Asynchronous Negotiated-access

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Scheduling access to people and selectively sharing the state of one's activities are essential elements of collaborating with others. These processes are fundamental to arranging face-to-face meetings and coordinating access to shared information. Examples include scheduling meetings, contacting others in real time (by phone or instant messaging), and checking on the changing status of a jointly-authored document. In this paper, we first discuss challenging social and technical problems associated with scheduling and sharing activities and then describe a novel computational technique designed to help mediate access to people and their work products. We argue that providing effective negotiated-access will be an issue of growing significance as computational and wireless technologies make us increasingly and perhaps overly accessible.

1   Introduction

Consider the everyday task of scheduling a meeting. If those involved are in close proximity, the most common approach is for the person initiating the meeting to speak directly with the other people they want to meet with to compare calendars, share the state of relevant activities and commitments, discuss options, and ultimately decide on a mutually agreeable meeting time.

When the parties are not in close proximity, a similar process of negotiation often takes place over the phone. In both cases, the parties participate in real time. Scheduling by phone is complicated because it is often difficult for parties to reach one another. What frequently results is a game of phone tag. One party tries to reach another, is unable to, and leaves voice-mail indicating an interest in finding

a time to meet. The other party returns the call, more often than not fails to reach the original caller, and leaves voice-mail in response. The process routinely entails multiple iterations, with the participants leaving suggested times to meet, confirming previously mentioned times, or proposing new times. This continues until finally a mutually acceptable time is chosen or not. The process is further complicated as the number of meeting participants increases. The negotiation is inefficient and frequently tedious.

People commonly remove themselves from scheduling negotiations by having a secretary participate on their behalf. A principal virtue of this is the secretary is available by telephone throughout the day, so the back and forth problem of phone tag ends as soon as people initially contacted call back. The secretary has access to their employer's calendar as well as knowledge of other constraints and is able to negotiate a time for the appointment.

A process similar to this phone-tag negotiation is now often carried out via electronic mail. A person proposes a meeting in email, perhaps suggesting potential times for the to-be-scheduled meeting, and the process proceeds through email acceptance or counterproposal until a time acceptable to all involved is negotiated. Though this process may be less frustrating than phone tag, it can still stretch out over an extended period before agreement is reached. It is also possible that by the time one of the participants responds another participant's schedule may have changed due either to the lack of timely response to a suggested potential time or to a conflicting obligation arising. It is the nature of asynchronous interactions that a proposed time may no longer be valid by the time all parties respond and commit to it.

2 A Negotiated-access Proposal

In this paper, we propose a negotiated-access mechanism that alleviates a number of problems associated with arranging access to people and coordinating information sharing. It is implemented via a lock-and-key technique that supports asynchronous interaction and provides flexible boundaries between less urgent and more urgent access. In addition, it allows control over timing of access and permits tailoring of access level to specific individuals or groups. We first describe our negotiated-access proposal in the context of arranging meetings and then show that it is a general approach to a wide range of problems.

2.1 Scheduling: Problems with Calendar-sharing Approaches

Let's begin with the common problem of scheduling a meeting. Calendar-sharing systems provide one approach. In this model, all parties keep appointment calendars in electronic form using compatible software. Someone wanting to schedule a meeting can view other people's calendars, see the times they are available, choose an appropriate time, and notify everyone involved of the meeting time, without the other parties ever needing to be involved in the negotiation.

Although calendar-sharing software has enjoyed modest acceptance, it has not been made to work well in practice. First, such systems require all parties to maintain their calendars in electronic form and to continually ensure that they are up to date.

The payoffs for these added burdens are often not equitably distributed. There are large costs associated with keeping schedules updated, and payoffs frequently may not be worth the effort for many of those involved. Grudin (1987) discusses this in terms of who does the work and who gets the benefit. He notes that such systems often fail because while requiring everyone involved to keep their calendar online and current, often only managers derive benefit. Second, because such schemes allow people to view and modify the calendars of others, calendar sharing is limited to close associates who feel comfortable allowing such access. While it is not an uncommon practice for people working within the same organization to use calendar-sharing systems, they fail to meet the needs of those who:

1. do not use the same software;

2. are in separate organizations without needed connections;

3. do not find the reward-to-effort tradeoff suitably beneficial; or

4. do not feel comfortable sharing their calendars.

Knowing a person's schedule provides valuable information about their activities and raises complex confidentiality and security issues. In some calendar-sharing software, this is addressed in part by masking out the details of appointments. When someone else is viewing the calendar, only times available are presented but this is still information not everyone wants to share. If there is even one person an individual does not feel comfortable sharing his or her schedule with, then there is incentive not to participate in calendar sharing. Without universal acceptance of the sharing scheme, the whole process can become fragile and break down. In a significant number of situations, for the reasons listed above, it is simply not practical to use calendar-sharing software to schedule a meeting.

2.2   *Scheduling: Negotiated-access Approach*

To help describe our proposed negotiated-access approach, consider scheduling a simple two-person meeting. For example, imagine Irving wants to schedule a meeting with a business associate Roberta. He begins by composing an email message to her. It might be something like:

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Roberta,

I've been thinking more about your proposal and would
like to discuss it.  I'm in and out of the office a
lot this week, so the best thing to try is probably
scheduling a time that both of us are available.
You can choose a time for us to talk simply by clicking
on the link at the bottom of the page.  That link gives
you a one-time access to my calendar, and will allow you
to pick a time for us to talk.  Look forward to talking
with you, and hope things are going well.  - Irving
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After completing his email, Irving specifies restrictions on possible times for the meeting and on when scheduling can take place. For example, he might restrict the meeting to times he is free in the next two weeks and indicate that Roberta will only have one-time access to schedule. A program could then be run to insert a specially

constructed URL at the bottom of the page. The completed email message might look like:

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From: Irving@equi-pose.com
To: Roberta@hci.ucsd.edu

Roberta,

I've been thinking more about your proposal and would
like to discuss it.  I'm in and out of the office a
lot this week, so the best thing to try is probably
scheduling a time that both of us are available.
You can choose a time for us to talk simply by clicking
on the link at the bottom of the page.  That link gives
you a one-time access to my calendar, and will allow you
to pick a time for us to talk.  Look forward to talking
with you, and hope things are going well.  - Irving

http://www.equi-pose.com/cgi-bin/Irving/?token=roberta-1
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After Roberta receives the email and decides she wants to schedule the meeting, she simply clicks on the URL.* Roberta will then see a Web page displaying Irving's calendar with only the times he is available to meet with her. This Web page is generated by a program that is run in response to Roberta's click. It checks the token to ensure it is the unique token that was used to specify the meeting Irving requested and if verified allows Roberta one-time access to the calendar to choose an appointment time within the constraints Irving imposed. Once Roberta selects a time, the token *roberta-1* is deactivated. If Roberta or anyone else attempts to use the URL at a later time, they will not be allowed access to Irving's calendar. Cryptographic processes can be used to make the token secure and infeasible to guess. We discuss this and other variations later. Finally, Irving is automatically notified, by email or other means, that Roberta has confirmed their meeting.

2.3   Scheduling: Negotiated-access Advantages

Notice how this process removes problems associated with approaches mentioned earlier. Irving did not send a proposed set of meeting times explicitly in his email. Instead he sent a token that provides a mechanism to access a filtered view of his calendar. If in the interim between when he sent the message and Roberta responded his calendar changes, the filtered view Roberta will see can still be current. Irving and the automated negotiation process retain control over possible times until the other party responds. However, also notice that Roberta benefits from this process by being presented choices that are current at the time of access and the effort required from her is minimal. The effort to specify the filter and generate the associated token is done by Irving, the person wanting to schedule the meeting.

Advantages of the proposed process are further illustrated in the following situation. Suppose an employer needs to meet with eight job candidates applying for a position opening. He has a block of four hours during which he can conduct interviews, and he would like to meet for 30 minutes with each candidate. In a conventional system the employer might propose specific times in email messages to

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*Note that there are two parts to the URL: a path to a cgi-bin program for accessing Irving's calendar and a parameter that is the token used to generate the filtered view and schedule the meeting.

the candidates. However, the times proposed to a given candidate may not work for that person, whereas he or she could be available at a time proposed for a different candidate. If one candidate could swap times with another, then potentially everyone's scheduling needs could be satisfied. Unfortunately, working through this might take several rounds of email.

Our proposed token-based mechanism offers significant improvements for negotiating access. For example, the employer could send out eight emails, each with a separate token, but with each token giving access to the same four hour slot. After the first candidate who accesses the calendar chooses a slot, that time is marked on the calendar. The next candidate to access the calendar sees only the seven remaining choices, and so on for the other candidates. This example is a special case of scheduling a general multi-person meeting. What we want to highlight is the unique flexibility provided by asynchronous negotiated access to a filtered and dynamically updated database of state information. Arranging any multi-person meeting may benefit from application of the process disclosed here.

While the negotiated-access mechanism does not eliminate all possible problems (e.g. one of the candidates might have a particularly constrained schedule with demands that cannot be met), it can still simplify the negotiation process and minimize its duration. It should be clear that the underlying mechanism could be modified so that respondents can indicate subsets of the possible times that fit their schedules, or even indicate priorities for those times. Then as each person accesses the schedule via their token the schedule is in an updated state based on all previous interactions. While the mechanism could be varied to support posting individual time constraints when the scheduling negotiation is to find a mutually agreeable time, this introduces additional complexities. Here we want to emphasize the advantages of the basic method we propose:

1. The time involved in scheduling negotiation is minimized for all involved.

2. Each person negotiates their constraints within the context of the current state of the evolving schedule and in many cases doesn't need to be further involved.

3. Unlike calendar sharing software, significant effort is required only of the person initiating scheduling.

While we don't elaborate it fully here, in the case of specifying priorities, if the time is not uniquely determined as part of the automatic negotiation process, control can return to the originator but with potentially useful state information about the availability of other participants.

2.4 Instant Messaging: Similar Problems

The same fundamental scheduling problems exemplified above in arranging meetings are also confronted in a variety of other situations. Consider the example of instant messaging. The recent growth in instant messaging (IM) systems, as well as wireless access, presages a world where one is continuously available for interaction. In such a setting, there will be a growing need to restrict and negotiate access.

Instant messaging and similar chat facilities evolved from the *talk* command on early Unix systems. Talk was used for synchronous short text-based interactions, while email was used for longer messages sent asynchronously. This mechanism was adequate so long as:

1. the number of users on the system remained small;

2. users were likely to be acquainted with each other (which was typically the case, by virtue of working in the same small group); and

3. they were only logged on the system a relatively small fraction of their day.

Over time, this basic mechanism was expanded to handle collections of computers connected via multiple networks and resulted in a very large number of aggregate users. As a consequence, condition (1) no longer held. If all current users were notified each time a new user logged on, this would create almost constant interruptions. In addition, as networks grew larger, most users were no longer associates, in either a social or work-related sense. Thus, condition (2) no longer held. Users don't want information about their presence or absence on the system to be broadcast to other users they don't even know. These circumstances led to the creation of *buddy lists*, collections of people with whom one wishes to have instant messaging communication. Thus, today when a user logs onto the system, only those people who have the user on their buddy list are notified.

Instant messaging has now expanded beyond text to include voice. A real-time audio channel can be opened and remains continuously on, analogous to a text-based IM window remaining on the screen. While this is advantageous when both parties desire increased access to each other, the audio version of IM can be even more invasive than a text version, and leads to the need to further regulate access in situations where parties want to insulate themselves, at least temporarily, from access. In addition, the growth of wireless connectivity and other *always-on* systems creates a situation in which users can be logged on nearly continuously. In such circumstances, condition (3) no longer holds. As a result, additional means will increasingly be needed to regulate one's availability for instant messaging and similar forms of access.

2.5 Instant Messaging: Negotiated-access Approach

Many problems people confront in instant messaging derive from the absence of a negotiation mechanism being available at the time one individual wants to access another. While professors might want to provide students in their classes with instant messaging access, they likely also want to be on-line at times without that access being granted. The same mechanism described above to aid meeting scheduling can also be employed to provide negotiated-access for instant messaging. In this case, each individual or group can be provided with a token similar to the one used in the scheduling example. The token is used to negotiate access in the same lock-and-key method[†] described earlier. Just as in the case of meeting scheduling, the identity

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[†]A Web-based server technology, similar to the calendar example, can be employed to act as a negotiation intermediary. The negotiation could result, for example, in selectively and temporarily altering buddy-list members.

of the token is checked and the associated filter determines whether access to the person they seek is made available. Since access can be tailored to the token, at the same instant people could be available for IM to one set of individuals (perhaps those with whom they are working to meet an approaching project deadline) and not to others. Notice that negotiations can take into account any information available in the database at the time of attempted access. This is particularly advantageous because it gives all parties fine-grained control over access.

2.6 Pagers, Cell Phones, Wireless Email: Inner and Outer Circles of Access

In addition to instant messaging, pagers and cell phones further increase our accessibility and the need to regulate access. In fact, some people use access to their pager and cell phone numbers to distinguish between an *outer circle* of acquaintances and a more intimate *inner circle* of friends. They do this by simply giving the outer circle only their office phone number, and giving the inner circle their pager or cell phone number. A difficulty arises when there is a need for someone from the outer group to reach them via their pager or cell phone, perhaps on a urgent matter. To facilitate this, one is motivated to give the person one's cell phone or pager number. The side effect of this is that the inner circle expands, as it's not possible to ask the person to forget the number. It's also socially awkward to say: now that we've taken care of this issue, please don't ever call me on my cell phone again. Again, people can make use of secretaries to negotiate this form of access. The secretary determines which calls merit urgent contact and can connect a call without disclosing the cell phone number. Automated personal assistants (see for example, http://www.wildfire.com/) attempt to simulate this same process. Nevertheless, it still often leads to the need to query the person to see if they desire to take the call, which can be disruptive and time-consuming.

Allowing one more person access to the inner circle is at least a nuisance. As this process is repeated for multiple exceptional circumstances, the advantages of having the inner circle can seriously degrade. These outer/inner distinctions are present in the two previous examples as well, namely:

MEDIUM	OUTER CIRCLE	INNER CIRCLE
Telephone	Work Number, Phone Book Listing	Cell or Pager Number
IM	Public Directory	Buddy List
Meetings	No Calendar access	Calendar

The emergence of wireless email services is also starting to lead to a two-tier system of email accounts in which those in the outer circle are given one's main email address and those in the inner circle are given one's mobile email address. Below we discuss how our proposed negotiated-access process can be applied to all three of these new examples but to assist exposition we first discuss a generalization of the process.

3   Generalization of Negotiated-access

As we enter a world of increased connectivity via the internet and wireless, these and associated technologies (e.g. pagers, cell phones, and wireless email) intensify the

need for a practical method to negotiate access. Key issues include:

- maintaining, and hopefully increasing, individual control over the management of interruptions;

- supporting controlled access to personal information such as one's calendar and to shared information and work products to aid collaboration;

- creating a common integrated process for access negotiations;

- sharing the effort required for negotiation in appropriate and effective ways between the parties involved; and

- minimizing the need for participants to devote time unnecessarily to the negotiation process itself.

It is desirable that the method avoid the problems mentioned earlier: proposed times for scheduled events being out-of-date, losing control over sensitive information, requiring parties to use identical software, and creating burdensome overhead for all involved in the negotiation process. In addition, an effective solution should permit access to the privileges of an inner circle on a limited basis and provide a socially acceptable way for access to be withdrawn after the temporary need has passed.

Rather than providing specific instantiations of our negotiated-access proposal to handle pager, cell phone, and wireless email access, here we describe a generalization applicable to these and other areas. It allows people to efficiently negotiate access to others, to personal state information, and to shared work materials, while minimizing the need for synchronous interaction during negotiation. To implement the process requires:

1. a database of state information and filters;

2. a unique token generator;

3. a checker of tokens;

4. a process of applying a filter to authorize access and possibly generate a customized view of the database; and

5. a communication mechanism.

In the general case, a person sends a token to others he or she wishes to involve in a negotiated interaction. The originator maintains control over the period when a token and associated filter is valid as well as the process of negotiation. The receivers of tokens or their agents can, during the period the tokens are valid, use them to participate in a negotiated interaction with an agent of the originator. An agent can be a person or a computational process. The sender's agent uses the token and potentially additional information to select a filter from a database in order to dynamically configure and execute the negotiated interaction. This process can selectively reveal information to the token receivers, allow them to modify selected

portions of the sender's database of state information, or result in running a program to interface with other applications.

The filter and token combination provide the lock-and-key access mechanism alluded to earlier. They are created at the time one experiences a need for a new instance of negotiated access. In the case of scheduling, this involves specifying the meeting constraints, duration the token is valid, and parameters used to configure the calendar view parties will be given and access privileges they will have. In the cases of instant messaging, pager, cell phone, or wireless email access, the token also enables potential access. Actual access is determined by the associated filter and state information in the database. For example, a cell phone call from one's spouse might always be able to reach one but during an important meeting others might not have cell phone access. The database can contain information about an individual's location, schedule, state of work materials, status of various projects, desire to currently limit access, and a range of other information. While this information can be entered manually, there is the promise that portions of it can be included and updated without conscious effort, as the byproduct of other activities. For example, location information could, at times, be automatically updated when GPS chips start to be incorporated in cell phones, cars, and other devices.

Our generalization of the negotiated-access mechanism can also provide limited duration access to privileges of an inner circle. Upon the need for such access, a specific token and filter customized to the particular circumstances can be created. Of course, they could also result from modifying a previously configured filter. Negotiated access[‡] can then be exercised via the associated token at the convenience of the parties to whom one extends such privileges. The token might permit paging, placing a cell phone call, creating an IM connection, sending wireless email, or any combination of access. The token and execution of the associated filter determines whether access is granted. Suppose, for example, it results in a cell phone connection. After the call concludes, the token might be deactived as an automatic result of the filter. Note that the state of one's inner versus outer circle then reverts to what it was prior to the event. Notice also that the same mechanism can be used to further refine inner-outer distinctions to create multiple categories. This enables individuals to be temporarily recategorized so as to move them either inwardly and thus grant them additional access or outwardly to further restrict access. At any time access may be denied due to state information present in the database. For example, a called party may be in a location in which all filters automatically disable cell phone access.

The generalized negotiated-access process can be modified to permit additional discretion to all parties, to make it more convenient, to use multiple communication channels, and to increase the security of the process. While we don't elaborate these modifications here, we do want to emphasize token security. The only requirement for a token is that it be unique. It can be generated using cryptographic techniques.

[‡]This can take a variety of forms. The token could be passed via a Web connection, as described in the previous examples, or over a wireless network. The token could be a phone number to be called with extra digits to be keyed in once a connection to a server application is established. The token could even be constructed to be appropriate to be used in a verbal interchange with a person's secretary.

If the intended recipient of a token has a known digital signature, then one could require both the token and a digital-signature test of identity to gain access. In fact, with a known digital signature, one can dispense with the token altogether, simply using the digital signature as the token.

4 Summary

Currently we are at the beginnings of widespread wireless connectivity and ubiquitous computing. The Web is merging with a variety of technologies: cell phones, laptop computers, hand held organizers, information appliances, and GPS and other sensors. The capability for access anytime and anywhere is here. The increasing frequency of cell phone calls at inappropriate times testifies that people no longer can easily control access. Devices can know where they are located and can make a range of information available to users as well as make users available to others or their devices.

We have proposed a general technique that promises to assist in mediating access. It capitalizes on advantages afforded by computation(Hollan & Stornetta, 1992). We first described the negotiation technique in the context of problems involved in scheduling meetings and then showed that similar issues, which at first may seem unrelated but in fact have much in common, arise in other contexts. One such activity, gaining immediate access, is currently of growing importance because of expanding connectivity via wireless technology.

Cell phones and related technologies make it possible to be constantly available for synchronous interaction. At times, this can certainly be advantageous but the associated costs and benefits result in a complex tradeoff space for designers as well as users. The negotiated-access mechanism we describe can influence these tradeoffs as well as assist in arranging access to people and coordinating information sharing. It is implemented via a token-based lock-and-key technique that supports asynchronous interaction and provides flexible boundaries between less urgent and more urgent access. In addition, it allows control over timing of access, permits tailoring of access level for specific individuals or groups, and provides limited duration access to privileges of an inner circle without expanding and degrading the value of maintaining an inner circle and without offending those granted only temporary access. The implementation we sketch for meeting scheduling, instant messaging, and access via pagers, cell phones, and wireless email, does not require all parties to share the same software, allows late-binding of details to better support negotiation during changing circumstances, and minimizes overhead in the negotiation process. While many issues need to be further elaborated, not the least of which is the results from our prototype implementations, what we propose is a novel and promising approach to an increasingly significant problem.

References

Grudin, J. (1987), Social Evaluation of the User Interface: Who Does the Work and Who Gets the Benefit?, *in* H.-J. Bullinger & B. Shackel (eds.), *Proceedings of INTERACT '87 — Second IFIP Conference on Human–Computer Interaction*, Elsevier Science, pp.805–11.

Hollan, J. & Stornetta, S. (1992), Beyond Being There, *in* P. Bauersfeld, J. Bennett & G. Lynch (eds.), *Proceedings of CHI'92: Human Factors in Computing Systems*, ACM Press, pp.119–25.

Hollan, J. & Stornetta, S. (1992), Beyond Being There, *in* P. Bauersfeld, J. Bennett & G. Lynch (eds.), *Proceedings of CHI'92: Human Factors in Computing Systems*, ACM Press, pp.119–25.