Experiences of mobile learning in science: technological solutions for wireless network and content delivery

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Abstract: Mobile learning is a vision of learning no longer be confined to the desktop or classroom involving the use of mobile computational devices and wireless technologies. The paper describes a practical experience in the design and implementation of a wireless project with the main objective to assist students in attending an astrophysical course. Wireless computing was chosen because this technology transforms every wireless room into a flexible laboratory with students using handled devices both laptops and personal digital assistants to work on their own or in collaboration with others interacting with teachers.

Introduction

Mobile learning is the intersection of mobile computing and e-learning solution: accessible resources wherever people are, strong search capabilities, rich interactions, powerful support for effective learning and performance based assessments. Necessary based on wireless connectivity and handheld computers to combine content, practice activities and personalized feedback, it faces two major technological issues: managing learning through intermittent connection and device independent delivery. The paper describes a practical experience, part of a project called "Learning from Starlight" selected by the HP Philanthropy foundation that granted the required devices, in the design and implementation of a wireless project applied in science education with the main objective to assist students in attending an astrophysical course. Wireless computing was chosen because this technology transforms every wireless room into a flexible laboratory with students using handled devices both laptops (particularly tabletPC) and personal digital assistants (iPAQ) to work on their own or in collaboration with others interacting with teachers. Since wireless networks allow for ubiquitous computing, students can upload and download information, and do any activity from any location instead from desktop or crowed computer laboratories. The truly unique feature is that students work in different locations but could join together through wireless connection engaging in real-time document collaboration and exchange of files in several format. We focus on the two main aspects of the project: the technological solution adopted and the content delivery aspect for the provided mobile context.

Background

The "Learning from Starlight" project is one of the first Italian experiment in using mobile devices and wireless technologies to improve education and outreach of Astrophysics for students of different grades of Italian education. The overall goal is to demonstrate that this kind of technologies could improve learning and teaching of science in general and in specific of Astrophysics that is a science based on observations. Actually all the knowledge about this science is due to the observation and analysis of the received signal (historically starlight) that are all the electromagnetic radiation at all the wavelengths collected from ground and space observatories. For this aim HP Philanthropy foundation granted to INAF a package of mobile equipment suitable for building an interactive system environment, and INAF experienced mobile technology involving classrooms of the three different stages in Italian education (primary, secondary and high school). The equipment consists in about 50 handled deviced (iPAQs and tabletPC) all equipped with most used wireless connections (infrared, Bluetooth and Wi-Fi) plus 15 docking stations to support read and write of CD/DVDs together with some devices (Access Points, printers and digital projectors) required to provide network services. The project approach configures as a mobile learning application (an e-learning method where the medium used to exchange the content changes (radio waves) together with the devices that are essentially handheld and portable. This combination allows the actors of learning process to enhance

communication and do collaborative activities in several physical locations outside the classroom or fixed laboratory context. In this way it was possible to evaluate the impact of such technology at different ages and to realize a strict integration between research and educational environments.

The use case scenario

The use case scenario has involved pupils from 8 to 18 years old belonging respectively to a primary school, a secondary school and a high school and their teachers. Students attended an astronomical course about the observation and analysis of astrophysical phenomena divided into three modules that took place in different physical location (in classroom, at home and in a astronomical research institute). In particular the course main topic was about the knowledge of the difference between luminous and not luminous celestial bodies of our solar system observing some important physical parameters (i.e wave, distance). Attending each module students should be able to exchange content of different types and formats between each others and the teachers that should also monitor the entire learning phases. A first module was structured in a series of lessons to carry out in classroom and at home in order to observe moon and sun characteristics: in this phase for example each pupil took notes about moon phases on their PDAs at home in the evening and then elaborated his/her observations in classroom with the help of the teacher by using the tabletPC. Then they attended a module of one day in an astronomical research institute with the possibility to have a direct contact with astronomers that was structured as a set of lectures about the characteristics of another celestial body (i.e Mars) to take place in different locations and a final test in a laboratory to review the acquired knowledge and to be able to classify every other object as luminous or not-luminous.

The final module again in each classroom had represented a summary work of the previous ones. The realization of all these activities has required:

- the design and implementation of different wireless local networks (WLAN) to be deployed in the several different locations (i.e at home, in classroom and in several rooms of the research institute). This has implied the implementation of different wireless solutions according to the context.
- A particular focus on content delivery solution : it was necessary to provide content that should be as much as possible device-independent even if information is presented using different formats (text, formatted documents in Word or PDF, video, animation, etc).

Wireless technological solutions

A mobile learning system needs an appropriate wireless infrastructure to implement a wireless local area network that could be connected to the internet by the means of a wired line. The most available handled devices nowadays implement network functionalities support for the 802.11 family of specification (essentially the 802.11b also called Wi-Fi standard) developed by IEEE to specify an over-the air interface between wireless devices. Two different network topologies known as ad hoc and infrastructure mode, could be implemented to provide an infrastructure where deploy and use mobile content in different locations. The first refers to an intranet context such as a classroom or room environment where all the wireless nodes communicate in a decentralized way. The second is applied to wider context that make use of special devices called access points acting as a base station for providing wider range connectivity.

We use both these topology modes to realize the information system suitable for learning content delivery in the different locations (in classroom, at home, in different rooms) where students attended the several activities in which the course was structured. Examples of WLANs deployment in various locations are shown in figure 1.

For example infrared connection was adopted in the home context since it facilities the exchange between two devices, while it could be used both Bluetooh and Wi-Fi technologies in classroom context in order to make use of the functionalities of both the technologies. Even if Wi-Fi presents a

more simple installation and use, it doesn't allow in an ad-hoc network topology the unique acknowledge of iPAQs and makes difficult the communication with the tabletPCs. On the other end the Wi-Fi solutions is to be adopted if it is the necessity to integrate the network with a wired one.

Content delivery solutions

Mobile learning involves content that should be delivered in a location-independent and possible also device-independent method: as a new experience of such technologies in education, we don't choose any particular learning system to deploy the sub-modules of the course, but we developed content with the most used software (privileging open source one) in different format text, pdf, video, animation, html, etc in order that learning actors could read, write and manage it by using different devices.
The main issues are related to the real possibility of having the same content available both for tablet and palm by the means of the software.
For example video and animation content could be provided as Flash format for small size dimension of the resulted file, but there is a problem related to the free availability of a Flash player for PDAs. The best format content remains HTML files since by the use of XHTML format (and the related XML language) and style sheets (CSS) allow to define a schema for each device used to be included in the source of file and interpreted automatically by the browser (figure 1 show for example an interface for PDA).

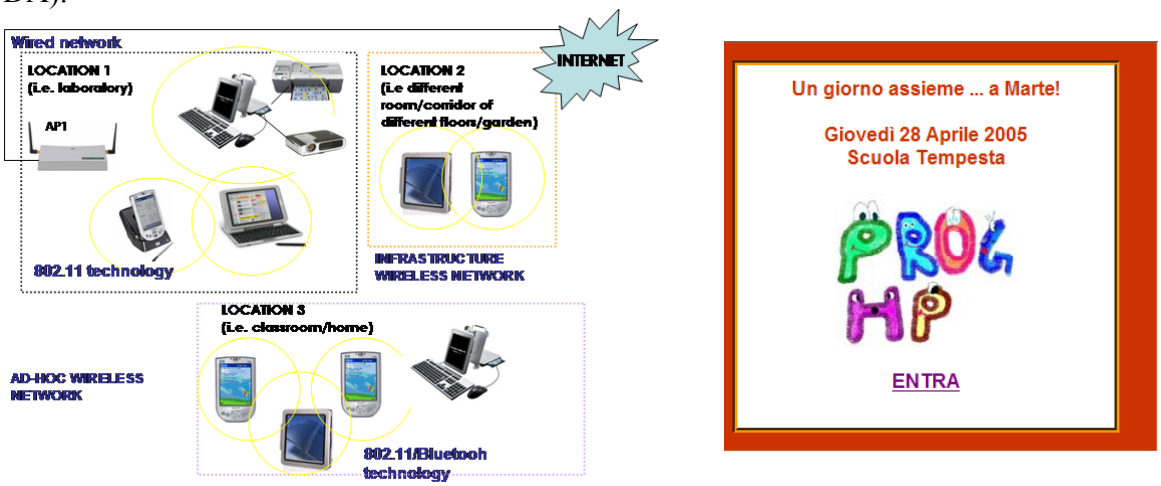

Figure 1: Technological solution (example of different WLAN implemented with Wi-Fi systems) and content delivery solution (example of content format use XHTML files that use CSS for device independent scope).

The use of other format such as PDF or Word/OpenOffice files requires the twofold versions of the same content to be easily readable by both devices.

Lessons learned and Future development

Wireless networks based on Wi-Fi standards are a good solution for implementing an infrastructure for mobile learning application, even if some problems arise in the maximum limited band (11Mb/s) on simultaneously exchange of great size file (for example movies). On the other end, a great effort is required to have content device-independent since the lack of software. The adoption of a learning system could be used in future for offering a common framework, but probably it should be necessary to develop specific interfaces to provide this important feature.

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