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Introducing Real-Time Collaboration Systems: Development of a Conceptual Scheme and Research Directions

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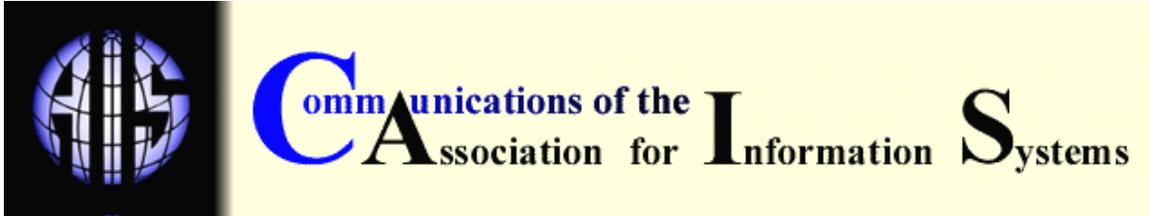
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INTRODUCING REAL-TIME COLLABORATION SYSTEMS:
DEVELOPMENT OF A CONCEPTUAL SCHEME AND RESEARCH DIRECTIONS

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ABSTRACT

This paper presents Real-Time Collaboration (RTC), a new and emerging type of Information and Communication Technology (ICT) system that has its roots in both the telecommunications and groupware market. The aim of the paper is twofold. First, it outlines the evolution of RTC systems and offers a conceptualization of RTC consisting of usage scenarios and four main building blocks – integration of communication channels, presence information, context integration, and further collaboration features. Second, in order to understand the organizational implications of this complex and socially embedded information system, the paper intends to offer a starting point for future research on RTC by touching upon and systematizing different directions and typical questions for researching RTC and its organizational implications.

Keywords: Real-Time Collaboration (RTC), Unified Communication (UC), presence information, instant messaging, virtual collaboration, research agenda

I. INTRODUCTION

Real-Time Collaboration (RTC) presents itself as a new and emerging technology in the communication and collaboration systems market with a wide range of new products currently entering the market [Riemer 2007a]. Initially created from the integration of instant messaging tools, with their text chat functionality and presence information, and communications technology, in particular Voice over IP (VoIP) communication, the field of RTC has been maturing over the past three years. Further information and communication channels have been added and RTC technology shows significant potential for integration with other collaborative applications, such as general purpose software like office software, or enterprise-specific systems, such as ERP. However, RTC is still in its infancy, with new systems not yet living up to the promises providers present in their roadmap documents. While roadmaps and showcase prototypes illustrate the potentials of RTC technologies, empirical examples of RTC application in organizations show that the envisioned features are yet to be implemented.

The aim of the paper is twofold. First, it outlines the evolution of RTC systems and offers a conceptualization of RTC consisting of usage scenarios and four main building blocks. Second, the paper is intended as a starting point for research on RTC by outlining potential research questions. For doing so, the paper first starts with a discussion of organizational and technological developments that led to workplace changes. Drawing from these challenges of dispersed workplace setups, section 3 discusses the evolution of RTC systems, briefly introduces RTC vendors and then provides a conceptualization of RTC. Section 4 introduces a set of typical RTC usage scenarios that illustrate RTC applications in contemporary work environments. Finally, section 5 presents a research agenda comprising propositions for future research. RTC technology is promising and complex at the same time and needs deep integration within organizations in order to unfold its potential. At the moment, there are not only many open research questions regarding the design of RTC systems, but also in regards to the social and organizational implications induced by the application of RTC systems.

II. BACKGROUND

Today's work practices have been undergoing significant changes over the past couple of years, which led to new forms of organizing, communicating, and collaborating. The virtualization of organizations and work contexts on the one hand and the emergence of new information and communication technologies on the other hand are two major causes for this development. These two drivers led to an all but perfect communication situation from the point of view of the users as well as those organizations that rely heavily on dispersed collaboration across organizational units.

VIRTUALIZATION LEADS TO DISPERSED WORKPLACES

New virtual forms of organizing present new challenges for people in their daily work. Virtualization is fuelled, on the one hand, by globalization, which leads to internationally diversified organizations. On the other hand, the ongoing trend toward inter-firm partnering manifests itself in the formation of strategic alliances, joint ventures, and business networks. These organizational developments are enabled by the capabilities of modern information systems and infrastructures like the Internet. The widespread claim is that organizations can improve their performance by capitalizing on the potentials of groupware technologies as teams can be formed corresponding to individuals' qualifications rather than their local availability [cf. Konradt and Hertel 2002; Tuma 1998]. "Virtual," "remote," "dispersed" or "mobile" forms of collaboration have gained increasing interest and assumptions are being made that some "new" sets of activities can be contrasted from 'traditional' forms of carrying out work [Bultje and van Wijk 1998]. A large body of research concentrates on understanding the implications of these forms of collaboration on issues such as leadership [Townsend et al. 1998; Tyran et al. 2003], trust [Javenpaa et al. 1998; Kanawattanachai and Yoo 2002], managerial issues [Hinds and Bailey 2000; Montoya-Weiss et al. 2001; Townsend et al. 1998], or communication [Carlson and Zmud 1999; DeSanctis and Monge 1999; Maznevski and Chudoba 2000]. Although recent studies caution against the performance claims of virtual forms of organization [cf. Introna 2000; cf. Riemer and Klein 2003], the existing academic interest in the topic mirrors the ongoing transition of today's work practices as well as the importance of the topic. As a consequence of these trends, fragmented and dispersed workplaces are common today. Hence, people rely more and more on computer-mediated communication and groupware-supported collaboration.

NEW COMMUNICATION TECHNOLOGY INCREASES COMPLEXITY

Over the last two decades, a number of new communication channels (e.g. Voice-over-IP telephony, instant messaging) have mushroomed, creating a heterogeneous accumulation of technologies that are available to the average user [Lyytinen and Yoo 2002b]. To add to the multitude of communication channels, many people do not just possess one e-mail address, phone number, or instant messenger account, but rather they use several similar channels for corresponding with their peers across a number of social groups [e.g. Rybczynski and Shetty

2005]. Consequently, the "escalating variety of communication devices and the ever-increasing volume of messaging activity" [Hutton 2001, 50] increase drastically the communicative complexity for both the initiator and the recipient of a communication request. For initiators situations are characterized by a high uncertainty as they have to think about the recipient's location and context, the appropriate channel, and the relevant contact details in terms of accounts and phone numbers [Lazar 2006]. Generally, all required information is not at the disposal of the initiator, resulting in failed communication attempts that are time consuming and costly. The recipient, on the other hand, is confronted with a myriad of communication devices as well as several addresses and numbers, creating a fragmented communication landscape whose coordination is time consuming and tedious.

INTERACTION OVERLOAD AS A CONSEQUENCE

The two aforementioned trends bring about structural changes to today's working environment that manifest itself in the workplace situation of people, i.e. the situation of virtual team members and mobile professionals [cf. Kakihara 2003]. Work conditions are marked by increased fluidity of interactions with others. While fluidity offers benefits, such as interacting remotely and flexibly with others, it also creates interruptions and disturbances as asymmetries of interaction become more likely [Kakihara et al. 2002]. Asymmetries of interaction occur if "the time and topic are convenient for the initiator, but not necessarily the recipient. This asymmetry arises because while initiators benefit from rapid feedback about their pressing issue, recipients are forced to respond to the initiator's agenda, suffering interruption" [Nardi et al. 2000, 83]. Current technologies such as mobile phones offer only limited support for people in managing their increased communicative volume. Specifically, the effect of decreasing communication delays of new technologies on the part of the initiator of a communication request often translates into work interruptions on the part of the recipient [Rennecker and Godwin 2005]. And interruptions most often come at the cost of deeper concentration on a single task [de Poot et al. 2005]. Information and communication requests reach each person unfiltered and people don't have gatekeepers which might help to manage and control the communicative volume. Consequently, people are potentially confronted with a level of interaction that might exceed their personal preferences causing a problem called interaction overload [Sørensen et al. 2002].

In such a situation, people might fall back on tactics for minimizing interruptions or avoiding communication altogether: "For many users, the only way to avoid this media terror is to abstain from these media completely: to have their telephone off the hook or work at home" [de Poot et al. 2005: 75]. While this situation is unsatisfying at the individual level it also translates into organizational frictions in that information processes do not operate as smoothly as they should. In addition, the lack in availability of key personnel causes problems in projects and ultimately leads to higher overall cost for the organization.

III. REAL-TIME COLLABORATION SYSTEMS

Real-time collaboration (RTC) systems are a technological attempt to mitigate the problems portrayed previously. A result of market convergence, RTC has its roots in both the telecommunications and the groupware market. Consequently, RTC systems integrate groupware functionality with (IP-based) communications media. In order to further describe the nature of RTC as well as its roots, we first take a historic approach and discuss the appearance of the term "real-time communications" in the literature; this leads us to identify and trace the evolutionary trajectory of concepts that resulted in the proliferation of RTC systems as discussed in this paper. We will give a brief overview of the RTC market and then characterize RTC by distinguishing a set of four main building blocks.

EVOLUTION OF RTC SYSTEMS

The first appearance of the term *real-time communications*, relevant in the context of our work, dates back to the 1990s in the computer science and telecommunications domains. The

increasing adoption of the Internet in both the private and business domain stimulated the need to transmit rich multimedia data over IP networks. However, multimedia applications such as voice and video services require predictable and timely data transmissions [Roman 1996]. The Internet infrastructure was originally designed for asynchronous data transmission; it was not reliable enough for voice or video transfer [Elliott 1997; Roman 1996]. Consequently, research focused on the design and development of network protocols for transmitting real-time data over the Internet [Baldwin et al. 1999]. The aim of such work was to enable effective, real-time, connection-oriented communication services in packet-switching networks that were originally not designed for real-time data transmission [Golden et al. 1999; Hui and Yip 1999; Shionozaki and Tokoro 1993]. The Internet as a medium is prone to problems such as delays, jitter or packet loss compromising the quality of applications that need real-time data transport [Figueira and Pasquale 1995]. Protocols that enhance the IP standard - such as the real-time protocol (RTP) and the session initiation protocol (SIP) - and architectural ramifications such as the Quality of Service framework [Golden et al. 1999] are therefore a technological prerequisite for services like voice over IP telephony or Web-based video conferencing.

Over time, business media attention as well as research efforts on real-time technologies shifted from the technical level to the service level. Being based on the previously described technological advances of the past decades, new services such as voice-over IP telephony and videoconferencing are spreading quickly and have made fast inroads into the corporate domain [Lazar 2006]. Today, the term RTC is being used to describe an emerging class of communication systems that integrate computer-based telephony, voice, and video services with presence technologies and business applications [Burton et al. 2007; Lazar 2006; Mohamed 2007; Rybczynski and Shetty 2005].

The general idea of these systems is to help people juggle with their communication requests in the face of interaction overload [Oliva 2003] and to improve accessibility by integrating media and devices [Hutton 2001]. This media integration is often referred to as Unified Communications [Minifie 2007; Mohamed 2007]. In fact, the terms RTC and Unified Communications (UC) are often used interchangeably both in the business literature [Burton et al. 2007; Mohamed 2007 Rybczynski and Shetty 2005] as well as by the systems providers.[1] Furthermore, the presence information concept is sometimes seen as part of Unified Communications [e.g. Rybczynski and Shetty 2005] and sometimes as a complementary concept [e.g. Jennings 2006]. For conceptual clarity, we will refer to the two as distinct concepts and subsume them under the RTC label (see following).

RTC as such is the result of an evolution of IP-based communication technology and the product of three types of convergence (it is also referred to as "converged communications" [Rosenberg 2005]): First, network convergence describes the merging of voice, data, and video communications onto a single Internet protocol (IP) [Rybczynski and Shetty 2005]; second, application convergence refers to the integration of communication media with groupware technologies and business applications; finally, these forms of convergence are reflected in the market convergence, which sees technologies from the software market being integrated with telecommunications infrastructures. This is mirrored in the list of vendors of RTC systems and their cooperation efforts.

THE MARKET FOR RTC SYSTEMS

Currently, providers from the telecommunications market such as Alcatel, Cisco, Nortel, and Siemens and traditional software companies such as Microsoft, Oracle, or IBM are entering the market with RTC solutions [Elliot et al. 2005; Mohamed 2007]. A comprehensive overview of RTC providers and their systems can be found in [Lazar 2006], a classification of RTC systems in the

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[1] While vendors such as IBM and Siemens refer to their systems as RTC systems, Microsoft, Cisco, and Avaya for example label their solutions "Unified Communications'.

wider context of the market for eCollaboration systems is presented in [Riemer 2007a]. We briefly introduce two examples.

Siemens developed Hipath OpenScape on the basis of its telephone and unified communications infrastructure. The system addresses enterprises which intend to set up comprehensive RTC environments integrated with their traditional telephone infrastructure [Gibbons Paul 2006]. From the end-user stand point Openscape provides what is called a "dashboard to manage real-time availability and preferred devices" [Moore 2004, 19]. IBM, on the other hand, extends and bundles existing groupware solutions (such as Lotus Notes) with its IBM Workplace Collaboration Services (WCS), offering various eCollaboration features that are going to be integrated with RTC features provided by Lotus Sametime. The idea is to provide RTC features in the context of people's Lotus Notes environment and to integrate Sametime with CRM and ERP applications [Mohamed 2007].

The ongoing market convergence is further reflected in recent alliances between software vendors and telecommunications companies: while IBM teams up with Avaya, and Cisco with Siemens [Yedwab 2007], Microsoft and Nortel have formed what is termed a "Unified Communications Alliance" in order to integrate Nortel's unified communications infrastructure with Microsoft's Office Communicator [Fontana et al. 2005; Musich 2007].

Table 1 gives an overview of some of the providers and their products. This list of vendors and the brief introduction of exemplary systems above reveal the nature of RTC systems as large-scale integrated systems that need to be distinguished from smaller tools in the private domain. Tools such as Skype, AOL messenger, ICQ and the like provide certain real-time features such as the integration of IP-based voice communication with instant messaging and presence signaling.

However, these tools do not provide true unified communications, a wider interpretation of the presence concept or the integration with other software applications that characterize the RTC systems presented in this paper. On the other hand, due to their high adoption rate in both the private domain as well as the business world [Bradbury 2005], tools such as Skype allow researchers to investigate particular RTC aspects (see section V below). In the next section we will clarify our understanding of RTC and distinguish four conceptual building blocks.

Table 1. Overview of RTC Providers

Provider	Product Name
Alcatel	OmniTouch Unified Communication
Avaya	One-X and Multivantage
Cisco	CU (Cisco Unified)
IBM	Workplace Collaboration Services (e.g. Lotus Sametime)
Microsoft	Office Communicator 2005 & 2007
Nortel	Multimedia Communication Server 5100
Oracle	Collaboration Suite
Siemens	Hipath OpenScape

CONCEPTUALIZATION OF RTC

As indicated previously, RTC is the product of the integration of various components and features. First, RTC is based on unified communications (UC), i.e. the computer-supported combination of communication channels. In doing so, RTC overcomes the traditional distinction between either synchronous or asynchronous technologies [cf. Johansen 1988] as both aspects may be integrated within one application. Second, one of the main features of RTC lies in the provision of presence information in regards to the availability of the user and his media and communication devices. Third, RTC systems unfold their strengths when integrated within the context of the user, in particular with organizational processes and business applications. Through this integration and the provision of presence information, RTC goes beyond the idea of simple synchronous communication in that it enables real-time communication within the work context, i.e. by enabling spontaneous initialization of a communication event. A core idea thus is to circumvent the need to pre-schedule communication and to solve the users' information needs by immediately allowing them to communicate [Lazar 2006]. Finally, RTC also incorporates various groupware and eCollaboration features. Consequently, we interpret the acronym RTC as real-time *collaboration* instead of real-time *communication* to account for the integration of a rich set of collaborative technologies [e.g. Burton et al. 2007], which goes beyond enabling mere communicative acts but allows for real-time collaboration, e.g. on shared object such as documents. All in all, four main components of RTC systems can be distinguished (see Table 2).

Table 2. Building Blocks of Real-Time Collaboration (RTC) Systems

Concept	Description
Unified Communications (UC)	Various media and communication channels
	Media and device integration
	Rule-based configuration of message routing and call diversion
	Definition of preferred media
	Unified messaging portal
Presence information	Presence awareness of people, media classes, and devices
	Aggregation of presence information on group, role, and object level
	Active buddy list management
	Individualized and automatic signaling
Contextualization	Embedding and customizing of RTC features to organizational processes
	Integration with office software and enterprise applications
	Context specific buddy lists
	Mobile RTC with location-based services
eCollaboration portfolio	Audio and video conferences, Web seminars
	Ad hoc application sharing
	Joint whiteboards and discussion forums
	Team calendars and contact management
	Document folders

Unified Communications (UC)

The idea behind Unified Communications (UC) is to relieve the user of the burden to juggle with a large number of devices and channels in different contexts. Unified communications can be defined as the integration of communication technologies to improve workers' ability to interact [Minifie 2007; Mohamed 2007]. UC systems thus aim at integrating different information and communication channels, such as e-mail, telephone, instant messaging, or SMS in order to reduce the fragmentation and complexity of today's information and communication landscape. UC is an extension of the earlier concept of Unified Messaging (UM) [Rosenberg 2005; Rybczynski and Shetty 2005]: The aim of UM systems is to manage and coordinate a user's asynchronous communication in a single mailbox [Hampton 1998] and thus to provide an all-in-one message-retrieval system [Clark 1999]. By collecting all incoming messages of various channels such as e-mail, audio, fax, or SMS, accessing all types of messages from one device becomes feasible [Brodsky 1999]. Moreover, UM allows for a conversion of messages between these media types (e.g. text-to-speech conversion) [Hampton 1998; Lai et al. 2002].

UC extends the UM integration idea to synchronous communications. Users are aided by a communication middleware in the management of channels and devices through a rule-based coordination and filtering system. The user can define preferred channels (text, audio, and video) and devices (landline, mobile or IP phones). The system provides users with a universal phone number which finds them wherever they wish to be found [Hutton 2001; Rosenberg 2005]. Incoming calls can thus be diverted and transferred between channels and devices according to a set of filters or rules [Jennings 2006]. These rules can be related to time, situations ("in the office," "at home"), or callers ("colleagues," "customers"). For example, when the user is not logged in to his or her office computer, all incoming calls from colleagues might be transferred to the mobile phone, while after hours any caller might be diverted to the voice box. On the technical level, this media integration is based on IP technology and consequently on protocols such as the previously mentioned SIP protocol [Rosenberg 2005; Steinmann 2007].

All in all, UC features enable users to manage their channel complexity and communication volume corresponding to their preferences and contextual demands. The locus of control is shifted from the initiator to the recipient who can decide which media and devices to use or which requests might need immediate consideration.

Presence Information

The second defining feature of RTC is what is most often termed "presence information" by the system providers [Jennings 2006]. Much like in the increasingly popular instant messaging (IM) tools, users can manage buddy lists of contacts that show a "presence status" icon for every contact. In the instant messaging literature, this status feature is sometimes also referred to as a *presence awareness capability* [Cameron and Webster 2005] or *presence management feature* [Li et al. 2005]. The idea of this presence information is to signal to the initiator of a communication act, independent of a recipient's physical location, the availability for interaction, i.e. the "ability and willingness to communicate" [de Poot et al. 2005: 84]. Combined with the UC concept, presence information enables someone to see if people are available to receive a phone call before dialing [Jennings 2006; Oliva 2003].

In simple IM tools, the status feature determines the availability of others by technical means, e.g. the system deduces from the user being logged into the system a "present" status; a lack of user activity is usually interpreted as "away" [Grinter and Palen 2002] (for presence signaling protocols and architectures see [Brok et al. 2006]). In RTC systems, presence information can originate from all devices a user possesses [Jennings 2006]. It can be derived from the technical availability of channels and devices in that for each device or for a particular channel (text, audio, video) a presence status is provided. For example, the status for audio communication might be "available," if one of the user's audio devices is registered being "active" by the RTC system [Riemer 2007b]. To the contrary, both audio and video communication status might show "temporarily unavailable" whenever the user is talking on one of the registered devices. In the latter situation, synchronous text communication via instant messenger might still be possible, as

this does not have the same disruptive impact on the recipient. Users can override this technically determined status and "explicitly set their own presence to one of several pre-determined states" [Herbsleb et al. 2002, 172].

While in most instant messaging tools the presence information is always related to the availability of one particular person, professional RTC systems extend the notion of presence information to identities such as roles, groups, locations, or objects. "Identities" can then be attached to documents or be used in enterprise applications to allow people to access, on an "on-demand" basis, responsible individuals without knowing in advance who they are.

Finally, another presence facet in the context of RTC is the possibility of active presence management by the user. To avoid interaction overload, recipients can filter incoming information and communication requests as they assign priorities and preferences to particular events. Recipients can actively manage their contact list according to priorities or contexts, thus restricting availability for certain people in certain circumstances. Active signaling is important to avoid interruptions when engaged in a particular creative or annoying/boring task, where interruptions are less tolerated [de Poot et al. 2005].

It is worth mentioning that the technological concept of presence information needs to be distinguished from the social concepts of presence and awareness [Frößler 2006]. Presence information (the status feature) supports the production of what is termed *presence awareness* in the literature [Herbsleb et al. 2002; Li et al. 2005; Ljungstrand and Segerstad 2000; Tran et al. 2005]. Awareness "is an understanding of the activities of others, which provides a context for your own activities" [Dourish and Bellotti 1992: 107] and helps people to align their interdependent activities [Schmidt 2002]. However, as we have argued elsewhere, awareness is not a product of technology, but the result of shared practices of using technology in a social context [Frößler 2006]. While presence information ideally signals the recipients' availability, its specific interpretation and the resulting value in creating awareness depend on the shared social practices of technology usage. As for the presence concept, Giddens defines presence as a sensation agents have whenever "they are close enough to be perceived in whatever they are doing, including their experiencing of others, and close enough to be perceived in this sensing of being perceived" [Giddens 1984: 67-8].[2] *Presence* in this sense refers to the sensation of closeness people experience in a shared virtual environment through the production of rich forms of awareness.

To sum up, presence information in RTC allows people to indicate their presence and availability for communication and thus supports a more focused communication in that it provides valuable awareness information for the initiator of a communication event. In addition, presence information can be derived on the device level and be attached to various types of objects in information systems.

Contextualization

The third building block of RTC comprises the previously mentioned integration of communication features with organizational processes for enabling context-sensitive collaboration. To this end, RTC vendors envision the integration of their RTC products across multi-supplier software environments such as CRM and ERP systems [Mohamed 2007]. Provided with such integration, the user can initiate a communication act immediately from the software application in use, without having to decide on a particular channel for reaching a recipient or having to search for contact details and a suitable device. The RTC system can present the user with a context-specific buddy list that only contains, together with their presence status, people that are relevant in a particular context (e.g., all specialists for a problem). For example, an insurance specialist

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[2] The notion of 'being close' is not limited to physical proximity, rather Giddens argues that computer-mediated communication also permits some of the intimacies existing in unmediated contact [Frößler 2006].

might be able to see immediately in the CRM application whether a colleague, who has entered a customer complaint to the system, is accessible for immediate communication. The integration of RTC systems with enterprise software enables contextualized real-time communication which reduces the interrupting character of communication, especially when specific information from colleagues is needed urgently.

Portfolio of eCollaboration Features

Finally, RTC systems can comprise an additional portfolio of eCollaboration resources and features. While ad hoc *communication* is at the centre of RTC, *collaboration* features might enrich the ad hoc interaction between users. True real-time collaboration is enabled by integrating features such as Web conferencing and application sharing. With Web conferencing functionality users might be able to establish communication with more than one recipient at the same time. Using presence information on the group level, a user is able to see if a particular group of people (or at least a certain number of group members) is available for ad hoc communication, i.e. an audio or video group conference. By integrating application sharing features, the RTC system might allow users not just to communicate with their peers, e.g. in regard to a particular document such as an insurance file, but to jointly edit the document on an ad hoc basis.

Another facet of integrating RTC with established eCollaboration resources is the integration with team calendars. Presence information of people might be combined with calendar information in order to provide background information as to why and for how long a particular person might be unavailable. Also, the integration of presence information of team members in the calendar might improve the scheduling of meetings [de Poot et al. 2005].

In summary, four areas can be distinguished that characterize RTC systems (see Table 2). Potential benefits of RTC comprise a better management of personal communication complexity, a better availability of people and required information, improved control over incoming requests, less unpredictable disruptions of the work situation by incoming communication requests, as well as the establishment of collaborative real-time interactions on an ad hoc basis. From a technical perspective, RTC may simply be seen as the evolutionary stage of existing ICT applications, albeit with the novelty of integrating a range of functionalities. However, we argue that such a view lacks to appreciate the potential individual and organizational implications RTC might bring about. Rather than being the next evolutionary phase on the organizational and individual level, RTC might represent a coming of a distinct form of communication which alters existing organizational processes and people's perception of each other in virtual environments. To motivate research on RTC and illustrate this assumption, four different scenarios are presented to show implications on both the individual and organizational level of analysis.

IV. RTC USAGE SCENARIOS

The following scenarios aim at illustrating the potential application of RTC systems in a range of organizational settings. These settings were selected with a view to illustrate RTC application on different organizational levels and to draw a rich picture of various RTC implications. As shown by the scenarios, RTC enables distributed collaboration in dispersed settings and mobile contexts, which can be found in consultancy firms or field service processes. Moreover, RTC improves reachability in time-critical situations that are prevalent in hospital emergency rooms or IT recovery scenarios. Finally, RTC also enables context specific and role-based communication, where recipients are not personally known to the initiator. Such situations are found in all of the discussed scenarios.

PROFESSIONAL SERVICE FIRM (CONSULTANCY SERVICES)

A consultant who travels frequently and works on site with the client can benefit from RTC applications by managing communication requests on different devices through criteria such as priority, presence status, time-of-day, day-of-week, or device. If the consultant, for example, decides to work at home, all incoming calls from team members via the office phone number will

automatically be forwarded to his/her private phone number and if that fails, to the mobile phone. All other calls will be diverted to a self-service-portal. The self-service portal allows, depending on the initiator's access properties, access to the consultant's calendar, to schedule appointments, and to read and retrieve documents stored on an exchange folder. The consultant can check e-mails, voice mails, and appointments over a voice portal while not in the office. The example illustrates that RTC does not shift control to the recipients without taking the initiator's needs into account. Rather, initiators are assured that they can close the bracket of a task, as RTC either allows direct communication or enables initiators to leave a message, schedule an appointment, or access requested documents. Therefore, RTC can contribute to minimizing delays on the side of the initiator and give recipients the control over organizing their work settings.

HOSPITAL LABORATORY (EMERGENCY ROOM)

In a hospital context the availability of critical information can have life-determining importance. This might apply to information in the patients' records and to background information regarding laboratory files. Given that an increasing number of hospitals use electronic patients' records today, an integration of these hospital information systems with real-time collaboration functions may prove beneficial. In such a system the presence information of authors of laboratory files or patients records can indicate their accessibility for urgent call-backs by the doctor on duty. Through such RTC features, the doctor might be able, in case of an emergency, to get in immediate contact with specialists and laboratory assistants in order to have access to background information about the patient's record or to consult with colleagues. A precondition for this scenario to work is the aggregation of availability information at the object level, in this case at the file level. Besides, organizational rules regarding the on-call service and the usage of mobile devices are necessary, in order for people to be available at any time for ad hoc communication via the RTC system.

FIELD SERVICES (TRAVELLING SALES MAN SCENARIO)

In mobile field services, RTC solutions might offer advantages, e.g., when a field representative urgently needs information from people in the organization or wants to contact a suitable expert. Examples are the insurance broker who has questions regarding a contract, the technician who needs immediate advice in order to solve a technical problem, or the reporter who needs background information for a report from the editorial staff in the back office. Common to all these examples is the urgency of the communication request. The information is required exactly when the employee is on site with the customer or at the place of an event. Hence, the direct accessibility of experts is paramount. A real-time collaboration system with suitable availability information may significantly improve communication in such situations. Initiation of communication might be role-based, because most often it is not necessary to contact a particular person, but somebody with a certain competence or role. Hence, aggregation of presence information at the role level supports the employee in selecting a suitable expert. In this case, a context-sensitive buddy list for a particular role (e.g. a network specialist or insurance broker) can be presented to the field representative. Preconditions for such a scenario are a context-sensitive role-selection algorithm in order to create the buddy list and the integration of the RTC system with the mobile devices of the field representative.

IT INCIDENT MANAGEMENT

In data centers, quick and focused communication is paramount in IT incident management processes. An RTC system that is integrated with the main systems recovery process and that helps in selecting available experts to be added to the communication process can offer significant support in tight incident situations. Such a selection of people may be carried out by the responsible incident manager or automatically by the software system, e.g. based on a databank of past recovery cases ("who was involved earlier in a similar incident"). Consequently, RTC systems may create context-sensitive buddy lists to present only those contacts people need to talk to during the recovery process. Another feature of such an RTC system could be to

automatically shield people involved in the recovery process from people outside the incident management for the duration of the incident. By doing so, interruptions can be reduced and concentration on the service recovery tasks improved. In this case, the availability within the recovery group might be guaranteed by the RTC system, while to the outside accessibility could be restricted temporarily, e.g., by signaling a special status (e.g. "not accessible due to major incident").

V. RESEARCH DIRECTIONS

Drawing from the four building blocks and the scenarios discussed previously, RTC presents itself as a novel type of information system rather than simply a combination of existing features. While RTC is about to reach a critical threshold to have an impact in organizations, at the moment it is still in a prototype stage; empirical cases have yet to show the full characteristics of envisaged RTC systems. At the moment, mainly single RTC components such as unified communication features (without presence information) or instant messaging tools are used in organizations. The design of RTC systems, their technical and organizational implementation, the configurations of the resulting socio-technical systems, as well as the resulting social and organizational implications have yet to show up on a broader scale. However, this early stage opens interesting perspectives for researchers in that the full RTC life cycle can be subject to research.

RESEARCH TOPICS FOR RTC

In this section, we set out to frame potential research topics for future investigations on RTC. As currently no systematic attempts have been made to circumscribe this new field of research, the section intends to provide a starting point for a discourse on RTC and to sensitize researchers for the qualitative shift in the information and communication landscape RTC might bring about. We argue that IS research should concentrate on three levels of analysis, namely the individual, group, and organizational level, on which RTC offers various potentials but also poses different challenges in relation to implementation, design, management, and use.

The applied theoretical lens for identifying the research issues is broadly informed by empirical results from case studies regarding the use of groupware [cf. Bansler and Havn 2004; Bødker et al. 2004; Kelly and Jones 2001; Malhotra et al. 2001; Orlikowski 1996; Orlikowski and Hofman 1997; Qureshi and Keen 2004] and existing research on instant messaging, which shows some characteristics of RTC and thus provides the closest understanding of the implications of RTC one can get at the moment.

While it can be argued that practitioners and academics might learn form the experiences already gained from these studies, it will be required to undertake new empirical endeavors specific to the application of RTC in order to fully appreciate its implications. This is all the more important since research on instant messaging itself is still in its infancy. While we frequently refer to existing IM research in the next sections it is important to point out that most research in this domain reports on the development, application, and evaluation of IM prototypes [Herbsleb et al. 2002; Isaacs et al. 2002; Ljungstrand and Segerstad 2000; Scupelli et al. 2005; Tran et al. 2005]. Due to the typically low ecological validity of such research [Bryman and Bell 2003], the transferability of its findings to other contexts such as the organizational application of RTC is problematic. Moreover, existing empirical research in the domain mostly concentrates on the individual [Grinter and Palen 2002; Li et al. 2005] and group level of IM application [Cameron and Webster 2005; Nardi et al. 2000]; to our knowledge no research is available on the organizational effects of this technology that appreciates the influence of the social context of systems appropriation and use.

As we will argue, in line with work on groupware applications [Orlikowski and Hofman 1997], RTC is best described as general-purpose technology that needs to be adapted to the organizational context to match with users' work practices, communication norms, and local conditions [Riemer et al. 2007]. Its properties are dependent upon the context and are enacted by individual or collective, intended or unintended activities. The implementation process is never completed but

should rather be understood as a continuous process with anticipated, emergent and opportunity-based changes. Next, informed by this understanding, we will develop a catalogue of research questions on the individual, group and organizational level for the following three domains: (1) potentials and benefits; (2) implementation and design; and (3) management and RTC-in-use. Table 3 shows a summary of these research questions. The following paragraphs discuss the research agenda in more detail.

Table 3. Research Questions Regarding Implications of RTC Systems

Level of Analysis	Real-Time Collaboration		
	Potentials & Benefits	Implementation & Design	Usage and Management Challenges
Organization	What will the main benefits of RTC be and under which conditions are they achieved – cost savings, better coordination, flexibility, etc.? Will RTC lead to lower cost of communication or will the savings be compensated by increased time spent using RTC? Will RTC systems strengthen social networking in the organization? Will RTC systems lead to a culture of open communication and information sharing? What type of organization/process might benefit the most from RTC - structured or already flexible ones?	What will be the retarding factors for RTC adoption – complexity, required change, investments, culture, lack of standards? What measures facilitate the implementation of RTC within organizations? Will RTC systems have to be heavily customized to show the desired effects in organizations? Will RTC systems have to be integrated with typical enterprise information systems? How can RTC be applied in inter-organizational contexts?	What management instruments are necessary to communicate structures, rules, and processes for the use of RTC? What kind of support is needed for users to make effective use of RTC? How are informal communication practices enacted via RTC? Will RTC systems lead to a culture of control and surveillance or trust and openness? Will RTC systems promote tighter management approaches or lead to more loosely coupled work environments?
Groups/ teams	Will RTC improve the quality of group communications? Will RTC help mitigate barriers in dispersed setups, e.g. bridge gaps of	How can RTC be adapted to different group structural setups? What is the effect of group culture on successful RTC	What changes to group processes will RTC induce; how are they managed? How is RTC appropriated by social groups?

Introducing Real-Time Collaboration Systems: Development of a Conceptual Scheme and Research Directions by K. Riemer and F. Frößler

Level of Analysis	Real-Time Collaboration		
	Potentials & Benefits	Implementation & Design	Usage and Management Challenges
	awareness and improve social inclusion? Will RTC help to mitigate issues caused by diversity in cross-organizational teams? Will RTC lead to better coordination in knowledge intensive work?	adoption? What effect do network brokers (or technology champions) have on RTC adoption?	What kinds of social protocols are needed for facilitating efficient use of RTC? Will RTC lead to higher centralization or decentralization of social networks? Will people accept the additional degree of team availability?
Individual	Will RTC help to attain time critical information more easily? Will RTC usage reduce unwanted interruptions? Will users experience more control over their interactions with RTC? Will RTC enable a better personal time management?	What are specific usability requirements of RTC interfaces? How can different user devices be integrated with RTC systems? Do RTC systems need to be adaptable to specific user needs? How can the cognitive efforts for the users be reduced in using RTC? What are suitable measures to automate the signaling process?	Will people show different interaction behaviors? Will people use the signaling mechanism to hide and block out others? Will RTC lead to increased interruptions of people? Will RTC (e.g. the chat feature) distract people from their actual work?

Organizational Level: Potentials and Benefits

At the organizational level, the introduction of new technology is always accompanied by promises and assumptions concerning the implications of the application. With RTC systems management may hope to reduce communication costs, improve coordination, or increase the flexibility of organizing work. However, as research on groupware shows, new technologies often fail to live up to such high expectations [Karsten 1999]. While the intended effect of RTC is to lower communication costs, increased communication volume could result as an unintended consequence of the use of RTC in the long run since increased awareness for the availability of people might trigger communication. By doing so, it might neutralize its positive effects. Similarly, rather than automatically determining positive changes on the social level - such as strengthened

social networking or a culture of openness and help-giving through improved awareness in the work processes - RTC should rather be understood as an enabler whose implications depend upon existing social protocols and the organizational context in more general. Related to the contextual aspects, spotting and assessing organizations or processes that could benefit from RTC may not only contribute to better understand RTC but also to identify potential sectors for further research.

Organizational Level: Implementation and Design

General-purpose technologies such as RTC need to be continuously adapted to the organizational context. Consequently, the implementation process is not limited to the installation of the computer system; rather it is best understood as a continuous process with anticipated, emergent and opportunity-based changes. Besides the technological dimension, social and political issues might have crucial implications for the acceptance of the RTC system. Understanding the retarding factors of RTC implementation might sensitize managers for the complexity of RTC initiatives and facilitate the identification of measures to support such endeavors. So far, organizations make mainly use of stand-alone applications whose main advantage is that they are easily implemented. However, over the next few years it is expected that more complex RTC solutions will gain ground which will raise new challenges. Questions need to be answered concerning the required scope of customization to a specific context and integration with legacy systems or enterprise information systems. Furthermore, while RTC is currently intended to support intra-organizational collaboration, in the mid- or long-term, applications are expected to expand beyond organizational boundaries. Because of varying technological infrastructures, processes, cultures, and business objectives, new challenges are likely to occur in interorganizational settings which need to be investigated in more detail.

Organizational Level: Usage and Management

Management needs to play a central role as to increase the acceptance or appropriation and use of RTC in organizations. For setting expectations and guidelines on how RTC is supposed to be used organization-wide, rules and processes need to be defined and communicated throughout the organization. This is especially important in regard to setting the presence signals and responding to communication requests. If people for example try to hide from their social peers by signaling non-availability, this might ultimately compromise the very idea of RTC. Research in the IM domain has already shown that reaching a critical mass of users is particularly important for success, but also challenging [Cameron and Webster 2005]. On the other hand, users should have the opportunity to adapt their usage of RTC over time as they get more experienced with the technology and learn new ways of integrating RTC in their work processes. More specifically, understanding the enactment of RTC by its users and the implications it has on the organization's communication practices could yield interesting results that help to fathom potential usages of RTC. Such research which takes account of the enactment of RTC within the broader organizational context could also bring about an appreciation for the conditions under which RTC might lead to a culture of control and surveillance or trust and openness.

Group Level: Potentials and benefits

Virtual or remote forms of collaborating with fragmented and dispersed team members are fragile ICT-enabled organizational constructs [cf. DeSanctis and Monge 1999; Montoya-Weiss et al. 2001]. Distributed settings challenge traditional ways of managing availability, coordinating and collaborating. At the same time, groupware and e-mail significantly shape the quality of interactions as they require users to express their experiences in writing, and by doing so, causing additional effort involved in creating these representations and placing limits on how much of a person's experiences can be usefully represented [Kelly 2005]. By emphasizing verbal communication, RTC might have the potential to overcome some of the shortcomings of traditional groupware and e-mail by putting the people back in the knowledge management loop rather than trying to externalize every bit of information. However, as indicated by research on instant messaging, ambiguity might arise if RTC is interpreted as both synchronous and

asynchronous technology since conventions of verbal and written communication get mixed up [Voida et al. 2002]. In addition, research is needed to appreciate whether the combination of presence information and integrated communication channels might lead to better coordination of knowledge intensive work, a feeling of inclusion in dispersed settings [Sahay 1997], improved awareness for peoples' work contexts, and a better understanding among team members from different professional and cultural backgrounds. While research on instant messaging has already pointed to the potentials of the technology in enabling the creation of rich types of awareness [Tran et al. 2005], further research is needed in this area.

Group Level: Implementation and Design

While virtual teams are often characterized as "all-star teams" [Goldman et al. 1995] with experts spending only a part of their time working on joint projects, the demands of virtual teams concerning technological infrastructure, but also collaboration, coordination, and communication differ widely depending on the tasks, experts, and organizational context. An understanding is needed of how RTC can be adapted to the varying requirements. Especially, in line with research on instant messaging, future studies should investigate the different functions for which RTC can be used, e.g., carrying out work, asking quick questions, coordinating work, or social talk [Isaacs et al. 2002]. Furthermore, a more in-depth understanding is needed on how a group atmosphere may be cultivated in which the use of RTC is highly appreciated. An appropriate culture with both formal guidelines but also informal social protocols might proof to be mandatory for the successful implementation of RTC. Managers and network brokers might play a crucial role in communicating the guidelines and social protocols; however, a dearth of knowledge currently exists concerning the mediation of appropriate measures in virtual settings.

Group Level: Usage and Management

Similar to groupware [Karsten 1999], different forms of RTC usage are likely to occur, namely (1) exploratory/ conservative/ cautious usage; (2) well-planned usage; or (3) extensive usage with proactive user involvement. Depending on the form of usage, changes to group processes might vary significantly. More detailed investigations are needed to elucidate the implications RTC has on group processes, i.e. formal or informal ways of communicating, collaborating and organizing. As mentioned before, while social protocols that buttress RTC-in-use need to be developed and nurtured over time, caution is required should RTC disturb existing group protocols and established modes of engagement. Understanding established social protocols and practices may then help to appreciate whether and under which circumstances RTC-mediated forms of organizing and collaboration will result in centralization or decentralization and whether team members accept the increased team availability. Additionally, studies may concentrate on forms of media switching and people's reasoning for preferring some communication channels over others; for related research in the IM domain see [Isaacs et al. 2002; Nardi et al., 2000]. Rather than perceiving RTC as a substitute for existing forms of communicating, such research might elaborate on different ways of how RTC complements the existing ICT landscape.

Individual Level: Potentials and Benefits

Flexible collaboration brings about a situation in which knowledge workers need instant access to information without any big delay. However, especially those professionals whose skills are in high demand have to cope with frequent interruptions. As already pointed out in the beginning, current communication technologies (e.g. mobile phones) decrease communication delays for the initiators while translating into interruption on the part of the recipient [Rennecker and Godwin 2005]. Research is needed to understand how rule-based forwarding of calls, self-service portals, integration of communication channels and presence information qualitatively shift the control over communicative events; i.e., does RTC enable knowledge workers to receive time critical information without delays? Does RTC reduce unwanted interruptions? Do knowledge workers experience more control over the outgoing and incoming communicative events? And does the increased control consequently result in more efficient time management? So far, research on instant messaging shows mixed results; while some studies point to a reduction in unwanted

interruptions through IM [Rennecker and Godwin 2005], others point to problems [Cameron and Webster 2005] or a possible contingent nature of the perception of interruptions [Cutrell et al. 2000]. Further research is needed in the RTC domain, especially because of its integrative nature and a possible interplay of features at the individual level.

Individual Level: Implementation and Design

Knowledge workers or mobile professionals (i.e. consultants, doctors, traveling sales men) work in (organizational) settings with significantly contrasting demands. Understanding the specific characteristics of different settings assists in deriving appropriate usability requirements. Part of the existing work settings are ICT devices such as personal organizers (e.g. Microsoft Outlook) or mobile devices (e.g. Smartphone, PDA, Blackberry). As to create a unified messaging platform, integrating RTC into personal organizers or mobile devices might be desirable from the user perspective. Consequently, respective RTC systems need to be designed that integrate these devices and applications. However, user requirements or organizational circumstances might change over time and strategies need to be set out to adapt RTC systems to these altered demands. Additionally, research on the workplace introduction of instant messaging has shown that people do not necessarily appreciate and integrate new communication media in their daily routines without explicitly illustrating to them the potential benefits for their work [Herbsleb et al. 2002].

Moreover, presence information is a central element of RTC systems with topicality and accuracy of availability information being crucial for facilitating the efficient management of personal communication. As the cognitive effort involved in constantly updating availability information often deters people from doing so, different types of automatically tracking and updating presence information are imaginable (e.g. availability based on physical presence, electronic calendar, or dominant device which defines status of other devices), whose feasibility needs to be tested.

Individual Level: Usage and Management

On the individual level, RTC might potentially alter the dynamics of interactions as people make use of presence information, self-service portals or other RTC specific features. Management needs to develop strategies to prepare and sensitize users for the transition process towards RTC-mediated forms of communicating and organizing. The changes that are potentially brought about by RTC are likely to be subtle and hard to track down although their impact on team dynamics could be substantial. Research covering the whole spectrum of RTC features is needed to understand its implications, e.g., are signaling mechanisms used to hide or block others? Is RTC opportunistic and will the technology inevitably lead to increased communication volume and more interruptions [Nardi et al. 2000]? With on-the-fly conferencing and other instantaneous forms of communication, will RTC cause more distractions and disturbances?

VI. CONCLUSION

Interpersonal communication and collaboration are essential processes in organizational knowledge work. These collective processes however need to be balanced with the interests of both the recipient and the initiator of an interactive act [de Poot et al. 2005]. Therefore, context information is needed in regard to activities and location of the recipient, which requires signaling of presence information to the initiator. This paper makes a contribution to elucidating the potential of RTC in tackling some of the issues of today's complex working environments. RTC might help people to organize their work by integrating information and communication channels, balancing delays and interruptions of work, and by supporting people to cope with the informative and communicative volume.

Over the next few years, it is expected for RTC to become closely integrated with existing legacy and ERP systems. Currently, no empirical studies exist on the implications RTC might have in organizations. Researchers therefore are "dreaming" and "creating problems as much as they are solving problems and recording and theorizing about effects" [Lyytinen and Yoo 2002a: 65]. This

paper dared to risk an outlook on the consequences of RTC and argued that people may contact others with the needed skills, resources or job roles, depending on their availability rather than previously established contacts. Communication therefore may become more instantaneous or spontaneous as others are only one mouse-click away.

However, it remains to be seen whether RTC systems may live up to the high expectations of their providers. The authors are cautious of any technological deterministic claims. Benefits that are often mentioned in line with mobile technology and RTC, such as minimization of idle time, faster response time, or more freedom and higher quality of life [Ala-Pietilä 2004], are not an automatic outcome of technologies. People should be aware that the implications and properties of RTC will depend on the enactment by its users. The most collaborative software is futile, if people are not willing to interact or share their ideas. However, generalized representations as given by this article are needed at this early stage as they provide the canvas upon which to perform deconstructive work. Currently, research in the groupware domain offers a pool of findings one can use as starting point and sensitizing devices. Nonetheless, more in-depth analyses are needed in the future to make sense of what the implications of RTC are on organizing dispersed work. While the technology is promising, as the conceptualization and the scenarios in this paper have shown, the technical and organizational challenges are manifold and yet to be fully understood. For doing so, the paper has presented open research questions and ideas for empirical research. RTC offers scholars a rich field for future research as aspects analyzed for earlier groupware need to be revisited and new questions need answering. With RTC systems still in early stages, today design-oriented research might be carried out to investigate certain usage and design aspects by developing prototypes, while this will be followed by research in context such as action research approaches, ethnographical studies, or case studies that provide a richer picture, from which conclusions in regard to a variety of research questions might be drawn once empirical examples of RTC applications become available.

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