

ADAPTIVE COLLABORATION IN PROFESSIONAL VIRTUAL COMMUNITIES VIA NEGOTIATIONS OF SOCIAL PROTOCOLS

Willy Picard

Department of Information Technology
The Poznań University of Economics
ul. Mansfelda 4
60-854 Poznań, POLAND
<picard@kti.ae.poznan.pl>

Support for human-to-human interactions over a network is still insufficient, particularly for professional virtual communities (PVC). Among other limitations, adaptation capabilities of humans are not taken into account in existing models for collaboration processes in PVC. This paper presents a model for adaptive human collaboration. A key element of this model is the modeling of some social elements involved during the collaboration process. Processes are modeled as social protocols. A second contribution is the proposition of negotiation as a mean for adaptation of these protocols.

1. INTRODUCTION

Enterprises are increasing constantly their efforts in order to improve their business processes. A main reason for this may be the fact that enterprises are exposed to a highly competitive global market. As a consequence, enterprises improve their business processes to become more competitive and to increase their performances. Among the most visible actions associated with this effort towards better support for better business processes, one may distinguish the current research work concerning Web services and associated standards: high-level languages such as BPEL or WS-Coordination take the service concept one step further by providing a method of defining and supporting workflows and business processes.

However, it should be noticed that most of these actions are directed towards interoperable machine-to-machine interactions over a network. Support for *human-to-human interactions* over a network is still insufficient and more research has to be done to provide both theoretical and practical knowledge to this field.

Among various reasons for the weak support for human-to-human interactions, one may distinguish the following two reasons: first, many *social elements* are involved in the interaction among humans. An example of such a social element may be the roles played by humans during their interactions. Social elements are usually difficult to model, i.e. integrating non-verbal communication to collaboration models. Therefore, their integration to a model of interaction between

humans is not easy. A second reason is the *adaptation capabilities* of humans which are not only far more advanced than adaptation capabilities of software entities, but also not taken into account in existing models for collaboration processes.

The insufficient support for human-to-human interactions over a network is particularly important for *professional virtual communities*. As mentioned in [Camarinha-Matos 2005], “professional virtual community represents the combination of concepts of virtual community and professional community. Virtual communities are defined as social systems of networks of individuals, who use computer technologies to mediate their relationships. Professional communities provide environments for professionals to share the body of knowledge of their professions [...]”. According to [Chituc 2005], little attention has been paid to the social perspective on Collaborative Networks (CN) business environment, including obviously professional virtual communities in which social aspects are of high importance.

This paper is an attempt to provide a model for human-to-human interactions within professional virtual communities. The proposed model addresses, at least to some extent, the two characteristics of the interactions between humans. It should however be kept in mind that the results presented here are a work in progress and therefore they are not claimed to be neither sufficient nor exhaustive.

The rest of this paper is organized as follows. In section 2, the concept of *social protocol*, used to model collaboration processes, is presented. Section 3 then expands on the use of *negotiation* as a mean for *adaptation* of social protocols. Next, related work is reviewed. Finally, section 5 concludes this paper.

2. SOCIAL PROTOCOLS

A social protocol aims at modeling a set of collaboration processes, in the same way as a class models a set of objects in object-oriented programming. In other words, a social protocol may be seen as a model which instances are collaboration processes.

Social protocols model collaboration at a group level. The interactions of collaborators are captured by social protocols. Interactions are strongly related with social aspects, such as the role played by collaborators. The proposed model integrates some of these social aspects, which may explain the choice of the term “social protocols”. A formal definition of the proposed model has been already presented in [Picard 2006].

2.1. Modeling collaboration processes

A *social protocol* p is a finite state machine consisting of $\{S_p, S_p^{start}, S_p^{end}, T_p, \varphi_p\}$ where S is the set of states, $S_p^{start} \subset S$ is the set of starting states, $S_p^{end} \subset S$ is the set of ending states, $S_p^{start} \cap S_p^{end} = \emptyset$, T_p is the set of transitions from states to states, and $\varphi_p: T_p \rightarrow [0,1]$.

In a social protocol, collaborators – as a group – are moving from state to state via the transitions. A transition may be triggered only by a collaborator labeled with the appropriate role. A transition is associated with the execution of an action.

Execution of an action means the execution of remote code. SOAP or CORBA are examples of technologies that may be used to such remote code executions.

The φ_p function puts an additional constraint on the execution of transitions. The φ_p function defines the “desirability” of a transition within the given protocol for the whole group. The highest the value of the φ_p function for a transition t is, the highest the desirability of this transition for the group will be. If the value of the φ_p function for a transition t is zero, then the group does not desire this transition to be executed. It allows collaborators for presenting various granularity levels of a given social protocol with regards to a *desirability threshold*. Desirability filtering is the transformation that causes all transitions with desirability value lowest than the desirability threshold to be suppressed.

The conditions that protocols have to fulfill to be valid, both structurally and semantically have already been presented in [Picard 2005a].

2.2. Social protocol example

The example of social protocol which is presented in this section is oversimplified for readability reasons. It is obvious that social protocols modeling real-world collaboration processes are usually much more complex.

The chosen collaboration process to be modeled as a social protocol may be described as follows: a set of users are collaborating on the establishment of a “FAQ” document. Some users only ask questions, while others, referred as “experts” may answer the questions. Other users, referred as “managers”, are may interrupt the work on the FAQ document. The work on the document may terminate either by a success (the document has been written and the manager estimates that its quality is good enough to be published) or by a failure (the users did not find any way to collaborate and the manager has estimated that the work on the FAQ should be interrupted).

A possible model of this collaboration process as a social protocol is presented in Figure 1.

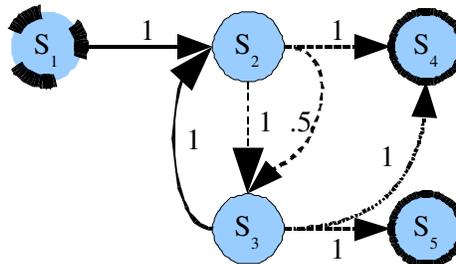


Figure 1. Example of social protocol

In Figure 1, five states $s_1... s_5$ are represented as circles. State s_1 , s is a starting state; states s_4 and s_5 are ending states. States are named as follows:

- state s_1 : *waiting for first question*
- state s_2 : *waiting for answer*
- state s_3 : *waiting for next question*
- state s_4 : *failed termination*
- state s_5 : *successful termination*

Transitions are represented as arrows, and the line style is associated with the role of the users that may execute a given transition. Continuous line style is used to represent transitions that may be executed by “normal users”, fine-dashed style for transitions that may be executed by “experts”, and fine-dotted style for transitions that may be executed by “managers”.

The figures closed to the arrows represented the value of the desirability function for the associated transition. As an illustration of desirability filtering, the “suppress question” transition would be suppressed by desirability filtering for the value of the desirability threshold 0.6. Transitions are summarized in Table 1.

Table 1 – Transitions for the example of social protocol and their associated desirability values

Source state	Destination state	Role	Action	ϕ
s1	s2	Normal	Ask question	1
s2	s3	Expert	Answer question	1
s2	s3	Expert	Suppress question	0.5
s2	s4	Manager	Failure ending	1
s3	s2	Normal	Ask question	1
s3	s4	Manager	Failure ending	1
s3	s5	Manager	Successful ending	1

3. ADAPTATION OF SOCIAL PROTOCOLS VIA NEGOTIATION

While social protocols support, at least to some extent, the integration of some social elements (such as roles) to models of interactions among humans, the adaptation capabilities of humans are not taken into account into social protocols. There is however the need to provide adaptation mechanisms to social protocols. Indeed, interactions among humans are often a context-aware activity. In this paper, context-awareness refers to the capabilities of applications to provide relevant services to their users by sensing and exploring the users' context [Dey 2001, Dockhorn 2005]. Context is defined as a “collection of interrelated conditions in which something exists or occurs” [Dockhorn 2005]. The users' context often consists of a collection of conditions, such as, e.g., the users' location, environmental aspects (temperature, light intensity, etc.) and activities [Chen 2003]. The users' context may change dynamically, and, therefore, a basic requirement for a context-aware system is its ability to sense context and to react to context changes.

Adaptive mechanisms are therefore required as complements to the formerly proposed model for human collaboration processes. The mechanism proposed in this paper is based the idea that social protocols may be negotiated. Two aspects of social protocols may be negotiated independently: first, the desirability function may be negotiated, second, states/transitions sets may be negotiated.

3.1. Desirability negotiation

The first element of social elements that could be the object of adaptation may be the desirability function. The values taken by desirability function for various transitions define the desirability of the whole group with regards to single transitions. By modifying the value of the desirability function, the whole group may adapt the social protocol to the situation in which the group is.

By increasing the desirability value of a given transition, a group may decide that a transition is “desirable” for a given desirability threshold, and therefore the transition associated with the modified value will become available. By decreasing the desirability value of a given transition, a group may decide that a transition is not “desirable” any more, and therefore the transition associated with the modified value will become unavailable for a given desirability threshold.

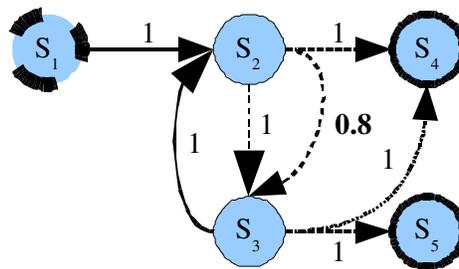


Figure 2 – Social protocol presented in section 2.2 after the desirability value of the transition “suppress question” has been increased by 0.3

Effects of a potential modification of the desirability function of social protocol presented in Section 2.2 are presented in Figure 2. In the presented example, the original social protocol presented in Section 2.2 has been adapted by the whole group via negotiations. The result of the negotiation is the group agreement stating that the desirability value for the transition “suppress question” has to be increased by 0.3. The modified desirability values associated with transitions are presented in Table 2.

Table 2 – Transitions for the example of social protocol and their associated desirability values

Source state	Destination state	Role	Action	φ
s_1	s_2	Normal	Ask question	1
s_2	s_3	Expert	Answer question	1
s_2	s_3	Expert	Suppress question	0.8
s_2	s_4	Manager	Failure ending	1
s_3	s_2	Normal	Ask question	1
s_3	s_4	Manager	Failure ending	1
s_3	s_5	Manager	Successful ending	1

3.2. Structural negotiation

The second element of social elements that could be the object of adaptation may be the set of states and/or the set of transitions. The set of states consists of the set of situations that may occur during the life of a collaboration process. The set of transitions consists of the set of interactions that collaborators may perform.

By adding/suppressing states, the whole group may adapt a social protocol by providing/suppressing situations to the collaboration process. It should be noticed that the addition/suppression of states is related with the addition/suppression of transitions leading and originating from the modified states.

By adding/suppressing transitions, the whole group may adapt a social protocol by providing/suppressing interactions to the collaboration process. It should be noticed that the addition/suppression of transitions is usually not related with the addition/suppression of states to/from which the added/suppressed transitions leads/originates.

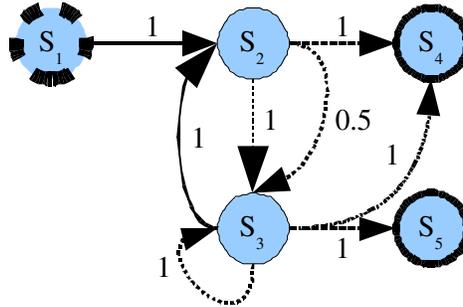


Figure 3 – Social protocol presented in section 2.2 after a transition related with the action “comment a question” has been added from s_3 to s_3 .

Effects of the addition of a transition in the social protocol presented in Section 2.2 are presented in Figure 3. In the presented example, the original social protocol presented in Section 2.2 has been adapted by the whole group via negotiations. The result of the negotiation is the group agreement stating that a new transition is needed so that an expert may comment a question many times before answering it. The modified set of transitions is presented in Table 3.

Table 3 – Transitions for the example of social protocol and their associated desirability values

Source state	Destination state	Role	Action	φ
s_1	s_2	Normal	Ask question	1
s_2	s_2	Expert	Comment question	1
s_2	s_3	Expert	Answer question	1
s_2	s_3	Expert	Suppress question	0.5
s_2	s_4	Manager	Failure ending	1
s_3	s_2	Normal	Ask question	1
s_3	s_4	Manager	Failure ending	1
s_3	s_5	Manager	Successful ending	1

4. DISCUSSION

As process modeling is concerned, many works have already been conducted in the research field of workflow modelling and workflow management systems. Paul Buhler and Jose M. Vidal [Buhler 2005] proposed a mechanism allowing for enacting workflows in an adaptive way using multi-agent systems (MAS). Robert Müller and al. presented in [Müller 2004] various mechanisms for adaptation of workflows to deal with exception occurrences in running workflow instances, with an application to medical treatments. However, to our best knowledge, current works concerning workflow adaptation focus on interactions among software entities. Characteristics of interactions between humans, such as the importance of social aspects, are not or insufficiently taken into account by these works.

Still in the field of workflows, some works [Aalst 2000] have focused on formal models and conditions under which a modification of an existing – and potentially running – workflow retains workflow validity. However, in the case of human interactions, some of these conditions may be relaxed as adaptation of a social protocol may lead to a social protocol which is temporally invalid. Such a case appears when a new state is introduced. The state exists but transitions leading to it have to be defined. The same applies for transitions having the brand-new state as a source.

Some interesting works have been done in the field of electronic negotiations to model electronic negotiations with the help of negotiation protocols. In [Kersten 2004], it is stated in that, in the field of electronic negotiations, “the protocol is a formal model, often represented by a set of rules, which govern software processing, decision-making and communication tasks, and imposes restrictions on activities through the specification of permissible inputs and actions”. One may notice the similarity with the concept of social protocol. The reason for this fact is that the model presented in this paper was originally coming from a work on protocols for electronic negotiations [Picard 2005c]. However, to our knowledge, none of the works concerning negotiation protocols provides mechanisms for protocol adaptation. Moreover, these works are by nature limited to the field of electronic negotiations which is just a subset of the field of human collaboration.

5. CONCLUSIONS

While many works are currently done on modeling collaboration processes in which software entities (agents, web services) are involved, modeling collaboration processes in which mainly humans are involved is an area that still requires much attention from the research community. Some of the main issues to be addressed are the social aspects of collaboration and the adaptation capabilities of humans. In this paper both issues are addressed. The concept of social protocol aims at being a start of answer to the question of computer support for social collaboration. The idea of negotiation of social protocol is an attempt to weaken constraints usually limiting the interaction between collaborators, so that the adaptation capabilities of humans may be integrate in the life of a social protocol.

The main innovations presented in this paper are 1) the introduction of the desirability function as a way to provide filtering functions to social protocols, 2) the

idea of negotiation of social protocols, based either on negotiation of the desirability function or on the negotiation of the structure of the protocol. The proposed concepts are currently under implementation as extensions to the *DynG* protocol [Huriaux 2005], a social protocol-based platform. The next steps will include a refinement of the concept of role, so that relationships between roles, e.g. specialization, compositions, may be integrate to the presented model. Automated support for social negotiation would be an interesting feature for a social adaptive protocol-based framework, but negotiation models supporting contextual and social elements are still to be built.

6. REFERENCES

- [Aalst 2000] W.M.P. van der Aalst, T. Basten, H. M. W. Verbeek, P. A. C. Verkoulen, M. Voorhoeve, "Adaptive Workflow: On the Interplay between Flexibility and Support", Enterprise Information Systems, Kluwer Academic Publishers, Norwell, 2000, pp. 63-70.
- [Buhler 2005] P. Buhler, J. M. Vidal, "Towards Adaptive Workflow Enactment Using Multiagent Systems", Information Technology and Management Journal, Special Issue on Universal Enterprise Integration, Vol. 6, (1), 2005; pp. 61-87.
- [Camarinha-Matos 2005] L.M. Camarinha-Matos, H. Afsarmanesh, M. Ollus, "ECOLEAD: A Holistic Approach to Creation and Management of Dynamic Virtual Organizations", Proceedings of the 6th IFIP Working Conference on Virtual Enterprises (PRO-VE 2005), Valencia, Spain, September 26-28, 2005, Springer, in: Collaborative Networks and their Breeding Environments, pp. 3-16
- [Chen 2003] H. Chen, T. Finin, A. Joshi, "An Ontology for Context-Aware Pervasive Computing Environments.", Knowledge Engineering Review, Special Issue on Ontologies for Distributed Systems, Vol. 18, No. 3. Cambridge University Press, 2003; pp. 197-207
- [Chituc 2005] C.M. Chituc, A.L. Azevedo, "Multi-Perspective Challenges on Collaborative Networks Business Environments", Proceedings of the 6th IFIP Working Conference on Virtual Enterprises (PRO-VE 2005), Valencia, Spain, September 26-28, 2005, Springer, in: Collaborative Networks and their Breeding Environments, pp. 25-32
- [Dey 2001] A. K. Dey, D. Salber, G. D. Abowd, "A Conceptual Framework and a Toolkit for Supporting the Rapid Prototyping of Context-Aware Applications.", Human-Computer Interaction, 16(2-4), 2001; pp 97-166.
- [Dockhorn 2005] P. Dockhorn Costa, L. Ferreira Pires, M. van Sinderen, "Designing a Configurable Services Platform for Mobile Context-Aware Applications", International Journal of Pervasive Computing and Communications (JPCC), Vol. 1, No. 1. Troubador Publishing (2005)
- [Huriaux 2005] T. Huriaux, W. Picard, "DynG: a Multi-protocol Collaborative System", Proceedings of the 5th IFIP International Conference on e-Commerce, e-Business, and e-Government (I3E 2005), Poznan, Poland, October 26-28, 2005, Springer, in: Challenges of Expanding Internet: e-Commerce, e-Business and e-Government, pp. 591-605.
- [Kersten 2004] G.E. Kersten, S.E. Strecker, K.P. Law, "Protocols for Electronic Negotiation Systems: Theoretical Foundations and Design Issue", in Proceedings of the 5th Conference on Electronic Commerce and Web Technologies (EC-Web04), Sarragoza, IEEE Computer Society, Spain, 2004.
- [Müller 2004] R. Müller, U. Greiner, E. Rahm, "AGENTWORK: A Workflow-System Supporting Rule-Based Workflow Adaptation.", Data and Knowledge Engineering, Elsevier, 2004.
- [Picard 2006] W. Picard, "Computer Support for Adaptive Human Collaboration with Negotiable Social Protocols", Proceedings of the 9th Int. Conference on Business Information Systems in cooperation with ACM SIGMIS, Klagenfurt, Austria, May 31 – June 2, 2006, LNCS, Springer, to appear.
- [Picard 2005a] W. Picard, "Towards Support Systems for Non-Monolithic Electronic Negotiations. The Contract-Group-Message Model", Journal of Decision Systems, Electronic Negotiations - Models, Systems and Agents, Volume 13, No.4/2004; Hermes, Lavoisier (Paris); pp. 423-439
- [Picard 2005b] W. Picard, "Modeling Structured Non-monolithic Collaboration Processes", Proceedings of the 6th IFIP Working Conference on Virtual Enterprises (PRO-VE 2005), Valencia, Spain, September 26-28, 2005, Springer, in: Collaborative Networks and their Breeding Environments, pp. 379-386
- [Picard 2005c] W. Picard, T. Huriaux, "DynG: A Protocol-Based Prototype for Non-monolithic Electronic Collaboration", CSCW in Design 2005, LNCS 3865, 2006, pp. 41-50.