation among administrations. It is based on four pillars which are leading-edge in terms of technologies, best practices and organization: *(i)* formalization, and successive publication, of *service agreements* between PAs (detailed in Section 3.1); *(ii)* definition of a federated identity management system for access control; *(iii)* definition of the metadata about the effective data to be used for cooperating, of the semantics and of domains' ontologies; *(iv)* open and continuous update of the SPCoop model, by taking into account the latest progress in technologies and standards.

A first set of documents including *(i)* the overall vision, *(ii)* the SPC network services and the security model were published in 2004 [4]. The starting point of the SPCoop has been the publishing in 2005 of a set of technical documents [5]. Such documents define the model of cooperation at the application level for national and local administrations and are, under a specific license, freely usable (e.g., for creating methodologies, software, dissemination, education, etc.).

Then, during 2006, four public tenders have been launched concerning:

– Network services, including VoIP and ubiquitous connectivity. The contract has been awarded in June 2006 to 4 providers for an amount of 543 M€ in 5

[4] http://www.cnipa.gov.it/site/it-it/In_primo_piano/Sistema_Pubblico_di_Connettività_(SPC)/

[5] http://www.cnipa.gov.it/site/it-IT/In_primo_piano/Sistema_Pubblico_di_Connettività_(SPC)/Servizi_di_interoperabilità_evoluta_e_cooperazione_applicativa/

years. Such network services will form the basic communication infrastructure connecting national and local authorities.
- Shared network infrastructures, including services for managing the Service Level Agreements (SLAs) of the SPC providers, the security and the VoIP services; currently a commission is selecting the partners.
- An initial set of interoperability services of SPCoop, including identity management, PA Web site/portals creation and management, Domain Gateways and tools for wrapping back-office applications as SPCoop Web services to be deployed on the Domain Gateways; currently a commission is selecting the partners.
- The effective SPCoop framework, as detailed in the following of the paper; the public tender deadline has been December 2006, and the commission for selecting the partner is expected to conclude its work by Spring 2007.

Moreover, 56 regional projects on *e*-Government, focussed on network and interoperability infrastructures, has been launched, for an overall amount of 100 M€. These projects will provide best practices as well as reference implementations of the different SPC and SPCoop elements, in order to direct the bottom-up approach. The biggest project is ICAR (Interoperability and Application Cooperation among Regions), started in June 2006 with 17 partners: 16 out of 19 Italian Regions plus the autonomous Province of Trento. The results that are expected from this projects are:

- the compliance of large *horizontal* [6]projects with SPCoop;
- the complete definition and advertisement of about 50 service agreements, and the beginning of the definition of about another 100 service agreements; moreover, the definition of the core of an upper ontology and of two specific domain ontologies; the development of a directory of public employees reaching 800.000 entries; finally the reference implementation of all the components.

Before concluding this section and outlining, in the following ones, the technical details of SPCoop, we would like to point out how the governance and strategic actions presented above represent the success element; adopting a common infrastructure for interoperability and cooperation on the basis of solely technical solutions has proved unsuccessful in the past, conversely the use of a community approach to realize evolving versions of the framework and to create a SPCoop "culture" in the PAs seems a better solution. Such a community is expected to be led by administrations, with the active participation of industries and universities. This also constitutes an enabling factor for the overall innovation process of the whole country. The documents published in 2005 represents a technical road-map for such a community towards the effective SPCoop development, whereas typical community tools (e.g., on-line forums, development

[6] Horizontal means that the focus is on the same subject across different administrations, e.g., dealing with PA employments, citizens and businesses data management, etc.

community [7] , the continuous evaluation of standards by CNIPA, etc.) will support the process. Figure 1 shows the overall approach to SPCoop.

3 Overview of SPCoop

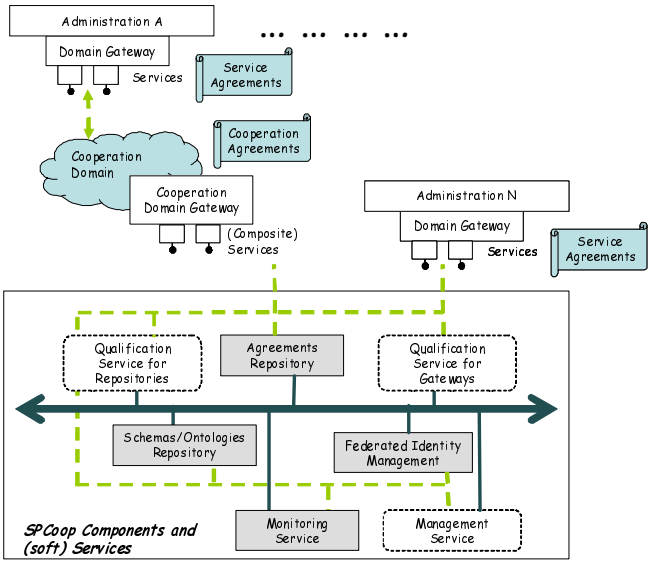

Fig. 2. The components and (soft) services of SPCoop

The model proposed for SPCoop is based on the following principles:

– The PAs cooperate through the supply and the use of *application services*; these services are offered by the single administration through a unique (logic) element belonging to its own information system called *Domain Gateway*. In this way the complete autonomy of the single administration is guaranteed, as far as it concerns the implementation and management of the provided application services, as they can be based on any application platform, being it pre-existent or new, as long as they are supplied through the Domain Gateway. The fruition of the application services is carried out through the exchange of messages, whose format is formally specified in the Italian standard referred to as *e-Gov Envelop*. Such a standard is basically an extension of SOAP.

[7] Cfr. `http://www.openspcoop.org/`, which aims at implementing open source reference implementations of some components.

– A service works on the basis of an agreement among at least two subjects (supplier and client); such agreements have a technical basis and an institutional/jurisdictional basis. These agreements should be formalized in order to support the development and the life-cycle of services in a (semi-)automatic way. The agreement specification is called *Service Agreement* and is based on the XML language.
– Sets of administrations which need to cooperate in order to provide composite application services form a *Cooperation Domain*; the services supplied by such a domain are *externally* described through Service Agreements, and *internally* by a specification describing how the different PAs concur to compose the final service, referred to as *Cooperation Agreement*.

It emerges that the cooperation model of SPCoop is organized as a SOA [2]; but even if the basic aspects related to a SOA are well defined under a technological point of view, conversely it is necessary to extend the advanced aspects in order to make the architecture suitable to the specific *e*-Government scenario. The reader should note that all the service architectures [8]/SOAs need a neutral element [9], with the goal to mediate between the different subjects cooperating for the service supply/use; the SPCoop framework includes a set of infrastructural components to be used to simplify these operations (e.g., retrieving a service trough automatic categorization, managing digital identities, etc). They are represented in Figure 2:

Agreements Repository is the software component used to register and to maintain the Cooperation/Service Agreements. It can be considered as the "database" of the cooperation. This component offers functionalities for the registration, the access, the update and the search of the agreements. The UDDI standard is the core of this component; however this standard does not offer all the required functionalities, therefore it has been extended.

Schemas/Ontologies Repository is the software component offering functionalities to deal with the service and information semantics, in order to find out services that are more suitable to provide required functionalities. This component acts as a structure to store ontologies and conceptual schemas, offering functionalities of registration, access, update and reasoning on them.

Federated Identity Management is used to authorize and control the access to application services over SPCoop; the federation is needed to reuse the already in-place identity management systems of regional and national authorities. Integration is be done through specific interfaces supporting SAML v2.0.

Monitoring Service is in charge of monitoring the respect, by the different services, of the Service Level Agreements (SLAs) declared in the Service Agreements. Its development is planned for the future (i.e., it has not been included in the currently active tender), as standards and technologies for

[8] This is true for both the W3C and ebXML/OASIS standards.
[9] Technically called *service directory*.

the definition and the enforcement of SLAs (e.g., WSLA or WS-Agreement) are not yet considered mature.

In addition to the previous components, a set of (soft) services, i.e., functionalities that need to be provided through different tools (either software or managerial) in order for the infrastructure to be effective, have been defined: *(i)* qualification services for both the repositories and the gateways, i.e., coded procedures for certifying that the components are compliant with the SPCoop technical rules; *(ii)* the management of the whole infrastructure.

In the next sections, some technical details on the most innovative aspects of SPCoop will be provided.

3.1 Service Agreements

A service agreement is a well-specified XML document that regulates the relationships of an application service between a supplier and a client in the following aspects: *(i)* service interface, *(ii)* conversations admitted by the service, *(iii)* access points, *(v)* Service Level Agreements (SLAs), *(v)* security characteristics and *(vi)* descriptions of the semantics of the service. The formal and well specified nature of the service agreement has been done to support the development and the life-cycle of services in a (semi-)automatic way. Moreover, the public nature of the service agreement makes easier the establishment of domain ontologies that allows to aggregate services with similar semantics. Finally, in the context of a set of public administrations (i.e., a Cooperation Domain), services can be composed and orchestrated, thus generating other services described in turn by service agreements.

The application services are supplied/used through Web service technologies and standards "enforced" by public service agreements. WSDL can be (and is actually) used to describe the elements *(i)* and *(iii)*. The element *(ii)* is considered as a typical application service requires multiple interactions between the service supplier and the client, and not all the offered operations are invocable in every step during the interaction. Thus, in order to use the service correctly (and therefore to develop *correct* clients), it is important to know in which steps operations can be invoked. This is different from the description of the internal process of a service, i.e., the description of the workflow implemented by the application service to offer such operations; nevertheless such conversational protocol can be obtained from the internal process by making abstractions in order to eliminate the details (internal view) while focusing on those service functionalities that are visible outward (external view) [3,4]. The model that describe the conversation protocol through a Finite State Machine [5], is considered meaningful and simple at the same time. Nowadays it does not exist a standard in the Web Service arena having the characteristics needed to describe this element, and therefore a new language, specifically designed for this purpose, has been introduced, namely WSBL (Web Service Behavioral Language), stemming from previous standard proposals (WSCL - Web Service Conversation Language [10])

[10] `http://www.w3.org/TR/wscl10/`

and academic ones (WSTL - Web Service Transition Language). When in the future, new standards or existing one will mature and will be appropriate for describing such an element, then the SPCoop rules will be in turn evolved by incorporating them.

As far as points *(iv)* and *(v)*, their importance is related to the particular scenario: application services that offer to citizens and enterprises operations belonging to the administrative/bureaucratic field, have to declare the supported levels of quality and of security. Again, nowadays, standards with the needed characteristics do not exist: *(i)* the WSLA (Web Service Level Agreement) proposal did not become a standard, yet showing many interesting conceptual elements; *(ii)* WS-Agreement is implied in a process of standardization in the limited context of the Grid Computing, whose final outcome is not yet clear; *(iii)* WSSF (Web Service Security Framework) seems to be promising, but its time of diffusion is not outlined. For all these reasons, those aspects can be described in a Service Agreement through whichever of the just cited languages, as well as through analogous formalisms based on the XML language and publicly available, according to an agreement between the supplier and the client.

The last point (i.e., *(vi)*) is introduced as, in an *e*-Government scenario, many concepts that should be shared and universally accepted, conversely show deep differences of meaning among different cooperating subjects, presenting different descriptions and formats. As a result, the description of the conceptual schemas and the ontologies related to the information carried out by a service, have the same importance of the definition of the interface [6]. Proposals for the description of these aspects are rapidly emerging; but the proposals related to OWL and/or WSML/WSMO (the so called *Semantic Web*) are not yet considered as standards, and their relationship with Web services and the related standards is under investigation; moreover techniques to compute semantic queries are still under investigation. The aim is to have, in the near future, as few ontologies as possible, through which to describe the semantics of all the application services offered by the different administrations.

3.2 Cooperation Domains and Cooperation Agreements

A Service Agreement describes a *2-party* collaboration/cooperation, with a subject offering a SPCoop application service and another subject using such a service. A lot of administrative processes do not concern only a single administration, but they involve different subjects.

The *Cooperation Domain* is the formalization of the wish of different subjects to join in order to cooperate for the automation of administrative processes. Inside the Cooperation Domain, a *responsible coordinator* should be identified, it assures the organizational and technical effectiveness and the coordination of all involved subjects and of the set of *composite application services* supplied outward by the Cooperation Domain. The Cooperation Domain is seen outward as a service supplier acting like a normal domain of a single administration; the main difference is in the way its services are designed and deployed: in the Cooperation Domain they are built by composing and integrating simple services

offered by the involved administrations; whereas for the single domain the supply of a service is related to applications that are fully under the responsibility of the single administration.

A *Cooperation Agreement* represents the specification of application services offered by a Cooperation Domain. The service supply is characterized by three basic elements:

- application services offered outward by the Cooperation Domain. From the user point of view, these services (*composite services*) are identical to any other service directly offered by a Domain, and like them they are described by a Service Agreement;
- application services used internally by the Cooperation Domain to build the composite services, referred to in the following as *component services*; they are described by their own Service Agreements too;
- the specification of the way the component services are coordinated to build the composite service. This specification, needed for each composite service, can be defined either in terms of orchestration (i.e., from the point of view of the composite service, by describing the process for the composition and coordination of the component services) or in terms of choreography (i.e., by an external point of view, by describing the constraints on the messages exchanged among the different component services). In SPCoop, the first solution, through the use of WS-BPEL, has been preferred.

Therefore a Cooperation Agreement consists of *(i)* an *institutive document*, expressed in natural language, describing the purposes and the normative or institutional basis of the Cooperation Domain; *(ii)* a set of references to the Service Agreements, describing the composite services offered by the Cooperative Domain; *(iii)* a set of WS-BPEL documents (one for each composite service) describing the coordination processes among component services [11]; such documents can be processed through suitable orchestration engines that are able to automate the coordination and the supply of a composite service; and *(iv)* a set of lists of references to the Service Agreements describing the component services (a set for each composite service).

3.3 Repositories for Agreements and Schemas/Ontologies

SPCoop provides an infrastructural software component to register and to maintain Service (and Cooperation) Agreements – it can be defined as the "database" of the cooperation. This component offers functionalities for the registration, the access, the update and the search of the Service/Cooperation Agreements. The UDDI standard is the starting point to define and implement this component; but this standard does not offer all the required functionalities, in particular UDDI defines content-unaware queries, while the Repository will offer the capabilities for queries about the content of the Agreements. Therefore, specific

[11] Further evolutions of the Cooperation Agreement will consider the specification of the documents describing the choreographies.

software layers have been designed to extend UDDI in order to realize all the envisioned functionalities. From a deployment point of view, the Repository has been organized into two layers, namely General and Local.

In particular, it is organized in a distributed *master-slave architecture with replication of information* with the following structure: *(i)* a singleton instance of the *General Repository* contains all the information needed for the supply of the provided functionalities; *(ii)* N instances of the Repository, referred to as as *Local Repositories*, contain (sub-)sets of information, defined according to different rules (e.g., geographic location, functional relationship, relationship with the supplier): if an information is in a Local Repository, it is surely in the General one, while the viceversa is not always true. Updates can be performed either at the level of General and Local Repositories, and a synchronization mechanism based on Publish&Subscribe technologies has been devised in order to guarantee the correctness of all the Repositories.

The Schemas/Ontologies Repository is the software component offering functionalities to deal with service and information semantics, in order to find out services that are more suitable to provide required functionalities. As described in Section 3.1, the "operational" point of view for the provided services is not the only possibility, being sometime better to search a service on the basis of the type of information that it carries on/deals with. The ontologies and the conceptual schemas represent the mechanism to describe this aspect, and suitable technologies, commonly referred to as "semantic" ones, allow the achievement of (semi-)automatic "reasoning" on the basis of such information. Even if the semantic descriptions are part of the Service Agreements, they are more effectively managed as separate elements.

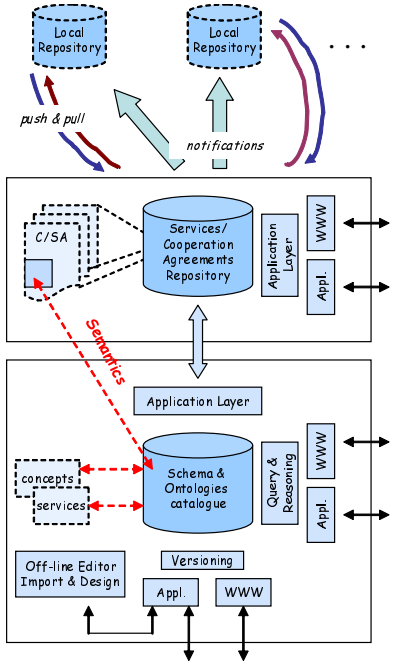

Fig. 3: Repositories in SPCoop

Therefore the Schemas/Ontologies Repository acts as a structure to store ontologies and conceptual schemas, offering functionalities of registration, access, update and reasoning on them; it is, in fact, the "database" of the ontologies and schemas. Figure 3 shows the complex architecture according to which Agree-

ments Repositories (one General and various Local) and the Schemas/Ontologies Repository (unique in SPCoop) are arranged in a distributed fashion.

4 Discussion and Future Work

Many European countries have engaged, in the last years, nationwide *e*-Government initiatives similar to the one presented in this paper. As an example, the *e*-Government Interoperability Framework (eGIF [12]) in UK is mostly focused on the definition of standard XML Schemas to be used for data integration and exchange among different PAs. Currently in Germany (cfr. the IDABC observatory [13]) there is no an overall legal framework for *e*-Government (i.e., something equivalent to the Law Decree n. 42 cited in Section 2), and no nationwide technical framework has been yet established (to the best of author's knowledge). In France (cfr. again the IDABC observatory [14]) a national infrastructure is being developed on top of the AdER network (very similar to SPC). For a complete overview of the various *e*-Government initiatives at European level, the reader is invited to refer to IDABC [7], which is being also developing a pan-European framework (EIF) for cooperation among PAs; SPCoop is fully compliant with such specifications.

In the following months, the SPCoop framework presented in this paper will start the operative phase, through the assignment of the public tenders and the design and implementation phase – also through open source communities that are already implementing some components [15] , that is expected to be concluded within the end of 2007. On the basis of the received feedbacks, and of the continuous update due to the consensus mechanism previously discussed, it is also expected a major revision of the technical specifications within Spring 2008.

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