Dynamic Personal Social Networks: a new perspective for CSCW research and design

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ABSTRACT
In this position paper, we motivate why the dynamic personal social network perspective is relevant for research and design of CSCW systems. Moreover, we identify opportunities for improvement of measuring the dynamics in personal social networks and we propose a classification of dynamic personal social network applications.

INTRODUCTION
The bulk of the CSCW literature generally assumes that workers are organized into teams with clearly defined and stable roles. An increasing number of researchers and studies in the CSCW area, however, support the view that for many tasks and settings, one should not take a group as the primary unit of analysis, but rather the individual within the context of his or her personal social network (see e.g., Wellman, 1997, 2001; Nardi et al., 2002a).

One of the most pronounced examples of this strand of work is the netWORKing study, an ethnographic study into modern working practices by Nardi et al. (2002a), who coined the term *intensional networks* to describe the personal social[1] networks that are built and maintained by people with considerable effort and that serve as a resource from which contacts can be selected and activated and grouped in *live subnets* at the time work is to be done, typically a for job or a project that runs from anywhere between several days to several months.

From this perspective, it is not surprising to see the rise in the workplace of applications that support building and maintaining personal social networks, such as Instant Messaging (IM) (De Vos et al., 2004), and tools that explicitly support awareness and exploitation of transitive links in a social network such as *LinkedIn*, *Orkut*, and *Friendster*. The personal social network perspective has also led to the development of CSCW prototypes such as *ContactMap* (Nardi et al., 2002b), and *Live Contacts* (Ter Hofte et al., 2004b).

[1] Throughout this paper, we use word 'social' as a neutral way to refer to ties with other human beings that do not necessarily have to involve affection, friendship, etc. (social network as opposed to technical network, not social network as opposed to professional network).

In this position paper, we first motivate why it is relevant to extend the personal social network perspective on collaborative work towards a more dynamic, context-dependent view we coin: the *dynamic personal social network perspective.* Subsequently, we explore novel methods and techniques that can be used in research to measure, monitor, model, analyze and explain the emergence and evolution in dynamic personal social networks. Finally, we propose a classification of applications that are designed to use information from dynamic personal social networks.

WHY DYNAMIC PERSONAL SOCIAL NETWORKS
In the last few years, mobile connected devices have increasingly penetrated work and family life, such as mobile phones and PDAs, and hybrid devices such as Pocket PC Phones, RIM Blackberry devices, and smartphones. Most of these mobile devices are personal in nature, i.e., they stay and travel together with one person most of the time and thus enter various social contexts of that person (e.g., being together with colleagues, with family members, with other students, with other commuters, with other team sport members, with other shoppers, with theater visitors, etc.).

These mobile devices pose various research opportunities and design challenges for the CSCW research area. How do these mobile devices impact collaborative aspects in the various social contexts of a person? Do they support or even cause an intermingling of the various social contexts (e.g., intermingling of work and private life) and to what extent is this effect desired? How can we use the mobile devices that people already have to get more insight in the dynamics of personal social networks? And last but not least: how can we design (more) effective, efficient, satisfactory and/or pleasurable applications that use these mobile devices and that support collaborative aspects in the various social contexts a person is in?

RESEARCH: MEASURING AND ANALYSING DYNAMIC PERSONAL SOCIAL NETWORKS
To answer some of these questions, we need to be able to capture and understand the dynamics of personal social networks better. There are various existing methods to measure (survey, interview, video, ethnography) and analyze social networks (see e.g., (Garton et al., 1997)).

These methods typically focus on more stable, slow-changing phenomena such as relations between people. Below, we briefly explore advances in three areas that provide opportunities to deal with more dynamic aspects in social networks, e.g. proximity and communication.

Logging

Recent advances in miniaturization of mobile and wearable technology provide various opportunities to log dynamics in personal social networks in a non-obtrusive way:

- *Logging Physical Proximity*. Dynamic patterns of physical proximity in a population can be logged with wearable devices explicitly designed for this purpose, such as the infrared-based *sociometer* device (Choudhury et al., 2002). Moreover, it becomes increasingly feasible to use short-range radio-based techniques present in contemporary mobile devices for this purpose. Examples include the Bluetooth-based *BlueAware* system that runs on a contemporary smartphone (Eagle, et al, 2004) and the WLAN based systems *PLIM* (Peddemors, et al., 2003) and *Reality Mining* (Eagle et al., 2003) that run on PDAs.
- *Logging Physical Location*: Logging physical location and correlating the logs can be an indirect means to log proximity. In recent years, various location-sensing techniques have become available, based on infrared receivers, radio frequency identification tags, small GPS receivers and, very recently, location services provided by mobile phone networks (Hightower & Borriello, 2001). Logging physical location itself can provide insight into the relation between location and personal social network dynamics. Note that not every research question requires logging physical locations with GPS-precision; in some situations it may be sufficient to log the Cell-ID of a mobile phone network a mobile phone is connected to.
- *Logging Communication*: Perhaps even more important than logging physical proximity is the ability to log when people are in communication, with whom and for how long. Communication patterns through electronic means for communication, e.g., telephony, e-mail and IM, are relatively easy to log (see e.g., (Garton et al., 1997; De Vos et al., 2004; Fisher et al, 2004) and commercially available tools such as *MetaSight* (http://www.metasight.co.uk/)). In systems such as IM, it is even technically feasible to log which groups of contacts are currently opened and closed, thus giving an impression which parts of a social network are currently relevant. Nevertheless, despite the increasing use of these electronic means, strong indications exist that face-to-face communication still plays a crucial role in many organizational settings (Allen, 1997). The *sociometer* and *Reality Mining* systems can also log face-to-face communication patterns based on capturing and processing audio.
- *Logging virtual/conceptual proximity*. When people access shared resources, e.g., browse the web, edit files from a shared network drive, or read or post in newsgroups, in a sense, they are present at a location in cyberspace. By correlating these logs, we can capture dynamic proximity patterns of users in cyberspace (e.g., when people are on the same web page, on the same web site, or working in the same project workspace (see e.g. work on *CoCoBrowse* (Ter Hofte et al., 2004a)) and/or browsing on web pages with similar content (see e.g., research on *I2I* (Budzik et al., 2001)).

Experience Sampling

Logging dynamics of personal social networks unobtrusively may be hard, e.g., when no adequate sensing technology is available, or when a momentary subjective judgment of a human is needed. In these cases techniques from the experience sampling method can be used.

The Experience Sampling Method (ESM) (Csikszentmihalyhi et al., 1987) is a research method in which respondents typically carry a mobile electronic device with them (e.g., a PDA, smartphone, mobile phone or pager), for one or two weeks. At random moments during the day (8-12 times per day), a respondent gets a signal to answer a very short questionnaire (2-20 seconds). One or more questions may inquire about factual information, at least one inquires about the respondent's momentary experience, for instance a feeling, emotion, and/or opinion. ESM seeks to maximize the validity of data collected by avoiding or minimizing retrospective recall present in other self-report techniques such as surveys and interviews. It is more obtrusive than logging, but typically less obtrusive than direct observation methods such as ethnography or videotaping.

Using experience sampling, dynamics of social networks can be sampled, e.g., by asking questions like "Who are you with? (friends/family/coworkers)" Also, feelings, emotions and/or opinions can be sampled that relate to the momentary personal social network situation, Moreover, dynamic social network logging techniques can be used to detect relevant moments to take an experience sample, e.g., directly after a meeting, or a telephone conversation.

Modeling and Analysis

Social Network (Modeling and) Analysis focuses on structural patterns of ties among actors, typically people but also organizations. Basic units of analysis are ties (typically: relations) and transitive ties between actors. A social network structure can be expressed in with various quantitative measures, including range, density, centrality, groups, and positions. Most social network models view the network structure as a static property of a social network. More recently, efforts have been undertaken to create models and techniques that can deal with the evolution of social networks (see e.g., Breiger et al., 2003).

DESIGN: A CLASSIFICATION OF DYNAMIC PERSONAL SOCIAL NETWORK APPLICATIONS

We define dynamic personal social network applications as applications that sense, mediate, visualize and in some cases interpret dynamic personal social network information as part of their service provided to end-users. In this section, we propose a classification of personal social network applications. It consists of three dimensions, which represent design issues we feel are crucial for the design of such applications. This classification and the associated issues are a work in progress and we would be very happy to discuss them at the workshop.

Interpreting context: by man and/or machine?

Dynamic personal social network applications belong to the class of context-aware applications, and like any context-aware application that operates in a multi-person context, three strategies can be used in dealing with context information. The application can:

- *mediate* the context information to relevant others;
- *aggregate* the context information, in one or more ways:
  - *multi-sensor* visualizations, which include several streams of context-sensors of a single person;
  - *multi-moment* visualizations, which reveal (temporal patterns in) the history of context-information;
  - *multi-person* visualizations, which include context information from multiple individuals.
- *interpret* the context information and adapt the service that the application offers to the current context.

Which strategy is appropriate depends very much on the problem at hand. In our view, the goal of designing dynamic personal social network tools should be to improve processes in socio-technical systems (consisting of humans and technology) as a whole instead of designing the most intelligent and accurate context-aware computing application (i.e. optimizing only the technology). Methods to measure dynamic personal social networks can help to select which context information should be conveyed or aggregated to other human users, and which context information can be interpreted reliably enough by computers. For the human users of the application, the context information on the one hand needs to provide added value (while satisfying requirements regarding privacy, trust, security and cost), but on the other hand, context information provided by the application is just one source of context information that humans use when making decisions in a situated context.

As an example, consider the work of Fogarty et al. (2004), who aim to improve interruptions in the workplace. They used both logging and experience sampling to determine which contextual factors automatically derived by sensors provided the best predictive power for interruptability at the lowest cost. Part of the interpretation of the contextual factors is done by a computer system, part by humans.

I-centric, they-centric and we-centric dynamics

We further distinguish three ways to deal with dynamics in dynamic personal social network applications:

- *I-centric dynamics*: Changes in my context (not only social context, but also location, task, etc.) give rise to temporarily (de)activating parts in my dynamic personal social network, e.g., opening and/or closing contact groups in an IM application, blocking calls from some personal friends while in a business meeting and appearing less available to coworkers in a context-aware communication application during a day off.
- *They-centric dynamics*: Dynamic context information about people in my personal social network can be displayed on my "social radar". This may range from feeling good when informed by IM systems that coworkers are online when working late (Nardi et al, 2000) to other forms of social visualizations that provide social translucence (Erickson et al., 2000).
- *We-centric dynamics*: When two or more humans are in physical or virtual proximity or in a conversation (e.g. two policemen temporarily working on the same case), parts of their personal social networks can be made available to each other, thus providing them easier ways to get in contact with relevant persons from their personal social networks. Note that this may involve both reflexive ("me to you and you to me") as well as transitive aspects of social networks ("my contacts are your contacts").

Past, present and future orientation

Finally, we distinguish three types of temporal orientation of dynamic personal social network applications:

- Applications with *future-orientation* are aimed at adding new people to one's personal social network that can be of future use. Examples include mobile dating systems like *LoveGety* (www.lovegety.com), systems like *SpotMe* (www.spotme.info) that signal when interesting people are near at a conference and systems like *Meeple* (www.mobilair.net/meeple.html) that can find common contacts in the contacts lists stored in mobile devices.
- Applications with *present-orientation* are aimed at getting in touch with "the right person" from a personal social network at the right near-future time via the right communication medium. Examples include *Awarenex* (Tang, et. al, 2001), *Live Contacts* (Ter Hofte et al., 2004b), and *Enhanced Telephony* (Cadiz, et al., 2004).
- Applications with *past-orientation* are aimed at supporting people in recollecting with whom they were, when and where. This may be useful for a variety of purposes, such as writing official reports by the police and systems providing suggestions whom to give access to particular subsets of your digital photos, e.g. based on a combination of proximity sensing, photo timestamps and social network information.

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