CSIDC 2001
Project Abstracts

Boston University

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The *i*Shop

The iShop allows for an enhanced shopping experience by creating a seamless link between customers and retailers. Customers have a keychain "personal identification system" in their pocket, allowing retailers administrative access to their shopping preferences, to interact with and better serve them.

Embracing Bluetooth, the latest technology in short range, high-speed personal area networks, the iShop communicates with stores and transfers information in just seconds, during the fraction of the time it takes for the customer to walk by the front of the store.

While passing a storefront, shoppers will be impressed by an interactive TV (eBillboard) displaying motion video and static content advertisements custom-tailored to their interests. With the click of their keychain, the personal interactive area will come to life; Shopper will interactively gain access to more information.

Retailers will have information at their fingertips that allowing them to tailor their product line and marketing strategies to the exact desires of the shopper, exceeding current methods of obtaining shopper preference information.

With the low cost of the device, plus the mutual benefit to the shopper and the retailer, it will be in the interest of all to get the device to the hands of shoppers. When the first round of this device is deployed, the concept of inexpensive, handheld advertising will become an added necessity to the wardrobe of the avid shopper.

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The Poket Doktor

While the ability to store and share information has increased exponentially in the last half-century, obtaining critical medical information in emergency situations remains problematic. Accident victims often require major medical attention from emergency personnel who know nothing of the patient's allergies, current prescriptions, or medical history.

Using Bluetooth wireless technology, we have developed a product capable of accessing a victim's critical health information at the scene of an accident. The "Poket Doktor" is a handheld device to be used by paramedics that communicates seamlessly with Bluetooth-enabled Smart Cards that contain vital medical information. Each card stores the data for a patient, including his allergies, major surgical history, blood type, and current medications. In emergency situations, the Poket Doktor will detect a Smart Card in a patient's wallet or purse and provide access to the card data. Health care professionals will thus provide better care and ensure that no mistakes occur due to ignorance.

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WPAN using UPnP over Bluetooth

Current *Bluetooth* specifications call for devices to discover services and connect in an ad-hoc fashion. This provides the basis for creating a Personal Area Network (PAN). New applications, which involve service discovery, are being developed everyday. Although a Service Discovery Protocol (SDP) is provided by the *Bluetooth* specifications, most electronic devices do not universally adopt it. Firstly, SDP does not define any method for accessing the services. Secondly, although SDP can be used to find devices where the connection is established at the L2CAP-layer, it does not have any mechanism to utilize services such as delivering the service access protocols. In summary, SDP works only among *Bluetooth* devices with pre-configured setting done in an ad-hoc fashion of a piconet.

What we need is a universal protocol that is easily adaptable by most devices. On top of service discovery, subsequent service usage is an important feature we expect while designing a thorough system for the Wireless PAN (WPAN). We chose Universal Plug and Play (UPnP) protocol, which is built on reliable, well-known technologies.

With UPnP, any device can be added to the network, be it a home automation component (e.g. security system) or a device at the workplace (e.g. a printer). Most importantly, the user can start using it with minimal configuration.

Our project comprises of a comprehensive report of the Personalized *Bluetooth* (PB) unit along with its implementation with UPnP standards. Specifically, *Bluetooth* profiles such as Service Discovery and LAN Access will demonstrate their functionality with UPnP technology built on top of them. We expect this unit to have zero configuration in an open network, which has an architecture that leverages web technologies to control and transfer data among networked devices in homes and offices.

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BlueGenius

BlueGenius is a toolset, including software developing environment and hardware basic motherboard platform, which can help us to build a robot, information appliance, or applications with Bluetooth device easily and efficiently. The toolset consists of the following components:

Software: Robot Language Compiler, Robot Virtual Machine (RVM), Robot Bluetooth Stack (RoboBlues), and Remote Control Center

Hardware: Robot, General Purpose 8051 Main Board, Display Card, Motor Control Card, and Neural Network Card

The Robot Language Compiler, offering friendly high-level interface to control robot movement, compiles the source code in Robot Language to RobotCode (cross-platform executable file). The Robot Virtual Machine executes the RobotCode on different CPUs; and the Robot Bluetooth Stack is an optimized Bluetooth Stack that supports communication among Robots. With these components, we can develop an application of distributed computing rapidly, such that the robots can do team work smartly. The Robot Language directly supports the Bluetooth Device. The Robot Bluetooth Stack makes it easy to connect with other wireless devices without knowing the details of the Bluetooth communication protocol. The Robot Virtual Machine for PC can help us to debug and simulate our application before implementation.

For demonstration the effectiveness of our developing environment, we have built two vacuum robots that can communicate with the server and take command to clean a room with furniture (simulated as obstacles) together. The verified application system can be easily ported to run on a basic platform system based on 8051 CPU.

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BlueEyes
Conscious Brain Involvement Monitor

Human error is still one of the most frequent causes of catastrophes and ecological disasters. The main reason is that the monitoring systems concern only the state of the processes whereas human contribution to the overall performance of the system is left unsupervised. Since the control instruments are automated to a large extent, a human – operator becomes a passive observer of the supervised system, which results in weariness and vigilance drop. Thus, he may not notice important changes of indications causing financial or ecological consequences and a threat to human life. It therefore is crucial to assure that the operator's conscious brain is involved in an active system supervising over the whole work time period.

It is possible to measure indirectly the level of the operator's conscious brain involvement using eye motility analysis. Although there are capable sensors available on the market, a complex solution enabling transformation, analysis and reasoning based on measured signals still does not exist. In large control rooms, wiring the operator to the central system is a serious limitation of his mobility and disables his operation. Utilization of wireless technology becomes essential.

BlueEyes Conscious Brain Involvement Monitor developed by our team is intended to be the complex solution for monitoring and recording the operator's conscious brain involvement as well as his physiological condition. This required designing a Personal Area Network linking all the operators and the supervising system. As the operator using his sight and hearing senses the state of the controlled system, the supervising system will look after his physiological condition.

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EUNICA: Extensible Universal Control of Devices

Nowadays, efforts to design comfortable mean to control of appliances in the household can be seen. People desire appliances to communicate each other and to adapt appliances to their own requirements.

Eunica offers solution involving user-friendly interface, easy incorporating of new appliances and high dependability. User interface takes advantages of adaptivity and adaptability to serve user according to his/her customs and preferences and uses Eunica remote controls – a Java based PDA-like browsers dedicated to displaying adapted sets of operational elements. User interface features make Eunica suitable also for elder and disabled people.

The wireless technology, namely Bluetooth, which comprises the primary way of communication, is granting Eunica great features to supersede conventional IR remote control. Although Eunica is not limited to a single set of communication methods or fixed set of appliances, rather uses the open concept of loadable drivers to be prepared for future devices and technologies.

The system contains features making it possible to use it also from outside of user's household via phone lines or Internet. Eunica contains strong appliance management functions that are kept hidden for the user. It provides trustworthy way of appliance installation and deinstallation. Sensitive information is protected by encryption schemes to avoid its misuse.

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Application of Bluetooth Wireless Technology to Guided Audio Tours

Bluetooth Wireless Technology can help overcome some of the limitations of the conventional audio guided tour systems that a growing number of museums, zoos, aquariums, and similar institutions offer to visitors. Such systems are designed to enrich the experience of visitors while revenue for the institution. Conventional audio tour systems, such as those developed by Acoustiguide, Stop & Listen, TourMate, SoundAlive, and other firms, are implemented using technologies ranging from low-cost portable cassette players to solid-state digital players that store hundreds of hours of commentary. Low-cost audio players deliver content in an inflexible, linear format that requires visitors to follow a pre-planned route. Solid-state digital players are more flexible, but are more complicated to operate and much more expensive. Maintenance of the equipment and providing instruction to visitors consume scarce institutional resources. As a result, many museums and others are still reluctant to go to the trouble and expense of implementing audio guided tours.

Here, we evaluate the suitability of Bluetooth for enhancing the performance and overcoming the limitations of conventional audio guided tour systems.

In particular, we describe our design and implementation of a proof-of-concept unit that we developed using a Toshiba Tecra 8800 laptop, an Ericsson Bluetooth Application & Training Tool Kit Module (ROK 101 007), and IBM's BlueDrekar protocol stack for Linux. We show how Bluetooth can be used to (1) allow flexible delivery of audio content (via a suitable combination of onboard storage, SCO links, and ACL links), (2) permit synchronization of audio content with real-time actions or events, (3) permit automatic selection of commentary based upon location (proximity to the appropriate exhibit), and (4) allow delivery of announcements, including reminders of scheduled shows/events and short messages targeted at a specific user. Bluetooth is not always the ideal solution for such applications. However, it will become increasingly attractive than proprietary solutions as hardware becomes cheaper and developers with Bluetooth experience become more plentiful.

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The Universal BTRC Remote Control System

The Bluetooth Remote Control system is a major step towards real ubiquitous computing in our every-day life. The BTRC system enables devices to communicate over various transport protocols, allowing them to be controlled remotely using either an XML based GUI, plain text messages, hyperlinks or speech.

Our BTRC protocol specifies how information has to be exchanged on the application layer. It can be embedded in Universal Resource Identifiers (URIs), as proposed by several RFCs [1,2,3]. Using our protocol, any networked device able to parse and deliver command strings can act as a BTRC remote control. A MS Windows based application simulating a Bluetooth PDA remote control was developed as a reference implementation. This application was equipped with a speech recognition interface to demonstrate a highly user-friendly system. Due to the fact that various types of remote controls do request for different graphical user interfaces a controlled device provides a set of several XML based GUIs.

A BTRC enabled Web browser and an HTTP based BTRC proxy were implemented to show how easy conventional Web and Internet applications can be integrated into a BTRC environment.

To prove the applicability of the BTRC approach, various types of server applications were developed. Several Bluetooth based Windows multimedia applications were implemented to demonstrate the collaboration of BTRC and Bluetooth. A BTRC-to-RC5-Infrared relay application that consists of both software and hardware components was designed to integrate legacy devices into a BTRC system.

The BTRC approach is particularly pervasive because the BTRC protocol is scalable down to pieces of equipment with even very restricted computing and networking capabilities. All implementations were tested to prove the compliance with the BTRC protocol specification.

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Head Mounted Control System

Quadriplegics and paraplegics have very limited motor control and therefore have to spend their entire life in a wheelchair, often depending on others to perform daily activities. The Bluetooth-enabled Head Mounted Control System (HMCS) is therefore focused on assisting people with severe physical disabilities to achieve an increased level of independence.

The HMCS environment enables the user to see a list of services on a head mounted display. The user is able to access these services through head motion and voice commands. This unit enables the user to function independently by offering the ability to control wheelchair movement, lock and unlock doors, and access software applications on a personal computer. The system can easily be expanded to interface with other bluetooth devices and provide additional services to the user. Wireless communication between the HMCS, wheelchair, personal computer and the door is accomplished with a Bluetooth network, which is well suited to the dynamic nature of the HMCS environment. The system is designed to provide a high degree of comfort, reliability, security and interactivity to the user.

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BlueStar:
A Design for Demand-Side Power Management Using Bluetooth-Enabled Appliances in a Solar-Powered Home

This project is a system for efficient power management in solar and hybrid (solar and grid-powered) homes. Solar power systems are currently expensive and too inefficient to attract many users from the grid, the BlueStar system is designed to ease the transition to solar power by improving the efficiency of solar power systems. We developed a low-power system using the Bluetooth chipset to enable home appliances to communicate with each other and with power sources. With ours system, appliances negotiate to receive power over a discrete time interval based on their individual need for power. An appliance's need is based on a metric that considers a variety of the appliance's characteristics, including the amount of power the appliance requests, if it has been deferred earlier in the process, and how important the appliance is to the homeowner. BlueStar allows more appliances to operated during times when solar power is available than would be able to operate in a normal solar home. Additionally, this system ensures that auxiliary power is available when solar power is unavailable. Energy issues, from electricity shortages in California, to environmental concern about the effects of fossil fuel combustion, have recently been the topic of much debate. Enabling homeowners to use solar power more efficiently could alleviate reliance on the standard grid, helping to sole these problems.

Microsoft Award for Innovation

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SkyMobile
Safe In-Flight Mobile Connectivity

Air Passengers today are required to switch off their mobiles once on board the flight by law (FCC mandate). This restrain has been enforced due to two basic reasons. Primarily, interference from the mobiles in the Air Traffic Control (ATC) band is detrimental to the safety of the flight and hence all its passengers. Secondly, a mobile at such an altitude connects to multiple Base Stations simultaneously clogging the resources of the ground network. Switching the mobile off renders a person unconnected, restricting his ability to make or receive voice calls, or access data services.

We propose and develop a novel solution based on the integration of diverse communication links: Bluetooth, GSM (or appropriate mobile network), Public Switched Telephone Network (PSTN) and an air to ground satellite connection, which enables the user to remain connected in-flight, while solving the above two critical issues. This switch over from the mobile network to our in flight network is seamless - requiring no user initiation and the user faces no perceptible change while communicating from air.

The critical in-flight link is enabled through Bluetooth. Bluetooth technology due to its low power, short range and fast frequency hoping presents negligible interference to Air Traffic Control Signals.

The GSM (or respective Mobile Standard) Radio Frequency Emissions of the mobile unit are automatically switched off when the passenger enters the plane and call forwarding is set up from the mobile network to a ground switching center. Thus, all voice (or data) is received at this switching center and transferred through an available air to ground link to the airplane. This is received at the airplane gateway and finally transmitted over the in-flight Bluetooth network to the passenger. The integration of diverse links such as the mobile network, PSTN, Ground to Air RF links, and Bluetooth is the key enabler in this new solution.

Our prototype consists of a Bluetooth enabled GSM phone, implemented in software, using a GSM modem for connecting to the cellular network and the Ground Switching Center using a phone modem for connecting to the PSTN. The novel and intricate task of setting up the various communication links, call rerouting and transmitting voice

across the various hops, terminating with voice transfer over Bluetooth, is demonstrated. Our system allows the user to receive or make a call from the mobile phone on air. This innovative solution enables people to remain connected in flight without requiring them to use a different handset or reconfigure the one that they carry on land.