Ad Hoc Networking Support For Pervasive Collaboration

Michael S. Thompson, William O. Plymale, Creighton T. Hager, Kevin Henderson, Scott F. Midkiff, Luiz A. DaSilva, Nathaniel J. Davis, Jahng S. Park
Bradley Department of Electrical and Computer Engineering
Virginia Tech
Blacksburg, VA, USA
stuboy, plymale, chager, kevhender, midkiff, ldasilva, ndavis, jahng@vt.edu

ABSTRACT

A key goal of computing is to enhance communication. Pervasive computing takes this a step further and strives to make communication less intrusive and more useful. This project investigates the network components required for a pervasive collaborative environment. We include user-to-user communication and an interface to interact with the surrounding (pervasive) environment. Instead of building pervasive devices from the ground up, we are leveraging legacy devices by pairing each device with a proxy device. These proxy devices act as mediators between the pervasive environment and the services of the legacy devices. Our implementation environment is composed of Microsoft Windows CE and Pocket PC devices connected in a wireless, ad hoc manner.

Keywords

Pervasive collaboration, ad hoc networking, ubiquitous collaboration

1. INTRODUCTION

The goal of pervasive computing is to enable computing anywhere at anytime. Person to person communication can be enhanced within the pervasive paradigm by providing additional collaborative dimensions such as shared objects and environmental interaction. The goal of this project is to investigate the components and design principles needed to facilitate user-to-user and user-to-device collaboration in a pervasive environment. Working towards this goal, we are developing a system that facilitates communication in a collaborative setting such as a business meeting or classroom session.

2. ARCHITECTURE

The system architecture consists of sessions, spaces, users, devices and objects. An object is the smallest element of the architecture and is anything that can be shared between participants. Thus far, objects may be files, uniform resource locators (URLs), or services. Objects are defined using a generic model, making it easy to add more object types in the future.

Traversing from smallest to largest, devices and users are the next step. A device is any computing node that can participate in the collaborative environment. Currently planned devices are projectors, printers and storage nodes. Users are specific devices that interface directly with a person, such as a personal digital assistant (PDA). Devices and users may share objects with the group.

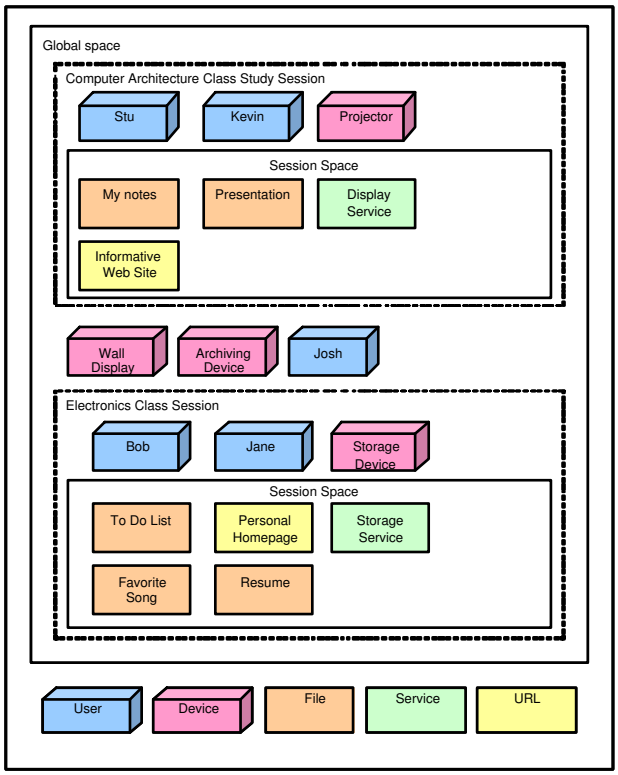

Figure 1: Example Collaboration Environment.

Continuing, session spaces are the common space, such as a tabletop at a meeting. Sessions spaces, users, devices, and objects are all contained within a session. Sessions are equivalent to a meeting. Users and devices participating in a session are associated with that session. Users and devices may only be associated with a single session at a time. Finally, the collection of all sessions and all unassociated entities (devices or users) is contained in a single global space. Figure 1 depicts the global space with two sessions, multiple users and multiple devices.

3. APPLICATION COMPONENTS

The components of our collaborative environment are a user interface (UI), session management, content management, adaptive security, and the pervasive environment.

Figure 2: GUI Screenshot.

3.1 User Interface

The UI provides the mechanism for the user to view and interact with the session. The UI is not the center of our study, so we have chosen to implement a simple UI that allows users to create a session, join a session, publish objects, view all of the published objects in the session, view the associated devices and users and interact with published objects. Figure 2 is a screenshot of the GUI.

3.2 Session Management

In any meeting, there is a need for moderation and control. Since connectivity for our collaboration sessions is wireless, a mechanism for limiting participation is needed. We need a virtual conference room where we can close the door.TThe session management acts as our door by controlling what users and devices may participate in a session.

Each session has an attribute specifying whether the session is closed or open. Users can join closed session by invitation only. Anyone may join an open session and participate. Each type has a group-wide access control list. In a closed session, the list includes only those that may join the session. The list, in an open session, contains users who may not join the session.

In addition to the group access list, each user may maintain a personal access list applying to that device only. This list affects any objects that the user device publishes.

3.3 Content Management

In an ad hoc environment, devices, users, and corresponding objects, may enter, exit, and move at any time. Movement makes it difficult to track what is available at any point in time. The content management component solves this problem through description, location, selection and interaction between entities in the system.

Elements of the system are described using a hierarchical template/subtemplate scheme that is extensible beyond defined descriptions. This allows descriptions to be standardized, but more information can be added when it is desired. The description scheme, combined with a flexible query engine, ensures accurate queries and fewer irrelevant responses.

The location of elements is done in a distributed fashion. Requesting parties pose queries to the network and entities are responsible for answering relevant queries with the requested information. Queries may target session, entity or object information.

The interaction between entities in the system is accomplished using standardized mechanisms. The Web Services Description Language (WSDL) [2] is used to describe interface methods and the Simple Object Action Protocol (SOAP) [2], to transport operation requests and responses.

3.4 Adaptive Security

The adaptive security manager provides devices in an embedded systems environment with improved performance and energy efficiency while maintaining desired levels of security. The security manager adapts an entity's security parameters and algorithms based on context. Context includes energy, network characteristics, location, and user desires. A change in context could cause the decision component of the manager to switch to a different security scheme.

3.5 Pervasive Environment

Pervasive environments offer many tools that are useful for collaboration. Projectors, printers and storage devices are examples of these tools. By pairing legacy devices with computation and communication elements called proxy devices, legacy devices can participate in the pervasive environment, increasing the breadth of available services. Since each device has its own proxy device, device mobility is also feasible. This is in contrast to environments where legacy devices are controlled by a single, central entity [1].

4. FUTURE WORK

Future work falls into three areas. The first area is exploring other possibilities for monitoring and controlling the session. Extending content management to enable interaction with unknown services is also of interest. Finally, bringing more devices into the pervasive environment using proxy devices is an area for additional research.

5. ACKNOWLEDGEMENTS

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[2] World Wide Web Consortium (W3C) http://www.w3c.org