38 SUPPORT FOR POWER IN ADAPTATION OF SOCIAL PROTOCOLS FOR PROFESSIONAL VIRTUAL COMMUNITIES

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Support for human-to-human interactions over a network is still insufficient, particularly for professional virtual communities (PVCs). Among other limitations, neither adaptation capabilities of humans, nor social aspects related to leverage are 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 power during the adaptation of collaboration processes modeled as social protocols.

1 INTRODUCTION

Enterprises are constantly increasing 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. 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 a strong limitation for a wide adoption of *professional virtual communities (PVCs)*. 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 been 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 *adaptation* of social protocols. Next, support for *power* as an important social aspect in adaptation of social protocols on PVCs is discussed. Finally, section 5 concludes this paper.

2 STRUCTURING COLLABORATION IN PVCS

Support for human-to-human collaboration in PVCs should obviously take into account the characteristics of PVCs as social environments. From an information system approach, at least two characteristics of PVCs should be distinguished: PVCs are heterogeneous and dynamic environments. Therefore, these two characteristics should be supported by a model for interactions within PVCs.

2.1 PVCs as Heterogeneous Environments

As defined by (Ekholm and Fridqvist, 1996), "a human *sociosystem* has a composition of human individuals, its structure is the social behaviour repertoire, i.e. interaction among human individuals". In professional virtual communities, the sociosystem is highly heterogeneous. The heterogeneity of PVCs exists at various levels of granularity within PVCs.

At a high level, a PVC consists usually of many different "sub-communities". Each sub-community is different from other coexisting in the same PVC sub-communities in terms of goals, intentions, knowledge, processes, members, etc. Additionally, some sub-communities may be overlapping, as they may share some members, allowing knowledge to be transfered from one sub-community to another. Other sub-communities are isolated. The lifetime of sub-communities may vary from a few hours – e.g. for short document translation – to many years – e.g. in open source development.

At a lower level, one may notice that the structure of a sub-community is usually complex and heterogeneous. The roles played by the sub-community members, their skills, their competences usually present a high level of diversity.

2.2 PVCs as Dynamic Environments

PVCs are not only heterogeneous environments, they are also usually highly dynamic. Similarly to the heterogeneity of PVCs , the dynamics of PVCs exists at various levels of granularity within PVCs.

At a high level, the set of sub-communities that the PVC consists of evolves in time: new sub-communities are created to answer new needs and opportunities, unnecessary sub-communities are dissolved, existing sub-communities changes as new members enter and leave the community, etc. The dynamics of PVCs may hardly, not to say cannot, be foreseen at design time, as changes of a given PVC are naturally related to changes in its business environment (which is usually not a deterministic system).

At a lower level, the structure of a sub-community is evolving in time: some members may have a job promotion, the skills of the members usually evolve (improve) in time. Additionally, it may be noticed that members of a given sub-community may face new situations implying the development of new solutions, new ways of collaboration, etc.

2.3 Modeling Group Interactions with Social Protocols

Support for human-to-human collaboration in PVCs should obviously take into account the characteristics of PVCs presented in the two former subsections, i.e. heterogeneity and dynamics.

A first model for group interactions within a PVC has been presented in (Picard, 2005). The proposed model is based on the concept of *social protocol*. Social protocols model collaboration at a group level. The interactions of collaborators are captured by social protocols. Interactions are strongly related to 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". Heterogeneity of PVCs at the sub-community level is then at least partially addressed by the social protocol approach.

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. Within a given PVC, various social protocols may be used to control interactions within different sub-communities. Therefore, one may state that social protocols address at least partially the high level heterogeneity of PVCs.

A *social protocol p* is a finite state machine consisting of $\{ S_p, S_p^{start}, S_p^{end}, Tp \}$ where S_p 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, $S_p^{start} \cap S_p^{end} = \varnothing$, T_p is the set of transitions from states to states.

In a social protocol, collaborators – as a group –move 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.

A set of *group actions* have been identified to support *group dynamics*, i.e. the dynamics of PVCs at a high level. A group action is a special action that may be executed to modify the set of sub-communities that the PVC consists of. A group action may for instance allow a collaborator to split a group in two or more groups,

or to merge two or more groups into a single group. Group dynamics may be modeled by a set of group actions.

A formal definition of the proposed model has been already presented in (Picard, 2006a), while an algorithm for structural validation of social protocols has been presented in (Picard, 2007).

3 ADAPTIVE SOCIAL PROTOCOLS

Social protocols address heterogeneity of PVCs at both high and low level, and dynamics at high level. However, the need for support for dynamics of PVCs is still only partially addressed at the sub-community level. Social protocol adaptation is proposed here as a mean to support dynamics of PVCs at the sub-community level.

3.1 Run-time vs. Design-Time Adaptation

In the workflow management literature, information required to model and control a collaboration process has been classified according to various perspectives.

In (van der Aalst et al., 2003), five perspectives have been presented:

- the *functional perspective* focuses on activities to be performed,
- the *process perspective* focuses on the execution conditions for activities,
- the *organization perspective* focuses on the organizational structure of the population that may potentially execute activities,
- the *information perspective* focuses on data flow among tasks,
- the *operation perspective* focuses on elementary operations performed by applications and resources.

A sixth perspective has been added in (Daoudi and Nurcan, 2003): the *intentional perspective* focuses on goals and strategies related to a given process.

One may easily notice that all six perspectives presented above focus on elements that evolve in time, for instance:

- in the *functional perspective*, new activities may be identified and some activities may be suppressed by new information systems and/or robots,
- in the *process perspective*, execution conditions for activities may change as some new activities may be required,
- in the *organization perspective*, the organizational structure of the population that may potentially execute activities may evolve, as some employees are promoted or are fired,
- in the *information perspective*, data flow among tasks may need to be defined among new tasks,
- in the *operation perspective*, a newly introduced information system may perform various operations that used to be performed by a legacy system,
- in the *intentional perspective*, changes in the business environment, e.g. the collaboration of two concurrent professionals, may lead to a redefinition of goals and strategies of a third professional on the same market, which may imply changes in business processes.

In typical workflow management systems, two parts may be distinguished: a design-time part allows for definition of workflow schemas while the run-time part is responsible for execution of workflow instances. A main limitation of typical

workflow management systems is the fact that once a workflow schema has been instantiated, the execution of the workflow instance must stick to the workflow schema till the end of the workflow instance execution. This limitation is not an issue if the lifespan of workflow instances is short in comparison with the time interval between successive requests for changes of the workflow schema. When the lifespan of workflow instances is long in comparison with the time interval between successive requests for changes of the workflow schema, a high number of workflow instances has to be executed with an ``incorrect'' workflow schema (i.e. that does not take into account required changes) or has to be cancelled. As a consequence, typical workflow management systems are not flexible enough to support collaborative processes in two cases: *highly dynamic, competitive markets/environments* and *long lasting collaboration processes*.

In highly dynamic and competitive markets/environments, situations which have not been foreseen in the workflow schemas are highly probable as business actors may appear and disappear from the market, the apparition and removal of products and services are frequent, the turnover among employees may be high, etc.

In long lasting collaboration processes, the workflow instance is supposed to run for years, e.g. production workflows. In long lasting collaboration processes, the occurrence of unforeseen situation is highly probable too: new knowledge – e.g. robot reliability – or new situations – e.g. legal restrictions about privacy – may appear many years after the workflow schema has been designed.

In the case of highly dynamic, competitive markets/environments and long lasting collaboration processes, there is a strong need for the modifications of a workflow instance at run-time, denoted here *social protocol adaptation*. Such modifications are usually needed to deal with situations which have not been foreseen nor modeled in the associated workflow schema. Social protocol adaptation refers to the possibility to *modify a running social protocol instance* to new situations which have not been foreseen and modeled in the associated social protocol.

3.2 Negotiation-based Adaptation

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, 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.

In (Picard, 2006b), negotiations have been proposed as a mean for adaptation of social protocols. Negotiation of social protocols has been presented as "an attempt to weaken constraints usually limiting the interaction between collaborators, so that the adaptation capabilities of humans may be integrated in the life of a social protocol".

The idea of using negotiations as an adaptation mean for social protocols comes from the fact that social protocols rule the interactions of all collaborators in a given group. Therefore each modification of the social protocol may influence all collaborators. As a consequence, the decision to modify a social protocol should be consulted and approved by many collaborators. Negotiations are a classical way to make collaborative decision and to reach an agreement in situations where expectations and goals of collaborators may be in conflict.

1. Power-enabled Adaptation

3.3 Definition(s) of Power

Negotiations of social protocols would allow collaborators to establish cooperatively a new version of the social protocol that 1) is acceptable by all collaborators; 2) allows collaborators to collaborate in a way which is better adapted to the current situation they are facing. We propose to integrate the concept of *power* to model social interactions influencing the negotiation process.

Power is often considered as a synonym for "capacity to influence". Power has been defined by Deutsch (Deutsch, 1973) in the following way: "an actor … has power in a given situation (situational power) to the degree that he can satisfy the purpose (goals, desires, or wants) that he is attempting to fulfill in that situation. Power is a relational concept: it does not reside in the individual by rather in the relationship of the person to his environment. Thus, the power of an actor in a given situation is determined by the characteristics of the situation as well as by his own characteristics". Lewicki, Saunders and Minton (Lewicki, 2000) proposed the following three main sources of power:

- *Information and expertise*: the accumulation and presentation of data intended to change the other person's point of view or position on an issue; and (for expertise) an acknowledged accumulation of information, or mastery of a body of information, on a particular problem or issue;
- *Control over resources*: the accumulation of money, raw material, labor, time and equipment that can be used as incentives to encourage compliance or as punishments for noncompliance;
- *Location in an organizational structure*: power derived from being located in a particular position in an organizational or communication structure; leads to two different kinds of leverage:
  - Formal authority, derived from occupying a key position in a hierarchical organization.
  - Access to or control over information or supply flows, derived from location within a network.

3.4 Modeling Power in Social Protocols

Support for power in negotiation of social protocols requires a model of power based on information available during the collaboration process. Some information may be implicitly available, while other information are tacit knowledge.

As a first attempt to model power of collaborators in collaboration processes driven by social protocols, we propose the following criteria based on implicitly available information:

- *Collaborator's involvement in the collaboration process*: measurable as the number of actions executed by a *given collaborator* during the whole negotiation process. This criterion may be normalized by dividing the number of actions executed by a given collaborator by the total number of actions executed by all collaborators.
- *Role rate of occurrence*: this criterion measures the "importance" of a *given role* with regard to other roles in the social protocol. A role rate of occurrence is measured as the number of potential transitions associated with a given role divided by the total number of transitions.
- *Locality and role*: when the negotiation of a given social protocol starts, the group is in a given state. From the current state, various actions may be performed by collaborators playing different roles. A collaborator playing a role which allows him/her to execute many actions from the current state has potentially more leverage than a collaborator playing a role which does not allow him/her to execute many actions. This may be extended to a broader locality, i.e. to actions that may be executed not only directly from the current state but close to it (two or more transitions away from the current state).

Other criteria require either some extensions of social protocols, or transformation of tacit knowledge into implicit knowledge:

- *Locality and competences*: social protocols should be extended to integrate the notion of competences with potential actions, e.g. the action `record an invoice` could be associated with `accounting` and `bookkeeping` competences. Similarly, collaborators should also be associated with labels describing their competences. Based on competence information of both collaborators and actions, a measurement of the matching of competences of a given collaborator and competences associated with local actions may be processed to measure the power of a given collaborator derived from being competent in the current state.
- *Organizational position*: as the power derived from the organization position of collaborators "cannot function without obedience, or the consent of the governed", we propose that each collaborator assigns to every collaborator a value representing their consent to accept decisions taken by the former.

4 CONCLUSIONS

The introduction of the concept of power in adaptation of social protocols is an attempt to provide collaborators with support for social aspects influencing their decisions during adaptation. The main innovations presented in this paper are 1) the characterization of PVCs as heterogeneous and dynamic sociosystems at various levels, 2) the idea of a support for power in the negotiations of social protocols, 3) a set of criteria that could be used to model collaborators' power in collaboration processes ruled by social protocols. The proposed concepts are currently under implementation as extensions to the DynG protocol, a social protocol-based platform. The list of criteria proposed to model power is obviously not exhaustive and additional research has to be done for a more accurate modeling of power in negotiation of social protocols. Additionally, the contribution of each criteria to the

global evaluation of a given collaborator's power in a given situation remains an open issue.

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