Ambience Project
“Find a Meeting” Video

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ABSTRACT

This video demonstrates a highly integrated system for automatically registering, guiding and assisting delegates of a conference. The delegate uses an iPAQ to communicate with a conference server system that delivers a variety of services that use fixed infrastructure to provide an ambient environment. The work was conducted as demo M1 of the Ambience European Project 2003.

Keywords

Ambience, ZigBee positioning, ad-hoc networking, robot routing, XML messaging, network monitoring.

INTRODUCTION

A video is presented which illustrates the integration of a number of new technologies in an ambient environment. This will show for a conference delegate:

- Automatic biometric registration
- Route guidance to a place or person
- Text messaging & file transfer to other delegates
- Robot routing & ad-hoc networking to seamlessly extend network coverage
- Custom applications for meeting chairman

The video presents a scenario that is designed to demonstrate the features of this Ambient system.

Scenario

Peter walks into a busy conference venue. His PDA beeps and he is invited to register for the conference by speaking into the PDA’s microphone. His voice is recognized and a user interface (UI) relevant to the conference is the automatically displayed on the PDA. This provides a range of useful applications presented in a very user-friendly way. Peter checks his messages. He needs to find his first meeting room, so he requests his PDA to work out a route. A map is downloaded onto the display showing a graphical representation of the building, his current position and visual and textual directions. As he moves, his position is updated on the map and the text window updates with reassuring messages until he reaches his destination.

Peter continues to use his PDA during the meeting to exchange text messages with other participants, follow the agenda and make notes. At the end of the meeting, the participants move to a coffee area. Anticipating that the network capacity will be more useful in the coffee area than the meeting rooms, the mobile robot routers are automatically moved to ensure a seamless communication service.

Figure 1 Interactive route guidance

SYSTEM OVERVIEW

Figure 2 shows an overview of the system. At its heart is the server that manages the applications and routes information around the system. The biometric identification is performed by voice recognition that forms the link between the iPAQ client and the delegate.

The iPAQ has a jacket with integrated WLAN and ZigBee radios. A WLAN access point at the server provides the connection to the iPAQs as they roam within the conference centre.

The integrated ZigBee communicates with a fixed ZigBee infrastructure to provide a position estimate derived by integrating Received Signal Strength Information (RSSI) measurements.

Messages are delivered to the iPAQ over WLAN informing the delegate of meetings/schedules. The user may ask to be guided to a room or person within the conference facility. The user's position is continuously monitored causing the server to download an interactive map that updates as the person moves towards the desired location.

The messages are defined in XML format to enable efficient data manipulation. The client software drives the messaging through a series of pre-defined message requests to which the server responds. In practice this means that the client applications poll the server regularly for updates.

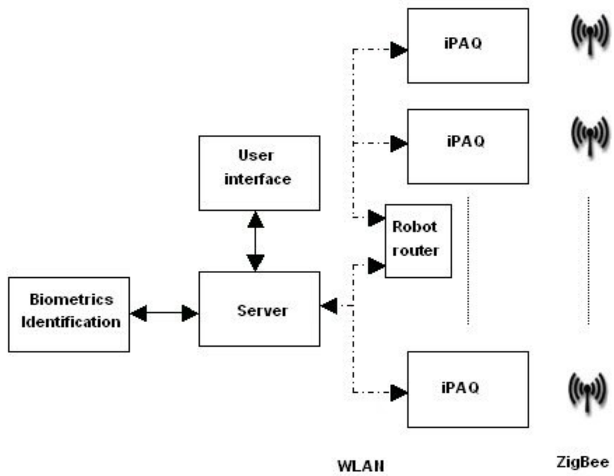

Figure 2 System Overview

Network coverage is extended beyond the fixed infrastructure by the use of ad-hoc networking, using other iPAQs or specially designed robot routers that anticipate network shortage and move to appropriately extend coverage.

Biometric Voice Recognition

The offline procedure

This phase is designed to generate an "Identity Card" for the delegate. This "Identity card" forms the link between the physical delegate and his digital profile. When entering the conference building, the delegate goes to the reception desk. The receptionist uses the "Welcome application" to launch the authentication procedure in which:

1. The delegate gives proof of identity.
2. The receptionist searches for the delegate in the shared database.
3. When found, the delegate speaks into a microphone to record a voice sample.
4. The "Welcome application" creates a biometric profile from the voice sample and stores it in the database.
5. The "Welcome application" extracts the delegate's data from the database and creates an X509 certificate with a biometric extension. This certificate is the "Identity card".
6. The delegate receives a MultiMedia Card (MMC) with the new "Identity Card".

This process is illustrated in Figure 3.

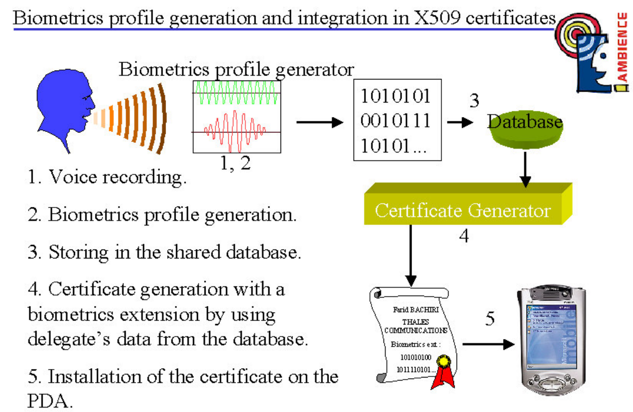

Figure 3 Biometic profile generation

Registration for Services

When the PDA carried by the delegate is first detected by the network, it will have no secure user identity. The delegate's identity card is used to establish an SSL connection. The user is prompted to authenticate for the conference services by speaking into the PDA's microphone. A few seconds of natural speech is recorded. The voice sample is sent to the server through the SSL connection. The server searches for the delegate's biometric profile in the shared database and the biometric features are compared to grant or deny access to the conference services.

ZigBee RSSI Positioning

The positioning technology used for the demonstrator is based on a prototype ZigBee radio system. A number of ZigBee beacons are installed at fixed known positions over the entire length of the demonstration site, so that at least two beacons can be detected at any one point. A ZigBee radio is also built into each iPAQ jacket providing a serial interface to the PDA.

The ZigBee radio in the iPAQ Jacket detects the beacons in range and measures their signal strength. This information is compiled into a beacon report that is received by the PDA and forwarded to the server. The server uses a table to convert signal strength into the range from each fixed beacon. This provides sufficient information to derive user position, using a triangulation algorithm. This process updates the position of each iPAQ every 2-3 seconds. The position is then filtered with previous position estimates to produce a more reliable smoothed position for the use in the demonstration.

iPAQ Client Device

Client devices are equipped with Familiar Linux operating system and Blackdown Java Runtime Environment. Actual client application software is Java 1.3.1 Standard Edition compatible. All messaging between clients and server is based on XML, which can be easily extended to future needs. Choosing open standards, such as Java and XML , gives the benefit of flexibility and the support for wide variety of different client devices and environments.

iPAQ Graphical User Interface (GUI)

The iPAQ runs a Java based application GUI to enable the user to select and control the available applications. It provides a simple user interface that allows the user to switch between a number of views that control each application for:

- Map – display map of local area
- Send – send messages to delegates present
- Find – locate places or people
- Msg – read received messages
- Doc – documents viewer
- Info – display status information of the system

Exmaples of two such GUI screens are shown in Figure 4 & Figure 5.

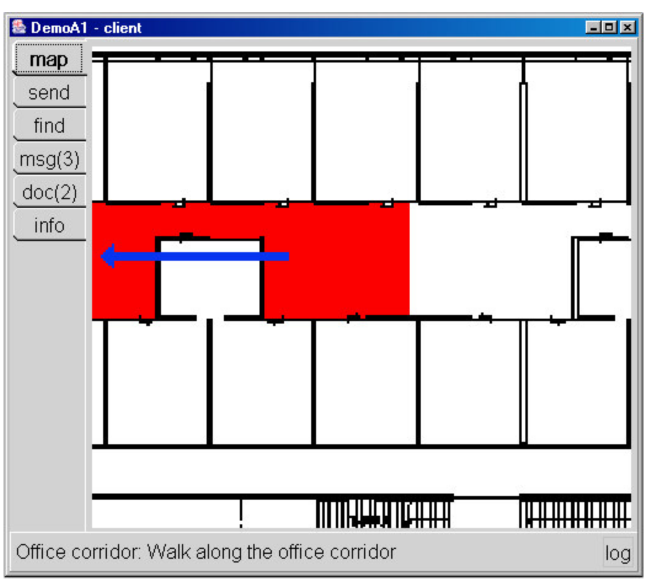

Figure 4 Map Application

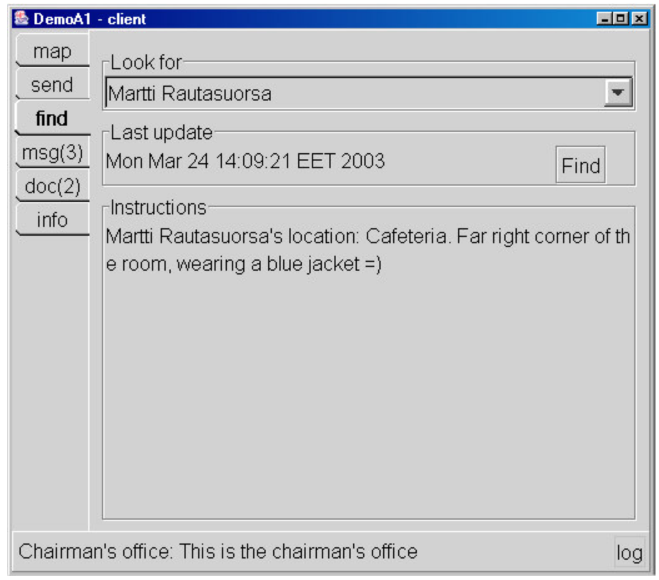

Figure 5 Find Applicaton

In general the interfaces provide:

- Graphical map of building and visual and textual instructions on how to proceed
- Ability to select recipients from the list of attendees
- Send messages with subject and message fields
- View received documents

Integrated Server System

The applications are made accessible to the users following a client-server architecture. The Tomcat servlet container from the Apache Software Foundation [Tom] is used, implementing the applications as servlets[1].

Following a scheme that resembles the popular web services scheme [ws], the communications between the GUI (client) and the server rely on the http protocol and the data exchanged between the clients and the server are encoded using XML.

The communications are secured using the SSL protocol. The use of X-509 certificates provide for mutual authentication of clients and server. These security mechanisms are supported by the Apache Tomcat server.

Finally, the data manipulated by the server and the applications are managed by an SQL relational database that supports concurrent accesses, synchronisation and permanent storage. “MySQL” , an

[1] A servlet is a small program that runs on a server.

open source database management system [MySQL], was chosen for this task.

The architecture of the server is depicted in Figure 5. It shows that TOMCAT contains two servlets: the chairman servlet that initialises the database, and the ambience server servlet that encapsulates the applications currently made accessible to the users. The messages received by this last servlet are parsed and dispatched to the appropriate service.

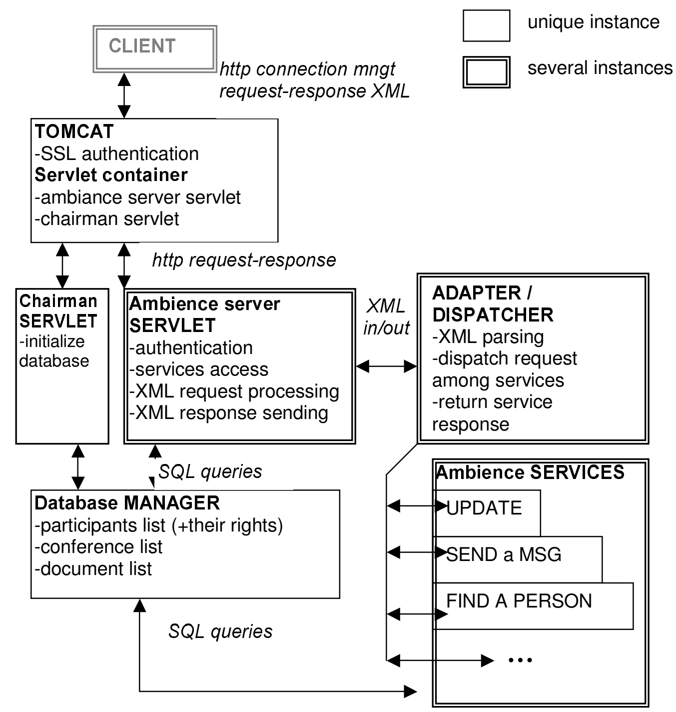

Figure 6 Server Architecture

Mobile Robots

The robots [SPIF] have been designed and built at ENST's Computer Science department with standard, low cost hardware components. Their architecture is open and modular to meet the needs of sensor and actuator customisation. The board offers standard communications: Ethernet, 802.11 and Bluetooth. It also provides a wide range of input output interfaces: USB, I2C, PCMCIA, 115 Kbits IRDA, ISO 7816-2 Smartcard, 8 bit audio CODEC, graphical LCD touchscreen.

The battery is controlled by a dedicated circuit that keeps the processor aware of its load level. When the battery's level reaches a low limit, the robot will complete its critical tasks, if any, and move towards a refuelling intelligent docking station. The station emits a laser beam to guide the robot back.

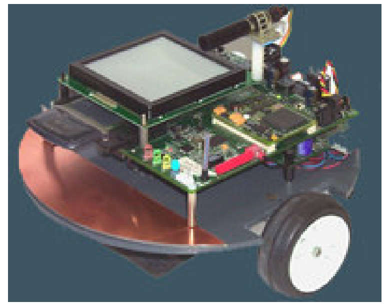

Figure 7 Mobile Robot

Ad-hoc Networking

In the scenario described when the participants move to coffee area for a coffee break, an ad hoc network is established to guarantee an ambient communication service between them. Ad-hoc networks are multi-hop wireless networks where all nodes cooperatively maintain network connectivity. Such networks provide mobile users with ubiquitous communication capability and information access regardless of location.

The main challenge in forming ad-hoc networks is the routing. Routing protocols in such networks must be adaptive to face frequent topology changes because of node mobility. Minimizing the number of hops is the most common criteria adopted by the routing protocols proposed within the IETF MANET working group. However, the number of hops criteria is not necessarily the most suitable metric to build routing decisions. Route selection must take into account the current link conditions, to offer a certain quality of service (QoS). The basic function of QoS routing is to find a network path that satisfies some given constraints.

For the purpose of this demo, we develop a Quality-of-Service (QoS) routing protocol for mobile ad-hoc Networks. This QoS routing protocol aims to enhance the perceived communication quality within the coffee area [MBA02]. We perform the proposed QoS-enhanced routing based on the Optimized Link State Routing (OLSR) protocol [OLSR], introducing a more appropriate metric than the number of hops. The proposed QoS routing protocol, called QOLSR, produces better performance comparing with the legacy OLSR protocol, as depicted in Figure 8.

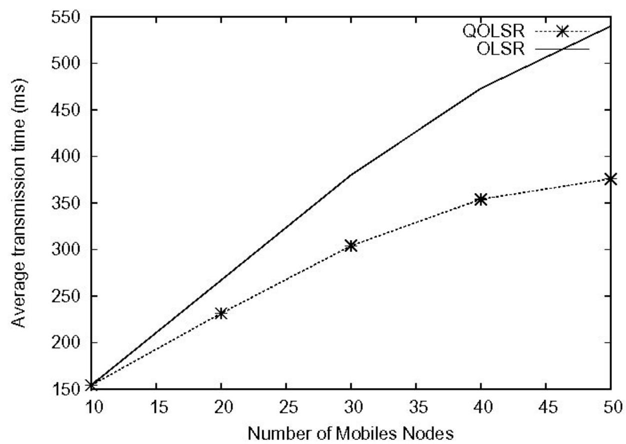

Figure 8: Performance evaluation of QOLSR

Robot Routing

The robot implements an ad hoc routing algorithm in order to support multi-hop routing (in an IPv6 environment). In other words, the robot can either be used to connect several wireless devices that are not within the range of one another or as an extension of an existing infrastructure – in which case a gateway between the fixed infrastructure and the ad hoc network is used, as depicted Figure 6. Contrary to many classical ad hoc networks, routing is designed hierarchically such that communication relays are exclusively robots (and not low capacity nodes -- battery, CPU, etc.). The use of a wireless network core made up of mobile robots adds some control in the ad hoc network. This feature is essential in order to provide an acceptable link quality, increase network performance, and thus support real time services in the network, as shown in [LeG03].

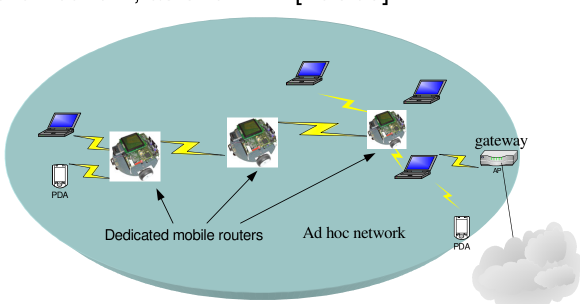

Figure 9 Ad-hoc Networking with the Mobile Robots

Monitoring the Ad-hoc Network

A monitoring station was developed to show the improvements obtained when using the QOLSR or the robot-based routing compared to the OLSR protocol. The monitoring station is based on monitoring agents installed on all wireless nodes (including robots in the robot-based routing). This tool allows the visualisation of the entire network state including the state of each node, links as well as the entire topology. It will also visualise the routing tables of each node (Figure 10). This tool was developed independently of the underlying ad-hoc routing protocol and can be used for either proactive or reactive ad-hoc routing protocols.

Monitoring agents gives the following set of information to the monitoring station (as shown in Figure 10):

- Timestamp (date:jjmmyyyy/hour:hhmmss)
- Node's addressing information (IP address, subnet mask, gateway address, MAC address, SSID)
- Routing table with neighbour's IP addresses
- Monitored wireless link characteristics (radio channel ID, noise, signal strength, packet error ratio)

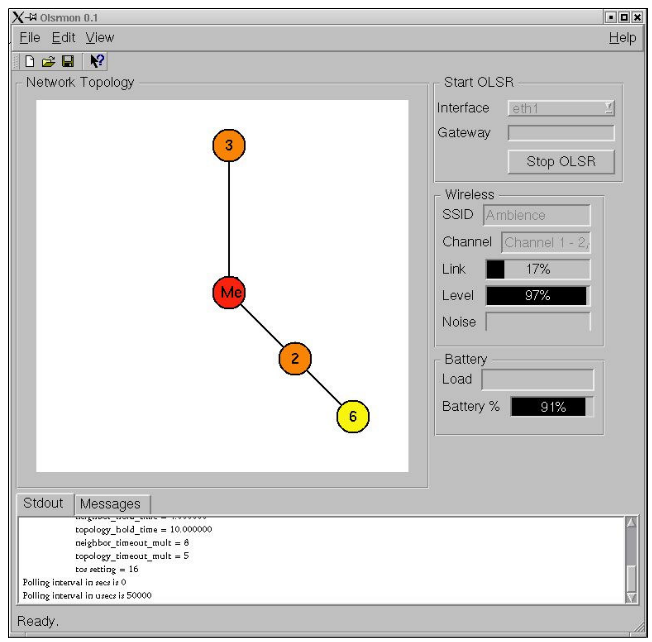

Figure 10: Monitoring station snapshot

Summary of Technology

The key technologies demonstrated are:

- Natural speech recognition – Thales, France
- Java based iPAQ GUI – CCC, Finland
- XML message system – CCC, Finland
- ZigBee positioning - Philips, UK

- Integrated server – ENST, France
- Robot routing/ad-hoc networking – ENST, France
- Network monitoring and analysis – LIP6, France

CONCLUSIONS

The video demonstrates an ambient environment designed to improve the experience of attending a conference. From the moment the delegate enters the conference venue, registration is simple and automatic which gives rise to a wealth of useful services available through the user's PDA. The system is designed to help make finding people and places easy and allow information to be exchanged.

The real work of this ambient system goes on in the background as the server authenticates people, tracks their movements, routes messages, exchanges documents and handles user requests. The server also successfully implements a scheme of ad-hoc networking and robot routing that fills holes in the network.

ACKNOWLEDGMENTS

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