Discovering Group Communication Requirements

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Abstract. Communication is one of the most important aspects to promote collaboration within organizations. The way communication takes place in a collaborative interaction is intrinsic to the nature of the group, the task to be performed and the environment where it occurs. Nevertheless, we observe that most groupware applications relies on basic communication channels, such as chat and message systems, and do not explore other possible communication requirements for each particular situation. This research work proposes a method to guide the definition of group communication requirements. It presents a conceptual framework for group communication aspects based on human communication and computer mediated communication that will be used in the method as a guide for identifying communication requirements.

Keywords: group communication, system requirements, groupware.

1 Introduction

In recent years, organizations have perceived that group work may improve the productivity and the quality of their business results. They have understood that the exchange of experiences and knowledge among group members increase their ability to produce better results. Thus, many organizations have been trying to promote the establishment of formal and informal work groups.

One way to encourage group work is to support communication, coordination, awareness and group memory through collaborative systems [1][11]. Communication is an important aspect, if not the most important of them, since only through communication the other collaboration aspects may occur.

Nevertheless, the identification of communication requirements in collaborative systems is not a simple task. Often, designers of collaborative systems adopt general and common communication channels such as chat and messaging systems. This decision does not take into consideration the specific communication requirements for certain groups and for particular contexts. This work assumes that it is necessary to understand how communication takes place in a specific context, before defining its supporting requirements.

Another important issue discussed in this work is that very often opportunities for improving collaboration within organizations are neglected. Information systems developed to support the organization's business processes have an embedded and undisclosed collaborative component. The potential collaboration that may exist in a business process is not properly explored by the supporting information system.

The purpose of this paper is to present a method to guide designers of information systems in the identification of group communication requirements. The method is based on a framework, which assembles and organizes aspects of group communication. The framework provides a theoretical basis that can be used by system designers at each method step.

The paper is divided into 5 sections. Section 2 presents the framework, which is the starting point to pursue the method; Section 3 presents the method. We present a case study on the use of the proposed method in Section 4; and Section 5 concludes the paper and points out future work.

2 A conceptual framework for communication aspects

To perform the identification of communication requirements, the system designer must know which communication aspects should be analyzed in a collaborative context. In order to help this analysis, a conceptual framework for communication aspects is proposed based on information gathered from literature. The framework does not aim to cover all the possible communication aspects but it comprises those which are relevant for the requirements definition and, consequently, for the software development.

The aspects are: *time-space*, *flexibility*, *symmetry*, *affectivity* and *formality*. Each aspect is described in the framework by means of factors that affect them. Factors can be considered as variables that combined configure the aspect.

Table 1. Conceptual framework for communication aspects

Aspect: Time-Space	
Aim: This aspect aims at determining when and where messages should be sent and received during an interaction. Interactions occur in a defined time with each participant located in one defined place [11]. However, the boundaries of time and space are not always evident, allowing them to change [7].	
Factors:	**Time.** A synchronous interaction occurs when participants interact at the same time. Both need to be available and prepared to interact and should have access to the necessary communication resources. In an asynchronous interaction the time is more flexible. It is not possible to know when the messages will be received or sent.
	Space. Participants can interact sharing the same physical place (face-to-face interactions) or they can be located at different places (remote interactions).

Aspect: Flexibility	
Aim: Flexibility deals with the autonomy that participants have or not to build messages and to structure their interaction.	
Factors:	**Message Construction.** Messages have a format. In some cases the format is explicit to the participant and in other cases is not. When this format is highly structured, the participant has little freedom to elaborate his messages. For example, most chat and e-mail systems let the users write the content of the message in a free format. Other situations require users to follow a pre-defined format such as a letter or a form.
	Structure of the Conversation. An interaction is characterized as a sequence of messages being exchanged. The way these messages are organized during the conversation is important for its understanding. According to [12], there are three modes of structuring conversation: *sequential*, *hierarchical* and *networked*. In sequential conversation, the chronological order of the messages is evidenced. However, the relationship among messages can provoke problems as the loss of context [21]. The hierarchical structure allows message organization as a tree, based on the relationship among them. It facilitates the understanding, since messages are organized by their subject. The networked structure enables the construction of complex relationships among messages. Many relations can be created, stimulating conversation. On the other hand this model of interaction can become very complex to follow, specially in anssynchronous interaction.
	Interaction Protocol. The interaction protocol can be established explicitly or emerge naturally. We suggest four interaction protocol types: *sequential*, *order independent*, *intercalative* and *concurrent*. In a sequential protocol, people follow a predefined order and they cannot be interrupted during their participation. The order independent protocol is similar, except for not having an order. In intercalative protocol only one person can speak for a time, but another participant can interrupt him. Concurrent protocol allows parallel conversations, as well as interruptions.

Aspect: Symmetry	
Aim: This aspect is to establish the similarities and differences of available resources for each participant. These differences can influence the contribution of each participant [15].	
Factors:	**Messages direction.** Unidirectional communication happens when the messages are originated always from the same source and for the same receivers while the bidirectional communication takes place when any participant can be both sender and receiver. In unidirectional communication, the roles of the sender and the receivers are clearly assigned. That is what happens in formal interactions such as lectures and announcements; and is sometimes an instrument to influence receivers. The bidirectional communication is a more symmetrical interaction where all participants are able to influence and to be influenced.
	Number. An interaction does not occur only between two individuals. Different means of communication such as telephone, chats, radios, etc, allow one person to communicate with many persons. Each combination (one to one, one to many, many to many) is considered a relation to be explored by supporting mechanisms.
	Resources Availability. During an interaction, participants may not access the same communication resources [15]. As an example, in some distance education applications, where the interactions occur through an audio channel, the teacher can observe the students through video, while the reverse is not possible. Sometimes, the disparity of resources can cause conflicts to some participants who feel harmed during the interaction [1].

Aspect: Affectivity	
Aim: Affectivity is understood as the emotions that participants are able to send and receive during an interaction, especially through nonverbal elements.	
Factors:	**Closeness.** The emotional distance can limit the influence that one participant has over others [1]. However, this distance can also make communication more objective since participants can speak freely between them [8]. The level of closeness can be influenced by the possibility of sending non-verbal elements during the communication [17][19].
	Trust. The concept of trust is related to how participants can be confident on other participants and in respect to their own interaction. Whenever one participant gathers more information about others and about how the interaction occurs, more self-confident he becomes [16][23]. In an interaction where anonymity is allowed, for instance, people tends to fell less exposed and this reflects on the way the interaction goes.

Aspect: Formality	
Aim: This aspect is related to the degree of formality that a message must follow. It is highly related to the affectivity and the flexibility of the communication process.	
Factors:	**Agenda.** Most formal interactions follow an agenda, the simplest it can be. However, depending on the characteristic of the interaction the agenda is elaborated and published so that the participants can prepare themselves for the interaction. In other situations, the agenda is elaborated in the beginning of the interaction in accordance with the subjects and issues brought by the participants. In informal and short duration interactions, the elaboration of an agenda is generally not necessary.
	Definition of Participants. In some cases it is important to define previously who the participants of the interaction will be. When a person is assigned in advance, he is able to get prepared, and dispose the required resources for the interaction. In other situations, participants´ admission occurs during the interaction; it can be free or through approval of the group or of a mediator.
	Role Definition. The assignment of tasks to roles is typical in formal interactions. Even if the assignment is made before or during the interaction, the presence of roles reveals some kind of formalism in the interaction.
	Opportunity. The prior arrangement of the interaction is very important in order to let participants adjust their schedules and be prepared. However, [18] and [28] affirm that the majority of the interactions are opportunistic, or either, they initiate without any planning. This type of interaction starts informally, but allows that the participants to argue different work subjects.
	Record of the Interaction. Recording an interaction can be very helpful for the organizational memory. This record makes possible to understand how some decisions had been taken, and correct potential problems. Nevertheless, interactions should become very formal, and in some cases, it can inhibit fluency. In informal contexts, interactions are generally not recorded.
	Interaction Context. The context where an interaction occurs has direct influence on its formality. An interaction that has informal features can assume a formal behavior, when it is into formal context. That can occur in the inverse situation too.

3 The method

This work claims that traditional methods for identifying system requirements can be enhanced in order to comprise the issues related to group communication. Therefore, we propose a method – MDRcom – comprising a sequence of phases, which helps to explicitly discuss communication requirements during system elicitation. The proposed framework is used by the method to guide system designers in finding relevant communication supporting needs for the system being developed.

The first step in this method is to define what a communication requirements is. In MDRCom communication requirements are the set of system requirements that define the characteristics that must be addressed by the system in order to support the group communication needs. According to Watzlawick [27], communication is composed by interactions. In this work we define interaction as any message exchange among participants with the intention of establishing communication. A message is defined as a set of structured visual, auditive and audiovisual signals shared by participants. A message has a beginning and an end, so it can be isolated and identified [27].

Next, MDRCom defines what is the basic unit for identifying communication requirements in a given situation. For this purpose, MDRCom defines the concept of *way of interaction* (WI). A WI is a generalization of communication interactions that have the same characteristics and can be equally analyzed and treated. For example, an attendant in a helpdesk answers to several calls daily. Considering each call as an interaction, and that they usually have the same characteristics, it can be said that they compose the same way of interaction between customers and attendants.

MDRCom assumes that the organization's business processes are the starting point for identifying system requirements [2]. Business processes models are the input for describing how the organization operates and help to identify what work routines should be automated. As an input to MDRCom, business processes are a basis for contextualizing where communication requirements should be searched.

Another input of MDRCom is the conceptual framework presented in the previous section. The framework will help the designer in discovering and classifying communication requirements by analyzing the interactions that occur within the organization's portion of the processes being analyzed. Finally, the MDRCom takes into account the system users´ information, expectations and needs. As a result, MDRCom expects that a set of communication requirements can be produced and added to the system's requirements documentation (Figure 1).

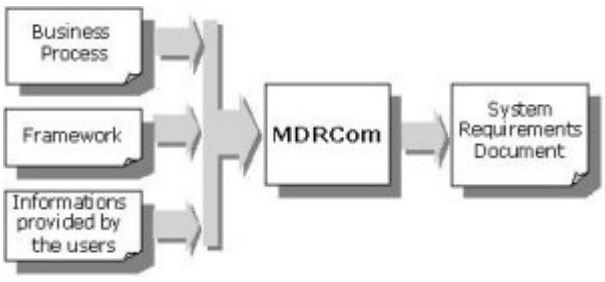

Fig. 1. Method overview

The MDRCom is based on the idea that the first step to identify system communication requirements is to understand how it occurs, independently from a computer-supported solution. Due to the fact that communication is composed by interactions (as explained in section 2), it is possible to understand that it is important to identify the ways of interaction (WIs) that compose a specific group or work process context. After identifying the ways of interaction, it is possible to characterize each one based on the aspects organized in the framework, leading to its specific supporting needs. The MDRCom has 3 phases that will be sequentially performed by a system designer to obtain a clear and detailed understanding of communication interactions and their characteristics (Figure 2).

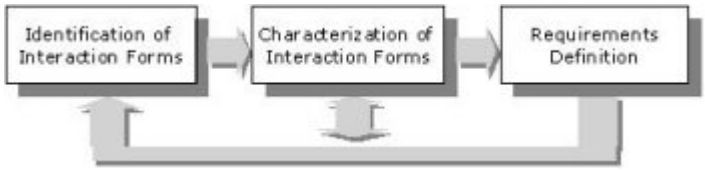

Fig. 2. Phases of the MDRCom

3.1. Identifying Ways of Interaction

While performing an activity, participants communicate by using different ways of interaction among them. Each WI has specific characteristics and contributes to the activity in a special manner. To identify which WIs exist is the first step to understand how the can be supported latter. This phase can be divided into the following steps:

Selecting participants. The designer can choose from the scope of the business process selected for analysis the roles that were defined to perform process activities. Representatives of these roles are candidates for participating in a brainstorm session for identifying ways of interactions. It is important that all roles are represented in the discussion in order to provide different points of view about the communication. A facilitator may also be defined to conduct the method dynamics and discussions. The facilitator can be one any of the participants selected or the designer.

Turning interaction explicit. Participants are invited to expose how they individually see the interaction that occurs during the activity/process. The method suggests the application of a group dynamics to capture this information. This dynamic is based on CRC cards [4], from object-oriented design. The basic use of a CRC cards is that each participant can write on a card what are his responsibilities in that activity and with whom (persons or other roles) he interacts/communicate in order to perform it [6] (Figure 3).

The purpose of this dynamics is to make this step more collaborative. Participants can share their views using the cards and make a sense about the overall communication, learning and criticizing about it.

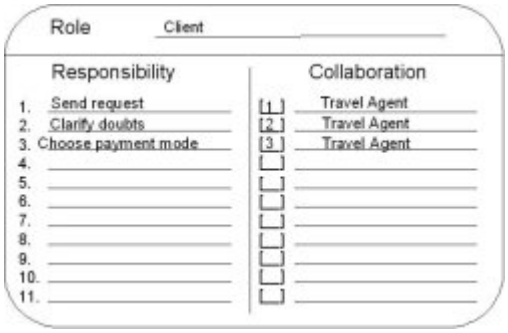

Fig. 3. A CRC card registering how a communication is perceived by one participant

Preliminary Representation. Information captured in the previous step must be formally registered using the Ways of Interaction Model. The interactions identified in the cards must be graphically represented and presented to participants for visualization and validation. Figure 4 presents a simplified representation of a possible way of interaction where a teacher answers to students' issues and the students report that they make questions to the teacher. Each line represents a view of an interaction reported by each participant.

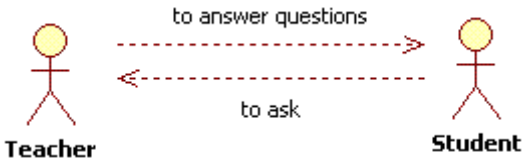

Fig. 4. Example of a ways of interaction model

Refinement. Inconsistencies can be identified after the translation of the information captured in the cards to the graphical representation in the model. The objective of this step is to eliminate them as also as to stimulate the discussion among participants in order to reach consensus. Figure 5 presents a refined version of the model resulted as presented in Figure 4. If both participants of this interaction – teacher and student – agree that they refer to the same WI, so it can be considered that this WI exists and can be explicitly represented as in Figure 5.

Scope definition. Based on the WIs identified in the model, it is possible to select those that will be considered in the following phases of method. The selected WIs will be those that the designers and participants agree that are candidates for automated support.

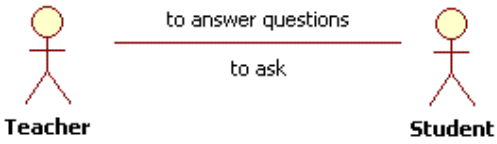

Fig. 5. A refined view of the WI model

3.2. Characterizing Ways of Interaction

The aim of this phase is to look at each WIs selected on the preceding phase and to try to have a deeper understanding of its nature. Thus, each WI will be separately analyzed. Two steps comprise this phase:

Describing WIs. Each WI must be briefly described so that the designer can document it and enforce his understanding about it. Taking Figure 5 as an example, the WI there represented can be described as: "*This WI describes the moment when students can solve doubts with the teacher"*

Analyzing WIs. At this step, the designer will try to analyze each WI based on the communication aspects framework presented in Section 2. To analyze the characteristics of an interaction may require the use of observation techniques, such as ethnography [14]. Using or not this kind of technique may be restricted to the project's schedule and budget and to the designer's competence in doing it. The communication aspects framework will be used here like a checklist, indicating each aspect that the designer must analyze/observe. The framework does not describe how the designer will find the information but just what to look for in order to describe the WI.

There is no exact order to follow the framework checklist. However, the framework was organized in a sequence that facilitates the analysis. For instance, aspects like flexibility and affectivity appear before formality because the framework considers that the latter can be easier understood if the former are already known. Table 2 presents an example of the results of the execution of this stage, using the example of Figure 5.

3.3. Defining System Requirements

The aim of this phase is to guide the designer into defining system requirements based on the characterization obtained in the previous phase. It is important to notice that the MDRCom does not have the objective of specifying requirements but just to identify them. As mentioned by Sommerville [25], the requirements definition aims at describing requirements in a way that users and designers without the need of using a

special notation or formalism can understand them. In the requirements specification activity, on its turn, a formal notation (diagrams) is used and it is necessary special skills or qualification to interpret it.

Table 2. Example of the results of the second phase

WI: To solve doubts with the teacher	
Description: A student, outside the classroom, can make questions to a teacher.	
Time-space	
Time	The interaction must be asynchronous to allow the teacher to access available material. Answers must be given within a defined period of time.
Space	students and teachers can be in different places
…	…
Formality	
Record of the Interaction	All the interactions are registered, comprising a memory that can be further searched by teachers.
…	…

Therefore, the final result of MDRCom is the collection of information necessary to define communication requirements. The MDRCom supposes that all its comprising steps can be conducted in parallel with traditional requirements gathering, being communication another aspect to be considered. This phase comprises the following steps:

Identifying needs. In this step, each factor that will be supported must be described as needs that will be treated by the system. To identify needs, it is necessary to understand that the information obtained in the previous step are related to the WIs and not yet to the system. Therefore, it is important to identify from the preceeding analysis, what would be the main system characteristics.

To maintain the system requirements rationale, each identified system need must be registered associated to WI and the framework aspect that originated it.

Considering the factor *Time* in the example of table 2, the following need can be identified: "*The system must manage the answer time of each teacher*."

Identifying functionalities and restrictions. Once the system needs have been identified, the next step is to describe how it will support them, i.e., to identify the system functionalities. For each identified system need, it is necessary to describe through which functionality it will be achieved, as well as eventual restrictions.

In that step, it must be obtained information such as: allow asynchronous interactions and notify the teacher when the deadline for answering the question has arrived.

Defining user access. This step aims at defining users' system access, i.e., to define which users have access to which functionalities. This information can be found by

analyzing the WIs in terms of suitable factors for providing this information, such as: Resource Availabity, Messages Direction, and Message Construction.

Example: *"Just teachers can access a database of previous interactions."*

Building a data dictionary. In this step, the analyst must define the information content that will be organized and registered by the system. Thus, a set of data concepts related to communication can be outlined and described and further incorporated to the system's overall data model and dictionary. Some factors are specially interesting for helping to discover these concepts, such as Message Construction.

Final Review. This step proposes the review of the defined requirements trying to guarantee their conformance with the whole set of requirements identified for the system and if they are addressing users' expectations. It is important to observe if there is no conflict or redundancy among requirements and if none of the communication requirements violate organization's business rules or project restrictions.

4. Case Study

A case study was conducted in order to verify the applicability of MDRCom as also as to verify if its outcome would be requirements that represents a set of group communication supporting needs. The case study was conducted in the context of a research project [3][22], which aims at specifying an environment for supporting collaborative social networks for software process improvement – the RCC-Sw. Collaborative networks are a kind of social organization or community that facilitates participants in performing collaborative actions towards a common objective. Through this network it is possible to mobilize people, even remotely located, to perform collaborative projects and actions. Communication among participants is of course a key aspect for the network dynamics. MDRCom was used, then, to identify communication requirements for the supporting environment for the RCC-Sw.

The sample. The team that took part on the case study was composed by the members of the research project – four researchers from IS area, two senior software developers and two undergraduate students. Among the researchers, only three of them were experienced in groupware and groupware development. However, all of them were senior requirements analysts. Among the software developers, both had experience with requirements gathering but only one of them had experience in groupware development. The undergraduate students had naive experience in both areas. Participants were divided into two groups, based on their profiles, to form an experimental group – the group that would use MDRCom – and a control group – the group that would identify requirements using any method they wanted, instead of MDRCom. An observer had been included in each group to analyze the work.

Scenario. To start the method execution within the experimental group, one of the RCC-Sw processes were presented. The chosen process was the one who deals with how the network rules should be changed and approved by network members (Fig 6).

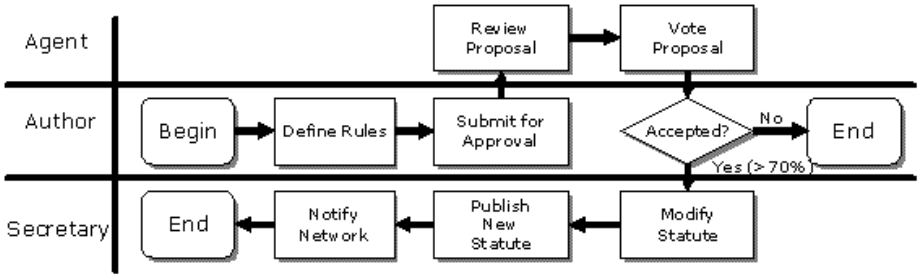

Fig. 6. Process description for changing the network rules.

Results. The questions we wanted to answer with this case study were:

Question 1: *The method can be performed as specified?*
To answer this issue, we tried to observe the results of each method phase and to evaluate if they represented the expected results. This evaluation was performed through reviewing the documents elaborated during the method execution. It was observed that all the method steps were performed and the results obtained were satisfactory and corresponded to what was expected as a result.

Question 2: *What were the barriers or difficulties faced by designers while using the method?*
Through observation, interviews and by analyzing the generated documents and results, we collected the number of doubts, errors and the amount of time necessary to complete the method. Participants reported some doubts on methods concepts that needed to be further explained.

Question 3: *The obtained requirements represent the group communication needs?*
As also as the previous question, observations, interviews and document analysis were used to identify the level of requirements detail and description obtained, the clarity of the results and the acceptance level of designers about the method. Participants reported that the results obtained would be hardly obtained if no method were applied.

Discussion. From the results obtained by the control group (the one which did not use the method), it was possible to observe that participants were concerned at specifying the communication mechanisms that would be incorporated in the system instead of understanding the characteristics that the software should have in order to support this specific collaboration context. Furthermore, designers did not focus on a specific process and defined requirements in a broader way, focusing all the system. The final definition comprised the identification of all the roles (external users, agents, work groups, secretary and support) that interact with the system as well as the communication mechanisms that will be provided classified as synchronous (chat)

and asynchronous (email, discussion form, and whiteboards). Also de cardinality of interactions using each mechanism

The results obtained by the experimental group (using the method) showed a very detailed requirements definition. The group identified 5 FIs for the process under analysis involving its participants (*Submit for approval – Author/Agent*, *Send/receive suggestions for change – Author/Secretary*, *Notify result/receive notification-Secretary/Agent*, *Send/receive voting result – Agent/Author*, *Discuss Proposal – Agent/Agent*). The analysis of each interaction resulted in a rich characterization of FIs and consequently, requirements. It was generated more than 50 requirements, both functional and non-functional.

It was possible to identify a small amount of intersections between the set of requirements gathered by the experimental group and the control group, such as having asynchronous ways of interaction through email and discussion forums. However, issues like anonymity, the need for recording interactions and discussions, associating them to the suggestions under approval, voting mechanisms among others, showed that the method helped the identification of a richer detail of requirements. The table bellow shows some examples of identified requirements that were not detailed or identified by the control group.

Table 3. Example of requirements identified by the experimental group

PROCESS: Change Network Rules				
FI	**Aspect**	**Factor**	**Requirement**	**Roles**
Submit for approval	Formality	Record of the interaction	The system must register the messages exchanged	Agent, Author
Send/receive suggestions for change	Flexibility	Message construction	The system must allow the Author to highlight the changes in the text before sending it to the Secretary	Author, Secretary
Send/receive voting result	Formality	Role definition	The system must allow the identification of the coordinator of the voting interaction	Agent, Author
Send/receive voting result	Affectivity	Trust	The system must allow anonymity	Agent, Author

Another benefit of the method was that the rationale of each requirement was recorded by associating each requirement to a specific way of interaction (WI) and to the business process.

Limitations. Time was the main limitation of the case study. Two weeks were spent for presenting the method and performing it. A longer period of time as well as additional training on the method steps would probably influence the results, since participants would be more able to perform the method activities. Another limitation was that the case study focused on only one business process. Analyzing more processes would have enriched the discussions and the resulting requirements.

6. Conclusion

This research has been motivated by the growing need of organizations to support collaborative work. It is argued that it should be profitable to consider collaboration supporting aspects while identifying system requirements to support organizations' business processes. Communication was the collaborative supporting aspect considered in this work. A framework and a method – MDRCom – were proposed in order to accomplish the task of identifying communication requirements.

The case study points out to evidences that the use of MDRCom helps designers to get a deeper understanding of the communication needs and, further, can define more suitable supporting requirements. However, more case studies must be conducted in order to assess its efficiency. Another possibility of future work is to specify and build a supporting tool to help designers in performing the method steps.

Finally, the contributions of this research – the framework and the method – are a first step for characterizing, respectively: group communication requirements and how to consider and organize them in a requirements elicitation process. Further steps of this research would be to formalize the aspects in the framework as non-functional requirements [9] and to formalize MDRCom with existing requirements elicitation techniques [10][20] and notations [29].

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