

Enabling Meetings for “Anywhere and Anytime”

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Abstract. Mobile technologies and services are playing critical roles in mobile work. One area is mobile collaboration where mobile telephony and data sharing are in high demand. This paper explores and demonstrates that enabling meetings for the mobile context to support “anywhere and anytime” collaboration poses new opportunities, challenges, and tools. EasyMeet incorporates four novel additions, compared to traditional, electronic, meeting tools that support these scenarios and opportunities. They include s60 widget, synchronous voice and data sharing, remote content access, and access to mobile phone platform capabilities through web services. Initial feedback from a pilot has provided insights and improvements about usability and system performance.

Keywords: AJAX, mobile meeting, phone platform capabilities, remote file access, S60 Web Runtime widget, simultaneous voice and data sharing, user feedback, Web 2.0.

Introduction

As Web 2.0 took shape in enterprises, organizations increasingly pushed for services to be hosted on the Web. With widespread use of and improvements in mobile devices and connectivity, there is an increasing demand to access these services with mobile devices. This demand is particularly strong for services in communication and collaboration. An informal poll of mobile workers reveal the need to participate in meetings using mobile phones; the simplest being to see shared slides. This request is not surprising given that meetings are commonplace within organizations.

The interest in mobile collaboration can also be attributed to the prevalence of mobile work and large numbers of mobile workers. For many, the need to carry a mobile phone for communication and a laptop for computing is burdensome but necessary. Mobile phones are unlikely to supplant laptops in the immediate future. Collaboration, however, is a natural extension of using mobile phones; when they are used to conference into meetings.

In response to the numerous requests for a mobile meeting service within our company, we created EasyMeet. Its initial functionality was modeled around simplified, traditional PC-based meeting tools like slide sharing, chat, people awareness, highlighter, and meeting minutes recording. People using and seeing this first prototype were excited; particularly as it enables them to conduct meetings

“anywhere and anytime.” Through a small, limited deployment, we gained many insights and feedback about use scenarios, usability and system performance. In addressing them, we have identified some key differences with a mobile meeting tool compared to traditional electronic meetings.

In this paper, we describe four new additions to traditional meeting tools for meetings using mobile phones. They facilitate several “anywhere and anytime” use cases that are not adequately supported with PC-based meeting tools. The next section uses several scenarios to illustrate the new use cases and functionalities. We then present the initial version of EasyMeet, a mobile meeting service for mobile phones. We introduce and describe the four new add-ons in version 2: S60 widget, synchronous voice and data sharing, remote content access, and access to mobile phone platform capabilities. We share experiences, challenges, and informal feedback with this service.

Meeting Opportunities Enabled by Mobility

Mobility adds a new dimension to electronic meetings. The most salient aspect is that individuals are not restricted in where they can conduct or participate in meetings. This was first evident for telephony when people were able to make phone calls “anywhere and anytime.” The same potential exists for mobile meetings. First, mobile phones are the primary entry to the Internet in emerging markets [17]. Second, fieldwork is underserved by synchronous collaboration technologies where “points of inspiration” or “no opportunity better than the present” are at play [1, 11, 22]. Third, traditional electronic meeting tools are typically used to enable meetings for virtually co-located people. While mobile collaboration is useful in those situations, it also enriches face-to-face interactions. O’Hara et al. (2001) found extensive talk around document use and vice versa; be it on a mobile phone or in person.

We give several use scenarios of mobile collaboration for meetings, collected in talks with business groups and users.

Scenario 1

Sue is a real-estate agent. Occasionally, her clients are from out-of-town and cannot review properties in-person. In such cases, Sue visits the properties alone. When she sees one of interest to her client, she starts a mobile conference. Her client receives the EasyMeet URL through an SMS. Both of them meet on EasyMeet and communicate using voice and sharing of slides and photos; the latter compiled on-site by Sue. Sue creates a permanent EasyMeet conference for each client she works with. Over the course of a client engagement, a number of EasyMeet sessions typically occur. Both or either one of them can return to this permanent conference to have further discussions or to review the uploaded content from the various sessions.

Scenario 2

Robert is a healthcare technician who travels to different villages in Kenya as part of a mobile health clinic. Occasionally, Robert encounters medical cases that require

remote consultation with doctors and specialists. Using the capture capabilities of his mobile phone's camera, Robert is able to provide pictures, notes, etc. to a doctor in Nairobi. As a doctor's on-site examiner, he can provide his assessment and measurements that help to diagnose the problem. Doctors can review and update the case file.

Scenario 3

Miika is traveling by train from Helsinki to Tampere. He joins a scheduled meeting by clicking a EasyMeet conference URL that he received via email. Using his mobile phone's voice and data connections, he can converse and view the meeting slides. He participates in the ongoing text chat and contributes minutes for the meeting. He observes, from the location and participant list, that several other participants are remote; including one person located near him. He sets out and finds his co-located colleague and sits through the rest of the meeting together.

Scenario 4

Janet is visiting a colleague in an adjoining office building. En-route, she bumps into Henry, a co-worker on a joint project. As part of a status update, Henry mentions new results that he obtained. Janet, eager to see them, pulls out her mobile phone and invites Henry to a permanent conference created for such ad-hoc interactions. Henry remotely uploads the PowerPoint file from his office PC to the conference using EasyMeet's file upload feature. Once uploaded and shared, they review the results.

Related Work

CSCW researchers noted that people are often mobile to meet others and to solve problems. Bergqvist et al. (1999) examined meetings occurring outside of meeting rooms. They found how such meetings took place (i.e., multi-threaded, work-related, situated and opportunistic) and how they are initiated and re-established. They recommended two tools to support such meetings: a dynamic ToDo list to support the establishment of mobile meetings and a portable project database to provide users with easy access to potentially relevant information in a mobile situation. Our scenarios reflect the structured as well as ad-hoc, serendipitous, and opportunistic nature of meetings and highlight EasyMeet capabilities to support them. We have also found the need for remote access to documents to be important and integrated EasyMeet with a service to access a user's various remote computers for files. In addition, the availability of a persistent meeting space and a Web-based handle to it supports not only ToDo lists as well as other resources related to a project (e.g., participants, document artifacts, chat logs).

Tamaru et al. (2005) examined the influence of cell phones in the way work is unconstrained by time and space in three mobile-work domains. They found that workers creatively and constructively restructured their work and communication to leverage social and human resources using mobile telephony and mobile email-for-chat. They argue that mobile phones are a fundamental element of CSCW technology

for mobile workers. Additionally, O'Hara et al. (2001) studied mobile workers and found a relationship between talk and text. These studies point to the importance of mobile phones for both its voice and data sharing capabilities and the ability of mobile workers to leverage them to enhance mobile meetings. Smart phones are central and primary device targeted in the development of EasyMeet.

There is a long line of research dating back to Doug Englebart's famous 1968 demo and plurality of research and commercial (Microsoft NetMeeting, IBM Sametime, Webex) systems developed to support desktop-based electronic meetings and meeting capture [5,14, 15]. Building off this long history, EasyMeet's initial version was seeded with a number of basic functionality common to all these systems but optimized for the mobile phone form factor [12].

In the specific area of developing systems to support mobile meetings, Wiberg (2001) found that it was critical to seamlessly integrate interaction from mobile meetings. Mobile meetings were defined as informal face-to-face meetings, with those interactions that are in-between meetings [20]. This was based on his field study work that found that work occurred in all four squares of a 2x2 matrix with axes of "time" (i.e., any time and particular time) and "space" (i.e., any place and particular place) and that the vision of work occurring "anytime, anywhere" is not easy to realize for mobile workers. He argued that the integration should address situations for divided use rather than divided user attention, for invisible computer support, and for seamless ongoing interaction across physical and virtual meetings. Roamware leverages three technologies (PDA, proximity sensor, and PC application) to enable seamless integration and re-establishment of different threads of interaction by offering to convert personal and public interaction histories into project contexts. Our work primarily focuses on the four zones with less attention to the in-between aspects.

PDAs have been used in meetings for taking personal notes. Myers et al. (1998) used PalmPilot PDAs to control a meeting PC and to draw [13]. Kobayashi et al. (1998) described a service from IBM involving Web-based synchronous voice and data sharing service for collaborative customer service. It is most similar in spirit to EasyMeet because of its integration of voice and data sharing and its notion of bringing virtually co-located people into a meeting. Most meeting support tools do not support voice directly, opting to use audio conference system or VOIP to do that. However, there have been efforts to bring data sharing to audio conferences (e.g., [21] provides out-of-band communication features such as text chat).

There have been several research projects to develop meeting tools for mobile devices [1, 10, 14, 19, 20] but none that are deployable for diverse set of mobile devices. EasyMeet aims to be both a practical tool as well as research testbed to study mobile meeting usage. Furthermore, while there have been studies on mobile work, mobile meetings, and mobile phone use, none have examined mobile phones for simultaneous voice and data sharing.

EasyMeet V1.0: Design and Implementation

EasyMeet is a Web-based, meeting service for mobile phones. It was seeded with basic capabilities found in other electronic meeting tools such as NetMeeting,

Sametime, and Webex. Feedback and requests in pilot of this service have led to several additions and refinements that differentiate EasyMeet from traditional electronic meeting tools. In this section, we present the initial version of the service. The next section introduces the extensions and refinements.

Features and Capabilities

Leveraging on prior experiences with electronic meeting tools, EasyMeet V1.0 supports the following capabilities and illustrated in **Figure 1**.

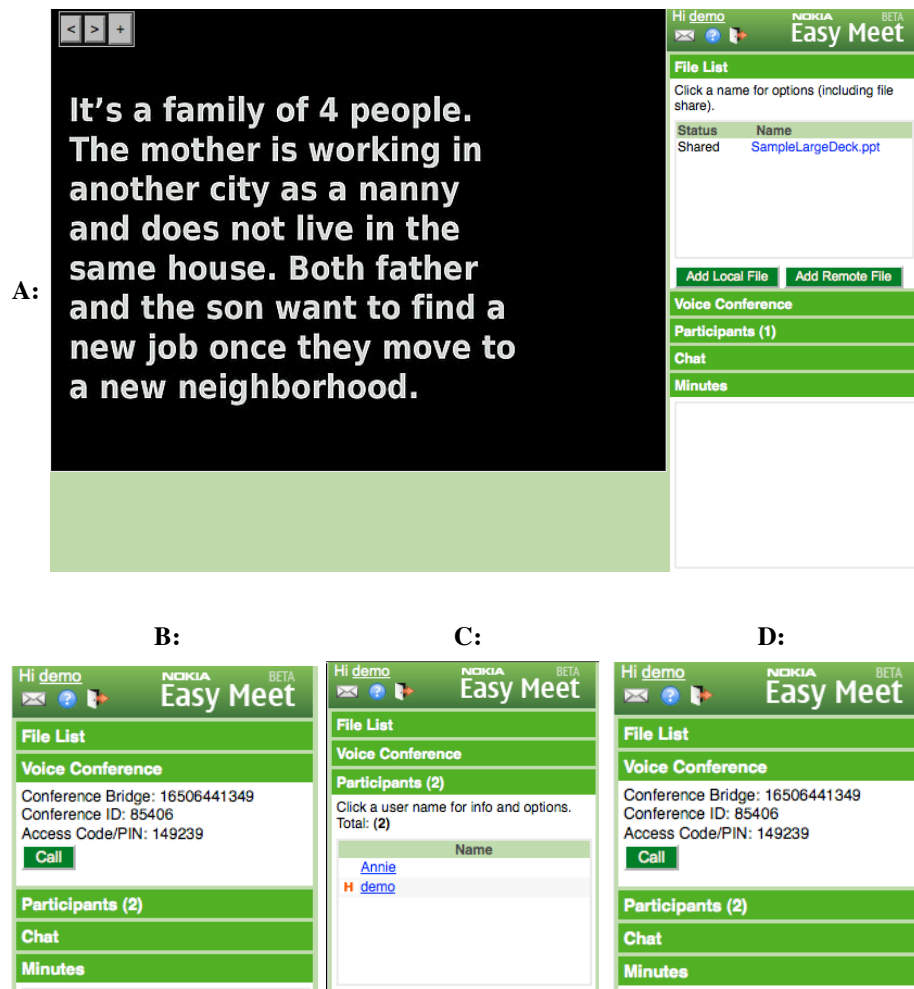


Figure 1: Large screen layout using accordion on right of A: slide-sharing with file list, B: voice conference, C: participant awareness, and D: chat.

- Meetings may be *scheduled* events or *permanent* events. Scheduled events have designated date, time, and length while permanent events are available at all times.
- Meetings may include a number of files that are uploaded before or during a meeting (see *files list* in **Figure 1A**).
- Image and powerpoint files may be shared simultaneously to all participants by the meeting host using *slide-sharing*, **Figure 1A**. For files with a content format that is not supported by EasyMeet's slide-sharing capability, participants can download the files to their device for individual viewing or safekeeping.
- A highlighter tool allows the meeting host to highlight contents of the slide being shared. These highlights are updated on all participants' view of the slide.
- A *participant list*, see **Figure 1C**, provides an awareness mechanism for all meeting participants of who is present and contact information.
- A *chat tool*, see **Figure 1D**, permits all participants to chat. While not all mobile phones make text chat easy, we opted for it over voice chat for many of the reasons identified by [14].
- A *meeting minutes tool* permits a designated meeting scribe to record textual notes about the meeting.
- Registered users can access their meetings through their *meeting list*. Invited participants, who are not registered users of EasyMeet, may also join the meeting. The latter lowers the barrier to meeting participation by not requiring registration to use the service.

Implementation of EasyMeet

EasyMeet is accessible from any mobile device with a standards-compliant Web browser; Nokia devices, Apple iPhone, Samsung Blackjack, Blackberry Bold and Storm, and GooglePhone. AJAX 2.0 technologies (CSS, HTML, Javascript, XMLHttpRequest) are used to develop client-side functionality. Apache and Django (high-level python Web framework) are used to develop the server-side functionality. A wide variety of mobile devices and laptops can access EasyMeet using these technologies.

A key challenge with developing applications for mobile phones is the lack of large displays, full QWERTY keyboard, or two-dimensional pointing device like a mouse [11]. EasyMeet supports two different screen layouts to accommodate different mobile phone screen resolutions (see **Figure 1** and **Figure 2**). The screen layout used is determined by a simple heuristic – mobile browser display width. Widths that are QVGA (320x240 or 240x320) or smaller use the small, tab layout and larger mobile displays use the large, accordion layout.

Display real estate and device interactions on mobile phones are constrained and can access-challenge able-bodied people. These issues surfaced in the case of small displays when displaying UI controls for slide sharing (see **Figure 3**). We addressed it by overlaying the slide controls on the upper left-hand corner of the slide where its effect of obscuring the underlying content is reduced. We anticipate some behavioral adaptations by slide authors when creating slide content for presentation on mobile devices. The slide control has a contracted form that allow common functions such as

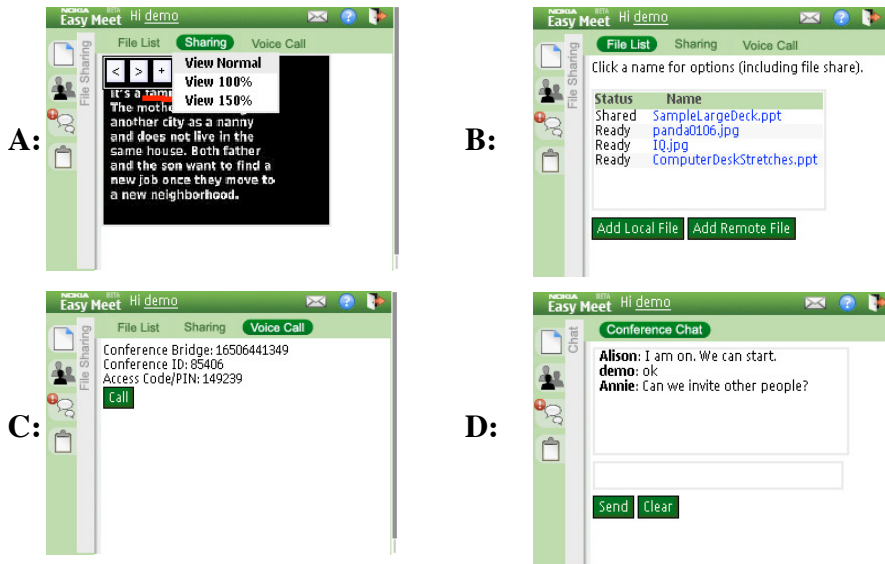


Figure 2: Small screen layout with tab widget to access functionality (A: slide sharing, B: file list, C: voice conference, D: chat).

next and previous slide to be accessed while less frequently used tools are accessed from the expanded form of the slide control (see **Figure 3**).

Each meeting is identified by a unique, randomly generated 8-byte alphanumeric id with 38^8 permutations that make it difficult for other people to guess and crash a



Figure 3: Slide sharing control.

meeting. The meeting can be accessed via a URL constructed from the unique id. This URL is sent to participants via email and SMS. In permanent meetings, the URL for a permanent meeting is a persistent workspace for the meeting participants in which all artifacts (chat, uploaded files) are available for access and review at all times and days. After the scheduled meeting, the minutes are sent to all participants and the meeting space remains accessible to the meeting creator.

PowerPoint files and images are uploaded to and shared in the meetings. During file upload, the slides are converted to JPEG using OpenOffice converters. Participants may download any uploaded content to their phone. The EasyMeet meeting serves as a repository for sharable and non-sharable documents. Using viewer applications available on the mobile phone, the non-sharable documents can be viewed.

EasyMeet V2.0: Design and Implementation

We obtained user feedback and feature requests from pilot of EasyMeet 1.0 that are incorporated in the current version. Several issues related to usability and system performance were highlighted.

S60 Web Runtime Widget

First, many early users had to key in the URL to the service on their mobile phone web browser. This was unwieldy for those without a QWERTY keyboard. While email and SMS were different ways to share the meeting URL with other participants and enable them to access the meeting with click on the URL, they were not sufficient. We redesigned and shortened the URL to reduce the amount of keying operations. The short URL consists of the domain name, a single command character and the unique meeting id.

However, the most effective solution was the S60 Web Runtime widget that we created for EasyMeet [1]. The S60 Web Runtime allows building mobile applications using Web technologies: HTML, CSS, JavaScript, and AJAX. S60 widgets are lightweight Web applications that are installed on the device (see **Figure 4A**). They use the same underlying technology that powers their Web browser counterparts. Mobile widgets give users a full Web experience with instant access to Web 2.0 services and content from their mobile devices.

Our EasyMeet widget uses the same AJAX code that powers EasyMeet's web application. Once launched, the widget connects to the EasyMeet service (see **Figure 4C,D**) and refreshes the user's meeting list (see **Figure 4B**). This list replicates the functionality available from the EasyMeet service but is always accessible. The widget can be left running on the mobile phone, in the background. The user can refresh the list by clicking the 'Refresh' button (see **Figure 4B**). From the meeting list, the user can join the desired meeting by clicking the respective meeting link. This launches the mobile phone browser and navigates the user to the EasyMeet service for

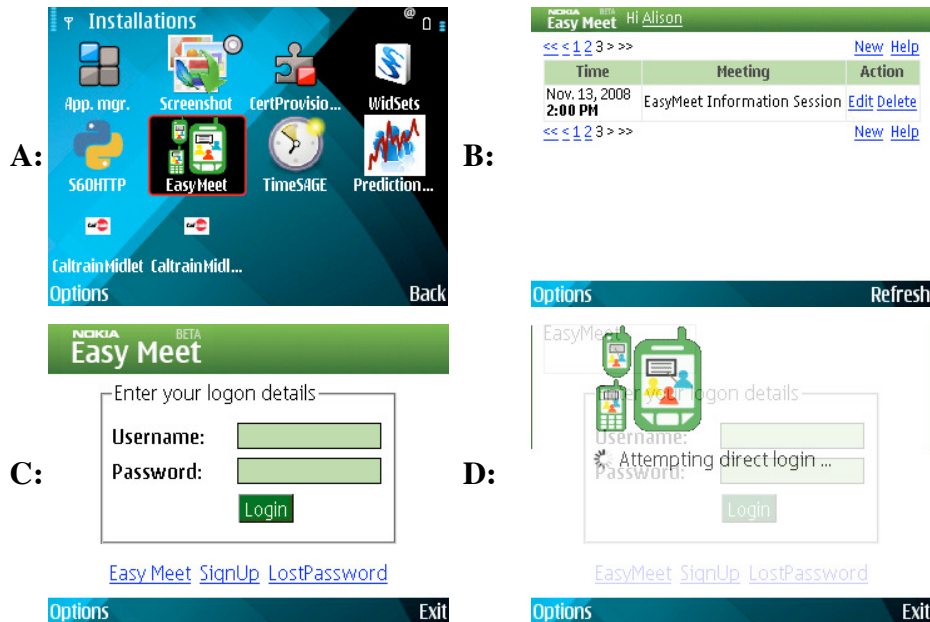


Figure 4: S60 Web Runtime widget for EasyMeet. A: Looks like any other native application on mobile phone. B: Meeting list for user. C: Widget configuration of user id and password. D: Subsequent auto-login to service.

the selected meeting. Thus, the user never needs to key in the URL for EasyMeet or the meeting.

Widgets also enable users to personalize the content and experience through preferences. We use this personalization feature to enable users to configure their widget with their EasyMeet user id and password (see **Figure 4C**).

Thus, the widget provides a number of key user experience enhancements to EasyMeet. The enhancements provide users with a personal on-ramp to the EasyMeet service. With about two clicks, the user can join a meeting without having to key in URLs or remember meeting ids. Finally, the widget provides users with personalized access to EasyMeet and allows them to refresh their meeting list with a click.

Simultaneous Voice and Data Sharing

EasyMeet supports simultaneous voice and data sharing as alluded to in the scenarios. Data sharing (text chat, slide sharing, file list, minutes, and upload files) is enabled by a data connection such as WIFI or 3G. Voice was frequently requested as a must-have feature. Thus, meeting participants can now initiate audio teleconference once they join a meeting (see **Figure 1B**). 3G-enabled mobile phones support both voice and data connection simultaneously. For 2G/2.5G mobile phones, users need to use WIFI for data connection and the cellular connection for voice. The reason is that

simultaneous voice and data is not allowed in these networks and voice connection is given priority over the data connection that is put on hold.

By clicking the 'voice conference' option, participants are presented with a dialog to select the country that they are currently located in (see **Figure 1B** and **Figure 2C**). Once the 'Call' button is clicked, the browser initiates a voice call to an audio conference bridge using the local access number for the country. In addition, the browser supplies the 'audio conference' id and pin along with appropriate delimiter codes without any further key entries from the user.

The voice telephony capability is enabled by the 'tel' URI (RFC 3966); a globally unique identifier ("name") for telephone number resources on public network, private telephone network, or the Internet [7]. All Nokia S60 Web browsers support the 'tel' URI. Thus, participants with mobile phones can call into an audio conference bridge where both the number and the authentication information can be encoded in the URI.

Remote Content Access from Mobile Phone

Mobile phones neither have large storage capacities nor are they storage devices. Meeting participants who use mobile phones and want to share files typically need to upload these files from their remote PCs rather than their mobile phones [16]. To upload such content to a meeting, we integrated a remote content access service (OVI Files) into EasyMeet. Each PC or desktop that a user wishes to access remotely must be registered with this service and a connector application installed. Thereafter, users may access their content from a mobile phone.

Our integration of this service involved creating a file browser UI for the mobile phone and server enhancements (see **Figure 5**). The latter includes the development of a number of JSON-based Web services that the file browser calls via asynchronous requests to login, authenticate, and request remote directory and file information. In addition, the EasyMeet server serves as a proxy to the OVI File service, forwarding login, authentication, and remote directory and file information. Once the remote file is selected, the EasyMeet server uploads the remote file from OVI File and stores it on the server; it converts the file if it is a Powerpoint document.

Leveraging Mobile Phone Platform Capabilities as Web Services

Beyond just voice and SMS capabilities, EasyMeet can leverage content and functionality from the user's mobile device (e.g., contacts and calendar for data and GPS and camera functionality). In our scenarios, we allude to the use of camera and GPS for enriching the content that can be shared in a meeting and the meeting experience. These platform capabilities are becoming commonplace features of smart phones. Estimates are that by 2009, 90% of mobile phones worldwide will integrate a camera. Also, mobile phones are beginning to include global positioning sensors and many phone operators support location information through cell ids. With this capability, services that provide positioning, navigation, and tracking are available.

EasyMeet provides access to these capabilities through JSON-based Web services. It can invoke these services as asynchronous requests. We developed a simple PyS60

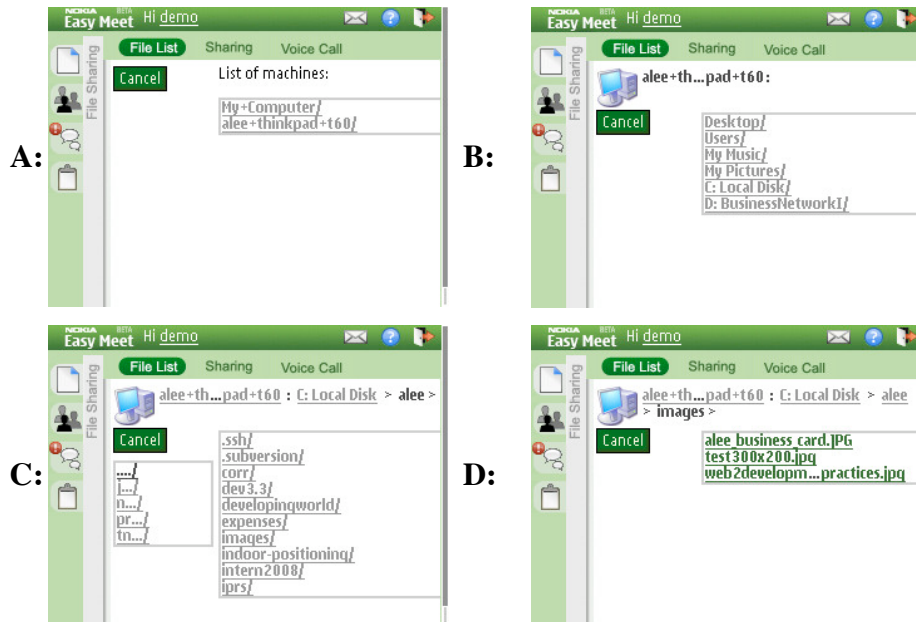


Figure 5: EasyMeet directory and file browser of remote content. It incorporates breadcrumb (see content to right of computer icon in C) that allow users to pop up during drill downs. Lists that are longer than those displayable are paged with the first sequence of characters for the first item of the page identified (see box under Cancel button in C). Directories are colored light gray (see A, B, C) and files are colored green (see D).

Web server (S60HTTP) for the S60 mobile phones that uses the HTTP1.1 protocol (see **Figure 4A**). The Web server cannot be accessed from the network but simply from the mobile phone. This keeps the server lightweight and reduces battery drain [11]. If care is not taken in managing computations and network operations, an application or a Web service can drain the battery and shutdown the mobile phone.

Initial Feedback

Our early user feedback came from a small pilot of EasyMeet V2.0 with 25 US-based users. Many of these users typically use their mobile phones for communication and reading email. Very few use their mobile phones for Web browsing. They rarely change the default settings of their mobile phones. Many issues that they encountered while using EasyMeet relate to issues with configuring and managing their mobile phones. Many of our users view their mobile phone as a communication device and not a computing device; smart phones are more complex than a telephony device. As mobile computing becomes commonplace and users become more sophisticated with using their mobile phones, we anticipate that these issues will arise less frequently.

While our two UI layout seemed to be a useful approach to addressing heterogeneous display sizes, early feedback suggests that the UI should be greatly simplified. Complex and highly interactive UIs like our tabbed and accordion interfaces are challenging because of the small screen real estate and reduced input capabilities. Most mobile phone users are casual, consumers of information and only a few are sophisticated mobile computing users. In general, it is important that application UIs are contained in one screen. Screens requiring scrolling increase search and panning. Mobile phones lack a full-fledge 2D pointing device for effective UI navigation; very few current mobile phones support touch or point interface. One way to improve accessibility of EasyMeet and other mobile applications is to develop keyboard navigation. The ideas underlying AxsJAX, a framework for making AJAX applications accessible, are useful for mobile Web applications [3].

We discovered that an hour-long meeting drains the battery due to network and processing of updates. We developed an Ajax broker to aggregate client-server messages and to adapt poll frequencies [9]. A resulting benefit was improved UI responsiveness and a reduction of flashing due to network activity.

Delays due to network bandwidth and load time impacted user experience. We improved load times for the meeting screen by compressing large JavaScript files; a 5-fold reduction in size. Our current download for the conference screen is approximately 225KB. Making greater use of XMLHttpRequest, popularized by Web 2.0, mitigate page reloads for any action requiring server capabilities and thus data transferred.

We have just completed an incremental rollout of EasyMeet2.0 in our company. Though it is too early to share behavioral usage data, users have requested integration of EasyMeet with other company productivity tools (i.e., IBM SameTime for collaboration needs, Microsoft Outlook for email and calendar, in-house built conference room and voice bridge booking system). Specifically, users feel it would be more productive if EasyMeet would allow them to do everything – create a meeting, book a voice bridge and conference room, add the meeting entry into the calendar and use SMS to send the meeting URL.

It is also worth noting that compared to rollouts of other internal, non-mobile phone-based, collaboration services where interest (i.e., registration) is less than 2%; our pilot has garnered 4% interest. Furthermore, while many users initially register and explore the system with desktop browsers, our more recent rollouts have seen increased numbers of registrants and returning users using their mobile phones.

Conclusion

We presented four new additions to traditional meeting tools that facilitate “anywhere and anytime.” They include S60 widget, synchronous voice and data sharing, remote content access, and access to mobile phone platform capabilities. These arose from insights and feedback with using EasyMeet Version 1.0. We are presently engaged in company-wide pilot of EasyMeet 2.0. We anticipate that usability and system performance remain primary and ongoing challenges. Findings from this pilot will

offer valuable insights about issues and challenges with designing and developing collaborative mobile phone applications.

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