Computer supported collaboration in the Public Sector: the ICTE-PAN Project

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Abstract. Electronic Government today focuses mainly on offering citizens and enterprises the capability to perform electronically their transactions with the Public Administration and also on the electronic delivery of the currently existing public services over the Internet. However, the huge potential of ICTs has only to a small extent been exploited in the higher level and most critical functions of Public Administration, such as the development, monitoring and evaluation of public policies and programmes, the decision-making for difficult and complex social problems, or for granting licenses and permissions with high social impact, etc. This paper is dealing with the exploitation of the methodologies and technologies of Computer Supported Collaborative Work (CSCW) in these directions. A general functional and technological architecture of a Government to Government (G2G) collaborative environment is described, for supporting the above high level functions of Public Administration, which has been designed as part of the ICTE-PAN Project. It is based on an extension of the classical Workflow Model, in order to include both 'Single Person Activities' and 'Collaborative Activities', and also on the use of modelling techniques and ontologies, in order to achieve a high level of adaptability to diverse requirements.

1 Introduction

Most of the current activity of researchers and practitioners in the area of e-Government is focused on offering citizens and enterprises the capability to perform electronically their transactions with the Public Administration (e.g. declarations, applications, etc.), and also on the electronic delivery of the currently existing public services (e.g. social services, etc.), over the Internet [12], [16]. The ICT-enabled innovation in this area is limited mainly to the development of 'virtual public agencies' or 'one-stop e-Government', i.e. of single points of access (e.g. portals) to many related electronic transactions and services, usually to all the electronic transactions and services required in a particular life event or by a particular target group (of citizens or enterprises), which are usually offered and managed by several different Public Organizations [6], [7], [26].

However, the innovation potential of ICTs concerning the reform and modernisation of Public Administration is much larger, and has only to a small extent been exploited [14], [16], [23]. Therefore, the concept of e-Government should be broadened and enriched, in order to exploit to a much larger extent the huge innovation potential of ICTs. e-Government should be directed not only to electronic transactions and services, but also to higher and critical functions of Public Administration [15], [16], such as:

- the development of public policies and programmes, as well as their monitoring and evaluation;
- decision-making, concerning difficult and complex social problems, or granting licenses and permissions with high social impact, etc.

These high level functions are of critical importance for the Public Administration and the society, and at the same time highly difficult and complex; they usually require close collaboration among many Public Organizations (POs) and very often participation of citizens, enterprises and their associations as well.

In particular, the development of effective public policies and programmes, for solving (or at least decreasing the intensity and social impact of) the big and complex problems of modern societies, is becoming more and more difficult. The social problems today are multidimensional and cross many regions or states. The continuously growing international economic cooperation and interdependence gives rise to new complex problems of international nature. The forthcoming enlargement of the European Union with new member states will give rise to many complex international problems and issues.

The development of effective public policies and programmes for such big and complex problems requires close collaboration among many POs from many regions or even countries (e.g. central governments, regions, prefectures, municipalities, local development organizations, employment organizations, social security organizations, education organizations, environment organizations, etc.). Each of these POs possesses one small, but valuable, piece of information, experience, knowledge and competence about the problem. Very often, there are differences among their values, interests and expectations. Therefore, it is necessary to organize properly the synthesis of these valuable 'pieces of information, experience, knowledge and competence', and also of their different values, interests and expectations, though close and effective collaboration of these POs. However, geographical distance and the existing time and budget limitations do not allow this collaboration to be close enough, resulting in suboptimal and ineffective public policies and programmes, developed without the required wide participation of all competent and knowledgeable parties.

Similar hold for the development of legislation, for the decision making concerning difficult and complex social problems, and also for granting licenses and permissions with high social impact; a high level of participation and collaboration is required, but very often it cannot be achieved, due to distance, time and budget limitations. Therefore, it is of critical importance to exploit the capabilities of modern ICTs for supporting and facilitating the required wide participation, argumentative discourse, interaction, synthesis and in general collaboration for the above mentioned high level functions of Public Administration.

This paper is dealing with the exploitation of the methodologies and technologies of Computer Supported Collaborative Work (CSCW) for this purpose. A short background on CSCW is given in Section 2. Then in Section 3 initially the objectives of ICTE-PAN (Methodologies and Tools for Building Intelligent Collaboration and Transaction Environments in Public Administration Networks) Project are described. ICTE-PAN is implemented in this direction, as part of the Information Society Technologies (IST) Programme of the European Union. Then is presented a general functional and technological architecture of a Government to Government (G2G) collaborative environment for supporting the above high level functions of Public Administration, which has been designed based on the users requirements analysis of ICTE-PAN Project. Section 4 is dealing with the use of modelling techniques and ontologies for configuring and customizing such a G2G collaborative environment to specific requirements. Finally, in Section 5 the conclusions are presented, together with directions of further research.

2 Background

Modern globalized economy has forced public and private organizations to use ICTs not only for increasing the personal productivity of individual employees (traditional approach), but also for enhancing the collaboration among the members (both co-located and remote ones) of various kinds of teams and for increasing their collective effectiveness. Thus, teams are considered as collections of co-located or remote individuals working for a common goal, who must interact extensively in order to achieve this goal. There are many ICTs which can support teamwork; special emphasis has been put on the various categories of software that can support synchronous or asynchronous collaborative work in teams, which are collectively referred to as Groupware, while the whole organization of collaboration among individuals based on Groupware is referred to as Computer Supported Cooperative (Collaborative) Work (CSCW) [1], [2], [13]. The most widely used categories of Groupware are shown in the Table 1 [13], organized in four groups, according to whether they support participants at the same place (co-located) or at different places (remote), and also whether the participants cooperate at the same time (synchronously) or at different times (asynchronously). The effectiveness of this ICTs-supported teamwork and its critical success factors, especially in the case of remote participants, has been a critical question and therefore has been extensively researched [5], [8], [13], [18]; the main conclusion of this research is that the effectiveness of ICTs-supported teamwork depends not only on the appropriateness of the utilized ICTs, but also on many other organizational, structural, processual and human factors. The most important of these factors are the design of the team, the organizational context in which it works, the synergy that will be developed among its members, the processes that will be followed by the team and the material resources available to it.

Table 1. Basic categories of Groupware

	Same Place (co-located)	Different Place (remote)

Same Time (Synchronous)	Electronic Meetings Systems Team Rooms Group Decision Support Syst. Electronic Whiteboards	Videoconferencing Teleconferencing Document Sharing Electronic Whiteboards
Different Time (Asynchronous)	Internal Mailboxes Electronic Bulletin Boards Virtual Rooms Document Management Syst. Shared Containers	E-Mail Workflow Management Systems Formflow Management Systems Messaging Systems Routing & Notification Systems

It is worth emphasizing the importance of two categories of Groupware, which have a high potential for supporting G2G collaboration: the Group Decision Support Systems (GDSS) and the Argumentative Discourse Support Systems (ADSS). GDSS is defined as an ICTs-based collaborative environment, which supports group meeting and decision making processes, in order to improve the productivity and effectiveness of decision-making, either by speeding up the decision-making process, or by improving the quality of the resulting decisions, or both [19], [25]. GDSSs attempt to increase the advantages and benefits of group decision making and decrease its disadvantages and dysfunctions. They can facilitate the generation of ideas and also their discussion, analysis, organization, prioritization and finally consensus building. ADSS is defined as an ICTs-based collaborative environment that supports argumentative discourse, in which several participants express different opinions, positions and solutions about an issue or problem [3], [4], [9], [10], [11]. The main objective of an ADSS is to improve the effectiveness of the discourse by: a) removing communication impediments, b) providing techniques for structuring the discourse and systematically directing its pattern, timing, or content, c) manipulating contradictions that arise during the discourse. An ADSS in general allows some agents (either human participants, or software agents) to perform some kinds of communicative actions, in order to establish common belief on some dimension of an issue or problem, e.g. the existing alternatives, their advantages and disadvantages, the criteria for their evaluation, etc. Usually an ADSS allows each agent to enter some kinds of elements, e.g. issues, alternatives, positions, etc., which all the other agents can immediately see, and on them express some associated elements, e.g. they can express some comments on (=associated with) an alternative, etc. In this way, a high level of interaction and collaboration among the agents is achieved.

Also, synchronous collaborative environments [1], [20], [21] have a high potential for supporting G2G collaboration; they offer a variety of tools for supporting synchronous on-line communication and collaboration among several participants, such as:

- Shared Whiteboard.
- Synchronous Text Exchange (Text Chat).
- Synchronous Audio and Video Conference.
- Shared Applications (e.g. Wordprocessor, Spreadsheet, CAD).

– File Sharing.

They can be very useful in order to achieve increased collaboration awareness, speed and immediate discussion of ad-hoc issues that arise. Synchronous collaborative environments have been successfully used in New Product Development (NPD) [20], [21], which is a highly collaborative function; it requires extensive collaboration among many geographically distributed engineers (e.g. from various plants of the manufacturing company, from its subcontractors, from customers, etc.), exchanging drawing, faxes, measurements data, etc. The experience and knowledge gained in this domain can be exploited (with proper adaptations) in the Public Administration for collaboratively developing legal documents, contracts, etc.

3 The ICTE-PAN Project - Development of G2G Collaborative Environments

The ICTE-PAN Project, which as mentioned above is implemented in the context of the European Union IST Programme, has been initiated to address the G2G collaboration needs of POs. The main objectives of this project are:
i) to develop a methodology for modelling collaboration among POs, and also for redesigning it based on the state-of-the-art ICTs,
ii) to develop a complete electronic platform with all the required meta-tools for creating high quality G2G collaborative environments,
iii) to elaborate sustainable measurement algorithms for evaluating such environments.
The project is implemented by a well-balanced consortium of technology providers and users, consisting of European Dynamics (Greece), University of the Aegean (Greece), TXT Solutions (Italy), National Environment Research Institute (Denmark), Ministry of Environment of Lower Saxony (Germany) and Province of Genoa (Italy).

3.1. Functional Architecture

From the analysis of the collaboration processes and requirements of the user POs in the project consortium, and also of the Public Administrations in general of the four participating countries (Greece, Italy, Denmark and Germany), it was concluded that an electronic environment for supporting effectively G2G collaboration should have a functional architecture of an ‘Extended Workflow Management System’, which can manage workflows:

- crossing more than one POs, i.e. workflows with some Activities executed by one PO, some other Activities executed by another PO, etc.,
- and also consisting of both ‘Single Person Activities’ and ‘Collaborative Activities’.

An Activity is characterized as a ‘Single Person Activity’ (SPA), if for each particular case this Activity is executed by only one person, e.g. in the workflow followed for

‘Processing an application for issuing license A’ the Activity ‘Checking if the certificates B, C, D have been submitted with the application’ is a SPA, because for each case (i.e. application) only one public servant is executing this Activity (i.e. doing this check). On the contrary, an Activity is characterized as a ‘Collaborative Activity’ (CA), if for each case a number of individuals have to be involved, contribute, collaborate and interact for executing this Activity, e.g. in the same workflow followed for ‘Processing an application for issuing license A’ the Activity ‘Final Consultation among Directors D1, D2, D3 of the involved Public Organizations PO1, PO2, PO3 in order to decide whether the license will be issued’ is a CA, because for each case (i.e. application) the 3 Directors D1, D2, D3 have to be involved in the final decision, collaborate and interact; each of them has to contribute in this consultation proposals and arguments, which will be taken into account by the others; also each of them listens to the proposals and the arguments of the others, and probably based on them expresses some more proposals and arguments, etc. (interaction). Also the development of public policies and programmes usually includes a sequence of CAs, in which representatives of several POs (and in some cases also citizens, enterprises and their associations) collaborate for understanding the corresponding problems and situations, generating and discussing alternatives, designing public policies and programmes, etc.

Therefore the classical Workflow Model [27], [29] and Wide Area Workflow Model [22], [28], [29], [30] should be extended, in order to include both SPAs and CAs, or only CAs. For each case, an appropriate electronic environment has to be created for each CA, in order to support the corresponding argumentative discourse, interaction and in general collaboration among remote participants. This collaborative environment should give to each participant the capability to contribute various elements, e.g. issues, alternatives, positive or negative arguments, etc.; each of the other participants should be given the capability to read them immediately, and possibly add positive or negative arguments on them, or add new issues or alternatives inspired by them, etc. In this way, a high level of interaction among the remote participants is achieved, which results in the collaborative development of a tree-like structure, looking like:

Issue1
- Argument11
- Argument12
- Alternative11
  - Argument111
  - Argument112
    - Argument1121
- Alternative12
- ……

Issue2
- …….

which incorporates the experience, the knowledge, the values and the interests of the participants, and supports the synthesis of them and the collaborative decision making and production of new knowledge, policies, programmes, etc. Also during any CA

the participants should have access to the outcomes of previous SPAs and CAs for the same case, and also on other relevant data sources (e.g. laws, directives, programmes, statistical databanks, etc.).

From the analysis of the collaboration processes and requirements of the Public Administration, it was concluded that for the development, monitoring and evaluation of public policies and programmes, and for the decision-making for difficult and complex social problems, or for granting licenses and permissions with high social impact, a big variety of CA types are required. These numerous CA types differ in the kinds of elements contributed by the participants, and the kinds of associations allowed among them. However we can distinguish eight basic types of CAs, which are the most usual ones in the PA practices :

- *Problem/Goal Understanding*: understanding better a social problem, or a particular situation, or a potential goal, by collaboratively elucidating its main dimensions and components.
- *Strategic Analysis*: conducting collaboratively a Strategic SWOT (Strengths, Weakness, Opportunities and Threats) analysis, e.g. of a public organization or geographic region, etc.
- *Alternatives Generation and Unstructured Evaluation*: collaborative generation of alternatives for a problem or issue, and also first-level elaboration and unstructured evaluation of them, in order to elucidate their advantages and disadvantages.
- *Evaluation Criteria Generation*: collaborative generation of evaluation criteria (based on the requirements, values and interests of the participants) for evaluating alternatives, which have been proposed for a problem or issue.
- *Structured Multicriteria Evaluation of Alternatives*: collaborative structured multicriteria evaluation of alternatives, which have been proposed for a problem or issue.
- *Design of Public Policies and Programmes*: for each of the selected alternatives, collaborative design of public policies and programmes for implementing it, in the required analysis level, e.g. up to sub-programmes, measures, etc.
- *Design of Projects*: for each of the above lower level programmes, collaborative design of projects for implementing it, and for each of these projects design of its internal structure, e.g. tasks, subtasks, deliverables, etc.
- *Project Monitoring and Evaluation*: collaboratively monitoring of these projects, concerning both physical implementation and financial management, and evaluation

3.2. Technological Architecture

Because of the above mentioned large variety of collaboration processes and CAs morphologies in the Public Administration, in order to support them effectively the most appropriate technological solution is to develop a generic electronic platform, consisting of general purpose units of functionality (meta-tools); in order to create a specific G2G collaborative environment for supporting a particular collaboration process and meeting particular requirements, we have to select, configure, customize

and combine the appropriate subset of these units of functionality. The main units of functionality of the ICTE-PAN platform are:

- **Environment Design:** This functionality is supported by the Designer Center module, which provides users with all necessary tools for creating, maintaining and expanding user-friendly environments for collaboration.
- **Information extraction:** Tools and methods for extracting, tagging and storing information out of unstructured data (excel files, manuals, public business procedures etc.) in XML, which provide a standard way to tag or mark-up information, so that the system will be easily extended and integrated with other systems or software components operating in different platforms.
- **Intelligent agents:** Two agents are included: a personal assistant and a search support agent.
- **Workflow:** An engine and a visual tool for designing and implementing workflows and rules.
- **Collaboration:** This functionality supports the management and maintenance of virtual teams operation, consisting of remote participants (members) from several POs.
- **Decision Module:** An application co-operating with the workflow module, which will support collaborative decision-making processes.
- **Storage:** Repositories for storing structured and unstructured data, user profiles, user preferences, rules, guidelines, mapping rules to remote systems and databases, and also caching recent and most requested data for easier access and faster response of the system.
- **Security:** Providing to the system, its users and the administrators a secure environment to operate and store information.

The ICTE-PAN platform has a modular architecture, which is illustrated in the following Figure 1. The core module is the Execution Environment, actually operating as an application server, where different modules with different functionality may plug-in, giving to the system extendibility and mobility. Users can access the system through an ordinary web browser.

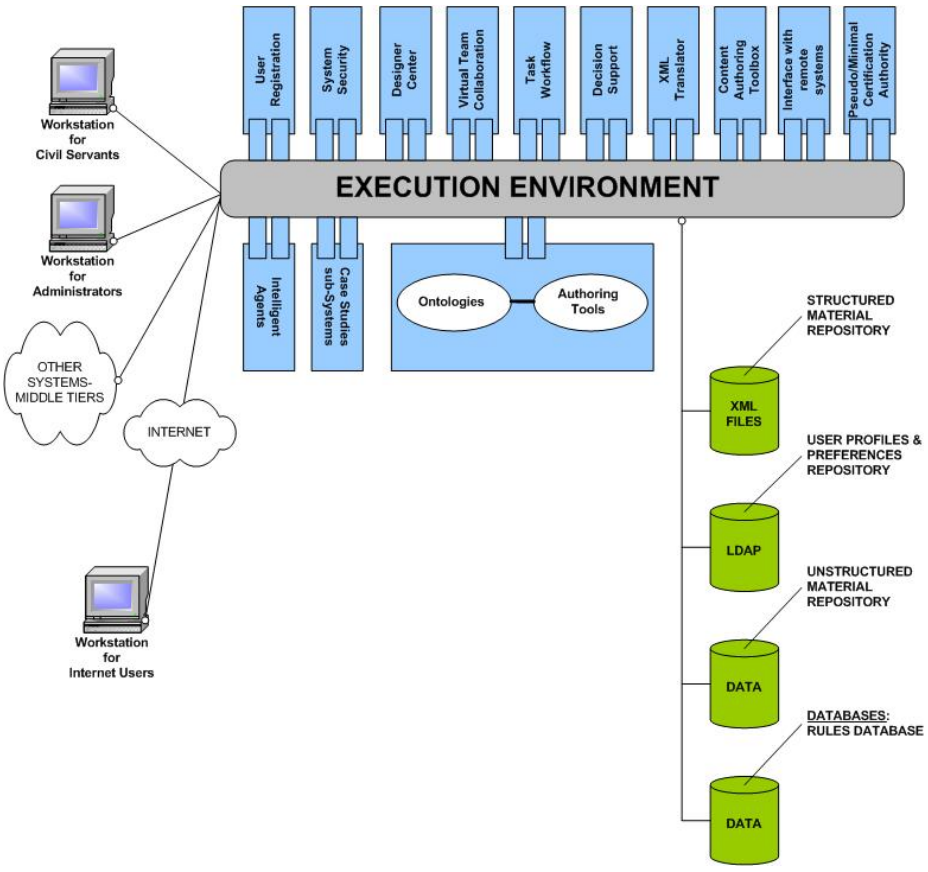

Fig. 2. ICTE-PAN System Technological Architecture.

4 Modelling Techniques and Ontology for G2G Collaboration

4.1 PA Operation Modelling Integrated Methodology (PA-OMIM)

In order to support the development of Collaborative Environments for Public Administration, based on the ICTE-PAN platform, a methodology for modelling collaborative operations in Public Administration (PA), named PA-OMIM (PA Operation Modelling Integrated Methodology), was developed. In particular the objective of PA-OMIM is to support :

– Describing and understanding PA collaborative processes, in which several POs are involved, via bulding "AS-IS" models.
– Redesigning these PA collaborative processes, so as to become more efficient and effective, based on the ICTE-PAN Platform, via building their corresponding "TO-BE" models.
– Specifying the requirements for the configuration and customisation of the ICTE-PAN platform, in order to support particular PA collaborative process and to fulfil their particular requirements, based on the corresponding "TO-BE" models.

In order to achieve the above objectives PA-OMIM combines ideas from Business Process Redesign (BPR) and Information Systems Development (ISD); it focuses on the domain of PA, with an emphasis on collaborative processes and activities.

The methodology consists of two components: the PA-OMIM Redesign Method and the PA-OMIM Modelling Language. The PA-OMIM Redesign Method consists of the following seven stages:

1. Definition.
2. Project Initiation.
3. Diagnosis.
4. Redesign.
5. Requirements Specification and Environment Design.
6. Implementation.
7. Evaluation.

4.2 PA-OMIM Modelling Language

In the above context the PA-OMIM Modelling Language has been developed to be used in stages 3, 4 and 5 with two aims:

– to model and redesign collaborative processes in PA; and
– to support the configuration and customization of the ICTE-PAN system, in conjunction with the PA-OMIM Redesign Method.

The PA-OMIM Modelling Language is a graph-structured language. It is based on the XML Process Definition Language (XPDL) of the Workflow Management Coalition [27], [31]. It has an intuitive format, that enables model building and understanding by non-experts, and also a simple, nevertheless powerful, notation that allows the modelling of the most complex PA collaborative processes. A multi-view approach has been adopted, in order to include in the models all the significant elements and associations among them. The PA-OMIM views are:

1) Environment View
2) Process View
3) Organisation View
4) Resource View
5) Information View

In the ‘Process View’ we can build models of processes consisting of both SPAs and CAs, or only of CAs (e.g. some collaborative problem understanding activities and some collaborative alternatives generation and evaluation activities). It should be

emphasized that these views are self-contained and PA-OMIM implementers may choose to build models following a few or all of them; however, the views are complementary and direct connections exist that link the views together: an element of one view, e.g. an activity in the Process View, may be linked to an element of another view, e.g. an organization unit or a person in the Organization View, responsible for implementing (or participating in) the activity, therefore the implementation of all the views is strongly recommended.

4.3 Ontology

As mentioned in subsection 3.1, there is a big variety of CA types in the PA, which differ in the kinds of elements contributed by the participants, and the kinds of associations allowed among them. For this reason it is necessary during the definition of the activities of a collaborative process in the Process View, for each CA to proceed to modelling this aspect of it ; therefore it is necessary to define the kinds of elements (e.g. issues, alternatives, arguments, programmes, projects, tasks, etc.) which can be contributed by the participants in this CA, and also the kinds of associations which are allowed to be made among these elements (e.g. an alternative can be associated with an issue). Based on these definitions, the ICTE-PAN Platform for each case creates the appropriate electronic environment for the execution of this CA.

In order to support the above definitions, an Ontology is required for the domains of PA policies and programmes development, monitoring and evaluation, and also PA decision-making, consisting of the main concepts (i.e. categories or kinds of discussion elements) used in these domains and their associations. Such an Ontology was developed, based on the relevant research literature in this area [3], [4], [9], [10], [11], on the analysis of the pilots of ICTE-PAN Project and in general of the PAs of the four participating countries, and also on the general experience of the members of the project team in these domains.

Using this Ontology we can easily define the nature of each CA, by selecting a small subset of the kinds of elements and associations of the Ontology (usually 3-4 kinds of elements and 5-6 kinds of associations from the whole Ontology) to be allowed in this CA. In this way, a high level of flexibility and adaptability to particular collaborative process requirements can be achieved, and a large variety of CA types of the PA can be supported. Also eight CA ‘templates’ have been defined, corresponding to the eight basic CA types mentioned in subsection 3.1. Each of them corresponds to a specific subset of the kinds of elements and the associations of the above Ontology. We can use these templates both as typical examples of CAs in PA, and also for the quick definition of new CAs; a new CA can be based on any of these templates: in this way all the kinds of elements and the relations of the template are automatically inherited by this new CA and defined to be allowed and usable in it.

5 Conclusions – Further Research Directions

In the previous sections a general functional and technological architecture of a Government to Government (G2G) collaborative environment for supporting higher level functions of Public Administration has been described. It is based on an extension of the classical Workflow Model, supporting both 'Single Person Activities' and 'Collaborative Activities'. In order to achieve a high level of flexibility and adaptability to particular collaborative process requirements, modelling techniques and ontologies are used. The first comments on this architecture from the Administrations of the four participating countries (Greece, Italy, Denmark and Germany) were quite encouraging. Further research is required in the direction of implementing and evaluating this architecture, in order to determine its strengths and weaknesses, and also possible needs for modifications, elaboration and extensions of the architecture. We plan to proceed in this direction with four pilot implementations in the user POs of the ICTE-PAN Project consortium.

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