Classification of Coordination and Awareness Mechanisms in Collaboration Systems

A thesis submitted for the

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By

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Pia Licht

Koblenz, January 2017

Abstract (English)

Coordination and awareness mechanisms are important in systems for Computer-Supported Cooperative Work (CSCW) and traditional groupware systems. It has been a key focus of research into collaborative groupware and its capability to enable people to efficiently collaborate and coordinate work. Until now, no classification of the mechanisms has been undertaken to identify commonalities and differences in coordination and awareness mechanisms and to show their significance in collaborative environments. In addition, there is a little investigation of coordination and awareness mechanisms in new forms of groupware such as socially enabled Enterprise Collaboration Systems (ECS). Indeed, both in science and in practices, ECS incorporating social software have become increasingly important. Based on the combination of traditional groupware and social software, ECS also include coordination and awareness mechanisms that may simplify collaboration, but these have not yet been investigated.

Therefore, the aim of this thesis is to identify coordination and awareness mechanisms in the academic literature to provide a general overview of those mechanisms examples. Additionally, this thesis aims to classify the mechanism examples. Based on a deep literature analysis, concepts described in literature are chosen and applied with the intension to analyse the mechanisms and to reach a classification. Based on the classification of the identified mechanisms their commonalities and differences are examined and described to gain a better understanding of them. For illustration purpose, examples of coordination and awareness mechanisms and their application are portrayed. The mechanisms examples refer to the classification groups derived. The selection of the mechanisms for the visualization is based on significant differences in their functionality. Subsequently, the selected mechanisms, more based on traditional groupware, are checked to a limited extend whether they can be found in socially enabled ECS. The collaborative platform of IBM Connections serves as a practical example of ECS incorporating social software. IBM Connections is used at the University of Koblenz to run the platform "UniConnect". On the platform it is investigated which of the identified mechanisms examples of the literature are applied in IBM Connections and which additional mechanisms are created by users. This work is the first step in the study of coordination and awareness mechanisms in socially-enabled ECS. In addition, it is expected to detect new mechanisms which are used while the social factor to collaborative work is new.

The purpose of this thesis is to examine and collect coordination and awareness mechanisms examples in literature to analyse them. Additionally, the purpose is to provide a first overview of mechanisms and to classify them by investigating their commonalities. Beside this thesis should give incentive for further investigations to investigate coordination and awareness mechanisms in socially integrated ECS.

Keywords:

Computer-Supported Cooperative Work (CSCW), Groupware, Enterprise Collaboration Systems (ECS), Coordination Mechanism (CM), Awareness Mechanism (AM), Classification, Collaborative Work

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Abstract (German)

Koordinations- und Bewusstseinsmechanismen sind in Computer-Supported Cooperative Work (CSCW) und bei traditioneller Groupware von Wichtigkeit. Die Wissenschaft ist bestrebt, deren Bedeutung bei der Nutzung von Groupware und die damit verknüpfte Zusammenarbeit von Menschen tiefgründig zu untersuchen, um ihre Anwendung und Effizienz zu beschreiben. Dabei wurde bisher noch keine Klassifizierung der Mechanismen vorgenommen, um deren Gemeinsamkeiten und Unterschiede sowie ihre Anwendung herauszuarbeiten und ihrer Bedeutung im kollaborativem Umfeld nachzugehen. Zudem fehlt die Betrachtung der Mechanismen in neuen Formen von Groupware. In der Wissenschaft als auch in der Praxis haben Enterprise Collaboration Systems (ECS), die Social Software Funktionalität beinhalten, wachsende Bedeutung. Basierend auf der Kombination von traditioneller Groupware und Social Software Komponenten beinhalten diese auch Mechanismen, die die Kollaboration vereinfachen sollen, jedoch bisher noch nicht hinreichend untersucht wurde.

Das Ziel dieser wissenschaftlichen Arbeit ist es daher, Beispiele für Koordinierungs- und Bewusstseinsmechanismen in der akademischen Literatur zu identifizieren um einen ersten Überblick über diese zu verschaffen. Aufbauend darauf ist es zudem Ziel, die Beispielmechanismen zu klassifizieren. Basierend auf einer Literaturanalyse werden Konzepte aus der Literatur übernommen und auf die ausgewählten Mechanismen angewendet um diese zu analysieren und zu klassifizieren. Dabei werden die Gemeinsamkeiten und Unterschiede der Mechanismen herauszuarbeiten und beschrieben. Um ein Verständnis für die Anwendung von Koordinations- und Bewusstseinsmechanismen zu verdeutlichen, werden einige Mechanismen exemplarisch visualisiert. Die Beispiele beziehen sich auf die verschiedenen Klassifizierungsgruppen. Die Auswahl der Mechanismen für die Visualisierung basiert auf deren signifikanten Unterschiede in ihrer Funktionalität. Anschließend werden die ausgewählten Mechanismen, die in der Literatur traditioneller Groupware identifiziert wurden, in kleinen Ausmaß in sozial integrierter ECS kontrollier. Dabei gilt es herauszufinden, ob die Beispielmechanismen vorzufinden sind und ob neue Mechanismen identifiziert werden können. Als Praxisbeispiel von ECS mit Sozialer Software dient die kollaborative Plattform von IBM Connections. IBM Connections wird an der Universität Koblenz eingesetzt, um die Plattform „UniConnect“ zu betreiben. Anhand einer ersten Toolanalyse wird herausgearbeitet, welche von den identifizierten Beispielen an Mechanismen in IBM Connections angewendet werden. Diese Arbeit stellt erste Schritte in der Untersuchung von Koordinierungs- und Bewusstseinsmechanismen in ECS mit Social Software dar. Darüber hinaus sollen Beispiele für neue, bisher unbekannte Mechanismen herausgearbeitet werden, die im Zuge des sozialen Faktors zu kollaborativen Arbeit eingesetzt werden.

Der Beitrag soll dazu dienen, Beispiele von Koordinierungs- und Bewusstseinsmechanismen in der Literatur zu identifizieren, zu analysieren und diese zusammenbringen um einen ersten Überblick zu erhalten. Desweiten wird eine erste Klassifizierung anhand der Unterschiedlichkeiten der Mechanismen vorgenommen. Nebenbei soll der Betrag einen Anreiz für weitere Untersuchungen schaffen, Koordinierungs- und Bewusstseinsmechanismen in sozial integrierter ECS tiefer zu untersuchen.

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Keywords:

Computer-Supported Cooperative Work (CSCW), Gruppensoftware, Groupware, Enterprise Collaboration Systems (ECS), Koordinationsmechanismen, Bewusstseinsmechanismen, Klassifizierung, Kollaboration

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List of Abbreviations

AM	Awareness Mechanism
BSCW	Basic Support for Cooperative Work;
CAS	Current Awareness Service
CB	Coordination Bar
CM	Coordination Mechanism
CMC	Computer-Mediated Communication”
C-CM	Computational Coordination Mechanism
CSCW	Computer-Supported Cooperative Work
CT	Coordination Theory
E2.0	Enterprise 2.0
ECS	Enterprise Collaboration System
ESN	Enterprise Social Network
ESS	Enterprise Social Software
FGBAS	Forschungsgruppe Betriebliche Anwendungssysteme
FGEIM	Forschungsgruppe Enterprise Information Management R
HCI	Human Computer Interactions
ICT	Information and Communication Technology
IM	Instant Messenger
IRC	Internet Relay Chat
IT	Information Technology
PD	Participative Design
SOP	Standard Operating Procedures
RQ	Research Question
RSS	Really Simple Syndication

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1 Introduction

The first chapter provides a brief introduction to the topic of this thesis. It begins by describing the motivation and problem statement (section 1.1) for investigating this topic. Deriving from the motivation, the research aim is described and is addressed by answering the research objectives and questions (section 1.2) of this paper. It continues with an outline of the thesis (section 1.3) focusing on the investigation of coordination and awareness mechanisms.

1.1 Motivation and Problem Statement

The term 'coordination' has already been investigated in many different disciplines including economics and computer science (Malone & Crowston, 1990; Malone & Crowston, 1994, p. 87). In particular, in computer science and the field of "Computer-Supported Cooperative Work" (CSCW) much investigation has already been conducted in order to understand coordination complexity (Schmidt & Simone, 1996, p. 155). CSCW researchers began to gain a greater understanding by developing and testing several technologies supporting communication in collaborative and cooperative work. During this time, the importance of coordination theory (Malone & Crowston, 1990, pp. 87-88), awareness (Dourish & Bellotti, 1992, p. 107) and their coexistence for successful cooperation in work were identified (Koch, 2008a, p. 417). Around the same time the term of "groupware", a research field included in the broad area of CSCW, emerged (Grudin, 1994, p. 19; Wainer & Barsottini, 2007, p. 28). Koch (2008a, p. 419) argues that CSCW and groupware aim not only to understand how collaboration works, but are also about shaping socio-technical systems supporting collaborative work, which is constituted by multiple and interdependent actors that are distributed in time, space and different circumstances (Schmidt, 1998). Hence there is a need to reduce the complexity of interdependent activities in collaborative work arrangements (Schmidt & Simone, 1996, p. 159) by applying diverse mechanisms to handle complexity (Schmidt & Rodden, 1996). Malone and Crowston (1994, p. 110) predict that to reduce complexity, additional work has to be carried out by actors which is referred to as coordination, which is supported through "coordination mechanisms" (Crowston et al., 2006, p. 128). The aim of integrating a coordination mechanism is to support coordinated activities in computer systems, using common practices, strategies and artifacts. Holt (Holt, as cited in Schmidt & Simone, 1996, p. 155) describes a coordination mechanism as: "The new capabilities at which coordination technology aims depend on finding and installing appropriate conceptual and structural units with which to express tasks, their diverse relations to each other and to the people who ultimately bear responsibility for them". This overall aim is important as a substantial part of today's daily activities concern the coordination of distributed work and multiple interdependencies (Robertson & Wagner, 2015, p. 289). Many CSCW studies of cooperative work situations also show that actors involved in huge projects are prone to tacitly monitor their neighbours and "[…] they perform their activities in ways that support co-workers' awareness and understanding of their work; they take each others' past, present and prospective activities into account in planning and conducting their own work" (Schmidt & Simone, 1996, p. 159; Divitini & Simone, 2000, p.

376). Thus, it is not a new idea that awareness concepts among cooperating actors are playing a central role in the CSCW research (Gross, 2013, p. 426) and "[…] have been described by Suchman as 'centres of coordination'." (Suchmann, as cited in Heath et al., 2002, p. 319).

Extending from traditional groupware and CSCW, coordination and awareness are also penetrating the area of Social Media and Social Software (c.f. Gross, 2013, p. 426). The concept of Social Media is based on platforms for profiles used in a social context, chats or file sharing tools that are used voluntarily by people in their free time. Social Media describes open platforms on the Internet that are run by providers and are based on Social Software functionalities that support social interactions (Diehl et al., 2013, p. 237; Schubert & Williams, 2013, p. 225). One famous example is "Facebook" (Williams et al., 2013, p. 252). The emergence of such applications was supported by the emergence of the Web 2.0, which allows users to facilitate direct or indirect communication between each other (Richter & Koch, 2007, p. 7). The use of Web 2.0 technologies in companies is referred also to as 'Enterprise 2.0' (E2.0) by McAfee (2006, p. 23). In order to ensure adequate data protection (Diehl et al., 2013, p. 237) several companies employed services alternatively referred to as "Enterprise Social Software" (ESS) to describe applications of Web 2.0 as behind-the-firewall technologies, for example IBM Connections (Williams et al., 2013, p. 252).

The integration of Social Software features in the classical field of CSCW has also been referred to as "Enterprise Collaboration Systems" (ECS) (Diehl et al., 2013, p. 237). To build an ECS, the combination of classical groupware functions, like group calendars, and "Enterprise Social Software" (ESS) is fundamental (Williams & Schubert, 2015, p. 1). To date, many studies on the use of coordination and awareness mechanisms have been conducted in the field of CSCW. However, a detailed classification of those mechanisms does not yet exist. Additionally, their role in the field of social enabled ECS is less well understood. That is somehow surprising since traditional ECS, is not a new research area as it belongs to the classical field of CSCW and groupware (c.f. Diehl et al. 2013, p. 237). Williams and Schubert (2015, p. 1) state that in the last twenty years ECS has been successfully used in organizations and that ECS are more and more being integrated into every day work (Hausmann & Williams, 2015, p. 361). The business value which can be delivered by ECS is to facilitate communication and the exchange of information within an organization (Williams & Schubert, 2015, p. 1).

While most of the mechanisms in academic literature on collaboration systems are distributed and are not providing a general overview of existing coordination mechanisms (CM) and awareness mechanisms (AM), there is the need to collect and classify existing mechanisms to gain an overview of them. Additionally, a better understanding of their commonalities and application is needed to learn more about their functionalities. As said before, much of academic papers mention divers CM and AM but not really describing their functionalities and benefits of application. Beside their usage in traditional groupware systems, their role in new socially enabled ECS is less well understood. However, to be able to reduce complexity in coordination and facilitate communication in collaboration systems, the understanding of different types of CM and AM is necessary. Thus, the motivation for this thesis is grounded on a in-depth analysis of existing CM and AM in academic literature and their classification. Starting with a collection

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of CM and AM examples that can be identified in literature, their differences and commonalities should be carved out that is based on a deep literary analysis in order to derive classification categories. It is expected that common CM and AM are used in traditional groupware and social enabled ECS, due to the fact social enabled ECS is a combination of traditional groupware functions that enables Social Software. It is also expected that new forms of CM and AM created by users are applied in social ECS, due to the point that Social Software provides new possibilities to users to collaborate when doing a variety of different tasks. For this part of the thesis the collaborative software of IBM Connections, used to run the platform 'UniConnect' at the University of Koblenz, is investigated briefly as the focus remains to the CM and AM classification. The results of the thesis are the first stepts to reach a collection and classification of existing CM and AM in collaboration systems by describing their commonalties. This first draft can be used to expand the classification of additional CM and AM and to boost their research in social enabled ECS.

1.2 Research Aim, Objectives and Questions

Based on a literature review, the research aim of this thesis is, to provide an over view of CM and AM examples in collaboration systems and conduct an in-depth analysis of the identified CM and AM to understand their diverse functionalities. Additionally, a classification scheme is elaborated by comparing the identified mechanisms for their commonalities. The elaborated classification categories are explained in more detail and are portrayed through CM and AM scenario examples. This aim, focusing on theoretical investigation, is accomplished by a practical part. In the practical part, the CM and AM examples selected are checked to a limited extend whether they can be found in socially enabled ECS and whether new CM and AM can be found. The collaborative platform of IBM Connections serves as a practical example of ECS incorporating social software.

By achieving the aim, the in-depth analysis, overview and classification of CM and AM, a better understanding of their functionalites and application should be gained in order to improve CM and AM research and guidance in future development of ECS. The aims are accomplished by the following research objectives and questions which are divided up into a theoretical and practical part. RO1 and RQ1 address the theoretical part of this paper and RO2 and RQ2 address the practical part.

During the literature review it was noted that a clear classification of the already existing CM and AM in classical CSCW and groupware systems is not available. The first research objective therefore is:

> **RO1:** To identify, analyse and classify the different types and functions of CM and AM defined in the academic literature.

In order to be able to reach the first objective, the first research question was formulated, containing two sub questions to solve the first main objective.

> **RQ1:** What are the different types of CM and AM defined in the academic literature?
>
> **RQ1 a:** What is the scope and character of the identified CM and AM?

RQ1 b: How can these CM and AM be distinguished or classified in terms of type and/or functionality?

As pointed out in the problem statement, CM and AM haven't been investigated in depth in the area of ECS that incorporate some different Social Software features (Schubert & Williams, 2013, p. 225). Therefore, the second main objective in this paper is:

RO2: To identify new examples of CM and AM found in social enabled ECS and describing their functionality.

To reach the second research objective, the second questions was elaborated, also consisting out of two sub questions. These will be addressed through a pratical investigation of IBM Connections at the University of Koblenz.

RQ2: Which of the identified CM and AM in goupware literature can be transferred to social enabled ECS?

RQ2 a: Which CM and AM are provided in IBM Connections?

RQ2 b: Which CM and AM are used in a practical context to support coordinating work and what additional CM/AM do users create themselves to coordinate their work?

1.3 Outline of the Thesis

This section gives the reader an overview of the structure of this thesis. This thesis consists of seven chapters, which are divided into sub sections.

The thesis starts with an introduction **(chapter 1)** including the relevance of motivation of this research topic (section 1.1). Furthermore, the research aim, the objectives, and questions are presented (section 1.2).

Chapter 2 presents the research design used for this thesis. The methodology and method are briefly outlined (section 2.1 and 2.2). The methods for data collection, especially the literature for this thesis, are presented (section 2.3). Also in a concise summary, the research scope is explained (section 2.4). Chapter 2 concludes with the presentation of the research steps which guide the process for reaching the objectives defined for this thesis (section 2.5).

Chapter 3 introduces to the topic of the thesis by providing theoretical foundations and clarifying terminologies used in the topic context. It is composed of historical background of groupware and CSCW as well as concepts and their relations (sections 3.1 until 3.3) focusing more on the background on CSCW and Social Media. A brief comparison presents the differences between the terminologies (section 3.4). This follows the description of ECS and its emergence (section 3.5) and the understanding of the term of coordination is outlined in section 3.6. Three different types of coordination are described in a short and will be used for grouping CM that will be identified in literature. Subsequently the introduction to coordination, articulation and cooperative work are explained to the reader (section 3.7) as it involves

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the coordination of activities. Section 3.7 is important because it describes the situation where a demand for CM and AM that should support collaborative work exists. Therefore, the notation and the construct of a CM are described in section 3.8. In this section, the importance of formal constructs and its role as well as the role of an artifact that is included in a CM is explained and the crossover to a computational CM is mentioned (section 3.8.1 until 3.8.3). As the role of an artifact is already outlined, the distinction between oral and artifact based coordination and additionally the distinction between implicit and explicit coordination is explained (section 3.9). These descriptions follow an outlook to related work that have been conducted in the same research area (section 3.10).

Following the description of the notation and construct of a CM the role of awareness for coordination is outlined to the reader **(chapter 4).** Subsequently, the theoretical examination, one main part of this thesis starts in **chapter 5.**

The presented concepts out of chapter 3 are discussed and single models appropriate for the investigation of CM and AM are selected (section 5.1). In the following section (5.2) the development of the coding scheme that is applied in this thesis is explained and portrayed. It also includes the presentation of coded CM and AM that are identified in existing literature. Next, the course of the investigation and its results for CM are explained and presented. Section 5.3 (CM) and section 5.4 (AM) are structured in the same way, starting by defining and describing the selected CM (5.3.1) and AM (5.4.1). It goes on with the presentation of the results that are emerging through the application of the concepts described (5.3.2) (5.4.2). Subsequently the steps for the classification of CM (5.3.3) and AM (5.4.3) are outlined and the results are visualised and accompanied with a short scenario where CM and AM can be applied (5.4.3) (5.4.4). **Chapter 6** presents the supplementary part to chapter 5. The mechanisms identified in literature are checked in the practical example of the socially-enabled ECS IBM Connections. It is examined which of the CM and AM can be found in the platform (section 6.1) by checking the categorised CM and AM in IBM Connections. Additionally, it is examined whether new CM and AM are created by users in IBM Connections (section 6.2). Finally, the findings of the whole investigation are interpreted in section 6.3. This section includes a review of the theoretical and practical examination, the experiences that are made during the examination as well as a suggestion for future work that can be taken into account in this research area (sections 6.3.1 - 6.3.3).

The last **chapter 7** contains a final summary and conclusion of the thesis. It begins (section 7.1) by answering the research questions elaborated in section 1.2. This follows a critical reflection of the whole work by providing information on the research contribution (section 7.2) and the existing limitations (section 7.3).

2 Research Design

In chapter 2 the research design of this thesis is presented starting by describing the theoretical perspective (section 2.1). It also comprises the description of theoretical and practical methodologies and research methods chosen for this thesis (section 2.2). The data selection (section 2.3) and the research scope (section 2.4) are also described. Finally, the research steps to be taken (section 2.5) are outlined and explained.

2.1 Epistemology and Theoretical Perspective

Epistemology provides a philosophical basis of what knowledge is legitimate (Crotty, 1998, p. 8). Crotty (1998, p. 3) describes the theory of knowledge as "how we know what we know" (p. 3) the epistemology for this thesis can be regarded as constructionism. In many theoretical perspectives constructionism, can be found, like symbolic interactionism (Crotty, 1998, p. 3). There is a need to construct the meaning, in contrary to the objectivist epistemology. The objectivist assumes that meaningful reality exists as such apart from the operation of any consciousness (Crotty, 1998, p. 8). The knowledge for this thesis will be constructed out of constructs existing in literature by suggesting a classification. Based on the constructivist epistemology, the theoretical perspective for this thesis can be assigned to the assumptions of the interpretive hermeneutics (Crotty, 1998, p. 5). The interpretative hermeneutics is a technique used in writing or speaking by interpreting textual meaning that divulge the intentions and context of the author (Smith et al., as cited in Callary et al., 2015, p. 63). This perspective is suitable for this study as it considers interpretation of textual meaning while it describes what humans experience rather than what they consciously know (Lopez & Willis, 2004, p. 726).

2.2 Methodology and Research Methods

Using the interpretative hermeneutics as the theoretical perspective for this thesis, the methodology applied is a qualitative literature analysis. For this purpose, a conventional content analysis as presented in Hsieh and Shannon (2005, p. 1279) is conducted. Hsieh and Shannon (2005) propose three different approaches to qualitative content analysis. Their first approach is a conventional qualitative content analysis. This approach seems to be appropriate for grounded theory development by directly and inductively deriving coding categories from the raw data materials. The second approach discussed in the paper is the directed content analysis. Here the initial coding is guided by a theory or relevant findings in research. The last approach, a summative content analysis, starts with the identification and quantification of content or words driven by the aim of understanding them in the contextual use. Due to the research aim of this thesis the content analysis approach to be conducted is the conventional qualitative content analysis (Hsieh & Shannon, 2005, p. 1279). The approach is suitable because prior research on CM and AM has already been done (p. 1281), but lacks a classification. Raw material data is read in order to derive codes from it accompanied by an initial analysis. As the process continues constantly, an initial coding scheme is developed to cluster meaningful group codes. Hsieh and Shannon (2005, p. 1279) point

out that a tree diagram can be developed during the analysis fitting for the classification. Additionally, theories and already existing research findings are addressed in the conventional qualitative content analysis. Furthermore, a constructive epistemology is chosen by seeking to construct meaning. The choice seems to be also appropriate for the investigation because it allows to apply the techniques described by Saldaña (2009). The chosen tequnique is the development of a coding scheme. The methods used for the coding scheme in this thesis are initial coding, supplemented by In Vivo and descriptive coding (first coding cycle methods) as also pattern coding (second coding cycle methods) (Saldaña 2009) for the theoretical part as illustrated in Figure 2.1. The first coding cycle method is about the identification of CM and AM examples in literature by using initial coding combined with In Vivo coding. Academic literature in the research area of CSCW and ECS is therefore analysed. Primary mechanisms identified through In Vivo coding are listed in a spreadsheet and are described with the help of further literature. The columns include a definition out of the Oxford and the Cambridge Dictionary, a general description of the mechanism and the literature were the mechanisms are identified. Additional columns that will be presented in separate spreadsheets are filled in too. These spreadsheets refer to chosen models and concepts that are selected out of chapter 3 and that are used to describe the mechanisms and their functionality in more detail. The spreadsheets should support the step of grouping and classifying the chosen mechanism in this thesis. In order to do so, descriptive coding is applied to identify commonalities within the raw data material. With respect to the first coding cycle, a second coding cycle method might be necessary to achieve a greater classification by applying the method of pattern coding. With pattern coding data material can be pulled together into a more meaningful content. The own conception is used then to classify the mechanisms. Indeed, the coding process is described in more detail when the tequnique is applied.

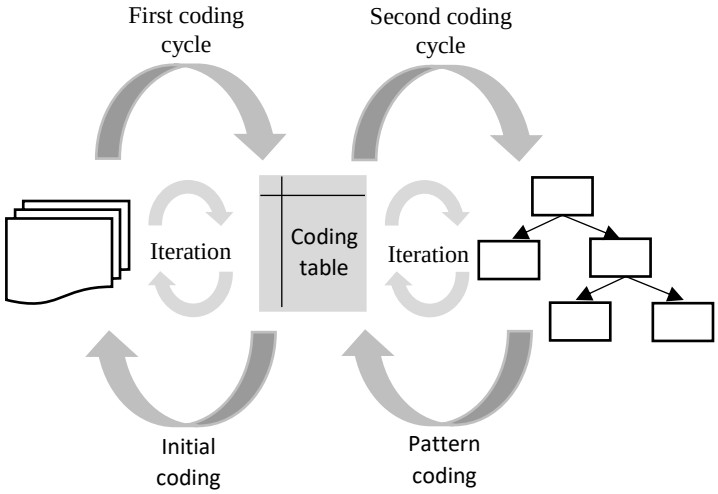

Figure 2.1: Coding cycles for classification (own illustration)

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Since a classification of chosen mechanisms is done, a small practical part is conducted by applying visual ethnography methods (c.f. Crotty, 1998, p. 5) to investigate CM and AM in IBM Connections at the University of Koblenz. The practical part deals with the comparison and identification of the classified mechanisms examined within this thesis. IBM Connections is investigated by taking screen shots, marking CM and AM and describing them in a short.

2.3 Data Collection

The study is initiated by analysing and reviewing academic literature. This includes journal articles, conference papers and books. The research aim, objectives and questions already defined in section 1.2 were elaborated on pre-reviewed academic literature of interests. The databases respectively, used are ResearchGate, ScienceDirect, SpringerLink, IEEE Xplore Digital Library, ACM Digital Library, JSTOR, and especially Google Scholar because of mostly free access.
As the terms of CM and AM are relatively well investigated in groupware and CSCW, following keywords were used for the search of relevant literature:

- “coordination mechanisms”, “awareness”, “awareness mechanisms”, “groupware”, “CSCW”, “collaborative work”, “workflow management”, “mechanism for cooperation”.

In contrast, “Enterprise Collaboration Systems” as a social-enabled system is a relatively new research area. Therefore, terms ECS broadly builds on are used for the literature research:

- “Enterprise Collaboration Systems”, “Enterprise 2.0”, “social software”, “web 2.0”, “collaboration 2.0”, “social business”, “collaborative software”, (“IBM Connections”).

2.4 Scope

As pointed out in the introduction, much research concerning CM and AM has already been done in the fields of CSCW and groupware whereas their role in social enabled ECS is less well understood. Therefore, this study has two focuses which will be combined and meshed during the investigation. On the one hand the theoretical part focuses on CSCW and groupware to collect basic information about CM and AM. On the other hand, the practical part focuses more on the area of social enabled ECS. For both parts, a broad literature review of papers is collected and organized with the free reference manager Citavi[1]. The investigation in the area of ECS is done only for the software of IBM Connections at the University of Koblenz. Reasons for choosing IBM Connections as the software to investigate is first, that according to Gartner (Gotta et al., 2015, p. 1) IBM Connections belongs to the leader segment in the ‘Magic Quadrant for Social Software in the Workplace’. Second, the accessibility at the University of Koblenz is given and frequently used in two research groups and their community for the “Oberseminar”. This circumstances give the opportunity to investigate social ECS software in a university environ-

[1] http://www.citavi.de/de/index.html (accessed on the 22.09.2016)

ment. To support the investigation, some models and concepts in literature are presented. Those concepts and models are the 3C-Model by Sauter et al. (Sauter et al., as cited in Koch, 2008a, p.419) in the groupware area, as the 8C-Modell elaborated by Williams (2011) to categorize Social Software features. Another framework appropriate to investigate awareness in IBM Connections is the 'workspace awareness framework' by Carl Gutwin and Saul Greenberg (Gutwin & Greenberg, 2002). Their first draft of the framework was exposed in 1995 were they were targeting to support awareness in small distributed teams using real-time synchronous shared groupware (Rittenbruch & McEwan, 2009, p. 19). These and additional models are described in more detail in chapter 3 and are for processing the investigation. The models and concepts are used for an in-depth analysis and to describe CM and AM in more detail. Additionaly they should be used for the coding process which is carried out in order to classify the mechanisms.

2.5 Research Steps

The following Figure 2.2 provides an overview of the research phases and steps which will be taken and the methods to be applied. The research is divided up into two parts, the theoretical and the practical part which are made up of different research steps. It begins with the main part, the analysis of academic literature, comprising the research phase one, and two. Each of the steps presented in the 4 different phases will be explained in the following:

Phase 1: Initialisation To define the research aims, objectives and questions the first phase, the initialisation phase, starts with a qualitative literature review and analysis of collected papers, articles and books which are organized in Citavi. The literature is reviewed and analysed in order to describe the motivation for this research and to develop the aim of this study. The initialisation and data collection phase used for the next phase and builds a basis for the whole thesis.

Phase 2: Identification

The next phase, the identification phase, builds on the initialisation phase. The first step includes the presentation of the results of a textual description of relevant terminologies. Based on a conventional qualitative content analysis it starts by clarifying the differences between the terminologies of CSCW, groupware, Enterprise Social Software (ESS), ECS, CM and AM, combination, coordination, communication and collaboration. Relevant models for this thesis are explained and related work is outlined. The next step, the collection and classification of CM and AM, is done with developing a coding scheme. Saldaña (2009) suggests two coding cycles, a first coding cycle and a second coding cycle. For this purpose, initial coding, incorporating In Vivo and descriptive coding (c.f. Saldaña, 2009, p. 81) (first coding cycle methods) and pattern coding (second coding cycle method) is used. As a first coding cycle, according to Saldaña (2009, pp. 81-82), initial coding is appropriate for a wide variety of diverse data forms like, journals or documents and is commonly used by qualitative researchers at the beginning to select data. It also includes codes that may have to be reworded during continuing analysis. Therefore, all academic research papers are carefully read and descriptions for CM and AM are identified by employing In Vivo coding. Descriptive coding is applied were text units are considered relevant for coding as it

assists in analysing the data's basic topics by using the content as a substance of the message code. According to Saldaña (2009, p. 70), descriptive coding is appropriate to formulate basic vocabulary that can be used to classify the mechanisms.

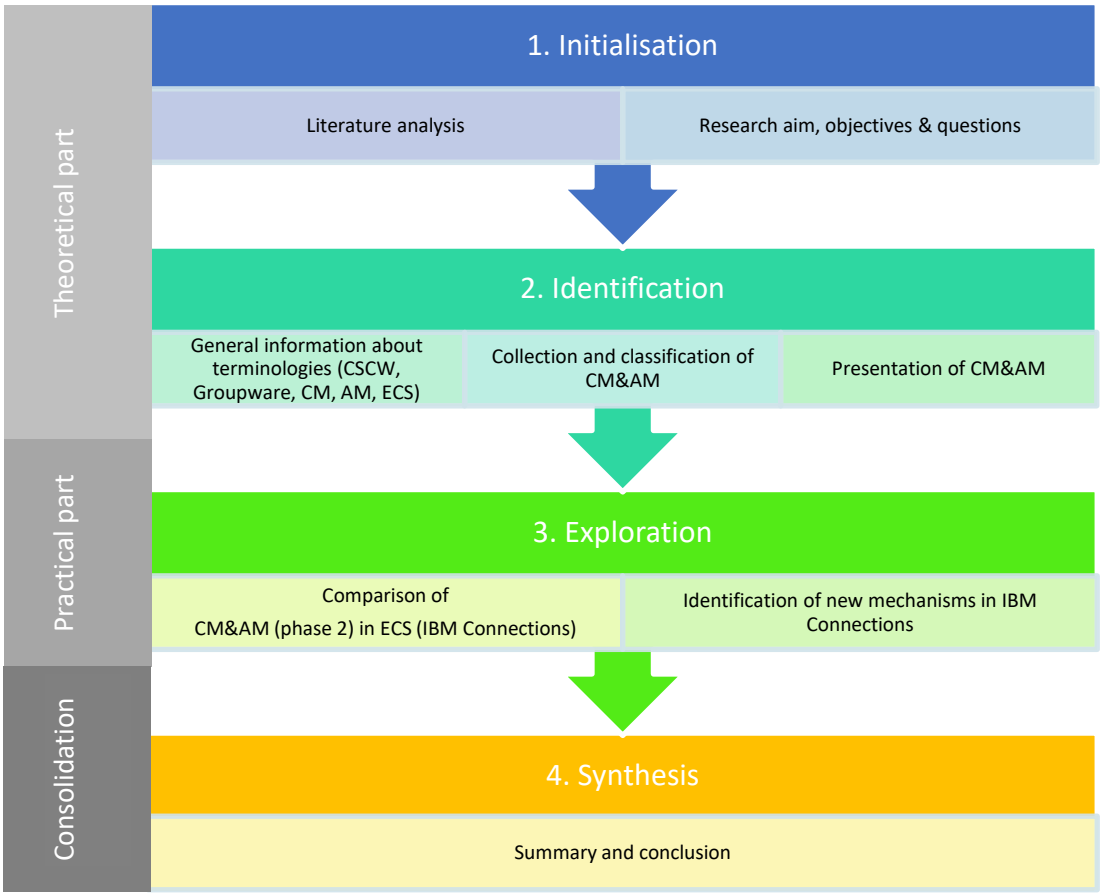

Figure 2.2: Research steps (own illustration)

Hence the first coding cycle builds the basis for the second coding cycle which is about the reorganisation the first cycle data (Saldaña, 2009, p. 149). For the second coding cycle, the method pattern coding is selected. The method is useful to examine the initial developed descriptions and to attribute meaning to them (Saldaña, 2009, pp. 150). Pattern coding is suitable for the classification of CM and AM. In order to do so, descriptive codes from the first coding cycle methods that assemble are gathered together into a more meaningful unit of analysis. Comparing the similar codes by applying pattern coding, data for classification is derived. The mechanism classification is portrayed in a tree structure that is accompanied by a description of the commonalities of the mechanisms and the classification category. For illustration purpose, some classification categories that are considered the most to convey the usage of CM and AM are visualised as a component and process model. This step presents the third step in phase two.

Phase 3: Exploration

Based on the theoretical research which is done in the two previous phases, the third phase introduces the practical part of this study. The identified CM and AM from the second phase are checked and compared in social enabled ECS and are carried out in IBM Connections. This follows a content analysis using visual ethnography methods (c.f. Crotty, 1998, p. 5) to investigate CM and AM in IBM Connections at the University of Koblenz. The Social Software IBM Connections[2] is chosen for this thesis due to the accessibility. I.e. the community of the "Oberseminar" from the research group "Forschungsgruppe Betriebliche Anwendungssysteme" (FGBAS) and of the research group "Forschungsgruppe Enterprise Information Management" (FGEIM) is used as an example for checking classified mechanism of phase two. The focus for the visualisation lies on representing the transferred mechanisms that are examined during the continuously process in this thesis by taking screen shots of respective mechanisms. Within the investigation it is expected to identify new forms of CM and AM in ECS elaborated and applied by users of IBM Connections as it was already pointed out in the motivation and problem statement. New mechanisms applied are expected due to the social enabled context of ECS.

Phase 4: Consolidation/ Synthesis

In the last phase the findings of the theoretical and practical part are merged and consolidated. Based on that suggestions for improvement in terms of the development of CM and AM in ECS are derived. The findings should lead to a better understanding of CM and AM characteristics by providing a fisrt overview and a classification. Additionally, the findings should give incentive for future research to investigate CM and AM in social enabled ECS in order to elaborate improvements of reducing collaborative work in ECS by boosting their investigation at the same time.

[2] http://www-03.ibm.com/software/products/de/conn (accessed on the 22.09.2016)

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3 Clarification of Terminologies

Chapter 3 gives the reader an overview of the historical background and development of CSCW, CM and AM as well as ECS. This phase presents the first research step in the second research phase (identification). The section starts with the development of the classical field of CSCW and groupware by going over to new forms of social enabled ECS. It will be outlined how the technological development and the emergence of the Web 2.0 did influences the communication and coordination in cooperative work environments.

3.1 CSCW and Groupware

"Computer Supported Cooperative Work" or "CSCW" is today an established research area and well beyond its first quarter century of existence and represents a milestone (Schmidt & Bannon, 2013, p. 345). The emergence of the personal computer and its usage led over some time to the idea not only to use it for the processing of data, but also to work collaboratively (Borghoff & Schlichter, 2000, p. 88). The roots of the terminology of CSCW can be traced back to the early 1980s. The term CSCW was formed in the mid-1980s by Paul Cashman and Irene Greif (c.f. Bannon, 1993, p. 4; Grudin, 1994, p. 19; Penichet et al., 2007, p. 237; Koch, 2008a, p. 417; Schmidt & Bannon, 2013, p. 346; Gross, 2013, p. 425) where they organized a multidisciplinary workshop in order to help people working together by using "Information Technology" (IT). The workshop took place in 1984 in Massachusetts, Endicott House, where participants from different disciplines came together to exchange their ideas and results about using IT for supporting for collaborative work (Koch, 2008a, p. 417). Since then, CSCW researchers began to gain a greater understanding of collaborations by developing and testing several technologies supporting communication, collaboration and cooperative work. According to Ellis et al. (1991, p. 39) the term of CSCW that is about looking on how computers can support groups in working and seeking together. Hence the development and integration of computers over the last years have been adjusted for coordination purpose and cooperative work (Schmidt, 2011, p. vii; Gross, 2013, p. 425). During the further research in the area of CSCW the importance of coordination theory (Malone & Crowston, 1990, pp. 87-88), awareness (Dourish & Bellotti, 1992) and coexistence for successful operational work was exposed (Koch, 2008a, p. 417). Some focus of work in CSCW was to gain a better understanding of social interactions in groups and communities by using adequate technology (Gross, 2013, p. 425). This led to the development of models for understanding different modes of communication among groups and their social interaction. In this context, five different forms of social interaction were exposed concerning communication, coordination, coexistence, consensus and collaboration (c.f. Koch, 2008c, p. 39). The most important of these terms will be explained in more detail in section 3.5, where the core elements of the 8C-Model by Willliams (2011) are explained. To give an example of modes of communication, the people/artifact framework by Dix et al. (1993) (c.f. Koch, 2008a, p. 417) was developed. The model explains the functional relationship between group members and the tools to support their collaboration (Koch, 2008a, p. 417). Such computer systems supporting collaboration in groups are often referred to

as “groupware” (Koch, 2008a, p. 417; Koch, 2008c, p. 40) which presents another research field included in the broad area of CSCW (Grudin, 1994, p. 19; Wainer & Barsottini, 2007, p. 28; Penichet et al., 2007, p. 238). First, it should beemphazised that the umbrella label of CSCW during its development created five different point of views as Bannon (1993) predict. The first view is *“CSCW as simply a loose agglomeration of cooperating and at times competing communities”* (p. 9). Here, different groups of people are more interested in building tools by regarding CSCSW as the possibility to leverage a point for creating novel applications. As the focus here lays on the development of new software applications, most people equate the CSCW field with groupware. It also focuses on communities with shared and competing interests. The second view is “*CSCW as a paradigm shift*” (p. 10) where the designing of computer support systems of all kinds should be focused. This is in accordance with Suchman (Suchman, as cited in Bannon, 1993, p. 10) where she predicts that CSCW is “. . . the design of computer-based technologies with explicit concern for the socially organized practices of their intended users.”. The third view is *“CSCW as technological support of cooperative work forms”* (p. 11). The emphasis here lies on the understanding of cooperative work as a distinctive form of work which is supported appropriate technology. *“CSCW as Participative Design”* (p. 11) is the fourth view according to Bannon (1993). The ‘Participative Design’ (PD) is about exploring conditions for participation of users in the design of computer based systems at their work (Kensing & Blomberg, 1998, p. 167) overlapping with CSCW and thus leading to confusion in both fields (Bannon, 1993, p. 11). The last view is *“CSCW as software for groups”* (p. 10). This form leads to the term groupware focusing on small teams with convivial work relations (Bannon, 1993, p. 10).

As already mentioned above, groupware are computer systems supporting collaboration among groups. Koch (2008a, p. 419) points out that CSCW is not only about understanding how collaboration works. It is also about shaping socio-technical systems which are fostering and supporting this collaborative work by means of technology that can be referred to as groupware. Hence groupware represents the use of computers as a medium to communicate and to collaborate (Koch, 2008a, p. 419). Groupware, firstly used by Peter and Trudy Johnson-Lenz, is about social group processes using computational systems as support (c.f. Ellis, 1991, p. 18; Gross, 2013, p. 425; Penichet et al., 2007, p. 237). It is more about the technology supporting collaboration, communication and coordination for people having a common goal (Babar et al., 2006, p. 914). Contrary to CSCW it is more about the research of those technologies (Grudin, 1994, p. 20; Penichet et al. 2007, p. 238) characterized by coordination, communication and information sharing (Penichet et al., 2007, p. 240). Ellis et al. (1991, p. 40) define groupware as “computer-based systems that support groups of people engaged in a common task (or goal) and that provide an interface to a shared environment” making the user aware that they are a part of a group (Lynch et al., 1990, p. 160; Gross, 2013, p. 425). By providing awareness, groupware attempts to reduce isolation from actors by assisting in the actors’ activities (Koch, 2008a, p. 419). Groupware can be referred as to a software applied in multiple user environments to coordinate activities so that everybody else can see it, too (Koch, 2008a, p. 419). Usually they contain a diverse set of tools, like e-mail, calendar and video conferencing (Ellis et al., 1991, p. 53). To be able to classify workplace collaboration in the research area of CSCW and groupware systems a lot of effort has already been undertaken (cf. Ellis et al., 1991, p. 34;

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Williams, 2011, p. 12). The '3C-Modell' of Sauter et al. (Sauter et al., as cited in Koch, 2008a, p. 419) builds one foundation. In the 3C-Modell, illustrated in Figure 3.1, three key areas of interaction were identified to support groupware functionalities. Within this key areas, the positioning of diverse applications supporting collaboration among groupwork is illustrated. Babar et al. (2006, p. 914) have pointed out that groupware applications, like audio video conferencing tools or e-mails, support planning activities and problem solving among organizations increasing efficiency. Furthermore, groupware applications have been proven to be effective in resource planning by minimising the inter-activity delays and intervals. Another attempt to classify groupware systems, even if it is a simplification, was elaborated by Johansen in the 1988s with his time andspace matrix (Penichet et al., 2007, p. 239) building the basis for further classification attempts in groupware.

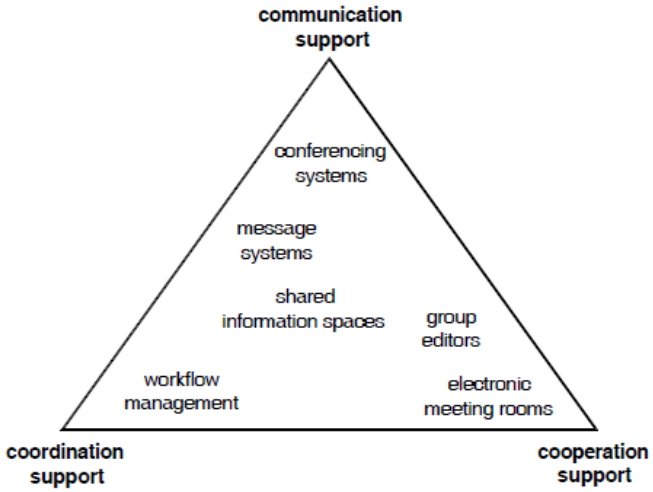

Figure 3.1: The 3C-Modell of Sauter et al. (1994), adapted from Koch (2008a, p. 419)

Figure 3.2 illustrates the interaction between human and computer. The left column concerns the dimension of space. Hence a computer-human interaction can take place at the same place, like in meeting rooms, or in distributed places like a videoconferencing room. The upper row concerns the dimension of time where interaction can take place at the same time, for example in IP-telephony, or the time is different, like in e-mailing. This simple groupware classification of four types can be done and will be considered in this work when CM and AM are analysed. Since today's applications are

	Same Time	Different Time
Same place	Face to face interaction	Asynchronous interaction
Different place	Synchronous distributed interaction	Asynchronous distributed interaction

Figure 3.2: Johansen's time and space matrix (adapted from Penichet et al., 2007, p. 239)

getting more and more complex, the time and space matrix of Johansen seems to be no more appropriate (Penichet et al., 2007, pp. 239-240). Grudin (1994, p. 25) extended the time and space matrix by the new characteristic of the actors' knowledge bearing in mind the predictability of situations. A further extension to classify groupware was elaborated by Andriessen (Andriessen, as cited in Penichet et al., 2007, p. 239) who elaborated five possible groups of processes in Information and Communication Technology ("ICT") which are divided up into three main processes:

- Processes that are orienting to groups and regarding social interactions.
- Processes for person interchange by regarding communication.
- Processes that are task oriented regarding coordination, cooperation and information sharing.

However, beside the research advances made since 1968, Greenberg (2003, p. 1) argues that groupware hasn't brought many changes to daily work life since programmers are faced with technical problems in designing groupware and prototyping (c.f. Bentley et al., 1997a, p. 1). This statement can be underlined with the findings of Wainer and Barsottini (2007, p. 34) claiming that in research in CSCW a decrease of empirical reports can be observed. Schmidt and Bannon (2013, p. 425) stated that the emergence of CSCW was possible because researchers engaged with the development and use of different technologies and applications on work were faced with related problems and then tried to explore and articulate these problems. However, a core characteristic of groupware is to break the isolation of users by providing likability and connect ability for them and making them aware of the work of others (Koch, 2008a, p. 419). Hence, the large body of work experience in CSCW and groupware can be used in the organizational and social aspects of setting to support communication and cooperation in enterprises by using the World Wide Web (Bentley et al., 1997a, p. 1). "The World Wide Web, initially launched in December 1989 […]" (Schmidt & Bannon, 2013, p. 347) became a platform for facilitating interaction and communication for billions of users and providing now an infrastructure for collaborative technologies. Building on this infrastructure, the emergence of diverse technologies was possible. Among them 'Social Media' (Schmidt & Bannon, 2013, p. 347). Koch (2008a, pp. 424-425) stated that the experiences of CSCW research and the application of the World Wide Web can lead to contribution of the usage of Social Software in enterprises. This seems to be interesting since Social Software is increasingly being applied in companies (Koch, 2008a, p. 416).

3.2 Emergence of the Web 2.0

The concept of "Social Media" originates with platforms containing profiles used in a social context, chats or file sharing tools. Hence, they are used voluntarily by people in their free time by providing "Social Software" functionalities which support social interchanges and interactions (Diehl et al., 2013, p. 237; Schubert & Williams, 2013, p. 223), like for example "Facebook" (Williams et al., 2013, p. 252). The emergence of those applications was supported by the emergence of the Web 2.0 which allows users to facilitate direct or indirect communication among themselves (Richter & Koch, 2007, p. 7; Koch, 2008b). The term Web 2.0 can be traced back to the Web 2.0 Conference of 2004 (c.f. O'Reilly, 2007, p.

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17; Richter & Koch, 2007, p. 4; Williams et al., 2013, p. 251) where the term was used to describe emerging capabilities of the web as a collaboration platform. Special about the Web 2.0 is that the user in no longer regarded as a consumer, but rather a designer providing his own content (Richter & Koch, 2007, p. 4). One example is the project of 'Wikipedia', an open community where the producer is consumer at the same time, hence a 'prosumer' (Klamma et al., 2007, p. 72). This leads automatically to a higher communication through the Internet (Richter & Koch, 2007, p. 6). As O'Reilly defines the Web 2.0 himself:

> *Web 2.0 is the business revolution in the computer industry caused by the move to the internet as platform, and an attempt to understand the rules for success on that new platform. Chief among those rules is this: Build applications that harness network effects to get better the more people use them. (This is what I've elsewhere called "harnessing collective intelligence." (*O'Reilly, 2006)

Some basic concepts to meet participation of most users as possible by avoiding limitations of organisation, processes and technologies are (Koch, 2008c, p. 50):

> The *usability* of the services which are realizable through web-based services and interactivity should be easy and understandable to reach high voluntary participation, thus every user can contribute his information (Koch et al., 2007, p. 448; Koch, 2008c, p. 50).
>
> The *'me'-centricity* which provides the core of Web 2.0. That means that every application has to yield a benefit for each user (intrinsic motivation) standing in contrast to the values defined by the benefit for communities (Koch et al., 2007, p. 448, Koch, 2008c, p. 50).

However, applications in the Web 2.0 were already available some years ago, for instance through "Really Simple Syndication" (RSS) feeds, blogs and Wikipedia for information sharing (Richter & Koch, 2007, p. 4; Williams et al., 2013, p. 252). As Richter and Koch (2007, p. 5) predict, the Web 2.0 is a combination of new forms of technologies, applications, social movements and business models. This combination provided the possibility for the emergence of Social Media platforms, like Twitter, Flickr, Facebook and co. (Williams et al., 2013, p. 252) for private use.

3.3 Social Media in Groupware

This new form of social communication among the Web 2.0 was also remarked by enterprises seeing the potential in the flexible and ad hoc information exchange through the Web 2.0 (Nedbal et al., 2013, p. 677). The use of Web 2.0 technologies in enterprises is referred to as "Enterprise 2.0" (E2.0) by McAfee (2006, p. 23). Alternatively, the term "Social Business" was later adapted by IBM describing the use of Social Media in enterprises (Schubert & Williams, 2013, p. 224). The conceptualisation of Social Media is through platforms for social profiles and personal pinboards, file sharing tools, chat or microblogging. Those platforms are used by people voluntarily in their free time to chat, exchange ideas and to share information among them. For instance, it provides software functionality which is also referred to as "Social Software" to support social interaction and interchange (Diehl et al., 2013, p. 237; Schubert & Williams, 2013, p. 223). To characterize Social Software, some application classes can be

used which are illustrated in the Social Software triangle of Koch (2008a, p. 422) in Figure 3.3. The classes concern forinstance, wikis and group editors, social networking etc.

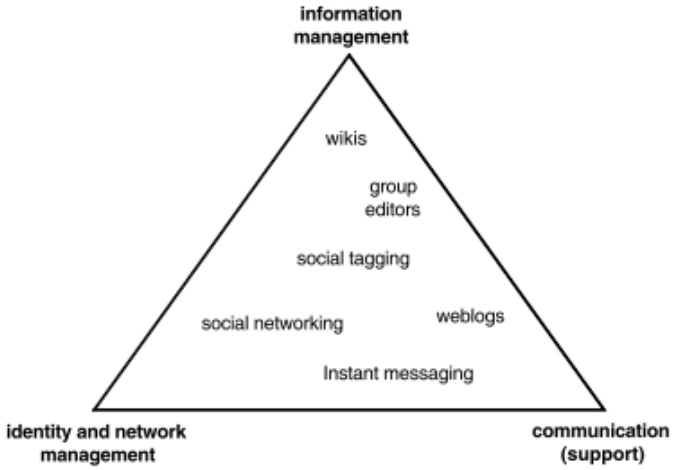

Figure 3.3: The classification of Social Software arranged in a triangle (adapted from Koch, 2008a, p. 422)

Following the characteristics of Social Software, those Social Software features can be categorised into the 4Cs', the core of the 8C-Model for Enterprise Information Management (Williams, 2011) (c.f. Figure 3.5). As Koch (2008b) describes in his paper, Social Software (Figure 3.3) provides the possibility to make tacit knowledge and best practice in enterprises available and to make this software work. McAfee (2006, pp. 26-27) names four requirements, these are: "A Common Platform", "A Receptive Culture", "An Informal Rollout", and "Managerial Support". Over time some other terminologies describing the integration of Social Software in enterprises is "Enterprise Social Software" (ESS). The term is used to describe an application of Web 2.0 which is behind-the-firewall technologies, for example IBM Connections (Williams et al., 2013, p. 252). IBM Connections for instance, integrates collaborative systems with multiple Social Software functionalities (Schubert & Williams, 2013, p.224). This allows for the restriction of unauthorized access (Richter & Stocker, 2011, n.p.). Several companies had the idea to protect their confidential business information by employing comparable technology as provided in Social Software applications (Diehl et al. 2013, p. 237). Hence, social interactions in enterprises are also supported by using Social Media tools like chats, pinboards or file sharing tools, but having controlled access (Diehl et al., 2013, p. 237).

In the classical field of CSCW, the integration of Social-Media features has also been referred to as "Social Business Software", "Enterprise Social Networks" (ESN), "Enterprise Social Software" (ESS) (Schubert & Glitsch, 2016, p. 44) or synonymously as "Enterprise Collaboration Systems" (ECS) (Diehl et al., 2013, p. 237; Schubert & Glitsch, 2016, p. 44). Indeed, the term "social"' can be regarded as 'friendly

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companionship' (Schubert & Williams, 2013, p. 224). And this social functionality in the software might be the new and interesting aspect in ESS.

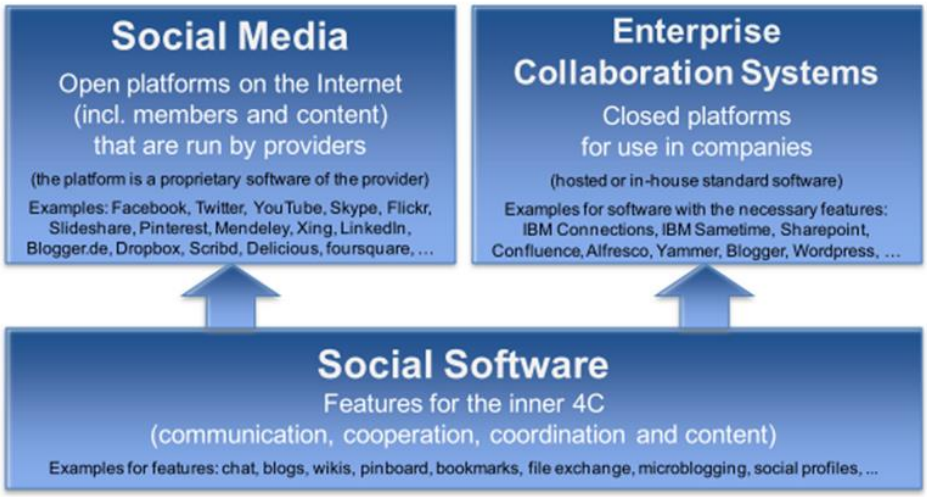

Figure 3.4: Differentiation between Social Media and ECS (adapted from Schubert & Williams, 2013, p. 225)

3.4 Traditional and Social Enabled Groupware

To carve out some differences between traditional and new social enabled ECS, Koch (2008a, pp. 422-424) was the first putting effort in this clarification. He points out that CSCW and Social Software can benefit from each other by taking a closer look in the newer Social Software field. This is because Social Software applications are extending in company support (Koch 2008a, p. 416). ECS, as a combination of groupware and Social Software, can be described by voluntary participation, a large number of users, self-oriented communication, coevolved conventions and no project limitations, having in mind that groupware tools have long been built only with processes and algorithms. The special phenomena in Social Software is the 'user generated content' (Koch, 2008b). In contrast, Koch (2008a) describes groupware as group-oriented communication and enforced participation, a small number of users having a limited time-period and pre-planned ways of working together. Schubert and Glitsch (2016, p. 44) state that ECS in traditional CSCW support employers in their daily work. The new form of social enabled software used for collaborations is emergence. The incorporating of social software functionalities in traditional ECS lead to support of collaborations between people (Schubert & Glitsch, 2015, p 162). However, companies embracing ECS can learn from insights provided in CSCW literature. Both areas aiming to deliver value in collaboration. Moreover, investigations have shown that is not sufficient to study only people in the way they use the technology, but also to test the developed solutions (Koch et al., 2015).

3.5 Enterprise Collaboration Systems (ECS)

The integration of ESS into the classical groupware area is described as ECS, as the usage of Enterprise 2.0 seems no more meaningful (c.f. Schubert & Williams, 2013, p. 224). To build an ECS, the combination of classical groupware functions, like group calendars, and ESS is therefore fundamental (Williams & Schubert, 2015, p. 1). Hence, ECS can be regarded as enriched groupware function benefitting from the newest development in technologies (Schubert & Williams, 2013, p. 224). Even if both areas, Social Media and ECS are supplemented with Social Software, there exist a difference between ECS and Social Media (c.f. Figure 3.4). While ESS or ECS are platforms with limited access and are in-house software or are hosted, Social Media are open platforms accessible in the Internet run by providers but are both liked to Social Software.

Generally, the emergence of ECS can be traced back to the year 2005 when Social Media platforms were becoming popular. First it was used only for private practise but was soon adapted in business (Schubert & Glitsch, 2016, p. 44). Williams and Schubert (2015, p. 1) stated that in the last twenty years ECS has been successfully used in organizations and that ECS is more and more integrated into every day work (Hausmann & Williams, 2015, p. 361). The business value which can be delivered by ECS is to facilitate communication and exchange of information within an organization (Williams & Schubert, 2015, p. 1).

The extension of groupware with Social Software technologies led also to the extension of the 3C-Model of Sauter et al. (Sauter et al., as cited in Koch, 2008a, p. 419) to the 8C-Model elaborated by Williams (2011, p. 12). This model can be applied to categorize Social Software features to analyse and evaluate collaborative and groupware technologies focusing on combination, communication, cooperation and coordination in business processes. The outer 4C's concerning the extension to the management area (Williams, 2011, p. 16). The inner 4 core functionalities of the 8C-Model in Figure 3.5 are regarded as indirect or direct interpersonal interactions emerged due to the new development of technologies in the Internet. They are also referred to as Social Software (Koch et al., 2007, pp. 448-449). These functionalities are described in brief to clarify their context in ECS starting with combination.

Combination:
Especially content combination present a core functionality in collaborative tools as they have to be manged somehow, like e-mails or collaborative documents. The focus lies here on the facilitation of organizing digital content (Williams, 2011, p. 15) by means of different methods, functions or tools to improve the search of information. One example is the creation of metadata and the tagging of information.

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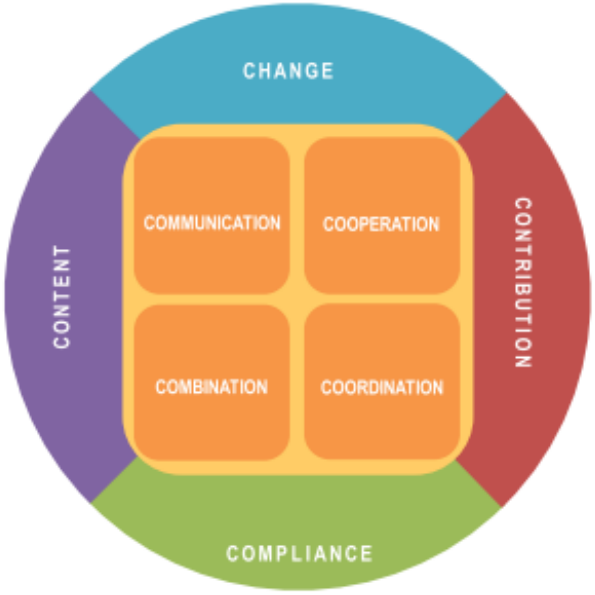

Figure 3.5: 8C-Modell in the context of ECS (adapted from Williams, 2011, p. 12)

Communication:

It is important for information exchange, especially between people. Communication can take action in a direct way (e.g. via Skype) or indirect (e.g. via e-mail). The space and time matrix by Johansen (c.f. Figure 3.2) can be used in this context. Communication can take place in time (synchronous/asynchronous) and space (same/distributed). It must be considered that the communication relations (one-to-one: one-to-many), directions (uni- bi- or multi-directional) and medium (text, picture, video etc.) can differ (Williams, 2011, p. 13). Cook (2008, p. 37) describes communication platforms as platforms that allow people to communicate with text, video or other combination s together.

Collaboration/Cooperation:

Collaboration takes place between more than two people in order to reach one aim defined. The focus lies on the tools and functions which are used to work in collaboration. It is not only about communication, but more about defined relation on collaborative work (Williams, 2011, p. 14). Cook (2008, p. 37) describes collaboration as a tool that gives users the possibility to collaborate during problems in an in-/direct way. Furthermore, successful collaboration depends on awareness (Rittenbruch & McEwan, 2009). Cooperation resembles to collaboration as it involves also people and users, respectively. Software for cooperation allows users to share their content in an unstructured or structured way (Cook, 2008, p. 37). Williams (2011, p.14) points out that in contrast to collaboration the relation between the user is not so well defined as it considers also the division of labour.

Coordination:

It is the orchestration of workflows, processes and actions. In this context, coordination is necessary for the tasks and the access to resources for the management (e.g. the reservation of a meeting room). The

term coordination is used to refer to tools or activities supporting workflows and other processes (e.g. reminder). This can also include ad hoc processes. One example for a coordination tool is appointment planning in one common calendar, likewise the distribution of workspace awareness which supports implicitly the attention to the work of others (Williams, 2011, p. 14).

3.6 Notation of Coordination

To return to coordination of the 8C-Model by Williams (2011), Malone and Crowston (1994) have already pointed out that the term of coordination is difficult to define due to the high variety of starting point for concept in this interdisciplinary area (p. 90). According to Crowston et al. (2006, p. 125) many definitions for coordination have been proposed in literature. The most appropriate definition of coordination for this investigation can be found in "Coordination Theory" (CT) elaborated by Malone and Crowston (1990). In CT, the authors define coordination as *"the act of managing interdependencies between activities performed to achieve a goal"* (Malone & Crowston, 1990, p. 361) and that *"Coordination is managing dependencies"* (Malone & Crowston, 1994, p. 90). CT (c.f. Malone & Crowston, 1990; Malone & Crowston, 1994) investigates how people coordinate their work and how coordination occurs in new forms of technology, like in groupware by regarding interdependencies describing a resource (flow, fit and share) and a temporal process. Interdependencies can be first, *prerequisite by* meaning that an output of an activity is required by a following activity. Second, a *shared resource* describes a resource that can be required by multiple activities. Third, *simultaneity* describes that at one time more than one activity can occur (Malone & Crowston, 1990). Regarding the latter definition, the management of dependencies in CT according to Malone and Crowston (1994, pp. 92-97) defines coordination as the effective management of dependencies among tasks/subtasks, simultaneity constraints, resources and people (producer/consumer).

For illustration purpose the first definition of Malone and Crowston is explained with the example of a basketball match. It is when the basketball team (actors), which members are interdependent (interdependency), coordinate their tactics (activity) in order to win the match (goal). By regarding the example, it gets clear that coordination is composed of four components interacting together (Malone & Crowston, 1990) which are illustrated in the Figure 3.6.

Rogers (1992, p. 296) predicts that interdependencies among activities can be referred to as "common objects" (c.f. Malone & Crowston, 1990). In CSCW the notation of common objects is often created by people mediating cooperative work using the same object at different times, in different groups for different purpose.

In a more dynamic way to characterize interdependencies between actions is the consideration of "mediating mechanisms" (Rogers, 1992, p. 296). Mediating mechanisms present a combination of first, "explicit representations". This occurs when specific information about a current status of artifact and actions constituting the work are provided. Second, "implicit representations" when a form of action signifies a change made to a current status of an object (Rogers, 1992, p. 296). Hence, when changes occur

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in in a work setting, the mediating mechanisms often need to be re-aligned, as the common object too. That's why coordination in collaborative work is important.

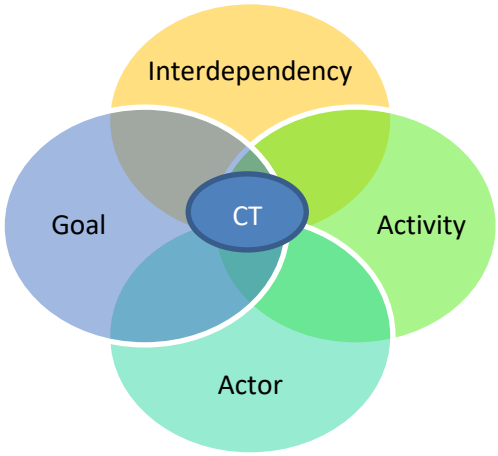

Figure 3.6: Four components of coordination in CT (own illustration)

The question of how people continuously coordinate their interdependent activities during collaborative work was investigated by Bardram (2000, p. 163) who examined three distinct types of "temporal coordination". "*Communicative", "scripted*" and *"instrumental" coordination (*Bardram, 2000, p. 165).

To clarify now the term of temporal coordination Bardram defines it as following:

> *"Temporal Coordination is an activity with the objective to ensure that the distributed actions realising a collaborative activity takes place at an appropriate time, both in relation to the activity's other actions and in relation to other relevant sets of neighbour activities. Temporal coordination is mediated by temporal coordination artefacts and is shaped according to the temporal conditions of the collaborative activity and its surrounding socio-cultural context." (Bardram, 2000, p. 163)*

He distinguishes temporal coordination into three parts. Starting with the description on temporal coordination as an "activity" which can be fulfilled "intrinsically" or "extrinsically". The latter one refers to coordination which is organised more from the outside. McGrath (McGrath, as cited in Bardram, 2000, p. 163) identified three levels of collaborative work situation which are referred to 'macro-temporal levels'. First, the "scheduling" (temporal plan creation by setting up temporal goals), secondly "synchronisation" (e.g. ad hoc effort) and "allocation" (resource assignment to overall aim of collaborative work. Contrasting to the extrinsic coordination, the intrinsic coordination can be regarded as a kind of self-organisation of an actor: More generally, it refers to collaborating group sharing the same goal. Second, also temporal coordination is mediated by artifacts, for example the clock of a calendar, or more by a start end ending time. The third part refers to the act that temporal coordination is shaped by conditions of its object and the social environment (Bardram, 2000, p. 165).

Communicative coordination: Communicative coordination of collaboration takes place for example through symbol, iconic and conceptual communication (Borchorst & Bødker, 2011, p. 176). Previous study of the London Underground Railway Control (c.f. Heath & Luff, 1991) has shown how the integration of signs were used to mediate the coordination work. Hence, communicative action or semiotic resources (c.f. Tenenberg et al., 2016) are used to mediate the coordination work, often in combination with devices. In the study of Bardram the telephone was an important device used as an artifact (Bardram, 2000, p. 165). Actors can discuss how they want to continue with their work, e.g. for continuous synchronisation by using a communication device which can be a telephone or a paper.

Instrumental coordination: Instrumental coordination means that coordination according to what other actors do is key, hence supporting awareness of the work of others. It is serving as means of pursuing an overall objective. The example of Bardram (2000, p. 166) provided a situation where the actors involved can coordinate their work by looking at the work of their colleagues, using a common object of work, a wallboard. In the CSCW literature several examples of studies revealing how people coordinate their work by providing awareness to the work of others to avoid redundant work, for example in software testing (Andersen et al., 2002) the shared editor (Dourish & Bellotti, 1992) or the shared intentionality (Tenenberg et al., 2016) by shifting from "I-Awareness" to "We-Awareness". In the study of Tenenberg et al. (2016) collaborative work is also possible among gesturing when working on the same software project and the single monitor without interrupting the workflow.

Scripted coordination: Scripted coordination makes use of a script for action to coordinate the distributed activities. The script normally is predefined in a written character used to give instructions to carry out some tasks in a specific order. That means each actor can look up the timing of the distributed collaborative activity and hence can coordinate his work according to this script. Bardram (2000, p. 167) provide an example in a hospital to describe scripted coordination. According to him, a plan specifies where patients should be operated, what the operation sequence is, which surgeons are involved etc., and finally this plan is presented publicly to the employees at the hospital. As long everything follows its order and there is no interruption, it can be used to coordinate the work which is distributed in space and time. But every employee is able to coordinate his work in accordance to the plan used to schedule the work. However, when an unforeseen situation takes place, like illness among the staff or complications during an operation, the plan must be changed in order to maintain it as a mediator for a script (Bardram, 2000, p. 167). Therefore, the plan has to be malleable. The term of malleability is described in more detail in section 3.8.3.

3.7 Cooperative Work and Articulation of Work

As already pointed out in the background of CSCW, this research area addresses questions like: What requirements can support cooperative work? How can IT support this cooperative work arrangements (c.f. Schmidt & Bannon, 1992, p. 48). Bentley et al. (1997b, p. 827) suggest also that with the emergence of the World Wide Web there are more and more reasons for, and there is increasingly the necessity of supporting collaborative and cooperative work. The term 'cooperation' (Malone & Crowston 1994, p.

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90) can be used to manage dependencies between people and activities. Artman and Garbis (1998) for instance propose that situated cooperation is conceptualized out of coordination and communication. A definition by Marx (Marx, as cited in Schmidt & Bannon, 1992, p. 50) for cooperation is “multiple individuals working together in a conscious way in the same production process or in different but connected production processes.” To define collaborative work, Schmidt and Simone (1996, p. 158) propose that it is constituted by multiple and interdependent actors who are distributed in time, space and different circumstances, thus there is the need to restrain the complexity of interdependent activities. This complexity of interdependent activities need to be meshed, aligned, integrated, coordinated etc., in a short “articulated” in a way which is referred to as the “articulation work” by Schmidt and Simone (1996, p. 158). For example, a “Configuration Management System” can support the articulation of work. As the support is done electronically, it can be regarded as a type of groupware (Grinter, 1996, p. 450). With the term “articulation work” the description of further interaction engaged by actors which is necessary to achieve coordination, composed of dynamic activities and formal procedures, can be noted (Symon et al., 1996, p. 2). Schmidt (2002) describes it as “Articulation work is work to make work work. Or to be exact, articulation work is cooperative work to make cooperative work work.” (Schmidt, 2002, p. 184). Strauss (1988, p. 164) provides a distinction between two different types of articulation work. The first type is referred to as local articulation or only articulation in a way that local tasks and resources are connected to ensure availability in specific circumstances (Strauss, 1988, p. 164; Gerson, 2008, p. 196). The second type is the specified work to be done on a high level, which is also referred to as *metawork* by Gerson (2008, p. 196). This distinction can be helpful when it comes to the analysis of multiple organization (Gerson, 2008, p. 197). But what does articulation in a general context mean? In the literature, it is variously described as scheduling, aligning, integrating, meshing and so on of interdependent activities. In order to do so, some special artifacts are necessary (Tellioğlu, 2010, p. 2). With the application of those artifacts, the articulation of individual activities can be synchronized with the activity of other individuals to reach a shared goal (Artman & Garbis, 1998). Moving in the area of CSCW Schmidt and Bannon (1992, p. 56) described articulation work as the following: "However in 'real world' cooperative work settings- [...] the various forms of everyday social interaction are quite insufficient. Hence articulation work becomes extremely complex and demanding. In these settings, people apply various mechanisms of interaction so as to reduce the complexity and, hence, the overhead cost of articulation work”. These “mechanism of interaction” (Schmidt & Rodden, 1996, p. 162; Schmidt & Simone, 1996, p. 162) can be protocols, plans, formal structures, procedures, and classification schemes. By applying such mechanism in high complex articulation and collaborative work arrangements the complexity of articulating cooperative work can be reduced (Schmidt & Bannon, 1992, p. 56). Those mechanisms are also referred to as “artifacts” (Schmidt & Rodden, 1996, p. 162; Schmidt & Simone, 1996, p. 162). The artifacts, that are a set of procedures and conventions in a context, mediating and stipulating articulation work, are called “coordination mechanisms” (Simone et al., 1995, p. 44) CM.

3.8 Notation of Coordination Mechanisms

The aim of the usage of a CM is the support of coordinated activities in computer systems, using common practices, strategies and artifacts. Holt (Holt, as cited in Schmidt & Simone, 1996, p. 155) describes a CM in short as: “The new capabilities at which coordination technology aims depend on finding and installing appropriate conceptual and structural units with which to express tasks, their diverse relations to each other and to the people who ultimately bear responsibility for them”. This overall aim is important due to the point that a substantial part of daily work concerns the coordination of distributed work and multiple interdependencies (Robertson & Wagner, 2015, p. 289). To give just a short idea of the importance of coordination, Carstensen and Sørensen (1996, p. 391) pointed out that a lot of different people with different competencies who are local distributed, have to work interdependently together to carry out a complex project which supplements CT. To define a CM, Simone et al. (1995, p. 44) propose the definition of “[…] a protocol, encompassing a set of explicit conventions and prescribed procedures and supported by a symbolic artifact with a standardized format, that stipulates and mediates the articulation of distributed activities so as to reduce the complexity of articulating distributed activities of large cooperative ensembles.” The most general definition that can be found in literature is the definition proposed by Schmidt and Simone (1996, p. 180). They define a CM as "A *coordination mechanism* is a specific organizational construct, consisting of a *coordinative protocol* imprinted upon a distinct *artifact*, which, in the context of a certain cooperative work arrangement, *stipulates* and *mediates the articulation of cooperative work* so as to *reduce the complexity* of articulation work of that arrangement." Carstensen and Sørensen (1996, p. 391) describe it as “It is a conceptual framework for describing artifacts supporting the process of coordinating who is doing what, when, where, how, and why. The concept introduces an analytical distinction between different objects of coordination work.” Those objects of coordination work, in accordance with Carstensen and Sørensen (1996, p. 391) are listed in the following:

- Actors in a cooperative ensemble,
- Roles the actors have,
- Their obligations and responsibilities,
- The tasks the actors are doing,
- Their activities (in a closer sense, a course of action),
- In a general sense, conceptual structures and in a closer sense classifications,
- Resources which can be informational, technical, infrastructural or material.

Those objects are reflected in a CM and can be smoothly interpreted as “conceptualizations of structures in the work arrangement, the field of work, the wider organizational setting, or as being references to time and space” (Carstensen & Sørensen, 1996, p. 392).

By regarding the definitions above some typical characteristics of a CM can be outlined as it was already done by Simone et al. (1995) and are illustrated in Figure 3.7. They indicate the following characteristics to describe a CM in CSCW:

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- A *"protocol"* which is referred to as a set of explicit procedures and conventions stipulating the articulation of the distributed work.
- The stipulation of the protocol is a kind of "*symbolic artefact"* which is independently accessible from the current situation.
- The symbolic artifact allows the *mediation of* the articulation of the distributed work. Meaning that every change made to the protocol is conveyed to other actors.
- For symbolic artifact a "*standardized format"* exists.
- The *decoupling* from the state of the artifact form the state of field of work. Meaning, changes made to the protocol are not automatically reflected to the field of work.

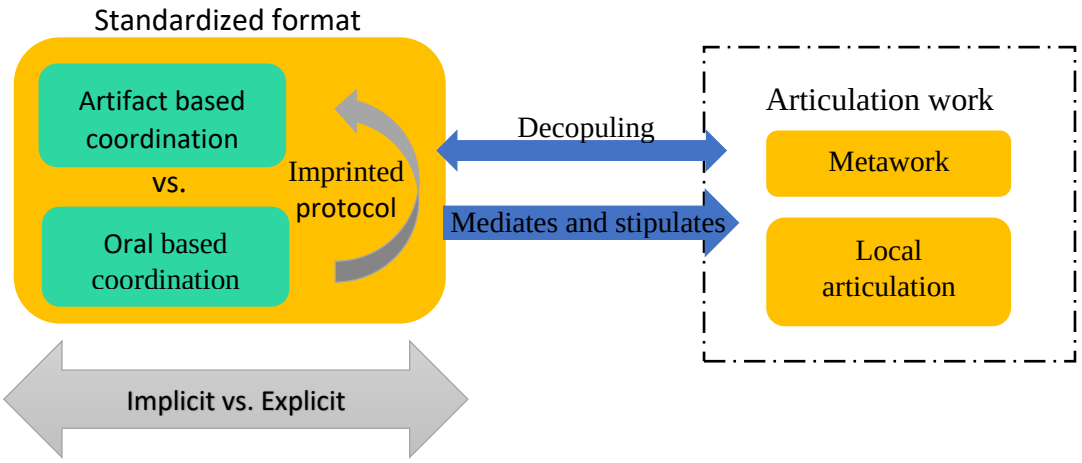

Figure 3.7: Characteristics of a CM (own illustration)

3.8.1 Formal Constructs in Coordination Mechanisms

In the definition of Schmidt and Simone they use the term of *organizational constructs* (e.g. procedures and workflows) (Schmidt, 1997, p. 138). These constructs are referred to as formal constructs which are applied by organizations in order to support coordination (Divitini & Simone, 2000, p. 365). These formal constructs can be described as "*maps" ("weak role")* or "*scripts" ("strong role")* (c.f. Schmidt & Simone, 1996, p. 174; Schmidt, 1997, p. 138). Awareness can deliver information to transform a reference map into a detailed script and in the other way a script into a map (Divitini & Simone, 2000, p. 376). Maps and scrips have in common that the formal construct (map or script) is depending on the current situation, hence its main requirement is adaptability (Divitini & Simone, 2000, p. 366). To ensure adaptability Divitini and Simone (2000) name three dimensions concerning the modelling language, visibility and modification. Starting with the modelling language the most suitable language for the process is necessary. The visibility of a formal construct is related to the actor skills utilising the construct during its lifecycle. The last dimension, the modification is based on the possibility to support incremental changes

and design made to the constructs (Divitini & Simone, 2000, p. 366). Next to the common ground of adaptability the two forms of a formal construct differ in some way. On the one hand, a map can be regarded more as a reference for orientation purpose to decide what things it should come to and not as prescribed actions, for example a checklist (c.f. Schmidt, 1997, p. 142). A map is partially specified as at the same time also modifiable and adaptable at a reasonable cost, relating to the changing application domain and the requirement of an organization (c.f. Divitini & Simone, 2000, p. 366). On the other hand, a formal construct serving as a script is more a precomputation of interdependencies. The determination is made in a stronger sense and the rules applied in a current situation should be fully specified by the actors during their actions (c.f. Schmidt, 1997, p. 144; Divitini & Simone, 2000, p. 366). The notation of using organizational constructs to conceptualize a CM can be regarded critically (c.f. Schmidt & Simone, 1996, p. 166). That is why the term of a "coordinative protocol" elaborated by Schmidt and Simone (1996) was applied to conceptualize a CM. Per Schmidt and Simone (1996, p. 165) a coordinative protocol is a form of conventions and procedures which stipulates the responsibilities of different roles and competencies of team members. Hence, it contains a set of procedures which are stipulating the articulation of distributed and interdependent activities (p. 166).

3.8.2 Role of Artifacts in Coordination Mechanisms

Next to the role of a protocol integrated in a CM, the presence of an artifact has been identified as important in coordinating cooperative work. Robertson and Wagner (2015, pp. 289-299) pointed out that a CM does not always have to be connected with an artifact, but they have been used for coordination purposes in some research (c.f. Simone et al., 1995; Carstensen & Sørensen, 1996; Schmidt & Simone, 1996; Schmidt 1997). Examples for those artifacts are timetables, checklists, routing schemes, classification schemes etc. Artifacts objectify permanence to the protocol in a way that it stipulates the protocol in an independent manner. Jack Goody (Goody, as cited in Schmidt & Simone, 1996, p. 176) observed the potential of the "written language" is to provide a number of people with the same information at the same time. While the word always stays the same, written artifacts can be mobilized to clarify and settle disputes, hence acting as a mediator between collaborating actors (Schmidt, 1997, p. 144). Thus, an artifact is fundamental for the coordinative protocol by objectifying and giving performance to it. This can take place through the dynamic execution of the protocol and thereby mediating information about changes to the protocol during execution. The role of an artifact, as a set of conventions and procedures, can mediate and stipulate articulation work by serving as an instrument to reduce its complexity and in alleviating the need for ad hoc communication (Schmidt & Simone, 1996, p. 159). Artifacts can sometimes be regarded as symbolic artifacts, like schedules, which are connected to conventions (Carstensen & Sørensen, 1996, p. 410) having a physical form. Schmidt (2002, p. 168) pointed out that an artifact mediates coordinative practices of a pre-established protocol. Hence, a persistent part of an artifact, with an imprinted protocol, that has a social nature in the form of before agreed conventions in cooperative ensembles together build CM (Schmidt & Simone, 1996, p. 165). From this explanation, the derivation of a social and symbolic or visual phenomena can be used to describe an

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artifact. This is in accordance with Gutwin and Greenberg (2002, p. 423) where they say that artifacts rely on visual information: “they are physical objects, they form spatial relationships to other objects, they contain visual symbols like words, pictures, and numbers, and their states are often shown in their physical representation.” (2002, p. 423). Beside their visual nature, they also can be acoustic.

3.8.3 From CM to Computational- CM

Similar to the CM, Simone et al. (1995, p. 45) provide the term of a “computational coordination mechanism” (C-CM) which represents the technological support (Divitini & Simone, 2000, p. 371). A C-CM can be defined as “[…] a computer artifact that incorporates aspects of the protocol of a coordination mechanism so that changes to the state of the mechanism induced by one actor can be automatically conveyed by the artifact to other actors in an appropriate form as stipulated by the protocol” (Simone et al., 1995, p. 45). Hence, Schmidt (1994b) identifies the following main requirements that should be established for CM.

Malleability: Since CM are “resources for situated action” (Schmidt, 1994b, p. 22; Schmidt & Simone, 1996, p. 184; Simone et al., 1995, p. 45) they must be “malleable”, meaning that an actor can specify or re-specify the mechanisms to current situations. In other words, an actor should be able to develop new mechanisms or to make modifications to existing ones.

Visibility: A C-CM must be accessible and should be able to be manipulated for the actor which also has to be “visible” (Schmidt, 1994b, p. 23; Schmidt & Simone, 1996, p. 186) to the actor. The specification made by the actor should be appropriate and make sense in terms of articulation work. The manipulation and access take place at the semantical level of articulation work (Schmidt, 1994b, p. 23).

Control: Since a C-CM must be malleable, the construction of the C-CM should be controllable to the actor to the propagation of changes to the protocol.

Relation to the field of work: A C-CM, a specialized software device which is embedded in an application, must provide means of identifying pertinent features to support the articulation wok. As articulation work is a recursive function, a C-CM should be reconfigurable and able to take another C-CM as its “field of work” (c.f. Simone et al., 1995, p. 45). The dynamic reconfiguration of the protocol should give the actor the control of changes made to the specifications of the C-CM (Schmidt, 1994b, p. 24).

Temporary and Locality: To cope with unforeseen contingencies, C-CM provide the behaviour for local and temporary changes. Since the C-CM are local and temporarily changeable, there exist no single mechanisms which can be applied to all aspects of articulation work. Hence, they must be embedded in an application in that way that the articulation of distributed activities of multiple actors are supported (Schmidt, 1994b, p. 23).

Common likability: As the organizational context is getting wider and moving away from paper-based coordination with a static protocol and the embedding of C-CM in different applications, a C-CM should be constructed in a way that allows the “likability” to other CM (Schmidt & Simone, 1996, p. 188).

Partial specification of attributes: Furthermore, C-CM should provide means of "partial specification of attributes" as they are often under-specified because their construction demands for prescribed procedures and conventions (Schmidt, 1994b, p. 23).

3.9 Oral vs. Artifact Based and Explicit vs. Implicit Coordination

Next to the existence of formal constructs and artifacts, Espinosa et al. (2004, "Introduction") pointed out that teams that need to coordinate their work making use of a number of explicit and implicit mechanisms and processes. This includes the characterizing mode of coordination which can be "*oral"* or, as already mentioned before, "*artefact"* based. Oral based coordination defined by Carstensen and Nielsen (2001, p. 81) is in accordance with the implicit mechanism of Espinosa et al. (2004) whereas the artifact based coordination is in accordance with the explicit mechanisms.

Some essential characteristics of *artifact* based coordination were outlined by Carstensen and Nielsen (2001, p. 86) where they pointed out, that it is made visible to the user which is in accordance with the description of an artifact in previous section. Furthermore, a persistent coordination of communication is provided as an overview of the state of affairs, whereas uncertainties have to be managed by other means of interactions. Also here the protocol stipulates the process and is easy to handle automatically when it is computer based.

In contrast, *oral* coordination can be characterised as (Carstensen & Nielsen, 2001, p. 85) a closed paradigm where information is distributed in focus and background. This enables speakers to coordinate in a smooth way and to question implicit assumptions. Furthermore, existing norms, function as autonomous and concurrent guidelines, are publicity available constituting a protocol which is self-referential.

To explain in more detail how oral and artifact based coordination can be understood, Carstensen and Nielsen (2001) provided eight dimensions of coordination that are described in Table 3-1 below. The artifact-based coordination is explained with the example of the bug report form whereas the oral-based coordination is explained with the example of maritime commands. The left side of the table presents the dimension of coordination and the right columns are separated into artifact- and oral-based coordination.

On the one hand, teams can coordinate their work "implicitly", for example without consciously trying to coordinate through team cognition. Implicit coordination is about not directly stating something, but give suggestions indirectly to effectuate a purpose. It is normally based on shared knowledge that team members have about each other and their tasks. Shared knowledge helps team members to understand what is going on in their environment and their work and also helps them to anticipate what is going to happen next. Indeed, shared knowledge helps them to coordinate (Espinosa et al., 2004, "Introduction"). At this point it is noted, that Cooke et al. (Cooke et al., as cited in Espinosa et al., 2007, p. 139) distinguish between two types of knowledge, which are "long-term knowledge and fleeting knowledge or 'awareness'". Long-term knowledge, or shared knowledge, develops over time with the application

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of tools and processes and may exist prior to the current tasks. It helps in coordination team work because individuals develop an accurate expectation and explanation about team members and tasks (Espinosa et al., 2007, p. 139).

Table 3-1: Artifact and oral based coordination according to the dimensions by Carstensen & Nielsen (2001)

Dimensions	Artifact	Oral
Persistency	• Maintenance of communicative content over a long-time • Persistent coordination can maintain information long time which can really support assessing the state of affairs in cooperation • Through persistency a historical background of activities can be maintained	• Oral interactions cannot easily maintain a historical background of information • Difficult to find out who did what, when, how etc. • Historical overview of actions is labour intensive
Non-exclusive and dedication	• Dedicated coordination support is exclusive • Formal and standardised information structures are features that support coordination • The bug report for e.g. was originally designed to support coordination of distributed activities	• Work components are used with the view to support coordination • The form can change slightly over time. • The actor on the bridge for e.g. of a ship may choose to turn off the loudspeaker or confirm the message while the conversation will be remained unchanged
Automation	• Example of computer implemented bug-report that leads to automatization of the workflow	• Example of oral or paper based bug report doesn't lead to automation
Stipulation of work	• The bug report shows that a limitation of fields and information exists that is needed to be entered to stipulate the coordination	• Oral commands show a higher flexibility in the objectified artifact that implies physical constrains
In-/direct referencing	• Indirect referencing can be found by using an artifact, e.g. the bug report • It provides actors with information but no direct commands	• Oral coordination makes use of both modes • Direct commands on the bridge are combined with information which is necessary to trigger certain activities (direct referencing is mostly common)
Static and dynamism	• An artifact, i.e. the bug is more static as it doesn't reflect changes of its surrounding	• Oral coordination is dynamic, means it automatically reflects the surrounding of its work arrangement
Detachment and coupling	• A bug is detached from the field of work • There is no mechanical causality that a state change in the form leads to a state change outside the form • Artifact coordination can also be coupled to the field of work (was investigated within the use of a workflow)	• Oral coordination is detached from the field of work • There is no mechanical causality that a state change in the form lead to a state change outside the form
Reduction and flexibility of workload	• Artifact based coordination (e.g. bug report) makes use of stipulation (in computerized form automation)	• Oral coordination makes use of backgrounding

Contrasting, the fleeting knowledge, awareness or team awareness as mentioned before, depends on a current situation. It is “up-to-the-minute” (c.f. Gutwin et al., 1996a, p. 282) knowledge and understanding of what is happening in the task environment (Espinosa et al., 2007, p. 139). Turning back to implicit mechanisms, they can be defined as mechanisms which are available for team members from shared cognition enabling them to anticipate member actions as part of certain tasks in order to manage task dependencies. Mechanisms are referred to as implicit when they are available not consciously employed for the purpose of coordinating but to the team in the form of shared cognition. The development of implicit CM is based on the team members developed experience with the task and interactions with each other (Espinosa et al., 2004, “Implicit Coordination Mechanisms”).

On the other hand, to coordinate “explicitly” (Espinosa et al., 2004, “Introduction”), teams communicate for example orally, in writings, formal or informal, in groups or interpersonally. Or they make use of task programming mechanisms in the form of schedules, procedures, plans or other mechanisms. Those mechanisms can be referred to as explicit because users apply them purposely to coordinate. Hence, explicit CM (or processes) can be defined as mechanisms explicitly employed by a team to support the management of task dependencies (Espinosa et al., 2004, “Explicit Coordination Mechanisms”). When routines change teams resort to communication (interpersonal vs. group, formal vs. informal), like feedback, instead of applying task organization mechanisms due to less effectivity because dependencies can no longer be managed in a programmed way (Espinosa et al., 2004).

3.10 Related Work

In CSCW literature, coordination draws attention to the way that CM support the actors activities in collaboration and the articulation of those activities for them to come together. This also includes mechanisms which provide awareness between collaborators (Dourish & Bellotti, 1992, p. 108; Holten Møller & Dourish, 2010, p. 66).

Articulation can be conducted as a collaborative activity where to ensure that activities or things come together when they need to be articulated. When thinking about collaborative technology, Holten Møller & Dourish (2010, p. 66) pointed out that a social component is shaping articulation, social components give it a shared meaning in a community. Some previous research focused on the way that CM form into material objects in turn to shape coordination practice (Simone et al., 1995, p. 45). The procedures and artifacts of a CM can be analytically distinct but agreed to procedures make sense to actors in their context where their meaning is clear, hence they are shaped by social components. Therefore, to support the shared meaning of a particular context, the incorporation of social components in CM becomes important because the main characteristic of a CM is to reduce the complexity of articulation work (Schmidt & Bannon, 1992, p. 56; Gerson, 2008, p. 197). Focusing on the usage of an artifact which structures coordination it emphasizes that different actors and processes come together.

However, the coupling of an artifact and a protocol lead at the beginning of investigations to the results, that a protocol was not modifiable, as it was in the case of “The Coordinator” (Simone et al., 1995, p.

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46; Schmidt & Simone, 1996, p. 155). Another point was that facilities of the mechanism to change it by the actor was not supporting a specification. Examples for this results were outlined in “DOMINO” (Schmidt & Simone, 1996, p. 155). This leads to the experience that there is a need for more flexible coordination facilities being available to actors. Some examples are the “Egret” and the “ConversationBuilder” (c.f. Simone et al., 1995). The ConversationBuilder supported collaboration in a flexible way as a generic framework. A different approach is the “OVAL” (Malone et al., 1995) where a set of primitive like objects views etc. was provided (c.f. Schmidt & Simone, 1996, p. 155). The OVAL provides a general framework which includes a flexible notation for expressing coordination work. Later the linkable and malleable notation of “Ariadne” was developed by Simone and Schmidt (Schmidt & Simone, 1996, p. 156). "Ariadne is a notation for the construction of tools supporting articulation work that uses the notion of Coordination Mechanism as the unit of analysis of the target reality." (Divitini & Simone, 2000, p. 371). Here, awareness is important in combination with coordination to construct an “active artefact” (p. 375). Another study where AMs were also regarded as a critical factor for successful collaboration and is supported in CSCW systems is the study of the shared editor “ShrEdit”. ShrEdit is a multi-user, synchronous text editor, from Dourish and Bellotti (1992, p. 110) which shows that awareness information in shared workspace allows actors to coordinate their work dynamically and in smooth collaborations.

However, in CSCW a large amount of research effort has been done in examining the co-editing of documents, whereas little work was done in the co-editing of process maps, though this aspect is crucial in distributing a process across different sites (Grasso et al., 1997, p. 74). To design distributed processes, the requirement to provide possible collaborations around them, to discuss and share them as resources for example even to be aware of “remote” changes made by other actors is important. One appropriate example for a collaborative environment in the World Wide Web is the “Basic Support for Cooperative Work” system (BSCW) developed at GMD (Bentley et al., 1997a, p. 9). This knowledge management system is developed in Python (Penichert et al., 2007, pp. 239-240) and allows its users to cooperate asynchronously or synchronously over the Internet or from an intranet.

> *The basis for this work is the BSCW Shared Workspace system, an application which extends the browsing and information download features of the web with more sophisticated features for document upload, version management, member and group administration and more, to provide a set of features for more collaborative information sharing accessible using unmodified web browsers, and, therefore, across different platform and network infrastructures. (Bentley et al., 1997b, p. 828)*

The main usage of the BSCW is in shared workspaces of multi-party projects to share for example documents, especially among students and teachers (Gross et al., 2003, p. 784). The BSCW provides a way to control information access, the management of different versions of documents to users, the support of advanced searches, and the provision of a mechanism to approve documents (Penichert et al., 2007, p. 242). The BSCW solves several problems and solve conflicts about the document management. For example, when concurrent editing occurs, BSCW warns the involved users with a note (Grasso et al., 1997, p. 74). However, the standard server offers already several mechanisms for providing awareness

(Gross et al., 2003, p. 784). For instance, awareness is statically provided through web-based icons. Those web-based icons are enriching the web page for each single artifact with information about its current state and immediately indicate recent activities on the shared document. In a dynamic way, the current state of the artifact is transmitted via a “Monitor Applet” that continuously provides information about activities in the workspace to the author (Samar et al., 2003). Furthermore, users can subscribe to a daily activity report summarising all changes made in the workspace in the last 24 hours (Gross et al., 2003, p. 784). The main challenge here is to stay in contact with each single user, as the usage number is high (c.f. Gross et al., 2003, p. 784). Samar et al. (2003) pointed out that “BSCW lacks pair-wise comparisons, severity information, and a mechanism to scope the events of interest” (Samar et al., 2003, p.454). The main usage of the BSCW is in shared workspaces of multi-party projects to share for example documents, especially among students and teachers (Gross et al., 2003, p. 784). Among students, the usage of BSCW for information sharing is highly used as AM in BSCW are tending to be specialized for writing documents. However, to gain awareness of activities in larger groups, using a larger number of files and folders, the AM are not fulfilling their purpose (Prasolova-Forland, 2002, p. 3).

Per Prasolova-Forland (2002) the BCSW is not effective enough to support social awareness in a university. Schiefner (2011a, p. 308) found out that universities tend to use Social Software more and more in three areas which are: Teaching, research, administration.

Also, Schiefner (2011b) is cast doubt in the adding value of the usage of Social Media in Universities by demanding if Social Software is only beneficial to institutional problems and teaching but lacking support for research. She points out that the usage of Social Software in both areas can lead to changes at University in problem solving. Schiefner talks here about collective intelligence, participation and dynamisms, communication and interaction by not forgetting the authenticity of the virtual community by highlighting the mutual employment of old and new media.

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4 Awareness in Coordination

There has been significant research in the areas of “Human Computer Interactions” (HCI) and CSCW into the role of awareness in groupware systems (Rittenbruch & McEwan, 2009, p. 4). Although it represents an essential part of groupware (Gross, 2013, p. 425), defining the term has been a challenge in CSCW research (p. 431). It may depend on the elasticity of the general term of awareness as it was described by Schmidt (Schmidt, as cited in Gross, 2013, p. 431) who pointed out that the word can have highly different meanings depending on the context. In technology development, references to formal constructs and awareness promotion have been considered as support to coordination (Divitini & Simone, 2000, p. 376). Suchman describes awareness as “centres of coordination” (Suchman (1997), as cited in Heath et al., 2002, pp. 319-320). Also, many CSCW studies in cooperative work situations showed that actors involved in huge projects are prone to tacitly monitor their neighbours and “[…] they perform their activities in ways that support coworkers' awareness and understanding of their work; they take each other’s' past, present and prospective activities into account in planning and conducting their own work” (Schmidt & Simone, 1996, p. 159; Divitini & Simone, 2000, p. 376). Thus, it is not new that awareness concepts among cooperating actors are playing a central role in the CSCW research (Gross, 2013, p. 426). Dourish and Bellotti define awareness as: "an understanding of the activities of others, which provides a context for your own activity” (Dourish & Bellotti, 1992, p. 107; Sarma et al., 2003, p. 445). Thus, all people involved, aware of the work of others, will need to coordinate their work collaboratively in order to ensure successful collaboration and reaching a goal defined. Therefore, the management of interdependent tasks and activities between actors involved need to be coordinated with the involvement of software devices and other objects that act as a CM (Malone & Crowston, 1990; Rapaso et al., 2001).

The work of Dourish and Bellotti (1992) investigated awareness information in loose or close collaboration in the shared editor “ShrEdit” that was key in driving force in awareness research (Gross, 2013, p. 427). Other evidence for the phenomenon of awareness was conducted in the work of Heath and Luff (1991) where they investigated collaboration and coordination in the London underground railway control or the air traffic control study by Harper et al. (1989) which investigated awareness in high pressure situations in highly integrated groups (Harper et al., 1989; Heath & Luff, 1991; Rittenbruch & McEwan, 2009). Beside these important studies, Gutwin and Greenberg examined a framework of “workspace awareness” as a kind of combination of the types of awareness that are present in daily life situations considering “the up-to-the-moment understanding of another person’s interaction with a shared workspace” (Gutwin & Greenberg, 2002, p. 412). The framework presents a combination of their own groupware applications with the perception-action cycle developed by Neisser (Neisser, as cited in Gutwin & Greenberg, 2002, p. 412) (Gross, 2013, p. 431). Workspace awareness is a combination of the different types that were defined by Gutwin and Greenberg (1996) (Greenberg et al., 1996, p. 30; Gutwin et al., 1996a, p. 286) and illustrated in Figure 4.1 in a modified way. Even they form their own type of aware-

ness, they are overlapping and can rely on synchronous and asynchronous actions. For example, a synchronous action takes place when authors are working together in real-time on one document and it would be asynchronous when they would not be working together in real-time (Figure 4.1).

- ***Informal awareness:*** Informal awareness provides information about who is around, for example when people are working together at the same place in the same office, hence who is available at the moment (Greenberg et al., 1996). With the usage of media spaces, CSCW researchers have attempted to provide such social presence to distributed groups (Gutwin et al., 1996a).
- ***Social awareness:*** Social awareness is about the information that users maintain about other people in a conversational or social context (Greenberg et al., 1996, p. 30). It is about the emotional state or their level of interest. In a conversational context, social awareness can be maintained through back channel feedback and through non-verbal cues, for instance, body language. In groupware, social awareness can be supported through video conferencing (c.f. Greenberg et al., 1996; Gutwin et al., 1996a).
- ***Group-structural awareness:*** This type of awareness provides an overview over the users' roles, movements, activities, responsibilities and status in a process. By making the group structures and roles explicit, groupware can lead to support (Greenberg et al., 1996; Gutwin et al., 1996a). One example are open-source projects maintaining awareness primary through text-based communication (Gutwin et al., 2004, p. 72).
- ***Workspace awareness:*** As mentioned above, workspace awareness research was conducted by Gutwin and Greenberg. This type of awareness concerns the user's presence in the workspace and what are users are currently doing. It can describe the people's interaction in a shared workspace in up-to-the-moment knowledge (Gutwin & Greenberg, 1996, p. 208). People get to know who is in the workspace, hence there is a limitation to the workspace itself (c.f. Gutwin & Greenberg, 2002, p. 417).

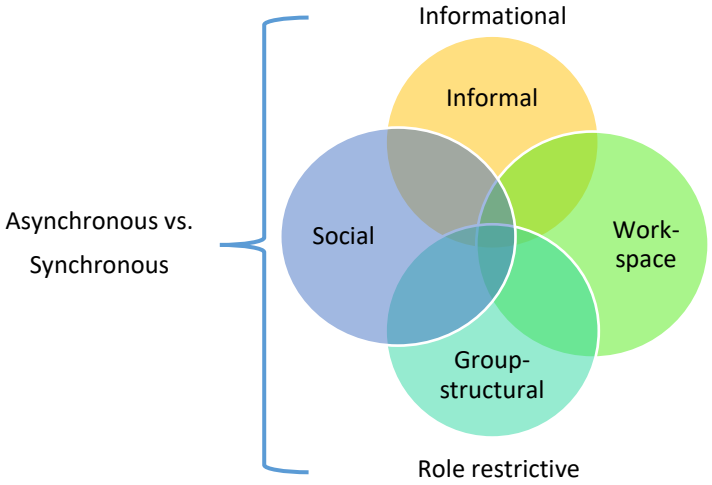

Figure 4.1: Four types of awareness in collaborative work (modified version of Greenberg et al., 1996, p. 30)

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In general, the CSCW systems differ in the support of awareness. Dourish and Bellotti (1992) therefore provide two terms that are referred to *as "informational"* and *"role restrictive"* (p. 110) mechanisms. The informational mechanisms provide *explicit* facilities enabling collaborators to inform each other of their activities (Dourish & Bellotti, 1992). With informational awareness, it is also possible to update users about recent activities happened since their last visit that can be explicitly entered or automatically (Brush et al., 2002). Whereas the role restrictive mechanism normally arises through the explicit support for roles built into a collaborative system where people are assigned to roles. Role based awareness however provides not only information about the content, but about the character of the activity which is done. Dourish and Bellotti (1992) define a role as "an individual's relationship to the shared work objects and to other participants, and is typically linked to a set of operations which can be performed." (Dourish & Bellotti, 1992, p. 109). Next to the AM mentioned above, some attention was paid to characterise and organise awareness in task vs. social and asynchronous vs synchronous settings (Rittenbruch & McEwan, 2009, p. 3). The importance of awareness to human interaction and conduct was recognised in social and technical research in CSCW to support collaborative work (Heath et al., 2002, p. 317). Additionally, as mentioned in the motivation, the role of awareness is also penetrating the area of Social Software (Gross, 2013, p. 426).

5 Theoretical Examination

Chapter 5 represents one main part of this thesis and the second research phase (identification), including the second and third research step of phase two. Firstly, concepts described in the theoretical part in chapter 3 are presented. Secondly, concepts and models chosen for the theoretical investigation are outlined. To reach the objectives defined in section 1.2, the first coding cycle method of section 2.2 is applied. During the investigation, two interdependent coding processes are carried out. The first coding process, includes the first coding cycles to identify the mechanisms and iterate the raw data material. Continuing with the classification of CM and AM elaborated as part of a second coding cycle. Some of the most commonly mentioned CM and AM are represented by short guiding scenarios and visualised to clarify the application of respective classified mechanism in groupware. Parallel to the first coding process a second process is conducted that makes use of the concepts applied out of the literature incorporating first coding cycle methods.

5.1 Selection of Concepts

In section 3 several concepts and models to classify groupware and CSCW applications were outlined and described. It was concluded that not all of those described concepts are suitable to classify the examined CM and AM in this thesis.

To classify the CM, it has been emphasized that the 3C-Model of Sauter et al. (Sauter et al., as cited in Koch, 2008a, p.419) for the presented investigation is not suitable because no value could be added to classify CM. The model contains three key areas of interaction which can be used to support groupware functionalities. Furthermore, the 3C-Model contains overlapping and repetitions with the 8C-Model of Williams (2011) with its inner 4 core functionalities that focus on indirect or direct interpersonal interactions emerged due to the new development of technologies in the Internet. Both models contain the investigation of functionalities of coordination, cooperation and communication that would have been repetitive when they are used to analyse the CM. Moreover, they focus more on the technology than the single mechanisms itself.

The time and space matrix for groupware classification by Johansen (in the 1988's) has been considered inappropriate for the classification of the CM. The main reason is that most of the CM can be applied for asynchronous actions. There are only few CM that are used for synchronous actions, for example a chat or synchronous editing of documents. For the classification of the AM the time and space matrix has also been deemed inappropriate because AM seems to be applied for both, synchronous and asynchronous actions in a shared workspace. Hence a contribution for the classification is not achieved. The Social Software Triangle of Koch (2008a) described briefly in section 3.3 focuses more on the software features that support social interchange and interaction instead of the individual components and therefore it is not considered for this investigation.

Finally, it was identified that the four components (c.f. Figure 3.6) in CT by Malone and Crowston (1990) could be applied to classify CM and AM and build a main part for the intended grouping. This model delivers rich information about the activities that take place during coordinating an action in collaborative situations by applying CM and AM. The four components cover first the actors that are involved in a collaborative setting carrying out their activities by applying CM and AM. Another component covers the main objective, showing why a specific CM and AM is applied in a collaborative situation. Furthermore, it is interesting to get to know how the actors and activities are interdependent and how a CM and AM can help to coordinate these interdependencies in order to reduce articulation work. To resume to the factor that coordination concerning time is necessary in interdependent collaborative activities, the three different forms of coordination that were elaborated by Bardram (2000) are also applied to classify CM. The three diverse coordination forms can deliver more information about the CM, i.e. which form respective mechanisms rely on. Meaning, if it is used more as a script, an instrument or as communication. Bardram (2000) argues that coordination is about an *activity* that is mediated by an *artifact* in which the practical process of realising coordination *is not detached* from the work situation. Hence those three coordination forms match the CT of Malone and Crowston and the description of a CM. These coordination forms are considered appropriate and form a part for classifying CM.

In addition to the concepts of Bardram, Malone and Crowston, the dimensions of oral and artifact based coordination of Carstensen and Nielsen (2001) are considered as useful to classify CM. The dimensions of oral and artifact based coordination concern for example the persistency of a CM, if they can provide a historical background or not or if they can support automatization. This distinction in the dimension support the possibility to carve out weather CM rely on an artifact like it is described in Figure 3.7. Oral and artifact based coordination, outlined in section 3.9, relate to the concept of implicit and explicit CM by Espinosa et al. (2004) that is also integrated for the classification. Oral based coordination is in accordance with the implicit mechanism of Espinosa et al. (2004) whereas artifact based coordination is in accordance with the explicit mechanism. It is interesting to get to know whether the examined CM are applied implicitly in articulation work or are explicitly used by the actors in order to reduce the complexity of work. It is about the shared cognition and knowledge in a group that enables them to act together and the explicit application of mechanisms that are purposely applied to coordinate work.

To investigate and classify the AM, as mentioned before, the four components of Figure 3.6 in CT by Malone and Crowston (1990) are also applied to explore how the AM function. In detail that means which actions take place among which actors involved. What is their purpose of the application of the AM and how do the actors work interdependently on their activities that are supported by AM. Next to CT, the potential of the workspace awareness framework elaborated by Gutwin and Greenberg (2002), where different types of awareness that can occur in daily life situations, is used for the classification of AM. Within the framework it should be examined in which situation the selected AM is most appropriate. The workspace awareness framework is expanded with the findings by Dourish and Bellotti (1992).

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They differentiate the mechanisms into their support of awareness by distinction between *"informational"* and *"role restrictive"* awareness. The awareness support that can be reached by selected mechanisms was considered to provide further information about AM in this study.

5.2 Development of a Coding Scheme for CM and AM

The examination of CM and AM, both in CSCW and ECS, is organized within a first coding cycle that is described in section 2.2. This first coding cycle builds a part of the first coding process. The first coding cycle method used to identify CM and AM examples in literature is initial coding. Initial coding as a first cycle method is considered appropriate. Per Saldaña (2009) its results are "to remain open to all possible theoretical directions indicated by your readings of the data" (Charmaz, as cited in Saldaña, 2009, p. 81). Furthermore, Saldaña (2009, p. 82) points out that initial coding includes codes that may need to be reworded during the analysis. Initial coding is also suitable because it can incorporate In Vivo coding. In Vivo coding is as well considered suitable to examine the CM and AM examples out of literature. Mainly because the codes refer to a word or phrase found in the qualitative literature (Saldaña, 2009, p. 74). Within the progressing investigation, it is also intended to apply descriptive coding. According to Saldaña (2009, p. 70), descriptive coding is used to summarise in a word or a short phrase the most basic topic of a passage of collected data. Tesch (Tesch, as cited in Saldaña, 2009, p. 70) states that "it is important that these [codes] are identifications of the topic, not abbreviations of the content. The topic is what is talked or written about. The content is the substance of the message".

Before continuing with the description of the first coding cycle methods it is important to note that during the examination and collection of the necessary data for the investigation of CM and AM, the mechanisms are all listed together in one single table. That is, they are not differentiated in the research areas of CSCW and social enabled ECS. A separation of the research fields is considered inappropriate at this stage because there are many mechanisms, for instance a group calendar or event icon that can be found in both fields. In case the respective CM and AM can only be identified in the area of socially ECS, it is highlighted in halftone printing. All tables are organised in alphabetical order according to the name of the CM and AM to give the reader both a more structured overview and a better orientation.

The examination of CM and AM is carried out in the first coding cycle (first coding process) applying initial coding in combination with In Vivo coding. At first, academic literature is reviewed in order to compare the data for similarities in presented CM and AM. The literature types included in the review are mainly journal articles, books, and conference papers. The databases respectively used are ResearchGate, ScienceDirect, SpringerLink, IEEE Xplore Digital Library, ACM Digital Library, JSTOR, Google Books and Google Scholar because of mostly free access. The selected literature is also used to describe the concepts and models presented in chapter 3.

As the terms of CM and AM are already investigated in groupware and CSCW, the following examples of keywords are used for the search of mechanisms of relevant literature:

- “coordination mechanisms”, “awareness”, “awareness mechanisms”, “tools for collaborative work”, “collaborative work”, “workflow management”, “mechanism for cooperation”, “mechanisms for awareness”, “awareness tools”, “mechanisms in collaborative work”, “coordination mechanism in groupware”, “coordination mechanisms in ECS”, “awareness mechanisms in ECS”.

A criterion for the selection of a CM for further investigation in this thesis is that the respective CM has to be mention at least in three academic papers that are analysed. For AM, two papers are considered sufficient, as information about AM is more difficult to find. If three (CM), or two (AM), academic papers are identified that are describing the common CM and AM, the respective mechanism is collected for the investigation process. During studying the academic literature, In Vivo coding is applied and the names of the respective mechanisms are highlighted. Subsequently further literature is consulted to describe the respective mechanisms in more detail. This included also the consolidation of the Oxford and the Cambridge Dictionary.

Finally, the mechanisms selected for the category of CM are presented in Table 5-1. The choice for this thesis seemt to be suitable as the mechanisms provide differences in their functionalities, even there are outstanding CM.

Table 5-1: Selected CM for investigation (own illustration)

(Group) Calendar	Index	Standard Operating Procedures (SOP)
Catalogue	Memo	Tag
Chat (Message)	Plan	Template
Checklist	Schedule/Timetable	Version Control
Comment	Spreadsheet	

Since the variety of AM in existing literature is also huge, only a set of the most commonly mentioned ones that are considered to be used in daily work situations are selected. The selected AM for this thesis are listed in Table 5-2. The choice is considered suitable due to their difference in terms of awareness provision.

Table 5-2: Selected AM for investigation (own illustration)

Activity Stream	Event Icon	Radar View
Alert	Feeds	Screen Sharing
Community Bar	Feedthrough	Telepointer
Consequential Communication	Online Status Display	

As mentioned above, additional literature is consulted to describe the selected CM and AM in more detail. The databases respectively used are ResearchGate, Google, Google Books and Google Scholar.

Regarding the additional literature for the description of the respective CM the following examples of keywords and phrases are used for the search.

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- "how tagging works", "tagging in groupware", "tags for coordination", "group calendars in groupware", "group calendar for coordination", "what is a plan", "plans for coordination", "what is a schedule", "scheduling for coordination", "what is a checklist", "version control in collaborative systems", "chats in groupware", "what is a comment", "comments for coordination", "what is a spreadsheet", "standard operating procedures for coordination", "what is a memo", "what is an index", "what makes up a catalogue", "templates for collaborative work", "what is a template".

Regarding the additional literature for the description of the respective AM the following examples of examples of keywords were used for the search.

- "feedthrough for coordination", "activity stream in groupware", what is an activity stream", "alerting services", "how feeds work", "news feed", "screen sharing in collaboration", "screen sharing in groupware", "what is a telepointer", "telepointer as awareness tool", "radar view for groupware", "event icon as awareness mechanism" "awareness mechanism in BSCW", "community bar for awareness", "what is an instant messenger", "online status display in BSCW".

Table 5-3: Concepts applied for CM and AM (own illustration)

Concepts applied for CM	Concepts applied for AM
Table 5-4: Definition and description of CM in academic literature (own illustration)	Table 5-7: Definition and description of AM in academic literature (own illustration)
• Name of the CM • Definition of the Oxford and the Cambridge Dictionary • Literature references	• Name of the AM • Definition of the Oxford and the Cambridge Dictionary • Literature references
Table 0-1: Four components (CT) by Malone and Crowston (1990) in CM (own illustration)	Table 0-4: Four components (CT) by Malone and Crowston (1990) in AM (own illustration)
• Actor • Activity • Goal • Interdependency	• Actor • Activity • Goal • Interdependency
Table 0-2: Coordination types by Bardram (2000) (own illustration)	Table 0-5: Framework of "workspace awareness" by Greenberg et al. (1996) (own illustration)
• Communicative • Instrumental • Scripted	• Informal awareness • Social awareness • Group structural awareness • Workspace awareness
Table 0-3: Oral vs. Artifact (Carstensen & Nielsen, 2001); Implicit vs. Explicit coordination (Espinosa et al., 2004) (own illustration)	Table 0-6: Awareness support by Dourish and Bellotti (1992) (own illustration)
• Oral vs. Artifact • Implicit vs. Explicit	• Informational • Role restrictive

The identified and selected examples of CM and AM are listed in Table 5-1 and Table 5-2. The mechanisms are described and structured according to the concepts and theories selected (as outlined in previous section) and listed in Table 5-3. The names of created tables are listed and are complemented

with the components respective concepts cover. Each table is filled in with raw data material usable for a coding cycle. Parallel to the first coding process (c.f. Figure 5.1) that includes a first (initial coding in combination with In Vivo coding) and a second (pattern coding combined with descriptive coding) coding cycle, the concepts are used to conduct an in-depth analysis and to elaborate core elements for the classification that forms a second coding process. In the second coding process, the concept of CT is coded by applying descriptive coding and presenting the results in a mind map whereas in the other concepts each mechanism is assigned to components included in the concepts. The assigned mechanisms are compared and results are presented in tables. In addition, all mechanisms are provided with a general description including a reasoned justification for why they can be regarded as CM and AM, respectively. It is also intended to figure out whether the mechanisms are already embedded in applications or are additionally created by the actors involved.

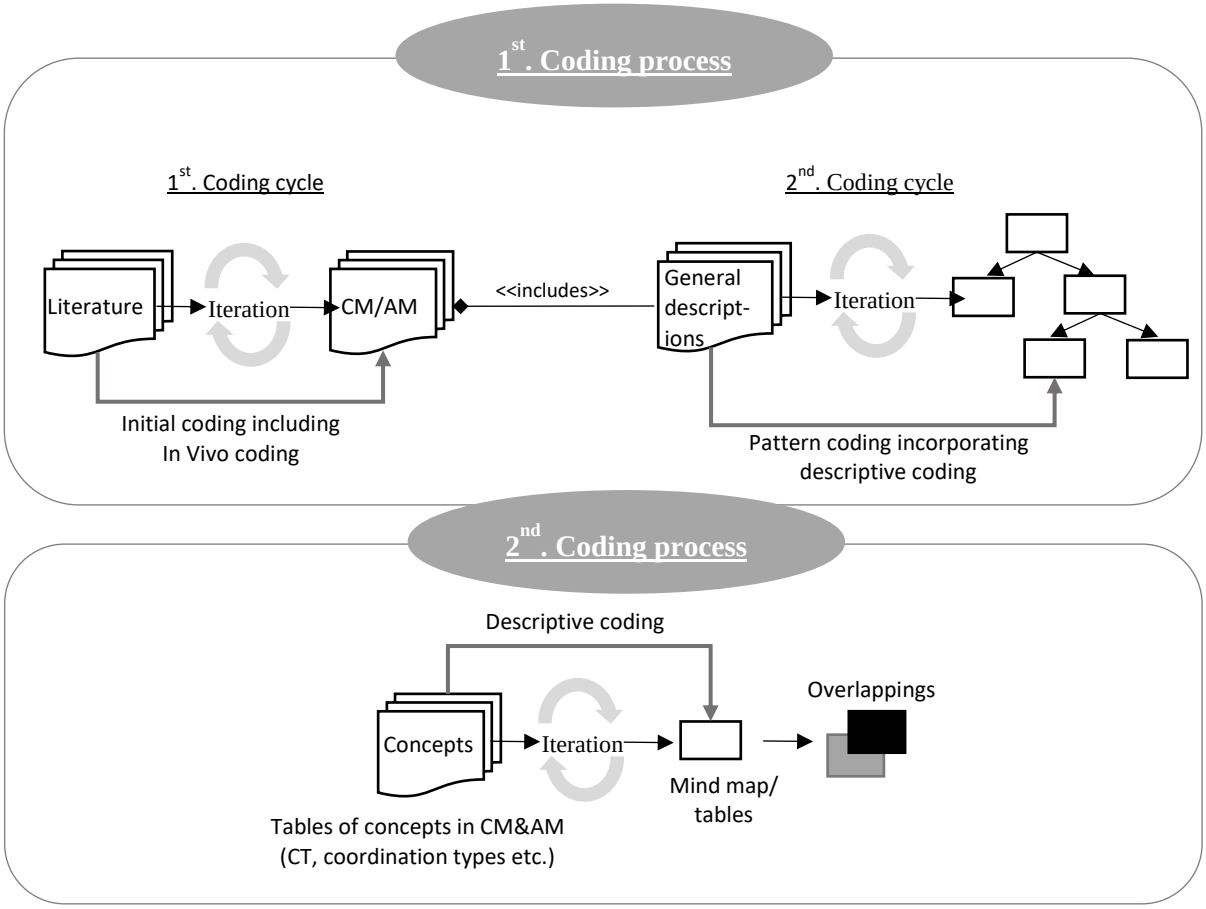

Figure 5.1: Coding scheme for CM and AM (own illustration)

Even if the preliminary work, like the selection of the concepts and the development of a coding scheme is described together in previous section, the deeper investigation in CM and AM is separated. The separation is justified with maintaining a clear structure in both field. The investigation starts with the field of CM that follows AM.

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5.3 Coordination Mechanisms (CM) - Investigation and Results

This section starts with the definition and description of CM in both research areas, CSCW and ECS. Subsequently, the results derived from the presented concepts used for the investigation are outlined and visualised. The presentation of the results is followed by the elaboration of the classification categories. For illustration purpose, scenario examples for some classification categories are presented that are considered to be most different in their characteristics.

5.3.1 CM Description

In the previous chapter, the first coding process was already introduced. That is, that the first coding cycle is about the selection and presentation of existing CM (and AM) examples that are identified in existing literature (see Figure 5.1). Therefore, the coding cycle method of initial coding and In Vivo coding is applied. In Vivo coding is applied during the coding of the mechanism, for instance the name of the mechanism is taken. The mechanisms finally are listed in a spreadsheet to provide a first overview of the examples found.

Subsequently, Table 5-4 (CM) is created that contains definitions that are taken from the Oxford and Cambridge Dictionary and additionally general descriptions of all identified CM. Furthermore, the authors of the articles where respective mechanisms are found, are given. The general description contains information about whether the selected mechanism is considered appropriate to count as CM. In order to do so, Figure 3.7 was used to compare if the mechanisms contain e.g. an artifact that implies a CM. Additionally it is described whether the respective CM is already embedded in an application or if it is additionally created by actors themselves for their coordination of work. The general descriptions of each single mechanism are useful to gain a greater understanding of the mechanisms and is grounded on the motivation described in chapter one. That is because the mechanisms are not well described in the article where they are identified. Since having filled in the table with raw data for a general description, another second coding process is initiated. Therefore, the concepts considered to be appropriate for classifying CM are transferred into tables and filled in with information.

The raw data material in the Table 0-1 of CT is coded by making use of first coding cycle methods that are Initial coding incorporating descriptive coding. Initial coding is used in order to break down collected data into different parts and further iterations. This included a comparison in the descriptions for similarities or differences that can be used to classify the mechanism collected. Initial coding is considered appropriate because with it all theoretical directions for further steps remain open in research. Furthermore, for the respective descriptions of the different concepts applied initial coding provide the possibility to code the data quickly and spontaneously. In CT, descriptive coding is applied in order to find a topic, i.e. subgroups, for the four main components. The most important information in each component are coded and collected together. The results are presented in in a mind map. During the data

collection, it was identified that some codes of mechanisms were overlapping and therefore were rationalised to improve the information. Furthermore, where mechanisms have the same meaning or resembling each other, are merged together.

The results of the other concepts applied for CM (c.f. Table 0-2, Table 0-3) are not coded but presented in tables (Table 5-5, Table 5-6). Another visualisation style was considered not suitable because the results provide more information about whether respective mechanism belongs to a component of presented concept or not. This is in contrast to CT where more raw data material is collected. After the first coding cycle methods of the second coding process and the results of the concepts are presented and explained, the classification of CM is outlined.

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Table 5-4: Definition and description of CM in academic literature (own illustration)

Coordination mechanism	Definition of Oxford/Cambridge dictionary	General description	Literature
(Group) Calendar	"A chart or series of pages showing the days, weeks, and months of a particular year, or giving particular seasonal information."/ "a book with a separate space or page for each day, in which you write down your future arrangements, meetings, etc."	Group calendar tools already embedded in a software, e.g. MS Outlook, can be used by individuals in order to share their personal information and make it public available over a computer network that support the coordination in work. E.g., when a team meeting needs to be planned, the organizer can verify the attendance of colleagues in the group calendar for a specific time in order that there will not arrive overlapping's in attendance and the meeting invitations can be send. Individuals can allow their colleagues to make inferences about one's personal schedule. Group calendars adding the possibility to coordinate also social affairs by open new forms of interpersonal communication. They can facilitate information sharing and time coordination in an enterprise as they can be shared across a network (c.f. Palen, 1999). Apart from scheduling meetings, group calendars provide also functions in "Temporal Orientation", "Tracking", "Reminding", "NoteRecording/Archiving" and "Retrieval & Recall".	Ellis & Wainer (1999). Flores et al. (1988). Kling (1991). Schmidt & Rodden (1996). Williams & Schubert (2011). Xiao & Seagull (2007).
Catalogue	"A complete list of items, typically one in alphabetical or other systematic order, in particular." or "A list of works of art in an exhibition or collection, with detailed comments and explanations." / "(a book containing) an ordered list of names, goods, books etc."	A catalogue (belongs partly to classification) is a function which presents a directory of information about content, data sets, files, or also a database. A catalogue function can be embedded in software and are filled in with information by actors. Catalogues usually describe where information like data set, files or database entities are located and stored. It can also include additional information like descriptions (Rouse, 2005). The usage of a catalogue helps to manage complex information flows and arrange a large information that facilities collaborative work and its coordination. Carstensen and Schmidt (1999) predict, that manufacturing for example has become beset by rampant product diversification which lead to the demand in companies to expand variants of their sales catalogues.	Carstensen & Schmidt (1999). Divitini & Simone (2000). Schmidt (1994). Schmidt & Simone (1996).

Coordination mechanism	Definition of Oxford/Cambridge dictionary	General description	Literature
Chat (Message)	"Exchange messages online in real time with one or more simultaneous users of a computer network." / "a discussion that involves sending messages over the internet, by phone, using a messaging service, etc."	A chat is a tool already embedded in a software. It can be useful for collaborative groups in ad-hoc situations to coordinate their activities. Chats belongs to "synchronous computer-mediated communication" (CMC) (Lai & Zhao, 2006) allowing actors to talk to each other in chat rooms in real time over the Internet. The history goes back to a finish student who developed the Internet Relay Chat (IRC). The transmission of the message is text based from one sender to one or more than one receiver (c.f. Peris et al., 2002) or from many to many (c.f. Haase et al., 1997). To be able to response quickly, the development of new languages in chats was created (c.f. Peris et al., 2002) likewise the application of usernames and number of actors. The textual based message resembles to normal communication, but as it is fixed visual, it provides a readable artifact (Beisswenger, 2007) which is presented on the desktop. Next to the traditional text chat, also some tools provide the functionality of a video chat in order to help groups to coordinate their ad hoc activities.	Borges et al. (2000). Grinter & Eldridge (2001). Penichet et al. (2007).
Checklist	"A list of items required, things to be done, or points to be considered, used as a reminder." / "a list of things that you must think about, or that you must remember to do."	A checklist is a tool or concept that is applied or created by actors in order to ensure reminding of carrying out every action. In general a checklist is a normal list of items that is used to coordinate, organizes and check tasks to reduce local control. A checklist can be applied whenever there is a set of activities which need to be organized, typically when the performance of actions demands for a particular order that need all to be performed. One example is the checklist in the flight-deck where the pilot has to perform different tasks in order to ensure safeties. In general, a checklist is a form of a preparation before the performance take place. In a short, it is "an artifactually imprinted protocol" (Schmidt & Simone, 1996).	Carstensen & Nielsen (2001). Simone et al. (1995). Schmidt & Simone (1996). Divitini & Simone (2000).

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Coordination mechanism	Definition of Oxford/Cambridge dictionary	General description	Literature
Comment	"A verbal or written remark expressing an opinion or reaction." / "(a) spoken or written remark."	A comment provides a concept of a written annotation that can be attached by an actor to another (web) document or content. Comments are explicitly applied by actors as an external remark in order to mediate the articulation of distributed activities. Because they are external, commentary annotations to a document can be interdependently used without changing or editing the original document itself. That's why they are considered as metadata.[3] A good example to explain annotations where user can leave comments to each other about a document material (Dourish & Bellotti, 1992) is the writing in Word. In Word[4], actors can comment text parts in external bubbles to make not any change to the original document. It can be useful when more people have to work on one single document.	Büchner et al. (2009). Dourish & Bellotti (1992). Ellis & Wainer (1999). Roth et al. (2016).
Index	"A set of items each of which specifies one of the records of a file and contains information about its address." / "a collection of information stored on a computer or on a set of cards, in alphabetical order."	An index in a database is similar to a book that is derived from a collection of content. A query is pointed to the physical location of data in a table having the purpose to improve data retrieval performance (Stephens et al., 2011). As more general understanding an index is the systematic, arranged listing of items, usually contained in an article or document. It contains metadata to give characteristics to the data items and the information (Tella, 2016, p. 179). An actor can use it as a guide to trace a document or information that is contained in other sources as it contains references to locate data. Indexes are reference tools helping users to find and retrieve information about content (Sharma & Sharma, 2007, p. 2). Schmidt et al. (1995) provide an example of the ABOM and its CAD model where the ABOM updates the CAD model repository. This is done by consulting the classification scheme of the product and by filling in the indexation form of CAD model.	Schmidt (1994a). Schmidt et al. (1995) Schmidt & Rodden (1996).

[3] https://www.w3.org/Amaya/User/06.doc/Annotations.html (accessed on the 06.10.2016)

[4] https://support.office.com/de-de/article/Einf%C3%BCgen-oder-L%C3%B6schen-eines-Kommentars-8d3f868a-867e-4df2-8c68-bf96671641e2 (accessed on the 06.10.2016)

Coordination mechanism	Definition of Oxford/Cambridge dictionary	General description	Literature
Memo	"A written message in business or diplomacy." / "a written statement about a particular matter, often passed around between colleagues."	A memo is function or concept that is in general additionally created and used by actors to provide a summary of important information. They can also be used to make suggestions for further actions which is based on informal writings. For example, they can be applied to word or adobe documents to give instructions, to remind or to highlight something. They are used as a means of communication between one or more people, e.g. in the same company, to coordinate agreements in the course of articulation work helping to articulate and mediate distributed activities. Memos, a symbolic artifact, can be quiet long (over some pages) (c.f. Bauer-Ramazani, 2012) or short and likely to accomplish the author's purpose. For instance, a memo can be used to inform employees about updates in a project schedule as a type of announcement.	Hayashi et al. (1999). Schmidt & Bannon (1992). Schmidt (1994).
Plan	"A detailed proposal for doing or achieving something."/ "a set of decisions about how to do something in the future."	A plan can function as a concept used to coordinate activities over a time period in a more structured way. A plan in general is created and developed by actors for specific purposes where a storey is defined[5]. To give an example, a project requires a plan where it is specified when milestones (what?) must be completed and by whom (who, how?) to archive an overall objective. A plan can be a formal representation[6] of steps and activities, including times and resources. In general it depends on how plans are used in a current situated action to handle complex work situations (c.f. Bardram, 1997), which normally involves collaboration and coordination. Plans can be formal as an approved document[7] like a project plan, or based on ad hoc improvisations in more personal way.	Bardram (1997). Ellis & Wainer (1999). Schmidt & Rodden (1996).

[5] https://www.entrepreneur.com/article/239407 (accessed on the 05.10.2016)

[6] https://www.reference.com/education/differences-between-formal-informal-planning-78017f18b913e23b (accessed on the 05.10.2016)

[7] http://www.cioarchives.ca.gov/itpolicy/pdf/PM3.2_Planning_Process_and_Plan.pdf (accessed on the 05.10.2016)

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Coordination mechanism	Definition of Oxford/Cambridge dictionary	General description	Literature
Schedule / Timetable	"A plan for carrying out a process or procedure, giving lists of intended events and times." / "a list of planned activities or things to be done showing the times or dates when they are intended to happen or be done" / "A plan of times at which events are scheduled to take place, especially towards a particular end." / "a detailed plan showing when events or activities will happen."	A schedule or timetable is elaborated by actors and can be embedded in scheduling systems (Grudin, 1988) and applied by actors in order to coordinate their activities which are depending on time and resources. In general, does a schedule represents a graphical order of tasks, time, resources, deadlines etc. (Adeli & Karim, 2001). It is the plan of work that documents the sequence and timetable of execution which is called scheduling. A schedule communicates all the work which has to be performed[8] and which timeframes exist for this work, mean the starting and ending time of a task. A schedule can be applied by individuals in order to coordinate their daily activities, or in a group in order that everybody knows who is responsible for what activity. One example is the scheduling of a meeting. Actors in a group can enter suggestions for meetings in a standardised calendar form. This calendar can be regarded as an artifact. The way how to fil in the form, can be regarded as the embedded protocol. If the suggestions work, people involved are informed about the action.	Carstensen & Sørensen (1996). Grudin (1988). Schmidt (1994). Schmidt et al. (1995). Schmidt & Simone (1996). Schmidt & Rodden (1996). Williams & Schubert (2011). Xiao & Seagull (2007).
Spreadsheet	"An electronic document in which data is arranged in the rows and columns of a grid and can be manipulated and used in calculations." / "a computer program, used especially in business, that allows you to do financial calculations and plans."	A spreadsheet in electronical form is a tool that allows the organisation of information into software defined rows and columns (Power, 2004) for example for financial calculation**.** Spreadsheets can support the communication between actors, support design, development and use by actors with different levels of knowledge. It can be regarded as an artifact which is facile to understand and to share among a group (Nardi & Miller, 1991). Schmidt and Simone (1996) provided an example of a project schedule in the form of a spreadsheet. The spreadsheet was used to capture the relationships between actors, their tasks and responsibilities and schedules to handle the bug reports and was added additionally by actors.	Carstensen & Sørensen (1996). Flores et al. (1988). Grudin (1999). Schmidt & Simone (1996).

[8] http://www.projectinsight.net/project-management-basics/project-management-schedule (accessed on the 06.10.2016)

Coordination mechanism	Definition of Oxford/Cambridge dictionary	General description	Literature
Standard Operating Procedures (SOP)	PROCEDURES "A series of actions conducted in a certain order or manner." / "a set of actions that is the official or accepted way of doing something; a set of instructions in a computer program that does a particular task."	Standard operating procedures (SOP) is a function that are additionally created and applied in organisations to instruct people to carry out routine operations. SOP are textual and reliable descriptions in documents (c.f. Angiuoli et al., 2008) that describe necessary activities and steps in a process. Especially in disciplines where it is important that e.g. a production process is repeatable there is a demand for SPO which are in accordance to industrial regulations laws and the own business standards[9]. Bardram (1997) provide an example of a SOP in medical work where it provides a prescribed standard treatment for a disease for a standard patient. This type of protocol is developed by the clinical team to support their work in general.	Bardram (1997). Cataldo et al. (2006). Schmidt & Rodden (1996). Schmidt & Simone (1996).
Tag	"A character or set of characters appended to a piece of text or data in order to identify or categorize it." / "a word, phrase, or name used to identify digital content such as blog and social media posts as belonging to a particular category or concerning a particular person or topic."	A tag is a keyword or index term additionally attached by users to content/ documents in a non-hierarchical structure (Golder & Huberman, 2006). The functionality to tag is integrated in the software whereas the freely chosen tag itself is explicitly applied by people. Tagging resources or content support its categorization. In collaborative tagging, the group members only need to agree in a general sense of a tag and if it's meaning is sufficient to label similar resources. It provides the capturing of associations people have towards a current resource by putting content resources on the semantic level of the retrieval. Tagging can provide arbitrary content to people as it doesn't demand for lot of effort. In general, the concept of tagging provides potential for collaborative work by contextualizing content on an individual and collective level and therefore also provide awareness and grounded vocabulary. It allows the browsing of personal and public categorized information. Tags refer to metadata that is added to the content and act as filter to return just the document tagged with exclusive metadata (Prilla & Ritterskamp, 2010). The most popular tags can be visualised in a tag-cloud.	Koch (2008a). Koch et al. (2007). Williams & Schubert (2011).

[9] https://www.brampton.ca/EN/Business/BEC/resources/Documents/What%20is%20a%20Standard%20Operating%20Procedure(SOP).pdf (accessed on the 05.10.2016)

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Coordination mechanism	Definition of Oxford/Cambridge dictionary	General description	Literature
Template	"A preset format for a document or file." / "a system that helps you arrange information on a computer screen."	A template is a tool for enforcing a standard layout and look which reduces the complexity of workload in collaborative settings. Schmidt (2011) argues that templates, like a blueprint, is an artifact that specifies properties. Those properties are results of individual contribution. A template can be regarded as a file that serves as a starting point for similar new documents[10]. Especially for frequent occurring type of operations they can stipulate the articulation work. One example of a template are the slides in PowerPoint. The slide is a template that is pre-formatted in some way. The template would likely have a space for title of the slide, date, slide page etc. Templates can be already embedded in a program (PowerPoint template) or are additionally created by an actor (Excel template).	Bannon & Schmidt (1993). Bardram (2000). Benford et al. (1993). Schmidt (2011).
Version Control	"A particular form of something differing in certain respects from an earlier form or other forms of the same type of thing." / "the use of a particular number to refer to each stage of development of a piece of software, or each new form of a file or document."	Versioning, or versioning control, is a tool embedded in a software that can be useful when web documents need to be edit collaboratively. It refers to a variation or form of an earlier instant. It is used in coordinative group work to support multiple revisions to the same document which are used and accessed by multiple actors (Baerisch, 2005) by avoiding overlapping's of changes (Chien et al., 2001). It ensures data controlling as by providing the possibility to keep the original document by allowing collaborators to download the document and make any changes to the draft locally. With the check in operation (Vitali & Durand, 1995) the user then can upload the document to the same place where the original is stored. It can avoid many standard techniques such as locking and replication of objects or synchronization and serialization of operations and provide structure through access to the document history. One example of a version control is Subversion[11].	Bentley et al. (1997a; 1997b). Carstensen & Sørensen (1996). Gutwin et al. (2004). Grinter (1996).

[10] http://techterms.com/definition/template (accessed on the 06.10.2016)

[11] https://subversion.apache.org/ (accessed on the 25.10.2016)

5.3.2 CM Results of Applied Concepts

In the following section, all results that are derived in CM are outlined. The results are derived from the concepts applied which are listed in Table 5-3. The fitting tables are attached in the appendix of this thesis. However, the outcomes are described in a brief and a conclusion of the presented results is given.

5.3.2.1 CM Results in Coordination Theory (CT)

Based on the descriptions of the selected CM presented in Table 5-4, the concept of CT by Malone and Crowston (1990) is applied for each CM. For illustration purposes, little example scenarios are described in the table for each mechanism and the related components. For each component (activity, actor, goal, interdependency) the words considered most relevant for a later grouping of the mechanisms are underlined and presented in a mind map. This constitutes a part of the second coding process making use of descriptive coding. The mind map, created with freemind, is to provide a general overview of the results in CT that present all mechanisms together assigned to the components. To structure the collected information, initial and descriptive coding is used to break down the collected information. The codes derived from each CT component are considered to be used to generate sub groups already leading to a small clustering of information. The names of the subgroups are generated in that way that the coded words and phrases in Table 0-1 are compared and grouped together. Figure 5.2 shows the original four component model with the first subgroups that are elaborated during the filling in of the mind map. The *activity* in a mechanism is divided up into *asynchronous* and *synchronous* activity whereas most of the mechanisms are used for asynchronous activities. Asynchronous means, that actors do not have to be at the same place in the same time to do an action collaboratively. Synchronous means that actors at least have to be present at the same time. This applies, for example, to chat. An exception concerning CM is chat (message). The component of the actor is divided up into three subgroups that represent the relation (1:1, 1:m, etc.) of an applied mechanism, the people involved in an activity (actors doing an activity) and the entity. An *entity* here can be the CM itself or an application. *Interdependencies* are divided up into three subgroups. The first subgroup describes a *shared resource*, i.e. a resource can be required by diverse activities. Second, *prerequisite* is about an output of one activity that is required by a following activity. Finally, *simultaneity* describes that more than one activity can occur at the same time. The *goal* of applying a CM can be divided up into support (i.e. where they can help), coordination (what is coordinated), communication (ad hoc) and controlling (e.g. ensuring of process). Furthermore stipulation (i.e. how CM is used), reduction (in general each CM is applied to reduce time, complexity etc.) and efficiency (e.g. faster information retrieval). However due to overlapping's, CT is not used finally for classifying the CM.

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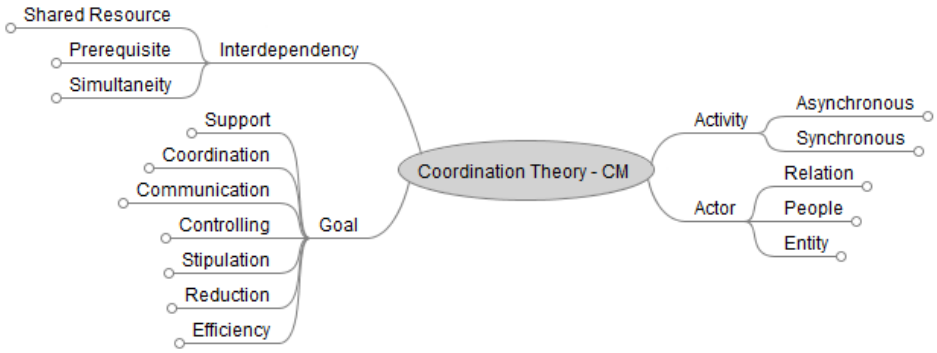

Figure 5.2: CM – CT parent nodes overview (own illustration)

CM Results in CT - Activity

The results in CT for this investigation in the component of *activity* (c.f. Figure 5.3) show that activities in the branch of *synchronous* collaboration is more restricted to CM that support direct communication, such as chat. The chat, selected as a CM in this thesis, can be for example used for ad hoc situations to avoid conflicts, e.g. in communication to ensure that an important e-mail or something else was received.

The branch of *asynchronous* activities is divided up into six sub-branches. The sub branches are created with descriptive coding to give the activities coded in CT a topic. Going from the top to the bottom, the first sub branch describes *communication*. For instance, the CM comment can be used in collaborations to communicate indirectly by leaving a comment for a colleague. This form of communication can also be applied to remind another person. The second sub branch that is coded is the adding of metadata. The CM of a tag for instance provides additional data to the original. A tag is attached to content to characterise and describe it. The tag finally can be used by other people, e.g. for personal data structuring and storing. One can also make use of tagging in order to find respective data or similar data attached with the same tag. This can reduce the workload in information search. The third coded sub branch is the *stipulating* of activities. With stipulating it is described, that the activity that should be carried out is defined to guarantee that the aim defined is reached. An CM example are the SOP that describe, for each actor involved, how to carry out an activity that is repeatable and provide also standardisation. Stipulating activities can facilitate collaborations and reduce error proneness. *Organizing* is the fourth sub category coded. In this context, organising means that data can be organized in order to use it in future activities. This can be reached e.g. by using an index or a tag. Even if a tag is already given as an

example for the adding of metadata, it is also considered appropriate for organising data. Because with a tag, data can be categorized and indirect references to other resources can be reached. The index gives data a well-defined structure that reduces the effort in information search. The sub branch of organising and adding additional information somehow influencing each other. Because by adding metadata, data can be organised. However, in this thesis the groups are regarded interdependently from each other to structure the component of activity more meaningful. The fifth sub branch describes the *coordination* of activities. The group calendar is given as a CM example here. A group calendar allows its users to invite colleagues e.g. to meetings, sending them a reminder etc. Each actor involved gets aware of the activities of others in the same group that is essential to coordinate collaborative work. A schedule also provides rich information in collaborative work. Definitions of milestone, allocation of resources and the responsible people for specific task are public. This publication provide collaborator with rich information in order to coordinate their activities. Last but not least, the sub branch of *support*. With support in this case it is described that collaborative work can be facilitated a little. For instance, a checklist as a CM support its user by providing all information that need to be carried out. It gives a support in the actor's memory. At the same time, failure proneness can be reduced because the checklist is created before the activity takes place. Furthermore, does version control as a CM support the actors in that way that interdependently from each other, multiple users can e.g. manipulate a document, save it at the same time without overwriting the wok of others.

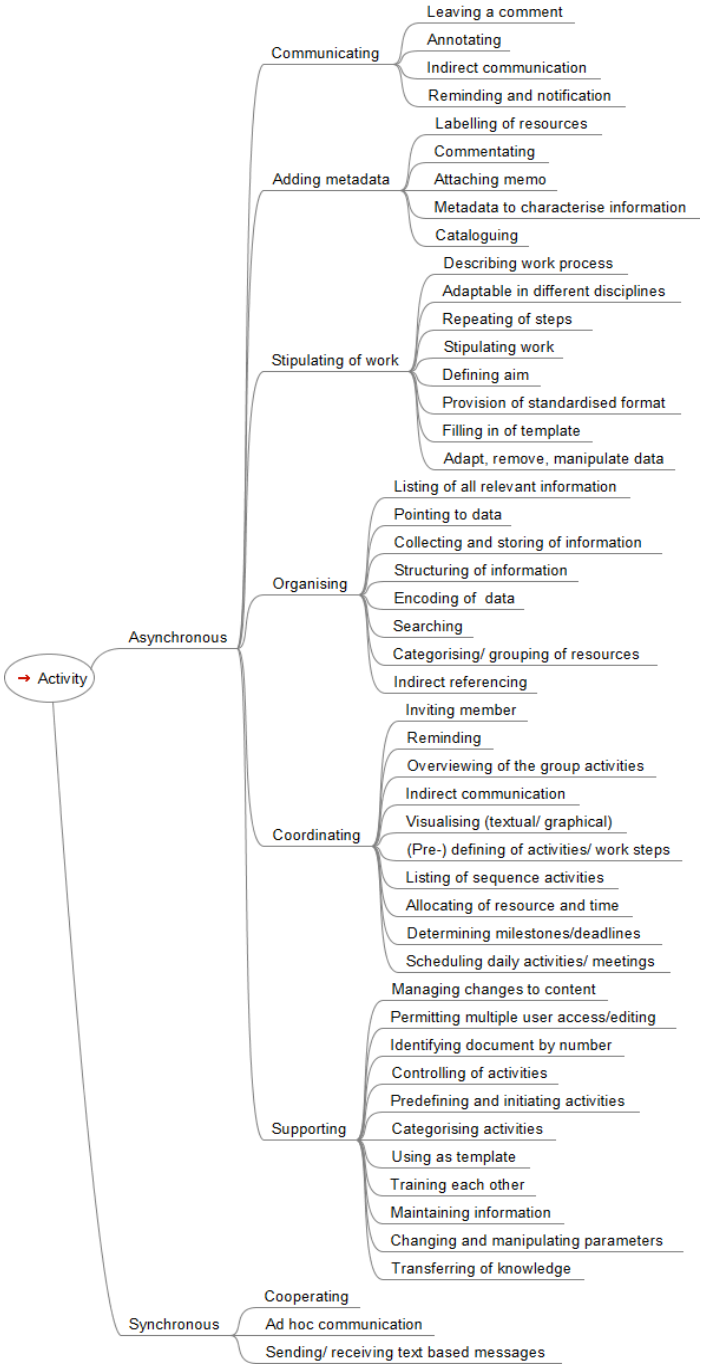

Figure 5.3: CM results in CT – component „activity" (own illustration)

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CM Results in CT - Actor

Continuing with the results of CT in the component of *actor*(s) (c.f. Figure 5.4), the main component is divided up into three sub branches. The first sub branch is coded as *relation*. It describes the relation of the actors involved. E.g. a single actor communicates with another single actor. Or a plan as a CM counts for the whole team (1:m). *People* is coded as the second sub branch. Table 0-1 provides names of actors that can appear in applying CM. For instance, an author can appear in version control in collaborative writing. The first author gives access to co-authors making use of version control to avoid overlapping in editing. The third coded sub branch is called *entity*. With an entity, the respective CM in this thesis are meant. Additionally, the CM can be combined with other entities, like a resource is combined with a tag. Therefore, the entity is not described in more detail at this point. The people involved differ from case to case. In general, it can be remarked that often an actor can be described as the creator of a CM, e.g. the creator of a template. The template is created by a single actor (or sometimes in a specialized group) and used by a lot of other actors, i.e. a collaborative group that stipulates articulation work. Or another CM example of actors provided in a chat is: one actor, acting as a message sender, initiates the written conversation that is received by another actor (or actors) that is the message receiver. The chat acts as a mediator in communication that can rely on 1:1 relation (in the use case). An actor can initiate an activity by applying the chat CM to interact with another single actor or the team. Reflecting the coded results in CM of provided CM examples, a CM seems to be applied often for 1:m relation. This result is not surprising because a CM is used to reduce complexity and workload in a collaborative setting.

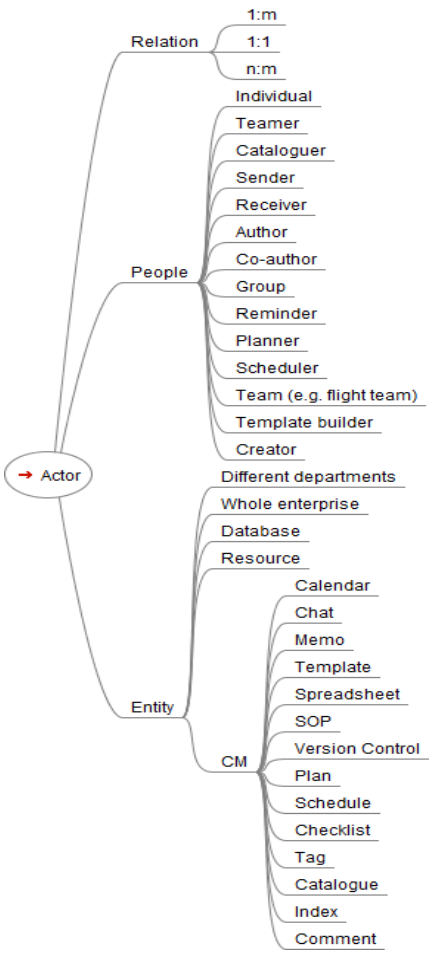

Figure 5.4: CM results in CT – component „actor“ (own illustration)

CM Results in CT – Goal

Comparing the results of CT in the component *goal* (Figure 5.5) with the component of activity (c.f. Figure 5.3) it can be realised that a lot of overlapping in the sub branches occur. It is conjectured that the overlapping appears because the components goal and activity influence each other or i.e. are depending on each other. For instance, the sequential listing of activities in a schedule, concerning the sub branch of coordinating in the component activity, is used to portray the sequence of activities that is used to coordinate the collaborative work. The artifact is manipulated in a way that a particular goal can be achieved by applying the CM, containing the artifact.

For the component of the goal seven sub branches are coded. Beginning with the first branch of *support* with the CM example of a memo. A memo is attached to a document that should be used by another person to support indirect communication (asynchrony) to reduce the communication effort. The second sub branch describes *coordination*. For instance, using a group calendar provides an overview of the activities of group members, the coordination of group activities can be ensured because information is provided for each actor. *Communication* as a coded sub branch is reached through communicating for example through a chat. The respective CM aims to reduce the workload in communication, i.e. collaborative actors do not have to meet others in a face-to-face situation or have to call them. The fourth sub branch is about the *controlling* of collaborative work reached through CM. For instance does a checklist provides a structure of task that initiate others, used in order to control the activity. The activity can be for personal purpose or for the group. The *stipulation* of work, the fifth sub branch, is a goal because through the application of diverse CM, like SOP, collaborative work can be ensured by reducing failures. The standardisation of carrying out a task directly stipulates how to do the activity. This leads automatically to the sixth sub branch, the *reduction*. Reduction i.e. means, that failures in activities are reduced. The workload is reduced through stipulation or the communication effort by applying divers CM. All in all, a CM is used in order to reduce the complexity of articulation work. Finally, the sub branch of *efficiency* describes that a CM is applied in order to do efficient work, connected to the branch of reduction. For instance, does the usage of an index as a CM provide the user with effective search as the index points on the demanded data.

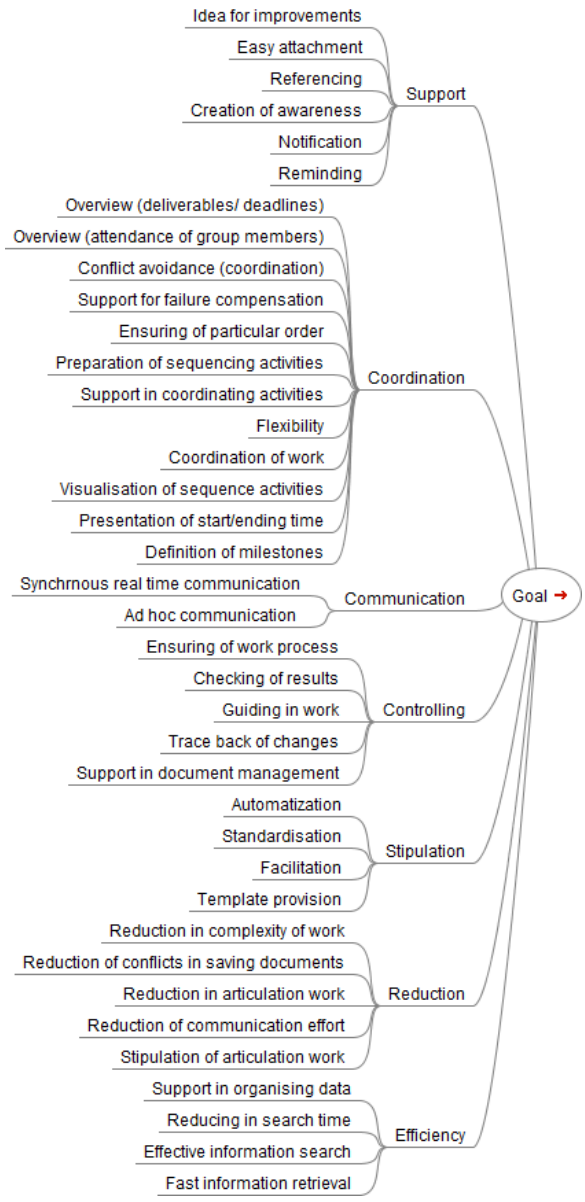

Figure 5.5: CM results in CT – component "goal" (own illustration)

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CM Results in CT - Interdependency

The results in CT in the component of *interdependency* (c.f. Figure 5.6) reveal that the three branches already mentioned in chapter 3 can be used to assign the codes derived from CT. Most of the CM can be assigned to a *shared resource* and *prerequisite*. The latter one describes that an output of an activity is needed for the following activity. Contrasting does a shared resource describe that a resource can be used by multiple activities. For instance, a group calendar can be used for different activities, like inviting people, using it as an overview, scheduling, reminding etc. This description leads to the assignment to a shared resource. However, the functionalities provided in the calendar can be assigned to prerequisite. The creation of a meeting in the calendar is necessary to send invitations to participants and that the meeting will take place. Another example is provided with the plan in a hospital setting. The CM can be a shared resource by showing a nurse and a doctor when they need to check a patient. The plan as an overview can indicate at the same time that e.g. the nurse has to check the patients' blood pressure two minutes before the doctor carries out another examination. In order that the nurse and the doctor know, when and what they should do, the plan must be created in advance that is prerequisite. The creation of metadata is carried out by an actor to categorise it. This metadata is used by collaborators in order to find information. Considering the given examples, the result is not surprising because a CM should facilitate collaborative work. And collaboration often demands an order in which the collaborative activities should be carried out. The activities are connected often to a same resource that is shared in the collaborative work. The third sub branch, *simultaneity*, is not found often for the given CM in this thesis. Simultaneity describes that at one single time, nearly two or more activities can occur. It is suspected to demand for synchronous access of content or activities. For example, a single document that needs to be edited in a group is stored in a single repository. Two group members access and open the same resource to manipulate the resource. With version control they can do it interdependently from each other without creating any conflicts or overlapping in saving, i.e. that one actor does not overwrite the changes made to the document by the other actor. Or in a chat, an actor can send a message and receive a message at the same time.

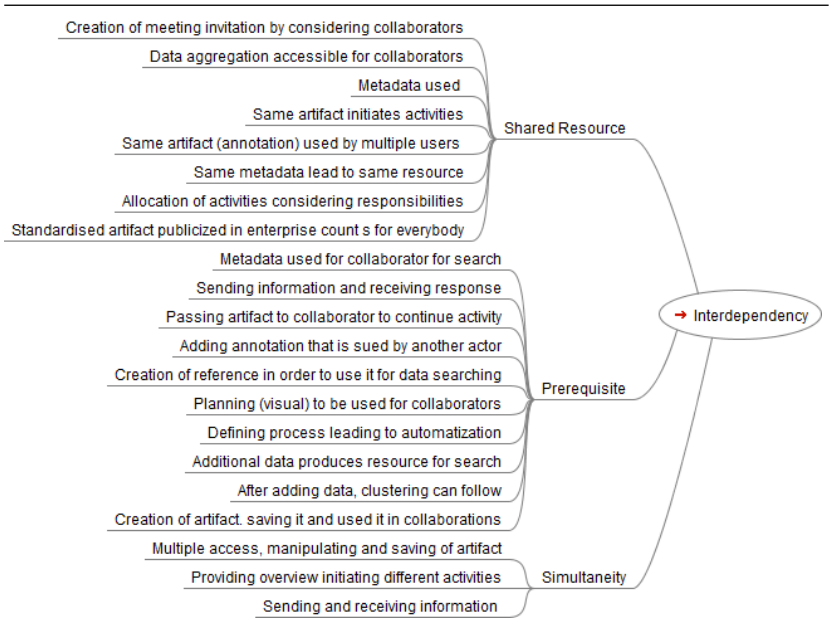

Figure 5.6: CM results in CT – component „interdependency" (own illustration)

Conclusion of CM Results in CT

The activities that take place by applying a CM sometimes overlap, like a plan and a schedule. This is not surprising because they are both mainly used to coordinate activities. In general a CM is used to coordinate collaborative work. The main purpose often is to reduce the articulation work by sometimes stipulating activities or providing the user with the possibility to leave e.g. a comment for a co-collaborator. It needs to be remarked that most of the presented CM are created by humans. This can be done in previous before the activity is carried out (like the checklist) or during an activity takes place (like a tag). Applying CM support also the efficiency in carrying out an activity like it supports as well as awareness of collaborators. For instance, a group calendar provides also awareness of the activities of others to coordinate personal and group activities. The topic of awareness (AM) however, is discussed in the section 4. The actors applying CM often remain the same. It is often about a creator of a CM, like a template, that is used for colleagues. Or only a CM user applying a CM embedded in a software (e.g. calendar). However, the roles of actors applying CM seem not to be static, but dynamic. The simplest example for illustration purpose of dynamic actors is provided with a chat (message). In a chat the role of an actor switches always from sender to receiver and vice versa. The interdependencies in collaboration seem not do differ a lot. However, it is suspected that in general one activity needs to be done by an actor in order that other can make use of it in collaborative work. This demands a lot for prerequisite. For instance, does a tag needs to be created by an actor in order that other users can benefit of the existing tag to receive the particular data. Staying with the CM of a tag it is remarked that this CM also demand for a shared knowledge. To give data a common meaning, the tag must be neutral and understandable for each actor involved. Reflecting the CM examples in general sense, it is suspected that CM provide intuitive usage and do not demand for a lot of mechanic experience.

Having discussed CT by applying a parallel coding process incorporating descriptive coding, the concepts provide in Table 5.2 are applied in the following section. In order to do so, the CM are assigned to the concepts. For further details to the raw data, the original tables are attached in the appendix.

5.3.2.2 CM Results in Coordination Types

The coordination types by Bardram (2000) reveal that the selected CM in this investigation often overlap in terms of the three coordination types. A clear distinction or rather assignment to a single type seems not clearly viable, since it depends on the specific situation in which the respective CM is applied. For instance, a template can be assigned to different types. This means that in one situation a template can be used as a script, it can be communicative and is usually not instrumental. Different cases and situations where the respective CM mentioned in Table 5-1 can be applied for is described more detailly in Table 0-2 The table contains the names of the CM in the left column. The listed CM are classified according to the coordination type (communicative, instrumental, and scripted). The descriptions and examples of the coordination types in section Notation of Coordination3.6 are considered to classify the CM and to figure out to which type the CM can be assigned to the most.

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The results of investigating coordination types for respective CM affecting this investigation are presented in Table 5-5. The symbols used in the table stand for:

- (✓) The coordination type does apply to the respective CM
- ("✓") Depending on the situation the coordination type does apply to the respective CM
- (×) The coordination type does not apply to the respective CM

Table 5-5: CM results – Coordination types by Bardram (2000) (own illustration)

	Coordination types by Bardram (2000)		
Coordination mechanism	**Communicative**	**Instrumental**	**Scripted**
(Group) Calendar	(✓)	(✓)	(✓)
Catalogue	(×)	(×)	(✓)
Chat (Message)	(✓)	(✓)	(×)
Checklist	("✓")	(✓)	(✓)
Comment	(✓)	("✓")	("✓")
Index	(×)	(×)	(✓)
Memo	(✓)	(×)	("✓")
Plan	("✓")	(✓)	(✓)
Schedule/ Timetable	("✓")	(✓)	(✓)
Spreadsheet	(×)	("✓")	(✓)
SOP	(✓)	("✓")	(✓)
Tag (→ ECS)	(×)	(✓)	(✓)
Template	("✓")	(×)	(✓)
Version Control	("✓")	(✓)	(×)

Having classified the CM, following results for the coordination type communicative are recorded:

- (✓) Five out of the fourteen CM are assigned to communicative coordination. Those CM are the (group) calendar, chat, comment, memo and SOP. A communicative situation can take place directly (chat) or indirectly by applying a CM. The CM then acts as the shared artifact used to communicate the coordinate work in collaboration. The CM somehow communicates directly the message to another person, i.e. as a reminder.
- ("✓") Five out of the fourteen CM are assigned to communicative too, but it depends on the situation where the CM is applied. For instance, a checklist can be used for communicative purpose when people collaboratively create and edit checklists and thus tell other people how and when to act. The artifact is malleable for the actor and in indirect way they communicate the actors involved how to act.
- (×) Four out of the fourteen CM are not assigned to communicative coordination. It concerns the catalogue, spreadsheet, index and tag. They are not classified to be communicative because those CM are more used to find in collaborative setting information.

The results for the instrumental type of coordination reveal that:

- (✓) The group calendar, chat, checklist, plan, schedule, tag and version control, seven out of fourteen CM are assigned to instrumental coordination. These mechanisms mainly provide

awareness of the work of others, which is the aim of instrumental coordination. For example, a group calendar can be used in collaborative teams to get aware of appointments, tasks, etc. of colleagues.

- (“✓") Three CM, the comment, spreadsheet and SOP are classified to be instrumental depending on the current situation. For instance, a comment is created by an actor that is e.g. attached to a document. A next person using this document can see what the previous actor did in an indirect way.
- (×) The catalogue, index, memo and template in this study are not classified to instrumental coordination. Those four CM are considered inappropriate to be used for instrumental coordination because they do not create direct awareness of the work of others. For instance, a template can be used by a lot of people, but they can be also used for individual purposes that do not provide awareness of other activities.

For the scripted type of coordination following results are recorded:

- (✓) Nearly each CM, apart from four CM, is considered appropriate for scripted condition. Because nearly each of those CM provide a script for actions to coordinate distributed activities. Those scripts are also malleable for the users and can be adapted when unforeseen situations occur. Even SOP can be adapted e.g. when a law change, the SOP is adapted to the new law. Also, a plan in a hospital, that is public available to the employees, can use the plan as a script given them instructions.
- (“✓") Depending on a particular situation the CM of a comment and memo are not directly classified to scripted coordination. This is because even if they can contain an artifact with a written character, they are in general not predefined but crated more in ad hoc situations. Furthermore, they are not considered to be malleable because a comment is created e.g. to a particular part in a document or rely on verbal commentary. The comment points to a part that need to be changed.
- (×) Chat and version control are not considered suitable for scripted coordination because they don’t provide a character that can be predefined and is neither planned to be publicly available. For example, the chat seems to be used more for ad hoc situations. Version control does not provide an artifact with a written character. Only a time-stamp and the person who changed the document is provided in the version control.

5.3.2.3 CM Results in Oral vs. Artifact / Implicit vs. Explicit Coordination

In the results of oral vs. artifact based coordination it is emphasized that the selected fourteen CM in this investigation are seldom used in oral condition. Only five of the fourteen CM can rely on oral based coordination.

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- (✓) A comment and a plan in this investigation are considered to rely on oral based coordination in collaborative ad hoc situations. For instance, when a group creates a project plan together, other can leave comments in verbal form for ideas or improvements for the project plan. The coordination can be more categorized to face-to-face collaborations.
- ("✓") Seldom can a chat, checklist and a memo be used for oral coordination. In general, a chat can be oral, but the CM is more based on the chat message, that's why it is classified to be seldom oral. However, the other two CM can also be applied in ad hoc situations in verbal form. For instance, if an actor asks another one if he/she already did a specific task in order that another task can be initiated. This situation somehow provides oral coordination as a checklist.
- (×) The remaining CM are not classified to oral coordination because they have in general a visual form with a textual character that is be malleable by actors.

The investigation reveals that each CM implies artifact based coordination (c.f. Table 5-6)

- (✓) Fourteen out of fourteen CM are artifact based. This result underpins that the selected mechanisms in this investigation definitively are in accordance with the characterization in Figure 3.7. The artifact, having a physical form like a checklist, can be connected with a CM for coordination purpose. The role of an artifact, as a set of conventions and procedures serving as an instrument to mediate and stipulate articulation work, also for ad hoc communication. Each of the selected CM relies on visual information, often having a textual and persistent character that is manipulatable by actors. Furthermore, a change to its state of art do not lead to a change of the environment, whereas the information change is visible to its users.

Furthermore, the results reveal that CM can be implicitly applied but tend to be more explicitly applied for coordinative purpose.

- (✓) Four out of fourteen, namely the group calendar, plan, schedule and tag can be used for coordination in an implicit way because if actors e.g. take a look at the CM, they can receive in general all necessary information that they need to coordinate their own work in the team. For example, a group calendar provides all information about a group's activity that provide awareness of the work of others.
- ("✓") Four out of fourteen CM, namely the catalogue, index, schedule, template and version control can rely on implicit coordination but seldom. For example, a template for a power point presentation provides a standardised format that needs to be filled in in date, topic etc. Without further explanation, an actor is already aware of how to fill in the form and to use it.
- (×) Six out of the fourteen, i.e. the chat, checklist, comment, memo, spreadsheet and SOP are inappropriate to classify them as implicit. All the CM provide explicit information about how to do something like a comment or they demand for explicit actions that need to be knowing a group, e.g. using a spreadsheet for calculation.

However, all the mechanisms are explicitly applied for coordinative purpose fitting to the aim of a CM. The result can be explained by comparing the artifact based coordination that is in accordance with explicit coordination as it is described in section 3.9. That is why it is not surprising that a CM is often coupled with an artifact and explicitly applied by actors to coordinate collaborative work and to mediate articulation work. Contrasting to the agreements of artifact and explicit coordination, oral and implicit coordination do not match in this investigation. They are more contrasting each other, exceptional plan, spreadsheet and SOP. These three CM agree on oral and implicit coordination, whereas the other CM are rather contrasting, i.e. the group calendar is classified not to be oral, but implicitly used in collaborations to coordinate work in a group. Another example is the comment that also can rely on oral nature but is inappropriate for implicit coordination because comments contain direct information in verbal or written form. This result leads to the development of the question, why oral and implicit coordination contrasting each other whereas artifact and explicit coordination agree on each other, which is not in accordance with the description of section 3.9.

Table 5-6: CM results – Oral vs. Artifact / Implicit vs. Explicit Coordination (own illustration)

	Oral vs. Artifact (Carstensen & Nielsen, 2001)		***Implicit vs. Explicit (Espinosa et al., 2004)***	
Coordination mechanism	**Oral**	**Artifact**	**Implicit**	**Explicit**
(Group) Calendar	(×)	(✓)	(✓)	(✓)
Catalogue	(×)	(✓)	(“✓")	(✓)
Chat (Message)	(“✓”)	(✓)	(×)	(✓)
Checklist	(“✓")	(✓)	(×)	(✓)
Comment	(✓)	(✓)	(×)	(✓)
Index	(×)	(✓)	(“✓")	(✓)
Memo	(“✓")	(✓)	(×)	(✓)
Plan	(✓)	(✓)	(✓)	(✓)
Schedule/ Timetable	(×)	(✓)	(✓)	(✓)
Spreadsheet	(×)	(✓)	(×)	(✓)
SOP	(×)	(✓)	(×)	(✓)
Tag (→ ECS)	(×)	(✓)	(✓)	(✓)
Template	(×)	(✓)	(“✓")	(✓)
Version Control	(×)	(✓)	(“✓")	(✓)

By reflecting the elaborated results of applied concepts it is assumed that they are not useful to derive classification categories from them. Indeed, the comparison of the results reveal that many overlapping are included and therefore are not considered for investigation process.

5.3.3 CM Classification

Having completed the second coding process (using first coding cycle methods) concerning the concepts applied for CM, respective mechanisms are now classified. During the first and second coding process, it is realised that CT neither one of the other concepts (coordination types, oral vs. artifact, implicit vs explicit) are suitable for a classification. A reason for this observation is based on the smooth overlap-

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ping like in the coordination types by Bardram (2000). A clear assignment to a coordination type is almost not possible because it can depend on the specific situation where a CM is applied. This observation leads to revision of the data material that could be useful for the mechanisms classification. Finally, it is decided to use the general descriptions of the single CM (Table 5-4) for the classification.

In order to do so, another coding cycle as a part of the first coding process is initiated (c.f. Figure 5.1). The definitions and general descriptions of Table 5-4 are reduced and slimed down to main statements identified by making use of first coding methods. Initial coding in combination with descriptive coding is used to derive main topics from the coded raw data material. Descriptive coding is considered fitting the most. According to Saldaña (2009, p. 70) descriptive coding is useful in analysing the data's basic topics that leads to categorising the data for further analysis, i.e. the second coding cycle method.

The descriptive coding, as a first cycle method follows the second coding cycle method. For the second cycle coding method pattern coding is applied as it is proposed by Saldaña (2009, p. 152). Pattern coding compensate material into more meaningful units. It is useful to group data summaries into a smaller number of sets. In this case the classification categories for CM. In order to do so, similar coded data from Table 5-4 are compared for commonalities and are assembled together in Table 0-7 to create a pattern code. In some cases, the coded data provide no differences that facilitated the pattern coding. The derived pattern codes in the second coding cycle produce five codes that present a classification category, presented in Figure 5.7.

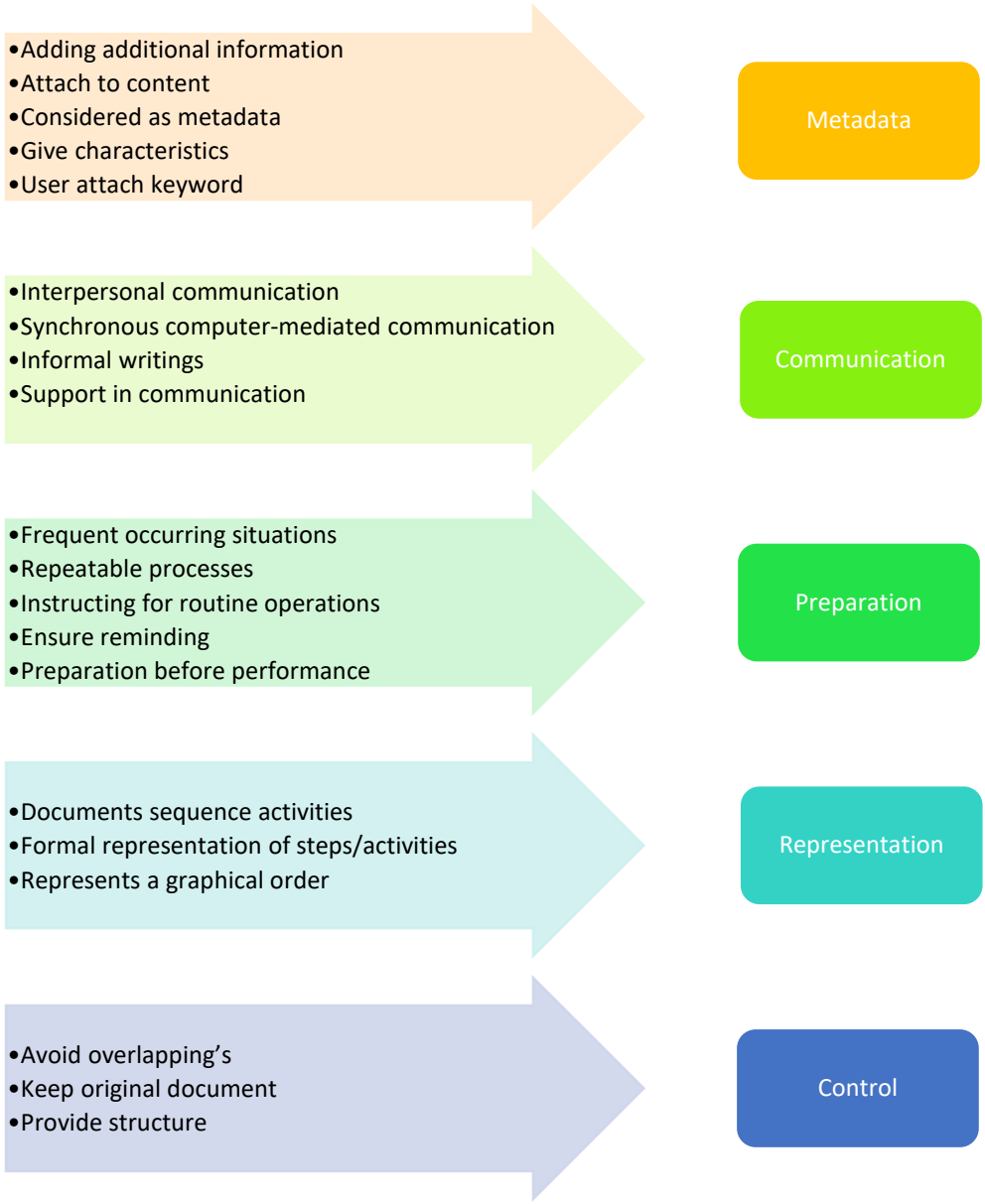

Figure 5.7: Pattern codes derived in CM (own illustration)

The five classification categories are presented in a tree structure (see Figure 5.8) with the respective CM that belong to distinctive categories. Each of the presented categories are outlined and described in the following in detail to carve out what the particular CM have in common.

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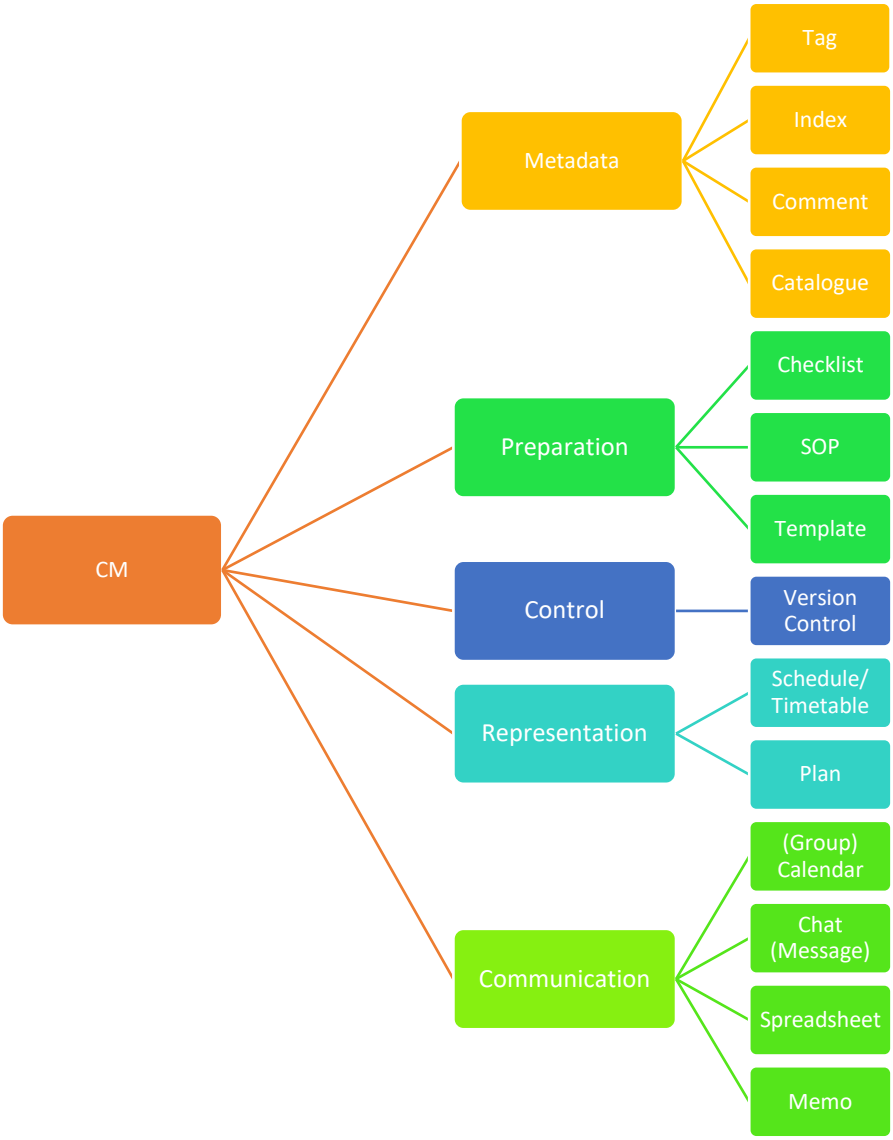

Figure 5.8: Classification categories in CM (own illustration)

Metadata

Starting with the category of metadata it is detected that four CM, tag, index, comment and catalogue resemble in their general description. Metadata is considered as data about the original data. It is used to describe other data in that way that particular data can be found, e.g. in data repositories. According to Smith (2007, p. 65) three different type of metadata exist. They are based on descriptive, administrative and structural metadata. Metadata is applied by actors to describe information resources of digital content. Cataloguing recording, e.g. books, use metadata to describe the print with author, date etc. Therefore, catalogues are referred to belong to metadata. Indexing or indices also resemble this description. In indexes metadata characterises an item and its relationship to information. In general, all have in common that the metadata is added to content by actors, i.e. humans. For the actor itself it is

not necessary to have an advanced knowledge in a specific topic. This is because metadata is set on a shared knowledge (c.f. Golder & Huberman, 2006). However, metadata can rely on subjective or objective knowledge (Duval et al., 2002). Subjective metadata, often referred to as descriptive (c.f. Alby, 2007), can be found in applying tags, for instance in Flickr. In contrast, objective metadata is attached in catalogues, like in a library. Next to the attaching of additional data, metadata can support the categorization of content. In cataloguing the same applied metadata is used e.g. to form a single main group. For instance, some books in a catalogue are labelled with the tag CSCW, those books are grouped to the main group of CSCW. Another categorization can be achieved with a tag. That is when one single tag is used to characterise more than one resource that resemble in their character. Giving content a character, indirect referencing to similar content can be reached that creates awareness. This phenomenon can be assigned to tags and comment making indirect references to content.

Communication

The results in the second coding cycle reveal that four CM, (group) calendar, chat (message), spreadsheet and memo (c.f. Figure 5.8) have in common that they are used to communicate information. In general, communication provides an exchange of information between two or more people aiming to convey intended meaning. In order to do so, the "Shannon and Weaver Model of Communication"[12] is considered. The model describes how information transmitted by a sender through a medium is understood by the receiver who finally gives feedback to the received information. In general, the information in respective CM is communicated in a written form, like in the chat. Because the focus lies on the written form, a chat is considered as CM to communicate. Depending on a specific situation the written form can be accompanied by a verbal form. For instance, the CM spreadsheet is used to communicate information written on a paper. Additionally, communication in verbal form accompanied the CM in order to explain the CM. The group calendar is used to communicate e.g. dates for meetings.

Preparation

Three CM (checklist, SOP, template) presented in Figure 5.8 are classed with the category of preparation. Preparations are typically done in anticipation of an activity that occurs in the future. It is about the preparation of something to make it ready for usage, for personal usage or with the intension to pass the prepared object to others. All three mechanisms are prepared in advance for activities that occur after preparation. For instance, the checklist is a well prepared artifact that is created before an activity takes place, like the example with the flight deck. It is also detected that the three mechanisms have in common that they are applied in activities that require returning operations or particular orders. All CM are predefined by humans to stipulate the same activities in future work. For instance, the checklist is predefined by an actor in order to reduce local control. Furthermore, the checklist and SOP have in common that they are used in a process of activities to ensure that a particular order is carried out

[12] http://communicationtheory.org/shannon-and-weaver-model-of-communication/ (accessed on the 14.11.2016)

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constantly. The predefinition of the CM support also a standardisation, i.e. that no differences in the results appear.

Representation

Representation is the fourth classification category coded in this study. The schedule/ timetable and plan are assigned to representation as they have this functionality in common. Representation is referred to as "The description or portrayal of someone or something in a particular way"[13]. The definition is taken from the Oxford Dictionary. Both mechanisms have in common that they represent a particular order of activities or tasks by documenting also the sequences of the activities, like the schedule. A plan is also used to represent in a formal way the steps and activities that need to be carried out by actors. Both mechanisms incorporate an artifact that can be manipulated and malleable by the actors providing a visual form.

Control

Finally, a single classification category is coded that describes the term of control. The assigned mechanism to this classification is version control. Control is defined in the Oxford Dictionary as "The ability to manage a machine, vehicle, or other moving object" or "A means of limiting or regulating something"[14]. This is in accordance with the version control mechanism because in a closer sense does it describes the avoidance of document overlapping's, the keeping of the original document by providing a structure and the serialization the management of content.

5.3.4 CM Scenarios and Visualisations

Five classification categories in CM are established during the second coding cycle in the first coding process. Three of the five categories with the most assigned CM are now described in more detail. For each classification category one CM is chosen that conveys an idea of the application of a CM. In order to do so, scenario examples are described first. These scenarios are visualised by paying attention to the process that is created by using the respective CM. Additionally the components included in the CM are presented in a separate figure too. The other two categories are dropped out because the other three CM are considered most interesting and difers in their charcter. However, the three categories chosen in this thesis are the following:

Metadata > Tag

Communication > (Group) Calendar

Preparation > Checklist

[13] https://en.oxforddictionaries.com/definition/representation (accessed on the 14.11.2016)

[14] https://en.oxforddictionaries.com/definition/control (accessed on the 14.11.2016)

5.3.4.1 Category: Metadata

Scenario: Tag

Hans is product manager in the company “XX”. He had heard of the social bookmarking service of delicious. He has the idea to sign in to delicious. Hi intention is to collect all the websites of clients, suppliers and competitors to categorise and label them, i.e. to give them a category by tagging them. He wants to then share the information with his team. In order to do so, Hans has to save the websites in his account. He attaches tags to websites. In the case where he has already used the tag, the system recommends the already used tags to Hans. Additionally, Hans gets to see which tags have already been applied by other users to the website. He can decide whether he uses his own tag or a recommended tag. In the following he can then share the categorised bookmarks with his team and use it for his personal purpose. The scenario is portrayed in Figure 5.10.

The component model for a tag, see Figure 5.9, contains information about the actors that are involved in using the CM tag. A tag represents more a new form of CM. It has been raised within the social media and Web 2.0 context (Rae et al., 2010). Some popular examples that introduced tagging, especially in a social and collaborative context, were YouTube, Flickr and delicious (c.f. Alby, 2007). Individuals subscribed to a social media website, e.g. Flickr, can tag photos individually. Considering their behaviour on the website, users can resemble each other through their individual interpretation by applying the same tag (T2) for resources. Or they can be similar by using the same resource (middle and right user). In contrast, resources can be similar through the same users making use of them (bookmark, photo) or they are similar through the tag characterising them (T5, T6).

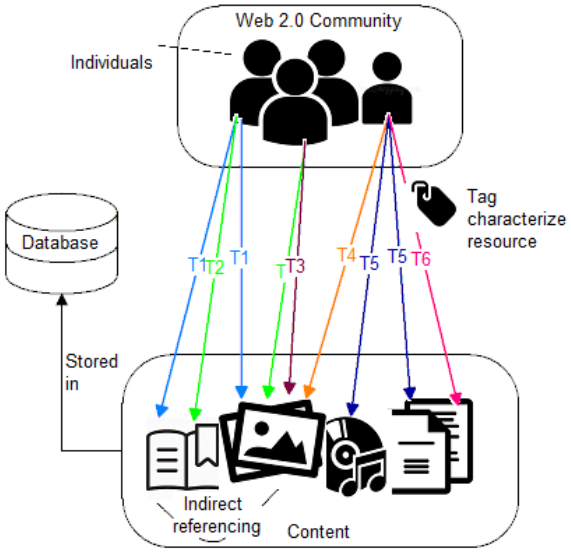

Figure 5.9: Component model for the CM tag (own illustration)

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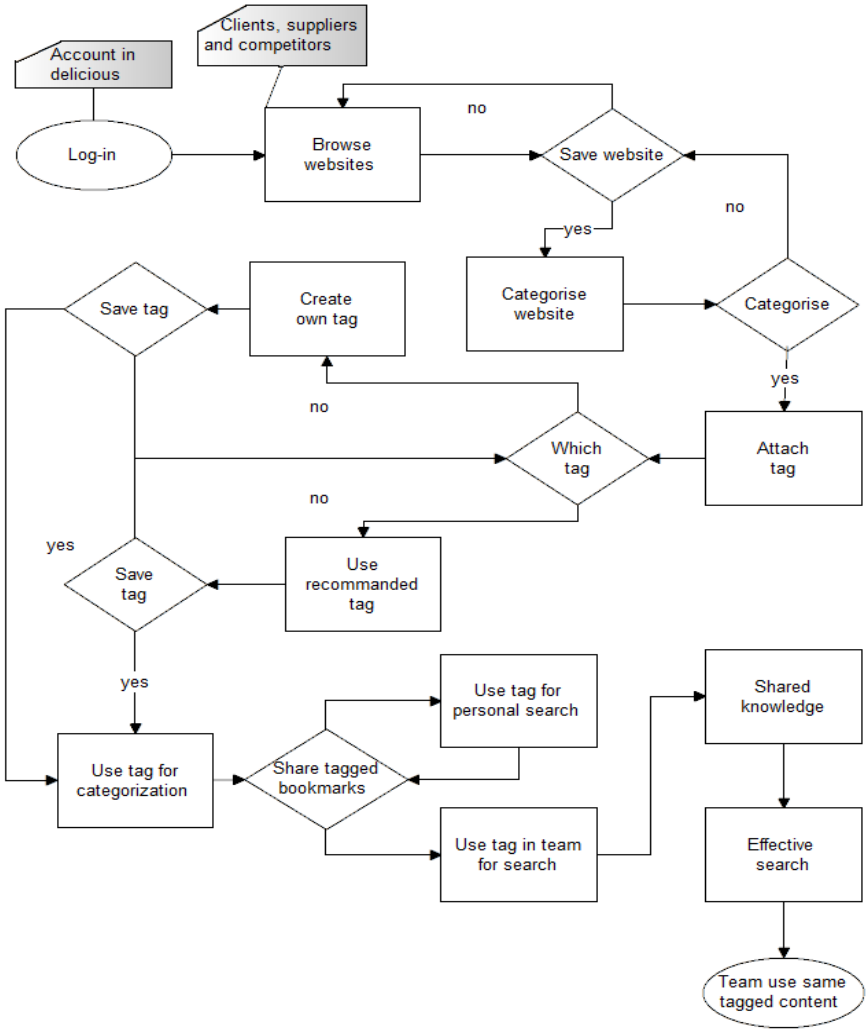

Figure 5.10: Process model for the CM tag (own illustration)

5.3.4.2 Category: Communication

Scenario: (Group) Calendar

In the enterprise „Mustermann“ a team meeting needs to take place to discuss next marketing strategies. For the meeting, different people, with different responsibilities from different departments (finance, IT, etc.) need to join the meeting. In order to do so Henry, the team-leader in marketing, organises the meeting. He makes use of the function of a group calendar in Outlook. He creates a new calendar and gives it a name (marketing). He creates a group list (the list contains the names and e-mail addresses of the concerned people). He selects the respective e-mail addresses in Outlook and subscribes them to the calendar. To use the calendar collaboratively he creates a public folder and checks if he can see the individual appointments from colleagues. During comparing the whole calendar, he

finds a free slot for everybody. In this free slot, he creates the meeting. Henry types all necessary information in the mask, the time date, room, the reason etc. Finally, he invites the necessary people through Outlook. All people receive an invitation, e.g. via e-mail, and they can accept, neglect or leave the invitation open. The process is portayed in Figure 5.11 describing the sequences of activities and decisions that take place in the scenario described.

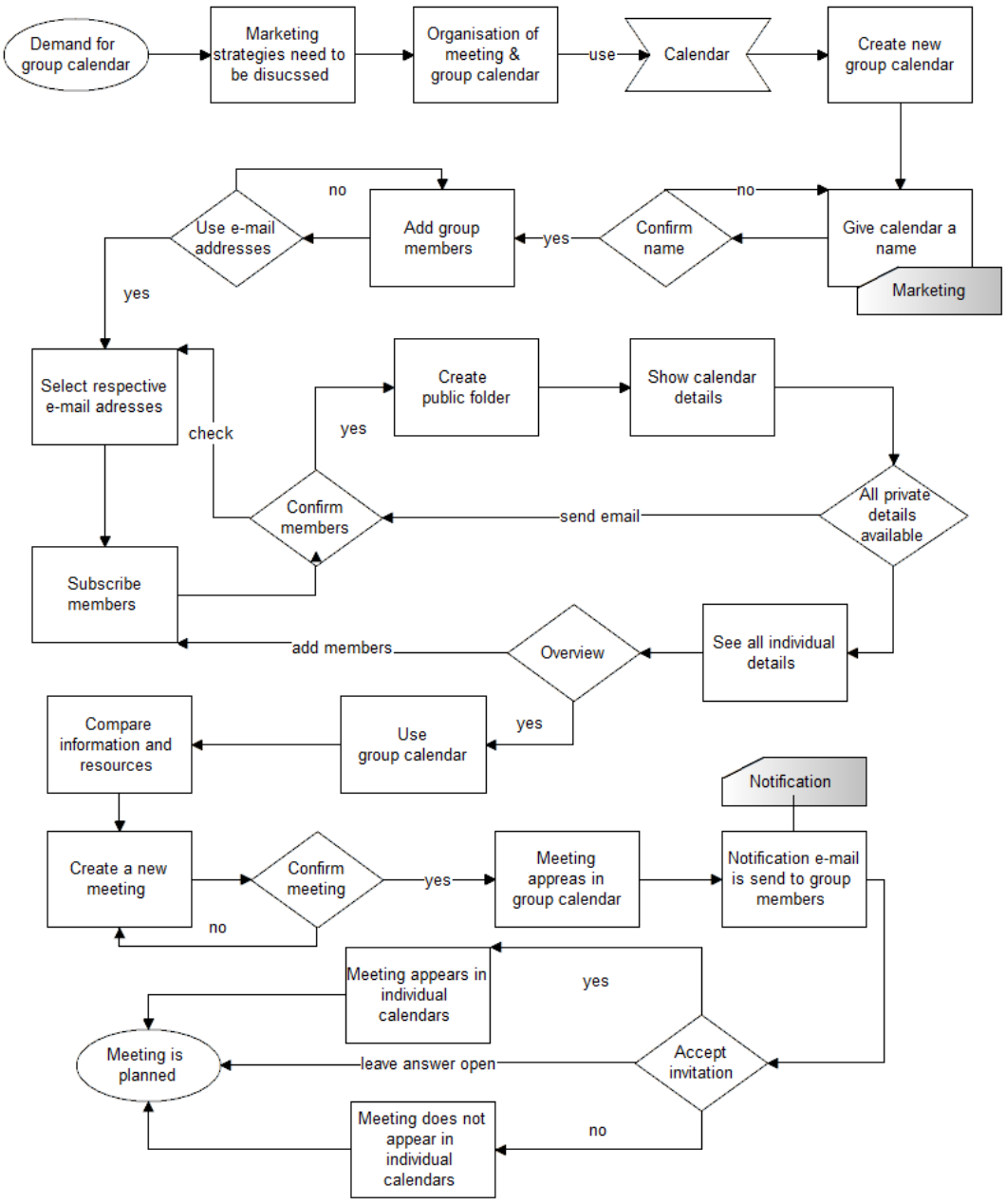

Figure 5.11: Process model for the CM group calendar (own illustration)

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Subsequently another model is created that looks at the different components of the group calendar. The component model (Figure 5.12) is limited to the main components, the individuals that own personal calendars that are finally released and merged together in one single group calendar. The group calendar can be used to communicate appointments and resource allocations.

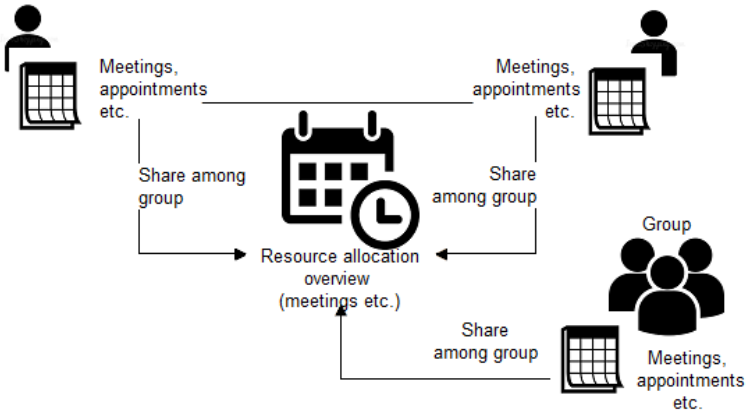

Figure 5.12: Component model for the CM group calendar (own illustration)

5.3.4.3 Category: Preparation

Scenario: Checklist

In the software department xy the software team has created a new application. To ensure that the application runs without failure, the application is tested. The tests are carried out with a predefined checklist, based on a Word document that was created in advance by the IT team and the quality manager. They stored the checklist in a shared repository. The testers have access to the repository and can download the checklist. The checklist itself is arranged in a particular order and divided up into different categories. Each category contains different items and functionalities that need to be tested by responsible testers. After having tested a functionality, the responsible tester can say whether the functionality worked or not and leave comments and his name on the checklist. If the test for instance wasn't successful, the list is passed to another tester. With the checklist, the other tester can see what has already been tested and where a functionality has to be rechecked to be able to continue testing the subsequently functionalities. The checklist stipulates in which order the tests have to be carried out as the process steps will have the same order. The according process is portrayed in Figure 5.13.

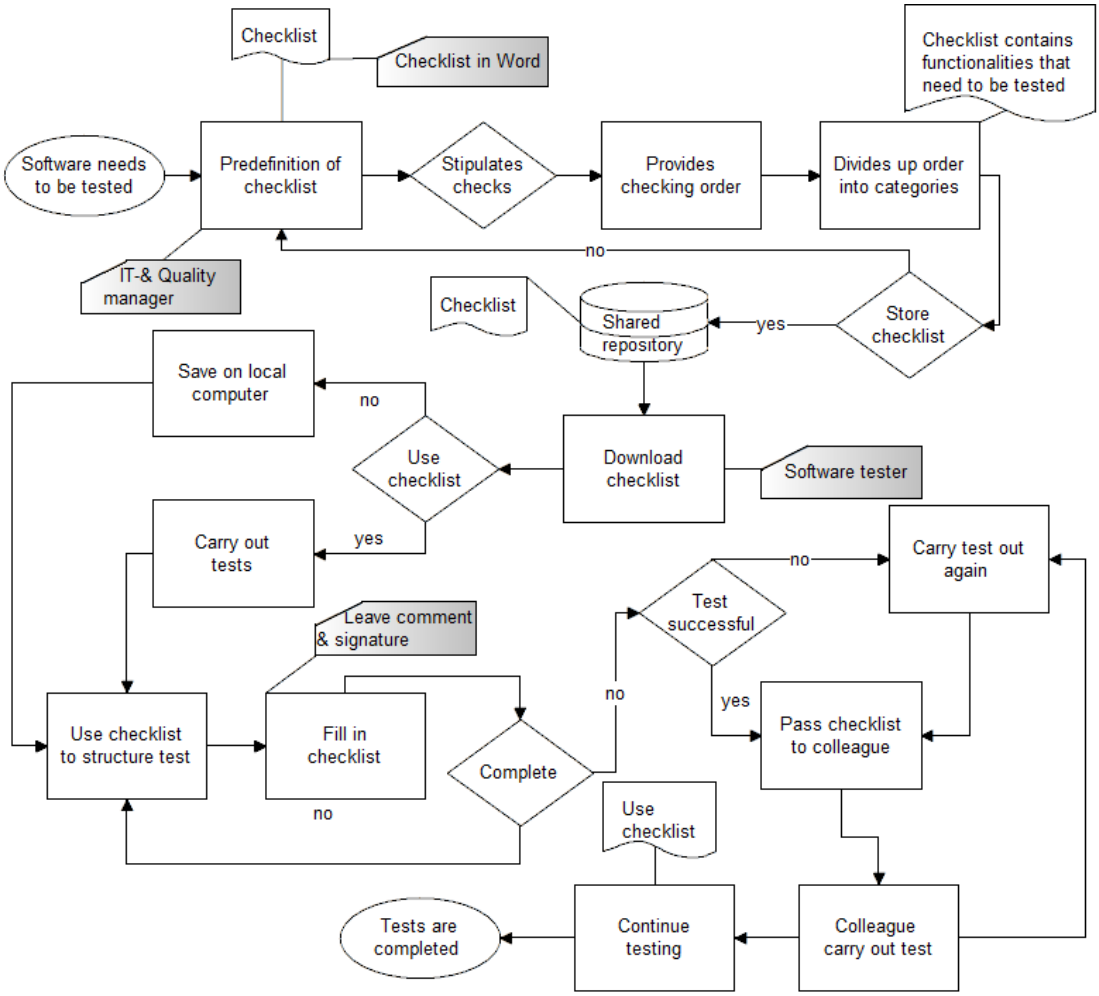

Figure 5.13: Process model for the CM checklist (own illustration)

Figure 5.14 illustrates the suitable component model. The components describe the actor who creates the checklist before the corresponding process is carried out. The list stipulates the activities and is used to ensure that all activities are carried out. The checklist can be passed to the collaborators (a team) in order to initiate subsequently activities that need to be carried out in a group by several people. It can also be the case that the predefined checklist is crate and passed to another single person. This individual can finish the tasks or can pass the checklist again to other actors.

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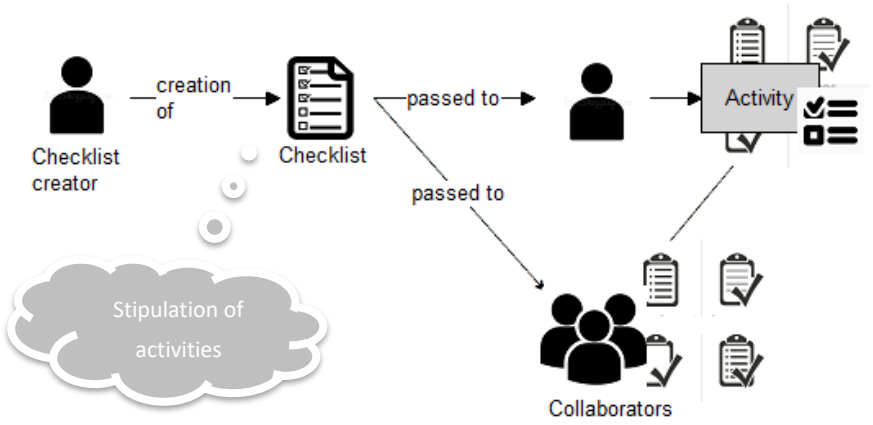

Figure 5.14: Component model for the CM checklist (own illustration)

5.4 Awareness Mechanisms (AM) – Investigation and Results

Comparable to section 5.3, this section also starts with the introduction to AM by defining and describing selected AM in both research areas, CSCW and ECS. Subsequently, the results derived from the presented concepts used for the investigation are outlined and visualised. The presentation of the results is also followed by the elaboration of the classification categories. For illustration purpose, scenario examples for some classification categories are presented that convey the most differences in their functionality.

5.4.1 AM Description

As already described in section 5.3.1, the first coding process, within the first coding cycle, is about the selection and presentation of existing AM examples that are identified in literature (c.f. Figure 5.1). Therefore, the coding cycle method of initial coding and In Vivo coding is applied. In Vivo coding is applied during the coding of the AM where the name of the mechanism is taken. Also for AM, the AM examples are listed in a spreadsheet to provide a first overview of the found examples.

Subsequently, Table 5-7 (AM) is created that contains definitions that are taken from the Oxford and Cambridge Dictionary and additionally general descriptions of all identified AM. Furthermore, the authors of the articles where respective mechanisms are found, are given. The general description contains information about whether the selected mechanism is considered appropriate to count as AM. It is discussed whether the AM is a tool used in distributed activities, i.e. when awareness is created by applying a tool. Or whether the AM is applied or created in a same physical location through activities. It is analysed whether people apply the mechanisms for themselves or whether they are automatically

being generated. The general descriptions of each single mechanism are useful to gain a greater understanding of the mechanisms and is grounded on the motivation described in chapter one. That is because the mechanisms are not well described in the article where they are identified. Since having filled in the table with raw data for a general description, another second coding process is initiated. Therefore, the concepts considered to be appropriate for classifying CM are transferred into tables and filled in with information.

Comparable to CM, the raw data material in the Table 0-4 of CT is coded by making use of first coding cycle methods that are Initial coding incorporating descriptive coding. Initial coding is used to break down collected data into different parts and further iterations. This included a comparison in the descriptions for similarities or differences that can be used to classify the mechanisms. Initial coding is considered appropriate because with it all theoretical directions for further steps remain open in research. Furthermore, for the respective descriptions of the different concepts applied initial coding provide the possibility to code the data quickly and spontaneously. In CT, descriptive coding is applied to find subgroups for the four main components. The most important information in each component are coded and collected together. The results are presented in section 5.4.2 in a mind map. Also in AM, it was identified that during the data collection some codes of mechanisms were overlapping and therefore were rationalised to improve the information. Furthermore, where mechanisms have the same meaning or resembling each other, are merged together.

The results of the other concepts applied for AM (c.f. Table 0-5 and Table 0-6) are not coded but presented in tables (Table 5-8 and Table 5-9). Another visualisation style was considered not suitable because the results provide more information about whether respective mechanism belongs to a component of presented concept or not. This contrasts with CT where more raw data material is collected. After the first coding cycle methods of the second coding process and the results of the concepts are presented and explained, the classification of CM is outlined.

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Table 5-7: Definition and description of AM in academic literature (own illustration)

Awareness mechanism	Definition of Oxford/ Cambridge Dictionary	General description	Literature
Activity Stream	ACTIVITY: "A thing that a person or group does or has done." / STREAM: "A continuous flow of data or instructions, typically one having a constant or predictable rate."	Originally coming from the social media sites like Twitter, Facebook and co. an activity stream is a tool that can be embedded in the application to deliver collaborative and social services that help to raise connections between people. These connections are used to provide awareness of the activities of others that concern their past, present and future, like the main page e.g. in Facebook. It is a subscribe and publish notification mechanism which lists activities of persons, groups, topics or everything else in the environment. "For example, a project management application may add status information, while a physical object connected to the Internet may report its state (e.g., tunnel lane closure) (Gartner, 2016). In enterprises activity streams enables people to interact and share behind the firewall (Guy et al., 2012), hence it syndicates the employees' activities across the social media integrated in enterprises (c.f. Guy et al., 2013). Activity streams, text and metadata, allow people to get informed about recent updates, discover new information relating to their personal interest and increase awareness of organizational processes (c.f. Guy et al., 2012; 2013).	Schauer & Zeiller (2011). Schubert & Glitsch (2016). Williams & Schubert (2015).
Alert	"A signal on an electronic device that prompts the user to do something or attracts their attention." / "(with to) watchful and aware."	Alert-services, also commonly used as "current awareness services" (CAS) (Fourie, 2006), are information services that are keeping their clients up-to date about new documents or events (Hinze & Faensen, 1999). It is comparable with the "up-to-the-minute" notification (c.f. Gutwin et al., 1996a, p. 282) of what is going on in a common workspace. It supports the organisation of information search and reduces the workload in time as subscribers always get informed about new activities and added content. Alerting services inform their clients over their personal defined objects of interest which are located at the supplier's side. The user is informed by e-mail (Barr, 2006) or RSS. One example is Google Alerts[15], typically delivered through a notification system. Alerts can also be triggered e.g. in a calendar as a reminder to coordinate appointments when an item is created, changed or deleted.	Bowers et al. (1995). Cabitza & Simone. (2013). Williams & Schubert (2011).

[15] http://praxistipps.chip.de/was-sind-google-alerts_8122 (accessed on the 06.10.2016)

Awareness mechanism	Definition of Oxford/ Cambridge Dictionary	General description	Literature
Community Bar	*(No definition found in the Oxford or Cambridge dictionary.)* "(in a graphical user interface) a narrow vertical area that is located alongside the main display area, typically containing related information or navigation options." / "a narrow area at the side of a page on a website, giving extra information or links."	A community bar is a tool that can be described as an AM that contains another AM. It is applied in groupware to support ad hoc situations that leverages also the design ideas of media items and sidebar metaphor. In the latter one, an actor get awareness of different groups at the screen and with media items rich multimedia awareness is offered through blocks (c.f. McEvan & Greenberg, 2005). A community bar can support casual interactions with colleagues as they are usually unplanned, brief and keep up individuals with information about each other contexts and facilitating the transition to collaborations using artifact (Romero et al., 2006). The display of a community bar is divided into different places that represent a subgroup, tools, communication and public information. In a menu actors can join or create other places that contain different multimedia items in order to provide awareness (like conversation, artifact etc.) for activities taking place in a common workspace. One example is the sidebar of the Windows Explorer.	Prinz et al. (2010). Tee et al. (2006). Tee et al. (2009).
Consequential Communication	CONSEQUENTIAL: "Following as a result or effect." / "happening as a result of something." COMMUNICATION: **"**The imparting or exchanging of information by speaking, writing, or using some other medium." / "the act of communicating with people."	Consequential communication, "the visible or audible signs of interaction with a workspace [4]. Watching someone work provides clues about their actions." (Gutwin & Greenberg, 1996, p. 209) is an AM, next to explicit communication, that is evoked by an actor during listen and watching the others as they work (Prasolova-Forland, 2002). In a shared workspace actors have the possibilities to monitor the bodies and gestures of their colleagues and infer what they are about to do (c.f. Tee et al., 2007) that is important in team operations. Consequential communication can be coupled with the feedthrough, where information is transmitted via a manipulated shared artifact in a group. Or information gets accessible by general characteristic actions of an actors' embodiment in the common workspace (Gutwin & Greenberg, 2000).	Gutwin & Greenberg (1995). Gutwin et al. (1996). Gutwin & Greenberg (1996).

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Awareness mechanism	Definition of Oxford/ Cambridge Dictionary	General description	Literature
Event Icon	EVENT: "A thing that happens or takes place, especially one of importance." / "something that happens; an incident or occurrence." ICON: "A symbol or graphic representation on a screen of a program, option, or window." / "a small picture or symbol on a computer screen that you point to and click on (= press) with a mouse to give the computer an instruction."	An event icon is a tool that provides awareness about recent document activity like reading or editing. By clicking on the event icon the actor can retrieve information about the time of change and who changed the document that is somehow resemble with version control. One software example that makes use of the event icon is the BSCW. Every performance in the workspace is recorded in the system and presents this information to its users, e.g. as an event icon attached to the document. Therefore, event icons can support awareness of events occurred in the last time in the shared workspace (c.f. Appelt, 1999) because they automatically inform other actors in the common workspace about recent activities.	Prinz et al. (2010). Bentley et al. (1997a; 1997b).
Feeds	"A facility for notifying the user of a blog or other frequently updated website that new content has been added." / "a web page, screen, etc. that updates (= changes) often to show the latest information."	A feed is a service that automatically provides information about recent changes and updates to a resource, for example in a wiki (c.f. Prilla & Ritterskamp, 2010). Normally they provide a summary of text-based resources and provide information of updates in a shared workspace, e.g. in a scholarly digital library, were one is subscribed that offers collaborative support through awareness. The usage of feeds allows its subscribers to stay aware of new published content. One example are RSS feeds and similar to push mails, the underlying protocol in feeds depend on client-side pull request.	Collins et al. (2005). Farooq et al. (2008). Williams et al. (2013).
Feedthrough	"An electrical connector used to join two parts of a circuit on opposite sides of something, such as a circuit board or an earthing screen." / "-" "the observable effects of someone's actions on the workspace's artifacts. Seeing an object move indicates that someone is moving it." (Gutwin & Greenberg, 1996).	A feedthrough is an AM that makes it possible for users to stay informed about recent activities that are carried out by another user through a shared artifact. When the shared artifact is manipulated (Dix et al., 1993) or changed by one actor it gives off information and reflects one's actor activity on another actors' screen that support the coordination of work. A feedthrough can be comparable to a feedback when people are working together providing awareness of the work of present actors. When an actors' activity and the artifact can be seen, consequential communication is coupled with the feedthrough. One example of a feedthrough is provided by Hill and Gutwin (2004) who consider a pushbutton in a groupware interface. When an actor moves its cursor over the button this will be highlighted to all others collaborative users screen. If the button is pressed, it will be pressed on all user's screens. The feedthrough it to show weather another person is also about the way to press the button.	Gutwin & Greenberg (1996). Gutwin & Greenberg (2002). Gutwin et al. (2004). Tee et al. (2009).

Awareness mechanism	Definition of Oxford/ Cambridge Dictionary	General description	Literature
Online Status Display	ONLINE: "available on or performed using the Internet or other computer network." / "connected to a system." STATUS: "The situation at a particular time during a process." / "an accepted or official position, especially in a social group." DISPLAY: „An electronic device for the visual presentation of data or images." / "the way in which words, pictures, etc. are shown electronically, for example on a computer screen."	The displaying of the online status of a member is a function that indicates the current absence or presence of a single actor in a shared workspace that creates awareness of other actors. E.g. the BSCW support this function where the indication of being present depends on the time span of the current and the latest activity of a user. It depends e.g., on the movement with the mouse in the window. In the example of BSCW, the status is coded by four different colour codes: Green, yellow, white and read. The users' activity decreases from green to red. Online status displays are also used in Instant messengers (IM) that support informal workplace communication (1:1) in collaborative settings to support coordination. An IM allow to create a "buddy list" to monitor easily who is currently available or off-line to clarify quick questioning, and impromptu meeting coordination (Tee et al., 2009).	OrbiTeam (2011). McEwan & Greenberg (2005). Romero et al. (2006).
Radar View	*RADAR: "*Used to indicate that someone or something has or has not come to the attention of a person or group." / "a system that uses radio waves to find the position of objects that cannot be seen." VIEW: "The visual appearance or an image of something when looked at in a particular way." / "what you can see from a particular place, or the ability to see from a particular place."	Radar view is a widget that presents a viewport of each actor in a common map of the workspace. The area in which actors are working and the activities they are undertaking is made visible for others. It renders the entire workspace that is shared within a small overview window where the activity of each user overlaps. Hence it supports the provision of information about people's interaction to a basic overview. With the viewports, the locations and telepointers of users can be indicated (Tran et al., 2006). Especially in situations where it is difficult to describe the activity verbally, the radar view can reduce the complexity of work as is shows its users where another user is currently looking at (Gutwin & Greenberg, 1998) that enhance the awareness in collaborative work. Because the entire workspace is shown, radar view provides awareness in relaxed WYSIWIS (Gutwin et al., 1996b).	Gutwin & Greenberg (1998). Gutwin et al. (1996b). Gutwin et al. (1996c). Tran et al. (2006).

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Awareness mechanism	Definition of Oxford/ Cambridge Dictionary	General description	Literature
Screen sharing/ Shared windows	SCREEN: "The data or images displayed on a computer screen." / "the surface on which films or television pictures appear." SHARE: "A part or portion of a larger amount which is divided among a number of people, or to which a number of people contribute." / "to have or use something at the same time as someone else."	Screen sharing is a function that allows actors to share their personal computer screen explicitly with colleagues in a common workspace to facilitate communication and to work together collaboratively. The content of one screen, mediated by privacy control, allows an individual to indicate which activities should be collaboratively used. This allows one person to show which topic he/she is working on to allow also interactions. Screen sharing is often embedded in video conferencing systems, integrating audio and video teleconferencing technologies, in order to support collaborations, teamwork and meeting for distributed individuals that leads to causal interactions (c.f. Tee et al., 2006; 2009). One social software example which allows its users to share their screen in enterprises is "Skype for Business"[16].	Dourish & Bellotti (1992). Tee et al. (2006). Tee et al. (2009)
Telepointer	*(No definition found in the Oxford or Cambridge dictionary.)* "A cursor used to mark the point on a screen display at which the presenter is pointing."[17] (no definition found)	A telepointer is a tool that can be useful to coordinate remote collaborative writings, like in ShrEdit or in general shared workspaces. They support the understanding of gesturing of team members even in distributed activities as gesturing provide an essential part of communication (Gutwin & Penner, 2002). Telepointers show location, presence and activity of users by watching their movements on their screen when an actor interacting with the shared context. Hence it can direct the attention of colleagues to particular documents. It allows the identification of co-authors that are editing a text part. The telepointer as a mouse cursor is made visible to more than one computer screen and can be moved by collaborators in a session by pick and release and whereas one person point on something, the co-author stays frozen (Santos, 2012, p. 87).	Dourish & Bellotti (1992). Gutwin & Penner (2002). Gutwin et al. (1996b). Tee et al. (2006). Tran et al. (2006).

[16] https://support.office.com/de-de/article/Freigeben-Ihres-Bildschirms-in-Skype-for-Business-2d436dc9-d092-4ef1-83f1-dd9f7a7cd3fc (accessed on the 09.10.2016)

[17] http://www.wordow.com/english/dictionary/?t=telepointer (accessed on the 18.10.2016)

5.4.2 AM Results of Applied Concepts

In the following section, all results concerning AM are outlined. The results are derived from the concepts applied which are listed in Table 5 3. The fitting tables are attached in the appendix of this thesis. However, the outcomes are described in a brief and a conclusion of the presented results is given.

5.4.2.1 AM Results in Coordination Theory (CT)

After the selected AM are described in more detail in Table 5-7, the concept of CT by Malone and Crowston (1990) is also applied at each AM. For illustration purposes, little example scenarios are provided for the respective mechanisms and the related components. For each component (activity, actor, goal, interdependency) the words considered most relevant for a later grouping of the mechanisms are underlined and presented in a mind map. This constitutes a part of the second coding process applying first coding cycle methods of initial coding including descriptive coding. The mind map is to provide a general overview of the results in CT that present all mechanisms together assigned to the components. To structure the collected information initial and descriptive coding is used to break down the collected information. The codes derived from each CT component are considered to be used to generate sub groups already leading to a small categorization. However due to overlapping, CT is not used finally for classifying the AM. The names of the subgroups are generated in that way that the coded words and phrases in Table 0-4 are compared and grouped by using descriptive coding. Figure 5.15 shows the original four component model with the first subgroups that are elaborated during the filling in of the mind map. The *activity* in a mechanism is, like the CM, divided up into *asynchronous* and *synchronous* activity. The component of the *actor* is divided up into two subgroups that are the *human*, the *actor* itself and *object* that is referred to as e.g. machine. *Interdependency* consists of three subgroups that are first a *shared resource*. This means that a resource can be required by multiple activities. Second, *prerequisite* is about an output of one activity that is required by a following activity. Finally, *simultaneity* describes that more than one activity can occur at the same time. The *goal* of applying an AM can be divided up into *timesaving* (faster collaboration), *communication* (ad hoc), *interaction*, *support* (what is supported) and finally *real time* that can be referred to as synchronous.

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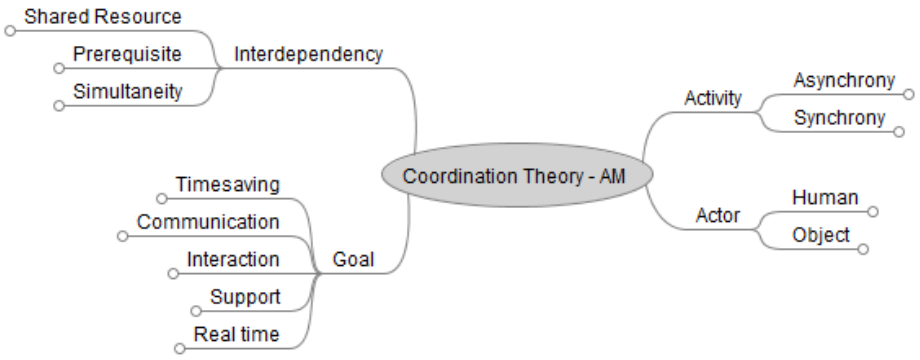

Figure 5.15: AM – CT parent nodes overview (own illustration)

AM Results in CT– Activity

The investigation of *activity* in AM in the concept of CT shows that contrasting to CM, AM are often applied for synchronous activities in collaboration (see Figure 5.16). For asynchronous collaboration the activity stream, alerts, event icon and feed are assigned. They provide awareness depending on historical actions, hence awarenss of recent activities that stay also visible for collaborators for the next day. The branch of *asynchrony* is divided up into two sub-branches that are *organisation* and *coordination*. Organisation descibes in which activity an applied AM can support the collaborators to reduce the complexity in work. It reveals that the automatic update of information is quite important and should be remarked by the actors involved. For instance, with an alert, collaborators in a shared space get aware of new changes to content that triggers automatically e.g. an e-mail as notification that is sent to the actor. Furthermore, to get attention and awareness of collaborators it is also interesting to show recent activities that are performed by actors. The activity stream for example, shows a listing of activities which are recorded as an event that triggers the resource update performed by an individual. The individual activities can be picked up in the community as awareness and can be used for other activities, like the publishing of news in the intranet by an individual person. For *synchronous* activities the other seven AM are considered. They are likely to be used at the same day for the same purpose in order to collaborate in real time. Distributed actors can come together e.g. for ad hoc coordination. The synchronous activities are divided up into three sub-branches containing *direct* and *indirct communication* and also *support*. Direct communciation can take place within e.g. a community bar. The AM can imply the facility of a chat where collaborators can join or initiate conversations or ad hoc questioning. Indirect communcation is provided for instance through a telepointer. When an actor moves the telepointer to a specfic place, he/she in general has the intention to make the remote collaborators aware of the specific item that he/she is pointing on. This indirectly communicates that this item is the one that should be modified, changed or something else. Also through gesturing information can be unintensionally and implicitly transmitted to collaborators with consequential

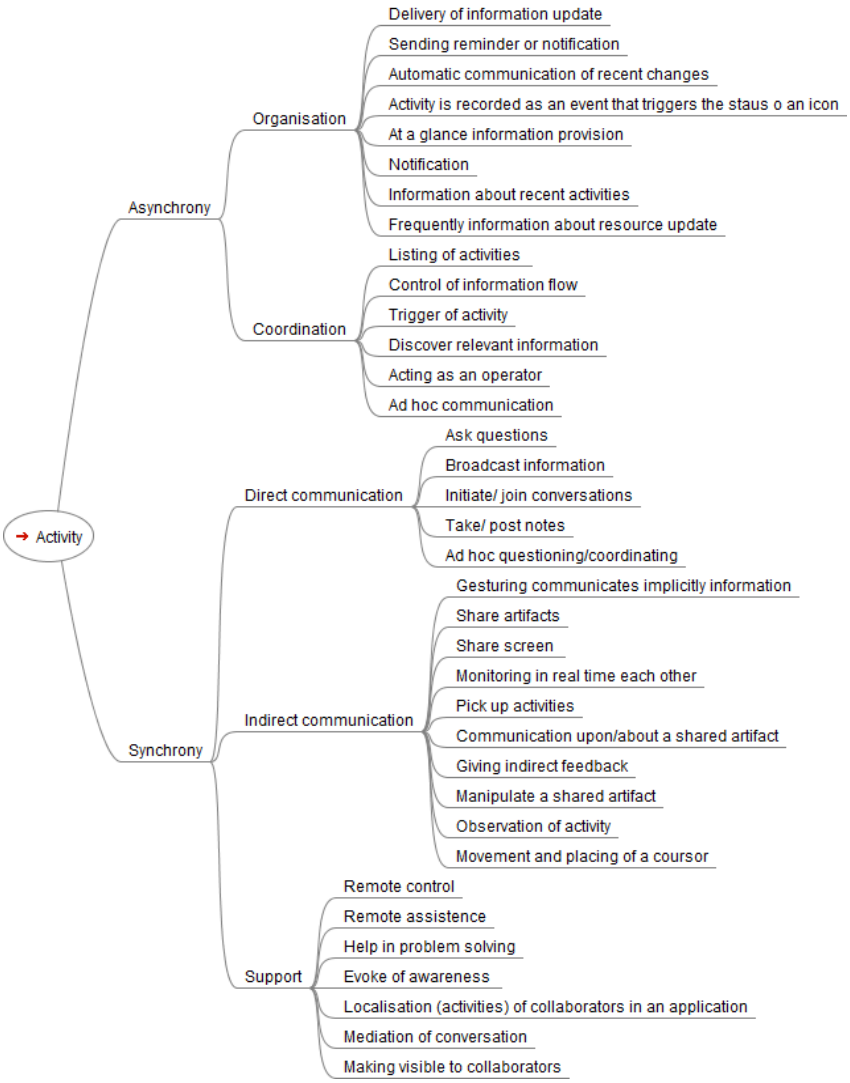

Figure 5.16: AM results in CT – component „activity“ (own illustration)

communication that evokes awareness. An other example is the feedthrough. This AM is used for indirect communication through a shared artifact. For example in an online chat an actor types a message in his text field on his/her desktop and sends the message to another actor. The message first arrives on his/her display and after some time the same massage is transmitted to the other actor and appears on the display. The third branch relies on the activity support reached through the applied AM. The selected examples in this thesis provide facilities for remote control and access like the mechanism of a screen sharing. Support takes place in the way that e.g. another person co-located in another country can take over control of the screen of another person without being present. This allows smooth collaboration or can help in local problem solving on the PC. In addition, with the support of a telepointer the mediation of a conversation in a group can be reached. The telepointers localisation indicates where one person is working on in the shared workspace and what he/she is about to do. Colab (Stefik et al., 1987) is regarded as an example where people can select pens, i.e. telepointer, to draw pictures together.

AM Results in CT – Actor

The results in the component of *actor* (see Figure 5.17) reveal that in general AM include activities performed by *human* actors, like a communication initiator in a community bar or a subscriber in a social community to receive information updates in form of feeds. Feeds or alerts can be grouped to a machine-to-person communication because interactions take place between these two actors. Changes to an item in a group calendar triggers an (e-mail) alert in the system that is send to another actor. In a

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closer sense, a first actor manipulates a shared artifact that triggers an alert which is communicated to another person. The purpose is that this person gets aware of the recent changes to the respective artifact. It can be remarked that in AM there is often a combination of a human actor and an *object*, i.e. an artifact that is manipulated by a human. A good example for this phenomenon is the mechanism of a telepointer. The telepointer is the common shared object that is picked up and released by different collaborators. By moving the telepointer (done by a human actor), the object is manipulated which is visible to remote collaborators. However, depending on the specific AM that is applied, actors can have different roles to use a shared artifact. Shared artifacts in general are visible to remote collaborators.

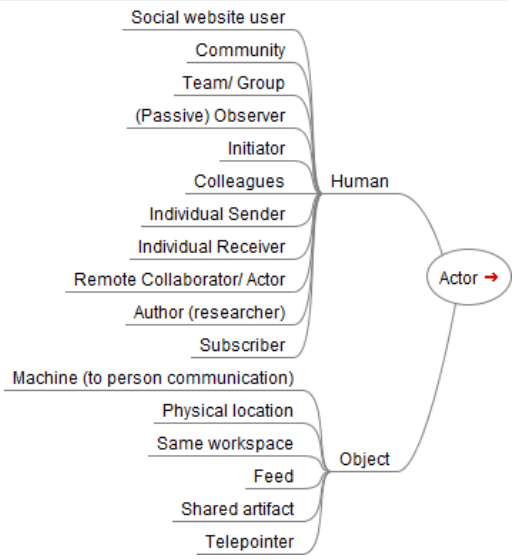

Figure 5.17: AM results in CT – component „actor“ (own illustration)

AM Results in CT – Goal

In the component of the *goal* in applying CT in AM, the component is separated into five sub-branches (c.f. Figure 5.18). The sub-branches are created by applying descriptive coding in the data information of CT to describe the selected AM. The five sub branches concern first *timesaving*. Timesaving, i.e. the reduction of the complexity in carrying out an activity for distributed actors, can be reached through AM. This criterion is achieved in the way that instead of traveling to another actor in another located enterprise, screen sharing can be applied that entails nearly the same opportunities for collaborations. The actors involved can see the same things, even if they are distributed in space, but are aware of the activities of their collaborators. By applying a feed as an AM, subscribers are frequently updated about new content that support awareness in a shared space. An advantage is, that the actor does not much time to search for the content. After subscription where they define the topics they are interested in, actors automatically get updated with information. The second sub branch describes *communication* that is supported by AM. For instance, an AM can provide indirect communication in form of a telepointer comparable to gesturing or a feedthrough. The feedthrough gives indirect feedback through communication upon or about a shared artifact, also in order to understand his/her own activity. Again, the example with the chat includes a feedthrough. The first actor types a message and sends it to another actor. First, he sees the message (feedback) and some time later the massage appears by the other actor (feedthrough). During the investigation of the selected AM it is remarked, that AM support *interaction*s in group work that describes the third sub branch. Interactions occur when more than two objects or humans are involved having effects on each other. This is also referred to as causal interaction. For instance, causal interactions are "… the brief, unplanned meetings that commonly occur during

the day between co-located people with shared interests" (Tee et al., 2009, p. 677) that can be supported by screen sharing. Computer screens can be explicitly shared by actors to collaborate because actors can see where collaborators are working on in real time. Also, alerts cause causal interaction as awareness is the effect of the received alert. The fourth sub branch covers, as the activities, the *support* for collaboration and awareness. AM provide facilities that can leverage awareness in a shared workspace, e.g. through active notification and reminding as it is used in alerts and feeds. Workspace awareness is supported through screen sharing or the application of telepointers. Those mechanisms for example provide remote collaborators with the real-time activities carried out by others. Like already mentioned, the last sub-branch relies on real time awareness. Through the application of some of the chosen AM in this thesis, distributed collaborators can coordinate their activities in *real-time* staying aware of synchronous activities that are carried out by other actors. AM can give actors' the impression to be at the same place, like it can be reached through screen sharing. Or the application of telepointers provides its users with real-time interaction in remote collaboration ensuring workspace awareness of actors' presence and their current activities. Telepointers support the pattern of signifying something that depends on human movements as their virtual location on the remote display.

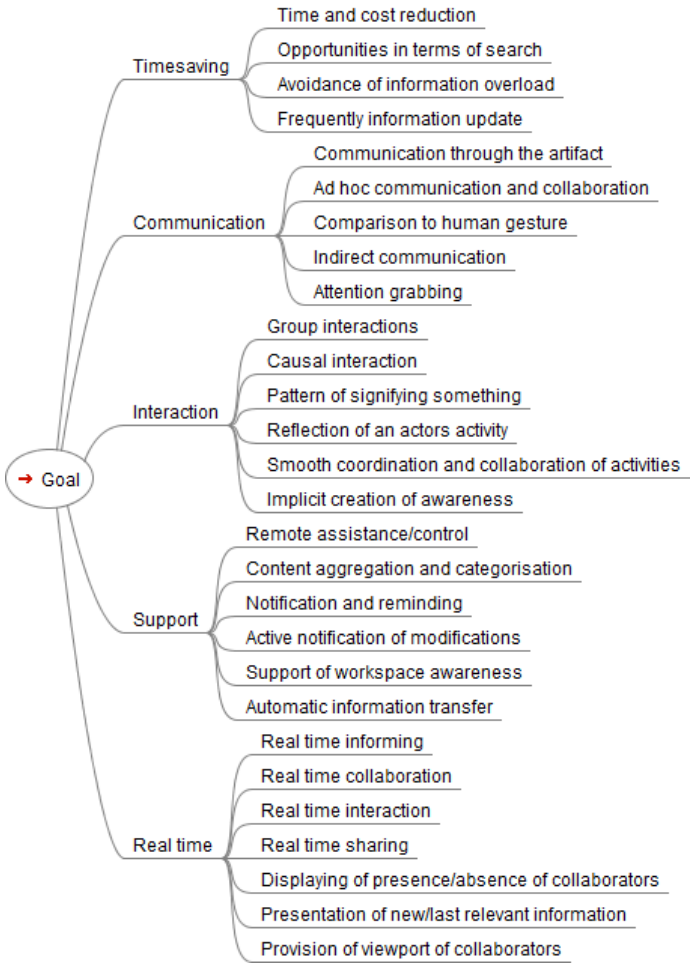

Figure 5.18: AM results in CT – component „goal" (own illustration)

AM Results in CT - Interdependency

The results in CT in the component of *interdependency* (c.f. Figure 5.19) for AM reveal that the three sub-branches already mentioned in chapter 3 fit to the results that are examined during the investigation of AM. The interdependencies that are described in CT could be assigned to a *shared resource*, *prerequisite* and *simultaneity*. The latter one is provided through the AM example of the community bar that implies further AM. Therefore, more than one activity can occur in a community bar at one time. For example, an actor can initiate a chat and simultaneously upload a document in a facility provided in

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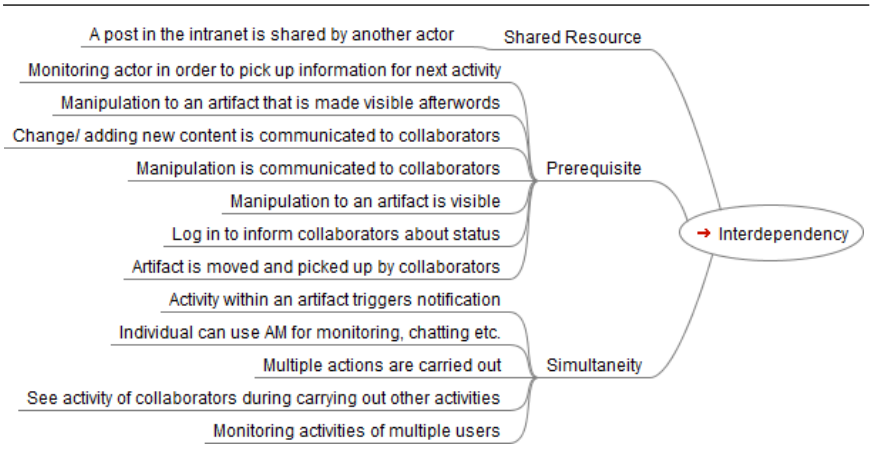

Figure 5.19: AM results in CT – component „interdependency“ (own illustration)

the community bar that needs to be discussed in the chat. Or a person can monitor a collage through one facility while there are discussing through a chat. Another AM example for simultaneity is screen sharing. For instance, an actor can monitor another actor as he/she works during listening to the other actor. By providing the possibilities to monitor the bodies and gestures of colleagues, collaborators can infer what others are about to do. This is important in team operations. However, most of the AM are considered *prerequisite*. For example, in the CM of a feedthrough activities that are carried out by actors are prerequisite. Interdependently from each other a first actor needs to manipulate a shared artifact so that another actor sees the manipulation and gets aware of the change. Another example is an alert that is only triggered after a manipulation on a shared artifact (e.g. a calendar) was carried out by another actor. I.e. the prerequisite interdependency means that one activity must occur in order that another activity is initiated or carried out. For a *shared resource* the activity stream is considered appropriate. For instance, an actor can post news on the intranet that is shared by another actor that creates awareness on the landing page among the team.

Conclusion of Results in CT – AM

Reflecting the results of CT in AM it reveals that contrasting to CM, most of the AM are used for synchronous activities. This implies often rather direct than indirect communication. With communication awareness seems to be ensured mostly. It can take place in physical location that provide workspace awareness or in a virtual shared workspace. Individuals often switch their attention between personal and shared activity. This includes for example information gathering like glances over at another actor's activity in a community bar. Most of the AM presented maintain a sense of awareness of where collaborators are located and what they are about to do. Actors can use their knowledge to assist colleagues in difficulties, e.g. with remote controlling. Like in CM, the roles of actors in AM can smoothly change, for instance, from monitoring to acting in consequential communication. It is often about the switching of a passive to an active actor. AM are applied in order to interact with collaborators and support them, possible synchronously in real time. However, AM often requires prerequisite actions like a manipulation to a shared artifact that needs to be done by an individual in order that this action is communicated to collaborators, like a feedthrough.

5.4.2.2 AM Results in Workspace Awareness

The investigation in the framework of workspace awareness for the selected AM reveals that a single AM is not assigned to only one framework type but at least two. This is possible because the framework types used for the analysis generally overlap, as outlined in section 0. The total results of the investigation for the selected AM are presented in the following.

The symbols used in Table 5-8 stand for the same meaning like for the results in CM.

- (✓) The awareness type does apply to the respective AM
- ("✓") Depending on the situation the awareness type does apply to the respective AM
- (×) The awareness type does not apply to the respective AM

Table 5-8: AM results – Workspace awareness (own illustration)

Framework of "workspace awareness" by Greenberg et al. (1996)

Awareness mechanism	Informal	Social	Group-structural	Workspace
Activity Stream (→ECS)	(×)	("✓")	(✓)	(×)
Alert	(×)	("✓")	(✓)	(×)
Community Bar	("✓")	(✓)	(✓)	(✓)
Consequential Communication	(✓)	(✓)	("✓")	(✓)
Event Icon	(×)	(×)	("✓")	(✓)
Feeds (→ ECS)	(×)	(×)	(✓)	("✓")
Feedthrough	("✓")	("✓")	(✓)	(✓)
Online Status Display	(✓)	(×)	(×)	("✓")
Radar View	(✓)	(×)	("✓")	(✓)
Screen Sharing	(✓)	(✓)	("✓")	(✓)
Telepointer	(✓)	(×)	(✓)	(✓)

After assigning the AM to the different awareness types, going from right to left, the following results for workspace awareness are be recorded:

- (✓) Nearly all of the selected AM in this investigation can be assigned to workspace awareness, excepting activity stream, alert, feeds and online status display. These mechanisms can be used also for asynchronous actions whereas the other seven mechanisms seem to be applied more in synchronous interactions. The respective mechanisms provide information about the current status of the actors in the workspace or on what they are currently working on. For example, screen sharing provides its user with a real-time transfer of the knowledge of the activities of other people because it creates the impression for the user to be at the same place interaction with other people around that takes place in real time.
- ("✓") Feeds and online status display can provide workspace awareness. For example, the online status display provides its users with information on the absence or presence of collaborators in the shared virtual workspace. However, the real interaction within the space is not communicated to the collaborators. Feeds can be assigned to workspace awareness, depending

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on the interpretation, but the workspace in this case can be defined as the website, e.g. a scholarly digital library, where a user is subscribed to. Information update or changes on this website are then shared in this workspace.

- (×) The activity stream and alert are considered inappropriate for workspace awareness because they do not provide information about an actor's presence and their current work in the workspace, comparable with the up-to-the-minute knowledge of actor's interactions with the workspace. Those mechanisms can be used also for asynchronous actions whereas the other mechanisms seem to be applied more in synchronous interactions.

In the framework for group-structural awareness following results are pointed out:

- (✓) Six of the eleven AM are assigned to group structural awareness. The example explained here is the example of a telepointer. A telepointer gives a user an overview of the other users' activities and movements on the shared artifact or screen. The telepointer clearly shows the movements of other users in the process. Roles are delegated to the person moving the telepointer, while the others are only watching. This means that one role is assigned to a user, actively moving the telepointer, and another role is assigned to the passive observer.
- ("✓") Four mechanism, consequential communication, event icon, radar view and screen sharing can somehow be assigned to group-structural awareness. For instance, an event icon can provide information about activities and status of a person in a process. In BSCW an activity (uploading a document) of a person can be visualised with an icon that will be presented to other users in the workspace having only the role to view the document.
- (×) The online status display is the sole AM that is not assigned to group-structural awareness because the people's roles, responsibilities and their positions on an activity like their status in a process is not transmitted to collaborators. However, information about recent activities, in a closer sense activities (being presence or absence) in the shared workspace of people in the virtual workspace are conveyed.

In the social awareness type the following results are recorded.

- (✓) The community bar, consequential communication and screen sharing are assigned to social awareness. These mechanisms are considered appropriate because in general, they provide the facility for its users to see also other people in the virtual space. Not only a cursor and their movement but their real face like it can be in a shared office in face-to-face situations. For example, screen sharing can be used for synchronous conferencing that is video based. Through the video users get aware of the emotional state of others, that is close to real communicative situation. Also, gestures can be picked up and the main focus of the collaboration gets clear like it can be found in consequential communication, too. Depending on the current situation, through non-verbal cues, like eye contact or gesturing, people can pick up social maintained information in the workspace that provides consequential communication.

- (“✓") Depending on the specific situation, activity streams, alert and feedthrough can be assigned to social awareness, but seldom. For instance, an alert maintains information about the level of interests of an actor in an asynchronous way (e.g. knowing that a colleague has also received the update information). However, their emotional state is not made visible through an alert. The level of interest of collaborators can be provided through those mechanism, but a remark of the natural body language of collaborators stays hidden.
- (×) The remaining mechanisms, i.e. event icon, feed, online status, radar view and telepointer do not provide social facilities. Neither of those mechanisms can express body langue, facial expression or back channel feedback. For example, an event icon only communicates a manipulation or recent activities without any human interaction.

The results for the informal awareness type reveal that:

- (✓) The mechanisms of consequential communication, online status display, radar view, screen sharing and telepointer are considered appropriate for informal awareness because they support the information transfer of who is around in the shared space. The online status for example shows its users if another actor is absent or present in the shared space, which is comparable with the real office situation that provides awareness of colleagues and their attendance. Screen sharing also provides real workspace awareness in the way that users can have the impression to be in the same office with the other collaborators because they see and are aware of the other users’ activities.
- (“✓") Depending on the specific situation, a community bar and feedthrough can be assigned to informal awareness. In a community bar it depends on the awareness facilities that are installed in the CB that could be used to provide informal awareness. A feedthrough can be informal e.g. when an actor modifies an object in the shared space, his action is visible to the other users, in a physical or virtual workspace that indirectly indicates that this person is available at this moment.
- (×) Activity stream, alert, event icon, feed are considered inappropriate to provide informal awareness because they can rely on asynchronous use, hence by applying those mechanisms users get not informed about colleagues and their attendance in the shared space.

5.4.2.3 AM Results in Awareness Support

Dourish and Bellotti (1992) describe two forms of awareness support (c.f. Table 5-9) that are reached through the application of AM. The support concerns the informational and role restrictive support. The latter one arises through the explicit support for roles built into a collaborative system where people are assigned to and provide information about the character of an activity. To say whether a mechanism can be assigned to role restrictive support or not is difficult because roles are fluent are hart to define in this case. In contrast, the informational support provides explicit facilities enabling collaborators to inform each other of their activities.

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Nearly all selected mechanisms can be assigned to the information support. This result is not surprising because AM are explicitly applied in order to be aware of the activities of others and to inform collaborators about one personal activities. The results reveal that:

- (✓) The AM listed below are considered appropriate to be assigned to informational support because in general they provide facilities for synchronous actions that allow its users to inform each other about their individual or collaborative recent activities. An event icon also supports awareness that gives off information about recent activities happened since their last visit in the shared workspace.
- ("✓") Consequential communication, alert and online status display can be assigned to informational support. For example, consequential communication does not provide explicit facilities to inform each other about recent activities, whereas an activity of a person is picked up by another person who implicitly infers what the first person wants to do. Similarly, an online status does not provide explicit facilities to inform each other about recent activities but about the recent presence in the shared space.
- (×) No mechanism is considered appropriate.

As already mentioned above, role restrictive support is difficult to define because roles seem to be fluent in AM. It depends on the interpretation of the current situation where the AM is applied.

- (✓) Nearly all AM in this investigation can be assigned to role restrictive support because in applying the diverse mechanism by its users, the roles that are assigned to the user can fluently change. For example, actors can have first the role of an observer that then changes to the active role, e.g. like in the application of telepointers that can be picked up and released in collaborative ensembles. In general, the roles in AM change from active to passive roles and vice versa.
- ("✓") Activity stream, feed and event icon can, but not have to be role restrictive. For example, an event icon does not provide information about roles because people are generally not assigned to icons. However, with an icon an action of a person is made visible that can somehow be a role, e.g. when a person uploads a document, the icon is matched with this activity carried out by the specific person. It really depends on a current situation where a specific AM is applied.
- (×) The online status display in collaborative systems does not support roles. The relationship of individuals stay unknown because they only provide information about the users' presence in the workspace, which is not comparable with a role that occur in collaboration scenarios.

Like for the CM, it is also intended to derive classification categories from the results of the concepts applied in AM. However, based on the comparison of the results that are overlapping, presented concepts are also neglected for further investigation.

Table 5-9: AM results – Awareness support (own illustration)

Awareness support by Dourish and Bellotti (1992)

Awareness mechanism	Informational support	Role restrictive support
Activity Stream (→ ECS)	(✓)	("✓")
Alert	("✓")	(✓)
Community Bar	(✓)	(✓)
Consequential Communication	("✓")	(✓)
Event Icon	(✓)	(×)/("✓")
Feeds (→ ECS)	(✓)	("✓")
Feedthrough	(✓)	(✓)
Online Status Display	("✓")	(×)
Radar View	(✓)	(✓)
Screen Sharing	(✓)	(✓)
Telepointer	(✓)	(✓)

5.4.3 AM Classification

Having completed the second coding process (using first coding cycle methods) concerning the concepts applied for AM, respective mechanisms are now classified. During the first and second coding process, it is realised that CT neither nor the other concepts (framework of workspace awareness, awareness support) are suitable for a classification. One reason is the smooth overlapping of AM in the concepts themselves, for instance in workspace awareness as the framework itself is overlapping. A clear assignment to a single component is almost not possible because it can depend on the specific situation where an AM is applied in particular. This observation leads to revision of the data material that could be useful for the mechanisms classification. Finally, it is decided to use the general descriptions of the single AM (c.f. Table 5-7) for classifying the AM, like it was already done in CM.

In order to do so, another coding cycle as a part of the first coding process is initiated (c.f. Figure 5.1). The definitions and general descriptions in Table 5-7 that convey most interesting information are coded by making use of initial coding in combination with descriptive coding as a first coding cycle method. According to Saldaña (2009, p. 70), descriptive coding is useful to analyse data and derive basic topics from it that lead to the categorization of the data based on the application of a second coding cycle method.

The descriptive coding, as a first cycle method follows the second coding cycle method. For the second cycle coding method pattern coding is applied as it is proposed by Saldaña (2009, p. 152). Pattern coding compensate material into more meaningful units. It is useful to group data summaries into a smaller number of sets. In this case the classification categories for CM. In order to do so, similar coded data from Table 5-7 are compared for commonalities and are assembled together inTable 0-8 to create a pattern code. In some cases, the coded data provide no differences that facilitated the pattern coding. The derived pattern codes in the second coding cycle produce five codes that present a classification category, presented in Figure 5.20.

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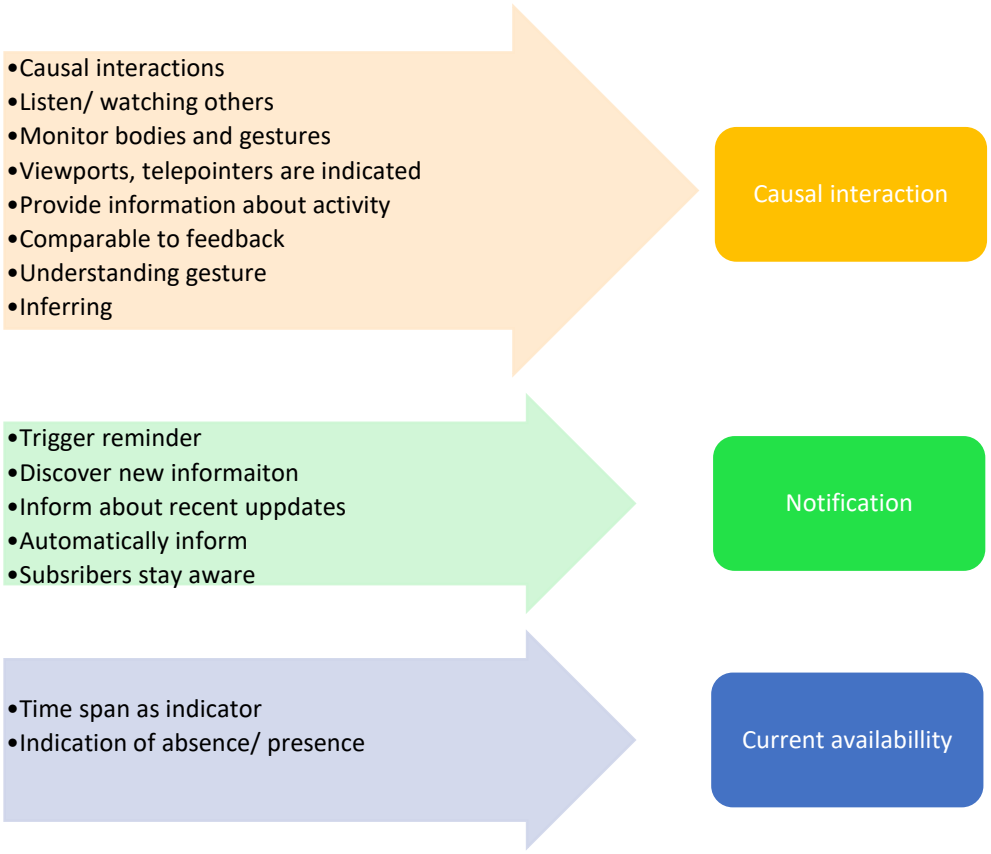

Figure 5.20: Pattern codes derived in AM (own illustration)

Each of the above-mentioned categories (causal interaction, notification and current availability) are defined in more detail in order to carve out what the particular AM have in common. Figure 5.21 illustrates which AM are assigned to which classification category. Starting with the category of causal interaction it was realised that six AM resemble in their general description.

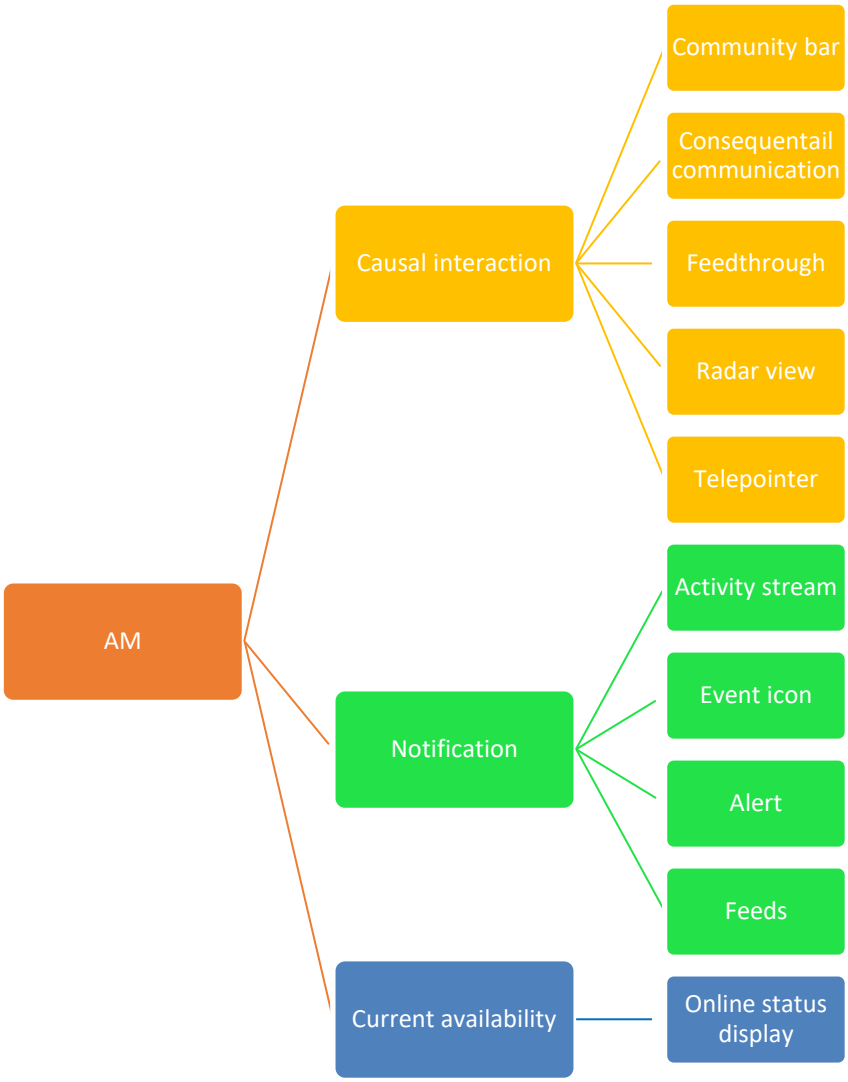

Figure 5.21: Classification category AM (own illustration)

Causal interaction

The six AM, community bar, consequential communication, feedthrough, radar view, screen sharing and telepointer are classed with the category of causal interaction. Causal interaction describes the activity that occurs during looking, talking or sharing something with another person, i.e. reacting to each other.[18] The term of causal underlines the closer relationship between the interactions, by meaning that one activity (the cause) is linked to another activity (the effect). In other words, the second activity is dependent from the first activity.[19] All the mechanisms mentioned above are considered to have this

[18] http://dictionary.cambridge.org/de/worterbuch/englisch/interaction (accessed on the 15.11.2016)

[19] http://dictionary.cambridge.org/de/worterbuch/englisch/causal (accessed on the 15.11.2016)

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characteristic in common. Regarding the general description of the AM, consequential communication and feedthrough can be used to provide an example. Consequential communication is evoked by an actor during watching or listening to other actors during their work. By monitoring the gestures of each other (cause) they can infer about what the other actor is about to do (effect). Especially when consequential communication is coupled with a feedthrough, the manipulation of a shared artifact (cause) is transmitted via the artifact to another actor. This actor picks up the manipulation of the shared artifact for his activity (effect). The other three AM, radar view, screen sharing and telepointer have additionally in common that they only create awareness among a PC screen. With the radar view, that provides a viewport of the collaborators activities and localisations, information about the interactions of people are made visible on the individual screen. Actors can follow telepointers that is already the effect from a previous action, i.e. that another person moves the telepointer. Similar is the AM with the telepointer that is already combined with radar view. In a closer sense, actors pick up the activities of collaborators (effect) on the screen that is caused during work collaboratively in a shared workspace. Furthermore, one can say that an AM can be included somehow in other AM, like the telepointer in radar view. Radar view can be implied in a community bar that can also include a facility to share a screen. That can be also a reason why those mechanisms are classed with the same category.

Notification

The second classification category coded is notification. Four AM, the activity stream, alert, event icon and feeds, are assigned to notification as they have this characteristic in common. By notification it is meant that a message is automatically send to an actor in order to provide him/her with the information about new activities in a shared space where one is subscribed. In the Cambridge Dictionary [20] the example of a social media account is given that describes the activity when someone has commented something or has written something on somebody's personal Facebook wall. This example is considered appropriate as the activity stream as an AM can be assigned to Social Media and i.e. to social enabled ECS. Overall, the four AM provide their users (or subscribers) with information updates to content or activities that are triggered automatically when recent changes in the shared workspace occur. This action is transmitted to actors as a notification, e.g. as feeds. The feeds can also be combined with an alert as it attracts the user's attention. The mechanism provides their users with an alert, icon, e-mail, symbol etc. that attracts the attention and simultaneously creates awareness about recent activities.

Current availability

The final classification category describes current availability. With current availability it is meant that the AM provide collaborators with information about the availability of colleagues, i.e. it provides information about whether someone is free to speak for work, etc. The online status display is the only AM assigned to this classification category. All other AM are not assigned to this group because they are

[20] http://dictionary.cambridge.org/de/worterbuch/englisch/notification (accessed on the 15.11.2016)

more dynamic, i.e. that activities within the AM are more complex and do not have the focus on displaying the current availability collaborators. As part of the collection of AM, it was decided not to include for instance the Instant Messenger as a separate AM as it resemble to the online status diplay and thus were merged together. Both AM provide the same awareness form. However, the online status display is the more general AM and therefore selected in the study.

5.4.4 AM Scenarios and Visualisations

Three classified categories in AM are established during the second coding cycle. The categories, excepting the category of current availability are described in more detail. For each category one AM is chosen conveying the most information about the application of an AM. In order to do so, scenario examples are described firstly. These scenarios are visualised by paying attention to the process that is created by using the respective AM. Additionally the components included in the AM are presented, too. The category of current availability is omitted because it doesn't provide additional information. In addition, the AM of current availability can be part of the other AM too. Therefore, the two categories chosen for AM in this thesis are:

Causal Interaction > Feedthrough

Notification > Activity Stream

5.4.4.1 Category: Causal Interaction

Scenario: Feedthrough

Susi and Peter are working together on a single document. In order to facilitate communication, they use the online chat function in Skype for business. Susi has a question regarding the modification to the document created by Peter. She types in her message text into the chat window. After she has proofread her question she sends this message by entering it. The message is transmitted through the Internet to Peter. Susi sees that her message was sent and some seconds later Peter receives the message on his chat window and reads it. He reacts to Susi's question by answering the question. He decides to do it also per chat function instead of going into her office to talk to her personally. The scenario is visualised in Figure 5.22.

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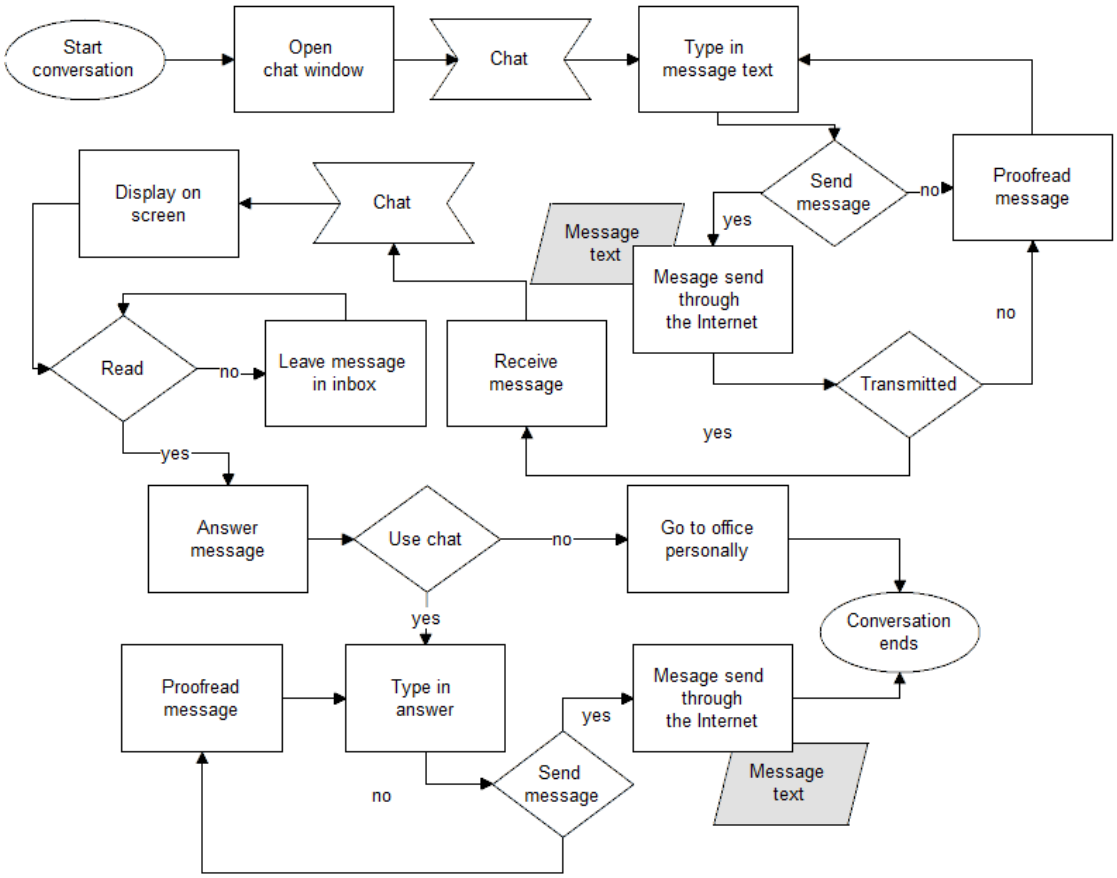

Figure 5.22: Process model for the AM feedthrough (own illustration)

The fitting component model (see Figure 5.23) shows how actors manipulate the shared artifact. The manipulation of the artifact gives feedback on control to each single actor, e.g. user x is typing. Meanwhile the information transfer is transmitted as a feedthrough to the collaborator. The feedthrough can be coupled with consequential communication that shows the reaction of collaborators after the manipulation to the shared artifact.

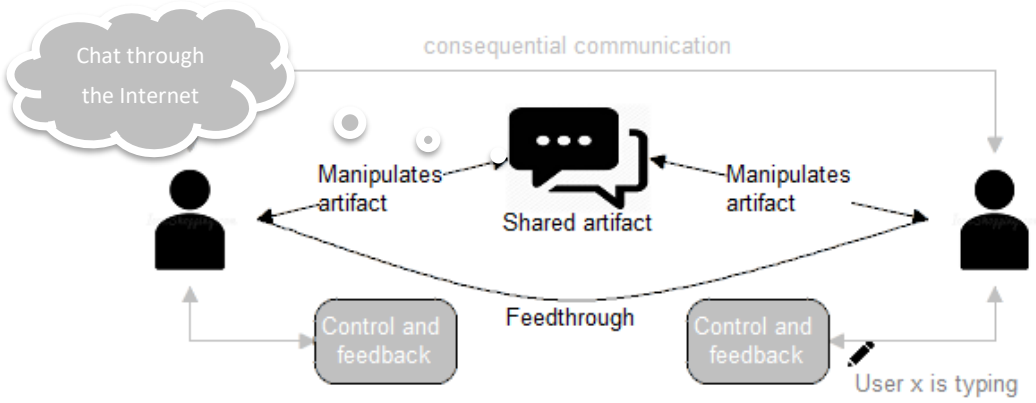

Figure 5.23: Component model for the AM feedthrough (own illustration)

5.4.4.2 Category: Notification

Scenario: Activity Stream

The enterprise abd has introduced the new collaboration platform of chatter[21]. Chatter is used for instance to recommend relevant content to communities that includes people, files, and information based on defined activities and interests. Additionally, it provides information updates about recent activities in the shared space. On the landing page of the Intranet in abd and its community of the sales department, employers get aware of recent activities. For instance, Anna (employer) has created a wiki component in chatter for the sales department in order to collect and store important information for the team. Annas activity is displayed in the activity stream. Christian, her colleagues, comments this activity as he likes this new component that is also displayed in the stream. Anna writes a message and shares the information about the new component in the community. Additionally, she adds and recommends a hyperlink where her colleagues can look up how to fill in and use the wiki. The recommendation functionality triggers an e-mail to the community users. All these activities are presented in the activity stream that provides also the date and time when recent activities took place. The scenario is portrayed in Figure 5.24.

[21] https://www.salesforce.com/products/chatter/features/ (accessed on the 21.11.2016)

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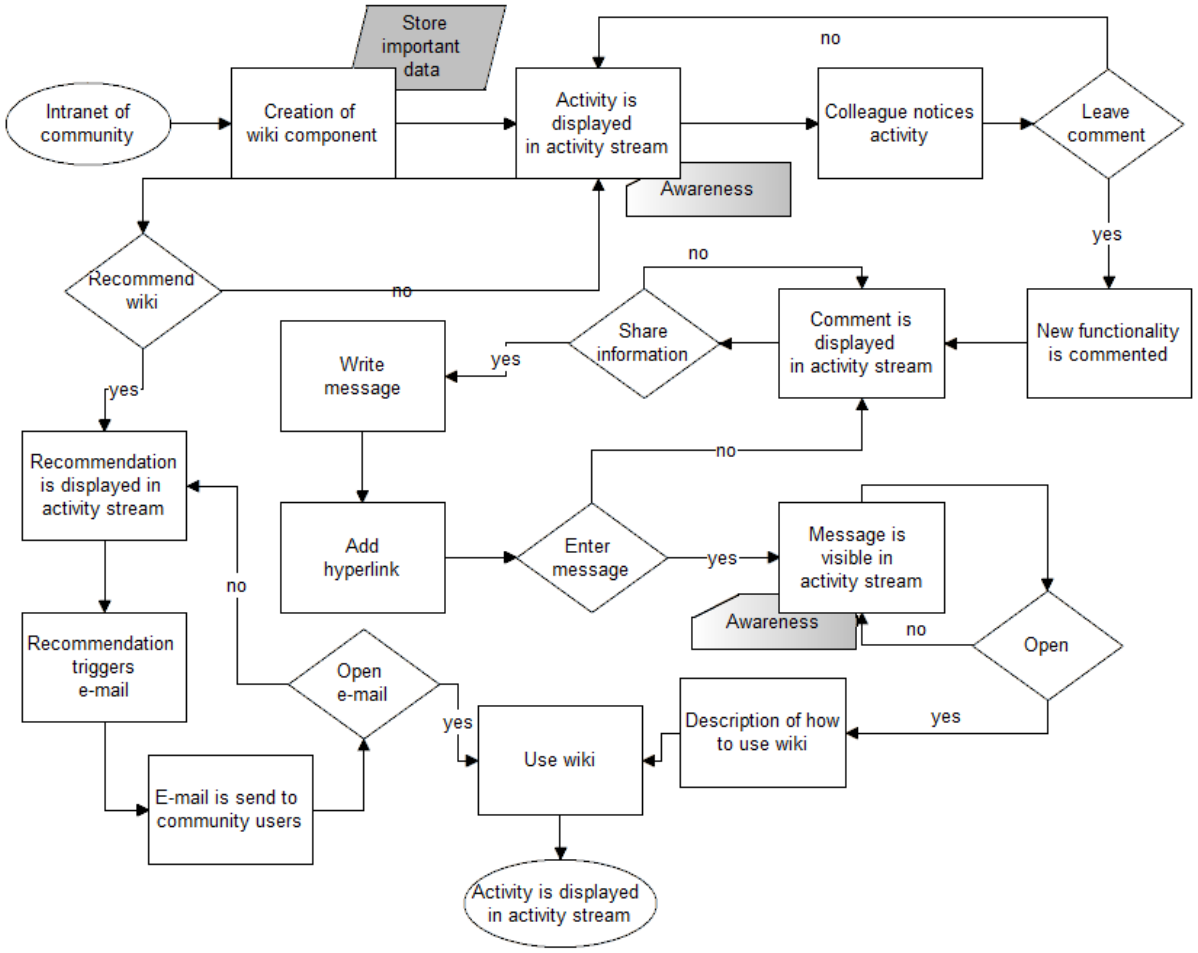

Figure 5.24: Process model for the AM activity stream (own illustration)

The belonging component model in Figure 5.25 portrays the different components that can be included in an activity stream. The activity stream alerts its users about every action that is performed in the community on a social website, comparable to Facebook. For example, when someone adds a new person to one's profile this information might be included in the activity stream of Facebook visible to all the other people this person is connected. The information update includes information that leads directly to the resource behind the update that facilitates information retrieval.

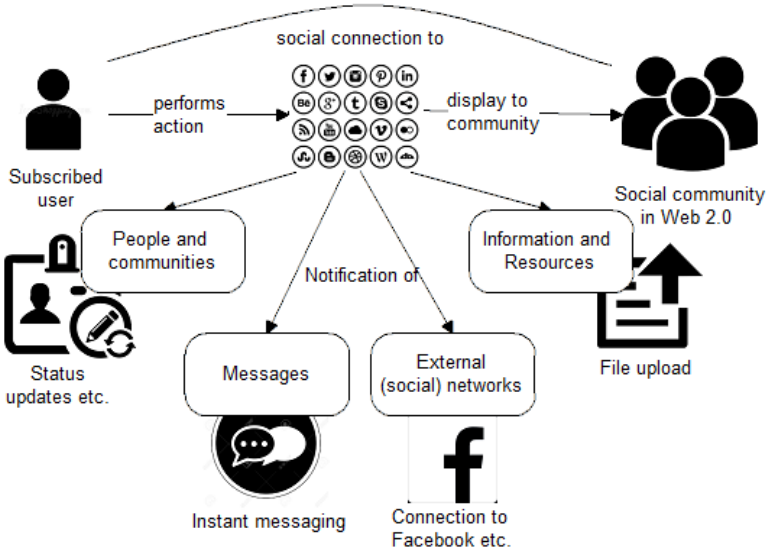

Figure 5.25: Component model for the AM activity stream (own illustration)

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6 Exploratory Investigation

As part of this exploratory investigation it examined whether the identified and classified CM and AM can also be found in ECS. For this purpose, the socially-enabled ECS IBM Connections that is used at the University of Koblenz is analysed, due to its accessibility. This phase represents the third phase (exploration) of the research design, incorporating two research steps. Firstly, IBM Connections is investigated by comparing and checking the presented CM and AM examples of the theoretical part in the Social Software platform itself. The landing page and further integrated software modules of the "Oberseminar" community FGBAS and FGEIM (University Koblenz) are used as examination examples in IBM Connections. Secondly, IBM Connections is investigated by browsing through the platform. It is expected to identify new CM and AM due to its new Social Software functionalities traditional ECS does not incorporate.

6.1 Checking of CM and AM examples in IBM Connections

The checking of the CM and AM examples, as a result of the theoretical part, to IBM Connections reveals that almost all CM and some of the AM are integrated and used in the platform.

The found CM are red highlighted in Figure 6.1 and Figure 6.2. Nearly all CM could be found in IBM Connections except for the catalogue, index, schedule and SOP. One reason for it might be that a schedule and SOP are created by actors in textual and visual form and are added to the software. It is possible that users provide these CM in IBM Connections, but as a part of this practical investigation they were not identified (maybe also due to access control to communities and the included roles for users). However, the other CM, memo, tag, plan, checklist, chat (message), comment, spreadsheet and template are not included in the software itself but are additionally added by actors in IBM Connections in the form of artifact based content or document. For instance, tags are created by the actor who, for example, uploads a document. In order to characterise this document, a tag is added. Finally, the most common tags are also presented in a tag cloud on the left side in IBM Connections. A schedule, for instance, in the "Obserseminar" community is created and modified regularly by the supervisors of the research groups FGBAS and FGEIM. The content of the plan as a shared artifact is malleable by the actors and can be manipulated to the current situation. Indeed, a checklist is detected as the "Anwesenheitsliste" in the Oberseminar. The Anwesenheitsliste includes the names of students who attended the Obserseminar course units. Every time when the lesson takes place, the attendees have to sign the document that is passed through during the lesson. However, it is a predefined document that is usable for recurring actions. It is detected that a spreadsheet can be included in a CM that is used as a template. A comment for instance, can be attached to a template that includes information about telling for what activities the template should be used for. The CM version control, already implemented in the software, shows the actors in the form of a version number that the same but manipulated document was uploaded. In a closer sense, user have to upload the same document in order that the version control reflects that

the artifact was manipulated. The group calendar exists also in the platform. However, its content needs to be added also by the user itself to coordinate their work.

The identified AM are highlighted in the colour orange in Figure 6.1 and Figure 6.2. The AM of an alert, feeds, activity stream, event icon, online status display, feedthrough and consequential communication are found in the platform. The AM feeds allows the user to decide which subscription he/she is interested in and wants to get informed frequently (c.f. Figure 6.2). The online status display can be changed by the actor as he like to be visible to the community subscribed to or not. The user has also the possibility to be shown as offline, even if he is online. By clicking on the online status window, a separate chat window opens. This window provides the functionalities to start a chat with another user added to the chat window. This mechanism is coupled with a feedthrough and consequential communication. Users can control and get feedback when they write a message for instance and enter it in the chat window. The feedback is that the user sees that the message is entered. The feedthrough occurs when the message is transmitted through the Internet to the other user's chat window. This is coupled with consequential communication as the second actor reacts to the message in form of answering in the chat. The AM of an activity stream in IBM Connections at the University fits to the topic of "Neuigkeiten" on the left column. In this area, most recent information updates, like that somebody uploaded a file in a shared space, appears at the top of "Neuigkeiten". By clicking on the new information, the user is directly directed to the original folder or space where the upload was originally done. The symbol of the bell on the right top fits to the AM of alert/ event icon. When news are shared in the community a user is subscribed to, it can be highlighted in red showing that 1 to n updates took place during the absence of the respective user.

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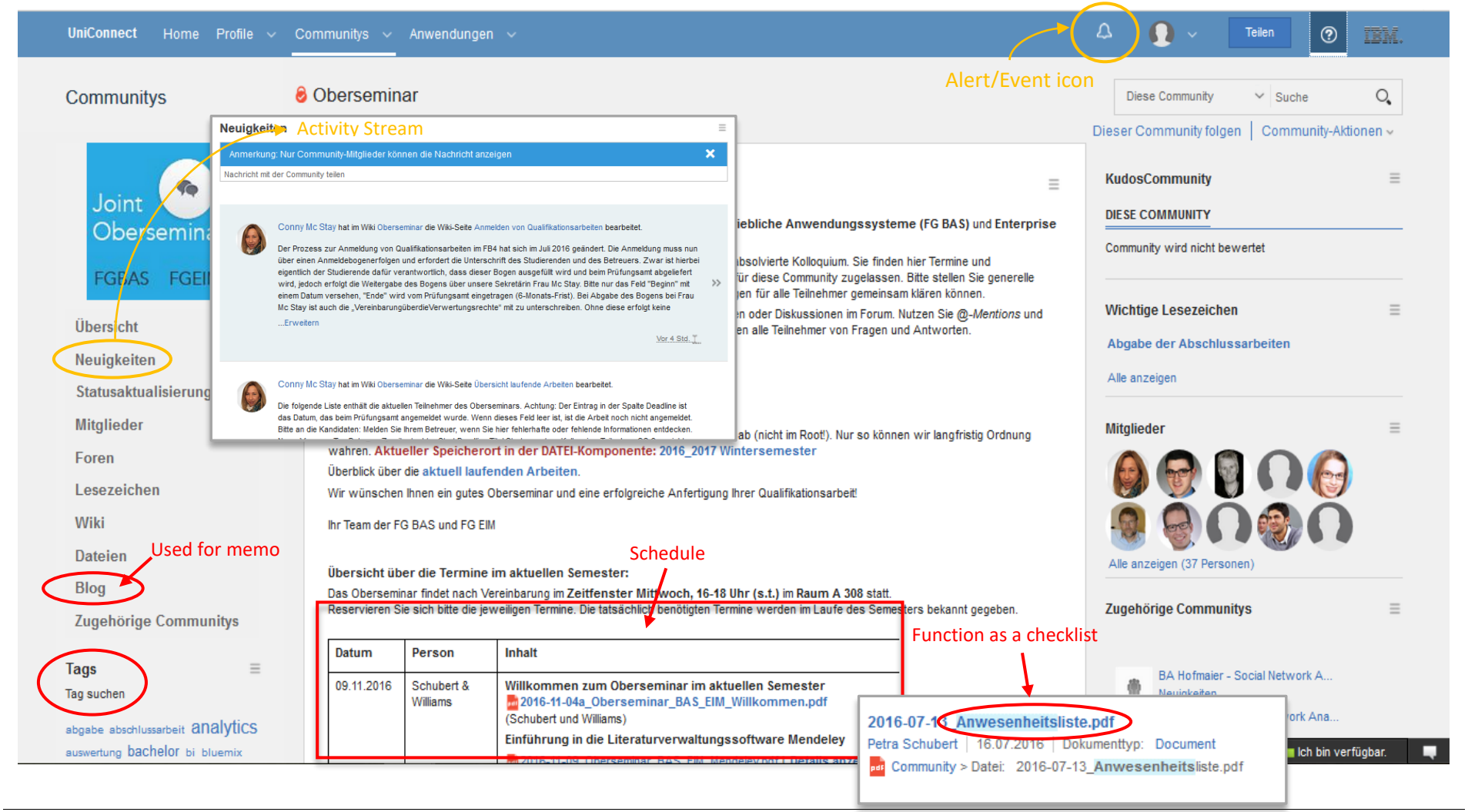

Figure 6.1: Screenshot (1) IBM Connections – CM and AM check (own illustration)

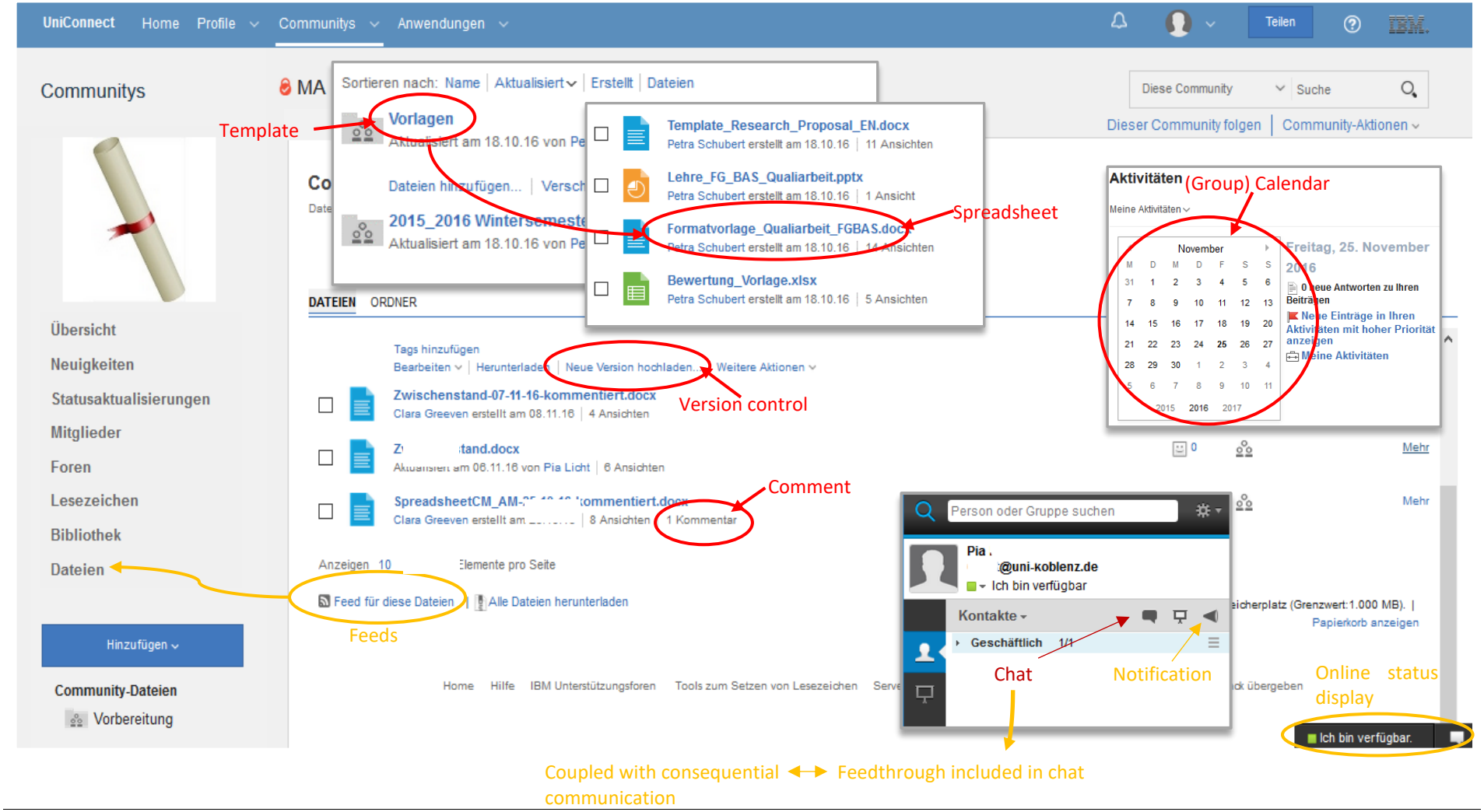

Figure 6.2: Screenshot (2) IBM Connections – CM and AM check (own illustration)

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6.2 New (and old) CM and AM in IBM Connections

Following the comparison of the CM and AM examined based on the existing literature and their check in IBM Connections, this chapter should give the reader an overview of new mechanisms that are identified in IBM Connections as well. To get a complete picture, sometimes “old” mechanisms from the theoretical part are mentioned too as they are combined with new mechanisms. In IBM Connections, the Oberseminar community used by the two research groups FGBAS and FGEIM serves as an example of socially-enabled ECS. It should be worked out whether social software features yield further mechanisms in ECS. These mechanisms are then presented. However, the mechanisms are not all specific to socially enabled ECS, but also to traditional groupware. Indeed, it is expected that self-created mechanisms are considered to provide richer information about CM and AM applied in ECS as they are explicitly applied by actors for coordination purpose.

Starting with the first mechanism on the landing page of the Oberseminar (Figure 6.3), addressing a CM that is added by users. The CM includes a *description* of how to work with the community of the Oberseminar. The description can be regarded as organizational procedures stipulating the collaborative work. Additionally, it includes a *hypertext* where content to the seminar should be stored. Also the hypertext is crated and added by users to coordinate their work by reducing the search effort. By clicking on the hypertext the user is automatically routed to the right place. The description is appropriate for a CM as it is artifact based that forms persistency and its content is malleable by the users. It also includes an imprinted protocol that is referred to as a set of explicit procedures, stipulating the articulation of the distributed work. The description is considered also appropriate to count as a CM as its decopulation of the field of work exists. The description for instance could be classed to preparation as it provides instructions for daily work and ensures reminding how to work with the Oberseminar. The hypertext could be appropriate for a new class, for instance “time-saving” as it is explicitly applied to facilitate the finding of the correct folder that demand for little search effort.

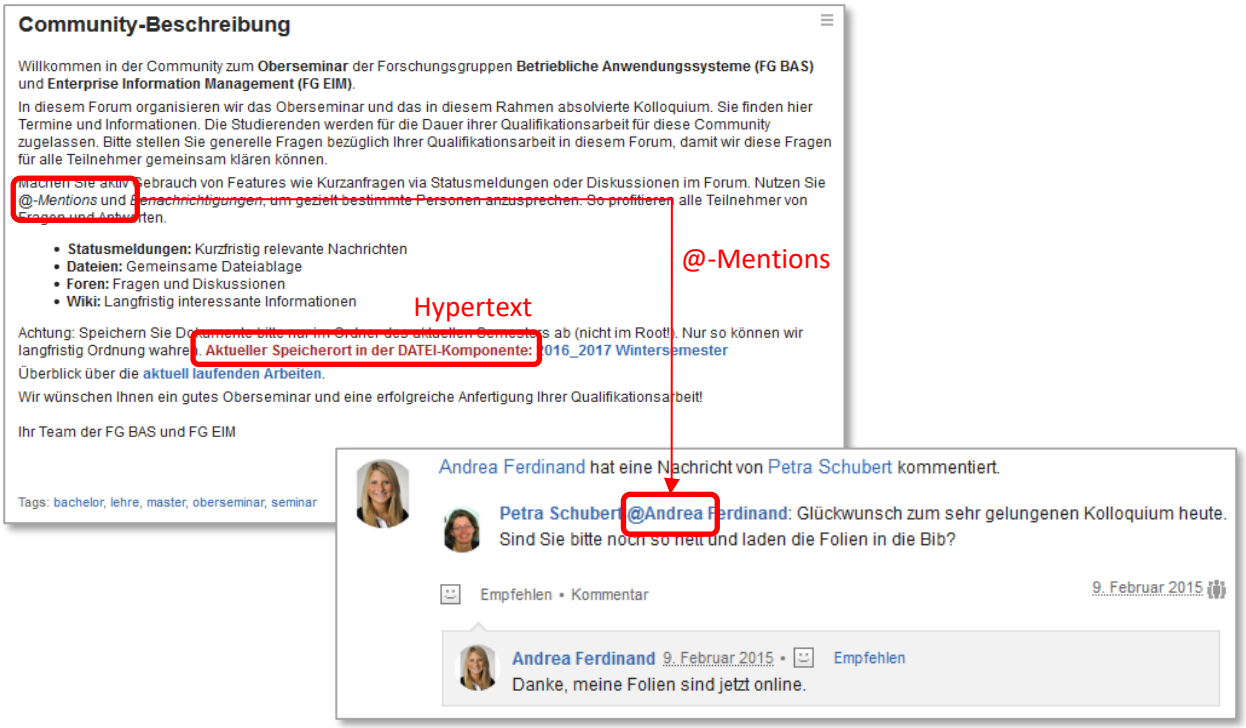

Figure 6.3: Screenshot – hypertext and @-Mentions (own illustration)

Interesting is that the description incorporates a new form of AM. Indeed, the authors of the description refer directly to the mechanisms of the *@-Mentions* functionality. By applying this mechanism in a text, the person who is mentioned is informed through a notification (per e-mail and highlighted in the bell on the upper right side as an event icon). Hence, the functionality of this mechanism (already integrated in the software) is explicitly used to make collaborators aware of items, content etc. that are created by an actor. Indeed, this AM is not created by actors, but actors can make use of this functionality already provided in IBM Connections. This mechanism can be classed with the category of notification as the person mentioned receive a notification e-mail.

Even though the CM *schedule* is already described in the previous section (check of CM in literature) this mechanism is further described for illustration purpose in Figure 6.4. That is because this schedule is created by the supervisors of the Obersemniar. The schedule, acting as a symbolic artifact stipulating the Obersemniar, presents a graphical order of meetings that communicates the activities which has to be performed by respective responsible actor, including times and resources. The schedule is freely created and filled in with information that is important to coordinate the course of the seminar. The authors attach additional documents to the content sections of the Oberseminar course units they relate to. Hence, the schedule i*ncorporates* another mechanism concerning *specific content* that is usually discussed within the Obserseminar sessions. It is prior upload to the community and allows students to later find it online again. Those documents can be opened and downloaded directly by clicking on the

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link that reduces the search effort for the users. Indeed, this incorporation provides persistency over time, underpinning the functionality of a CM.The incorporation of another mechanism in the schedule could also be assigned to preparation, as the incorporated mechanisms are created in advance before the action takes place.

The CM schedule incorporates additionally another AM created by the authors. This is the *highlighting of important information in red colour.* This mechanism is positioned in a way that allows directly recognising it when glancing on the schedule. Therefore, another classification category like “emphasising” could be appropriate to describe this mechanism.

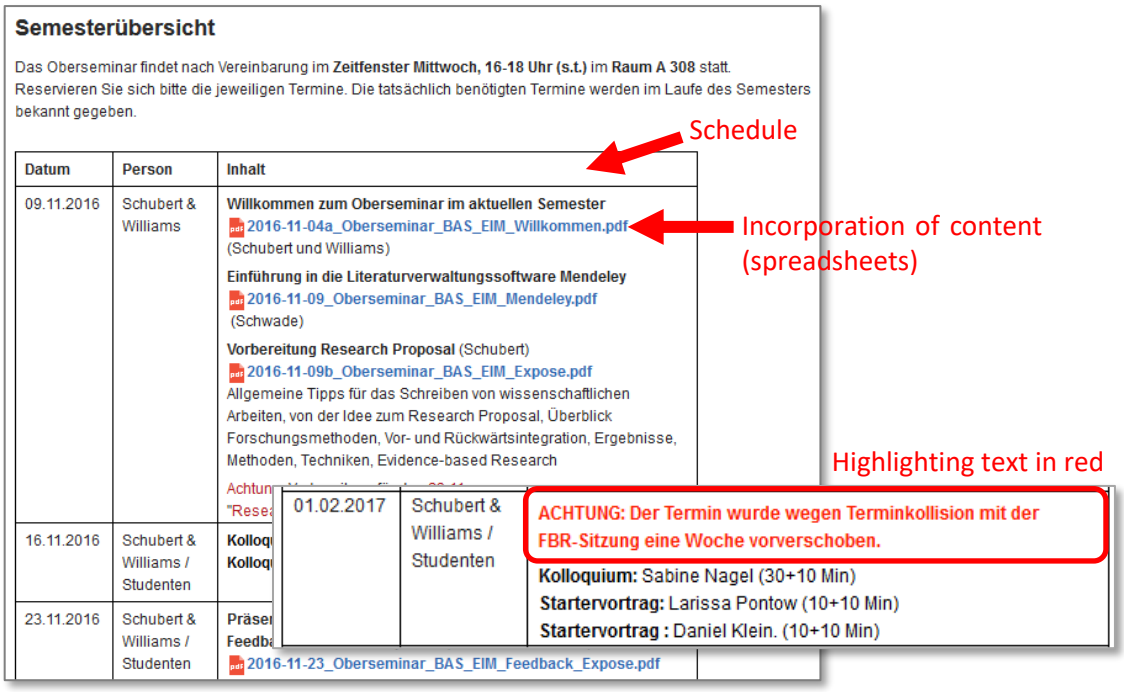

Figure 6.4: Screenshot – plan and text highlighting (own illustration)

On the landing page of the Oberseminar another CM is detected. At the beginning of the Oberseminar, participants of this course are grouped into “Startervorträge” and “Kolloquien”. The participants are all *listed* in a row as portrayed in Figure 6.5. During the Oberseminar, the participants are assigned to slots in the schedule where they have to present their thesis work. The *combination of schedule and list* is used to coordinate the content of the Oberseminar. When participants out of the list are assigned to a date in the schedule of the Oberseminar, the participants are taken off the list. Hence, the list is used to provide an overview of people that need to be assigned to courses. Indeed, the list is a symbolic artifact that mediates further assignment of students to free slots in the large collaborative ensemble and can be classed to preparation as the list is created in advance before the Oberseminar starts.

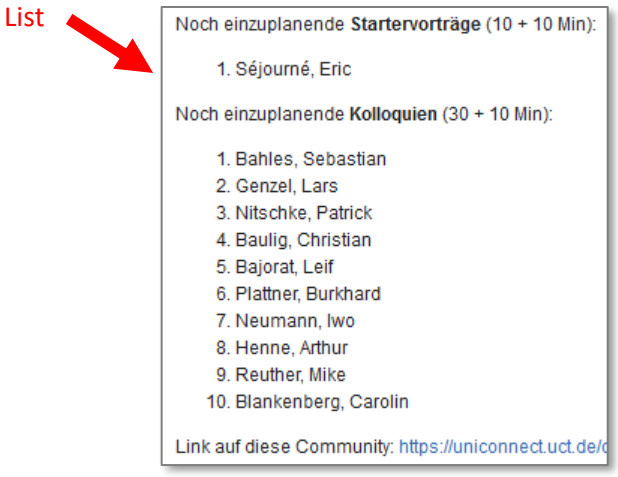

Figure 6.5: Screenshot – list (own illustration)

Another CM that is created by actors is the creation of *folders* (see Figure 6.6). The folders in IBM Connections are created and named with appropriate descriptions to structure its content. The folders act as a symbolic artifact as the creation of its name is malleable by actors and provide persistency over a time period. The labelling of the folder also facilitates the searching for information for the folder creator and his/her co-collaborators. Additionally, they can be used in order to categorize content. Indeed, folders often are labelled with keywords providing information about the information they contain. Therefore, they could be assigned to the classification category of metadata. In the folders, other *content* can be stored, for instance templates accessible for the whole community. Hence, the CM folder can also incorporate another CM.

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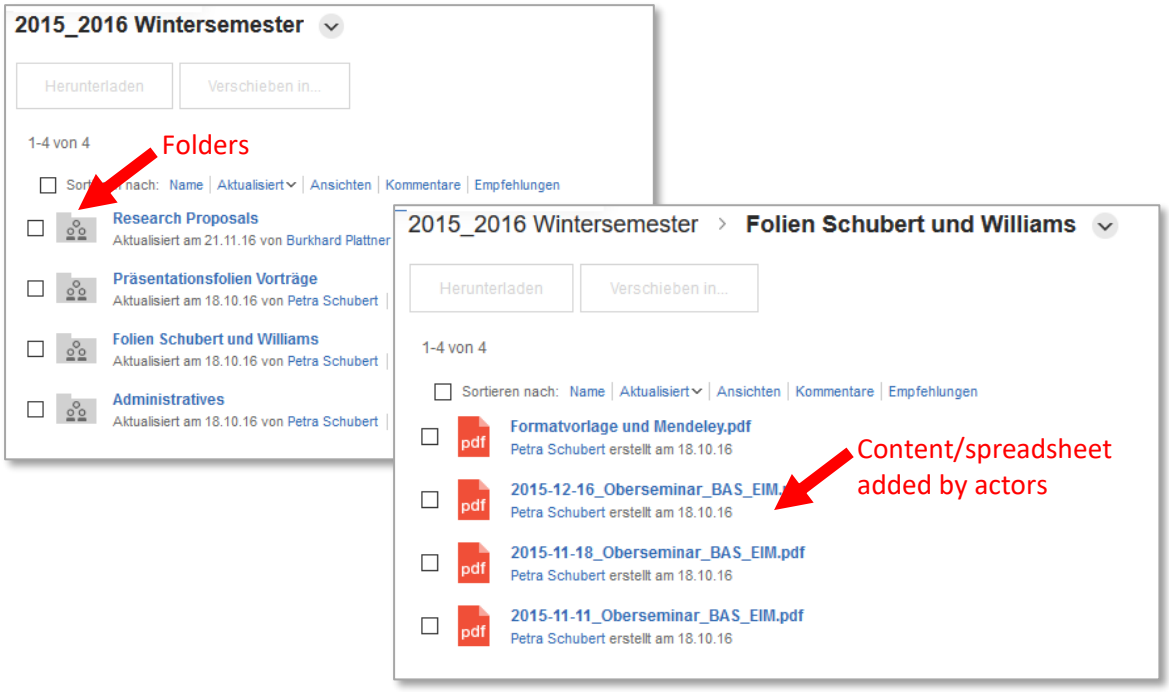

Figure 6.6: Screenshot – folders and added content (own illustration)

The component of the wiki function is already embedded in IBM Connections. It is not considered as a single CM or AM but can include CM and AM. The *content* that is included in the wiki is added by actors in an organised and *structured* way like presented in Figure 6.6. Indeed, the authors stipulate what content belongs together and in which depth it can be categorised. It can be assumed that the wiki pages are created and organised by the collaborators to provide everybody with the same information and to facilitate information search and predescribed procedures that is made accessible to a large collaborative ensemble. For instance, the content (in written form) is combined with hyperlinks to templates that had already been created by the actors.

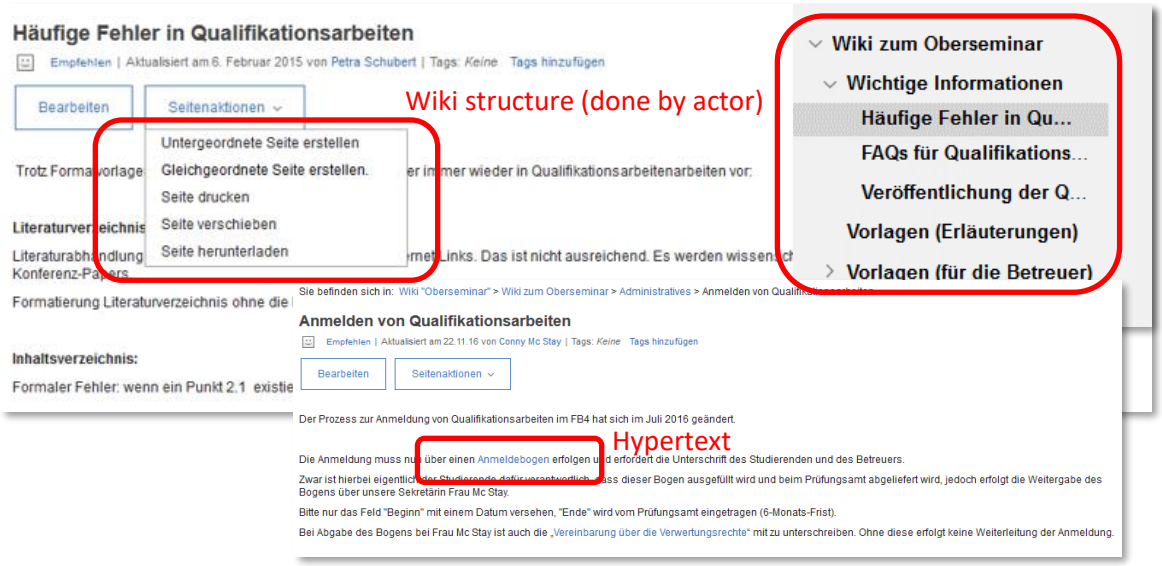

Figure 6.7: Screenshot – wiki structure and hypertext (own illustration)

Comparable to the wiki component already embedded in the system, the *bookmark* component is also already included in IBM Connections. However, the bookmarks are added by actors (c.f. Figure 6.8). For instance, important information that affects the whole community is assigned to a bookmark in order to reduce the search effort. Additionally, the whole community is provided with the same information by using the specific bookmark that is explicitly created for the purpose of the community. For example, like the bookmark example in “Abgaben der Abschlussarbeiten”. When a community member clicks on the bookmark, he/ she is automatically redirected to the original website. Furthermore, the bookmark is labelled with a *tag* that is chosen by the bookmark creator. The purpose of a tag is already described in Table 5-4.

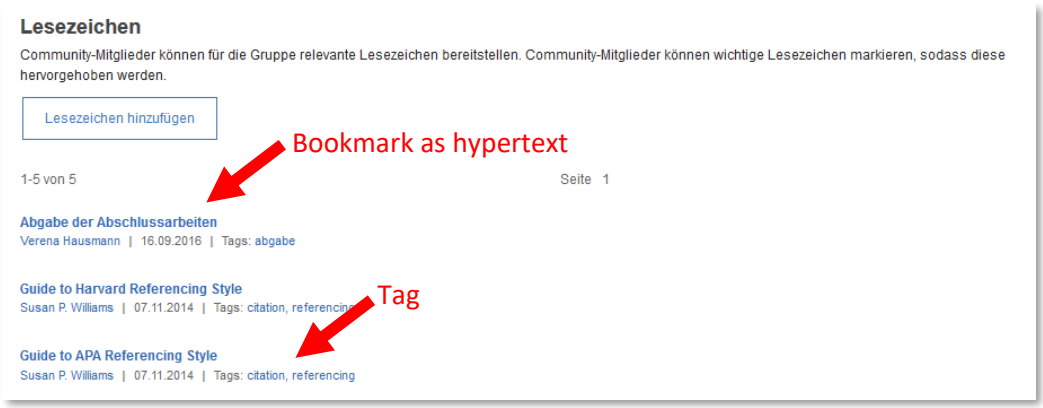

Figure 6.8: Screenshot – bookmark incorporating hypertext and tag (own illustration)

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An AM, not created but indeed applied by actors in IBM Connections, is the *recommendation* like in Figure 6.9. This mechanism can be known form Facebook with the "likeing" of something. For instance, an actor can recommend content he/she has recently uploaded into the community or when collaborators comment statements from each other as presented in the screenshot below. By recommending the content, the collaborators are informed via e-mail. That is why this AM can be assigned to the classification category of notification.

Figure 6.9: Screenshot – recommondation (own illustration)

A further AM that is detected in IBM Connections (community of MA Licht- Coordination mechanisms) is the offline and online document editing functionality for efficient collaboration on a single document presented in Figure 6.10. Indeed, this mechanism is not self-created by actors. However, the content created collaboratively can be easily and efficiently edited with this AM. Actors can download the document and store it locally to edit it. Or they can do it online and share it after finishing the editing, here a docx document. For instance, while user A is editing the document, user B cannot edit the document which supports that content is not overwritten. The AM becomes apparent when one user is already editing the document and another one wants to edit it as well. The user B will see a note that he/she cannot edit the document at the moment because user A has already opened it and is currently editing it. Indeed, user B gets aware of the work of user A. Having edited the document online, it can be shared in the community and the new version is accessible for further work. This AM can be assigned to the classification category of causal interaction as it is about an activity that occurs during working on a shred artifact reacting to the activities of collaborators. Additionally, the CM *comment* is also included.

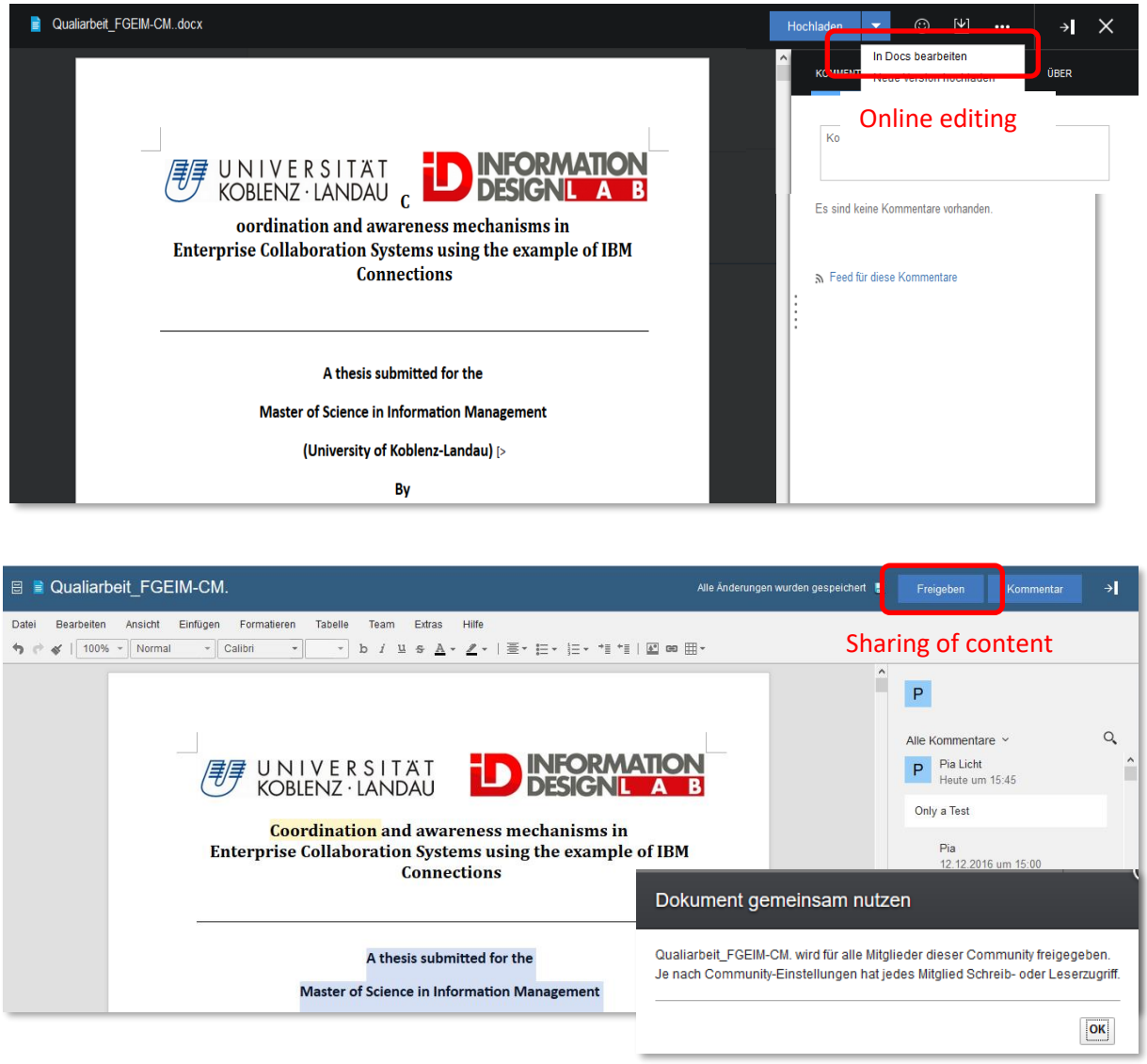

Figure 6.10: Screenshot – offline and online document editing (own illustration)

As some new mechanism in IBM Connections could be identified, a general overview of them is given below in Table 6-1 including also a classification category they are suitable to be classed with. The classification categories are concerning the created categories of the theoretical part, however new categories are also proposed that are put into "…" as those categories do not exist until now.

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Table 6-1: New mechanisms in IBM Connections

Mechanism form	Name of mechanism	Classification category
CM	Description	Preparation
CM	Hypertext	"Time-saving" (new: reduce search effort)
AM	@-Mentions	Notification
CM	Incorporation of specific content	Preparation
AM	Coloured highlighting	"Emphasising" (new: coulour to grab attention)
CM	List (in combination with schedule)	Preparation
CM	Folder (in combination with content andtag)	Metadata
CM	Structure (in a e.g. wiki)	Representation
CM	Hyperlink	"Time-saving" (new: reduce search effort)
CM	Bookmark (in combination with hyperlink)	"Time-saving" (new: reduce search effort)
AM	Recommendation	Notification
AM	Offline and online document editing	Causal interaction

It is assumed that further CM and AM that are created by actors in IBM Connections will exist. However, if actors create mechanisms for their personal purpose to coordinate their personal activities, those mechanisms cannot be detected in the community, as they are not shared by the mechanism creator. Since this practical investigation is limited to particularly two communities in one specific context, AM and CM in socially-enabled ECS should be investigated in future research. It would be particularly interesting to see what new CM and AM are created and applied by actors to coordinate their daily activities in collaborative work.

6.3 Interpretation of Findings

In this section, which presents the fourth phase of this thesis, the theoretical and practical investigations are reviewed and lessons learned are presented. Additionally, suggestions for future work in terms of CM and AM in social enabled ECS are given.

6.3.1 Review of Theoretical and Practical Investigation

During the theoretical investigation of CM and AM some experiences were made that are summarised in this section by starting with the examination of CM and AM examples in literature. During reading the academic papers, it was realised that the mechanisms are kind of distributed in literature and some authors only mention diverse mechanisms. However, the mechanisms were not explicitly outlined and described in more detail. Therefore, additional literature was consulted to describe the CM and AM to understand their characteristics. Additionally, it was realised that some mechanisms resemble in their description but are named differently, for instance the online status display and the instant messenger. In this case, the more general mechanism (online status display) was chosen for the investigation process.

In order to address this issue, the mechanisms were identified within coding cycles that covered two coding processes. The first coding process included the identification of CM and AM in academic literature. The methods applied in the first coding process were the first coding cycle method initial coding incorporating In Vivo coding (first coding cycle). The names of mechanisms were coded, for instance the group calendar. Following the coded mechanisms, a second coding process was introduced that covered the usage of presented theoretical concepts in this thesis, supplemented by first coding cycle methods. The concepts were used to examine core elements and characteristics of the mechanisms. Therefore descriptive coding was used to create the mind map, making use of CT. Beside this, Table 5-6, Table 5-7, Table 5-8, and Table 5-9 were created by filling in raw data material. It was expected that the derived information, by coding and iterating the raw data material, could be used to classify the mechanisms. However, it was realised that the mechanisms could not be clearly assigned to single components in the concepts used. Many overlapping in characteristics and usage occurred during the coding process. Clear assignments to single concepts components were not possible. Indeed, reasons for the overlapping are considered to rely on the smooth overlapping in the concepts themselves, like in CT or the framework for workspace awareness. The elaborated mind maps for CT were inappropriate for the classification of the mechanisms due to the overlapping in the components. Often it is the case that one component is also included in another component, e.g. actor and activity. In the framework of the awareness support for instance, it was found out that a clear assignment of people to roles is not possible as roles can smoothly change during collaborative work. For illustration purpose the AM of the telepointer is used. By applying a telepointer, an actors' role can change from being an active actor (moving the telepointer) to a passive observer. That happens when the user drops the telepointer and another user picks it up and moves the telepointer around. In the other concepts, same observations were made.

These observations gave reasons to revise the data material that could be useful for the mechanisms classification. Finally, it was shown that the general descriptions of the mechanisms were the most appropriate solution for a classification in this thesis. The main reason for this decision is based on the description of the core features characterising the mechanisms. Therefore, the tables including only the general descriptions were coded as part of a second coding cycle in the first coding process. I. e. the first coding cycles (identification) in the first coding process is followed by a second coding cycle and the iteration of the raw data material. In this second coding cycle, pattern coding incorporating descriptive coding was applied to give coherent meaning and order to the mechanisms and finally the classification categories. The classification categories were transferred into a tree diagram and each single mechanism was assign to its fitting classification category. Additionally, each classification category was described to carve out commonalities of the mechanisms. Indeed, five classification categories in CM and three classification categories in AM were created. One reason for this result can rely on the chosen number of mechanisms examples, as for AM three less mechanisms were selected than for CM.

To sum up the theoretical part, its key contribution is an in-depth analysis of a variety of different mechanisms and the general overview including the comparison between the mechanisms as the working out of existing characteristics and elements altogether. This analysis was important to gain a greater

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understanding of the mechanisms that were finally classified in the theoretical investigation and visualised.

The practical investigation however showed that nearly all mechanisms that were selected in the theoretical investigation are integrated or used in IBM Connections. This finding underpins the usefulness of the mechanisms chosen for this investigation. The examined CM and AM are often used to coordinate collaborative work. In the platform, users have to create some CM themselves in order to coordinate their activities, for instance via a schedule. Indeed, most of the CM are, or need to be, created by actors and are manipulated in the way so they fit to the current situation, like the schedule in combination with the list. Additionally, the mechanisms are in general created freely, i.e. there is no guide or description how to do it, for instance like the schedule on the landing page of the Oberseminar.

The AM found in IBM Connections are, however, often combined with a functionality that is already embedded in the system. For instance, the recommendations function. By clicking on the icon, a notification e-mail is triggered. The AM of "@-Mentions" is explicitly used by actors to make specific collaborators aware of their activities. The mentioned actor receives a notification and can follow the activity of the others. Both given examples are functinalites already embedded in the system, but explicitly applied by users to create awareness. The assumption of the practical part however should give incentive for further investigations as the role of CM and AM in socially enabled ECS is less well understood.

6.3.2 Experiences and Lesson Learned

The collected and analysed CM and AM in CSCW and partly ECS have shown that CM can be often used for asynchronous whereas AM seems to be more applied for synchronous actions. The differences of CM and AM that were analysed in this thesis are that CM often are self-created by actors. By contrast, AM are often functionalities already embedded in the system and used for creating awareness of others. However, the AM do not show a self-created character. Indeed, do CM and AM partly rely on each other. For instance, the community bar (CM) that can incorporate diverse CM and AM. Another example is the feedthrough that seems to be coupled often with consequential communication. Or the example of the Oberseminar community reveals that the schedule (CM) is combined with a list (CM) and the highlighting of text (AM) in different colours to create awareness.

Another important inside provided is that the classification categories are not so varied, especially for AM. Only three classification categories were created that underpin the resemblance of the chosen mechanisms selected in this thesis. A greater variation would have been more interesting to investigate. For CM, a greater diversification of classification categories could be reached. This accentuation can be based on the different number of CM and AM selected in this thesis. Additionally, the concepts outlined in the theoretical section were not suitable for a classification. Indeed, it was expected that the described concepts could be used as a framework to classify the mechanisms as they already have been proven to deliver rich input in the research of CM and AM in CSCW. However, in this investigation it

reveals that not the concepts, but the general descriptions of the mechanisms deliver the most appropriate information input to derive classification categories from them. However, the concepts were suitable for in in-depth analysis of the mechanisms to gain a better understanding of their characteristics.

Another important point is, that the classification of CM and AM is grounded more on the CSCW and groupware research area, though the new form of socially-enabled ECS is concisely described. However, as an outcome it was shown that the CM and AM identified in traditional groupware are also applied and integrated in new forms of ECS. Since socially-enabled ECS is based on traditional groupware, this result is not surprising. Indeed it would be interesting to investigate whether social software features yield further mechanisms that could not be studied as part of this work.

6.3.3 Suggestions for Future Work

In order to be able to verify the collected information and experiences with CM and AM regarding the classification and usage in traditional groupware, further investigations need to be conducted in socially-enabled ECS. For this purpose, it is therefore relevant to investigate ECS like IBM Connections in more detail. To be able to identify CM and AM that are additionally created by actors to coordinate their activities within social platforms, it may be interesting to carry out interviews with experts and users of socially-enabled ECS. By interviewing daily users and experts it is expected to identify new CM and AM as the social functionality is new. For this purpose, it would be interesting to create scenarios that should be carried out by interview participants. Within the scenarios, specific activities that need to be carried out by the participants need to be set. The interviews might reveal that the same scenarios are carried out differently by the participants as they might apply different mechanisms to coordinate the activities, as CM and AM can often rely on self-created mechanisms. Therefore, it would be interesting for future research to investigate if social software features yield further mechanisms next to traditional ones.

In addition to the identification of new CM and AM, their frequencies in daily usage to coordinate work could also deliver rich input in their usage and boost research in new ECS. For this purpose, it would be interesting to investigate whether CM and AM are applied always for the same activities or are manipulated for other activities. Additionally, it might be interesting to look at the frequency of the application, for instance if a CM is applied one time a day or for coordination purpose.

Next to the research in social enabled ECS it would be also interesting to extend the collection and classification of CM and AM examples, as outstanding examples are provided in literature.

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7 Conclusion and Outlook

The final chapter summarises the key findings of this thesis presenting the last research phase (phase four) of the research design. For this purpose, the research questions created at the beginning in section 1.2 are concisely answered. Finally, this thesis concludes with a critical reflection of the work and its limitations.

7.1 Research Objectives and Questions

Since the findings of the thesis are based on the predefined research objectives and questions in section 1.2, each of them is answered concisely in the following.

RQ1: What are the different types of CM and AM defined in the academic literature?

The different types of CM and AM in academic literature are based on two different types. The mechanisms identified through the qualitative literature analysis conducted in this study allow the distinction between mechanisms created by humans or incorporated mechanisms in the software. Some mechanisms, in general more AM, are already embedded in the software and are explicitly used by actors to create awareness of their collaborators. Indeed, CM are often artifact based mechanisms that are created by human actors, for instance a plan, and are additionally added in the platform for coordination purpose.

RQ1 a: What is the scope and character of the identified CM and AM?

The scope of CM and AM is to reduce the complexity of interdependent activities in collaborative work arrangements and to give understanding to the work of others. CM and AM are applied to support coordinated activities in computer systems demanding for additional work that has to be carried out by actors themselves for CM. The mechanisms are characterized by integrating a shared artifact, having in general a textual character that is malleable by the actor, using common practices and strategies. Indeed, the in-depth analysis of the mechanisms by applying the diverse concepts presented in section 5.1, reveal that the characters of those mechanisms resemble sometimes and therefore overlapping each other. Especially in AM, respective mechanisms resemble often. For instance, the online status display and the instant messenger were merged together to one single AM that is the more general one, the online status display. Also, a schedule and a plan for instance have a lot of commonalities. All in all, the identified mechanisms in this thesis have provided same characteristics. This observation was not expected at the beginning of the investigation. Indeed, a variety of different characteristics of CM and AM was intended to be identified.

RQ1 b: How can these CM and AM be distinguished or classified in terms of type and/or functionality?

To classify the mechanisms in terms of type and functionality, concepts have already been proven in literature to characterise mechanism were used. Those concepts referred to the four-component model by Malone and Crowston for CM and AM. Additionally for CM, the coordination types by Bardram and

oral vs. artifact (Carstensen & Nielsen) in combination with implicit vs. explicit coordination (Espinosa et al.) were applied. For AM, the framework of workspace awareness (Gutwin & Greenberg) and the awareness support (Dourish & Bellotti) were applied. In each concept, each mechanism was described in detail for each component. However, it was emphasized that functionalities in the concepts were partly overlapping, for instance the framework for workspace awareness. These observations lead to the decision that the more general descriptions of CM and AM are meaningful to be used for a classification. The distinction between the mechanisms emerged through analysing literature using coding methods. For this study, two parallel coding processes were necessary. As the second coding process focus on the concepts selected (using first coding cycle methods and assignment to concept components), the first coding process builds the main process. The results derived from the first coding cycle in the first process were reorganised in a second coding cycle aiming to develop classification categories by applying pattern coding to give meaning to the CM and AM.

The elaboration of the research questions was necessary to reach the first objective defined that is described below:

RO1: To identify and classify the different types and the functions of CM and AM defined in the academic literature.

All in all, twenty-five mechanisms (CM together with AM) were identified in academic literature through the first coding cycle method in the first coding process. Self-created tables describing the mechanisms in general (incorporating definitions) were coded by applying first and second coding cycle methods to derive meaningful patterns from the raw data material. The classification scheme was created through the second coding cycle method looking for commonalities and differences of the mechanisms. Finally, eight classification categories were derived. Five categories for CM (metadata, preparation, control, representation and communication) and three categories for AM (causal interaction, notification and current availability).

Beside the theoretical objective, a practical objective was elaborated that was accompanied by research questions answered below.

RQ2: Which of the identified CM and AM in CSCW literature can be transferred to social enabled ECS?

In social enabled ECS, nearly all CM and AM that were identified in groupware literature for this thesis could be found in social enabled ECS within the example of IBM Connections. For CM, the (group) calendar, chat (message), checklist, comment, memo, plan, spreadsheet, tag, template and version control could be found and checked in new ECS, apart from catalogue, index, schedule SOP. For AM, the activity stream, alert, consequential communication, event icon, feeds, feedthrough and online status display could be identified, apart from the community bar, radar view, screen sharing and telepointer.

RQ2 a: Which CM and AM are provided in IBM Connections?

Comparable to RQ2, nearly all fourteen CM could be identified in IBM Connections. Those mechanisms are indeed the (group) calendar, chat (message), checklist, comment, memo, plan, spreadsheet, tag,

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template and version control. Content in the mechanisms (group calendar and version control) are created or uploaded, whereas the other CM are artifact based CM that are additionally created and integrated in the software by users. The lacking provision of the other CM could be based on the roles that are given in IBM Connections, particularly in the Oberseminar community. Some AM were identified in IBM Connections, the activity stream, alert, consequential communication, event icon, feeds, feedthrough and online status display. Users can make explicitly use of those functionalities that are already embedded in the software. The other AM were not identified. Maybe this observation can be grounded on the "social" functionality. For instance, a radar view is not found in Social Media platforms like Facebook, and therefore might not integrated in the social enabled ECS. However, this is more an assumption.

RQ2 b: Which CM and AM are used in a practical context to support coordinating work and what additional CM/AM do users create themselves to coordinate their work?

Which CM or AM are used within the practical context depends on the current situations. Regarding the example of the Oberseminar community in IBM Connections, the schedule on the landing page is created for coordination purposes by the supervisors. Its content is manipulatable by the supervisors, too. The schedule is combined with a list, which is also created by the supervisors to coordinate the seminar that presents an additional CM. The colouring of important information is also done by the actors in order to make collaborators aware of content that forms an additional AM to literature. The creation of folders and the content stored in the folders, for instance spreadsheets, are created by users to coordinate their work too. Indeed, actors create tags themselves to give content characteristics to coordinate work by reducing the search effort. Also, it can be remarked, that templates are added by the supervisors of the Oberseminar that are accessible by the students in order to stipulate the work. Most of the CM used in this thesis are in general created by actors for coordination purposes to reduce the complexity of workload. Concerning AM, the actions that are performed by actors in a shared workspace, like the Oberseminar community, are giving control and feedback to the actors performing. The actions trigger an event, like an alert. Indeed, additional mechanisms in the Oberseminar were found. Those mechanisms are for instance for CM, the description in textual format that stipulates how to work within the Oberseminar. Another new mechanism is the list that is combined with the schedule created by the supervisors to coordinate the seminar. Beside the CM, the recommendation function, embedded as a functionality in the software, is applied by actors to make their collaborators aware of interesting content for instance. Also, the offline and online documenting functionality is used in collaborative work. Another mechanism that is self-created is the highlighting of important content in order to make other actors aware of it.

Based on answered research questions in the practical part, the research objective is answered in the following.

RO2: To identify CM and AM found in new forms of ECS and investigate their functionality of support.

New forms of CM and AM in (socially-enabled) ECS can be found that have been examined in CSCW literature. The tag (CM), for instance, is based on new forms of ECS contrasting the activity stream, feeds, @-Mentions and recommendation (AM). Those mechanisms are referred to be more specific to social enabled ECS. For instance, the tag as CM is used to identify and categorise content. A Social Media example that makes use of it is Flickr. To be able to do so, a keyword is attached to the content by an actor. However, a tag also creates awareness be indirectly referencing to similar content that is labelled with the same tags. New AM have been examined in IBM Connections. The activity stream, known from Social Media sites like Facebook, is used to provide awareness through listing the recent activities of community members. Additionally, feeds known for instance from Twitter, are referred to a new functionality that automatically provide information about recent changes about updates to resources done in a collaborative community. Another new AM found in IBM Connection is the "@-Mentions". This AM is explicitly applied to create awareness by addressing specific collaborators, comparable to Facebook where users can address specific people. Indeed, the new mechanisms can deliver rich input to coordinate work as they facilitate for instance the searching ot information through a shared knowledge and that relevant people are directly addressed for coordination purpose.

7.2 Research Contribution

In the course of the presented thesis CM and AM in the traditional groupware environment and socially enabled ECS were analysed. The qualitative content analysis resulted in CM and AM mainly found in groupware literature. However, the first research contribution of this thesis is the in-depth analysis of a variety of different mechanisms and the general overview of CM and AM provided. Beside this contribution, this work came up with a first classification of CM and AM, as such a classification was lacking in literature until now. The in-depth analysis and the classification of the mechanisms conducted, focusing mainly on traditional groupware, allowed a first comparison of traditional CM and AM within social enabled ECS. The first investigation in a socially-enabled ECS, IBM Connections, was conducted with the intension to underpin the usefulness of those mechanisms and identify new CM and AM used in socially enabled ECS. The contribution of the practical investigation therefore is to give incentive and boost research for CM and AM for future investigation in socially enabled ECS, as Social Software provides new possibilities for actor to collaborate during their work.

7.3 Limitations

A first limitation in this thesis is that the collected mechanism examples were not very different in their functionality. Especially for the AM there were more mechanisms selected that resemble each other. Therefore, the classification in AM came up with only three categories. Indeed, the concepts applied for the mechanisms were not appropriate for a CM and AM classification as many overlapping occurred. However, the concepts were useful to conduct an in-depth analysis of the mechanisms. The usage of

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the general descriptions for the classification also did not allow a clear distinguish between the mechanisms by going into more detail, but for this thesis it was the most appropriate solution. Beside this, the number of selected CM and AM is limited to a total number of twenty-five mechanisms. Indeed, there are examples for outstanding CM and AM that provides another limitation. It is expected that by considering a larger number of CM and AM in literature, a richer classification of mechanisms could have been achieved because of a greater diversity in functionalities. Another limitation is that the content focuses more on CM and AM in traditional groupware literature and not profoundly on the new form of socially-enabled ECS. Additionally, how far the mechanisms really reduce the complexity in coordination effort in work is not shown yet.

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Appendix

Appendix 1: Concepts applied in CM

Table 0-1: Four components (CT) by Malone and Crowston (1990) in CM (own illustration)

Coordination mechanism	**Activity**	**Actor**	**Goal**	**Interdependency**
(Group) Calendar	Group calendars are used asynchronously. They support actors in avoiding timing conflicts within a group, e.g. for scheduling meetings and inviting members to it. They support in organizing and coordinating time and resource allocation. They also can be used individually to crate own tasks as a reminder. By looking at a group calendar, an actor get an overview of the group activities that take place at a specific day or week etc. that is indirect communicated to the group.	In general, each individual actor has his/her own calendar where scheduling of meetings, tasks and activities are organised. In a group calendar, it can be about 1:m direction. One person /e.g. teamer) creates a meeting and other participate. Or it can be 1:1 direction for individual coordination.	Group calendars enable people to look at combined schedules of single users, resources and public folders in the calendar. The main goal is to get on overview of deliverables and deadlines in a group as attendance of group members. Although time and resource allocation can be coordinated and conflicting situations can be avoided.	Individuals can plan their own activities by considering the activities of the whole group (meeting, inviting etc.). E.g. one person has a meeting. The team of this person need to meet. After the single meeting of the first person is finished, the group can meet. Hence it supports the execution of dependencies in time.

Coordination mechanism	**Activity**	**Actor**	**Goal**	**Interdependency**
Catalogue	The main activity in a catalogue is the collection and storing of information and data and giving them a structure by encoding them. This leads to creation of metadata as information to the resource is added. For example, in a library, a lot of information to different books need to be manged, stored, sorted and be accessible to actors. Information about books, their authors etc. are added to the catalogue and are encoded. This allows a user to enter a search in a field, such a title of information to receive fast information	A catalogue normally belongs to one single entity (cataloguer). All information is stored in that catalogue and are accessible to many users, like for e.g. in the library.	A catalogue reduces the complexity of work in that way that it tells its user directly where to find the information. Hence it recuses the time of work (effective search) and facilitates the retrieval of information.	A catalogue can be used from a lot of interdependent users. E.g. a cataloguer retrieves a new book that should be integrated in the book catalogue. He adds all the necessary metadata in the catalogue. A second person than can search for the book using the metadata that was added by the cataloguer before.
Chat (Message)	The main activity in chats is synchronous cooperation through ad hoc (direct) communication between two or more actors by sending or receiving text-/ video based messages in daily work or ad hoc situations. Text-based messages are entered in the chat window and are send to another actor through the Internet. The activity can be compared to a face-to-face situation whereas in chats, the communication takes place in distributed places.	Actors involved can be larger groups or individual. They can rely on a 1:1 communication or n:m communication, depending on the chatting situation. A chat partner (sender) enters a text in the chat application, starting a communication with one or more other people (receiver(s)).	Providing the possibility of synchronous real time communication in distributed collaborations. This way to coordinate and communicate activities can be effective in ad-hoc situations to reduce the articulation work and communication workload.	People which are distributed in space are interdependent in communicating with friends, colleagues etc. in real-time, like a face-to-face communication. The execution of an activity starts with the first communication text that is followed by a response, e.g. when in a project ad hoc communication is necessary to clarify something.

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Coordination mechanism	**Activity**	**Actor**	**Goal**	**Interdependency**
Checklist	The activity in a checklist is about co-operating, coordinating and controlling that important activities are carried out and nothing will be forgotten. It is about predefining important activities which might can be categorised. After finishing the activity, a checkbox on the checklist is crossed through and the next activity will need to be done or need to be initiated. Especially when activities demanding for a specific order checklist are useful for coordinating them.	Using the example of the flight-deck checklist, the flight institution created a checklist for controlling the flight deck before going up into the air. This checklist is used by the pilot or the flight team to control critical items. It can serve in a form of 1:1 for individual purpose or for a 1:m relation, e.g. the flight deck checklist. It depends on the situation where a checklist is applied.	A checklist is an aid or support for compensating failures in the capacity of human memory. By applying a predefined checklist, it can be ensured that all activities are carried out in a particular order. This lead to stipulation of articulation work. In general, it its usage depends on an indirect form guiding as an overview for critical items.	The flight team can use one single checklist. E.g. categories on the checklist belonging to different responsible actors that are working interdependent from each other. The checklist is passed over to another actor after verification. It can be ensured that everything before was checked and therefore the coordination of tasks can be facilitated. If somebody forgot to cross something on the list, the responsible person can be easy identified.
Comment	Actors can leave a comment to a (web) document in textual form of an annotation that provides additional information (metadata) and is attachted to the original document without editing the original. Comments can be applied for indirect communication. E.g. an actor in collaborative authoring can add a comment to a textual part where he proposes to change the wording. The collaborative team see the comment and decide together weather they accept the comment or not that reduces articulation work.	Depending on the situation, actors involved can differ. Here it is suggested that it is a 1:m relation in collaborative authoring as a comment is created by a single person (author) leaving a comment for a single actor (co-author) or the whole group (co-authors).	The goal of using commentary function is that opinions, improvement ideas etc. can be attached to an original document, by making references to a specific part. In collaborative authoring co-authors get aware of the proposals of each other and coordinate their work easier by reducing the complexity of work (e.g. that each co-author has to be contacted separately).	Actors involved can comment content interdependently from each other that can be useful for collaborative authoring. For example, a group have different suggestions that fit to a specific part of a document. The ideas can all be attached and the group can later collaboratively decide with the comments which solution fits the best. As comments are external information, interdependent from the original text, it doesn't influence the original data.

Coordination mechanism	Activity	Actor	Goal	Interdependency
Index	An index lists all relevant information in a (alphabetical) order or table. They are arranged by listing items pointing on them in form of metadata indicating the relationship and giving information structure that can also be grouped. Actors use the index to search information. They are used to search, add and remove information. E.g. in a book, the index references where the searched data is found.	The creator of an index assign specific data to it.	In index the purpose is to encourage effective information retrieval by pointing to a location where searched data is stored. It supports the organisation of information accessed in collaborative work that reduces the effort in searchingtime.	Indexes provide interdependencies in collaborative work because they provide same references for each user. That allows interdependent actors to search e.g. information in a database by retrieve always the same information.
Memo	A memo can be attached to documents or be left as a note (paper or electronical). Actors can use a memo as a reminding or notice function in a text-based format that can relyon on informal and indirect communication E.g., next day two colleagues have to discuss the finalisation of a document. Because they were not able to work on the document synchronously and one of them has already left the office, the other person attach a memo to the document where he remarks that a statistical number has to be checked. Next day the colleague enters the office and can directly check the number without any more effort.	Depending on the current situation a memo can be created by one single actor (reminder) in order to remind another actor (1:1), e.g. to check a statistical number. Or one single actor can leave a notice for a whole team (1:m) to check the number.	The main goal of the memo is the notice and reminding function which should reduce the workload in collaborative settings, e.g. as the checking of a statistical number in an important document that should be presented to the chef. The usage of a memo can reduce the complexity of the workload as it is a short memo to a specific topic which is quickly attached to something.	Actors in a team can work interdependently from each other and fulfilling their activities by applying memos. When one actor realise that something isn't correct, e.g. in content, this actor can create a memo attaching it to the content. This memo will be considered by another actor for his/her activity in to continue the activity.

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Coordination mechanism	**Activity**	**Actor**	**Goal**	**Interdependency**
Plan	A plan includes the management, organization and definition of steps, in a textual or graphical form, that need to be done in the future. It defines by whom, when and how, to archive the aim and planning of times, resources etc. A plan includes predefinitions of future work and is used asynchronously. For instance, in the hospital, a plan for the patients' diagnostic and treatment is used. The plan covers information about the involved staff, about the illness of the patient and how it should be treated.	Depending on a specific situation, a plan can be created by a single person (planner) for personal purpose (1:1) or in a collaborative group for a larger project (1:m) like in a hospital.	Appliance of a plan aims to prepare a sequence of activities which have to be done in order to reach an objective as soon as possible by using as less as possible resources. Plans support coordination by reducing time and effort in archiving a goal. Moreover, they are useful when changes occur due to their flexibility. Then, those changes can be integrated and thus having less influence on the time structure and furthermore with plans communication effort can be reduced. .	For example, in a hospital some people need to take care of a patient due to their different responsibilities. With the coordination and allocation of all those interdependent activities in the plan, guiding as a structure for collaborative work, overlapping's and failures can be reduced. People involved know what to do, and what have already been done, by looking at the plan. The activities can be fitted to the sequence of treatments that need to take place.
Schedule / Timetable	The activity in a schedule is the sequential listing of activities which need to be done in future. Scheduling considers the allocation of time and resources. Next to it, it contains the definition of milestones for specific tasks as deadlines. Those partial objectives are determined to specific deadlines in time. With scheduling, daily activities can be coordinated so that everybody knows who is responsible for what at what time, which place etc..	Considering an example of the schedule usage in project management, there exist one or a couple schedule creator. The created schedule then can be indirectly used as an outline for the whole team to coordinate their activities in structured way propose as a 1:m relation. For personal purpose, a schedule can be created by an individual in order that he or she knows at what time for e.g. a meeting takes place.	The goal of the usage of a schedule is the coordination, representation or visualisation of sequential activities which need to be done to reach an overall aim in the future. A schedule presents a starting and ending time, between milestones are defined which are assigned to deadlines in time.	In a project schedule for instance, dependencies in time and resource need to be coordinated and allocated. Actors involved in a project are interdependent from each other (might belong to different teams) that are distributed in space. One project leader (developed the project schedule) is responsible for his project team which uses the schedule as an overview to coordinate and fit their interdependent activities in a flow to reach the objective. After one milestone is reached, the next can be initiated.

Coordination mechanism	**Activity**	**Actor**	**Goal**	**Interdependency**
Spreadsheet	Spreadsheets can be used for further activities. E.g. for calculations or to store and add information. One actor, having more technical knowledge, can add a columns or specific formulas. This spreadsheet can then be used as a template for another department. Spreadsheet user can collaboratively design spreadsheets, training each other in their use and maintain them together. One example could be, that a spreadsheet is used to add new products in an online product catalogue. Actors can change and manipulate parameters in the spreadsheet to forecast e.g. calculations. Hence activities in spreadsheet usage can be knowledge transfer and programming expertise.	Many actors can be involved in collaborative work with a spreadsheet. In a single-user way (1:1) it can be designed for e.g. calculate investigations and to control activities. Or it can be designed in 1:m usability to upload products in a product catalogue. This spreadsheet might be used as a template by colleagues to upload further products as they are coming from different departments.	The goal of a spreadsheet is the facilitation of cooperative work arrangements. This can be aimed through spreadsheets by using it as calculation templates for e.g. in financial departments. A well-developed spreadsheet template supports somehow the automatization of calculation by using implemented formulas in the spreadsheet.	People using the spreadsheet can interdependently use it in collaborative work situations whereas the execution of the activities follow an order. For example, at the end of a year an enterprise need information about its turnover. They need the information from finance, tax etc. Each department receive a predefined spreadsheet that can be fill in. After filling in, automatic calculation happens due to applied formula from another department. Finally, the results can be merged to one single spreadsheet.
Standard Operating Procedures (SOP)	With unique standard operating procedures (SOP) in an enterprise, actors have access to text-based and readable documents that describe and communicate process steps which can be widely adapted in different disciplines. The activity is often a process that is repeatable or auditable which provide a stipulation of articulation work. In SPO the overall aim is defined, how this aim should be reached, who is responsible etc.	SOP are crated and developed in a higher team and then documented textual. This document is then accessible to all employers in the enterprise used as a presentation, hence it is a used in a 1:m relation. One SPO in a specific segment which counts for all people involved in this segment.	The goal of SPO is a reliable textual description of enterprise or work processes by providing appropriate usability. It also includes the checking of the results in order to ensure a stable quality of results (products, services etc.). Especially for no changing, stable processes SOP are defined to serve as a guideline.	For example in the chemical industry, the ingredients of explosive products have to be combined in a specific order to ensure safety. The way, how to do it is documented in the SPO that is shared in the whole enterprise that count for everybody. By reading the SOP employer interdependently from each other, which order is necessary. Even if they might not responsible for a specific part in the production, the SOP explain how to do it.

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Coordination mechanism	Activity	Actor	Goal	Interdependency
Tag	The main activity in collaborative tagging is the labelling of resources with keywords. This keywords are generally freely chosen by the item creator in a sense that it can describe the resource in a more general term and can be used as indirect communication. By tagging resources, metadata is added in order that a categorization of this resources can be reached and referencing to other similar content can be achieved. Tagging takes place asynchrony because people don't have to be at the same time at the same place in order to tag a content. One example is Flickr, a photo-sharing website, where people can share digital objects with others.	Taking the example of Flickr, the actors involved are the item creator itself tagging the resources for his or her own purpose or for other users. Normally, more than one tag is used to describe a resource or content which provides a n:m connection. Also the tagging application of Flickr belongs to the actor, as the people that are using it, as the resource and tag that contains it.	The overall goal of applying tags in Flickr is the description of resources and digital objects in order find the resource easily again by browsing and searching the content as it gets categorised. Tag support the tracking, sharing and finding of information on websites and the indirect referencing to similar objects, hence it supports awareness of similar content.	For example, in Flickr one person tags a resource with "holiday". The tag produces a resource that can be also used by other users to find the resource or to tag other resource also with "holiday". With the same tag the resource can be clustered in order that the information can be easier found. Even if tagging is done interdependently, each user can find the information looking for by using the appropriate tag.
Template	A template provides a standardised format with empty fields already fixed in a place that need to be filled in by actors. In general, actors can adapt, add, remove or change different fields and items. These fields concern specified information that are necessary in order to use the template for effective work. Templates can be filled in manually or in an iterative automated process. In programming templates can refer to generic functions.	A template builder can create a general template, e.g. Power Point slides for an enterprise that should be used for each person that needs to hold presentation in the name of the specific enterprise. The template is accessible and usable for all employees (1:m).	The main aim of templates is the complexity reduction of articulation work in that way that, especially for returning processes, an ensuring of the same information that need to be transformed. An activity will always contain the same information (standardization). Also, do templates can lead to automatization of processes.	For example a template builder creates a Power Point template. After creation and saving, this template is used by all other employees in the enterprise that are interdependent form each other. Hence, there can exist a temporal flow (activity creates template, template is used for other activities).

Coordination mechanism	Activity	Actor	Goal	Interdependency
Version Control	Version control supports the management of changes made to documents or content. For example, person An open a document which was imported before in a common repository. At the same time, person B open the same document as person A. Both edit the document, but person A save the document before B. Because of the later saving of the document from B, the version of A get lost. Version Control permits multiple users to edit an object collaboratively by avoiding overwriting's. The different versions can be uploaded which is identified by a version number providing for example a user name and a time stamp when a document was uploaded.	Actors involved is first the author of the content who allows that the content can be edit by team members. Another actor can open and edit the document and finally commit it to the common repository.	The goal of versioning is the documentation and trace back of changes to a document which is registered in the history. If there is a mistake in the current version of a document one can easier get back to an old version. Versioning allows the accessing and changing of content by different actors which later can merge their individual changes collaboratively. Conflicting situations in editing can be avoided.	Collaboration of interdependent groups can be coordinated through versioning. E.g. a product catalogue is stored in a common repository that counts for different departments. Each actor, interdependent from the others, can edit the product catalogue (add, remove etc. information) and commit it to the common repository again, that can cause synchronous activities. The newest version will be used for further activities, but the possibility to go back to the older version stays present.

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Table 0-2: Coordination types by Bardram (2000) (own illustration)

Coordination mechanism	**Communicative**	**Instrumental**	**Scripted**
(Group) Calendar	(✓) A calendar can be communicative when it is combined with semiotic actions (e.g. reminding clock for a meeting). The calendar itself can be regarded as a communicative device used for synchronising work that communicates indirectly somebody what to do next.	(✓) A calendar can be also used for instrumental coordination e.g. when people involved coordinate their work by looking at the work of their colleagues, using a common object of work which symbols the group calendar. Hence it supports awareness in collaborative work situations.	(✓) The calendar can be regarded as a common object of work which acts as a script. It can provide a prepared script for distributed activities and its content is malleable by its users. Furthermore, it provides instructions (e.g. which appointment comes next) which are carried out in a specific order. People can also look at the calendar and coordinate their work by considering the work of the team.
Catalogue	(×) A catalogue is not communicative because it provides only a directory of information and where data is stored. It doesn't make use of indirect or direct communication.	(×) A catalogue is neither appropriate for instrumental coordination. Through a catalogue awareness cannot really be supported and is serves only the aim to give a good structure for stored information.	(✓) In a form of a script a catalogue can support distributed activities in collaborative work because it provides a predefined structure containing information that are collected before usage. The structure supports through its specific order to find easy the information. Also the content of a catalogue is malleable by the user.
Chat (Message)	(✓) Chats can be used for communicative coordination. The chat text can be regarded as a coordination artifact where people involved can discuss how to go on with their further work. It is comparable with the example of Bardram (2000) where a telephone was used to coordinate work.	(✓) Chats can be instrumental as they provide awareness of the work of others. Because it is synchronously and direct communication, awareness can be supported by chats and actors can coordinate their work by considering the work of the others too.	(×) Chats are rather scripted as there doesn't exist a prepared common script which can be used for distributed activities.

Coordination mechanism	**Communicative**	**Instrumental**	**Scripted**
Checklist	(“✓") Depending on the checklist type it can be communicative. For instance, when people collaboratively create and edit checklists and thus tell other people how and when to act and in which order.	(✓) In a different sense a checklist can be instrumental because people involved can coordinate their work by looking at the work of others that has already been checked using the checklist as the common object of work. A checklist can show what has been done, i.e. when a person view such a checklist and see that a certain task has already been completed by the responsible person, another task may be initiated by the person viewing the checklist. Also, the own work can be coordinated.	(✓) Checklists can also refer to scripted coordination. They can present a predefined, common script of actions for distributed activities that need to take place in a particular order. As long there is no interruption in the activity order, the collaborative work can be coordinated by applying a checklist.
Comment	(✓) Depending on the situation, a comment can be communicative. For example, when a person attach a comment to a document telling somebody else how to change a part of the document.	(“✓") A comment can be instrumental e.g. when the comments can be regarded as readable reflections of the work from others. The commentator gives an idea which is picked up then from the person who read the comment and convert it.	(“✓") A comment can also be classified to scripted coordination as it can provide a preparation for improvements or for further collaborations, based on a written script. The content of a comment point to the part that can be malleable by an actor.
Index	(×) Indexes are not communicative because they do not support communication, e.g. how to do a work in collaborative work. They provide indirectly the information where something is stored.	(×) An in index is not really instrumental because it provides more information where a collection of information is stored. This information can be used in a workspace for distributed activities but rather provide awareness of others activities.	(✓) An index can be assigned to scripted coordination because they provide information e.g. about localisation where data can be found that is predefined before the data can be search. A predefinition takes place when the index is assigned to an object.
Memo	(✓) Depending on the situation where the memo is used, it can be communicative when the content of the memo delegates another person to do something in a collaborative ensemble.	(×) A memo can be seldom instrumental because they can be applied to provide awareness of the work of others. Memo serving an aim, for example to remind a colleague for the next meeting.	(“✓") A memo can be scripted when they are used as a short note, with a written character, to remind important activities that need to be carried out in distributed activities. Its content creates awareness of what have to be done and give instructions for actions in order to reduce complexity in work.

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Coordination mechanism	**Communicative**	**Instrumental**	**Scripted**
Plan	(“✓") Plans can rely on communicative coordination as it can be used to look at the work of colleagues. Using the plan as a common object of work a team can discuss how to go on in the project to synchronise their work. The plan itself is the communication device that is used to delegate actors in collaborative work.	(✓) In an instrumental way plans can be used to pursue an objective defined. E.g. a project plan has on objective defined showing millstones, responsibilities, resources etc. Therefor a plan also provides awareness of the work of others.	(✓) A plan can also be scripted in use of coordination having a written character. It reflects for example who is responsible for a task and which resources are needed. It is a common, predefined script embedded normally in norms and procedures. It can be used for distributed activities giving instructions for the people involved.
Schedule / Time Table	(“✓") A schedule can be communicative in that way when it is visualized, e.g. the milestone and the responsible person. Without a real communication, the visual communicates the message itself. With the help of a schedule one can discuss how to go on with the work.	(✓) Schedules can also rely on instrumental coordination as they are used to serve as means of pursuing an objective defined and at the same time provide awareness of the work of others. Because people can use a schedule to coordinate their individual work considering the work of others.	(✓) A schedule can rely on scripted coordination because it reflects the predefinitions of who is responsible for a task, which resources are needed and what timeline is foreseen for a task. It is a common script embedded normally in norms and procedures visualizing instructions for a specific order in which tasks should be carried out.
Spreadsheet	(×) A spreadsheet cannot really be used for communicative coordination, depending on the situation. But seldom can it be used to communicate how to fill in a form for example.	(“✓") A spreadsheet can also be instrumental serving as means of pursuing an objective by applying it. For example, when an actor see the colleague already fillies in his part of information and now his part is missing to finish the work, he can continue to fill in the form.	(✓) A spreadsheet can be scripted when it is used as a common script of work which is embedded in division of work and norms. For example, a predefined spreadsheet is used as a standardised template in the financial department which is filled in a specific order to standardised procedures and norms.
Standard Operating Procedures (SOP)	(✓) SOP can be can be communicative as they provide standardised procedures how to work, using a document as a guide. The procedures are communicated to employees instructing them how to do a task.	(“✓") Seldom SOP are instrumental. Indirectly they provide a structure to reach an objective and providing awareness because each employee knows that the others doing the same tasks.	(✓) SOP can be scripted. They are based on predefined written documents which provide a specific order how to proceed a work. These documents are accessible to all people involved. SOP, or more the content, is malleable by actors as there arrive changes. Even, as a standardised document, they can be used for local distributed work.

Coordination mechanism	**Communicative**	**Instrumental**	**Scripted**
Tag	(×) Tags are not communicative as they don't make use of iconic communication and are not helpful for continuous synchronisation.	(✓) The main focus of instrumental coordination is being aware of the work of others and to avoid double work. Tagging seems to be quiet individual action, but with tags people get also aware of the knowledge of other users by tagging the content. There is also the possibility of using a tag for a status (e.g. "reviewed") or simply getting to know to which field of work/domain etc. a document, an entry etc. belongs to.	(✓) Tagging can also be regarded as scripted coordination. Because with the application of a tag actors can search for data in their personal and collaborative way. The tag itself is the script, predefined with a written character.
Template	("✓") Depending on the type of template it may be communicative. This may be the case when people can collaboratively create and edit the template and thus tell other people to act.	(×) A templet is rather instrumental. Somehow it can provide awareness of the work of other, e.g. when somebody added a column or information. And in general, it serving as a means of pursuing an aim, e.g. in the financial department to calculate the turnover.	(✓) A template can be scripted, because it can be a predefined document, having a textual character. Its content is malleable by its user and it can be used as a script of action for distributed activities.
Version Control	("✓") It might be communicative when symbols, like a timestamp or something else are used to provide coordinative possibilities, but seldom.	(✓) Versioning control can provide awareness because it is possible to coordinate and control who did what and when. The workspace provides a kind of common object where the aim is to avoid overlapping's in documents and hence double work. That is why version control can be instrumental.	(×) Versioning doesn't belong to scripted coordination because there is no script provided which can be used to coordinate distributed activities.

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Table 0-3: Oral vs. Artifact (Carstensen & Nielsen, 2001); Implicit vs. Explicit coordination (Espinosa et al., 2004) (own illustration)

Coordination mechanism	**Oral**	**Artifact**	**Implicit**	**Explicit**
(Group) Calendar	(×) Group calendars are not oral based because the form of the calendar doesn't change dynamically over time. Furthermore, a calendar provides persistency which is contrasting to the oral coordination definition in section 3.9.	(✓) Group calendars are artifact based as they act as a common object of work that is visible to the users. The content of the calendar is accessible, malleable and controllable by the user in cases of changes to the protocol. The form in which dates etc. can be entered is typically persistent which applies to artifact based coordination. The formal and standardised structure stipulates the coordination work.	(✓) In an implicit way a group calendar can be used by any user, e.g. when a meeting should be coordinated. A shared knowledge, how to use a calendar is given by its users. Without explicitly demanding all colleagues separately to coordinate an appointment, next day, a scheduled appointment entered in the group calendar will be automatically distributed to all people involved.	(✓) A group calendar is explicit applied in groups to avoid conflicting situations. By using a group calendar, a team can manage tasks dependencies easier by applying formal arrangement of meetings. The calendar content clearly state activities in a group and there is no room for confusion.
Catalogue	(×) Catalogues do not belong to oral coordination because they are persistence and maintain information over long time. Its form seldom change slightly over time.	(✓) A catalogue belongs to artifact based coordination because they are designed to support coordination of work and distributed activities. E.g. a catalogue in a library stipulates the work because there are only limited fields which need to be filled in to find a book or an article.	("✓") Somehow a catalogue can be implicit when for example a user enters a keyword like "ECS" and find information to enterprise collaboration systems or enterprise content systems. Implicitly it suggests other topic creating awareness.	(✓) In general a catalogue is explicitly applied in order to reduce the complexity of work, especially when there is a need to find fast an article to a specific topic. By using a catalogue work can be coordinated effectively in search. A catalogue does not leave place for implications.
Chat (Message)	("✓") A chat (not a message over the Internet) can also take place in oral situations. E.g. in a face-to-face situation where people chat to coordinate quickly some activities.	(✓) The online chat, regarding the text or video-based chat, can be regarded as an artifact which is embedded in standardised procedures that provide a historical background and is persistence over some time.	(×) A chat is not classified to implicit coordination because it provides an indirect communication that is often applied to directly express something verbally.	(✓) A group can explicitly communicate in informal writings through the chat. Hence, a chat is explicitly applied by a team to coordinate activities by giving e.g. instructions.

Coordination mechanism	**Oral**	**Artifact**	**Implicit**	**Explicit**
Checklist	(“✓") Depending on a particular situation, a checklist can rely on oral nature. For example, in a flight deck, the pilot can delegate the manual checking to the second pilot whereas he uses the checklist to name all relevant items orally and cross them through.	(✓) Checklists are artifact based. They are static documents, often visualized in a list or table that is connected to conventions. Those conventions describe e.g. standardised procedures how something need to be checked. Furthermore, a checklist is also persistence over a longer time stipulates the works by providing information to its users.	(×) Checklist are seldom implicit because they are organised in that way that they express concretely what to do in a specific order to coordinate dependencies. Moreover, they don’t leave place to improvisations.	(✓) Checklists are applied explicitly by groups to ensure that each necessary step to reach an aim defined will be fulfilled. A checklist support control during the work because no activity will be forgotten which is noted in a formal writing that gives explicit instructions.
Comment	(✓) Comments can rely on oral nature. E.g. during a meeting one person can give feedback to a current status of an activity by commenting it. They are currently applied with the view to support coordination.	(✓) As an artifact a comment can be regarded as it is visible to the user. The content of the artifact is malleable, hence it can be specified to a situation. Attached to a document it is persistence over time giving indirect references	(×) A comment is not implicit because they already contain an explicit remark that are spelled out (or noted) in order to change something on a current situation.	(✓) Comments belong to explicit coordination because they can rely on informal writings that are explicit applied with the view to support coordination. E.g. when a comment contains direct instructions to do an activity.
Index	(×) An index is not oral-based as it is inscribed into objects and persistence over time. It is a persistent pointer to content.	(✓) Because it provides persistency over time an index is artifact based. It gives indirect references of information to content.	(“✓") An index can be implicit when they are automatically created in the database, e.g. when an object is added to a table.	(✓) An index can be explicit when a user gives the command of creating a new index that point on a specific content. This can be the case when a user want to find quickly another user in a team table.

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Coordination mechanism	**Oral**	**Artifact**	**Implicit**	**Explicit**
Memo	(“✓") Regarding the general description of a memo in previous table, a memo is not oral based. Seldom they can be oral, e.g. in a real communication where one person reminds another of changing a document. But it depends on the situation.	(✓) Memos are artifact based because they are persistence and provide indirect communication over time. In general, they are attached to a document to support coordinating work. They are visible (text-based) and its content is malleable to the actor. Furthermore, a change in the form of the memo doesn’t affect its environment, hence it is detached from the field of work.	(×) Memos are not implicit used to coordinate because they are not based on a shared knowledge in a team. They are explicitly applied with the purpose to remind a specific action, e.g. an appointment leaving no place for other interpretations.	(✓) Memos are explicitly applied in teams to coordinate their work. For example to give a team information update to a project schedule. They can rely on informal writings to manage team dependencies and are applied with the view to support coordination
Plan	(✓) A plan can be oral, e.g. in face-to-face situations in a meeting. People can communicate further steps which need to be done e.g. in a project to adapt to a current situation. This phenomenon would be a regarded as an oral and informal plan for ad-hoc situations.	(✓) A plan is usually artifact based. In textual or visual form (that is more static) it guides as a roadmap for future actions, hence a formal construct. Its content is visible and malleable to its users. A plan also provides persistency that is documented in general in a formal and standardises structure that stipulates the articulation work.	(✓) Plans can implicitly be used for coordination for e.g. in a team which already works long time together where team members develop accurate expectations and explanations to each other’s tasks. By looking at the plan without giving direct instructions, people involved know what to do e.g. in the next phase.	(✓) Plans can be explicitly employed by a team to manage tasks to reach an overall objective. They have normally a formal structure, textual or visual form that is apply purposely to coordinate articulation work. For instance, a single person is explicitly responsible for one activity which is explicitly outlined in the plan.

Coordination mechanism	**Oral**	**Artifact**	**Implicit**	**Explicit**
Schedule / Time Table	(×) A schedule itself is not oral based. They can only be used as additional information in a face-to-face meeting to communicate further steps that need to be done e.g. in a project to adapt to a current situation, means ad hoc.	(✓) In general is schedule is artifact based and visible to the user. The artifact (formal construct) is guiding as a roadmap for future actions. Its content is visible and malleable in the way that users can transform the schedule to current situations. Changes made to the form itself don't affect changes to its environment. Also an automatization of the workflow can be reached which stipulates the articulation work, also through the limited fields which can be filled in in a schedule.	(✓) Based on an evolved shared cognition and experiences, actors of a team anticipate which team member is doing what activity at which time. Also when actors know the interdependencies between different activities carried out by different actors at different times, then a schedule can also be implicit in its nature just by providing information about current activities.	(✓) Schedules can be applied as explicit coordination in a team to manage tasks to reach an overall objective. They have normally a formal structure, textual or visual using the schedule as a coordination mechanism. Schedules are applied purposely to coordinate task dependencies in teamwork that provide an explicit structure.
Spreadsheet	(×) A spreadsheet does not rely on oral coordination as it presents a coordinative artifact.	(✓) A spreadsheet is a coordinative artifact that can be easy used and understood in groups to mediate the articulation work. The artiact is the spreadsheet itself which is visible and malleable for the user to particular situations. The embedded protocol, how to use it, stipulates the articulation work.	(×) Spreadsheets are not implicitly used. In general, the usage (e.g. for calculation) demand for specific information feeding in order that the spreadsheet lead to contribution in complex work.	(✓) Spreadsheets can be explicitly applied to coordinate work explicitly. For example, when the chef of the financial department instructs one employee explicitly to fill in the spreadsheet to get the results of the turnover, the spreadsheet as a mechanism is applied explicitly.
Standard Operating Procedures (SOP)	(×) SOP are not oral based because they always have a formal, written form and they are used e.g. to control if an enterprise stick to its SOP. They are more static and persistent over time.	(✓) As a written document, SOP are artifact based because they have a standardised and static format that support coordination of work. They are originally designed to support distributed activities to ensure standardisation and they provide a history.	(×) SOP are not implicit, because they are elaborated extra to coordinate work and give direct instructions how to do something in what order.	(✓) SOP are explicitly designed in enterprises to ensure that every employee proceed his/her work according to standardised formats to guarantee always same quality. They are communicated in in formal writings giving explicit instructions to the user.

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Coordination mechanism	**Oral**	**Artifact**	**Implicit**	**Explicit**
Tag	(×) Tags belong to metadata that is not oral-based as it is inscribed into objects and persistence over time.	(✓) The artifact is the tag itself, which normally has a standardised format, a keyword which is made visible to the people. A tag provides persistency and a historical background. Tagging make use of indirect referencing as it provides people with information. Also, it is detached from the content, means changes to the state in the form don't lead to a state change outside the form.	(✓) With the appliance of tags, people understand what other people or members having in mind or are knowing. They making use of a shared knowledge and awareness, the work of others. E. g. tags are chosen collaboratively in a sense which seems to be the more general. But they can also rely on unspoken assumptions how to tag. Through the notice of how things are commonly tagged (experience) team work can be facilitated.	(✓) Tags can also be applied explicitly as they are used in collaborative environments to coordinate the search of information. The tag is explicitly applied because the content fits to the keyword that should give indirect references about the content.
Template	(×) A template is not oral based as it is not flexible and its form doesn't change.	(✓) A template is artifact based as it is persistent over time and can be regarded as a design which support the coordination of work in distributed activities. Each actor involved has the same template which ensure standardisation of quality and workflow. It is detached from the field of work because a state change to the form of the template lead to a state change outside the form.	("✓") Depending in the situation a template can be implicit as it gives suggestions for its user how to use it or how to fill in the form without directly stating. Because the purpose of applying a template doesn't change in time.	(✓) Taking for example the bug report form, a paper based document that can be regarded as a template. Each developer identified a bug was able to fill in the document that ensured that every necessary information was noted and the bugs could be corrected easier. The form is explicitly developed in order to support the coordiantion in bug reports.
Version Control	(×) Versioning is not oral based, as it is about an embedded tool in a software.	(✓) Version control is artifact based as it is visible to the user in form of textual information. It provides an overview of the state of affairs and what is going on which is stipulated through a protocol and provide indirect references of the work of others.	("✓") Implicit coordination can be reached with version control in that way that group members can develop a shared knowledge over time by using the tool and with provision of history (contain time stamps) see what other users did.	(✓) Version control can also be explicitly applied by a group to coordinate division of labour and interdependent tasks. A change to a document is explicitly visualized to the user through an icon or a time stamp.

Table 0-4: Four components (CT) by Malone and Crowston (1990) in AM (own illustration)

Awareness mechanism	**Activity**	**Actor**	**Goal**	**Interdependency**
Activity Stream	An activity stream is about the listing of activities performed by an individual user or an operator between social tools that can be shared across other different networks. Activities can be any kind of actions, like posts, comments etc. on a social website. People can also discover information that can be relevant to them by looking at latest actions. Activity streams also can be used in order to control the flow of information in enterprises or used for ad hoc collaboration and communication. E.g. a tweet that is posted (includes information about author, date of creation etc.) can be shared by another actor.	Actors involved are the user performing an action on a social website, e.g. post a tweet. That tweet can then be shared by another user that is accessible for a community or team having the same interests.	The goal of an activity stream is to present new/latest and relevant information, to avoid information overload to an individual actor and to provide opportunities in terms of search. Moreover, it can support awareness of organisational processes.	E.g. in enterprises, where distributed teams need to be updated about recent actions, activity streams can create awareness of those recent activities concerning a specific topic. An interdependent user can post news on the intranet that is shared by another interdependent actor that creates awareness on the landing page among the team.
Alert	Alerts deliver updates about the newest information to a subscribed user by presenting the newest activity to the topic of interest. An alert is triggered e.g. when an item in a calendar is created, changed, deleted or when a tasks status is modified. The system automatically communicates recent changes to its users or sending reminders or notification e.g. in form of an email.	The actors involved is a subscribed user interacting with a machine, i.e. a machine-to-person communication.	The main goal of alerting services is the information update about newest content of point of interest of a subscribed user. An alert can, for instance, be sent by an e-mail that contains the information about recent modifications to an item, hence acting as a form of notification and reminding that create awareness.	E.g. in a group calendar an actor creates an appointment for a meeting. The saving in the calendar triggers an email alert that is send to the group members in the calendar. Each actor is provided with the same information and the whole group is aware of the next meeting, reminded by the system.

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Awareness mechanism	**Activity**	**Actor**	**Goal**	**Interdependency**
Community Bar	In a community bar user can monitor their workspace environment in a single window on their desktop. The community bar can provide a collection of divers mechanisms applied for different activities that are used to provide awareness. Tee et al. (2009) give an example of a community bar that contains different items providing facilities to communicate, share artifacts, take and post notes. People can collaborate to ask questions, initiate or join conversations and to broadcast information. E.g. a person can share a presentation slide to get feedback.	Actors are the people interacting through the community bar e.g. in a same application. For example, one actor can start to communicate through a chat functionality with another actor that is provided in the community bar. Or a passive observer monitor a colleague in another provided item.	A community bar can contain some media items that provide divers functionality to allow ad hoc communication and collaboration in a workspace. Group interactions are made visible to actors (activity, availability etc.) that can lead to light causal interactions. It is a virtual setting where a community can share activities in real time for remote collaboration.	E.g. one actor sees his/her colleague in an item that shows the presence of somebody with name that has posted a document in the community bar. They can start a discussion to the document in the chat item. Hence, they still can work interdependently on their personal tasks.
Consequential Communication	Consequential communication can take place in a shared physical workspace through e.g. gesturing that communicates info unintentionally and implicitly as it evokes awareness of others. Awareness allow the actors to pick up activities that communicates indirectly information, from other by monitoring another actor's movements and actions to coordinate their work. It allows smooth interactions in groups. E.g. in remote collaboration a telepointer can evoke consequential communication.	E.g. in a physical location an actor (individual sender) moves his/her hand towards a binder on its colleague desk, the colleague (individual receiver) is aware of the intension of the other actors by picking up the gesturing.	The main purpose of consequential communication is to get aware of collaborative interactions implicitly through visible (gestures) or audible (communication) sights by monitoring each other that allows facile and smooth coordination of activities and communication.	E.g. in a shared workspace one actor (A) prints out a sheet and fills it in. A colleague, responsible for the collection of all filled in sheets in the team, monitors the actor (A). As he sees, that actor (A) puts the sheet beside, the other person directly can pick up the sheet to continue his tasks.

Awareness mechanism	Activity	Actor	Goal	Interdependency
Event Icon	For instance, in BSCW each activity in the shared workspace is recorded as an event and each actor in the space is informed about recent events A event is triggered whenever an action is performed by a user in the workspace, e.g. uploading a document. Event icons in the example of the BSCW, give information to the user at a glance or is delivered as a notification via email or special event monitor. In BSCW there exist five types of events that are the creation, a change, move and read an object.	In BSCW collaborative actors are a group that use the same workspace. If an actor e.g. uploads a document in the workspace that triggers an activity, the system give off information to remote collaborators in the workspace as an event icon.	The main purpose of event icons in a shared workspace is the support of informing the collaborative actors about events and recent changes to an object in the shared workspace. It provides an active notification and awareness mechanism informing directly each user about recent changes occurred during their absence.	E.g. in BSCW one actor uploads a document that is to be finished for the next day presentation. This uploading is the only action performed by this actor. Now it is the turn of the team colleague to finish the document. If the colleague is signed in to BSCW he will be informed in the iconic way about the activity (upload) of the document. Hence, each actor can work interdependently from each other, but is aware of the other users' activities in the workspace.
Feeds	Feeds inform frequently subscribed users about new updates made to content on the website. E.g. in a scholarly digital library a subscriber can determine if they wat to be informed about new articles in the research are they are interest in or if another researcher cited the own article. These activities are delivered via Feed, contain aggregated content, to the actor (subscriber).	E.g. in a scholarly digital library an author (researcher) uploads his/her new research paper to the topic of awareness. Subscribers of the scholarly digital library, interested in the same topic will receive a feed that is transmitted through the system. One feed (contain the same information) is send to all the interested subscribers (1:m)	The main goal of feeds is to stay always informed frequently in real time by retrieving the latest content from the website interested in that leads to time saving in content search. The content to a specific topic is aggregated and can be categorised.	E.g. an author uploads his/her new article to the topic awareness in the shared workspace of a scholar digital library. The upload is saved in the system. This activity is transmitted to other subscribed users involved and interested in the same topic that contribute to knowledge of collaborations worker's awareness.

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Awareness mechanism	**Activity**	**Actor**	**Goal**	**Interdependency**
Feedthrough	Feedthrough provide to its actors the possibility to observe the effects of another's actors' actions on a shared artifac in a virtual space. Based on the recognition of other activities from, feedthrough gives indirect feedback through communication upon or about the artifact, e.g. in an online chat. An actor types a message and send it to another actor. First, he sees the message and sometime later the massage appears by the other actor.	Actors are remote collaborators, shared editors, working on a shared artifact. E.g. an actor push a button on his interface, change a shared artifact, this will be automatically transmitted to the remote collaborators screen.	Feedthrough for actions like selecting a push button, aims to reflect an actor's activity to another actor's screen. I.e. changes made to a shared artifact is indirectly communicated to remote collaborators through the artifact.	People involved can handle their activities interdependently from others. The example of the push button: Actors in a group can have the intension to push the button (shared artifact). One actor push the button firstly. After the action is triggered the manipulation of the artifact is transmitted to all remote collaborators. .
Online Status Display	If a user log on to an application, the activity triggers a change in his/her individual status from offline to online, or vice versa, visible to remote collaborators. With the support of this mechanism users can ad hoc ask questions, coordinate and schedule meetings etc. E.g. in BSCW the presence of users is marked in different colours. The colour depends on the recent activity of a user in the last time. A logged-on user is coloured green that provide awareness of remote collaborators that this individual is available at the moment. Another tool making use of this mechanisms is an IM.	Actors (individuals) for the online status display are remote collaborators. One single status is assigned to an individual user (presence/absence) providing awareness in a group shared workspace.	The main purpose is the displaying of absence and presence of remote collaborators in a shared workspace. It supports workspace awareness that could e.g. facilitate ad hoc collaboration.	E.g. in BSCW group members can work interdependently on one single task or document in the shared workspace. If the group members that one specific person is absent at the moment also if this person is needed to finish a task, the remote collaborators can wait for this person to return in the space. Meanwhile the group can coordinate their personal activities in order to work on something else.

Awareness mechanism	**Activity**	**Actor**	**Goal**	**Interdependency**
Radar View	In radar view people can keep being aware of the work of others on a shared artifact and what they are paying attention to. Locations, activities and presence of people in the shared workspace are transmitted to other users' small windows that captures the whole workspace. People can monitor each other in activities involving the manipulation of an atrifact.	Actors can be remote collaborators in a shared workspace working e.g. on a same mind map adding new branches. Each remote actor see members in the shared space moving around.	Radar view aim to provide its remote collaborators with the information of other actors can see (viewport) in the current shared workspace, like their location and what they are paying attention to, if they are making changes on a shared artifact etc. in order to provide workspace awareness of the activities of collaborator's.	Interdependent navigation in the radar view is allowed for each user. They can work interdependently on different items, but also can see where other people are working on and join them on the screen. E.g. they can watch a telepointer moving to another place and one could follow it in order to discuss about an item that is regarded on the screen.
Screen Sharing/ Shared windows	Next to the exchange of data and information, screen sharing allows its users to work collaboratively on one tasks and help in problem solving, e.g. for desktop conferencing. In a 1:m communication one single screen can be shared with users that are distributed locally, reducing time and cost, e.g. travel costs. Everybody has the same picture on the screen and everybody get to know where somebody is working on. Screen sharing also provide the activity of remote assistance where a system administrator takes remote control of another person's computer assisting in performing a tasks and remote access to control a PC in distance.	Screen sharing is allowed by one individual actor that invites other people to work together collaboratively. E.g. one single screen can be shared within a group in order to work on one single presentation. It is also possible that a screen is only shared between two people, e.g. for a remote assistance.	The main goal of screen sharing is the real- time collaboration for distributed actors, hence the provision and facilitation of working together collaboratively. With screen sharing, time and costs can be reduced because users have the possibility to interact together among one single screen without traveling, that also support the awareness of collaborative activities.	Members of distributed groups can collaborate by using screen sharing. It is initiated by an actor, e.g. invite colleagues to a desktop conference. Distributed actors join the conference and work together in real time on a presentation by working. Each actor can contribute his/her opinion.

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Awareness mechanism	**Activity**	**Actor**	**Goal**	**Interdependency**
Telepointer	The activity of a telepointer is the movement and placing of a marked cursor on a screen that is made visible to members of a group session. They can be compared to gesturing of a person to make other people paying attention to a specific item. Telepointers also can support the mediation of conversation in a group as their localisation indicates where one person is in the workspace and what he/she is doing. One example is Colab (Stefik et al., 1987) where people can select pens to draw a picture together.	Actors constitute a group that works together collaboratively. One single actor can move his/her telepointer (1:m) to a specific item in order to show the group where he is working on or where they should pay attention to.	The telepointer's main function is to point to a specific item on a display so that its motion can be compared with human gestures. They provide real time interaction in remote collaboration that provide workspace awareness of actors' presence and their current activities. Telepointers support the pattern of signifying something that depends on human movements, a location on the remote display. When a local actor watches the remote actor's curser, he is aware of the foci of the remote actor.	A collaborative group can create a sketch or a picture for example together by doing that interdependently from each other. E.g. one person starts by sketching the first draft and puts the telepointer on a specific place where another person should continue. The second person then continues from this place, as he is aware of the work from the previous person.

Table 0-5: Framework of “workspace awareness“ by Greenberg et al. (1996) (own illustration)

Awareness mechanism	**Informal**	**Social**	**Group-structural**	**Workspace**
Activity Stream	(×) An activity stream does not belong to informal awareness because it does not provide information about who is around in a group, their reachability and their intension.	(“✓") Activity streams can be categorised to social awareness because they provide information about the users interests and attentions. Opinions and trends in global enterprises where employers are locally distributed, can be exposed and awareness of processes and projects can be supported. However, the emotional state of the people stays unknown.	(✓) Group awareness can be provided through activity streams because they provide information about the users’ activities and status in a process showing their current common ground. A publication of news on the intranet by a single person can catch attention by another person having the same level of interest.	(×) Activity streams are not grouped with workspace awareness because it doesn’t provide information about present users in a workspace working on common artifacts.
Alert	(×) Alerts are not grouped with informational awareness because they do not give information about who of actors is present and if they are reachable. That counts for the physical and virtual shared space.	(“✓") Alerts can be grouped to social awareness because it can maintain information about the level of interests in an asynchronous way (e.g. knowing that a colleague has also received the update information). However, their emotional state is not made visible through an alert.	(✓) Group structural awareness can be achieved through alerts services because the alert can contain information on activities going on represented by the latest content created/edited within the system or workspace. Also a person’s position to a current status can be publicised.	(×) Workspace awareness is about the interaction between presence people in a common workspace. Alerts services do not fit in there as they are a machine-to-person communication.

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Awareness mechanism	**Informal**	**Social**	**Group-structural**	**Workspace**
Community Bar	(“✓") A community bar can be grouped with informal awareness because it can contain mechanisms showing who is present in a virtual community and on what activity they are working on.	(✓) Chat and video functionalities can be provided in a community bar. These functionalities allow the user to see also the emotional state of group members that can be connected to social awareness. Some facilities in the community bar can support awareness of attention and emotional state of a person.	(✓) A community bar can be grouped to group awareness because it also provides for its users the possibility to maintain who is around while working in the group. However, roles might be supported in the community bar through the different usage of the facilities that are provided. In general, people get aware of the activities of user users.	(✓) Using the community bar with its different facilities, people can get aware of the activities and interactions of other people in the current workspace. They can interact among chats and video chats, like in a face-to-face situation. The visual contact can be used in order to perform a task collaboratively.
Consequential Communication	(✓) Through consequential communication the intension of people, what they want to do, can be transmitted when are physically present or virtual (e.g. telepointer). It provides the listening and monitoring of each other.	(✓) Consequential communication is also grouped to social awareness because depending on the situation, back-channel feedback can be maintained, and through non-verbal cues like eye contact or gesturing, people can pick up social maintained information in the workspace.	(“✓") Rather consequential communication is group structural because their positions and roles in the shared space are not transmitted with this mechanism. Only the current status in the process is made visible to other people.	(✓) Consequential communication fits to workspace awareness because it can be compared with the “up to the minute knowledge” of peoples interaction as an activity is monitored by others users affecting smooth collaborations.
Event Icon	(×) Event icons are not grouped with informal awareness because they do not provide information about the presence and intension of other people. They more present recent activities (history actions).	(×) Neither event icons are grouped to social awareness. Icons cannot provide information about attention and an emotional state of people in a conversational context.	(“✓") They might can be grouped to group awareness because they can provide information about activities and status of a person in a process. E.g. in BSCW an activity (upload a document) of a person can be visualised with an icon that will be presented to other users in the workspace having only the role to view the document.	(✓) Event icons are used in a virtual workspace, like BSCW. People get informed how other people in the workspace interacting and what they are doing, but is also limited to the visual workspace. When a shared artifact is modified, people in the workspace get aware of it through the event icon.

Awareness mechanism	**Informal**	**Social**	**Group-structural**	**Workspace**
Feeds	(×) Feed do not provide awareness about present users in a community neither what they have as intention or if they are reachable because they provide awareness to news.	(×) Because social awareness describes more the information actors maintain about each other's, feeds are not grouped with it. However, they can provide information about the level of interest (subscribed) of an actor, but it is not really social.	(✓) Feeds can provide group awareness because they indirectly provide information about the members' roles to a specific topic, e.g. if a member only receive feeds or if an action of him/her triggers a feed too.	("✓") Feeds are grouped with workspace awareness. The workspace in this case can be defined as the website, e.g. a scholarly digital library, where a user is subscribed to. Information update or changes on this website are then shared in this workspace.
Feedthrough	("✓") A feedthrough can be informal if e.g. an actor modifies an object in the shared space, his action is visible to the other users, in a physical or virtual workspace that indirectly indicates that this person is available at this moment.	("✓") Rather a feedthrough can be grouped with social awareness. Somehow, they indicate where users are paying attention to but somehow it indirectly provides gesturing a user's action.	(✓) A feedthrough can be grouped to group awareness that provide information about the users' movements, activities, responsibilities and status in a process, e.g. if a user already modified an artifact that gives off information to the next user.	(✓) Workspace awareness is reached through a feedthrough because people obtain information about an up-to-date version of the current work. It is similar to feedback of a person in a physical space, whereas it takes place in a virtual environment. E.g. the movement of a cursor over a button on a screen is visible to all the other people.
Online Status Display	(✓) Informal awareness is supported because it shows the online status of users in virtual workspace that implies if users are present or not. E.g. in the IM when a user is present, other are aware of being able to contact this person.	(×) The online status does not support social awareness. Users only get to know who is working in the system but they do not see where colleagues are paying attention to or what gestures they are doing. It is limited to a virtual workspace.	(×) The online status gives information about the recent activities of users in the virtual workspace that provide information about the users' presence or absence. However, their specific role in the workspace is not communicated.	("✓") The actual presence of users and their identity in the common virtual workspace can be shown with the online status. However, what those active people are doing in the shared workspace and how cannot be shown with the status.

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Awareness mechanism	**Informal**	**Social**	**Group-structural**	**Workspace**
Radar View	(✓) Radar view can be grouped with informal awareness because in distributed activities they provide awareness of who is around in the virtual space an on what those people a currently working on and to make other persons aware of the own work.	(×) Social awareness does not fit to radar views because it doesn't provide information about the social conversational context. Somehow attention to activities are transmitted, but the social context is not captured.	("✓") Group awareness seldom is provided through radar views. Collaborators get aware of the movements of other is the space, but the roles they have in this process stays unknown.	(✓) Radar view can be grouped to workspace because in a small window users are provided with the information of the presence of other users and what they are currently doing, in the whole workspace. E.g. if a user is working on the same object like another in order to monitor the activity.
Screen Sharing/ Shared windows	(✓) Screen sharing can provide informal awareness in a virtual space. E.g. when a team in the same office makes use of screen sharing in order to facilitate communication by showing directly of what they are working on to solve a problem collaboratively.	(✓) Screen sharing can also be grouped to social awareness because it is applied e.g. for synchronous conferencing (video based). E.g. through the video users get aware of the emotional state of others, that is close to real communicative situation. Also gestures can be picked up and the main foci of the collaboration gets clear.	("✓") Sharing a screen can be group structural because people get to know about the users' activities, movements and foci however their responsibilities can be not figured out really. Depending on the situation, screen sharing is explicitly done in a group to combine the personal different roles and responsibilities in order to work collaboratively together. Or the role is assigned to the person allows other to work on the screen together.	(✓) Screen sharing belongs to workspace awareness as it provides users with the information about who is doing what at the present workspace and what is the next step to be done. Their interactions can be supported and they are always up-to-date about the others users actions and awareness in their group work, e.g if one person has to anticipate in another's action to assist.

Awareness mechanism	**Informal**	**Social**	**Group-structural**	**Workspace**
Telepointer	(✓) Telepointers can be grouped with informal awareness because by pointing on a specific object in the virtual space that is visible to collaborators, they get aware of what the person moving the pointer is up to.	(×) Social awareness is not provided with telepointer, even if their positions give of information to the level of interest. However, the social factors, like gesturing or emotional state is not provided with the telepointer.	(✓) Group awareness fits for telepointers because they give a user an overview of the other users' activities and movements on the shared artifact or screen. The telepointer clearly show the movements of other users in the process. Roles are delegated to the person moving the telepointer, meanwhile the others only watching.	(✓) A telepointer can be grouped with workspace awareness because users in the same virtual workspace get aware of their colleagues, who is around and what they are currently doing. With the example of the drawing a sketch, users know in a realtime where another person is drawing on that facilities collaborative work because direct interactions can take place between the users.

Table 0-6: Awareness support by Dourish and Bellotti (1992) (own illustration)

Awareness mechanism	**Informational**	**Role restrictive**
Activity Stream	(✓) An activity stream can be grouped to informational awareness because its facilities enables collaborators to inform and update each other of their recent activities since their last visit. For example, with a tweet people inform their environment about their current status and the newest status is always on the top. The activity stream itself inform users of each other.	("✓") Role restrictive awareness is inappropriate for an activity stream because it doesn't provide explicit facilities for the support of a role and it is more focused on the content of the activity. Whereas a Tweet that is submitted by a user (author) provided in the activity stream is visible to others (follower).

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Awareness mechanism	**Informational**	**Role restrictive**
Alert	(“✓") An alert can be informational because recent activities in a shared workspace are communicated to the collaborators to inform each other making use of e.g. a signal. Each actor involved receive the new information update. However, the information transfer is grounded more on the application itself than the collaborators.	(✓) Alerts can be role restrictive because somehow a role in an alert can be defined in that way that a subscribed user is only informed about newest content added in a database. However, he himself cannot provide and update information to the database because it is not his role.
Community Bar	(✓) Community bars provide divers facilities that allow its users to explicitly collaborate with other people to inform them about their recent activities. For example, one user can share a document where he/she recently worked at in order to inform the colleague that this activity is finished.	(✓) Role restrictive awareness can be supported by a community bar in that way that it gives explicit information about individual relationships to the shared workspace and other participants because it provides some facilities to collaborate within the shared space. Even, which facility is used by an actor can be transferred to a role.
Consequential Communication	(“✓") Consequential communication does not provide explicit facilities to inform each other about activities, whereas an activity of a person is picked up by another person that implicitly infer what the first person want to do.	(✓) Consequential communication is role restrictive because its activity takes place between collaborators with different roles that can change. E.g. person A is the active person (actor) pointing with his/her finger on a binder (indirect message) that is remarked by person B (passive observer). The passive observer change the role than in an active actor as he passes the binder over to person A.
Event Icon	(✓) Event icons rely on informational awareness because they provide information about recent activities e.g. on a document that was manipulated by an actor, that is made visible in iconic form to the other actors working in the same space. The icon can be regarded as an explicit facility support collaborators to informed each other about recent changes since their last visit.	(×)/(“✓") Event icons do not provide information about roles because icons in general people are not assigned to icons. Only with an icon an action of a person is made visible that can somehow be a role, e.g. when a person uploads a document, the icon is matched with this activity carried out by the specific person.

Awareness mechanism	**Informational**	**Role restrictive**
Feeds	(✓) Feeds provide informational support because they allow the transmission of information to subscribers when changes in the workspace occur. E.g. in scholarly digital library a person (author) uploads his new article, a feed is triggered that gives of this information to the subscriber (reader, colleagues) interested in the same topic. The feed itself is used to inform each other in collaborative settings.	(“✓") In a shared space, like in scholarly digital library that make use of feed to update the subscribers about newest content, roles can be assigned to the users in the space. E.g. author, reader, abonnement, reviewer etc.
Feedthrough	(✓) The feedthrough explicitly gives off information about a manipulated shared object, visible for other people that should provide them with information about recent activities to the object. The feedthrough gives off directly information, like a feedback in real physical workplace.	(✓) A feedthrough can be regarded as a role restrictive mechanism that provide information about the character of an activity. A role in this context is defined as an individual’s relationship to a shared work object (artifact) and also to other participants. The shared object, acting as a communication medium, is manipulated by person A (initiator/or sender). This information is retrieved by another person B (receiver).
Online Status Display	(“✓") Online status explicitly show the presence of people in a shared space that is compared to inform each other about their current status in the workspace. Other users indirectly get aware about recent absence/presence of a person in the shared spaces. However, the specific activity stays hidden and the information about recent changes that a person made in the space stays unknown.	(×) The online status in collaborative systems do not support roles. Also, the relationship of individuals stay unknown because they only provide information about the users’ presence in the workspace that o not really provide a role.

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Awareness mechanism	**Informational**	**Role restrictive**
Radar View	(✓) Radar view can be informational because with its explicit usage collaborators are enabled to inform each other of their activities as they are made visual on the radar view. Whereas there is no automatically update for users of recent actions that have been taking place. However, it can be used explicitly in collaborations to inform group members of recent actions.	(✓) Explicit roles can be given in radar view as each user can have assigned different roles in the collaborative work that can smoothly change during a setting. E.g. a person in the role of a passive observer (e.g. watching a telepointer) can switch in the active role of the actor moving the pointer.
Screen Sharing/ Shared windows	(✓) Screen sharing can be informational because it provides explicit facilitates to inform the group about current activities which are transmitted synchronously to the group. Due to the synchronous activity, each user can identify changes made by another person.	(✓) Somehow screen sharing can be also role restrictive. One person, who wants to share his/her screen with other users, need to invite them. With the invitation, this person allows then other for example to look and follow what he/she does, but not to make edits. Hence, roles can change during screen sharing.
Telepointer	(✓) A telepointer can be informational. Collaborators in the shared screen can inform the other people explicitly about their current activity (e.g. drawing an eye in a figure) by moving the telepointer to the correct space on the screen. The telepointer also show to the user the changes made to a sketch for example if the users follow the movements of the telepointer.	(✓) A telepointers support role restrictive awareness in that way, that for example during somebody is drawing on a sketch (role of drawing) all the other users are only allowed to watch how the other person draws (role of just watching). By picking up the telepointer, the role can change explicitly in the group.

Appendix 3: Codes for second coding cycle

Table 0-7: Descriptive codes used for pattern coding in CM

Coordination mechanism	**Descriptive codes - Dictionary**	**Descriptive codes - Description**
(Group) Calendar	• chart giving particular seasonal information • separate space or page arrangements	• make inferences • interpersonal communication
Catalogue	• list of items, typically (alphabetical/systematic) • collection with detailed comments and explanations	• classification • directory of information about content • where information is located • additional information (descriptions)
Chat (Messages)	• exchange messages online in real time • involves the internet	• computer-mediated communication" (CMC) • text based from • similar to normal communication
Checklist	• list of items • used as a reminder	• ensure reminding • list of items reduces local control • particular order
Comment	• verbal/written remark expressing opinion	• attached to • are considered as metadata
Index	• set of items • specifies one of the records of • contains information about its address	• pointer to physical location of data in a table • to improve data retrieval • metadata • reference tool
Memo	• written message/statement • passed around	• informal writings • a means of communication • symbolic artifact
Plan	• detailed proposal • how to do something in the future	• coordinate activities i • formal representation of steps and activities, • formal or on ad hoc improvisations

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Coordination mechanism	**Descriptive codes - Dictionary**	**Descriptive codes - Description**
Schedule/ Timetable	• plan for carrying out a process • giving lists of intended events • a list of planned activities and events are scheduled	• coordinate activities • represents a graphical order of tasks, • documents sequence and timetable • communicates
Spreadsheet	• document in which data is arranged • rows and columns • can be manipulated	• a organisation of • support communication
Standard Operating Procedures (SOP)	• series of actions conducted in a certain order or manner • a set of instructions	• instruct carry out routine operations • reliable descriptions in documents in a process. (repeatable)
Tag	• characters appended to data • to identify or categorize it	• attached to content by user • support categorization • refer to metadata
Template	• present format for a document • system that helps you arrange information	• enforcing a standard layout • for frequent occurring operations
Version Control	• particular form of something • respects from an earlier form	• avoiding overlapping's of changes • keep the original document • avoid locking and replication of objects/ synchronization and serialization • provide structure

Table 0-8: Descriptive codes used for pattern coding in AM

Awareness mechanism	**Descriptive codes - Dictionary**	**Descriptive codes - Description**
Activity Stream	• ACTIVITY: person or group does • STREAM: continuous flow of data or instructions • constant or predictable rate	• raise connections between people • subscribe and publish notification mechanism • lists activities of actor (past, present future) • interacting and sharing (behind firewall) • syndicates the employees' activities across the social media integrated in enterprises • activity streams, text and metadata, allow people to get informed about recent updates • discover new information relating to their personal interest
Alert	• signal on an electronic device • attracts attention. • watchful and aware	• "current awareness services" (CAS) • keeping clients up-to date about new documents to their personal defined objects of interest • support the organisation of information search (reducing the time) • user is informed by e-mail or RSS. • triggered e.g. in a calendar as a reminder to coordinate appointments
Community Bar	• "(in a graphical user interface) a narrow vertical area that is located alongside the main display area, typically containing related information or navigation options." / "a narrow area at the side of a page on a website, giving extra information or links."	• contains other awareness mechanism • support ad hoc situations • leverages also the design ideas of media items media items offer multimedia awareness • support casual interactions (usually unplanned), keep up individuals with information/contexts • facilitating the transition to collaborations using artifact
Consequential Communication	• CONSEQUENTIAL: happening as a result of something • COMMUNICATION: imparting or exchanging of information by speaking, writing, or using	• is evoked by an actor during listen and watching others • visible or audible signs of interaction with a workspace • actors monitor bodies/ gestures of colleagues • infer what they are about to do • can be coupled with the feedthrough/ or an actors' embodiment

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Awareness mechanism	**Descriptive codes - Dictionary**	**Descriptive codes - Description**
Event Icon	• EVENT: thing that happens or takes place, especially • ICON: a small picture or symbol on a computer screen that you point to and click on (= press) with a mouse to give the computer an instruction	• provides awareness about recent activity • clicking on the event icon → actor retrieve information • performance in the workspace is recorded • automatically inform other actors in the common workspace about recent activities.
Feeds	• "a web page, screen, etc. that updates (= changes) often to show the latest information."	• automatically provide information about recent updates to a resource (shared workspace) • summary of text-based resources • usage of feeds allow its subscribers to stay aware of new published content • RSS feeds and similar to push mails
Feedthrough	• "the observable effects of someone's actions on the workspace's artifacts. Seeing an object move indicates that someone is moving it."	• allows users to stay informed about recent activities • through a shared artifact • when shared artifact is manipulated it gives off information • reflects one's actor activity on another actors' screen • comparable to a feedback
Online Status Display	• ONLINE: performed using the Internet • STATUS: situation at a particular time during a process • DISPLAY: electronic device for the visual presentation	• indicates the current absence/ presence of actor • depends on the time span (current/latest activity) • used in Instant messengers (IM) • IM support informal workplace communication • IM allow to create a "buddy list" • in order to clarify quick questioning, and impromptu meeting coordination
Radar View	• RADAR: indicate that someone or something has or has not come to the attention of a person or group. • VIEW: visual appearance of something when looked at in a particular way	• presents a viewport of each actor in a common map • provision of information about people's interaction to a basic overview • area/ activities of others is made visible • viewports, the locations and telepointers of users are indicated • in situations where it is difficult to describe the activity verbally • reduces the complexity • enhance the awareness

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Awareness mechanism	**Descriptive codes - Dictionary**	**Descriptive codes - Description**
Screen Sharing/ Shared windows	• SCREEN: surface on which pictures appear • SHARE: to have or use something at the same time as someone else	• actors share personal computer screen explicitly with col-leagues • to facilitate communication/collaboration • mediated by privacy control • one actor provides information about his activity • interactions • integrating audio/ video • leads to causal interactions
Telepointer	• cursor used to mark the point on a screen display	• to coordinate remote collaborative writings, • support the understanding of gesturing • show location, presence and activity of users • watching movements of collaborators • interacting with the shared context • directing attention of colleagues to particular documents • identification of co-authors • is visible (more than one screen) • can be moved by collaborators (pick and release)

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