Newport: Enabling Sharing During Mobile Calls

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ABSTRACT
Newport is a collaborative application for sharing context (e.g. location) and content (e.g. photos and notes) during mobile phone calls. People can share during a phone call and sharing ends when the call ends. Newport also supports using a computer during a call to make it easier to share content from the phone or launch screen sharing if the caller is also at a computer. We describe Newport's system design and a formative evaluation with 12 participants to study their experience using Newport to share location, receive directions, share photos, and perform desktop sharing. Participants preferred using Newport to current methods for these tasks. They also preferred limiting sharing location to phone calls compared with publishing it continuously. Tying sharing to a phone call gives individuals a social sense of security, providing a mechanism for exchanging information with unknown people.

Author Keywords
Collaboration, sharing, mobile phone, desktop sharing.

ACM Classification Keywords
H.5.3 Group and Organizational Interfaces.

General Terms
Design, Experimentation, Human Factors.

INTRODUCTION

There are many situations, from asking for directions to collaboratively making travel arrangements where the ability to easily share information with someone while you speak on the phone can be helpful. The number of people carrying smart phones capable of running numerous applications is increasing [12], but most mobile phone applications do not take advantage of an active phone call. Although applications and services for sharing content from phones exist, these services (e.g. Flickr, Glympse, Google Latitude, Loopt) typically do not support synchronous sharing; instead they require other people to subscribe to information published by a user. In contrast, we wanted to explore sharing during mobile phone calls by leveraging the active phone conversation as a channel to set up and enable a range of different sharing options. We developed Newport, a collaborative mobile phone sharing application that facilitates sharing content (e.g. photos and notes) and context (e.g. location) during phone calls. Beyond the value of sharing with the person you are communicating with, sharing potentially sensitive context information such as your location only during a phone call may address some of the privacy concerns raised by systems that constantly broadcast your location to your contacts [9].

We also designed Newport to bridge a gap between phones and computers, inspired by frustration that mobile phones and computers with complementary functions are often used in isolation, even when both devices are available. Newport's desktop client recognizes via Bluetooth when you are on a mobile phone call and provides additional functionality on the computer to support sharing and collaboration. For example, allowing browsing photos from the phone on the desktop for easier viewing and selection, and providing one-click access to desktop sharing with the caller if he or she is also by a computer. Allowing a mobile phone user to easily use a nearby computer helps address scenarios described by Wiltse and Nichols [23], where a mobile phone user calls someone at a computer to complete a task such as searching the web or getting directions.

To study the value of sharing during phone calls and the ability to make use of computers in the environment during a call, we conducted a user study of Newport with 12 participants. The study explored three types of sharing: receiving directions after sharing one's location, sharing photos using either the phone or phone and computer, and collaborative screen sharing. Our participants reported regularly experiencing the sharing situations that Newport was designed to support. They preferred using Newport for synchronous sharing tasks including getting directions, sharing photos, and planning trips. Feedback from our participants suggests that sharing location information only during a phone call gave many participants a sense of control and a social sense of security that made them more comfortable sharing their location, even with an unknown person, compared to publishing their location all the time to a set of contacts. Eleven of our 12 participants preferred using a computer in addition to the phone for sharing when available, but only six would seek out a computer if one were not nearby.

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RELATED WORK

Most research addressing sharing on mobile devices has focused on collocated situations. Collocated mobile sharing often relies on Bluetooth as a means to collaboratively share files between mobile phones [e.g. 15, 16]. Mobile devices interacting with computers or large shared displays have also been studied. Several projects including ProD [8] and work by Paek et al. [18] and Churchill et al. [7] explore posting content to large displays using means such as Bluetooth or SMS. Newport instead supports sharing between people who are not collocated, while allowing each person to leverage technology at their own location.

Because mobile phones contain personal information, many researchers have focused on concerns about what information is being shared. Research by Huang et al. [14] and Garriss et al. [13] addressed people's discomfort when accessing information from their mobile phones on public kiosks by offering more granular privacy controls or secure applications. Applications such as MobShare [20], for sharing photos amongst groups, have strict permissions settings to enable users control over who sees what. Though MobShare enforces permissions programmatically, users also developed social protocols to marshal who should be viewing photos and when. Kun and Marsden [16] noted similar behavior in the deployment of their collaborative, collocated photo sharing application.

Sharing location from mobile devices has also been studied in depth. In a study of a mobile application for sharing location with groups of friends, Barkhuus et al. [2] reported that when people share location they often embed activity information in status messages—thereby giving more clarity and context to messages. Cheverst et al. [6] examined sharing location and social awareness with both known and unknown people using portable tourist city guides. Similarly, the Whereabouts Clock [21], a situated awareness device that displays the locations of family members, demonstrated that contextual activity information is as important as location information at times.

Consolvo et al. [9] studied how social relations affect the level of detail of location a person is willing to share with others. Google Latitude and Loopt enable sharing location with other individuals, but their sharing is more general, not contextual (i.e. based on a specific task at hand) nor is there a sharing permission model that addresses social relations issues discussed by Consolvo et al. Glympse adds time constraints to location sharing—enabling users to share location for specified time periods—adding a notion of a task bound by a time to location sharing. Throughout research dealing with mobile phones and sharing practices there is a consistent thread of nuanced social practices around what types of information are appropriate to share with whom. We believe that supporting sharing during a phone call might be a straight-forward way to leverage a natural occurring social situation in which participants may wish to share, providing a "social sense of security."

Plenty of research covering sharing and synchronous collaboration predates the era of ubiquitous mobile technology. In the 1970s Chapanis et al. [5] studied the effects of communications modes on teams in cooperative problem solving and demonstrated that when people communicate visually, in addition to verbally, task completion improves measurably. Ever since, synchronous remote collaboration using desktop computers has received a great deal of commercial and research attention [e.g. 3, 4]. Numerous applications exist to share desktops between people including Adobe Acrobat Connect Pro, Microsoft Live Meeting and several applications built on VNC's open source code. Recently, communications tools such as Apple iChat and Skype and have added the ability for people to share their desktop. File sharing over personal computer networks and the Internet has also been studied thoroughly. Voida et al. [22] examined sharing practices amongst people and the characteristics of effective file sharing tools.

In contrast to all of these systems, with Newport we focus on sharing using a mobile device with a remote caller, and make use of known computers (where Newport has been installed) to assist the user when sharing. Users interact with a trusted computer and have control over with whom they share their data by using the phone call as a means to determine trustworthiness. Newport attempts to simplify the process of initiating or establishing the sharing experience and facilitates desktop sharing when possible without the user having to worry about bandwidth, firewalls or network security permission restrictions.

Newport's emphasis on collaborating while speaking on the phone is influenced in part by PlayByPlay [23]. This collaborative web browser allows desktop and mobile users to share a web browsing experience while talking on the phone. PlayByPlay gives each user the autonomy to browse individually or follow another user as desired. Privacy is maintained if a user does not share his web browsing session. While PlayByPlay concentrated on collaborative web browsing, Newport focuses on the experience of sharing applied to any application. Newport's goal is to enhance communication during phone calls by making sharing information more transparent and to lighten the cognitive overhead normally involved with sharing.

NEWPORT

When a user initiates a mobile phone call using Newport, sharing options automatically appear on the phone and, if appropriate, a nearby computer (Figure 1). Newport consists of two pieces of software: a mobile phone application (Newport Mobile) and a supporting computer application (Newport Desktop Client) for use when the phone is within Bluetooth range of a computer. Newport Mobile supports sending maps, photos and notes to the person a user is speaking with on the phone. The user can annotate any of these screens before sending. For example, the user could circle a specific person in a photo before sending it. When displaying maps, the user can opt to

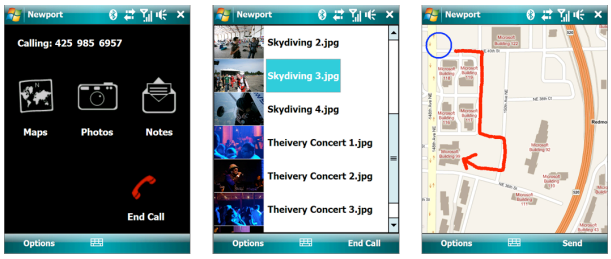

Figure 1. Newport Mobile includes notes, photos and maps applications that allow users to share screen captures and make annotations on the screen captures.

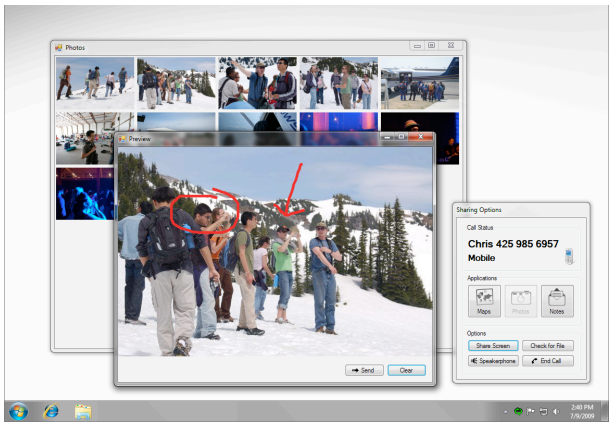

Figure 2. Newport Desktop Client's photo browsing feature has similar features to Newport Mobile including shared screen annotation. Full computer desktop screen sharing is also available in the Newport Desktop Client.

display her location, shown as a circle before sending the map[1]. To assist the user with selecting and preparing content while talking on the phone, Newport Mobile also provides options for controlling important phone functions (e.g. speakerphone, end call, etc.), viewing a history of screens received, and sending the current screen.

Newport Desktop Client's Sharing Options dialog (Figure 2) supports the same features as those on the mobile client and provides the option to launch desktop screen sharing if the caller is also near a computer. Desktop sharing functionality coupled with voice can be done with software such as Skype, but the Newport Desktop Client also facilitates accessing the phone's files and functionality from the computer including putting the phone in speakerphone mode or ending the call. This enables the user to effortlessly switch back and forth between the mobile phone and computer. For example, when a user clicks the photos button on the computer, it accesses the mobile phone file system and displays photos from the mobile phone on the computer. This allows the user to take advantage of the computer's larger display and enhanced input capabilities and makes Newport unique from other sharing software. Newport is also designed so users can leave the computer and solely use the mobile phone when mobility is desired without disrupting an ongoing conversation on the phone. To use the mobile phone in conjunction with the computer, the two devices must be paired together on Bluetooth once. If the devices have not been paired before, Newport Mobile scans for computers nearby running Newport Desktop Client and prompts the user to connect to the computer.

[1] Newport reported simulated locations for user study tasks requiring participants to ask for directions. A participant received a random location to simulate being lost.

Sharing Architecture

We now describe the architecture of Newport using the example of "Alice" sharing photos with "Bob" during a phone call shown in Figure 3. First, Alice calls Bob on her mobile phone. Her laptop, running Newport Desktop Client in the background and paired to her phone, recognizes the phone call using Bluetooth and displays caller identification information on the screen (Figure 3: #1). Bob answers the call on his phone.

When Alice sends a photo to Bob, Newport Mobile transfers the photo to her computer via Bluetooth (Figure 3: #2). Newport Desktop Client uploads the file to the cloud (Figure 3: #3). Once Newport Mobile receives an acknowledgement that the file has been uploaded (Figure 3: #4), it sends an SMS to Bob's phone with information about how to obtain the file in a simplified XML format (Figure 3: #5).

On Bob's phone, Newport Mobile intercepts SMS text messages (Figure 3: #6) and checks the SMS for suitable XML tags that contain file location information or events for the software to handle. Text messages without such tags are ignored by the software and sent to the default message service on the phone, allowing a user to view the text message normally. When a Newport SMS message arrives, if Bob's phone is also near a paired computer running Newport Desktop Client, Newport Mobile sends the file name over Bluetooth to Newport Desktop Client on Bob's computer (Figure 3: #7), which downloads the file from cloud services (Figure 3: #8) and then sends it via Bluetooth to Bob's phone (Figure 3: #9). If Bob is not near a paired computer, Newport Mobile can use the phone's data connection to download the file. Sharing using Newport Desktop Client occurs in a similar fashion. If the user wishes to browse photos on her phone from the computer, a request is sent over Bluetooth to the mobile phone.

Newport is written in Microsoft .NET C#. The software runs on any Windows Mobile phone with Bluetooth capabilities. To access phone call functions, Newport relies on the .NET compact framework and Microsoft's Telephony Application Programming Interface (TAPI). Bluetooth communication between the mobile phone and the desktop computer is done over a Bluetooth serial

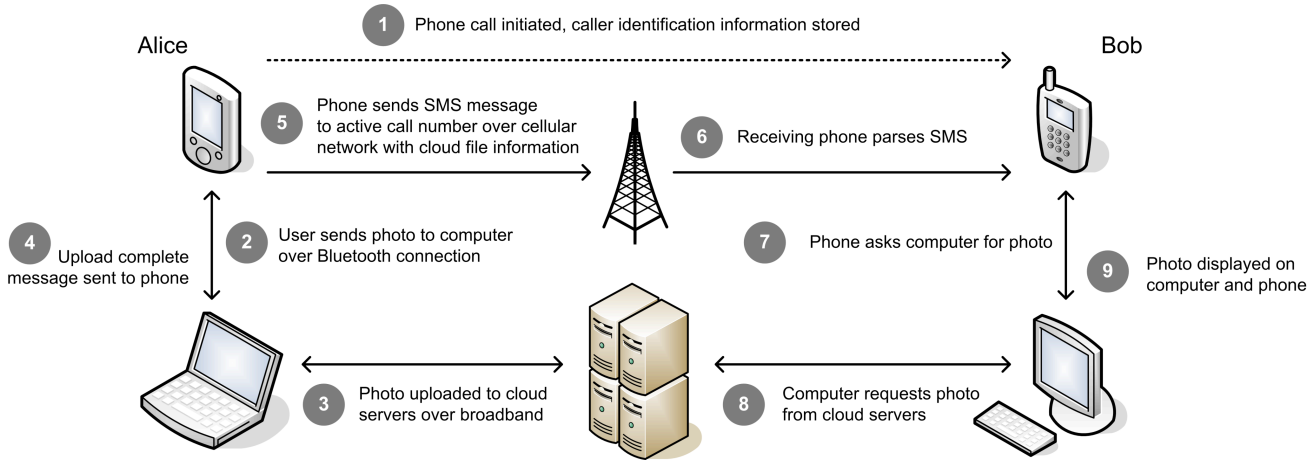

Figure 3. Newport's architecture for sharing a photo from Alice's phone to Bob's when both are in proximity of a computer.

connection. The desktop computer listens for Bluetooth requests from the phone and opens Bluetooth network communication streams as necessary. Files shared are stored using a cloud data storage service[2], which is comprised of a set of APIs that allow data to be shared and synchronized across multiple devices.

Design Advantages and Challenges

Our Newport design has several advantages including enabling sharing without a data plan, improved speed to share files when broadband networks are available, and providing some sharing security by using SMS during the phone call to send sharing information. However, there are also some potential disadvantages related to speed of SMS delivery and lack of Bluetooth.

Sharing Without a Data Plan: Technology experts assert that expensive cellular data plans in North America discourage the adoption of devices that utilize mobile broadband [19]. With Newport, sharing can be done without a data plan when near a computer. People with phones that do not have data plans can use a broadband connection to share when available by tunneling through Bluetooth. While it is possible to transmit files and images through a series of SMS, for example, it would be slow, because of cellular network prioritization, and costly without an unlimited text-messaging plan. MMS can also take several minutes to transmit photos or other media, making it unsuitable for real-time collaboration.

Broadband Transfer Speeds When Available: Transmitting files or photos over broadband is faster than using GPRS or 3G networks. Automated detection of a user's computer coupled with switching of data streams allows users to seamlessly take advantage of fast, inexpensive broadband data connections when they are available, while maintaining the flexibility of using more widespread, yet slower and more expensive cellular data connections [1]. We plan to implement this switching capability using a cloud data storage service API that supports Windows Mobile. This switching also allows users to start a sharing session while mobile and continue the session in front of a computer with the benefit of a faster broadband connection.

Securing Sharing by Using SMS: Newport leverages phone calls by sending the SMS containing sharing information and file location to the active phone call number. Using an active call phone number to send text messages makes it unlikely sharing information will be sent to the wrong person and provides a way to limit sharing to the duration of the phone call. This may be especially important when dealing with unknown people (e.g. a receptionist or travel agent). This method of sharing information is subject to the same security attacks and privacy concerns as SMS. In general, SMS is a fairly secure means of transmitting information. A device's phone number is included in an SMS, but that does not mean messages are insecure or subject to eavesdropping. Cellular networks authenticate devices on their networks ensuring security. SMS also functions well when cellular network traffic becomes congested and is considered by many as a reliable method of communication when all other means appear unavailable [11].

Unpredictable SMS Delivery Speed: While the ubiquitous support for SMS makes it effective for sending Newport's sharing commands, its main drawback is its unpredictable delivery speed. It is possible for sharing commands sent by Newport via SMS to take anywhere from seconds, in an optimal case, to hours or days in their worse case. During the user study, several users noticed a slight delay when sending and receiving shared information, but the majority of users expected a delay when transmitting information. Three of 12 users experienced longer delays during one of their tasks, which we worked around using an option built

[2] Newport used a beta version of Microsoft's Live Mesh API and required the Newport Desktop Client to be active. However, the software could easily be modified to use any cloud data storage service provider.

in the software that enabled the user to check if a file had been shared and retrieve it.

In a production quality system, requiring an SMS response from the receiving phone and then retransmitting the SMS if the response was not received within a reasonable time frame could address unpredictability of SMS delivery speed. Alternatives to consider for replacing SMS that would be more reliable include tones over a voice channel or directly making use of cellular data plans. For example, Madhavapeddy et al. [17] have transmitted audio data packets on the phone's voice channel.

Bluetooth Adoption: Given that Newport depends on Bluetooth for communication between a mobile phone and personal computer, our study assumed that Bluetooth would continue to move towards becoming an increasingly ubiquitous technology. While Bluetooth is not yet ubiquitous on all computers, trends of Bluetooth adoption are encouraging. IDC market research indicates that by 2012 more than 70 percent of consumers will have used Bluetooth on their mobile phones to attach a peripheral [10]. Laptops we used during the development of Newport had built-in Bluetooth support, but the desktop computers required a USB Bluetooth adapter. With current Bluetooth adoption trends, we anticipate most users will not have difficulty finding a phone and computer with Bluetooth support. For older computers that do not include Bluetooth, installing a USB Bluetooth adapter is a relatively simple and inexpensive process.

Cellular Carrier Restrictions: Occasionally carriers disable or modify functionality on phones for business or security reasons [19]. Bluetooth could be disabled so malicious applications are less likely to be inadvertently installed on a phone or to prevent data tethering to a laptop. That said, there is a trend towards making devices open and customer backlash has motivated carriers to remove restrictions on device use.

USER STUDY DESIGN

To evaluate the type of sharing enabled by Newport we recruited 12 people (six men, six women) to each use the prototype in a two-hour lab study.

Four research questions guided our study design:

R1: Have participants experienced the sharing scenarios that Newport seeks to address (e.g. calling someone while mobile for information; simultaneously using computers together while speaking on the phone)?

R2: Do participants find it valuable to share content and information (e.g. location) with people they are talking to on the phone? How does Newport compare with what they can do using existing technology?

R3: Does the phone call make individuals comfortable sharing with unknown people and more inclined to share additional information?

R4: How valuable do participants find the ability to make use of additional trusted displays in the environment when sharing?

To enable comparison between different participants' use and reaction to Newport, we recruited individuals, rather than pairs of participants. During sharing tasks in our study, the study facilitator went to another room and interacted with participants over the phone. The study facilitator followed a script to ensure consistency across participants.

We recruited participants with smart phones (one Android user, three Blackberry users, four iPhone users and four Windows Mobile users) because we wanted participants who were already aware of the capabilities of smart phones so that their feedback would be based on their experience using Newport, and not the reaction of someone using a smart phone for first the time. Our participants ranged in age from 20 to 53 years old, with a median of 34. We compensated participants with software.

Procedure

The study consisted of four phases preceded by gathering background data from participants about their phone usage and whether they shared content from their phone (e.g. by email or uploading to an online service):

Installation: Easily installable software is more likely to be adopted. Therefore, to test Newport's ease of installation each participant's introduction to the prototype started with a phone call from the non-collocated study facilitator to send installation instructions to the participants who then installed Newport on an HTC Touch Diamond phone and a laptop computer we provided.

Users opened an email with a link to a downloadable installation executable. The installation process on the mobile phone required users to plug in their phone to the computer's USB port before running the installation executable. For user testing purposes and to maintain user test logging data on the mobile phone, the desktop software installer only installed software on the computer.

Once the participant completed the installation process he or she called the study facilitator. The study facilitator asked the participant to pair the phone to the computer and then sent the participant a note using the software so the participant could experience using the system.

Sharing Location Data: Next, participants completed a set of tasks related to sharing when they only have a mobile device. First, to address R1, we asked participants how often they call people while mobile to ask them to look up information and how often they receive similar calls from others, what Wiltse and Nichols termed *calling a proxy* and *being the proxy* in their "Awareness from Mobile" scenario.

To simulate the experience possible with current mobile phones, we then had participants call the study facilitator to request directions to a park based on a fictitious current

location we provided. The participant had to describe the location to the facilitator who did not know it beforehand. Participants then completed a similar task using Newport, calling the study facilitator, sharing a map with their location and receiving an annotated map from the facilitator with directions to a building (R2). To share location, the maps application in Newport displays a user's current location by showing a circle on a map. For greater realism, we randomized this location in user testing so the study facilitator did not know the location of the participant. Whether participants received directions to the park or meeting using Newport or verbally over the phone was counter-balanced across participants. Research shows users care deeply about controlling the granularity of shared location information [2, 9], and this is often tied with intricate issues surrounding social relations and privacy. However, this study concentrated on understanding the utility and social protocols used when tying location sharing to an active phone call. While privacy concerns are important, they are not central to understanding the fundamental utility of Newport.

Our study emphasized understanding Newport's utility over understanding how it affects perceptions of privacy, but we did have interest in participants' reactions to sharing with an unknown person (R3). The final location-sharing task had participants make a restaurant order by talking to a researcher they had never met and then sharing location data to receive a personalized map to the restaurant. We finished off this phase of the study with a short semi-structured interview with participants to gauge difference in their comfort level sharing location data in the two Newport tasks and compare their experience completing the tasks with and without Newport. Participants also answered survey questions about their experience.

Sharing Using Multiple Devices: The next set of tasks compared a participant's experience using only the phone to share content with using the phone and computer together (R4). We first asked participants qualitative questions about how often they share content from their mobile phone and whether they are often near computers while they are using their phone. Next, we asked them to send a photo to the study facilitator from their own mobile phone. Last, they performed two sharing tasks using Newport, sharing two photos using only the mobile phone and then sharing two photos using the mobile phone and computer in conjunction. This phase ended with a short semi-structured interview about their experience and short questionnaire.

Synchronous Collaboration: The final set of tasks explored the use of Newport to facilitate synchronous collaboration to allow shared web browsing when planning a trip together, a scenario also described by Wiltse and Nicols. Again, we first interviewed participants about how commonly they spoke with people by phone and simultaneously both used computers to explore the frequency and/or appeal of the scenario (R1), as well as understand if they used desktop VOIP solutions such as Skype for sharing. Next participants collaborated with the facilitator to find a flight from Seattle to Hong Kong without using Newport to experience planning a trip without screen sharing. Then participants used Newport's Remote Desktop Sharing feature to collaborate with the facilitator to book a flight from Seattle to Florence, Italy. The two destinations, Hong Kong and Florence were counter-balanced across completing the tasks with and without Newport across participants.

Lastly, participants called a "travel agent," again played by the unknown researcher, to review options for hotel locations in Florence and make a selection, so that we could explore again whether participants felt differently about collaborating with known or unknown people (R3). In the short semi-structured interview at the end of this phase, we asked questions about comfort and sharing. To complete the study participants filled out a final survey.

RESULTS

Generally speaking, participants indicated their experience with Newport to be positive and the software's collaborative sharing features helped enhance phone calls. All participants preferred using Newport over voice only phone calls and over voice phone calls in conjunction with currently available collaborative technologies such as email, IM, SMS, MMS and available remote desktop sharing software. In the survey participants indicated they agreed Newport's install procedure was easy to accomplish.

Current Phone Use and Sharing Behavior

Participants in the study used their phones frequently, making and receiving calls at least once or twice per day. Most participants also sent and received SMS at least daily (83%, 10 of 12 participants), while eight participants (67%) sent or received email daily. Beyond communication applications, participants used their phones for web browsing, taking photos and playing games. Listening to music was less common, but still done by six participants.

Our first research question asked if participants experience the types of sharing scenarios that Newport seeks to address. While a full ethnographic or longitudinal study could better confirm people's self-reported activities, our data are useful for understanding how and when people share. Our participants all reported having called someone on the phone to ask him or her to look up information. Eight participants did this on a weekly or monthly basis and the remaining four almost never made a phone call for this reason. Similarly, 11 participants received calls where someone asked them to find something on a computer. This happened less frequently with only five participants indicating this happened on a monthly basis.

The reasons described to us for calling a proxy or receiving calls were overwhelming what Wiltse and Nichols termed "high-urgency" requests, information that was needed at

that time [23]. As in Wiltse and Nichols' survey, the most common requests involved directions, with eleven participants describing instances of asking and/or receiving requests for directions. Participants used a variety of strategies for managing the directions they received, six described using technology, either having directions sent to them by text or email or entering addresses they received into programs running on their phone. Five participants memorized directions while four wrote down the directions. We also had seven participants describe calls involving other types of information including movie times, phone numbers, hours of operation and prices on eBay. Two other reasons for calling, each mentioned by three participants, were asking for files to be sent to a mobile device and checking email.

We were also interested in how often participants share photos from their phone. Eight participants send photos from their phone directly to other people using MMS (5) and/or email (8). One participant reported beaming photos to others using IR. Four participants reported frustration with MMS including inconsistent delivery and no support for it. For example, P4 reported, "my MMS is flaky, half the time it sends and they don't get it, I ask for a response when sending MMS and use text messaging in addition." Four participants described sending attachments including music files, PDFs and word documents.

Given we had recruited participants with sharing experience on smart phones we were somewhat surprised that only two participants uploaded photos directly from their phone to an online service on a weekly basis. Seven of the remaining 10 participants described moving photos from phone to computer. Syncing the phone typically does this, but two participants (P4, P10) described emailing the photos to themselves from their phone to get them to their computer. Participant responses and their actions suggest that our participants wanted to share photos from their phones and while some were successful, others experienced challenges or currently had phones that no longer supported features such as MMS that they had used in the past.

Lastly, we asked participants how often they communicated on the phone with someone while they both used a computer. All 12 participants had done so and again the median response was "Monthly" for how frequently this occurred. Making travel plans this way was common, with half our participants describing recent experiences. Nine participants reported some type of web related task including buying concert tickets, asking friends about changes to Facebook pages, and discussing stock information. Four participants described work related tasks including editing files and discussing code. During their collaborations, people primarily confirmed they were looking at the same content as the person they were talking to by describing what they were seeing (nine participants described such a case), however several participants also used other methods to share, with 10 participants describing instances where they used email or IM to send additional information back and forth during the call such as links.

While eight of the 12 participants used desktop sharing programs, the median response for how often was "Almost Never." Three participants (P2, P7, P9) were frequent users of desktop sharing, one for a previous job where he performed IT support over the phone using Windows Remote Desktop, another used GoToMeeting and the third did screen sharing to help students with programming in an animation class using Windows Remote Desktop and Skype. Participants did not use IM client screen sharing options with any great regularity.

Overall, the data our participants reported about their current experience show that they do share information with people during mobile phone calls, both making requests for information and handling them from other mobile callers. Participants also collaborate with others over the phone while using computers as resources and share photos and other files from their phones. We believe these behaviors highlight the potential value that Newport can offer by making it easier to share with someone during a call and also leverage nearby computers to enhance collaboration.

Share Location

Location privacy is a major topic in itself, our study emphasized one situation: sharing during a phone call. Our main focus for the first set of tasks was exploring participants' interest in sharing location and whether sharing only during a phone call would make them more willing to share compared to sharing continuously. Before the tasks we asked participants about their current location sharing usage. Only one participant, P1, shared his location and used Google Latitude to share with a "close circle of friends, not business colleagues." Seven participants said they would be interested in location sharing, two said "maybe" and three said they would not be. Two participants mentioned privacy concerns as a reason for not sharing.

Participants' responses after tasks suggest Newport's model of sharing location during the phone call was received positively. Eleven participants said they would be interested in sharing location during phone calls and this seemed more appealing than sharing their location continuously with individuals or groups. Participants' median response was "Agree[3]" that they would like to have the ability to share location data with people they were talking to on the phone. Eight participants were less interested in sharing location continuously compared to sharing with people they were talking to on the phone, while four were equally interested in sharing in both situations.

Six participants commented on having a feeling of "control" when sharing during the phone call. P1 said, "I

[3] All Likert data reported is on a 5-point scale from Strongly Agree to Strongly Disagree.

would use [Newport location sharing] more than how I use Latitude now." P2 said, "I did feel like I had control over who I sent [to]. I knew who it was going to, it was sending my location to that caller" and P8 reflected, "I wouldn't want to have anyone track me down, I had more control over the phone. I was sending it to them, they weren't taking it without my knowledge." This control, akin to the time constrained location sharing of Glympse, seemed to alleviate some privacy and security concerns that two participants raised about having access to their location continuously. For example, "I prefer giving my location over the phone to a specific person rather than sharing like Loopt" (P2) and "[I have] privacy worries of someone knowing my location 24/7, but I [would give] it up manually." (P5). Participants' sentiments regarding location and privacy echoed previous research [9]. Four participants explicitly mentioned privacy potentially being an issue when sharing location with unknown people. P3 asked to introduce some ambiguity about her current location. Another female participant (P5), had reservations about sharing her location with unknown individuals due to her gender saying, "Since I'm a woman I would feel uncomfortable sharing my location with people I don't know well, but I do feel a bit more comfortable sharing when I'm talking to someone on the phone."

Lastly, participants seemed to find using Newport to get directions an improvement over their current practice. After completing the first two tasks—getting directions from the researcher verbally and then using Newport to share their location and receive a map from the researcher—11 participants reported preferring using Newport while one had no preference. Survey data showed eight participants had more confidence in the directions they received using Newport, and nine participants indicated getting the directions verbally over the phone took more effort.

Multiple Devices

Newport allows people using mobile phones to take advantage of computers in their environment. To understand whether or not participants found this valuable, in our second set of tasks participants shared photos using a phone and then the phone and another computer.

To gauge the current state of photo sharing, our first photo task asked participants to email a photo to the researcher. This turned out to be more difficult than we anticipated. Only seven participants attempted to send photos from their smart phones as email attachments. Of those participants, four succeeded in sending a message with photo attachments to the researcher. Unsuccessful participants faced a range of obstacles from inadequate cellular network coverage to becoming confused when browsing their phone's file system while looking for photos.

Participants then used Newport on the mobile phone to browse photos and send photos to the study facilitator in another room. Given their problems sending from their own phones, not surprisingly, eleven participants preferred using Newport to send photos with one having no preference. Only one user who experienced significant delays in receiving SMS messages indicated in the survey that Newport took more effort to send photos than email.

For the last photo sharing task, after making a call on their mobile phone, participants could use a computer to browse the photos on the phone and send them to the study facilitator. Participants were generally positive about having the ability to use a computer (if available) when sharing photos from their phone (median = 4.5, between "Agree" and "Strongly Agree") and eleven preferred using the phone and computer to share photos. In terms of effort, eight participants indicated sharing on the mobile phone took as much effort as on the computer. Three participants preferred the computer to the mobile phone and one participant preferred the mobile phone to the computer.

To explore how often participants might be engaged in a call where they could take advantage of a computer, we asked participants how often they were less than a five-minute walk to a computer when they were on the phone. For three participants this was more than 50% of the time, for four participants it was between 25-50% and for five it was rare, less than 25% of the time. We also asked participants if they were not near a computer, but wanted to share photos using Newport if and how long they would walk to reach a computer. Six participants indicated that they would use the phone and did not need a computer. Three participants would use a computer if it were within a one-minute walk; another three stated a five-minute walk would be acceptable. No participants would walk more than 10 minutes to find a computer during a phone call.

Synchronous Collaboration

In the final set of tasks, participants first collaborated with study facilitator to book airplane tickets with and without Newport. Participants' survey responses strongly favored screen sharing enabled by Newport. This suggests that if complexity and reliability problems are resolved, people will use sharing software because there is a desire to see a collaborator's screen. Those who had done remote desktop sharing in the past on current software found it difficult to set up and in many cases had another person set up the system. Not surprisingly, these participants indicated in the survey that Newport's one-click desktop sharing is far easier than current software.

Nine participants preferred using Newport to share their screen while booking tickets, while the remaining three had no preference. Eight participants also felt it took more effort to book tickets while talking on the phone without using Newport. All users agreed having the ability to share their screen while on the phone is desirable—with nine strongly agreeing. P1 said, "That was actually easier for me and I've used quite a few [desktop sharing programs]." P11 said, "this was really seamless and really easy to use, you just

click share screen and it's done." Six participants explicitly mentioned the value of seeing the other person's screen. For example, P10 said "because they could see what you are seeing it just makes everything a lot easier, it takes less time and makes everybody's life easier."

In their final task of booking hotel accommodations with a travel agent, all participants agreed having the ability to see the travel agent's screen made them feel more confident in booking their accommodation with ten strongly agreeing it is desirable. Eleven of 12 participants felt equally comfortable collaborating with the study facilitator and the travel agent they had not met, while one, P5, preferred collaborating with the study facilitator. She told us, "I would trust you more than I would trust somebody I did not know." P6 felt more confident with the shared screen saying, "I could see what she was looking at and the prices, could tell I was getting the right price."

DISCUSSION

Returning to our first research question, all participants in our study had experience with the sharing scenarios that Newport seeks to address at least on a monthly basis. Our participants preferred using Newport to do collaborative tasks such receiving directions, sharing photos or planning trips to the methods they currently use.

Social Sense of Security

Participants' responses after sharing their location with known and unknown people provides some evidence that limiting sharing to a phone call might provide a social sense of security that makes people more comfortable sharing information while on the phone they might not otherwise publish. The model of sharing during a call is straightforward and easily understood giving our participants a sense of control over what they were sharing. This is particularly exciting because many scenarios involving phone calls to unknown people (e.g. booking reservations at a restaurant or ordering food to pick up) could benefit from easy mechanisms for sharing.

While our study suggests that call-based sharing might be valuable for sensitive information such as location, additional studies would be valuable to confirm this—particularly since our participants completed tasks with the study researcher who assumed the role of a known, trusted friend. This may have affected how participants expressed their comfort levels with known and unknown individuals. A study better mirroring real world circumstances would pair two people who knew each other together, have them use Newport for sharing tasks and then have them share with unknown individuals.

Bridging Multiple Devices

One of Newport's goals was to allow people to seamlessly take advantage of additional technology in their environment. Many disparate technologies are used to make Newport function, these are sewn together in a way that makes them transparent to the end-user. In follow-up interviews participants said they did not notice Newport's underlying technologies working in concert with each other.

Participants' experience during the tasks highlighted the appeal of using the computers' larger displays and input capabilities for sharing and collaboration when available. Although the mobile phone used in the study had a relatively high screen resolution of 480 by 640 pixels, for complex tasks such as viewing multiple photos or sharing web pages, participants overwhelming preferred using the large screen of the desktop computer to the smaller mobile phone display. P12 said, "being able to clearly see thumbnails of photos on my desktop helped me figure out more quickly what photos to open and send." Six participants said they would not actively seek out a computer if one were not within a five-minute walk, but eleven participants preferred using a computer when it was available, meaning Newport's use depends on having a conveniently accessible computer.

We also observed participants effortlessly transition from mobile phone to computer during the photo sharing and travel booking tasks. For example, participants started a task talking on the phone on one side of the room and then moved to the computer without hesitation to share while talking on the phone. In interviews following the study, all users indicated they did not notice when they switched between the computer and mobile phone and the experience of using Newport across multiple devices felt natural.

While most participants' found Newport's ability to allow them to interact with the mobile phone via the computer valuable, P3, a younger, highly technical participant had a very strong preference for using her mobile phone saying, "I'm able to take my mobile phone anywhere, which makes it easier to access than a computer, but it has limited storage. I'd like to access my computer's files and music from my phone." Although she was in the minority for our study, her comments are a good reminder that applications that bridge multiple devices should likely provide similar capabilities on both devices when appropriate.

CONCLUDING REMARKS

Newport attempts to address user concerns about sharing task complexity and information privacy by introducing a social sense of security that ties sharing to a phone call and a user interface that automates the complex technical process of initiating secure screen sharing. Our study suggests tying sharing to a phone call may make people more comfortable sharing both with known and unknown people. While Newport currently only supports sharing maps, photos and notes, it could easily be extended to any application running on Windows Mobile.

Newport also bridges the capabilities of a mobile phone and desktop computer by leveraging their strengths—enabling a user to effortlessly switch between a mobile phone and a desktop computer based on where they are and the task at

hand. Our study shows people feel there are benefits for using a mobile phone coupled with a conveniently located computer for sharing tasks. However, it is unlikely people will actively seek computers outside of their vicinity to pair with their mobile phones.

Participants in our user study indicated they would be more likely to share information if a system as simple as Newport were available. Corroborating past research demonstrating the benefits of being able to visually share information with another person, all users in our study agreed that the tasks they completed with the assistance of Newport's visual sharing capabilities greatly enhanced the quality of the phone conversation.

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