myUnity: A new platform to support communication in the modern workplace

要　旨

　現代のオフィスワークにおいては、時間や場所の制約にとらわれない働き方が増加しており、同僚や協業する仲間との交流が困難になってきている。この問題を解決するために開発した myUnity は、職場における豊かな相互認識とコミュニケーションの調整を可能にするソフトウェアとセンサーのプラットフォームである。独立したセンサー群と外部のデータ集約手段から情報を収集して、各ユーザーの場所、取り掛かっている仕事、コミュニケーションの可否や最適なコミュニケーション・チャネルを示せるように統合されている。myUnity のセンシング・アーキテクチャはコンポーネント・ベースであり、ユーザーの状態を認識するための情報のチャネルはいつでも追加、更新、削除することができる。複数チャネルからの入力は結合・合成されて、ひとつのハイ・レベルな状態として識別される。myUnity を用いた初期の実験は、このプラットフォームが、重要なユーザーの状態を認識するための情報への素早いアクセスを可能にすると共に、現代の職場においてコミュニケーションやコラボレーションを促進する有用なツールとなることを示している。

Abstract

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　Modern office work practices increasingly breach traditional boundaries of time and place, making it difficult to interact with colleagues. To address these problems, we developed myUnity, a software and sensor platform that enables rich workplace awareness and coordination. myUnity is an integrated platform that collects information from a set of independent sensors and external data aggregators to report user location, availability, tasks, and communication channels. myUnity's sensing architecture is component-based, allowing channels of awareness information to be added, updated, or removed at any time. Multiple channels of input are combined and composited into a single, high-level presence state. Early studies of a myUnity deployment have demonstrated that the platform allows quick access to core awareness information and show that it has become a useful tool for supporting communication and collaboration in the modern workplace.

1. Introduction

A shift is taking place in the modern office: being "at work" no longer implies being physically at a desk in an office building. Workers are increasingly mobile, on both a small and large scale. Increasingly work is being conducted outside the conventional "9-to-5" Monday-through-Friday work schedule. This shift in work practices is occurring due to pressures from globalization, soaring transportation costs, environmental concerns, technological advancement, and desire for a healthy work-life balance.

A Gartner report [10] claims that as much as 25% of office work has become "non-routine," characterized as working with unfamiliar people, less rigid hours, and/or in a variety of places. The report predicts this will jump to 40% by 2015. Nonetheless, the volume of peer-to-peer interactions necessary to successfully perform work tasks remains high in most professional domains. González and Mark [11] summarize studies showing that workers spend a majority of their time in direct communication with peers. With assumptions about a colleague's location and availability now more uncertain than ever, communication breakdowns are becoming both more frequent and more costly.

While previous work has explored the potential of awareness systems to address this challenge, existing solutions are largely designed for a previous generation of workers. New design challenges have emerged; the critical importance of mobile devices in the day-to-day lives of workers and the explosion of communication tools used in the office [19] are just some examples of this changing landscape.

We conducted structured interviews to identify breakdowns induced by this new work environment. Our results show that information needs transcend time and space constraints, introducing new challenges for workplace communication. Further, our findings illustrate the difficulty workers have in mediating *immediacy* and *preference* in communication channel selection. Increasing communication capabilities creates tension between being *engaged* in a particular communication and being *available* to engage in others. We used these findings to generate a set of functional requirements for modern awareness systems, which were embodied in the design of myUnity, a fully functioning prototype. myUnity is the first awareness system that supports both information collection and dissemination across multiple platforms (desktop and mobile), aggregating data from automatic sensors and existing common systems (e.g., calendars, IM). Furthermore, myUnity implements unique features for negotiating communication events.

2. Related Work

We discuss the broader field of research related to awareness and communication tools and their impact on the workplace.

2.1 Awareness in the Workplace

Dourish and Bellotti [6] found that an ongoing understanding of others' activities was necessary for effective coordination in collaborating on written papers. Erickson and Kellogg [7] argue that visibility, awareness and accountability are important social cues in communication mediated by computers. Begole et al. [2] and Reddy and Dourish [17] observed that workers exhibit periodic, predictable behaviors, or *rhythms,* that can be perceived by colleagues and assist in decisions on how or when to establish contact. Our work builds on these, providing a platform that enables workers to quickly understand workplace rhythms and ongoing individual and group activities.

Recent work has investigated privacy concerns related to context-sharing systems. Lederer et al. [12] found that users' decisions on what to share were affected by situation

specifics and the information's target audience. Brush et al. [3] found differences among users in the information they allowed to be reported in awareness systems but not in where it was presented. myUnity addresses users' varied privacy concerns by providing direct user control over information collected and shared.

2.2 Awareness Systems

Several existing systems support awareness in the workplace, most providing a single channel of information. For example, shared calendars allow workers to be aware of others' scheduled activities. Chat and instant messaging software can relay whether or not a contact is using his computer. Tracking systems using ultrasonic or RF technologies (e.g., [20]) can determine a worker's location in a building. Video systems (e.g., Portholes [5]) allow workers to directly observe others' state and activity. However, the narrow channel of information in these systems often provides insufficient information to facilitate many common communications needs, leaving users to assemble information from multiple sources on their own, with cost in reliability, time, and effort.

Sideshow [4], Community Bar [13], MyVine [9], and ConNexus [18] collected some awareness information, such as IM status and calendar, into a side bar interface on the desktop. Awarenex [18], ContextContacts [15] and Connecto [1] are mobile awareness systems with various representations of location and other data such as calendar information, ringtone profile, and Bluetooth neighbors. These systems were all specific to a mobile or a desktop environment, and do not represent a complete solution for users. Combining desktop and mobile platforms provides important benefits for collecting awareness data and for presenting this information to users.

Some awareness tools not only provide information, but also help users to translate the information into action (e.g., initiate a communication). Cruiser [8] presents users with short, symmetric glimpses into co-workers offices to simulate the effect of walking down a hall of open office doors. Quiet Calls [14] enabled the receiver of a mobile phone call to respond by using buttons to trigger pre-recorded messages to the caller. Calls.calm [16] allows both caller and receiver to express details of their situations and desire to communicate explicitly at the time of initial contact. Note that these tools require users to explicitly and regularly provide information about themselves.

While individual components of awareness systems have been examined, breakdowns remain due to the lack of integration across resources, making it difficult to find the information in a manner appropriate to the situation. Our goal with myUnity was to extend the value of both awareness and communication-initiation tools by bringing them together into a single, integrated platform. The result is a platform with two important aspects: (1) it is largely automated, requiring little user attention to produce a rich set of information, and (2) it is comprehensive, enabling users to easily access previously disparate information and translate that information into informed action.

3. Understanding Awareness Needs

Past work provides a solid foundation for understanding communication and awareness needs in the workplace. However, much of this work studies a workplace that may no longer be contemporary. The emergence of mobile devices has profoundly shaped how we go about our day-to-day work. We performed a study of workplace communication practice to build on the foundation of past findings but with insights reflecting modern practice.

3.1　Method

We conducted 12 interviews (30-45 minutes each) with people from sales, medical innovation, software development, security products and research. We chose a diverse population to build an understanding of a variety of work practices and to identify breakdowns across multiple contexts. We asked participants about their communications practices: how they contacted co-workers and how co-workers contacted them. Participants described both general strategies and specific situations.

3.2　Findings

While we found that successful communication does occur, we also found a wealth of evidence that existing resources fail to support the needs of the modern workplace. These failures suggest a set of functional requirements, which we have included for each problem identified.

Problem Observed: *Communication is driven by interaction and information need, not time and place.*

All interviewees reported working outside the office—working entire days at home or remote sites, replying to emails on their phone while waiting for their kids, or getting up early to take calls from geographically distant peers. These experiences, even for those who described their jobs as "not time-critical" or who had little required travel, suggest that work is not defined by a physical space or traditional hours of a work day. As one said, *"I talk to our people, at least the key people, my direct reports … three times a day … regardless of where in the world I am. And that kind of tells you how important it is for me to communicate with them."*

Functional Requirement 1 (R1): *Awareness information must be accessible always, and across multiple platforms.*

Awareness information must be accessible ubiquitously to meet the needs of emerging work styles. Systems must support multiple platforms to fit the various environments that exist in modern work practice. Also, information about colleagues should be available at all times, as our interviews uncovered many situations where awareness information is just as useful (if not more so) outside of normal working hours. For one of our interviewees, his regular work behavior involves making late-night or early-morning calls to employees across the world. He often tries to take advantage of short periods of free time to catch up and coordinate with colleagues. Despite these needs, existing awareness systems fail to provide multi-platform, full-time access.

Problem Observed: *Channel choice can convey conflicting or wrong indicators of channel preference and immediacy.*

Nearly all of our participants expressed frustration that the choice of a communication channel conveys both immediacy and preference. Phone calls are a common example. A person who wants to have a conversation but doesn't need to have it immediately may still decide to make a call to satisfy the *preference* constraint while misrepresenting the *immediacy* constraint. Alternatively, if a person needs to discuss an issue right away, she may choose to use the phone because it will interrupt and get the caller's attention, thus satisfying the *immediacy* constraint but misrepresenting the *preference* constraint.

Participants recounted a number of examples of preference/immediacy conflicts. They varied from feeling obligated to take phone calls from bosses while in a meeting with customers to frustration in having to communicate technical details over an inefficient channel.

R2: *Tools should allow preference and immediacy constraints to be expressed independently and explicitly.*

Communication tools need to provide

facilities that allow a user to communicate intent and channel preference independently and outside of the channel itself. For instance, a user wanting to have a phone conversation should not be forced to interrupt the callee if the current activity and state of that person is unknown or unclear. Yet, the current state of the art provides little to no support for effective negotiation of communication intent. Today, the situation just described usually ends in the caller having to resort or default to a less preferred medium (e.g., email), either to conduct the conversation or to simply negotiate an alternative time and/or medium. Providing simple, out-of-band negotiations could all but eliminate the preference/immediacy overload.

Problem Observed: *It is difficult for individuals to convey how they prefer to be contacted.*

Related to the previous problem, we found that individuals seldom have the opportunity to express their preferences for receiving a communication. For instance, there is little feedback a user can give to indicate that a phone call is not appropriate at a given time, or that instant messaging is preferred for quick, non-time-critical conversations. Some tools do allow some expression of preference, for example the user-status message in many instant messaging systems. However, manually updating status messages can be burdensome, resulting in increasingly out-of-date information.

R3: *Systems should allow users to flexibly and dynamically express their preferences for being contacted.*

Participants expressed several dynamic factors that they consider relevant when receiving a communication, many of which illustrate the need for better technology support:

- *Situational factors limiting a channel's availability or acceptability.* A common example was wanting colleagues to be aware of when they were meeting with clients.

- *Personal preferences for specific channels.* Preferences varied and were well-articulated. Some preferred that all interactions be face-to-face and were willing to travel or postpone communication to achieve this. Others preferred email or other asynchronous channels, even when face-to-face interactions were easy. Many wanted to make these preferences more explicit.

- *Deferring or redirecting to an alternative channel.* Participants described situations where particular channels would be impossible (e.g., email while driving) or inappropriate (e.g., phone while in a meeting) to use for a communication event. In these cases, they wanted an easy way to redirect the communication to a different channel.

While these may seem obvious, it is surprising that many existing communication and awareness systems provide little support for these preferences.

Problem Observed: *Existing awareness tools are limited, unreliable, and infrequently used.*

Many participants reported trying to use awareness cues from personal and corporate calendars or IM status with limited success. Interviewees reported that these cues provided low-fidelity or inaccurate data. One interviewee reported sending IMs to individuals whose IM status was "present," but who were in fact not present at all. IM status may not represent a person's situation, while a person's calendar event may not supply sufficient detail if it was not written with the intent for others to check it.

The incompleteness and inaccuracy of these information sources has led to decreased use. Interviewees generally reported attempts to initiate communication without consulting these resources, only later to learn or remember that the desired information was available.

R4: *Awareness information should be complete and convey relevant information from the many*

channels users employ.

Our interviews indicated that awareness information, such as a colleague's physical location, was often incomplete. Those who worked less-traditional hours or often worked outside the office had more need for such information. Furthermore, accessing awareness information should not require the use of multiple tools (e.g., checking a calendar in one application and IM status in another). Unifying this information in a single place is essential. Awareness tools should also not provide incorrect or out-of-date information. For example, an IM status message may say "away" when the application has not seen activity on the computer, when in fact the user is there, just not actively using his computer. This is a shortcoming of nearly all IM systems.

***Problem Observed:** Many users struggle with the tension between "being present" and "being connected."*

Participants were concerned that receiving communications (e.g., phone calls, email) when already engaged in an activity, particularly during meetings and presentations, detracted from their engagement. Explicit attempts to avoid these distractions were viewed as unacceptable, since some communications may be urgent. But to determine if an email is urgent, they had to open and assess it. It is even worse for phone calls, where participants must answer the phone call. One interviewee explained his own battle with this tension: *"I think we've gotten to the point where we're too reliant on these [Blackberrys] in meetings … it takes away some of the focus. I'm guilty of it just like everybody else, but I'm trying now to start leaving this out of meetings."*

***R5**: Awareness systems should serve as a filter to minimize interruptions, shifting the burden from contactee to contactor.*

If users know that their awareness information is easily accessible to those who initiate communication with them, they can be more purposeful with their communication. The need to constantly check one's phone for important emails during a meeting will be made all but unnecessary if communication media are augmented to support the varying needs of all parties involved in the communication.

4. The myUnity Platform

We created myUnity to address the need for a contemporary platform to support the myriad awareness and communication needs of the modern work environment. Below we describe the three major components of the platform: client applications (desktop and mobile), sensor and data aggregators, and the central server.

4.1 Client Applications

We designed the client applications to provide users with quick and easy access to several channels of important awareness information. Additionally, the client provides facilities that assist users in coordinating communication with peers. We developed both mobile and desktop versions of the client, in support of R1. Below we discuss the main design features of the myUnity clients.

4.1.1 Awareness Dashboard

Figure 1 shows the dashboard, the main visual display, for the desktop and mobile clients. The dashboard features an array of photo tiles, each representing an individual in the organization. The border color of the tile reflects the individual's current presence state:

Green physically in office, alone

Purple in office with at least one other person

Yellow in office building, but not in office

Blue using computer from remote location (not office)

Orange on mobile client only, not in office building

Figure 1. The desktop (left) and mobile (center) dashboards. In addition to presence state, the desktop dashboard displays location from phone (A) or Bluetooth/Wi-Fi (C) as well as calendar information (B). The detail views for the mobile client (far right) and desktop (popup over dashboard) show presence data (D), status messages (E), contact information (F), and IM client status (G).

Grey system has no current information

The dashboard of the desktop client is resizable and configurable. As the size of the application window increases, the tile size expands to include additional information (e.g., full name, a description of presence state, and calendar data). Users can choose to show individual tiles in one of three sizes, allowing them to customize the visual representation to maximize the awareness details about specific individuals in the larger tiles, while collapsing the details of others.

The dashboard allows users to know the presence state of their colleagues at a glance. With quick access to presence states users can efficiently acquire information useful in determining a channel and time to communicate with a colleague, supporting R2. For example, one could quickly confirm that a peer is in his office alone before initiating a phone call or physically walking to his office.

In both interfaces, selecting a person's tile provides additional information about that person. This detailed view (Figure 1), provides the person's presence information, approximate location (for those who allow myUnity to determine their location), current status message, and links to phone numbers, IM, and email, in support of R2, R4, and R5. Clicking on

a link launches the appropriate interface to directly communicate over that channel. Only those channels activated by the recipient can be selected.

4.1.2 Structured Interactions and Messages

While awareness of a person's state is helpful in many situations, even a system that is always on and always correct will not enable users to share information about particular situations (R3), nor facilitate expression of channel preference and immediacy (R2). To support these needs myUnity provides the Nudge, Ping, and Status Messages.

Nudge provides a template for lightweight negotiation of communication channel and time. It allows users to separate immediacy and channel preference from the communication itself. A nudge is a four-step process, two steps each for the contact initiator and the recipient:

1. The initiator selects the time frame for a communication to take place, along with preferred and acceptable channels.
2. The recipient gets a message (Figure 2, left) with the initiator's information from step 1. The recipient responds with his own time preference within the initiator's time frame. In addition, he selects which of the proposed communication channels he prefers.

Figure 2. Nudge (left) and Ping (center and right) on the mobile client. The Nudge forwards information about the communication request to the recipient and ask him to share his availability. The Ping interface shows Ping initiation (center) and receipt (right).

3. The initiator sees the options provided by the recipient and can make a final selection or cancel the Nudge.

4. The recipient receives a final confirmation.

Although some of the functionality provided by the Nudge exists in other tools or practices, the Nudge is fundamentally different in that its interaction is designed to help initiator and recipient converge quickly on an agreed-upon time and channel. Further, the success of a Nudge depends only on the participation of the initiator and recipient during the Nudge interaction itself. This differs from other tools that require users to keep calendars or a precisely up-to-date set of rules or preferences.

Ping (Figure 2, center and right) provides a template that allows one to send a short, predefined message to another user, along with their awareness information. Unlike the Nudge, the Ping is not intended for back-and-forth communication, but only to provide a simple heads-up to others. For instance, a user can send a Ping with the message "running late" along with automatically collected location information, which could enable the recipient to understand how late the initiator is likely to be, without the initiator having to articulate it directly. A ping can be thought of as a structured, contextual SMS that requires fewer clicks to communicate much richer and up-to-date information.

Status messages provide a simple way for users to supplement the automatically collected data with details about their current state. Status message content is not restricted, but its length is short. Examples include: "hosting visitors today," "working on a paper deadline," and "working with customers off-site." These messages appear in a window on the desktop dashboard and in individual detail views.

4.2　Sensors and Data Aggregators

myUnity collects information from a bank of independent sensors and external data aggregators for presentation in the application clients. Our aggregator architecture is component-based, allowing channels of awareness information to be added, updated, or removed at any time. We implemented six aggregators that provide the core awareness information that we found to be essential to support communication and awareness in the workplace, and combine them to support achievement of R4:

● *Vision-based office activity.* A video feed from a small wide-angle camera (mounted in the corner of personal offices), is analyzed for motion. Users specify to the system the

physical spaces within their office that they and visitors typically occupy. When motion is detected in these spaces, an appropriate state is reported. Raw video is not shared.

● *Mobile phone location.* Bluetooth and Wi-Fi access points installed throughout the office space can trilaterate the signal of a user's mobile phone or other wireless device to provide a user's physical location. If the user is outside of the building, location can be reported directly from a phone's GPS sensors when it is running the mobile client.

● *Computer and network location software client.* The desktop client can report when a user is actively using the computer by detecting mouse and keyboard activity. It also reports network location according to the type of its address (inside a corporate network, remotely on VPN, or an external address).

● *Calendar.* Users can link information from various calendaring systems, such as a corporate calendar (e.g., vacation, sick, or travel day) and personal calendars (e.g., personal and professional meetings).

● *IM presence.* Users can have their status reported from IM protocols (e.g., Jabber, Google Talk).

● *Phone call status.* The mobile client and the IP-based office phones can report whether or not they are in a call.

An important design characteristic of the myUnity aggregators is that users can independently select which ones report information on their behalf. People can customize myUnity's data collection to conform to personal privacy concerns and requirements.

4.3   Central Server

The central server is responsible for collecting information provided by aggregators, fusing and summarizing this information, then streaming the result to client instances. myUnity takes a slightly different approach to fusion and summarization in that it does not infer or predict

state (as other systems do), but degrades the data's resolution to convey only what it knows to be true, an important feature to support R4. For example, if it receives data that a user is logged on to several IM protocols and present in the building, but no evidence from her office activity sensors, it will not infer that she is in her office, but only report that she is in the building. While degrading state may produce less useful results, it avoids situations where it is incorrect.

5.   Evaluation

To understanding the value and impact of myUnity, we performed a field deployment of the platform. Full details of our study methodology and results can be found in [21]. At a high-level, the study was able to validate the utility of the functional requirements discussed above. Moreover, the results show different adoption rates and characteristics of use that highlight the importance of providing pervasive access to awareness and communication facilities. In particular, high use and value was attributed to having access to awareness information across an integrated desktop and mobile experience. As a whole, the results are promising and show that technologies like myUnity can meaningfully improve the contemporary communication landscape.

6.   Conclusion

The workplace is changing rapidly to one that is less predictable and more dynamic. While technological advances enable this new workplace, there are clear shortcomings in existing solutions. myUnity combats these shortcomings by providing (1) convenient and universal access to awareness information, (2) automated collection of a wide variety of awareness information, and (3) facilities to express preferences that are otherwise not

communicated. These novel features were derived from gaining an understanding of the communication and awareness needs of the modern worker. We believe the findings from this investigation demonstrate the platform's value, and the necessity of each component to effect a positive change on workplace communication and collaboration practices.

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