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Electronic support of government-to-government negotiation and collaboration for the design and implementation of new policies

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Abstract: The growing complexity of the problems and needs of modern societies necessitate extensive negotiation and collaboration among government organisations from the same or even from different countries. Therefore it is an important challenge to extend 'electronic government' in this direction. In this paper we present the internet/WWW-based information system TNC (Trust-Negotiation-Collaboration), which offers a wide range of functionalities supporting initial trust relationship building and then negotiation and collaboration among public organisations. The development of TNC has been based on extensive analysis of the relevant requirements of public organisations from the USA and the European Union. Also, an application scenario of TNC is presented in the area of environmental policy design and implementation.

Keywords: e-government; e-negotiation; e-collaboration; e-services; public policy.

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1 Introduction

Modern societies are faced with a growing complexity of interrelated social issues and problems that impact almost every aspect of citizens' and companies' everyday life and activity and therefore government decision making both at the national and international level. Yet, for the most important problems that modern societies face today, there is not a unique public organisation possessing all the competence, experience and knowledge required for managing them successfully. Neither is there a common structure to facilitate and track extensive collaborations among the involved public organisations from one or more countries. For the most significant problems of modern societies there are many public organisations involved, each of them possessing only a part of the problem or offering only a portion of what is needed for managing it; therefore, a synthesis of these 'parts' is necessary, with an integrated system that mediates, facilitates and tracks the extensive collaborations required among the involved public organisations. Furthermore, many significant problems of modern societies necessitate not only collaboration, but also negotiation among several involved public organisations from one or more countries, which have different perspectives and concerns.

Therefore it is very useful to investigate ways of using Information and Communication Technologies (ICT) for supporting the abovementioned required collaboration and negotiation among public organisations, extending the 'classical' electronic government (e-government) tools and capabilities towards these critical directions. As e-government has been defined the use of ICT, and especially the internet technologies, in order to support electronically both the internal functions of public organisations and also their external communications and transactions with citizens, enterprises and other public organisations at the national and international level (Apostolakis et al., 2004); however, the main dimensions of e-government that have been researched and developed have been the internal IS of government organisations and also the 'outward-looking' Government-to-Citizen (G2C) and Government-to-Business (G2B) e-government. Therefore the effective electronic support of Government-to-Government (G2G) negotiation and collaboration is an important research challenge, because of the emerging new modes of communication and collaboration, both digital and physical, among government sectors.

Initially, e-government focused on supporting internal Information Systems (IS). Later, due the rapid growth and penetration of the internet and at the same time the increasing demands of citizens and enterprises for higher quality services, it became necessary to grow towards the 'outward-looking' IS, which enable citizens and enterprises to perform transactions with public organisations (e.g., various declarations, applications, etc.) over the internet or other electronic channels (e-transactions). So today, a major challenge in e-government practice is exploiting ICT to support not only internal and external functions, but also decision making for new policy design ('higher level functions') by the public administration, especially in 'difficult' cases where extensive negotiation and collaboration among several public organisations from one or more countries is required (Lenk and Traunmüller, 2001, 2002; Traunmüller and Wimmer, 2003, 2004; Leitner, 2003).

It should be emphasised that G2G transactions are lengthy and can involve complex bilateral and multilateral negotiations among disparate public sectors. These transactions are characterised by different parameters that may include, for example, the duration of a transaction or agreement, the parties involved, condition complexity, the history of previous outcomes, links to relevant documents exchanged after each meeting, and the goals of the public and private organisations involved. Therefore they require electronic support through effective ICT systems that track the evolution of an agreement, authenticate the users and ensure security and privacy for its data, conditions, and negotiations.

Furthermore, there are several other types of G2G collaborations aiming at the formation new public policies that take place mainly via 'physical meetings' of various inter-organisational teams, committees, etc., which can be very costly in terms of time and money. The results are often sub-optimal, resulting in ineffective public policies and programs designed without the wide participation of all stakeholders. Also these teams, committees, etc., are usually characterised by inefficiencies coming from many different social, cultural and historical factors. Therefore these G2G collaborations require electronic support through effective ICT systems that can contribute to overcoming these problems and increasing collaboration efficiency and effectiveness.

This paper contributes to filling the existing research and practice gap concerning the electronic support of G2G negotiation and collaboration. It presents an internet/WWW-based information system called TNC (Trust – Negotiation – Collaboration). It has been

developed based on the analysis of some of the requirements in the above domains of several public organisations from both the USA and the European Union and a series of research projects funded by the US National Science Foundation (NSF) and the European Union's Information Society Technologies (IST) Program. The TNC system integrates three subsystems which support three different types of G2G transaction:

a the building of trust relationships

b the negotiation to establish conditions on the sharing of information

c the collaboration through an interactive workflow approach.

It should be noted that this is an urgent and timely area of G2G research because of:

- the high interdependence among national economies,
- the development of various supranational entities (e.g., the European Union, the North American Free Trade Association (NAFTA), etc.) which gradually formulate their own policies
- the globalisation of the economy
- the development of a 'new digital economy
- new social problems such as massive immigration, international security, and absorption of migrating populations, which necessitate extensive collaboration and negotiation among public organisations from the same or different countries.

In particular, the proposed TNC system consists of the following three subsystems:

i The *Trust Subsystem*, which supports building trust relationships among public organisations, based on previous collaborations, through a process known as collaborative Automated Trust Negotiation (ATN) using locally trusted third parties (Ye et al., 2004), and is presented in Section 2.

ii The *Negotiation Subsystem*, which supports automated G2G electronic negotiations according to Zhao (2004). This subsystem is based on the use of metadata digital libraries that represent the conditions and other items of negotiation. It supports the creation, management and exploitation of digital libraries and the use of historic data (past agreements) from previous negotiations. It is presented in Section 3.

iii The *Collaboration Subsystem*, which supports G2G collaboration for the design and implementation of public policies, via both unstructured and structured consultations, inter-organisational workflows, documents sharing, etc.; it is presented in Section 4.

Additionally, we provide two cases to exemplify TNC. One case is in the area of G2G trade agreements (e.g., tariffs and quotas on exports from one country to another, or large government purchases across countries, etc). In reaching trade agreements, each country tries to erect barriers to the entry of products and services from other countries into its own market, while at the same time tries to promote its own products and services into the markets of other countries and to minimise the barriers they erect. In order to reach agreement several disparate entities are involved, such as ministries from the public sector and companies from the private sector. Each entity may have its own policy to follow and its own, often conflicting, aims. TNC automates and facilitates the process of reaching such an agreement.

Another case is in the area of G2G environment agreements, such as the sharing of natural resources (e.g., water) among neighbouring states. Here, decision making can include budget allocation, choosing common projects, and action plans to address emerging needs, problems or even disasters. The negotiations may include existing policies, laws and restrictions, as well as cultural and historical conditions that may need to be re-evaluated and represented in an interoperable format for the purpose of negotiation. For the implementation of environmental policies long inter-organisational processes may be needed before the granting of various types of licenses. For example, in the design of environmental policies for a river basin or lake area, extensive collaboration is required among many public organisations with different expertise and levels of competence (e.g., environment, agriculture, forests, industry, tourism, etc.).

The structure of this paper consists of six sections. As mentioned above this introduction is followed by three Sections 2–4 describing the three subsystems of the TNC that support trust building, negotiation and collaboration, respectively. Then in Section 5 we present a realistic application scenario in the area of environmental policy design and implementation, which demonstrates the capabilities and the applicability of the TNC system in G2G collaborations and negotiations. Finally, Section 6 concludes the paper and proposes directions for further research.

2 Trust subsystem

The Trust Subsystem of the TNC system enables trust building among public organisations before further negotiations and/or collaborations take place. We use a Peer-to-Peer (P2P) paradigm as the most powerful distributed environment for conducting negotiations. In particular, we investigated ways to build trust among government entities in a P2P environment, where parties can be physically distributed and do not know each other. P2P was originally used to refer to network protocols, where all the nodes have the same role and there are no nodes with specific responsibilities to act as the administrators or supervisors of a network (Oram, 2001). With the evolution of internet-based applications, the designation of P2P is currently used to identify a class of systems and applications that employ distributed resources to perform some function in a decentralised manner, where every participating node can act as both a client and a server, for example (Stoica et al., 2003; Castro et al., 2003). In many cases each node has different capabilities (processing power, shared files, connection bandwidth, etc.) and the success of the system depends on collaborations of the participating nodes. In modern societies, the collaboration behaviours among public organisations have properties similar to those of P2P systems. In the case of sensitive or critically important collaborations, peers must build some level of trust prior to collaboration. One option for building trust among public organisations is to use ATN.

Automated Trust Negotiation (ATN) (Winsborough et al., 2000; Winsborough and Li, 2002; Yu et al., 2000; Yu and Winslett, 2003) is an approach to access control and authentication in open and distributed systems. ATN enables open resource access by assigning an access control policy to each resource that could be accessed by strangers. In contrast with the traditional approach, where identities of the parties that can access a resource are listed, ATN access control policies are used to describe the properties of these parties. Properties typically consist of digital credentials/certificates, which are essentially digital versions of paper credentials used in the real world.

As a special kind of sensitive resource, credentials should be properly protected and not be disclosed freely to others. In what follows we provide a summary of how ATN works in a P2P environment. The notion of access control policy is central in that it indicates how two peers can share restricted documents or resources – they first build trust by gradually revealing credentials to each other.

A typical trust negotiation consists of the iterative, bilateral disclosure of digital credentials and related policies. It is initiated by a party who requests access to a resource belonging to another party, and progresses incrementally through the exchange of digital credentials. The purpose of trust negotiation is thus to find a credential disclosure sequence (C_1, C_2, …, C_k, R), where R is the resource to which access was originally requested, such that when each credential C_i is disclosed, its access control policy has been satisfied by credentials previously disclosed by the opposite party.

For a credential C or resource R, its access control policy (Yu et al., 2000) can be expressed as a Boolean formula consisting of credentials from the other party, '$\wedge$' (and), '$\vee$' (or) and parentheses if necessary. For example, consider two government agencies P_1 and P_2. P_2 wants to access P_1's document R, which is protected by an access control policy $R \leftarrow C_1 \wedge C_2$, meaning P_2 has to provide credentials C_1 and C_2 to get access to R. Similarly, P_2 also has access control policies to regulate disclosure of its credentials including C_1 and C_2. For example, P_2 may have $C_1 \leftarrow C_2 \vee C_3$: P_1 has to disclose its credentials C_2 or C_3 before P_2 discloses C_2.

Trust negotiation is a slow process, especially at the early stage since both parties are typically cautious and reluctant to disclose credentials to others with whom it has not built a sufficient level of trust yet. Furthermore, traditional trust negotiations are conducted separately between two parties at a time, even if a group of parties need to build mutual trust among them (a common situation for collaboration in modern societies). This means that a pair of peers often has to conduct trust negotiation from scratch. In our work we have applied the concept of Locally Trust Third Party (LTTP) to facilitate the trust building process among a group of parties (Ye et al., 2004). An LTTP is a party P_3 that is trusted by two peers P_1 and P_2 (assumedly through previous trust negotiations). LTTPs were originally proposed to break credential cyclic interdependencies in trust negotiations (Ye et al., 2004). For example, for two parties P_1 and P_2, if P_1 has $C_2 \leftarrow C_2$ and P_2 also has $C_2 \leftarrow C_2$, neither can disclose his C_2 to the other party due to the access control policy. If P_3 already has C_2 from both P_1 and P_2 from previous trust negotiations, it can act as a mediator and disclose P_1 and P_2's credentials and policies to each other when appropriate, thus breaking the cyclic dependency and allowing trust negotiation to succeed.

P_1 and P_2 can leverage their trust relationship with P_3 to help their trust building process from the beginning of the trust negotiation. Since P_3 already cached some of P_1 and P_2's credentials and access control policies from previous trust negotiations, it can help P_1 and P_2 to find a proper credential disclosure sequence to build some level of trust between them. Therefore P_1 and P_2 can start trust negotiation after they already have some level of trust, avoiding the overhead of starting trust negotiation from scratch. When a group of parties want to build mutual trust with each other, LTTPs can substantially reduce the communication and computational cost that could otherwise be incurred by traditional trust negotiations, speeding up the overall trust building process.

3 The negotiation subsystem

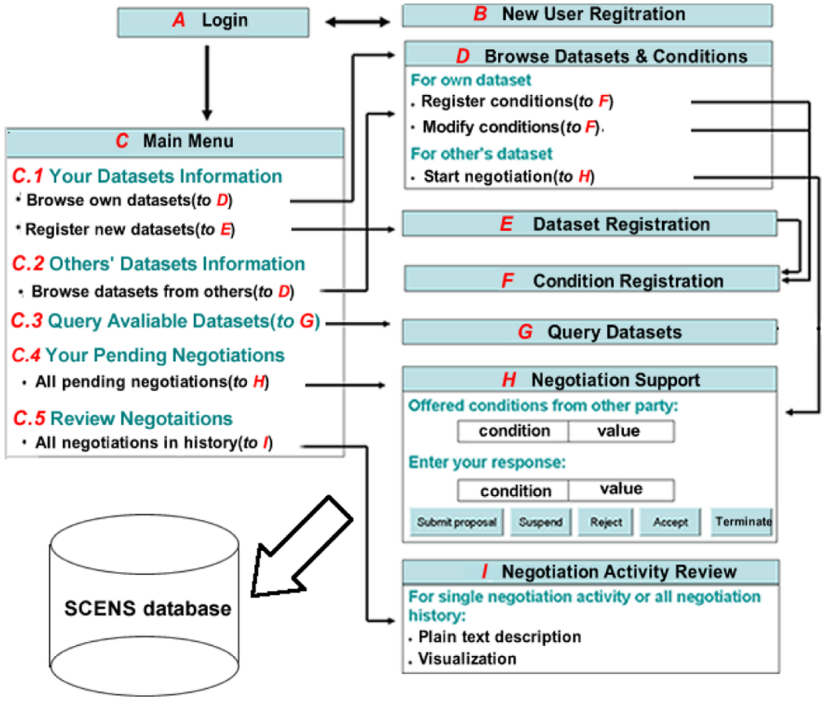
We designed the negotiation subsystem of the TNC system based on relevant literature on negotiation support systems, and on requirements of US and European Union public organisations for electronic support of negotiations. We implemented a specialised version called Secure Content Exchange Negotiation System (SCENS) (Ye et al., 2003) in order to support negotiations for accessing sensitive and/or high value information content (e.g., brain images in neuroscience, environmental data, financial data, data from previous negotiations, etc.). In this section, we introduce the architecture of SCENS and the negotiation protocol it supports.

G2G negotiation involves the exchange of conditions among government entities (e.g., persons, enterprises, public organisations, countries, etc., or software agents representing such entities) in order to reach an agreement on one or more matters of common interest (Bui et al., 1992). Systems to provide automated support and tracking of the exchange of conditions are needed due to limited information storage, limited retrieval and processing capabilities of the human brain and cognitive and emotional barriers which often result in inefficient and ineffective negotiations. In the last 15 years there has been research on various types of negotiations among co-located or remote entities. Initially, research in this area focused on supporting the decisions of the negotiating parties with appropriate analytic methods (the analytic decision support paradigm) (Jelassi and Foroughi, 1989; Foroughi et al., 1995; Kersten and Noronha, 1999; Kersten, 2002). Subsequently, motivated by the increasing need for negotiations in the private and public sectors, research in this area was extended to include support for the communication among the negotiating parties (communication support paradigm) (Schoop et al., 2003; Weingand et al., 2003).

The most widely referenced negotiation systems include WEBNS (Yuan et al., 1998), INSPIRE (Kersten and Noronha, 1999), NEGOISST (Schoop et al., 2003) and SMARTSETTLE (www.smartsettle.com). The WEBNS system offers negotiators capabilities for process-driven exchange of non-structured messages in natural language. Moreover, it allows a third person (or entity in general), acting as 'mediator', to monitor the negotiation and intervene in order to assist the negotiating parties in reaching agreement. The INSPIRE system mainly follows the analytic decision support paradigm; however it offers some communication capabilities as well. Initially, in the preparation phase, it offers to each negotiation party the capability to determine the weighting factors of the various attributes under negotiation (e.g., price, quality, delivery time, etc.), and then based on them to determine a utility function, which is used during the negotiation in order to evaluate the offers and counteroffers submitted by the other negotiating parties. During the negotiation phase it offers to all negotiating parties the capability to exchange offers and counteroffers via structured messages, which can also include free text in natural language. The NEGOISST system mainly follows the communication support paradigm, but it offers some analytic support of the decision of the negotiating parties as well; it offers them the capability to exchange four types of semi-structured messages: information, offer and counteroffer, clarification-request and rejection-acceptance. These messages consist of free text in natural language, some part of which can be semantically annotated based on pre-defined terminology, classifications or ontologies. Also it offers to each negotiating party the capability to calculate the utility of the offers and counteroffers submitted by the other negotiating parties.

Our negotiation subsystem SCENS has as goal to facilitate online negotiations using web services and web browsers, and enables users to seamlessly conduct negotiations among distributed parties or organisations, where one party may not know the other and where a variety of conditions and shared resources are possible, the latter including data, storage, bandwidth or other services. The current web-based SCENS implementation allows users to share program code through negotiation using a web browser. This implementation is based on Java™ technology and open source software packages. It is built on an Apache web server using the Apache Tomcat toolkit for servelets, and users can use any web browsers to access it. The system supports both online and offline negotiation: online negotiation is interactive, which means both negotiation parties are available during the negotiation, whereas offline negotiation allows parties to conduct negotiation even if they are not simultaneously online. Figure 1 shows the architecture of the implementation, including a central database and the essential components; the arrows show the relationship between these components. A database records information on the users, the datasets and the negotiations. The implementation includes all essential components for an end user to conduct negotiations with others.

Figure 1 SCENS online architecture (see online version for colours)



The key components of SCENS are as follows:

- *User Login* (component A), where the user logs in to SCENS with a valid user name and password.
- *New User Registration* (component B), where the user registers his personal information to SCENS in order to be authenticated as a valid user in User Login (1).

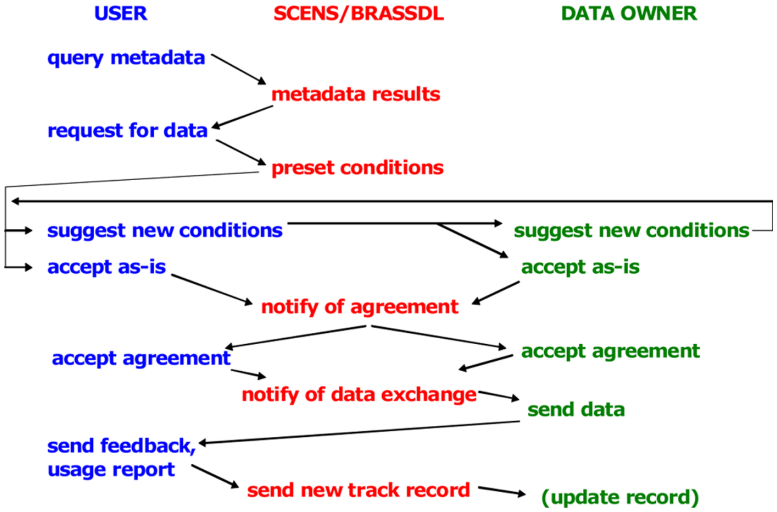
- *Main Menu* (component C), which is the main interface in SCENS, directs the user to different components for different purposes.
- *Browse Datasets and Conditions* (component D) lists all the datasets the user is interested (they could be the results from Dataset Query (7), or a complete list of datasets belong to others, or a list of the user's own datasets). It also shows the negotiation conditions of these datasets registered by their owner. From here, the user could start negotiation on the dataset he chooses.
- *Dataset Registration* (component E), where the user registers his dataset for sell through SCENS.
- *Negotiation Conditions Registration* (component F), used to register conditions (such as price, usage time, etc.) for a dataset by the owner (these are the conditions that this owner is willing to pre-authorise without negotiation).
- *Dataset Query* (component *G*) supports flexibly setting search conditions to find datasets.
- *Negotiation Support* (component *H*) allows parties to propose offers or make responses, using several options.
    - i '*Submit proposal*', which enables a party to submit his proposal to the party he is negotiating with.
    - ii '*Reject*', which enables a party to reject an offer, thus ending the negotiation as a failure.
    - iii '*Accept*', which enables a party to accept an offer, thus ending the negotiation successfully.
    - iv '*Terminate*', which enables a party to terminate or give up a negotiation independently of a specific proposal.
- *Negotiation Activity Review and Monitor* (component I) offers users the option to review the details of any of his previous negotiations (we also provide a facility to visualise the change of each negotiation condition separately by the means of plotting, as described below).
- *Negotiation analysis services* (component I) allows past data from previous negotiations to be reviewed and analysed, using data mining and neural networks methods, to extract knowledge that can be used to optimise negotiation strategies of future negotiations.

We also provide a separate *visualisation-based negotiation analysis service* to analyse what we call the Negotiation Communication Network (NCN) (Zhao, 2004), which is a graph consisting of negotiation parties and their transactions. Analysis of NCNs can reveal the collaborative relationships between negotiation parties, especially the way their negotiations evolve over time, and promote healthy and efficient negotiation-based collaboration.

A high-level schema of the SCENS negotiation protocol is shown in Figure 2. The user initiates the exchange by sending a QUERY FOR METADATA to BrassDL (a metadata digital library for brain image data), the component of SCENS that mediates

the negotiation of conditions. BrassDL responds by sending METADATA results that describe the desired resources. The User then selects the desired metadata and REQUESTS the raw resources from BrassDL. BrassDL sends the user any PRESET CONDITIONS from the dataset owner. The user now has the choice of ACCEPTING these conditions AS-IS, or SUGGESTING NEW CONDITIONS to the dataset owner. The owner can ACCEPT the new conditions AS-IS or respond with his own SUGGESTED NEW CONDITIONS. Once one side ACCEPTS AS-IS (the alternative is that one side never responds, in which case the negotiation is abandoned), BrassDL NOTIFIES both sides OF AGREEMENT being reached by both sides (meaning that BrassDL signifies to both sides that it has an agreement from both side). Both sides ACCEPT the AGREEMENT (a final handshake). BrassDL then NOTIFIES the data owner OF DATA EXCHANGE (original dataset) to be initiated. The dataset owner SENDS DATA to the user. The user, after having worked with the dataset, SENDS FEEDBACK and a USAGE REPORT to BrassDL. BrassDL updates both sides' records and SENDS a NEW TRACK RECORD to the resource owner. The dataset owner UPDATES local RECORDS (i.e. their advertised track record).

Figure 2 Negotiation protocol in SCENS (see online version for colours)



4 The collaboration subsystem

Extensive research has been conducted in the last 15 years in the area of 'Computer Supported Collaborative Work' (CSCW), aiming at the development of IS that enable efficient electronic collaboration among the members of a team, exchange and synthesis of their experiences and knowledge, and collaborative development of new knowledge, products, services, strategies, etc. As a result of this research, various types of tools have been developed, tools which can support various types of collaboration and teams, collectively referred to as 'Groupware' (Thomas, 1996; Beaudouin-Lafon, 1999; Lococo and Yen, 1998; McDonough, Kahn and Barczak, 2001). In Table 1 we classify some of these tools (Lococo and Yen, 1998) based on:

i whether they support collaboration among participants located at the same place (co-located), or at different places (remote)

ii whether they support synchronous collaboration (the participants cooperate at the same time) or asynchronous collaboration (each participant can cooperate at different time).

According to Ehrlich (1999), groupware generally supports one or more of the following four basic elements of the team work: communication, meetings, information sharing and coordination of actions. As main groupware applications supporting communication he mentions Videoconferencing, Shared Whiteboard, Group Editors, Shared Applications-Documents, Media Spaces (synchronous communication) and e-mail (asynchronous communication). Ehrlich (1999) lists various types of groupware applications that support meetings and where participants can enter ideas, comments on others' ideas, vote on various issues, etc. Information sharing is possible by enabling any member of the team to store a message or a document in a database accessible by all the other members. As main applications for this purpose Electronic Bulletin Boards, Document Repositories, Discussion Databases, etc. are mentioned. Workflow Management Systems are used for the coordination of the actions of the members of a team.

Table 1 Classification of groupware tools

	Same place (co-located)	*Different place (remote)*
Same time (synchronous)	Electronic meeting systems	Videoconferencing
	Team rooms	Teleconferencing
	Group decision support systems	Document sharing
	Electronic whiteboards	Electronic whiteboards
Different time (asynchronous)	Shared containers	E-mail
	E-mail	Workflow management systems
	Electronic bulletin boards	Formflow management systems
	Virtual rooms	Messaging systems
	Document management systems	Routing and notification systems

There are several electronic collaboration support platforms today; each of them includes a different subset of the abovementioned tools, and focuses on the support of different types of collaboration. To design the TNC collaboration subsystem we have chosen tools from existing collaboration support systems that fit the general requirements of public organisations and also address recommendations, standards and specifications of European Commission Programs, such as the "Interchange of Data between Administrations" (IDA) Program and its successor "Interoperable Delivery of European e-government Services to public Administrations, Business and Citizens" (IDABC) (http://ec.europa.eu/idabc/).

Taking into account the research has been conducted in the area of CSCW we designed the collaboration subsystem of TNC, which comes into play when two or more entities need support for arriving at a decision on a topic of common interest. This phase occurs after they have established trust and after they have agreed on the

general conditions for sharing information in their collaboration. The collaboration subsystem can create a virtual team, define its members, create its virtual workspace with all the required services and define for each member his or her access rights to these services. Once a team is created, this subsystem offers a wide range of capabilities for supporting both 'hybrid' operations of the virtual team (based on both 'electronic meetings' and 'physical meetings') and purely electronic operation (based on 'electronic meetings' only).

In particular, the collaboration subsystem (Loukis and Kokolakis, 2004) is an integrated platform that can guide virtual public administration teams through an interactive collaborative process that enables, among others:

- understanding and analysis of the social or other problems involved
- design of public policies for managing these problems
- analysis and/or extension of existing or new public policies
- extension of policies into action plans or projects
- monitoring the implementation and evaluation of public policies, action plans or projects
- supporting the entire 'lifecycle' of public policies.

The main modules of the collaboration subsystem are:

I Document Management

II Unstructured Consultation

III Structured Consultation (based on predefined ontology)

IV Extended Workflows Management

V Extended Workflows Modelling

VI Content Management

VII Advanced Search

VIII Calendar.

The 'Unstructured Consultation' module offers to each member of the virtual team the capability to enter his position (i.e., views or opinions) on the particular topic of the consultation. He is also able to read the positions entered by the other members on the same topic, and respond on each of these positions by entering new positions, thus leading to a threaded discussion. In this way, a discussion tree is gradually created, similar to the one shown in Figure 3. This tree consists of interconnected positions of the participants, and provides a synthesis and visualisation of the experiences and knowledge of the participants on this topic as they collaborate over a time period. The Unstructured Consultation module enables the effective electronic interaction and exchange of knowledge among a large number of geographically remote participants, without the need for Face-to-Face (F2F) contact, and the collaborative creation of new knowledge through this interaction.

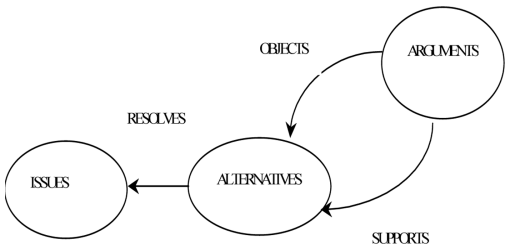
Figure 3 Discussion tree in the unstructured consultation module

Position1 (USER1)
    Position11 (USER4)
    Position111 (USER2)
    Position12 (USER3)
    Position13 (USER5)
Position2 (USER5)
    Position21 (USER1)
    Position22 (USER2)
Position3 (USER7)

Very often, however, it is necessary to have a higher level of structure in the collaboration process, especially if the topic is highly specialised and complex; the Structured Consultation module can offer this structure (Karacapilidis et al., 2005). It enables each member to enter semantically annotated positions, according to a pre-defined 'Consultation Ontology'. A Consultation Ontology is defined to be the set of the allowed kinds of positions that the participants can enter at any point in time, and a predefined set of allowed relations among these positions. For instance, in a structured consultation on a topic with the ontology shown in Figure 4, the participants are allowed to enter the following kinds of positions:

- 'issues' (e.g., problems to be solved, questions to be answered, etc.) concerning the topic of the consultation
- 'alternatives' for resolving each issue
- positive or negative 'arguments' on each alternative.

Figure 4 Consultation ontology

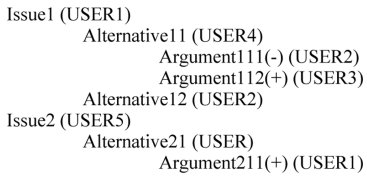


A structured consultation with the ontology shown in Figure 4 offers the following options to each participant:

- to read the issues that have been entered by the other participants concerning the topic of the consultation
- to add new issues on the topic of the consultation
- to read the alternatives that have been entered by the other participants for resolving each of these issues
- to add new alternatives for resolving any of these issues
- to read the positive and negative arguments that have been entered by the other participants on each of these alternatives
- to add new positive and negative arguments on any of these alternatives.

The discussion tree that will be generated from such a structured consultation will have the structure shown in Figure 5.

Figure 5 Discussion tree in the structured consultation module



Structured consultation offers a higher level of discipline and homogeneity in the contributions of the participants, who may have different backgrounds, experiences and assumptions, as they belong to different public organisations. This higher level of structure often results in a better focus and increased effectiveness of the consultation. The semantic annotation of the contributions of the participants enables a better processing, exploitation and management of the useful knowledge exchanged and produced in the consultation. However, unstructured consultation could be used as a first attempt to gather broadly the opinions and positions on the topic under discussion, before we proceed into a more structured mode of consultation, in which these opinions and positions are discussed in more detail. A Structured Consultation Ontology for public policy design has been developed by Loukis (2007). This ontology consists of the main concepts (i.e., kinds of discussion elements) used in public policy design and implementation, and also the relations among them. In order to define the specific ontology of a new structured consultation, we can use an appropriate (small) subset of the kinds of discussion elements and relations of the above public policy ontology, possibly in combination with other kinds of discussion elements and relations, which do not belong to this ontology, but are specific to this consultation. The 'Extended Workflows Management' and 'Extended Workflows Modelling' modules offer the capability to define, model and automate the management of an 'extended workflow', which is a workflow that includes both 'single person activities' (i.e., activities executed by only one person) and 'collaborative activities' (i.e., unstructured or structured consultations, in which several persons participate). Thus, the traditional workflow of 'single person activities' is extended to incorporate widely used practices of public administration, associated with 'collective decision making' and teamwork.

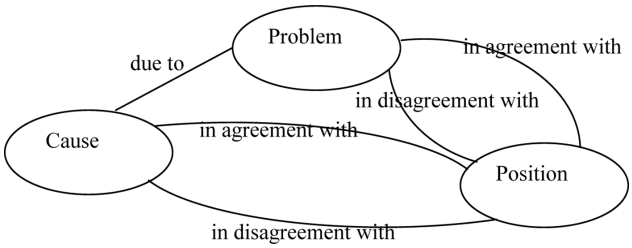
5 An application scenario

To illustrate the use of TNC, we provide a scenario from the area of environmental policy design and implementation. Let us assume that it has been decided to design and implement an integrated policy for the environmental management of a river basin that crosses several countries. For this purpose extensive collaboration is required among public organisations with diverse areas of expertise (e.g., environment, agriculture, forests, industry, tourism, etc.) from all the countries crossed by this river basin. Initially, using the Trust Subsystem, 'electronic credentials' are exchanged among these public organisations in order to build a trust relationship. Then, in order to overcome possible deadlocks in trust negotiations, the Locally Trusted Third Party (LTTP)

mechanism can be used. Next, in the Collaboration Subsystem, an initial virtual team is created, consisting of representatives from each of the involved public organisations, which is to have mainly 'electronic meetings' (using both the above Unstructured and the Structured Consultation modules).

As a first step, it is decided that each member of this virtual team will upload one document on a shared folder of the Document Management module. This document describes the projects or other activities in progress in his/her organisation that have an impact on the environment of the river basin. After this first exchange of information, an initial round of structured consultations among the members of the virtual team follows, with the aim of identifying the most important environmental problems in the river basin and their causes. These are based on a consultation ontology that all members agree on, which defines the kinds of elements that members are allowed to enter and also the allowed relationships among them; such a possible consultation ontology is shown in Figure 6, which allows each member to enter environmental problems of the river, causes of these problems and also positive/negative positions on these problems and causes (in agreement/disagreement with them).

Figure 6 Ontology for the first round of consultations



A second round of structured consultations will examine in more detail the strategies of the participating countries for the environmental management in this river basin, in order to identify commonalities, advantages and disadvantages; given the different topic of these consultations, it is necessary that they are based on a different consultation ontology that all members agree on, such as the one shown in Figure 7; in these consultations each member can enter strategies for managing each of the problems identified previously and also advantages and disadvantages of these strategies and comments on them. Some of these strategies, for which there is a wide consensus, can be further analysed into action plans in a third round of structured consultations, which has to be based on another consultation ontology that all members agree on, such as the one shown in Figure 8; in these consultations each member can enter actions for implementing each strategy and also positive/negative positions on these actions.

For some of the environmental projects identified in the consultations above, it may be that close collaboration between two or more of the countries involved is required; however, there may be disagreement between them on various issues, e.g., the allocation of construction and operating costs, the allocation of revenues that will be produced during its productive operation, etc. In order to overcome these disagreements it might be necessary that negotiations are conducted using the Negotiation Subsystem, which can ultimately result in an agreement between these two countries. Also, if one of the countries crossed by this river basin is interested in some environmental measurements, e.g., concerning an important pollutant in some adjacent water resources, and if these

measurements have recently been made by another country, then using the Negotiation Subsystem they can conduct 'electronic' negotiations on the conditions (financial and/or non-financial) for transfer of these measurements from the later to the former.

Figure 7 Ontology for the second round of consultations

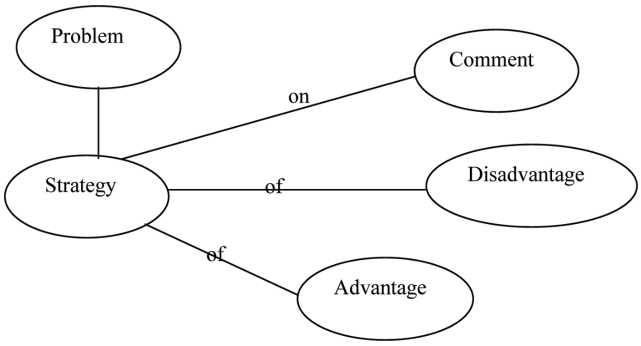
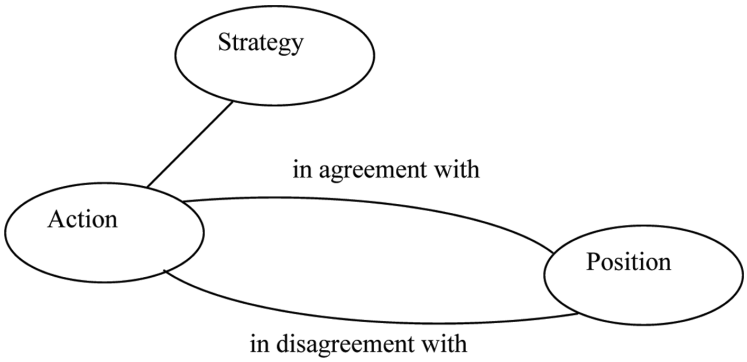


Figure 8 Ontology for the third round of consultations



Furthermore, the countries involved may agree on some specific actions for improving the environmental management of this river basin, e.g. that they will make some weekly measurements of some important pollutants in the water of the river, which will be shared by using the Document Management module. Their agreement may also cover the collaboration in granting licenses/permits for projects or activities having a significant impact on the environment of the river basin and mandate collaboration between all participating countries in the form of electronic 'extended' inter-organisational workflows, in which competent public organisations from all countries will participate. These workflows will consist of both 'single person activities' (e.g., detailed examinations of the technical plans and studies of proposed or approved projects/activities by experts from all countries) and also 'collaborative (consultation-type) activities' (e.g., consultations among higher level officers from all the involved countries in order to discuss and evaluate the conclusions of the above experts and decide whether a license/permit will be granted, and whether there will be any conditions on approval.

6 Conclusions

The most important problems that modern societies face today necessitate the negotiation and collaboration of many public organisations involved; each of them possesses only a part of the problem or can offer only a portion of what is needed for managing it, so a synthesis of these 'parts' is necessary. The use of ICT can be very useful for that purpose. In this paper we investigate ways of using ICT for supporting the collaboration and negotiation among public organisations for designing public policies and managing social problems. We present an internet/WWW-based information system called TNC (Trust – Negotiation – Collaboration), which has been developed based on the analysis of some of the requirements in the above domains of several public organisations from both the USA and the European Union. It consists of three subsystems, which provide electronic support for trust building, negotiation and collaboration among several public organisations involved in designing a public policy or/and managing a social problem. The Trust Subsystem supports building trust relationships among public organisations, based on previous collaborations, through a process known as collaborative ATN using locally trusted third parties. The Negotiation Subsystem supports automated G2G electronic negotiations; it supports the creation, management and exploitation of digital libraries and the use of historic data from past negotiations and agreements. The Collaboration Subsystem supports G2G collaboration for the design and implementation of public policies through unstructured and structured consultations, inter-organisational workflows, documents sharing, etc. Further research is in progress aiming at a more systematic and detailed evaluation of the TNC system using synthetic data and realistic application scenarios.

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