Towards Support Systems for Non-Monolithic Collaborative Document Edition: the Document-Group-Message Model

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Abstract *Traditionally, research in support for collaborative document edition has concentrated on non-monolithic edition, i.e. edition processes in which parties are unitary decision entities cooperating inside a single group. In this paper, a model for non-monolithic collaborative document model is introduced. This model, named the document-group-message model and being a work-in-progress, integrates a multiversion document model, and support for group dynamics and message exchange. Design of support systems for non-monolithic collaborative document edition based on the document-group-message model is also presented in this paper.*

1. Introduction

From prehistoric tribes to trade unions, group structure has always been at the heart of human activities. Grouping their competences, humans are able to achieve great projects, from pyramids to railroad infrastructure construction. The key word for group activities is *collaboration*. Collaboration is the process of sharing competences to achieve a common goal.

To a recent past, the collaboration process was limited by the requirement of a single location. People involved in a collaboration process needed to meet to exchange information. In reality, people are generally spread on large geographical area. Meetings are difficult to organize, because of schedule incompatibilities, and costly in terms of time and money.

Telecommunication networks provide a partial solution to the above problem. Telecommunication networks let collaborators be spread over various locations. The use of telephone allows collaborators to exchange information via voice communication. Documents can be exchanged via fax in a graphical format. Local area networks (LAN) are the basis of electronic information exchange inside enterprises, while wide area networks (WAN) - in between enterprises.

With the rise of telecommunication networks, collaboration models that rationalize the collaboration process have been developed. Most of them are document oriented, i.e. the fundamental object of the collaboration process is one or more documents. In enterprises' intranets, collaboration tools are currently widely used for sharing files, for group scheduling or for document collaborative writing.

Most works in the collaboration research field focus nowadays on the adaptation of collaboration models developed originally for intranets to the needs of Internet. Classical research areas are shared environments, collaborative drawing and writing, and workflows. Shared environment applications [9] aim at providing a virtual common place for collaborators. They are generally divided in applications based on virtual reality and applications aiming at window and service sharing. Collaborative drawing and writing applications [3] allow multiple users to simultaneously work on a given document or drawing. In the workflow field [4], works focus on managing, documenting, automating, and (if necessary) reengineering business processes and workflows, enabling organizations to be more efficient and agile. Works in the field of

workflows focus on the problem of systematically coordinating small process models to achieve coherent business operations.

Traditionally, research in support for collaborative document edition has concentrated on edition processes confined inside a single group. Few attention has been accorded – at least in the research area of collaborative document edition - to the case of *non-monolithic* document edition processes, i.e. collaborative document edition processes in which the edition process is spread among potentially many author groups. The term "non-monolithic" is taken from the negotiation vocabulary (see [8], pp. 4-5, 389-406), where a non-monolithic negotiation process is a negotiation process in which some parties do not behave as a unitary decision entity. In the field of computer support for collaborative work (CSCW), some works have addressed the issue of the group data organization in a dynamic way [2] but, to our best knowledge, the issue of support for non-monolithic collaborative document edition processes has never been addressed.

Three approaches to support systems for collaborative edition – originally from the field of negotiation support systems - may be of particular interest for non-monolithic edition processes: the *Agora* approach, the *Doc.Com* approach, and the *NeSSy* approach. In the first approach [1], i.e. the Agora approach, negotiators are exchanging messages in virtual negotiation rooms while coediting a contract. The most interesting aspect of this approach is the idea of combined message exchange and contract edition. However, it lacks support for group dynamics and both message exchange model and contract edition model are too simple for non-monolithic negotiations. The second approach [10][11][13][14], i.e. the Doc.Com approach, is based on a communicative approach and models the negotiation process as message exchange on a multiversion contract. The most interesting aspect of this approach is the idea of structured message exchange with the introduction of message type and message exchange protocol. However, no support for group dynamics and a too simple contract versioning scheme is a major obstacle to an application to non-monolithic negotiations. The third approach [5][6][7], i.e. the NeSSy approach, addresses the problem of mass electronic negotiations. In this approach, the negotiation process is modeled as a multiversion contract and analysis tools are provided to build synthetic views of the negotiation process. Even if the contract versioning scheme proposed in this approach may be used for non-monolithic negotiations, this approach lacks support for both group dynamics and message exchange.

In this paper, a new model for electronic non-monolithic collaborative document edition is presented. This model, named the *document-group-message* model and being still a work-in-progress, includes a document multiversion scheme, support for group dynamics and message exchange. The paper is organized as follows. The concepts of monolithic and non-monolithic document edition are introduced in section 2. In section 3, the document-group-message model, which consists of a document model, a group dynamics model, and a message exchange model, is presented. Next, the design of support systems for non-monolithic collaborative document edition processes with the help of the proposed model is discussed in section 4. Section 5 concludes the paper.

2. Monolithic vs. Non-Monolithic Document Edition

Monolithic edition processes are edition processes in which all parties are monolithic, i.e. each parties behaves as a unitary decision entity, and the edition process occurs inside a single group. In Figure 1, relationships (represented by arrows) among authors (represented by dots) are illustrated for monolithic negotiations.
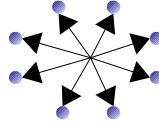
Figure 1. Monolithic edition process

On the opposite, non-monolithic edition processes are edition processes in which some parties may be non-monolithic and many groups may coexist. A non-monolithic parties consists of many persons with various perceptions and goals. A non-monolithic party may be an enterprise, a lobby group, or even a nation, depending on the edition process. An example of non-monolithic edition process could be the collaborative edition process that conduced to the establishment of the "road map" by the United States of America, Israel, and the Palestine.

In non-monolithic edition processes, not only parties are collaborating with other parties (external edition threads), but members of a given party may collaborate with other members of the same party (internal edition thread), as their perceptions and goals are different. It may happen that individuals, not necessarily representatives, from various parties collaborate directly (cross-parties edition thread). Contrarily to external edition threads, the cross-parties negotiations cannot lead to a final version of the document that may end the edition process. Cross-parties edition threads usually take place when some issues involving a high level of expertise have to be solved. In this case, representatives may decide to speed up the edition process allowing their respective experts to collaborate directly. Figure 2 illustrates external edition threads, internal edition threads, and cross-parties edition threads. In Figure 2, each party is represented by a gray rectangle, each author is represented by a dot, a circle is drawn around representatives, and relationships among authors are represented by arrows.
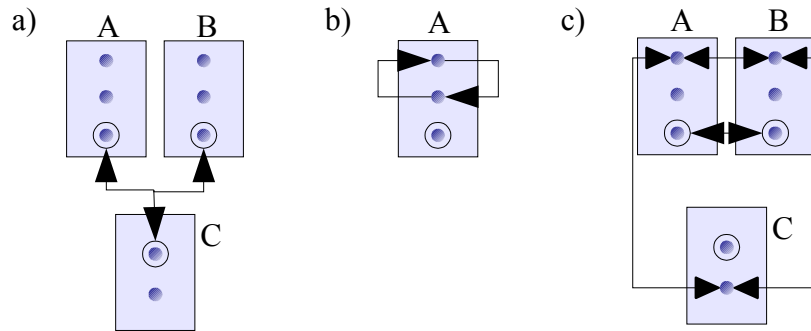

Figure 2. a) External edition thread; b) internal edition thread; c) cross-parties edition threads

3. Document-Group-Message Model

Three aspects of the edition process may be distinguished in the case of non-monolithic collaborative edition: document edition, group dynamics, and message exchange. The first aspect, i.e. the document edition aspect, concerns the object of the collaborative edition process, i.e. the document. The document model should be flexible enough to be adapted to various non-monolithic edition process. Next, in non-monolithic collaborative edition processes, edition groups evolve: new groups are created, some groups split, etc. The dynamic evolution of groups during the collaborative edition process are addressed by the proposed model. Finally, authors are exchanging message about the edition process. Message exchange allows authors not only to comment on the edition process but also to act during this process. This aspect is addressed by the message exchange model.

3.1. Document Model

In non-monolithic collaborative edition processes, the available amount of information is high. The cognitive overload results from the fact that each individual's capacity to process information remains fixed while a group generates more data that a single person. Authors may have difficulties to apprehend all available data. Individuals cannot keep track of all the information generated during the edition process.

The cognitive overload forces individuals to forget information. However, forgotten information could be useful to prepare or improve the document they are working on. Individuals would benefit from a mechanism giving them access to past information.

As a consequence, a document being the object of non-monolithic collaborative edition should be a *multiversion document*. A multiversion document consists of various versions of the document, some of them being "offer" or "counter-offer" (e.g. in the case of negotiations), while other versions could be draft versions. This implies that document versions must be associated with a *version type*. A version type may be for instance "draft", "offer", or "counter-offer".

Document versions are organized as an oriented acyclic graph. In the *document version graph*, edges capture the "answers to" relationship between the source version and the target version. In Figure 3, contract version 1.1.1 is an answer to contract version 1.1.
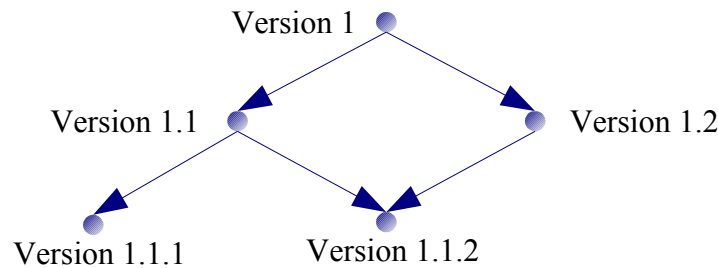

Figure 3. Example of document version graph

The "oriented acyclic" aspect of the document version graph allows a document version to answer to many versions. In Figure 3, document version 1.1.2 is an answer to both document versions 1.1 and 1.2.

A document version consists of a set of *parts*. A part is an atomic data unit. Its semantical and syntactical definition cannot be given as various documents may use different kind of parts. Examples of parts may be an XML element, an image, a link to a Web page, or some data capturing the structure of a document as a list of references to other parts.

The document model may be simply formalized as follows:

```
MvDocument  =    (VersionGraph)

VersionGraph =   ({Document Version}, {Oriented_Vertex})

Version  =       (VersionID, type, {parts})
```

Beside document model, various actions may be executed. Two kind of actions on the document may be distinguished. Modifications of the version graph take place with the help of *version actions*: creation of new versions of a given type and modification of existing version types may be examples of version actions. Modifications of document versions take place with the help of *edition actions*. Edition actions may permit to read, edit, delete, or add a new part, etc.

3.2. Group Dynamics Model

In non-monolithic collaborative edition processes, groups consisting of many authors, potentially from various parties, are the basic edition unit. Even when a single author works alone on a proposal, it may be considered as a group consisting of only herself/himself. Therefore, it may be stated that *a group is a non-empty set of authors*.

Groups evolve: an author may join or leave an existing group, a group may split in two or more groups, two or more groups may merge into a single group. Group dynamics may be modeled by a set of *group actions*. The following group actions have been identified:

- `create` action: creates a new group;
- `join` action: adds an author to the set of negotiators of an existing group;
- `merge` action: creates a new group consisting of the union of the set of authors of at least two groups;
- `end` action: deletes an existing group.
- `leave` action: removes an author from the set of authors of an existing group;
- `split` action: creates at least two groups from an existing group and the union of the sets of authors of the created groups equals the set of authors of the existing group.
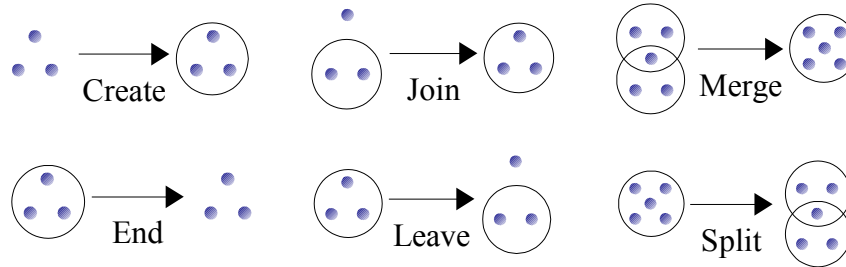

Figure 4. Group actions

Group actions are illustrated on Figure 4. Dots represent authors while circles represent groups. One may notice that, as shown on Figure 4 for the `split` and `merge` actions, a given author may participate at a given time in many groups.

3.3. Message Exchange Model

In a communicative approach, collaborative edition processes are modeled as a structured message exchange. In this approach, authors are exchanging messages related with the edition process, e.g. modification proposal or additional information concerning a given document part. The structured aspect of the message exchange comes from the introduction of message types [12]. In the case of electronic negotiations of a contract, the following message types have been identified: offer, request, counteroffer, accept, reject, confirm, and information. Message types are used to specified the intentions of authors and to limit misunderstanding that may occur during communication.
Moreover, some constraints may be set on sequences of message types to avoid communication non-senses. It makes no sense to answer a request for additional information by a counter-offer. A set of possible sequences of message types constitutes a *communication protocol*.

In non-monolithic negotiations, message exchange is not limited to messages concerning the document. Messages may for instance explain why an author is leaving a group. Therefore, message exchange should be extended to deal with group dynamics. Such an extension implies additional message types. These message types should reflect actions related with group splitting,

merging, exclusion, etc.

In the proposed model, a message consists of:
- some contents, usually a non semantically formalized text;
- a message type, used to structure message exchange;
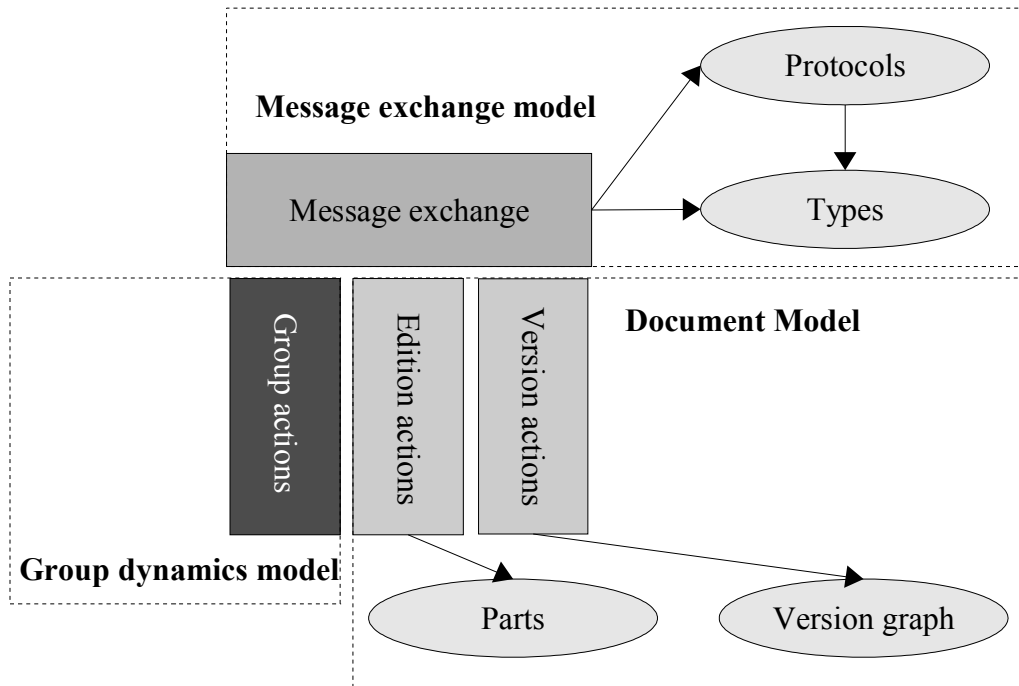- potentially an action: the action may be version action, edition action, or group action.

Figure 5. Document-group-message model

The whole document-group-message model is illustrated in Figure 5. It integrates all three models: document model, group dynamics model, and message exchange model.

4.Designing Support Systems for Non-Monolithic Collaborative Document Edition

The proposed document-group-message model may be used to design support systems for non-monolithic collaborative document edition. Following the model, specifications of a support system for non-monolithic collaborative document edition involve three areas: document specification, message exchange specification, and role specifications.

➢ Document Specifications

Before the collaborative edition process starts, the object of the collaborative edition and the way it is represented and accessed as a document have to be specified. This specification aspect, named document specifications, implies the specifications of document parts, as well as specifications of methods to access the document, i.e. version and edition actions.

➢ Message Exchange Specifications

Before the edition process starts, the way authors will exchange messages, as well as the messages they may exchange, have to be specified. This specification aspect, named message exchange specifications, implies the specifications of available message types, as well as

specifications of communication protocols.

> **Role Specifications**

An individual may play various roles during the edition process. Roles are used to define and control the prerogatives of authors during the negotiation process. A role is defined by:

• a set of available version actions: used to control access to the version graph (not everybody should be able to create a new version);

• a set of available redaction actions: used to limit access to the document contents (not everybody should be able to modify a price clause);

• a set of available group actions: used to control communication among authors (not everybody should be able to communicate with other parties representatives);

• a set of available message type: to control message exchange (not everybody should be able to post an "proposal rejection" message);

5.Conclusion

The proposed document-group-message model, being still a work-in-progress, captures relationships existing between document edition, group dynamics, and message exchange occurring during non-monolithic negotiation processes. It integrates two approaches from the research area of negotiation support systems – document-based and communication-based approaches – which were usually isolated, although complementary. To our best knowledge, it is the first model for electronic support to non-monolithic collaborative document edition. A prototype is currently developed to estimate the pertinence of the document-group-message model for non-monolithic collaborative edition.

The presented model may be applied to non-monolithic negotiations, such as international negotiations or business-to-business contract establishment. Another field of applications is the legislative process in which various political parties, potentially presenting various opinions, are (or should) collaborate in order to establish laws in form of new or modified legal acts. The document-group-message model could also be used to design support systems for collaborative documentation edition processes that often takes place between business actors.

Among future works, further modeling to ensure coherence of message types and available actions would be a valuable contribution to the presented model. Relationships between protocols and actions obey some constraints that have to be at least included in the presented model.

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