Enhancing Social Interactions at Conferences

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Als ein neuartiges soziales Konferenzmanagementsystem ermöglicht der Conferator die einfache Verwaltung sozialer Beziehungen und Interaktionen sowie das Management von konferenzspezifischen Informationen sowohl vor, während als auch nach einer Konferenz. Basierend auf RFID Technik gekoppelt mit sozialen Netzen bietet der Conferator die Möglichkeit, einfach und effektiv persönliche Kontakte und Information wie etwa den Konferenzplan zu verwalten. Wir beschreiben das System und präsentieren Analyseergebnisse in einem typischen Konferenz-Anwendungsszenario.

CONFERATOR is a novel social conference system that provides the management of social interactions and context information in ubiquitous and social environments. Using RFID and social networking technology, CONFERATOR provides the means for effective management of personal contacts and according conference information before, during and after a conference. We describe the system in detail, before we analyze and discuss results of a typical application of the CONFERATOR system.

1 Introduction

The emergence of ubiquitous computing has created new environments that include social and ubiquitous interactions of users in several dimensions. In this context, we present the CONFERATOR system: It aims at supporting conference participants in their social interaction during a conference. At its core, CONFERATOR features two key components: PeerRadar and TalkRadar. The PeerRadar application provides information about the social contacts, by providing context sensitive information, e.g., concerning the location of other conference participants or a contact history regarding conversations with other participants. It is based on active RFID technology developed by the SocioPatterns project[1] [5, 1]. The TalkRadar application helps to manage conference information like the conference schedule and talk details. Furthermore, it includes notifications for important events, e. g., for upcoming talks.

CONFERATOR is connected to the BibSonomy[2] system [4], a social bookmarking and publication management system. This integration allows a seamless transfer of interesting talks and publications from TalkRadar to BibSonomy, and vice versa, such that the talks can be copied, tagged, and retrieved for later use. Additionally, publication profiles represented by their tag clouds can easily be generated. A first prototype of CONFERATOR, developed by the Knowledge and Data Engineering group, University of Kassel, was successfully applied at the LWA 2010[3] conference [2] at the University of Kassel in October 2010. For further improving CONFERATOR, we are currently investigating how to combine the PeerRadar with components of the Conference Navigator [11] system, together with the School of Information Sciences, University of Pittsburgh.

The rest of the paper is structured as follows: Section 2 describes the CONFERATOR system, discussing the PeerRadar and TalkRadar components in detail. Section 3 discusses related work. After that, we analyze real-world data of CONFERATOR collected at a recent conference in Section 4. Finally, Section 5 concludes the paper with a discussion and summary of the presented work and outlines interesting directions for future research.

2 The CONFERATOR System

In the following, we describe the PeerRadar and TalkRadar applications, the localization component and the system architecture, we discuss important privacy issues, and finally conclude with the connection to BibSonomy.

[1] http://www.sociopatterns.org
[2] http://www.bibsonomy.org
[3] http://www.kde.cs.uni-kassel.de/conf/lwa10/

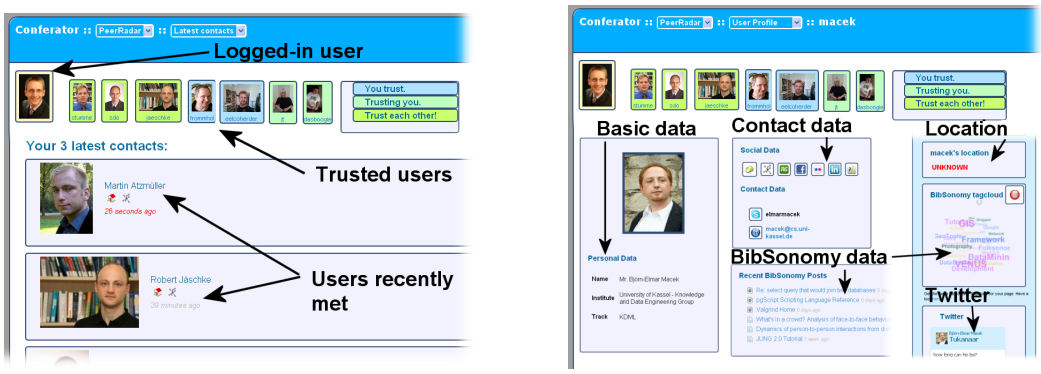

Bild 1: Screenshots of two exemplary PeerRadar views: The *latest contacts* view (left) displays which participants one has recently met, while the *user profile* view (right) summarizes information about a particular participant. Both share the same user-centered navigation, including the logged-in user and his/her trusted users (upper part of the images)

2.1 PeerRadar

PeerRadar focuses on the support of social person-to-person interactions during a conference. The conference participants should be able to browse and interact with their social neighborhood or extend it by connecting to new peers. These functionalities are best explained along three typically relevant phases of attending a conference – namely *preparation*, *participation* and *post-conference*; the presentation of PeerRadar within this chapter is structured according to these use cases.

2.1.1 PeerRadar Views

Table 1 summarizes the four different views offered by PeerRadar. Since PeerRadar is designed to be a social application, all views share the same user-oriented *navigation*: On top of each page one can find a picture of the logged-in user itself next to the list of people he or she trusts or is trusted by. Clicking the user images leads to the corresponding *user profiles*. Figure 1 displays exemplarily the *latest contacts* and the *user profile* view.

view	*core functions*
user list	search / browse participant list, connect to people
user profile	inspect users' interests / contact information
latest contacts	see persons / locations of recent encounters
contact history	summary of contacts

Tabelle 1: PeerRadar's views and their core functions.

2.1.2 Supported Conference phases

Preparation During the preparation of a conference, a natural question is: "Who else is attending?" The users can browse the ***user list*** to search for acquaintances, co-workers or friends. Each entry in the user list is linked to a corresponding ***user profile*** page, where one can find several kinds of additional information about the requested person. Sensitive information is protected by *privacy rules* (see below), which ensures that only a selected set of people has access to the data.

Participation An important and lively part of the conference experience is the dynamics of discussions and meetings. PeerRadar's ***latest contacts*** view is a useful tool in this phase, as it displays a just-in-time updated list of participants recently met. This makes it easy, e. g., to recall the name of an interesting conversational partner. It also contains information about the location of these encounters, which helps to enrich the context of recent conversations and meetings. In addition, again the ***user profiles*** are of great help for gaining background information about particular users one has met recently or one wants to meet. The more people one has met, the more important becomes the ***contact history*** view: It presents a condensed summary of all social interactions during the conference.

Post-Conference A worst-case scenario after a conference is that one cannot recall the people one has met and the conversations with them. PeerRadar helps to prevent this by offering the ***contact history*** view, which displays all social interactions during a conference in a compact way. Using a timeline navigation paradigm, it is easy to "replay" the conference meetings in different granularities. Again, each encounter is linked to the ***user profile*** of the conversation partner, which helps to stay connected to the participants and to keep being informed about their recent activities and interests.

2.2 TalkRadar

The TalkRadar focuses on the talks at a conference: Talks are grouped in sessions and tracks. A session is simply a sequence of talks without time overlap or longer breaks. Each talk belongs to exactly one session. Tracks are sub-events of the conference and modeled as sets of sessions without time overlap. Sessions that belong to more than one track are called joint sessions.

Preparation A usual workflow for creating a personal conference schedule is first to select all talks that are of potential interest and then to check for time conflicts and to resolve them by removing talks from the list. For deciding which talks to remove, several factors can be considered. Among them are subjective considerations, such as the personal interest in the topic, in the author or the presenter and factual circumstances like the distance between locations or the way that the talks are grouped into a session. Another influence on the decision can be the schedules of other participants – e. g., a group of participants could try to cover as many talks as possible and therefore avoid visiting the same talks or a participant may plan to meet a colleague and therefore deliberately choose talks which the respective colleague has already chosen.

TalkRadar aims to assist a participant with the task of creating a personal schedule: A browsable list of all talks provides a general view of the conference while a descriptive page for each talk provides additional details and functionality. In the list view all talks are ordered by their start time. Each talk is displayed with its title, its author(s), its (sometimes truncated) abstract and some organizational information, such as time, location, session and track. In the workflow described above a participant would first choose all talks that might be of interest. In TalkRadar this task is called *picking talks* and is realized via a pick/unpick button for each talk. To help resolving time conflicts, TalkRadar offers a timeline view, plotting talks with their duration against a scalable time axis thus visualizing parallel or overlapping talks. Five filters manage the displayed list of talks: Track, time, personalization, tag and keyword search. All filters can be applied at the same time thus allowing restrictions like "Display all talks that belong to Track 2, that are presented on the first conference day and have the keywords clustering and web." Using cookies the participant's filter configuration is stored and reloaded automatically.

Track and time filters include options to restrict the list of talks to one specific track or a specific day of the conference. For filtering by content, the tagcloud can be applied. In TalkRadar, the keywords that authors usually assign to their papers are used as tags. Clicking on a tag in the cloud will then yield only talks that have the tag as keyword. Furthermore, the personalization filter offers a participant the option to view all talks that he or she has picked, and also to view the picked talks of other participants if they trust him, cf., Section 2.5.

Participation and Post-Conference TalkRadar has several features that facilitate a conference day. The time filter option "Upcoming" displays at any time all ongoing and upcoming talks. Talks that have just begun are highlighted. In combination, the filter option "picked talks" provides a simple reminder of which talk to attend next. A talk's details page displays the full abstract, the presenter and all participants currently attending the talk. Due to privacy concerns, the latter is only displayed during the time of the talk to users attending it. Furthermore, there is a link to the paper's full text in the proceedings and to its BibTeX entry in BibSonomy. TalkRadar also provides the option to enter private comments for each talk. To facilitate interaction during the conference, all references to other participants – such as authors, presenters or listeners – link directly to their PeerRadar profiles.

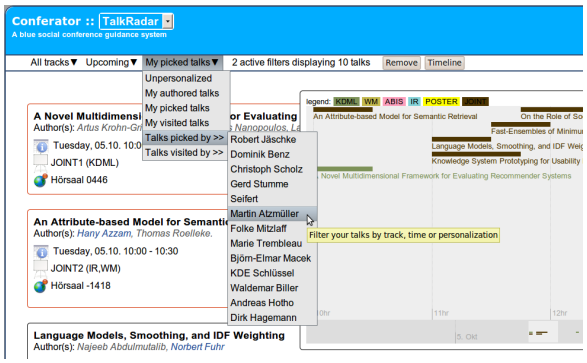

Bild 2: Detailed TalkRadar list view, displaying talks (two of them highlighted), the timeline containing those talks and the filter menu

2.3 System Architecture

The Conferator is based on the Ubicon software platform[4] for implementing social and ubiquitous applications. It applies active RFID technology developed by the SocioPatterns project and uses this for determining the locations and contacts of tags. The RFID tags are worn by the conference participants. They communicate with each other, and with readers attached to the walls. The tags are able to detect the proximity to other tags, while the location is determined using the readers.

2.4 Localization Component

One of the aims of the Conferator system is to enable the localization of a participant inside a conference venue. Conferator users can, e. g., see their own location as well as the location of others, given that their privacy settings allow that. It is also possible to use the system to identify 'hot spots', that is, conference rooms where a large number of people have gathered, e.g., listening to very interesting talks. In addition, Conferator offers the opportunity to see who is visiting a talk so that during breaks a more focused academic exchange is facilitated. Of course, all localization-based services implement appropriate privacy features.

For the localization process we aimed at a localization-algorithm with room-level accuracy which would be able to locate persons in complicated indoor environments. This means that the accuracy of the localization algorithm should be largely independent from factors such as

[4] `http://www.ubicon.eu`

multi-path fading, shadowing, the opening and closing of doors and the presence and movements of persons. The developed localization method is based on the algorithm presented in [10]. We installed RFID readers at adequate positions. Each participant of the conference is equipped with an RFID tag. Each RFID tag sends one package in four different signal strengths, every two seconds. The readers receive the packages and send them to the server where they are stored and analyzed. To determine the location of each participant p we calculate the number of packages sent from p, received by the readers in a specific time interval t_s, for each room r and each signal strength $s \in \{0, 1, 2, 3\}$. We allocate a participant p to that room where RFID readers received the most packages with the weakest signal strength.

2.5 Privacy in Conferator

In ubiquitous and social systems, privacy is a crucial issue. Since a variety of user data is collected, appropriate steps for their secure storage and access need to be implemented. Furthermore, the visibility of certain information for other users needs to be customizable. Both can also help to improve the user acceptance of the system and to increase the trust in the system.

The Conferator system implements privacy on several dimensions: The available information is only be made available to the (registered) users of the system. Additionally, there are different privacy levels (private, trusted, public) provided by the idea of *trusted* users, i. e., a user can keep all information to himself, a user can trust a set of other users (trusted) and make certain information available to them, or a user can make the information available to all participants (public). The trust relation is directed, which means that a user can decide to trust another user without the other trusting him back. By trusting other participants a user can make his personal schedule and his visited talks visible to the trusted parties.

2.6 Conferator and BibSonomy

BibSonomy is a social bookmark and publication management system which is currently one of the three most popular systems of its kind. It has been developed by our research group [4]. As collaborative tagging system it allows its users to quickly store a reference to a web page or publication. Users can then annotate the resource in BibSonomy using freely chosen keywords – *tags* – which facilitate later search and browsing.

BibSonomy is a useful tool for many scientists because they can use its *groups* to collaborate in communities of interests or let it automatically build publication lists for their homepages, articles or research reports.

Conferator is connected to BibSonomy, concerning both the PeerRadar and TalkRadar applications in order to obtain, e.g., helpful information about participants and to further manage interesting talks and papers discussed at a conference. PeerRadar integrates (public) profile information about the participants and also features the option to include their tag clouds in order to characterize their research interest. In this way, interesting contacts can be identified. Additionally, the TalkRadar application provides a tightly integrated BibSonomy experience: Talk information can be retrieved from BibSonomy and updated in both systems. Furthermore, utilizing these browsing features, similar talks and/or publications can be obtained using the recommendation features. An important feature after the conference is the option to transfer and store talks, publications, and notes directly in BibSonomy, for uniform publication access provided by TalkRadar.

3 Related Work

Regarding the tracking and analysis of conference participants, there have been several approaches, using RFID-tokens or Bluetooth-enabled devices. Hui et al. [8] describe an application using Bluetooth-based modules for collecting mobility patterns of conference participants. Eagle and Pentland [7] present an approach for collecting proximity and location information using Bluetooth-enabled mobile phones, and analyze the obtained networks.

Our system relies on the RFID technology that was developed within the Sociopatterns project, which resulted in the following publications. One of the first experiments using RFID tags to track the position of persons on room basis was conducted by Meriac et al. (cf., [10]) in the Jewish Museum Berlin in 2007. Cattuto et al. [5] added proximity sensing in the Sociopatterns project. Barrat et al. [9] did further experiments. Alani and colleagues, e.g., [1], also added contact information from social online networks. Our work is using the same technical basis which allows us the verify their very interesting results independently. In addition, we increased the precision of the localization component and linked tag information and the schedule of a workshop week. This is the basis for new insights into the behavior of all participants.

The Conference Navigator by [11] allows researchers attending a conference to organize the conference schedule and provides a similar functionality as our TalkRadar. An extension concerns the connection to the real live activity of the user during the conference. Therefore, we are currently investigating how to combine the PeerRadar and components of the Conference Navigator [11] into a future Conferator version. In order to increase the acceptance and trust in the system, Conferator also applies explanation-aware concepts, cf., Atzmueller and Roth-Berghofer [3], e.g., for browsing profiles at different levels of abstraction.

4 Deployment and Analysis

The CONFERATOR system was deployed and used at the LWA workshop week which took place from October 4th - 6th, 2010 at the University of Kassel. In total 97 participants registered to the workshop which involved 56 *talks*, organized in 20 *sessions* belonging to one or more *research tracks* (ABIS, IR, KDML, WM) as well as a joint poster session. 80% of the workshop's participants volunteered to permanently wear an RFID-Tag at the workshop. From those, about 65% actually used the CONFERATOR's web application.

4.1 Setup

The CONFERATOR installation at the LWA 2010 covered four lecture rooms, three social activity rooms and one passage way with a total of 17 tag readers. Near to the registration desk and at the social area, two public information screens displayed upcoming talks (cf. Section 2.2), each volunteering participant's location as well as participants which recently stayed in front of the corresponding information screen. Additionally around 40 RFID-Tags were installed on static objects (e. g., posters at the poster session) for tracking corresponding object interactions with participants.

4.2 Data Analysis

The following results focus on the proximity data, which was produced by the participant's RFID tags during the workshop. We interpret this data as undirected graphs $G^{t_E}_{t_S}(V, E)$, where each vertex $v \in V$ represents a workshop participant. An edge $e \in E$ exists between two vertexes v_1 and v_2, iff there exists at least one contact between the persons represented by v_1 and v_2 during the time interval $[t_S, t_E]$. Since we want to make distinctions between long and short contacts, we also define a contact-filter ${}^{t_f}G$, which removes all edges from the contact graph, that have a duration smaller than the given threshold t_f.

High Level Statistics At first we present some global statistics in Table 2. The unfiltered graph G, consists of one large component as it was already mentioned in [9]. Applying stronger contact filters with thresholds of 5 or 10 minutes hardly changes the situation: Although $|V|$ and $|E|$ decrease as expected, we obtain one major component nearly containing all vertexes. An analysis of G with smaller time intervals $[t_S, t_E]$, e. g., for the poster session (2 hours) or coffee break (1 hour) yields the same results.

Interdisciplinary Interactions Since the workshop was structured into four tracks $R = \{\text{ABIS, IR, KDML, WM}\}$, where each of the elements of R is a set containing its attendants, we analyzed how their members communicated within their own and to other groups. How interdisciplinary the community members are can be seen in Table 3. For each combination of two tracks $r_1, r_2 \in R$ a special graph is created. Let $G[r_1, r_2]$ be the graph that is constructed by removing all edges $e = \{v_1, v_2\}$ from G, where $v_i \notin r_1 \cup r_2, i \in \{1, 2\}$. Vertexes without incident edges are removed from $G[r_1, r_2]$. Thus, if $r_1 = r_2$ we consider the representation of the communication within the track group r_1, else interdisciplinary conversation.

In order to be able to interpret the table in a more intuitive way, it is helpful to consider that the density and transitivity of a graph measure the strength of connections between two groups of people: The higher both values are, the more connected are the edges at the 'borders' between two communities. As it can be seen, people did have great interest even beyond their own track and main topics, which reflects the open atmosphere at LWA.

	G	${}^{5m}G$	${}^{10m}G$	ps	cb
$\|V\|$	78	71	57	45	56
$\|E\|$	887	250	119	303	202
density	0.29	0.10	0.07	0.30	0.13
apl[5]	1.72	2.10	4.18	1.77	1.93
diameter	5	9	10	5	5
#conn.comp.	1	2	3	1	1
largest cc	78	69	51	45	56
transitivity	0.53	0.35	0.34	0.48	0.32

Tabelle 2: High level statistics for the full contact graph, the graphs with a minimum talk length of 5 and 10 minutes as well as the graph obtained only during the poster session (ps) and the coffee break (cb).

Distributions We looked at various distributions governing different empirical data sources. Figure 3 shows the cumulative degree distribution for the full contact graph as well as the distribution of the average length of social interactions among participants. Both distributions strongly deviate from a power-law like distribution but for a certain range, a power-law distribution can be fitted. According models applying the method proposed by Clauset et al. [6] are denoted by a dashed line in Figure 3. Restricting the contact graphs to varying time ranges (e. g., covering only social events) does not influence the distributions characteristics. These observations support the findings made in [9].

	ABIS	IR	KDML	WM
ABIS	0.62/0.64	0.23	0.19	0.28
IR	0.44	0.44/0.57	0.21	0.20
KDML	0.60	0.57	0.38/0.61	0.31
WM	0.67	0.53	0.58	0.58/0.71

Tabelle 3: The white cells contain the density of the graph $G[r_1, r_2]$, while the grey cells contain the transitivity. The main diagonal contains both values: (density/transitivity).

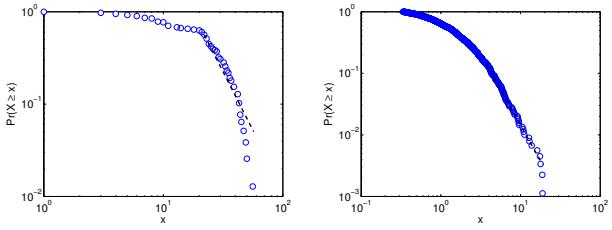

Bild 3: Cumulative degree distribution of the full contact graph (left) and the cumulative distribution of the average length of social interactions (right).

5 Conclusions

In this paper, we have presented the CONFERATOR system and its components for enhancing social interactions at conferences. The PeerRadar application is used for contact management, while the TalkRadar application helps to organize and personalize the conference schedule. Both allow for a retrospective analysis and transfer of important information during the conference. Furthermore, we have presented interesting analysis results using real-world social and ubiquitous data collected at the the LWA 2010 conference in Kassel, Germany.

For future work, we aim to consider more refined data mining techniques for enabling further notifications and enabling context-dependent profiling of interesting contacts. Additionally, we plan to extend the social capabilities of the system regarding, e. g., the trust network.

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The Knowledge and Data Engineering Group at the University of Kassel, Germany, cooperating with the Data Mining and Information Retrieval Group at the University of Wuerzburg, Germany, deals with the organizational and technical support of knowledge processes. Our vision is the Ubiquitous Web, where user-generated knowledge from the Web 2.0 and observations of the physical and social environment of the user are integrated.

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