Peer-to-Peer Platform for Anytime /Anywhere Connectivity in Educational Environments

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Abstract

Institutions are becoming wireless and most of the population are possessing wireless devices since they are becoming less expensive. Providing advanced services such as context aware applications where the personal devices adapt its behavior to the changing environment is challenging. In this paper we propose a P2P platform for a Campus Environment.

Keywords: *Mobility campus platform, context-aware systems, and mobile education.*

1. Introduction

Mobility has become a way of life. Nowadays more research has been focused to give information anywhere anytime the end user would like to have. Even in a university campus mobility has become a part of a students life. Research has proved that mobile solutions in schools can affect the learning environment a student encounters [1]. Mobile solutions can help the faculty members to offer top-notch course materials. In short, it can shape the quality of today educational Experience.

Wireless Technologies and Hand Held Devices are growing in popularity in the university campus these days. Most of the well-known universities already have made their campus completely wireless. Advances in wireless networking have introduced a concept of computing called Mobile Computing, in which users carrying portable devices have access to network resources independent of their physical location.

Mobile computing is rapidly growing due to both technical and economical developments. Improvement in wireless technology has enabled wireless communication almost as effective as wired communication.

A large amount of research has been focused on providing mobility inside a campus. They have been reports ranging from studies on design, coverage and infrastructure set-up for wireless networks to developing applications and services that enables mobility for a small population confined in an area like the university campus. From the infrastructure point of view, the Wireless Andrew project at the Carnegie Mellon University was one of the first attempts to give complete wireless coverage inside the campus. Then they had the Hand-Held Andrew project, which uses the wireless infrastructure to demonstrate the potential of ubiquitous access to information through the use of small size hand held computing devices. The need for ubiquitous services inside the campus environment, motivated us to develop a platform for our campus.

2. *m*-Campus Project

m-Campus (mobility-Campus) is a name of pilot project done to study the importance of mobility and to build applications that would cater to the needs of the population inside a university campus.

The campus that we took for this study is Institut National des Télécommunications (INT) in France. There are more than 2000 students and about 190 faculty professors.

To understand the needs of mobile campus, INT Management students conducted a survey with the people inside the campus. The survey was divided into two parts. One was whether the community inside the campus had the necessary equipments to be connected while on move. The other one was whether the community was interested to have mobile services. We illustrate the result of the two surveys in the subsequent Table 1 and Table 2.

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IEEE COMPUTER SOCIETY

Table 1. Wireless equipment's in INT.

Equipment	Ratio %
Mobile Phone	90%
Laptops	56%
Smart Phone	0.4%
Desktop PC	40%
PDA	1.8%

Table 2. Student needs for mobile services.

Service	Very Interested	Interested	Not Interested	Not at all Interested
Schedule	77.1%	17.6%	3.71%	1.59%
Instant Alert	69.03%	25.84%	3.41%	1.72%
Courses Online	25.95%	54.8%	13.84%	5.42%
Inscriptions Online	34.39%	44.39%	16.22%	5%
Information regarding student life	42.92%	41.56%	12.56%	2.96%
Chat	12.31%	25.41%	47.57%	14.72%
Mail	67.93%	23.62%	6.46%	1.99%
Restaurant Menu	8.46%	21.82%	49.84%	19.78%
Library Online	13.69%	37.96%	35.92%	12.44%
Other Mobile Services	25%	0	50%	25%

The Synthesis of the two tables (Table 1 and Table 2) determines that people related to INT have the necessary equipments that will facilitate them to communicate or access information while they are mobile and more importantly they see that there is a need to have mobile services. Desire for different mobile services expressed by the community can be categorized into three types:

- Services related to education like Schedule + Instant alert (professor absent) + Library Online + Inscription Online + courses Online
- Services related to Student Life like Restaurant Menu + Information regarding various associations
- Services related to private life like Chat + Mail

INT has good wireless infrastructure. Regarding wireless connection inside the INT campus we have set up Wireless Fidelity installed initially in 802.11g standard, which allows having a data rate transfer speed of 54 MB. Now we have intended to extend the field of reception such that information access can be done from anywhere inside the campus without a connection. But with all these facilities Wi-Fi bandwidth is very less consumed. There can be different reasons for this.

The main reason for the less consumption in bandwidth is, there are no specific applications like instant alert or location aware or buddy finder, available in INT so as the students can use while they are on move. Another reason we can quote is the community inside INT yet doesn't have the prior experience of mobile service before so as to relish its importance.

2.1. *m*-Campus Goal

The focus of this project will be to realize an

1. R&D Platform for researchers:
   - Introducing context aware applications, which will further make the communication inside the campus ubiquitous and pervasive. This can also help us to use similar applications while inducting the ideas to a enlarged goal like Context aware Applications in Corporate communications.
   - Developing applications, which can suit the population inside the campus. Most of these applications will be those that has been the requirements of the INT population [Table 2].
2. Test and Industrialization Platform:
   - Testing new communications concepts, new algorithms on P2P architecture, new services, and which will serve as the pilot phase for the future activities like industrialization of the products developed.
3. Extending the field of range:
   - Extending the field of range to the other schools near the proximity of INT (like Schools from GET – Groupe des Ecoles des Télécommunications) such that they can also benefit and in turn the population inside the campus can also benefit.
4. Using this platform for teaching school activities:
   - Courses, Labs, Projects with students.

5. Translation technology to industry:
- This Project will form as the first phase of an enlarged goal Mobile Industry or a Mobile Town like the cool town project of HP[3].

2.2. Peer – to – Peer

Peer-to-Peer (P2P) is the architecture, which has the mechanisms for individual machines to act both as a client as well as server. Unlike the client/server architecture, P2P networks don't rely on a centralized server to provide access to services.

It allows intermittently connected computers to find each other. By this mechanism, P2P enables all connected computers to determine different services available on the P2P network.

The main advantage of P2P networks is that they distribute the responsibility of providing services among all peers on the network; this eliminates service outages due to a single point of failure and provides a more scalable solution for offering services. In addition, P2P networks exploit available bandwidth across the entire network by using a variety of communication channels and by filling bandwidth to the edge of the Internet. Unlike traditional client/server communications, in which specific routes to popular destinations can become overtaxed, P2P enables communication via a variety of network routes, thereby reducing network congestion. P2P has the capability of serving resources with high availability at a much lower cost while maximizing the use of resources from every peer connected to the P2P network. Whereas client/server solutions rely on the addition of costly bandwidth, equipment, and co-location facilities to maintain a robust solution, P2P can offer a similar level of robustness by spreading network and resource demands across the P2P network.

There are different types of P2P models:

1. Pure P2P model, where each peer dynamically discovers other peer and exchanges content or services, in this case applications do not rely on a server.
2. Hybrid P2P model, where both P2P and client/server models co exist. In a hybrid P2P model a server is approached first to obtain a 'meta' information such as identity of the peer on which some information is stored. Once the identity is obtained and connection is set up between the two remote peers, then a P2P communication is performed.

In order to set up a *m*-Campus platform to have mobility in the campus we used the hybrid P2P model. The reason is in a pure P2P environment, research / localization mechanism is completely distributed, thus the trading performances are significantly reduced in such a dynamic context. In contrast to the pure P2P model in a client/server environment, the localization information is handled by only one directory service. Due to the dynamicity, the data updates would be too numerous to be managed efficiently. Thus, by using the hybrid P2P model, the partial centralization of the information allows to limit the research of information only on the central peers. Central peers are always connected and all peers can communicate with the others peers directly or used a central peer as relay.

Ordinary peers, which use central peers to communicate, are called light peers. Moreover, thanks to these central peers, the localization information can be distributed. Inside each communication area, some static users can provide the central peers. When a user enters in a communication area, his/her light peer connects to a central peer. Then, he/she can discover, the different proximity applications, the available services and the other peers. His/her information is replicated on his/her central peer thus, even if he/she is accidentally disconnected, the other peers can use his/her information.

3. *m*-Campus Platform

Rather than developing a software from scratch to set up a m-Campus platform we needed a tool which is already available and which can be customized according to our need. We identified an application package called Ipra*Cool which is a proprietary software from Ipracom. This client application package sets up a basic environment, where any application can be easily developed and plugged into the existing environment. This development environment permits application developer in such a way that he does not have to worry about the underlying complexities involved in communication between two peers.

Ipra*Cool can be installed in users computing devices like PCs, PDAs desktops and laptops. Once the Ipra*Cool client is installed it is able to share or exchange information with all the other devices which has an Ipra*Cool client installed in it. Communication is done wireless through Wi-Fi, GPRS, UMTS, and Edge and also with wired connections like Internet and Intranet. The plug-in applications that come with

Ipra*Cool contains generic mobile desktop applications like accessing a PC via smart phone for mail checking and also collaborative applications like file sharing exchange of information privately or within a community. New customized plug-ins can be designed, developed and integrated with the Ipra*Cool package.

Ipracom also provide another tool called Ipra*Box to users like a company or in our case the university to have Intranet access within the campus. Ipra*Box works as a routing server. The role of this software is to perform routing and traffic control. It uses a hybrid peer to peer model, where the peer which has an Ipra*Cool installed, initializes the connection sends a unique identifier of the remote peer to the centralized server which is the Ipra*Box. In this framework a unique Identifier identifies each peer. The Ipra*Box has a lookup table from which it identifies the IP address of the remote peer when the unique ID is passed to it. It then sends the received message to the remote peer. After the address resolution is made it should be possible for one peer to communicate with a remote peer without the help of the Ipra*Box. Individual users are connected to the Ipra*Box at the companies premises.

To making *m*-Campus platform, an Ipra*Box is installed in the Perceval platform which is a set of experimentation and research platforms contributing to the INT research programs as well as the expertise and technology transfer to the enterprises. The domain name for this Ipra*Box is INTTEST.

When, just after any Ipra*Cool client is installed in computing device inside INT, it will send an initialization message to the Ipra*Box. The Ipra*Box will assign a unique identifier to this new Ipra*Cool client. All the Ipra*Cool clients inside INT will have a name with INTTEST.* The * represents a numeric identifier, where with every new client installed it will be assigned with numeric incrementing.

Example: INTTEST.25 (nickname = Marc_PDA) – is a PDA equipment on INT Wi-Fi network, INTTEST.44 (Laurent_Portable) is a laptop on Home Personal Netwok connecting to Internet, INTTEST.54 (Marie_bureau) is a PC connection on LAN of INT, etc.

We can see in the Figure 1 and Figure 2 all possible configurations.

When a peer say INTTEST.2 wants to communicate with another peer INTTEST.5. At first INTTEST.2 will send a request to the Ipra*Box in search of INTTEEST.5. When Ipra*Box receive the request, it look at its look-up table, identify INTTEST.5 and acknowledge to INTTEST.2. After receiving the reply from Ipra*Box, INTTEST.2 communicate directly to INTTEST.5 without the interference of Ipra*Box. In all cases nicknames are used.

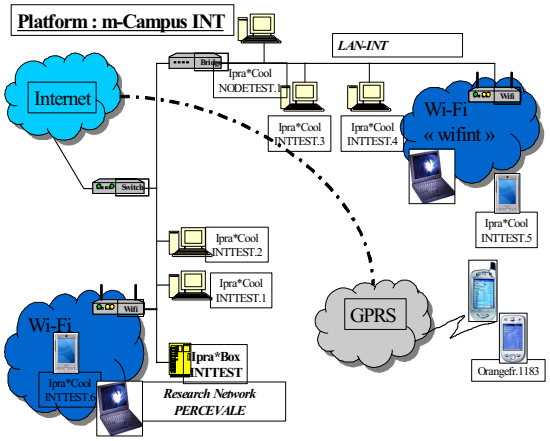


Figure 1. *m*-Campus architecture in INT

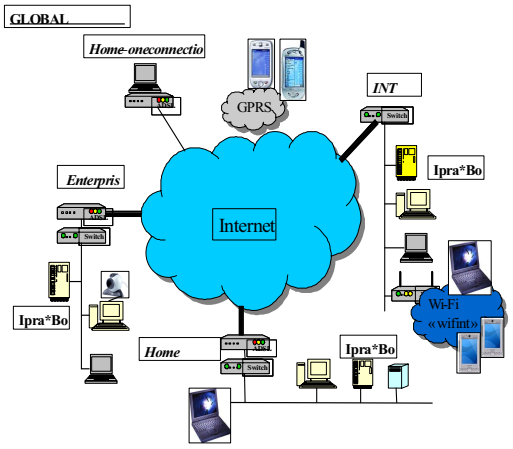


Figure 2. *m*-Campus architecture around Internet / GPRS Networks

If in case INTTEST.2 wants to communicate with a client outside the premises of INT campus, for example a smart phone with the identifier "orangefr.12" (here all the Ipra*Cool clients connected by the GPRS operator Orange and if they are in France will have there unique identifiers in the sequence Orangefr.*) the connection will first go to Ipra*Box in INT. When INT campus Ipra*Box identifies the remote peer is not within the domain of INT, the request will be sent to the Ipra*Box main

server in Ipracom. Then the main Ipra*Box will identify the Ipra*Box which deals with the domain orangefr.*, which in turn will send the acknowledgement through the same route to the peer which initialized the request. Once all this procedure is done INTETST.2 and orangefr.12 can communicate directly.

4. Ipra*Cool Application Development Structure

The application development framework on Ipra*Cool has a simple structure. The programming language is C++. There is a standard part, which is called the "Environment". The Environment contains the code, which takes care of how communication is done between two peers. The new application when integrated to the Environment can consist of one or more functional bodies. All these are derived from a standard parent class Application. The Application class obliges to define a set of methods, which are used as interface between each module and the environment.

Two derived functional models are mandatory. One corresponds to the application such as sight by the subscriber when he clicks on an icon, and The second corresponds to the treatment of the parameters. Other functional bodies are optional and can be added according to needs for the application such as for example the posting of a page of assistance to the user.

An application consists of a standard part, which makes it possible to integrate to the environment without having any prior knowledge of the environment. Essentially this standard part contains a function named PlugEntryPoint, which is the single entrance point by which the environment will be able to launch the modules.

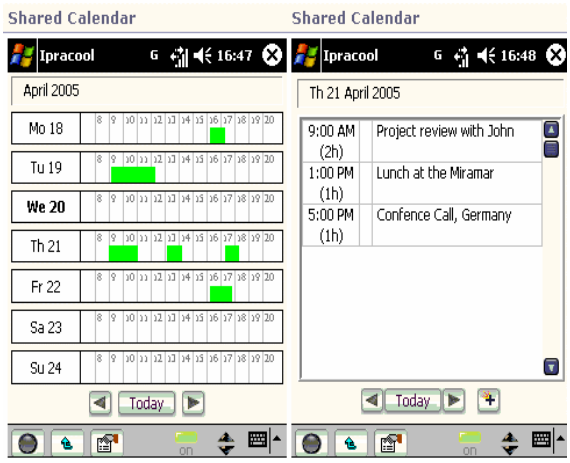
Even though a complete description of the framework is not inside the scope of this article, we just wanted to show how simple is to build a new application and integrate with the Environment.

5. *m*-Campus Applications

In this session we show a brief description of few applications developed on *m*-campus platform for the campus users.

5.1. Shared Calendar

With this application, users can share a calendar with their team or secretary. Everyone can access the calendar and add appointments. Any change is automatically transmitted to everyone who shares the calendar. Calendar can be shared between fixed and mobile users



Fsigure 3. Snapshot of Shared Calendar Application

5.2. Shared Documents

With this application, user can select a file and share it with a group of people. Every member will be able to read and modify it and everyone will automatically be notified of changes.

On your PC, you share a file by "dragging and dropping" it to the application interface. You then simply select the group of people you want to share it with.

5.3. Shared Database

With this service, members of a project group can share a simple database.

This application is ideal if you need to manage a light database of shared information (such as conference papers, course details or any other free-form information).

Everybody can access the records and modify them. Modified information is instantly synchronized within the group of users.

5.4. To-Do-List

This application helps users to manage tasks within their team. Everyone can add, delete or change the status of a task item; team members are then updated automatically.

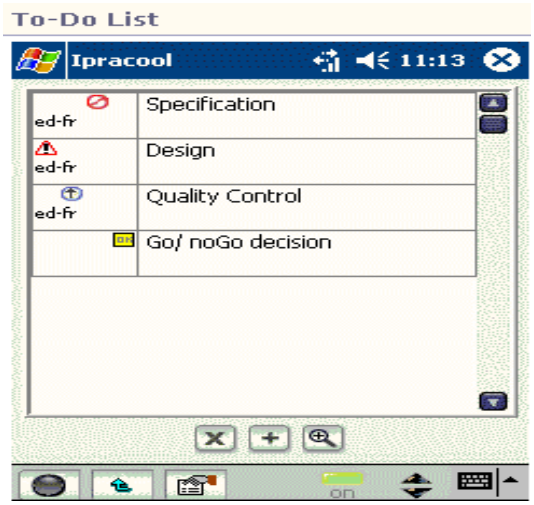


Figure 4. Snapshot of To-Do-List Application

6. Conclusion And Future Work

Most of the universities are making their campus mobile. The early adopters of the mobile campus concept like Carnegie Mellon University are starting to see the benefits of it in both in learning experience and the campus life. Small computing devices are becoming more powerful their uses are increasing. These handheld devices can make connectivity anytime/anywhere. In this report we have seen in step by step why mobile campus is important in a university campus like INT and how easily applications can be developed deployed and used through the existing framework.

Though Ipra*Cool which is used in *m*-Campus platform is a proprietary software, the cost of the applications package is very minimal. When comparing Ipra*Cool with other open source software's, the cost influence is marginal.

The next setup will be developing applications on this platform, which are ubiquitous and can adapt depending on the current context. These types of applications are called context aware applications. Such applications will abstract the technical complexities of configuring or installing software from the end user. In cases of hand held devices, power is a scarce resource. Cross layer interactions between physical, link and network layer seem to give power efficiency. This will be one of the domains we would like to concentrate on.

One of the worrying aspects in ubiquitous scenarios is privacy for the user. This will also be one of the outlooks for our future implementation.

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