«Ασύρματα δίκτυα στον πολιτισμό: Μελέτες περιπτώσεων σε μουσεία»

"Wireless networks in culture: Cases Studies in museums"

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Abstract

The use of new technologies, wireless networks and mobile devices in cultural sites is a new challenge and a major area of scientific interest for the specialists (archaeologists, museologists, computer engineers and system designers) and also for the guests of museums and other cultural sites. In this study, "Wireless Networks in Culture: Case Studies in Museums" wireless networks will be presented through a number of real applications, which are installed in cultural sites and especially in museums and exhibitions. In the first part of this study, there will be a brief presentation of the network technologies (Wi-fi, RFID, IR, GPS, Bluetooth, IEEE 802.15.4-2006 used to implement these applications, while in the second part several case studies of installation and use of wireless networks at various museums in the world will be presented.

Περίληψη

Η χρήση των νέων τεχνολογιών, των ασύρματων δικτύων και των κινητών συσκευών σε πολιτιστικούς χώρους αποτελεί μια νέα πρόκληση και ένα μεγάλο πεδίο ενδιαφέροντος τόσο για τους ειδικούς επιστήμονες (αρχαιολόγους, μουσειολόγους, μηχανικούς πληροφορικής και σχεδιαστές συστημάτων) όσο και για την χρήση από τους επισκέπτες και την συνεισφορά τους στην πολιτιστική και μουσειακή εμπειρία. Στην παρούσα εργασία: «Ασύρματα δίκτυα στον πολιτισμό: Μελέτες περιπτώσεων σε μουσεία» θα παρουσιαστούν, μέσα από μια σειρά πραγματικών εφαρμογών, ασύρματα δίκτυα που έχουν εγκατασταθεί σε χώρους πολιτισμού και ειδικότερα σε μουσεία και εκθέσεις. Στο πρώτο μέρος της εργασίας θα παρουσιαστούν οι τεχνολογίες δικτύων που χρησιμοποιήθηκαν για την υλοποίηση αυτών των εφαρμογών (Wi-fi, RFID, IR, GPS, Bluetooth, IEEE 802.15.4-2006), ενώ στο δεύτερο μέρος θα γίνει παρουσίαση περιπτώσεων εγκατάστασης και χρήσης ασύρματων δικτύων σε διάφορα μουσεία στον κόσμο.

Introduction

As we stated, this study which is titled**: “Wireless Networks in Culture: Case Studies in Museums”** will focus on wireless museum network applications. Museums are important public places for the storage and restoration of human heritage. Museums not only record culture and historical development from the past to the present but also preserve relics from the past as the basis for future development. Traditional museums generally provide their service by exhibiting important artefacts to the museum visitors. However, with the advance of modern technology, there will be further services for museums to discover for the benefit of the public.

Recently some of the world-class museums have started offering hand-held devices such as MP3 player and PDA in order to help visitors receiving more vivid contents. MP3 players provide an acoustic guide that not only assists visitors to appreciate artefacts but also allow them to receive the relevant information simultaneously. PDA, on the other hand, has been the centre of research interest for the improvement of existing museum guide system. Visitors are now able to surf museum web site, locate their place by a personal map, read relevant texts, images and listen music. Visitors also have opportunity to choose their native language for receiving of museum resources. ***(Schwarzer, 2001) (Mai,2005)***

For all these new trends in museum experience through mobile assisted guide tours, every museum has to rely on some basic wireless network infrastructure that fulfill certain needs and requirements. Applications that use wireless networks must be easy in use for the visitors, must have a reduced cost, must work well in technical means, must not cause problems to the proper view of the artifacts and must assist the visitor and not distract him from the real museum experience. Certainly the upper goal of these applications should not be only to deliver a good wireless museum tour but to give to the visitor the opportunity of a new learning museum experience. ***(Schwarzer, 2001)***

1. Network technologies in culture

In the first part of the study, i will present briefly the basic network technologies that have been used at the implementation of the cases studies that are presented at the next part.

1.1. 802.11 and Wi-Fi

Wi-Fi: 802.11 technologies is the universal standard for wireless transmission. The Wi-Fi Alliance, the organization that owns the Wi-Fi (registered trademark) term specifically defines Wi-Fi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards."

Initially, Wi-Fi was used in place of only the 2.4GHz 802.11b standard, however the Wi-Fi Alliance has expanded the generic use of the Wi-Fi term to include any type of network or WLAN product based on any of the 802.11 standards, including 802.11b, 802.11a, dual-band, and so on, in an attempt to stop confusion about wireless LAN interoperability.

Wi-Fi works with no physical wired connection between sender and receiver by using radio frequency (RF) technology, a frequency within the electromagnetic spectrum associated with radio wave propagation. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space. The cornerstone of any wireless network is an access point (AP). The primary job of an access point is to broadcast a wireless signal that computers can detect and "tune" into. In order to connect to an access point and join a wireless network, computers and devices must be equipped with wireless network adapters. ***(Kurose et all, 2004)***

Wi-Fi is supported by many applications and devices including video game consoles, home networks, PDAs, mobile phones, major operating systems, and other types of consumer electronics. Due to 802.11 wireless networks have high bandwidth capability, network users could access larger data and advance network service, such as video and audio files. Moreover, 802.11 wireless networks are able to transmit richer multimedia content and interactive content to deliver information and data promptly by hand-held devices. ***(Webopedia Wi-Fi, 2011)***

1.2. IEEE 802.15.4-2006

IEEE 802.15.4-2006 is a standard which specifies the physical layer and media access control for low-rate wireless personal area networks (LR-WPANs). It is maintained by the IEEE 802.15 working group. IEEE standard 802.15.4 intends to offer the fundamental lower network layers of a type of wireless personal area network (WPAN) which focuses on low-cost, low-speed ubiquitous communication between devices (in contrast with other, more end user-oriented approaches, such as Wi-Fi). The emphasis is on very low cost communication of nearby devices with little to no underlying infrastructure, intending to exploit this to lower power consumption even more.

The basic framework conceives a 10-meter communications range with a transfer rate of 250 kbit/s. Tradeoffs are possible to favor more radically embedded devices with even lower power requirements, through the definition of not one, but several physical layers. Lower transfer rates of 20 and 40 kbit/s were initially defined, with the 100 kbit/s rate being added in the current revision.

Even lower rates can be considered with the resulting effect on power consumption. Devices also include power management functions such as link quality and energy detection. 802.15.4-conformant devices may use one of three possible frequency bands for operation. ***(Baronti et all, 2007)***

1.3. Radio Frequency Identification (RFID)

RFID is the short for radio frequency identification and is a technology similar in theory to bar code identification. With RFID, the electromagnetic or electrostatic coupling in the RF portion of the electromagnetic spectrum is used to transmit signals. An RFID system consists of an antenna and a transceiver, which read the radio frequency and transfer the information to a processing device, and a transponder, or tag, which is an integrated circuit containing the RF circuitry and information to be transmitted. ***(Weinstein, 2005)***

Due to an RFID chip has low-cost and low-power features, it is easily deployed and commonly embedded in objects to be recognized and identified by RFID receivers. The range of RFID is short distance transmission which users are required in closer space to touch a tag or activate a trigger between 5cm to 25cm. Therefore, RFID signals can not travel a far distance than WLAN. RFID is usually used for security and in maintenance, such as animal identification which governs the source or control disease occurrence. ***(Liao et all, 2005)***

1.4. Infrared (IR)

IR is a short-range and line-of-sight transmission technology which refers to nature light between 15cm and 100cm to exchange data. IR is limited in indoor space because the transmission of IR path must be cleared so that it will not be interfered by any physical barriers. IR is usually used to trigger content which can be applied in active and passive conditions. To be precise, assuming a mobile device passes within the range of infrared beam to another IR device by active trigger, the IR device will be woken up passively and responds to the mobile device. Televisions and remote controls, for example are the active and passive infrared devices. ***(Mai,2005)***

1.5. Global Positioning System (GPS)

Short for G*lobal* P*ositioning* S*ystem*, a worldwide satellite navigational system formed by 24 satellites orbiting the earth and their corresponding receivers on the earth. The GPS satellites continuously transmit digital radio signals that contain data on the satellites location and the exact time to the earth-bound receivers. The satellites are equipped with atomic clocks that are precise to within a billionth of a second. Based on this information the receivers know how long it takes for the signal to reach the receiver on earth. As each signal travels at the speed of light, the longer it takes the receiver to get the signal, the farther away the satellite is. By knowing how far away a satellite is, the receiver knows that it is located somewhere on the surface of an imaginary sphere centered at the satellite. By using three satellites, GPS can calculate the longitude and latitude of the receiver based on where the three spheres intersect. By using four satellites, GPS can also determine altitude.

GPS was developed and is operated by the U.S. Department of Defense. It was originally called NAVSTAR (Navigation System with Timing and Ranging). Before its civilian applications, GPS was used to provide all-weather round-the-clock navigation capabilities for military ground, sea, and air forces. GPS has applications beyond navigation and location determination. GPS can be used for cartography, forestry, mineral exploration, wildlife habitation management, monitoring the movement of people and things and bringing precise timing to the world. ***(Wright, 2003)***

However, because the radio-wave signals are from satellites, the interruption from large and heavy buildings may restrict GPS working indoor. Thus, GPS is generally used in outdoor transportation, land surveying and local area exploration, for example.

1.6. Power over Ethernet

Power over Ethernet (PoE) is a technology that integrates power into a standard LAN infrastructure. It enables power to be provided to the network device, such as an IP phone or an access point, using the same cable as that used for network connection. It eliminates the need for power outlets at the access points and enables easier application of uninterruptible power supplies (UPS) to ensure 24 hours a day, 7 days a week operation.

PoE technology is regulated in a standard called IEEE 802.3af and is designed in a way that does not degrade the network data communication performance or decrease the network reach. The power delivered over the LAN infrastructure is automatically activated when a compatible terminal is identified, and blocked to legacy devices that are not compatible. This feature allows users to freely and safely mix legacy and PoE-compatible devices, on their network. The standard provides power up to 15.4W on the switch or midspan side, which translates to a maximum power consumption of 12.9W on the device side – making it suitable for indoor devices. ***(Power over Ethernet (PoE), 2011)***

1.7. Bluetooth

Bluetooth is a specification for the use of low-power radio communications to wirelessly link phones, computers and other network devices over short distances. Bluetooth technology was designed primarily to support simple wireless networking of personal consumer devices and peripherals, including cell phones, PDAs, and wireless headsets. Wireless signals transmitted with Bluetooth cover short distances, typically up to 30 feet (10 meters). Bluetooth devices generally communicate at less than 1 Mbps. Bluetooth networks feature a dynamic topology called a piconet or PAN. Piconets contain a minimum of two and a maximum of eight Bluetooth peer devices. Devices communicate using protocols that are part of the Bluetooth Specification.

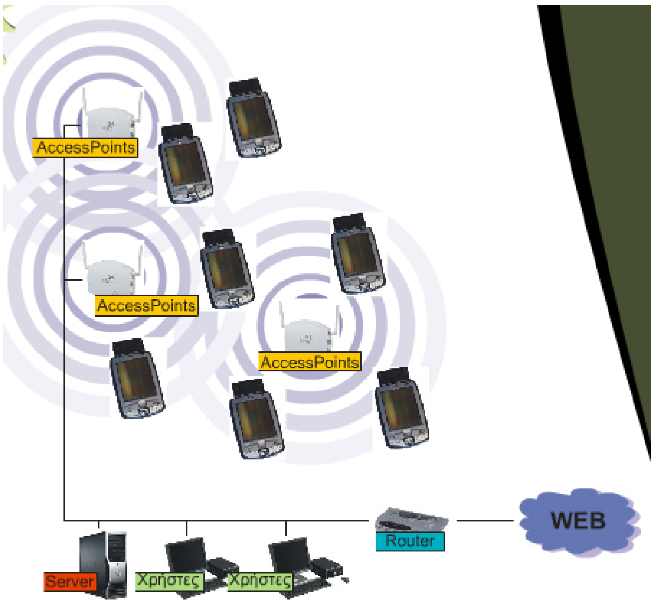
Although the Bluetooth standard utilizes the same 2.4 Ghz range as 802.11b and 802.11g, Bluetooth technology is not a suitable Wi-Fi replacement. Compared to Wi-Fi, Bluetooth networking is much slower, a bit more limited in range, and supports many fewer devices. As is true for Wi-Fi and other wireless technologies today, concerns with Bluetooth technology include security and interoperability with other networking standards. Bluetooth was ratified as IEEE 802.15.1. ***(Kurose et all, 2004)***

2. Cases Studies of wireless networks in Museums

In this part of the study i will present with text and diagrams some museum applications that use the network technologies that were presented at the previous part. The focus will be placed on the technologies and the infrastructure of the applications. Also focus will be set to the services that provide to the visitors and the scientists.

2.1. Xenagos: digital tour-guide

Xenagos is an advanced system that delivers an enhanced tour-guide experience to exhibition visitors. It is ideal for museums, exhibitions, galleries, city-sightseeing, archaeological sites, recreation /amusement parks, etc. Visitors, receive location-based, multimedia and exhibit-specific information and knowledge, interactively. It is designed and implemented by the Greek IT company Prisma Electronics S.A. ***(Πρίσμα ηλεκτρονικά ΑΒΕΕ, 2011)*** and is currently operational in the following locations: Archaeological museum of Arta, Museum of Natural History in Lesvos, Greek National Opera, Art of Silk Museum in Soufli, Ecclesiastical Museum in Alexandroupolis and at CERN, in Geneva.



Picture 1: Xenagos wireless system

Xenagos is designed with leveraging modular system architecture, capable of addressing customer requirements, in terms of scale and budget, while it allows for flexible modifications as the requirements of the exhibition area increase and vary.

The delivery of content is based on a wireless communication link between each mobile device and the system server. The wireless devices are discrete with minimal intervention to the aesthetics of the exhibition area. The use of advanced wireless technologies, such as Power over Ethernet (PoE) and WiFi, minimizes the need for data cables and electrical power outlets. Mobile devices are connected with the system router wirelessly through advanced access points. The system structure is flexible and can be reconfigured via software on-the-fly, to redefine optimal functionality parameters. At the lobby of the exhibition area, visitors are supplied with a mobile device capable of recognizing RFiD tags. RFiD (radio frequency identification) tags are placed one next to each Exhibit. Each RFiD tag has a code which corresponds to exhibit-specific content (text, audio, video, images) stored in the systems' database. By bringing in proximity the mobile device to each RFiD tag, the information, stored in the systems' database, is automatically retrieved and delivered to the visitor's mobile device. The two pictures show exactly how the network is implemented. ***(Xenagos virtual guide, 2010)***

Picture 2: The Xenagos system architecture

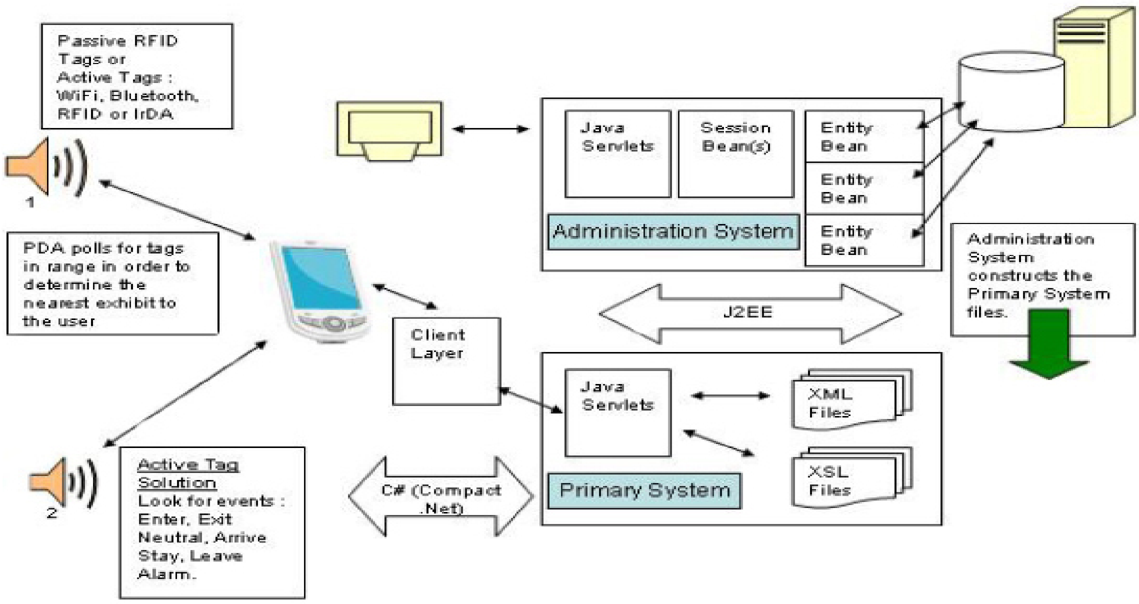
2.2. Mi-Guide

The next case study presents a context driven wireless information system for deployment within a museum environment. The application is called mi-Guide and provides a novel architecture combining a PDA user interface with Wi-Fi and passive RFID tagging giving access to a server-side multimedia web application. In this way the user's context (user type and location) is translated into real-time delivery of relevant content to visitors.

The diagram in picture 3 gives an overview of the mi-Guide system architecture. The primary mi-Guide system (Primary System) which is delivered to the mi-Guide PDAs is a client-server web application which consists of a client-side C# application and a server-side Java application. The latter resides on a Sun Java System Application Server and comprises a number of Java servlets working in conjunction with a set of xml files and their associated xsl files. The client-side application wraps around a web browser (Pocket Internet Explorer) embedded inside the application, which is then used to access the server-side web application.

The client is written in C# as this is better supported on the Pocket PCs that are used on the project in the form of the (Microsoft) Compact .Net Framework.

The purpose of the xml files is to allow a more simplified description of the information related to each exhibit. A single RFID tag (or equivalent active tag) can suffice for one exhibit, and the content related to that exhibit is sub-divided into sections, as specified by the museum. Alternatively a tag can relate to multiple exhibits and the user is given a choice as to which they wish to choose. Content is hierarchically structured.



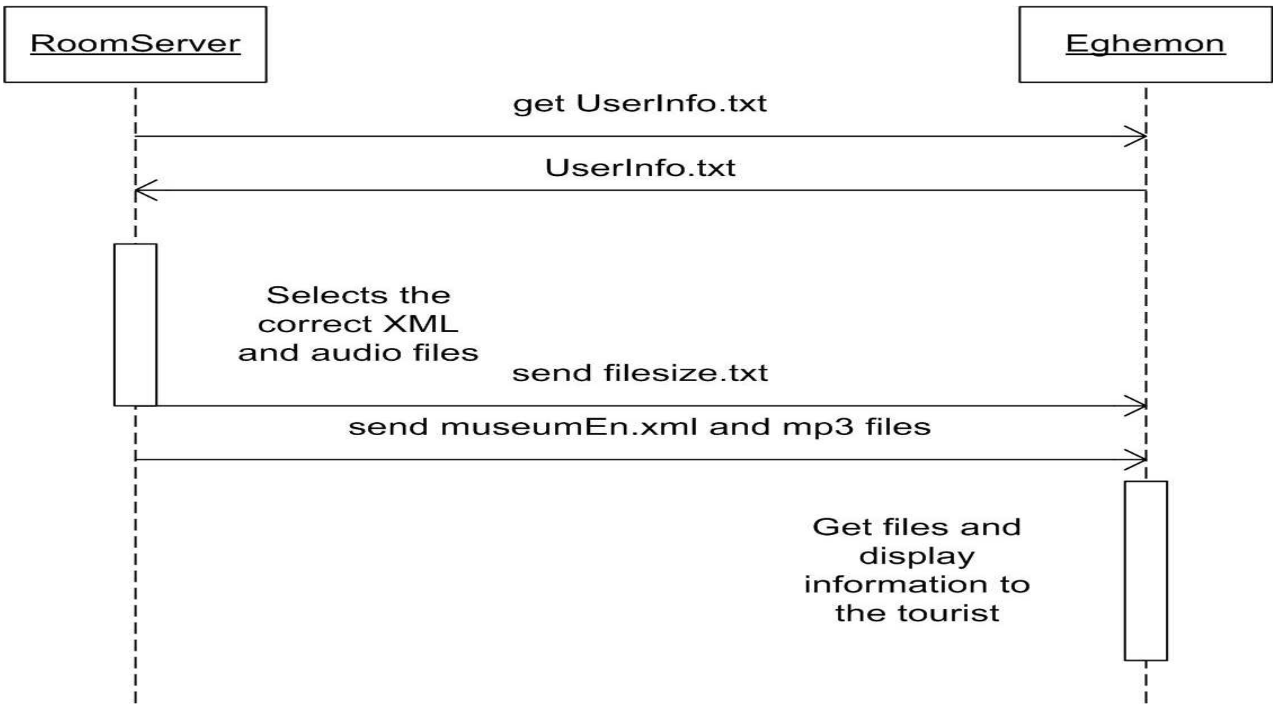
Picture 3: The mi-guide system architecture

From the home page the visitor can scan the PDA at a mi-Guide scan point (RFID tag). Depending on which exhibit is tagged, the content for that exhibit and its related information will then be delivered. Each section has an associated audio clip to describe the content on view, together with a section image and a relevant caption. In addition it may be possible to link to extra media files such as video and further audio clips or additional images that the museum might want to display related to the exhibit. All of this information is contained within the xml files for which a purpose built xml dialect was constructed, together with an associated document type definition (dtd) that describes this dialect. The network was set-up and tested at Museum of Science & Industry in Manchester. ***(Linge et all, 2007)***

2.3. ηγ□µων (Eghemon): a distributed, PDA-based Museum Guide

The next case study presents Eghemon (from Greek ηγ□µων, which means "guide"), a system developed for museum visit based on mobile devices and a PC infrastructure, which aims at providing IT (Information Technology)-based support to tourists during the visit to an enabled museum, allowing them to autonomously perform the visit. The tourist can move in an environment divided into different rooms inside which artworks are exposed, guided by a mobile device as a PDA that provides several pieces of information about artworks.

The museum must be provided with an appropriate infrastructure that stores the information and provides it to the PDAs on demand. The connections between the fixed infrastructure and the PDAs are wireless. In this case study the Bluetooth technology is chosen because the needed connections are usually inside a room, and this technology has a short-range with regard to reachable devices: this is useful to avoid interferences from different rooms; in addition, it does not require free space and direct connections as infrared technology do. Finally, this enables the research team to exploit off-the-shelf PDAs without additional cards. Last but not least, the researchers had adopted the context awareness i.e. the PDA is aware of the rooms where it is moving and loads and presents to the tourist only the needed information.



Picture 4: the Eghemon protocol procedure

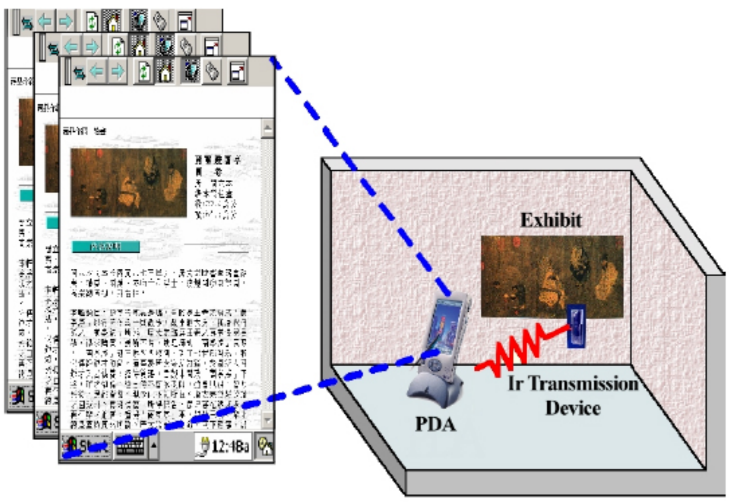
The software system relies on a distributed architecture and is composed of three components, each of them with a specific function: RoomServer, MainServer and Eghemon. The latter component, which has the same name of the whole system, is installed on the PDAs and provides the interface for the tourists; the first two components enable the management of the information related to the artworks, the definition of the guided paths and the connection with PDAs. The basic work is done in the RoomServer as the RoomServer stores a file called museumEn.xml (or MuseumIt.xml for the Italian version) that can be transmitted to the PDAs along with the audio files, by means of a Bluetooth connection, as soon as the devices enter in the room covered by the PC.

The communication protocol between the servers and the PDAs is quite simple and is based on file exchange. The servers run an appropriate thread that is in charge of searching for Blutooth devices reachable. Once one or more devices are found, serial connections are established with them to transfer data. The connections are kept only for the time needed to exchange data; during the visit the device is not supposed to be connected to the server. The protocol works as follows (see picture 4). First, the RoomServer pulls from the PDA the file UserInfo.txt, a textual file that contains the chosen language and path. On the base of these pieces of information, the server selects the needed the XML data and audio files to be transmitted to the PDA. Before starting the transmission of these files, the server tells the device the size of the XML data file and the number of audio files, again by means of a text file. This is needed to allow a correct synchronization. Then, the XML data file along with the mp3 audio files is transmitted to the device. Finally, the Bluetooth connection is closed.

The Eghemon project was developed by a research team at Universit`a di Modena e Reggio Emilia and been tested in various museums. ***(Cabri et all, 2007)***

2.4. Taipei Astronomical Museum Dipartimento di Ingegneria dell'Informazione

In this case study, tested at the Taipei Astronomical Museum, a position-aware multimedia mobile learning system for museums has been developed. The system was implemented on Personal Digital Assistants (PDAs), and was aware of the position of the visitor through the infrared positioning devices. As the visitor walks up to a specific exhibit, without any clicks or operations, the system can retrieve the corresponding multimedia narration of that exhibit automatically.



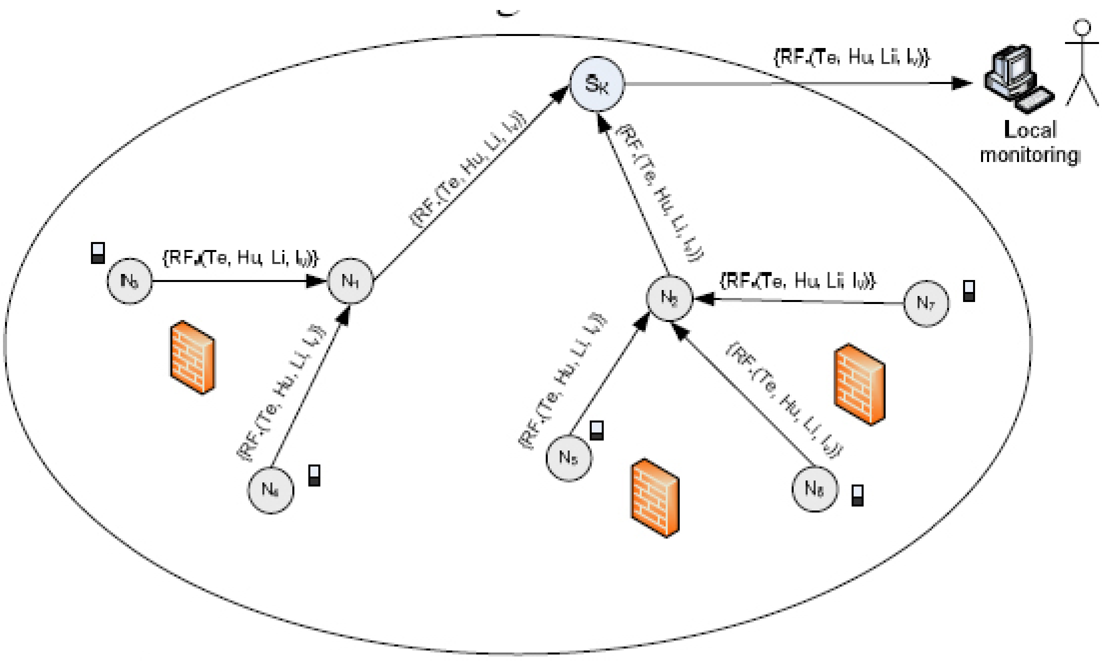
Picture 5: The use of infrared connection

The infrared transmission technique, that has been used, is a connectionless data communication protocol. Because no commercial products were matching to the design of the application, the researchers decided to design the infrared transmission device by their selves. Using an 8051 microprocessor to be the controller of the infrared transmitter, it keeps emitting an identifier of the exhibit into the air. Once a PDA gets the identifier, the system should switch the exhibit page to the correct one. At the picture 5 we can see how this application connects and works. ***(Chou et all, 2004)***

2.5. The Wise –Muse Project

A different use of wireless technologies at museums is that of the following case – study. A major concern to all museums’ managers is to properly conserve the artwork in museums and, for that to be achieved, it is fundamental to monitor the museum’s environment. Therefore, it is critical to continuously measure some environmental parameters, such as temperature, relative humidity, light and, also, pollutants, either in storage or exhibition rooms.

The deployment of a Wireless Sensor Network (WSN) in a museum can help implementing these measurements continuously, in a real-time basis, and in a much easier and cheaper way than traditional procedures. An experimental test was deployed by researchers of the Exact Sciences and Engineering Center, University of Madeira (UMa), in a contemporary art



Picture 6: The topology of the Wireless Sensor Network (WSN) of the Wise-Muse

museum that is located in Madeira Island, in Portugal. For this purpose, there was developed a new wireless sensor node that brings some advantages when compared with other commercially available solutions. This work was being developed in the context of the ongoing project on museum environmental and structural monitoring using WSNs, called the WISEMUSE project.

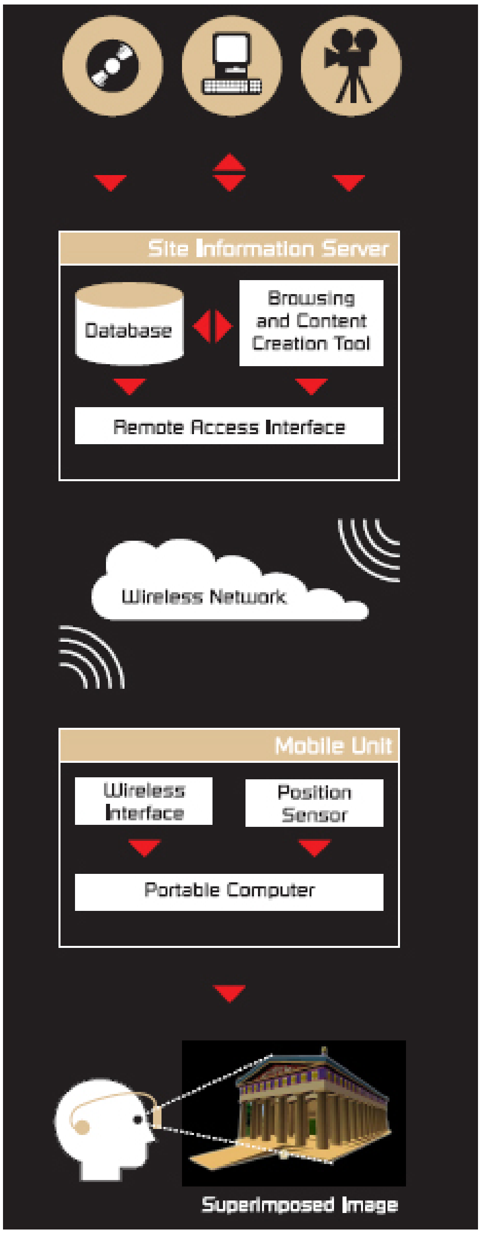
A Wireless Sensor Network (WSN) typically consists of a large number of tiny wireless sensor nodes (often simply referred to as nodes or motes) that are densely deployed. Nodes measure some ambient conditions in the environment surrounding them. These measurements are, then, routed to special nodes, called sink nodes (or Base Station), typically in a multi-hop basis. Then, the sink node sends data to the user. Depending on the distance between the user and the network, a gateway may be needed in order to bridge both, either through the Internet or satellite.

The research team have developed a new wireless sensor node. It is designed specifically for environmental monitoring applications, but also considering the specific requirements of the museum, for example, reduced size and cost. This device emerges as the element that collects the environmental parameters, such as temperature, humidity and light. In addition to these three parameters, it is possible to send the battery status (internal voltage) and the RSSI signal. The sensor node transmits the captured data to the base station, via radio frequency (RF). The radio module used is the XBee or the XBee PRO, from the Digi manufacturer which operate according to the ZigBee protocol ***(Baronti et all, 2007),*** i.e., it is designed according to the IEEE 802.15.4 standard and to support the specific requirements of WSNs. The ZigBee protocol allows the creation of PAN (Personal Area Networks) networks, supporting several network topologies, namely star, mesh and cluster-tree. At the picture 6 we can see how the network was designed and set up, where the wall obstacles were and how the data were transmitted to the central database. ***(Peralta et all, 2009).***

2.6. Archaeoguide

The last case study is not an indoor museum application, but an application of wireless technologies and network that was implemented for use at an open-air archaeological site. The ArchaeoGuide project's was developed by a consortioum of patners and was tested in Olympia archaeological site in Greece. The consortium envisions was to design a multi-user distributed computing system that will operate as follows: visitors, upon arrival on the site, shall "wear" a Mobile Unit (MU), i.e. a wearable computer equipped with a Head Mounted Display (HMD), camera and speaker and a very lightweight portable computer with sufficient hard disk space, processing power and wireless connectivity to the system server.

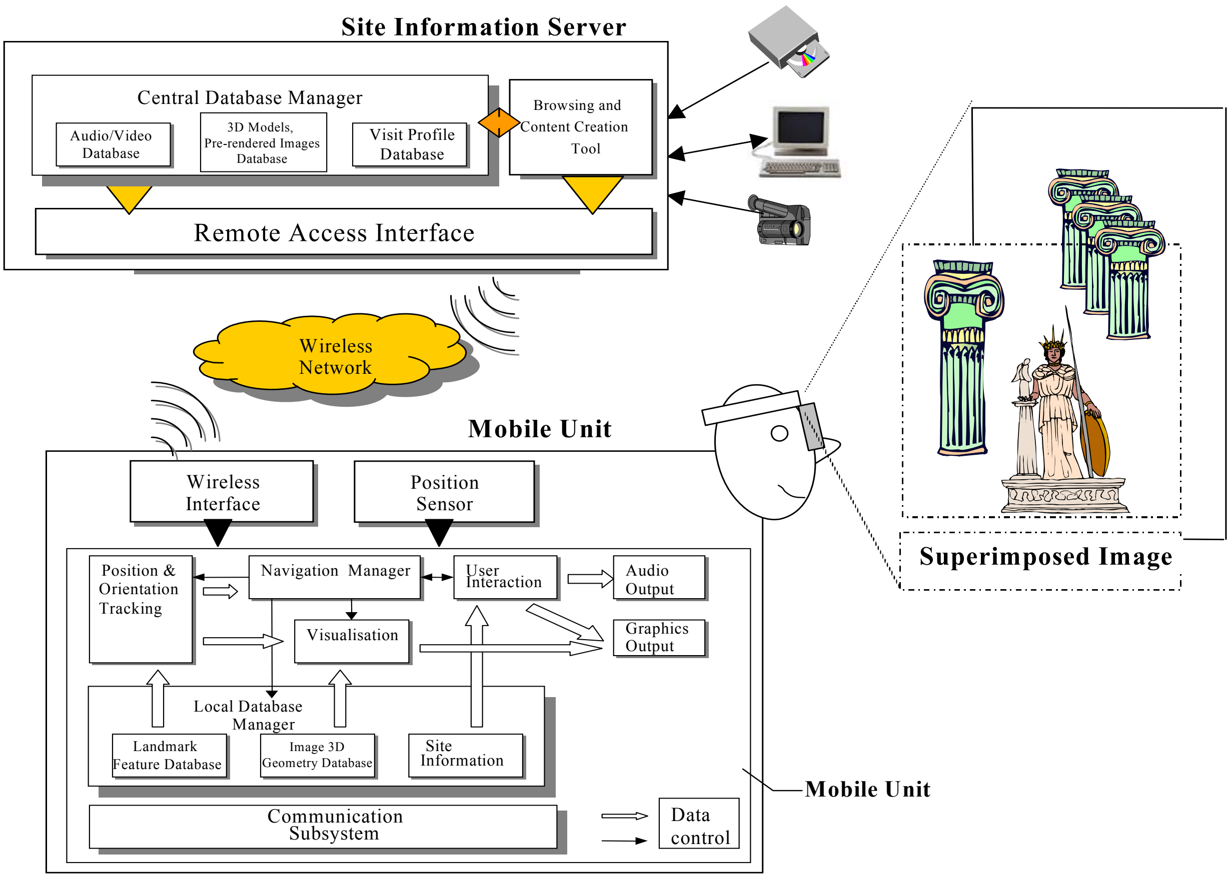
The visitor provides a user profile indicating their interests and background, and they optionally choose a tour from a set of pre-defined tours. The system guides them through the site, acting as a personal intelligent aid giving them audio/visual information suitable for them according to their profiles together with navigation help. Whenever and wherever appropriate, the system will render images of 3D models of the monuments and display them to the user's HMD. Correct object registration and occlusion handling of course requires having adequate position and orientation tracking systems and a detailed model of the site's static environment.



Picture 7: How Archaeoguide works

The system was designed to support concurrently many users without any serious sacrifices on the response time of the system. The architecture is a client/server architecture, where the clients are the wearable computers of the Mobile Units (MUs) equipped with a wireless network connectivity card. A wireless network with a sufficient number of Access Points (AP) provides connectivity to the server who is responsible for updating the contents of the MU's database whenever the user is moving to an area about which there is no content available.

Graphically, the system architecture is shown in picture 8. The hardware components of the system include a Site Information Server, the Mobile Units, and a Wireless Local Area Network (WLAN.). The site information server was a very powerful multi-processor system that was using multithreading to support many concurrent user requests for I/O and/or processing. The Mobile Unit (MU) is essentially a wearable computer consisting of a number of components. The MU contains a Global Positioning System and electronic compass device. A survey of the ancient Olympia site by the project partners, revealed that there is almost everywhere in the site an excellent reception of GPS signals, allowing GPS to locate the user with an accuracy of cm. Finally, the wireless network infrastructure assumes a wireless network connectivity card in each MU. It also requires a terrestrial wired network (with enough bandwidth) that will consist of a number of wired Access Points (AP) that receive, buffer and transmit information to the wireless transceivers and to each other. Each AP could support up to 50 connected wireless users. ***(Hildebrand et all, 2003)*** ***(Archaeoguide intranet, 2003)***

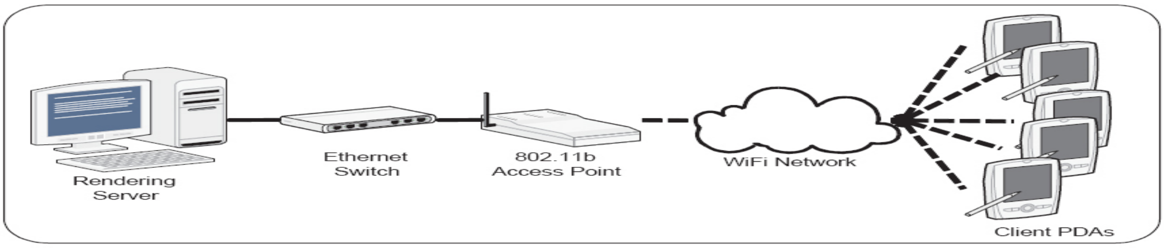


Picture 8: The Archaeoguide system architecture

Conclusions

The traditional way to introduce a cultural area or a culture organization like a museum is through human narrators, books, catalogues or something like that. Currently we can do it also through web pages of a web site. The defect of human narrators is high cost. As for books, catalogues or web pages of a web site, they are not in time and in place, such that the person involved and interested can not feel so impressed.

As we seen in the case studies above there would be a better efficiency if the person involved and interested in museum exhibits can get the information in time and in place. So it would be nice to construct software systems under a wireless Wi-Fi network to deliver the multimedia information of the current location to the user's mobile device in time and in place, just like the ones that were described above. Also it will be useful for the scientists of the museums to organise or protect better their exhibitions by collecting wirelessly certain information about the exhibits and the visitor's preferences.

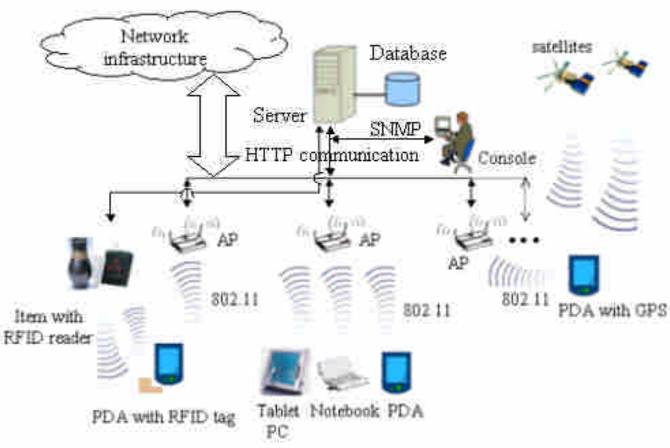


Picture 9: A wireless network architecture for PDA clients

The wireless networks have many advantages. The wireless network ignores the restriction of the space, so it has a more convenience than the traditional wired network in practicability. Therefore, it can overcome the obstacle on the environment, and offer the network environment that users can use whenever and wherever possible. The wireless network lets the information equipments link to each other to transmit the information, and does not need the circuit of the entity to avoid the connecting up perplexing. Also nowadays the number of wireless hot spots, public locations where users can find 802.11 wireless access to the internet, is rapid expanding. Nearly ubiquitous, anytime, access to the global internet is quite close.

Another aspect is that mobile devices and Personal Digital Assistants (PDAs) availability at cheapest price is growing steadily in the last years. In particular, PDAs with integrated WLAN (wireless LAN) and cell-phone capabilities (smart phones) accounted a significant part of this growth. The PDAs given their growing capabilities, interoperability with desktops/laptops, smarter applications and increased coverage of Wireless LAN in home applications as well as in public places (airports, theaters, restaurants, malls, etc.) ***(De Chiara et all, 2007)***

The way the wireless visit tour is done as we examined at the cases studies is the following: The targeted mobile devices are notebook PC, tablet PC, PDA and smart phones. When the user moves to a new position, the server will know this new position by cooperating with the positioning system, and convey the relevant web pages about this new place to the same mobile device, which the user can browse. Therefore, there would be a deeper understanding to the visited area or spot. We have seen four methods available about the positioning system for the server: They are GPS, the IP address of an access point, the infrared technology, Bluetooth technology and the technology of RFID. An overall system with the server, the positioning system, and mobile devices under Wi-Fi network can be applied to museums, art museums, aquariums, and also other indoor and outdoor applications. Furthermore, the web pages presented on PC are different from on PDA. Two sets of web pages have to be offered.



Picture 10: A general wireless network system architecture

At the picture 10 we can see a general infrastructure of a wireless network for museums and other indoor applications.

In closure we have to take notice that most online and multimedia on-site tours suffer from two main problems. The first is lack of content personalization and dynamic adaptation according to the visitor interests and the contextual information. The second problem is lack of connection between online tours and on-site/multimedia tours, which are usually separated into two tours without any connections. The challenge of building a personalized online and on-site museum tour for every visitor is an intriguing one and several research teams try to accomplish it. We have studied some of them like: The CHIP Interactive Tour Guide which offers various online and mobile tools to the users for the planning of personalized museum tours. ***(Roes et all, 2009)*** And the Humanoid Museum Tour Guide: Robotinho that uses humanoid robots an ideal platform for museum tour guide projects. ***(Faber et all, 2008)*** Because these two projects don't use advanced wireless technologies weren't presented in this study, but are certainly considered as the future of wireless museum tour guides.

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