# Visualising negotiation communications in setting library sharing policies

James Ford*, Yan Zhao, Song Ye, Sheng Zhang, Fillia Makedon and Zhengyi Le

The Dartmouth Experimental
Visualization Laboratory (DEVLAB),
Department of Computer Science,
Institute for Security Technology Studies (ISTS),
Dartmouth College, Hanover, NH 03755, USA
E-mail: james.c.ford@dartmouth.edu
E-mail: yan.zhao@oracle.com
E-mail: yesong@cs.dartmouth.edu
E-mail: sheng.zhang@dartmouth.edu
E-mail: makedon@cse.uta.edu
E-mail: zyle@uta.edu
*Corresponding author

Alexandros Koulouris and Sarantos Kapidakis

Laboratory on Digital Libraries
and Electronic Publishing,
Department of Archive and Library Sciences,
Ionian University, Plateia Eleftherias,
Palaia Anaktora, Corfu 49100, Greece
E-mail: koulouris.a@gmail.com
E-mail: sarantos@ionio.gr

**Abstract:** Today's libraries provide a broad and diverse range of resources, from books to videos and databases, and sharing conditions for each depend on modality, source, and mode of usage. In this paper, we introduce and discuss a flexible, semi-automated mechanism to assist in setting policies and tracking their implementation based on the Secure Content Exchange Negotiation System (SCENS). We consider how SCENS can be extended and applied to libraries, including as a tool for reconciling multi-institutional or multi-national policies. We also show how monitoring of SCENS negotiations can help set library sharing policies and resolve future conflicts by tracking the evolution of sharing agreements.

**Keywords:** systems approaches for information systems; electronic service systems.

Copyright © 200x Inderscience Enterprises Ltd.

**Reference** to this paper should be made as follows: Ford, J., Zhao, Y., Ye, S., Zhang, S., Makedon, F., Le, Z., Koulouris, A. and Kapidakis, S. (xxxx) 'Visualising negotiation communications in setting library sharing policies', *Int. J. Applied Systemic Studies*, Vol. x, No. x, pp.xxx–xxx.

**Biographical notes:** James Ford is a Research Assistant Professor in Dartmouth College's Department of Computer Science, a Researcher at the Institute for Security and Technology Studies at Dartmouth, and a Faculty Affiliate Researcher at the University of Texas at Arlington. He divides his time between work on data sharing, security, sensor networks, and medical imaging, often in combination. He received his PhD Degree from Dartmouth College in 2003, and has Undergraduate and Master's Degrees in biology, artificial intelligence, and computer science.

Yan Zhao studied Computer Science with a focus on e-commerce and visualisation at Dartmouth College. She defended her MS Thesis on Adaptive and Dynamic Methods for Visualising Patterns in Communication Networks in 2005.

Song Ye is a PhD candidate studying Computer Science at Dartmouth College. His areas of research include negotiation systems, negotiation networks, and collaborative automated trust negotiation. In addition, he is employed by Oracle as a member of the Senior Technical Staff in the cluster and parallel storage technology group.

Sheng Zhang defended his PhD Thesis on Collaborative Filtering Systems at Dartmouth College in February 2007. He has worked in several areas of collaborative filtering, including on security and privacy methods for recommendation systems. He now works for Microsoft Research.

Fillia Makedon is the Chair and Department Head for the Department of Computer Science and Engineering at the University of Texas at Arlington. In addition, she maintains a position as Research Professor at Dartmouth College, her previous institution, and is a researcher at the Institute for Security and Technology Studies there. She received her PhD Degree from Northwestern University in 1982. She has published more than 250 refereed conference and journal papers in areas ranging from graph layout to bioinformatics. Her current area of focus is human centred computing.

Zhengyi Le is a PhD candidate in Computer Science at Dartmouth College. Her work focuses on developing new collaboration solutions based on inherently secure multiparty protocols, extending automated trust negotiation, and devising peer-to-peer sharing solutions.

Alexandros Koulouris is a PhD candidate at the Department of Archive and Library Sciences of Ionian University at Corfu, Greece and member of the Laboratory on Digital Libraries and Electronic Publishing of the same department. From November 2006 until present, he works as a librarian, responsible for the development and administration of the digital library of the National Technical University of Athens. He has worked for four years (1998–2002) as a Head Librarian at the Department of Special Collections of the Library of Science and Technology of the National Documentation Centre of Greece.

Sarantos Kapidakis is Associate Professor and Head of the Laboratory on Digital Libraries and Electronic Publishing at the Department of Archive and Library Sciences of Ionian University at Corfu, Greece. He received a PhD

Degree in Computer Science from Princeton University in 1990 and his Diploma in Electrical Engineering from National Technical University of Athens in 1985. He has worked as a researcher at ICS/FORTH and as a Head of the Information Systems Department of the National Documentation Centre of Greece.

## 1 Introduction

Today's libraries are very different from the traditional libraries of the past as they contain a very broad and diverse range of resources, each of which may benefit from different types of conditions for sharing, depending on their modality (from videos to books), source (from author or web or a museum), copyright conditions and mode of usage (e.g., loaning to a user on a one to one basis, used as a web service to a distributed community of library users, used to support a scientific community with real time data, used for reference, used for literary analysis of rare materials, etc.). Setting the most efficient and appropriate policies for access or for resource sharing is thus a challenge. Given this broad range of resources and usage, it is overly simplistic to have one set of fixed guidelines. Instead, we suggest that a flexible, customisable negotiation system is needed to establish the conditions of access, a mechanism that can be refined through the process of negotiation. This negotiation mechanism can provide a foundation for metadata collection building based on outside resources (Mitchell, 2005) and also 'cooperative collecting' (Gammon et al., 2003; Haar, 2003; Straw, 2003) that libraries have engaged in recently in order to take advantage of the relative ease of sharing resources in today's environment. It can also support the negotiation process between libraries and resource suppliers, such as governments (Zhang et al., 2004a), and between libraries and institutional or individual users with unique needs.

Library sharing policies require that the conditions of the agreements reached at any one time are preserved. We propose a flexible mechanism that achieves both: mediates the conditions of sharing or access among two or more parties (libraries or users), and keeps track of the agreement conditions in case there is a dispute later on. The negotiation mechanism has the advantage of being semi-automated and enabling the sharing parties to refine and customise their policies in the process of reaching agreement on the conditions of sharing. It is also a searchable system that allows one to backtrack and search for previous agreements, search for resources of certain type, and has a strategy support system to help build new policies. The system is focused on providing negotiation, and thus leaves the actual exchange of resources to existing mechanisms. The basic interface in SCENS is a traditional web-based platform, which allows humans to interact with the system in order to conduct negotiations and get feedback on negotiation activities. It has been under development at Dartmouth College (Ye et al., 2003; Zhao, 2004) since its release, where it was demonstrated in the context of file sharing. In the paper, we provide insights on how this system can be extended and applied to libraries, including addressing multi-national policies where also different copyrights laws and policies may exist.

A second contribution of this paper is to describe how to provide oversight through traffic monitoring and visualisation. This is a powerful addition to the negotiation support system we propose because it can help in establishing library sharing policies. In our

approach, SCENS is the foundation for negotiation, and a monitoring, analysis, and visualisation system is built on top of it to create VIS-SCENS, an extended negotiation support system. VIS-SCENS is used to track, analyse, and produce visualisations of the Negotiation Communication Network (NCN) (Zhao, 2004) among a set of negotiation parties. VIS-SCENS tracks negotiation progress and provides analysis support by processing inter-party negotiation logs, identifying obstacles in reaching agreement (e.g., deadlocks) and

1 helps discover the collaborative relationships between these parties, especially the way their negotiation evolves over time, in order to promote healthy resource sharing
2 identifies the special needs of the resources and users
3 determines the demand for a particular resource over time
4 collects aggregate usage data that are valuable in improving its services.

We demonstrate how the visualisation system works on sample records of negotiation transactions among students in the Dartmouth Experimental Visualization laboratory (DEVLAB) at Dartmouth College.

## 2 Related work

Several web-based negotiation support systems are in use. WebNS (McMaster University, 2002) is a prototype web-based system designed to facilitate remote negotiations on the internet. SmartSettle (ICAN Systems Inc, 1997) attempts to find quantitative and qualitative preferences for all parties, and uses a central server to arrive at agreements without exposing confidential data. INSPIRE (Kersten, 1997) and INSS (Kersten, 1998) are web-based systems containing facilities for specification and assessment of preferences, a messaging system, a scoring function to aid in the construction of offers, graphical displays of the negotiation progress, and a facility for constructing compromises. Most existing negotiation systems do not focus on security and privacy concerns, which make them inappropriate in a security-sensitive (preserving the privacy of the user as to what materials are being accessed) and copyright-based environment. Since they are designed primarily for use in online markets, they also lack efficient support for representing the exchange of complex information, such as sharing of scientific data, tools and services, and neither of them offers the visualisations for tracking NCNs.

Data sharing of sensitive or highly valuable informational resources, such as rare library materials, requires new models of negotiation to promote communication with built-in incentives (to offer the owners of the materials a motivation to advertise their ownings), secure authentication, and new metrics of evaluation. SCENSs goal is to facilitate electronic negotiations among distributed parties or organisations. The basic interface in SCENS is a traditional web-based platform, which allows human beings to interact with the system in order to conduct negotiations and get feedback on negotiation activities. SCENS also provides negotiation web services to support semi-automated and fully automated negotiation. This paper will focus on web-based SCENS as it is extended with VIS-SCENS to provide monitoring visualisation facilities.

In order to analyse communications of negotiations conducted through SCENS, we have derived some basic knowledge from Social Network Analysis (SNA) (Krebs, 2005). SNA studies and measures the relationships and flows between people, groups, and organisations. Here we treat inter-party negotiations as social ties from resource providers to resource requestors and they will form a collaboration network for resource sharing. Hence, SNA research results can help us analyse and monitor the communication pattern in online negotiation activities.

## 3 Monitoring of negotiations

The SCENS (Ye et al., 2003) has as goal facilitating online negotiations among distributed parties or organisations where one party may not know the other. As libraries have a broad range of diverse multimodal resources, from videos, to books, to web-data, to rare books, both in physical and digital formats and with varying degrees of value, or security and privacy importance, they require differential conditions for sharing among a broad base of distributed library users. Setting policies of access for such a broad range of library resources and users, requires a flexible mechanism of negotiation that enables refinement of policies and customisation to the shared resources.

Monitoring and visualisation of the negotiation process is an integral part of such an infrastructure in that it provides ongoing monitoring capability to examine the evolution of a given transaction, as well as the capability for human intervention by the library administrators where necessary to alter the conditions in a timely fashion and thus help reach agreement faster. Having tools to visualise and analyse inter-party negotiation logs is important in setting efficient policies because we gain knowledge as the system

a discovers the collaborative relationships between the parties, especially the way it evolves over time in order to promote healthy resource sharing for SCENS

b identifies the most active resource contributors or requestors in order to give right recommendations for new parties or provide built-in incentives for active library users

c identifies the special needs of the resources and users

d determines the demand for a particular resource and collects aggregate data on its usage

e quantifies the popularity of specific library resource or service in order to establish better resource allocation or even establish future library development

f establishes incentives and rewards based on the level of participation by a data/resource owner, and the popularity of the resource.

Thus, visualisation is an enabling tool for negotiation and can be particularly useful in cases where a library's access spans multiple sites, with policies that have possibly conflicting rules for the sharing of the same resources. In this case, visualisation of the negotiation may help resolve policy conflicts.

Visualising negotiations is particularly useful in setting current and future policies. In a library infrastructure, the sharing of precious or copyrighted library materials among distributed global users may entail a complex set of policies that can vary from case to

case, depending on the resources and the parties involved. We describe the SCENS visualisation interface that not only supports the negotiating parties to conduct their negotiations online, but also allows them to access a pool of related previous strategies to help establish new policies (Zhang et al., 2004b). More information on negotiation strategy pools is provided in Section 3.3.

### *3.1 Design and implementation of SCENS and VIS-SCENS*

SCENS is currently under development. We have built a prototype system for testing that allows users to share program code (from individual functions through source code for entire applications) through negotiation. Our system is based on Java and is open source. In this paper, we consider an extension of this system to the sharing of library resources, including print and electronic documents, multimedia files and items, and electronic access to resources. Recently, we have extended SCENS with monitoring tools to create the VIS-SCENS system, which adds visualisations and analysis to SCENS.

The current VIS-SCENS prototype web-based negotiation system is built on an Apache web server using the Apache Tomcat toolkit for servlets. Users can use any web browsers to access the system, and the prototype system supports both online and offline negotiation. *Online negotiation* is interactive, which means both negotiation parties are available during the negotiation. *Offline negotiation* allows parties to conduct negotiation even if they are not simultaneously online.

In our web-based negotiation system we have designed and implemented all essential components for an end user to conduct negotiations with others. The system also enables administrators to track negotiation activities going through the system.

Figure 1 introduces the architecture of our SCENS system (Makedon et al., 2003). It is also a sitemap showing the components a user will encounter when he uses our system. Each component is denoted as a rectangle with its name inside it and arrows showing the relationship between components.

The VIS-SCENS components are:

1 *User login* (component A), where the user login SCENS with valid user name and password.

2 *New user registration* (component B), where the user registers his personal information to SCENS in order to be authorised as a valid user.

3 *Main menu* (component C), which is the main interface in SCENS. It directs the user to different components for different task purpose.

4 *Browse datasets and conditions* (component D) lists all the datasets the user is interested (they could be the results from Dataset Query, or complete list of datasets belong to others, or list of his own datasets). And it also shows the negotiation conditions of these datasets registered by their owner. From here, the user could start negotiation on the dataset he chosen.

5 *Dataset registration* (component E), where the user registers his dataset for sell through SCENS.

6 *Negotiation conditions registration* (component F) is used to register conditions (such as price, usage time, etc.) for a dataset by the owner. This are the conditions that this owner willing to archive through negotiation.

7 *Dataset query* (component G) supports user to flexibly set search conditions to find out datasets he fells interested.

8 *Negotiation support* (component H) allows two parties[1] to propose the offers or response to counterparties in order to process their negotiations. There are several options for a user to choose the way to continue a current negotiation he is involved. These options are 'Submit proposal', 'Reject', 'Accept' and 'Terminate'

   i 'Submit proposal' enables a party to submit his proposal to the other party he is negotiating with.

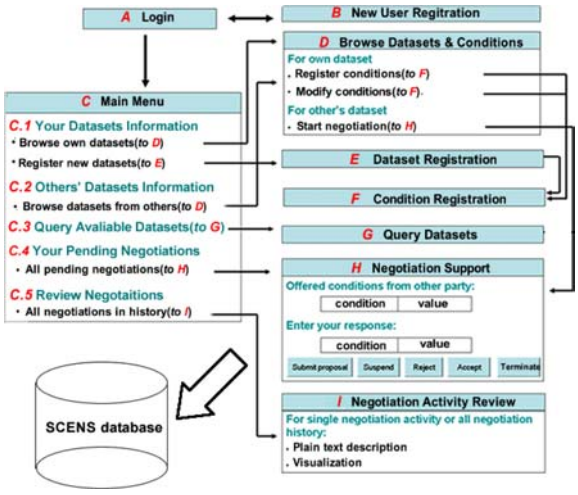
   ii 'Reject' enables a party to reject offer proposed by the other party, thus this negotiation is ended as a failure.

   iii 'Accept' enables a party to accept offer proposed by the other party, thus this negotiation ends as a success.

   iv 'Terminate' enables a party to terminate or give up a negotiation for any reasons. This will causes negotiation end by the reason of 'termination'.

9 *Negotiation activity monitoring* (component I) offers users the option to review the details of any his previous negotiation. The detailed information is described as text in a table (such as condition value in each round, etc.). And we also visualise the change of each condition separately by the means of plotting.

**Figure 1** SCENS online architecture: It is a web-based system with key components (marked as A, B, C, to I in order) and working with a central database. The arrows show the relationship between these components. Database records information of users, datasets and negotiations (see online version for colours)




## *3.2 Universal resource sharing policies in open distributed environments*

As with any large infrastructure providing informational or broad resource access, libraries must also guarantee a certain level of security and of trust. Using negotiation plus monitoring helps keep track of usage and users while providing guidance in setting policies to maintain security in authentication and authorisation. Authentication and authorisation are provided by basic SCENS facilities (Makedon et al., 2002, 2003, 2004;

Ye et al., 2003). However, this is not enough. What is also needed is data security and communication security in an open, highly distributed environment where users do not know each other. To ensure data integrity and user/usage privacy, we have been researching collaborative trust mechanisms (Ye et al., 2004) to establish trust in a Peer to Peer (P2P) environment. Trust plays an important role when highly valuable informational resources are exchanged. There is ongoing work in these areas at the DEVLAB (Ye et al., 2004) as well as efforts at establishing security metrics for resource sharing in highly distributed environments (Li et al., 2002; Winsborough et al., 2002; Winsborough and Li, 2002).

The current SCENS is account-based: new people (strangers) can sign up on their own and obtain accounts automatically, and each user is recognised (identified) by his or her user name and its associated past negotiation history. In order to better support existing library infrastructure, such as patron accounts, and to support decentralisation, we propose to move the system to one based on certificates. This has the advantage of removing some privacy concerns (such as the collection of all negotiation system account data in a single system, which must implicitly be trusted by all parties), although some, covered in Section 3.4, remain.

Setting library policies assumes an efficient knowledge management working in the background since different types of library content have different modelling and copyright requirements. In this case, we use metadata and ontologies to describe both the resources and the conditions semantically. This provides homogeneity and interoperability in the process or setting library sharing policies. Once resources are expressed this way, then SCENS

a helps the parties negotiate on the conditions under which the data should be shared

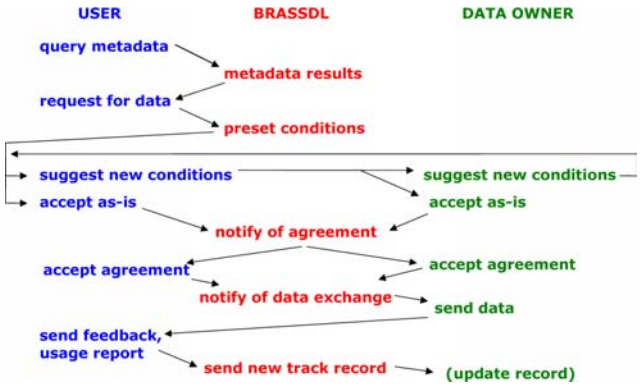
b negotiates on the type of sharing, whether it is just resources, or a bartering of resources for services, computation, analysis support, etc.

Here we assume *universal resource sharing* can take place where there is negotiation on library resources (books, videos), services, storage, bandwidth, and online resources. For example, a negotiation can mediate conditions where services are exchanged for storage, or storage for data, or bandwidth for data, etc. It is important to note that universal resource sharing allows the library system to integrate the different forms of administration, management, and policies for each type of resource. It is still an open question how, once we have a common metadata format, to resolve differences in policies in order to arrive at common access policies. Figure 2 visualises the negotiation process.

Negotiation Protocol: The user initiates the exchange by sending a *query for metadata* to BrassDL, 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 from the metadata the desired ones and *requests* the raw resources from BrassDL. BrassDL sends the user the *preset conditions* from the library-owner. The user now has the choice of *accepting* these conditions AS-IS, or *suggesting new conditions* to the library-owner. The library 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 sides.) Both sides *accept* the

*agreement* (a final handshake). BrassDL then *notifies* the data owner *of data exchange* (original library resources) to be initiated. The library/resource owner *sends data* to the user. The user, after having worked with the resources, *sends feedback* and a *usage report* to BrassDL. BrassDL updates both sides' records and *sends* a *new track record* to the resource owner. The library or resource owner *updates* local *records* (i.e., their advertised track record).

**Figure 2** Negotiation protocol: Negotiation is mediated by the BrassDL system, which serves as a trusted intermediary without being party to any data exchange (see online version for colours)




## *3.3 Setting negotiation strategy*

Negotiation strategies are a way to incorporate negotiation knowledge and intelligence into agents. Learning is widely used in negotiation strategies. A variety of research work (Governatori et al., 2000; Kowalczyk and Bui, 2000; Matwin et al., 1991; Zeng and Sycara, 1998) exists on negotiation strategies in the areas of social science, game theory, negotiation support systems, agent technologies, and machine learning. Unfortunately, automated negotiation agents based on any of these techniques usually face two problems. First, agents are not as flexible and adaptive to different negotiation environments as desired. Second, a fixed strategy or a static group of strategies may become known by competing agents as a result of negotiation processes, after which those agents can potentially exploit this knowledge in future negotiations.

We introduce a hybrid negotiation strategy mechanism (Zhang et al., 2004b) using a *strategy pool* framework that allows negotiation agents more flexibility and robustness in an automated negotiation system. The strategy pool framework supports:

a dynamically assigning an appropriate negotiation strategy to a negotiation agent according to the current negotiation environment

b creating new negotiation rules by learning from past negotiations.

The strategy pool is a repository for multiple negotiation strategies. By using the strategy pool, negotiation agents have a variety of choices for their strategies instead of always depending on a single strategy. To support strategy selection and the generation of new strategies, a classifier is adopted to learn from history data. In each negotiation process,

the negotiation agent enters the current negotiation environment features into a classifier; the classifier then selects a negotiation strategy from the strategy pool according to past experiences and feedback. The agent then uses this negotiation strategy to negotiate with the party. After the negotiation process ends, the agent and its user can provide a negotiation history and feedback on the result to the classifier. Over time, based on the negotiation results from past negotiation processes, the system can thus make use of machine learning to find the preferred strategy for each different negotiation environment. Moreover, the system may create new negotiation strategies by formalising new negotiation rules and incorporating them into existing strategies. Each such new strategy will then be added to the strategy pool for later use.

### *3.4 Preserving privacy*

In this paper, we suggest extensions to support a customisable negotiation system, where users can define their own negotiation conditions and policies, for example by automatically agreeing to share a particular resource with users who are members of a particular group. However, this may lead to privacy concerns – it means a negotiator may need request some sensitive 'attribute certificates' from his negotiation partner, such as whether or not the partner participates in particular groups or has some other attribute the negotiation wishes to test.

We propose to consider attribute certificates as 'special' and 'negotiable' data. In some cases, a negotiator may neither want to leave a record of a negotiation event in the system nor let other users know that the event occurred. Thus, this record should not show up in his (publicly accessible) negotiation history, although it should be available for tracking by the negotiation system if required by the library's policies. To implement this, we propose to use a prior negotiation by two parties before their 'main' negotiation happens to determine how it will be recorded and publicised. This step could also be used to agree on policies for disclosing attribute certificates, as discussed above, though in many cases it will not be possible to guarantee that parties subsequently follow such agreements.

Past negotiation history can provide one basis for a negotiator to use in making a judgment about whether to trust an agreement with another party, and can affect his or her negotiation policies and strategies. We previously proposed making use of the approach of automated trust negotiation to allow a new user to build his trust with other parties (Le et al., 2005). In this way, trust is pre-defined for some public authorities, so that if a user holds a certificate issued by one of those authorities, other users know they can trust him in reference to what the certificate says. This mechanism complements negotiation histories in facilitating negotiations, particularly by new negotiators.

## 4 Extensions for a library policy setting

Setting policy in library content sharing is very similar in some respects to our current negotiation system that works for sharing computer code files. However, there are also differences: the library environment is heterogeneous, with several different sharing relationships that may have different characteristics (between libraries and patrons, between libraries and publishers or other data sources, and among libraries). We propose

to incorporate into the new system user or usage parameters that may affect and diversify the policies used.

One particular feature that may be of interest for a library setting is support for libraries engaged in negotiating new contracts with publishers, for example by facilitating group agreements for "cooperative collecting" (Gammon et al., 2003; Haar, 2003; Straw, 2003), where individual institutions take responsibility for providing certain resources to the group. This will require extending the metadata (data about particular shared resources) that SCENS stores. Currently metadata in SCENS represent both the inherent characteristics of shared resources, such as their size, type, etc., and also certain characteristics based on agreements, such as cost and length of use. The latter category will need to be expanded to include representations of legal concepts, such as whether restrictions on use exist, or whether distribution through interlibrary loan is permitted.

The existing SCENS component for collecting aggregate data from negotiation logs for learning and improving negotiation strategies (Section 3.3) can also be used to improve library contract negotiations. The approach is based on negotiation parties sharing their negotiation history with each other, on the supposition that more negotiation history information may lead to improved results on future negotiations. As negotiation histories are usually private and confidential, this will require privacy preserving measures as discussed above (Section 3.4). The same approach can be used with library-patron data to improve library services by tracking times of peak usage, media popularity, and other criteria.

## 5 Negotiation Communication Networks

In this section we review NCNs and the monitoring and visualisation functionalities we have developed for SCENS. An NCN is a record of the activity that takes place among negotiating parties. The purpose of analysing it is to uncover patterns of collaboration structure in the context of negotiations for data sharing and exchange. In this section, we use sample records of negotiation transactions from experiments with student users to illustrate some types of monitoring and analysis. We focus on monitoring using visualisation techniques, in which the goal is to process information so as to make patterns easily apparent and interpretable to humans. We do not consider policy restrictions on sharing in our examples, such as restrictions that may limit how a party could redistribute a resource it negotiated with another party to receive access to.

We have derived some techniques from SNA research. There are two popular approaches in current SNA work: one derives from formal theory organised in mathematical terms (like adjacency matrices and network measures (Wasserman and Faust, 1994), and the other is based on creating graphical network visualisations for human interpretation (Freeman, 2000). Although graphs and matrices are equivalent in their ability to represent communication networks, we choose graphs as our primary way of representing NCN because they allow a viewer to understand nodes and relationships between nodes more rapidly than examining a raw mathematical model. Visualisation is also more intuitive and accessible for end users, so we believe that focusing on analysis that can create easily visualised results is a good choice.

To differentiate the resource owner and requestor in each negotiation transaction, we represent the negotiation networks in our visualisations using *directed graphs*. In such a graph, a node is a user of SCENS, a directed edge is a negotiation communication from a dataset owner to a dataset requester, and nodes are arranged in a specific way by a graph layout algorithm.

We base the graphs in VIS-SCENS on the Fruchterman-Reingold graph drawing algorithm (Fruchterman and Reingold, 1991) for force-directed placement, which has some attractive features. This method compares a graph to a mechanical collection of electrically charged rings (the vertices) and connecting springs (the edges). Every two vertices reject each other with a repulsive force, and adjacent vertices (connected by an edge) are pulled together by an attractive force. Over a number of iterations, the vertices are moved to a final place where the whole graph reaches a balanced force state. This kind of layout algorithm generates a graph in which the distance between vertices in the graph is inversely proportional to the communication frequency between them (i.e., the more communications occur between party A and B, the closer they are placed in the NCN graph). The algorithm places the most active parties in the centre of the graph. It is easy to identify the most active providers or requesters, since they have frequent negotiations with other parties. The graph can also be used as a way to identify the most popular combinations of datasets, which appear as large clusters in the centre.

## *5.1 Visualisations*

We have collected 11 sample negotiation transactions occurring in the interval from day 2005-1-12 to day 2005-1-19 between various users in the DEVLAB (Table 1), and we use them here to demonstrate how we visualise NCNs.

**Table 1** Sample negotiation communication data we use to illustrate visualisations. There are 11 negotiations that happened in the time interval from 1/12/2005 to 1/19/2005

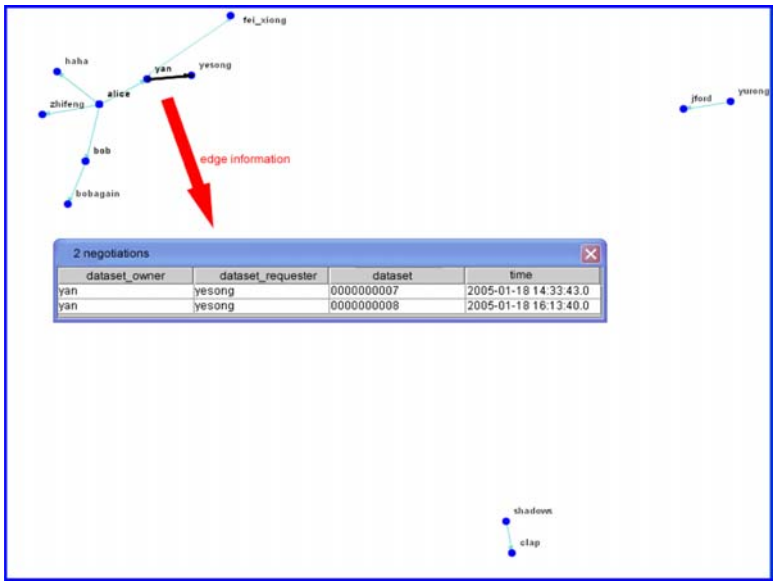
| *Dataset* | *Owner* | *Requester* | *Timestamp* |
|---|---|---|---|
| 0000000010 | yurong | jford | 1/12/2005 3:48:30 AM |
| 0000000007 | yan | fei_xiong | 1/12/2005 6:01:02 AM |
| 0000000009 | shadows | clap | 1/12/2005 7:11:48 AM |
| 0000000005 | bob | bobagain | 1/12/2005 9:02:56 AM |
| 0000000001 | alice | bob | 1/12/2005 11:03:56 AM |
| 0000000007 | yan | yesong | 1/18/2005 2:33 PM |
| 0000000008 | yan | yesong | 1/18/2005 4:13 PM |
| 0000000001 | alice | yan | 1/18/2005 4:14 PM |
| 0000000001 | alice | zhifeng | 1/18/2005 4:46 PM |
| 0000000001 | alice | haha | 1/19/2005 1:29 PM |
| 0000000001 | alice | yan | 1/19/2005 4:43 PM |

### *5.1.1 Static visualisation*

The static visualisation is a traditional visualisation that renders overall communications by means of a directed graph. Since distances in the graph correspond to communication frequency, we can gain a fundamental impression of the relationship between parties in SCENS at a glance.

Figure 3 shows the overall negotiation collaborative structure for the 11 sample negotiations based on this approach. We can infer three clusters from the graph, each of them negotiating for a different dataset. Based on this, if a new user feels interested in the dataset belongs to party *yan*, the system could recommend he or she negotiate directly with *yan* or with *yesong* and *fei_xiong*, since *yesong* and *fei_xiong* were partners with *yan* in the past (they all requested a dataset from *yan*). The user *yesong*, in particular, may be a good recommendation, since he has more frequent communications with *yan* (he is closer to *yan* than *fei_xiong* in the graph). This kind of information may be very useful for a new library joining an existing network of libraries and other institutions that negotiate to share data.

**Figure 3** Visualisation of overall negotiation collaborative network for 11 sample negotiation transactions between parties in the DEVLAB. A small window shows negotiation information between selected parties. There are three separate clusters that can be seen, each of which is independent; for example, parties jford and yurong are only negotiating with each other (see online version for colours)




### *5.1.2 Dynamic visualisation*

Besides the overall structure visualisation, we also generate time-based dynamic visualisation to study the evolvement of negotiation collaborative network over time. This kind of dynamic visualisation consists of an interactive movie showing the evolution over time of the communication network. The day is treated as the basic time unit.

A dragging time slider (each tick stands for one day in the time interval) is used to enable users to look at the network graph on the day where he puts the cursor down.

Figures 4 and 5 are snapshots of collaboration structure among parties up to day 2005-1-17 and 2005-1-18 respectively (using the 11 sample negotiation transactions in Figure 2 and Table 1). From these two pictures, we can identify a structural change that occurs on day 2005-1-18, which is a formation of a denser cluster based on two separate clusters that existed before day 2005-1-18. In Figure 3, there is no connection between parties *alice* and *yan*: they are isolated to each other, as with the other members in their own groups, and *alice* is the owner of dataset 0000000001 and *yan* is the owner of datasets 0000000007 and 0000000008. Parties like *bob* and *bobagain* are requesters of *alice*'s dataset and *fei_xiong* is the sole requester of *yan*'s dataset. But in Figure 4, because of a negotiation on dataset 0000000001 occurring between *alice* and *yan* (*yan* requested this dataset from *alice*), it becomes possible for parties in the same cluster as *yan* (e.g., *fei_xiong*) to have higher chances of success when he wants dataset 0000000001 since he is aware of the fact that he could negotiate with any party inside the whole cluster, since all the them have requested dataset 0000000001 from *alice* before.

**Figure 4** Visualisation of negotiation collaborative network on day 2005-1-17: Nodes denote parties in the negotiation and edge denote dataset exchange from its owner to its requester. The structure is formed by all the negotiation activities up to day 2005-1-17. There are four separate small-scale clusters for different datasets isolated from each other (see online version for colours)

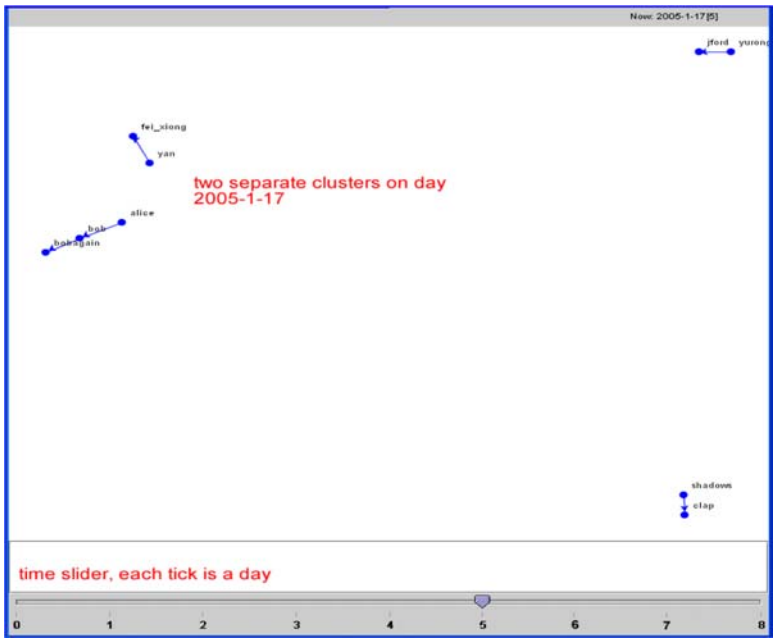


**Figure 5** Visualisation of negotiation collaborative network on day 2005-1-18: Thanks to a negotiation between party alice and party yan (yan requested a dataset from alice), these two clusters became connected with each other, thus forming a bigger cluster. There is subsequently a higher potential for parties inside this cluster to conduct negotiations with each other than there was before day 2005-1-18. Note that two new parties, yesong and zhifeng, also joined in the negotiations on that day (red circles) (see online version for colours)


## 6 Conclusion and future work

The current web-based implementation of SCENS can efficiently support two party online and offline negotiations. It provides several important functions, including dataset registration, interactive negotiation, and negotiation history review and visualisation. The VIS-SCENS Negotiation Communication Network visualisation adds the ability to uncover obstacles in communications during negotiations, as well as providing a means for promoting collaborative structures in resource exchanges or collaboration. In summary,

- we provided a scheme for establishing current library policies for diverse content sharing, both digital and physical
- we showed how a negotiation system can be used to collect information on this sharing, improve services, and develop better user models

- we demonstrated how visualisation is useful in monitoring system performance and ensuring risk-free usage of a sharing system
- negotiation together with visualisation provides a powerful combination and flexibility for customisation.

NCN visualisations could assist in finding subtle collaborative patterns between negotiation parties that are not evident in the raw data, and it can recommend negotiation counterparties for new users with the aim of encouraging more successful negotiations for a specific resource. However, to make SCENS a practical negotiation system that can be widely deployed, we are planning to continue the development of SCENS and VIS-SCENS in the following directions:

- Implement support for web services (a set of protocols and standards for interoperable data exchange) in negotiations, which will enable negotiation agents to communicate with SCENS server through web services. We have implemented several negotiation related web services.
- Support multiparty negotiation. Current SCENS supports only two party negotiations. To support multiparty negotiation, we will have to redesign the user interface and provide more negotiation functionalities that support both online and offline multiparty negotiations.
- Support personalised negotiation services. For example, SCENS should allow users to define their own dataset properties and negotiation conditions and create and/or choose their own user interface. Current SCENS online is implemented as a demonstration system and it does not provide enough flexibility to support personalisation.
- Enhance visualisations of the negotiation process to help users to intuitively analyse their negotiation transactions. Users should be able to gain experience from past negotiations, including both successful and failed ones, to revise their negotiation strategies and identify likely negotiation partners in the future.
- Advertise our system and attract more users.[2] It could be used as a testbed for many kinds of research on negotiation strategies. Since SCENS is an open negotiation system, researchers can implement their own negotiation agents and improve their negotiation abilities.
- Address privacy issues. When a negotiation policy or condition involves the other party's privacy, e.g., asks for some sensitive attribute certificates, our system should support this by treating attribute certificates as common negotiable data. Furthermore, a user may not want a specific negotiation that he is going to perform to be known or referred by others.

## Acknowledgements

Research at the Institute for Security Technology Studies was supported by Grant No. 2005-DD-BX-1091 awarded by the Bureau of Justice Assistance. The Bureau of Justice Assistance is a component of the Office of Justice Programs, which also includes

the Bureau of Justice Statistics, the National Institute of Justice, the Office of Juvenile Justice and Delinquency Prevention, and the Office for Victims of Crime. Points of view or opinions in this document are those of the author and do not represent the official position or policies of the US Department of Justice.

## References

Freeman, L. (2000) 'Visualizing social networks', *Journal of Social Structure*, Vol. 1, No. 1, http://www.cmu.edu/joss/

Fruchterman, T.M.J. and Reingold, E.M. (1991) 'Graph drawing by force directed placement', *Software: Practice and Experience*, Vol. 21, No. 11, pp.1129–1164.

Gammon, J.A. and Zeoli, M. (2003) 'Practical cooperative collecting for consortia: books- not-bought in Ohio', *Collection Management*, Vol. 28, Nos. 1–2, pp.77–105.

Governatori, G., Hofstede, A.H.M. and Oaks, P. (2000) 'Defeasible logic for automated negotiation', *Fifth CollECToR Conference on Electronic Commerce*, Deakin University, Burwood, Victoria, Australia.

Haar, J. (2003) 'Assessing the state of cooperative collection development: report of the working group to map current cooperative collection development projects', *Collection Management*, Vol. 28, No. 3, pp.183–190.

ICAN Systems Inc. (1997) *SmartSettle Online Negotiation System*, http://www.smartsettle.com/, Accessed 19-07-05.

Kersten, G. (1997) *Supporting International Negotiation with a WWW-based System*, Internet Research Report, INR05/97.

Kersten, G.E. (1998) 'Negotiation support systems and negotiating agents', *published online at InterNeg Research Centre*, John Molson School of Business, Concordia University, Montreal, Canada, http://interneg.concordia.ca/index.php?id=paper

Kowalczyk, R. and Bui, V. (2000) 'On fuzzy e-negotiation agents: autonomous negotiation with incomplete and imprecise information', *11th International Workshop on Database and Expert Systems Applications (DEXA'00)*, IEEE Computer Society Press, ISBN-10: 0769506801, ISBN-13: 978-0769506807, 4–8 September, London, UK,

Krebs, V. (2005) *An Introduction to Social Network Analysis*, http://www.orgnet.com/sna.html, Accessed 19-07-05.

Le, Z., Ouyang, Y., Ford, J. and Makedon, F. (2005) 'OC: A system for open collaborations', *Proceedings of the First International Workshop on Security, Privacy and Trust in Pervasive and Ubiquitous Computing (SecPerU 05)*, Santorini Island, Greece, 14 July, pp.93–99.

Li, N., Mitchell, J.C. and Winsborough, W.H. (2002) 'Design of a role-based trust-management framework', *2002 IEEE Symposium on Security and Privacy*, IEEE Computer Society Press, Berkeley, California.

Makedon, F., Ford, J., Shen, L., Steinberg, T., Saykin, A.J., Wishart, H. and Kapidakis, S. (2002) 'MetaDL: A digital library of metadata for sensitive or complex research data', *European Conference on Digital Libraries* (ECDL2002), Rome, Italy, pp.374–389, http://portal.acm.org/citation.cfm?id=700085

Makedon, F., Ye, S. and Zhao, Y. (2003) 'On the design and implementation of a web-based negotiation system', *Proceedings of 9th Panhellenic Conference on Informatics (PCI'2003)*, Greece, pp.46–57.

Makedon, F., Ye, S., Zhang, S., Ford, J., Shen, L. and Kapidakis, S. (2004) 'Data brokers: building collections through automated negotiation', *Proceedings of the Third Hellenic Conference on AI (SETN 2004)*, Samos, Greece, 5–8 May, Lecture Notes in Computer Science 3025, Springer, ISBN 3-540-21937-4, pp.13–22.

Matwin, S., Szapiro, T. and Haigh, K. (1991) 'Genetic algorithms approach to a negotiation support system', *IEEE Transaction on System, Man, and Cybernetics*, Vol. 21, pp.102–114.

McMaster University (2002) *WebNS*, http://webns.mcmaster.ca/, Accessed 19-07-05.

Mitchell, S. (2005) 'Collaboration enabling internet resource collection-building software and technologies', *Library Trends*, Vol. 53, No. 4, pp.604–619.

Straw, J.E. (2003) 'When the walls came tumbling down: the development of cooperative service and resource sharing in libraries: 1876–2002', *The Reference Librarian*, Vol. 40, Nos. 83–84, pp.263–276, http://www.informaworld.com/smpp/title~db=all~content=g903962956

Wasserman, S. and Faust, K. (1994) *Social Network Analysis: Methods and Application*, Cambridge University Press, The Edinburgh Building, Cambridge CB2 2RU, UK Edition cited is 1st ed. (ISBN-13: 978-0521382694 | ISBN-10: 0521382696).

Winsborough, W. and Li, N. (2002) 'Towards practical automated trust negotiation', *Third International Workshop on Policies for Distributed Systems and Networks (Policy 2002)*, 5–7 June, IEEE Press, Monterey, CA, pp.92–103.

Winsborough, W., Seamons, K.E. and Jones, V. (2002) 'Automated trust negotiation', *DARPA Information Survivability Conference and Exposition*, 25–27 January, IEEE Press, Hilton Head, South Carolina.

Ye, S., Makedon, F. and Ford, J. (2004) 'Collaborative automated trust negotiation in peer-to-peer Systems', *Proceedings of the Fourth IEEE International Conference on Peer-to-Peer Computing (IEEE P2P 2004)*, Zurich, Switzerland, pp.108–115.

Ye, S., Makedon, F., Steinberg, T., Shen, L., Ford, J., Wang, Y., Zhao, Y. and Kapidakis, S. (2003) 'SCENS: A system for the mediated sharing of sensitive data', *Proceedings of the Third ACM and IEEE Joint Conference on Digital Libraries (JCDL 2003)*, Houston, TX, USA, pp.263–265.

Zeng, D. and Sycara, K. (1998) 'Bayesian learning in negotiation', *International Journal of Human-Computer Studies*, Vol. 48, pp.125–141.

Zhang, S., Makedon, F., Ford, J., Sudborough, C., Ai, L., Kapidakis, S., Karkaletsis, V. and Loukis, E. (2004a) 'An international trade negotiation framework for e-Government', *Proceedings of the Third International Conference on Electronic Government (EGOV 2004)*, 30 August–3 September, Zaragoza, Spain, pp.211–217.

Zhang, S., Ye, S., Makedon, F. and Ford, J. (2004b) 'A hybrid negotiation strategy mechanism in an automated negotiation system', *ACM Conference on Electronic Commerce (EC 2004)*, New York, NY, pp.256–257.

Zhao, Y. (2004) *SCENS: Supporting and Visualizing Negotiation Communications*, Master's Thesis, Department of Computer Science, Dartmouth College, Hanover, NH, USA.

## Bibliography

British Library (1998) *Code of Practice for the Voluntary Deposit of Non-Print Publications*, http://www.bl.uk/about/policies/codeprac.html, Accessed 19-07-05.

Koulouris, A. and Kapidakis, S. (2003) 'Access and reproduction policies of the digital material of seven national libraries', *Proceedings of the 5th Russian Conference on Digital Libraries (RCDL 2003)*, Saint-Petersburg, Russia, 29–31 October, pp.35–44.

Koulouris, A. and Kapidakis, S. (2005) 'Access and reproduction policies of university digital collections', *Journal of Librarianship and Information Science (JOLIS)*, Vol. 37, No. 1, pp.25–33.

Lynch, C. (1997) 'Authentication and authorization, Part 1: The changing role in a networked information environment', *Library Hi Tech*, Vol. 15, Nos. 1–2. pp.30–38, http://dx.doi.org/10.1108/07378839710306981

## Notes

[1]Currently, SCENS only supports two-party negotiation.

[2]We have started to give out surveys to collect feedbacks from students in our school.