A Location Aware Virtual Communication System

Members:

James Bresler jbresler@uiuc.edu *
Zahid Anwar anwar@uiuc.edu
Ellick Chan emchan@uiuc.edu
Ian Yap ianyap@uiuc.edu
Roy Campbell campbell@cs.uiuc.edu

* Lead development role

Project Description

We have designed and implemented a framework for developing location-aware telephony applications using Voice over IP (VoIP). Our system combines the voice functionality from VoIP-enabled devices such as laptops, PDAs, and touch panels with intelligence, context and location information, derived from the Gaia system. The primary achievement is that we are able to use sensory information from environmental smart sensors such as cameras, microphones, and GPS-like Ubisense location tags. Using these measurements, Gaia composes the information together into a coherent context. Our smart telephony application then uses this information to enable privacy controls for phone calls and ‘follow-me’ applications, where a user can walk around the building, and have the call follow her by using the speakerphones in proximity.

Our current implementation is able to respect user privacy through priority based privacy policies. Every pair of users is assigned a priority level that represents a set of capabilities. In addition, each user has an activity level that can be manipulated by external programs. A call is completed only if the priority level corresponding to the incoming and outgoing callers is greater than the recipient’s activity level.

The bulk of the work in our system is done through a Private Branch Exchange (PBX). The PBX is not intelligent enough to dynamically route calls to different devices as a user roams. Our system extends the PBX to support dynamic call routing and follow me application. It utilizes the Gaia location service to determine user locations.

If this project is adopted for use in the Siebel Center, we envision that it might be useful for both academic and recreational purposes. We believe that the best applications of this location-aware communication technology are yet to come. Exciting new applications might involve tighter integration with building services such as touch panels and information displays.

Software and Hardware Prerequisites

Our system is designed with the assumption that ubiquitous computing frameworks such as Gaia will run the next generation of buildings. These systems offer new levels of privacy, security and capability to buildings that are designed with digital organs. Below, we list the various components the system comprises of:
Gaia System

Figure 1: System Diagram

Figure 1 shows the high-level system architecture for our Siebel Center VoIP service. The server consists of a VoIP PBX, an application server, a database, and several programs to extend the PBX. The PBX is a standard VoIP PBX capable of routing calls to locations reported by external programs and allowing external programs to place, disconnect, transfer and retrieve a list of active calls. It can use any VoIP protocol or codec. The PBX must proxy all VoIP control traffic so that the PBX may disconnect a call or initiate a call transfer. The SQL database maintains a database of devices, users, and devices where each user can be reached.

Gaia VoIP Service

The Gaia Ubiquitous computing system provides us with the necessary services to link our subsystems together. Within Gaia, we have the Ubisense adapter, which converts
multicast Ubisense location readings into a format that our application can use. Gaia provides a scripting language, Lua, to easily automate the instantiation of our application.

To provide the telephony services, we use Asterisk, an open-source PBX. Asterisk provides hooks that allow users to define control scripts. Our system modifies Asterisk through this interface, and adds a SOAP web service as well as Gaia bindings to the PBX. We support several extended options in our version of the software: privacy, call migration, and context awareness. The Gaia VoIP system works in tandem with the PBX via signalling to service clients intelligently.

Ubisense

Ubisense™ consists of tags and base stations that utilize Ultra Wideband technology. The base stations are able to pinpoint the location of a tag within 6 inches 95% of the time. Confidence values of Ubisense are obtained by the Gaia Location awareness. The Location Service is the source of location information for all location-sensitive applications. It reasons about location information from different sensors and provides a consolidated view to all location-sensitive applications. It performs the following tasks on the behalf of our VoIP application.

- Fuses data from Ubisense tags and resolves conflicts
- Answers object based and region based queries
- Accepts subscriptions for location-based conditions and notifies our VoIP service when the conditions become true.

Detailed set up instructions

PBX Server Installation
1. Install Mono 1.1.0 or later with XSP (http://www.go-mono.com).
2. Install and start MySql (http://www.mysql.com/). Create user account and a DB named gaiapbx. Import schema from distribution.
4. Install Asterisk 1.0.5 from (http://www.asterisk.org).
5. Create account from PSTN termination service such as VoicePulse Connect (http://www.voicepulse.com)
6. Copy files from config directory that do not end in .template to /etc/asterisk
7. Modify .template files in distribution directory
8. Modify genast.conf and Config.cs so all paths point to correct location
9. Run make in pbxdist directory
10. Run make install in root
11. Run genastconf
13. Start XSP web server in PBX distribution directory
15. Copy index.php to Apache htdocs directory.
Gaia VoIP Component Installation
1. Install Gaia (http://gaia.cs.uiuc.edu/internal)
2. Copy PhoneInputSensor.exe, PhoneModel.exe, PhonePresentation.exe, UbisenseAdapter.exe, and VoipLocationService.exe to $GAIA_ROOT/Repository/WinNT/Debug.
3. Modify $GAIA_ROOT/boot/idl/gaia.idl to include PhoneModel.idl
4. Copy lua script to $GAIA_ROOT/scripts and customize for local site
5. (OPTIONAL) Install .NET Framework 2.0 beta and copy PhonePrivacyManager.exe to $GAIA_ROOT/Repository/WinNT/Debug.

Gaia UbiSense Adapter
1. Unzip the included UbiSenseadaptor.zip

Usage Instructions
1. Start Apache, MySQL, XSP, and Asterisk on the PBX server
2. Boot up Gaia
3. Navigate to the installation folder of the UbiSense adaptor, and run ubi.bat under Debug.
4. Navigate to $GAIA_ROOT/scripts
5. Open up a shell (cmd.exe), type “luaorb phone.lua”
6. Start the VoIP location service, (voiplocationservice.exe)

Software building instructions

PBX Server Software
1. Run make in the pbx dist directory.
2. Run make install

Gaia Components

Each component may be compiled by using a Visual Studio build file. The components must be built in the following order: iaxclient, UbisenseAdapter, VoIPLocationService, PhoneModel, PhonePresentation, PhoneInputSensor.