Academic Activities Based on Personal Networks Deployment

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INTRODUCTION

Personal networking has already become an increasingly important aspect of the unbounded connectivity in heterogeneous networking environments. Particularly, personal networks (PNs) based on mobile ad-hoc networking have seen recently a rapid expansion, due to the evolution of wireless devices supporting different radio technologies. Bluetooth can be considered as the launcher of the self-organizing networking in the absence of fixed infrastructure, forming pico nets or even scatternets. Similar other wireless technologies (e.g., WiFi) attract a lot of attention in the context of mobile ad hoc networks, due to the high bandwidth flexibility and QoS selection ranges they feature, leveraging the path to develop advanced services and applications destined to the end user and beyond. Furthermore, personal networks are expected to provide a prosperous business filed for exploitation to third-party telecom players such as service and content providers, application developers, integrators, and so forth.

In this article, a personal-to-nomadic networking case is presented. Academic PN (AcPN) is a generic case that aims to describe several situations of daily communication activities within a university campus or an extended academic environment through the support of the necessary technological background in terms of communication technologies. The concept is straightforward: a number of mobile users with different characteristics and communication requirements ranging from typical students to instructors and lecturers, researchers and professors, as well as third parties (e.g., visitors, campus staff), are met, work, interact, communicate, educate, and are being educated within such an environment. This implies the presence of a ubiquitous wireless personal networking environment having nomadic characteristics. Several interesting scenarios and use cases are analyzed, along with a number of proposed candidate mobile technology solutions per usage case.

The article is organized as follows: first, a general description of the academic case is presented identifying examples of typical communication activities within an academic environment; the technical requirements necessary for a successful deployment of personal area network (PAN)/PN technologies within the academic environment are also listed. Next, specific deployment scenarios are presented, followed by a business analysis. The article closes with a concluding section.

ACADEMIC CASE DESCRIPTION

The AcPN case describes several situations of daily communication activities, taking place within a typical university campus environment. Members of the academic community, such as students, make use of personal networking concepts and related technologies to acquire and maintain constant connectivity among them or with local or remote networks, and utilize offered services—applications discovered at their point of presence. In this fashion, they may exchange files on the move, interact with each other in different ways (e.g., messaging, audio/videoconference), connect to a home desktop PC to download a missing file, or configure remotely a project installation located in a lab.

The AcPN case aims to support a number of communication activities known in an academic environment. Typical examples of such activities include:

- entering the campus, and making inquiries for local information (maps, buildings, etc.);
- monitoring information updates (announcements, urgent notices, deadlines, events);
- meeting with a colleague/friend/other student mates, exchanging data with others (docs, mp3, video clips, etc.), work management, and so on;
- seeking a friend/colleagues somewhere on campus;
- communicating with a professor/tutor/technical supervisor;
- reporting project results to colleagues and real-time discussion;

- borrowing/returning a book from/to the local library;
- performing remote home/office network setup (upon returning home);
- monitoring and controlling a lab experiment/project installation; and
- responding to emergency situations within the campus area (fire drill, medical assistance, etc).

The objective of developing the AcPN case is to provide the academic users with an easy way to perform their everyday work as efficiently as possible—in the least time and with the least cost. The academic entity concept-model used here is very general and includes all different types of academics existing in a typical university environment. These are undergraduates/postgraduates/PhD students, tutors/lecturers/professors, research associates, and third-party entities such as visitors and permanent/temporary staff. The campus infrastructure is supposed to support as many communication technologies as possible to the academic entities roaming on campus, in order to provide a variety of services, featuring flexibility in constructing different networking configurations. These technologies could range from short-distance wireless protocols (Bluetooth, infrared) to large-scale networking solutions such as WLAN or GSM/GPRS and 3G/UMTS.

In any case, academic users can benefit from PN concepts such as P-PAN, PAN/PN, W-PAN, and so forth in order to acquire access to other networks or services. Each user is equipped with a number of wireless communicating devices such as mobile phones, PDAs, laptops, headsets, and mobile storage devices, featuring GSM/GPRS/UMTS Bluetooth and WiFi technologies. These devices can detect and interact with each other in various ways, providing new communication capabilities and fields for different networking configurations.

For example, a student is able to form his own personally attached network or private PAN (P-PAN) by interconnecting his wearable short-range devices (e.g., headset, mp3 player, mobile hard disc, PDA) via Bluetooth or infrared protocol. On a larger scale, the user can also connect to a local network of short-range devices (other users' devices or local wireless printer) becoming part of the existing personal area network, and interact with users in his or her close vicinity who belong to the same network. The student may use his or her mobile device as a GSM/GPRS or UMTS terminal to extend his or her current P-PAN and PAN configuration in order to connect to his or her home DSL network to download an important file from the remote desktop PC. In this case, the student establishes a personal network that can be further used for numerous other remote actions. In the same way, the ubiquitous campus network provider can interconnect all PANs within the campus area and form a "personal"-like network: the campus PN.

Similarly, any other academic user can form one or more PNs dependent on the following parameters:

- the number of interconnecting devices,
- the inherent characteristics of used wireless technologies,
- the connection capabilities per technology in terms of bandwidth and QoS, and
- the requirements imposed by each service used on a particular PN.

Finally, administration of the campus PN is a very important issue for the successful management of attached users in terms of resources and security and successful service provision. Different security levels can be used, according to the trust policy followed when a foreign user (e.g., visitor) is accepted locally in a PAN or globally in the campus PN.

PN CONCEPT IN ACADEMIC CASE

PNs in our case comprise potentially all of a person's devices capable to detect and connect each other in the real or virtual vicinity. Connection is performed via any known and applicable wireless access technology (Bluetooth, infrared, WiFi, MAGNET low/high data rate, WLAN/GSM/GPRS/UMTS, and so on). PN establishment requires an extension of the present and locally detected PAN by the person's attached network (set of person's devices) called private PAN. The physical architecture of the networks and devices (for the AcPN case) has already been mentioned, while all interactions among them is illustrated in the Figure 1.

PNs are configured in an ad hoc fashion, establishing any possible peer-to-peer (P2P) connection among users belonging to the same local PAN and other remote PANs or PNs as well, in order to support a person's private and professional applications. Such applications may be installed and executed on a user's personal device, but also on foreign devices in the same way. PNs consist of communicating clusters of personal digital devices, possibly shared with others and connected through different communication technologies remaining reachable and accessible via at least a PAN/PN. Obviously, PANs have a limited geographical coverage, while PNs have unrestricted geographical span, incorporating devices into the personal environment, regardless of their physical or geographical location. In order to extend their access range, they need the support of typical infrastructure-based and ad-hoc mobile networks.

Strict security policies determine PNs' performance. Any visiting (foreign to the local PAN) mobile user bearing his or her own P-PAN may acquire trust and become a member of the locally detected PAN, as long as another member of the same PAN can guarantee his or her proper behavior in

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