2 From the Editors’ Desk

‘MOSAIC’: A New Section Is (re)Born

The members of the Editorial Team of UPGRADE announce the inauguration of a new section called MOSAIC, and the issues that will be covered in the monographs of year 2004.

3 Presentation

Wireless Access: Towards Integrated Mobile Communications – Vicente Casares-Giner and Jordi Domingo-Pascual

In their presentation the guest editors introduce the monograph, giving a brief historic outline of Telecommunication and explaining the present situation of Wireless Access technologies, where four families coexist: Cellular Systems, Cordless Systems, Wireless Local Area Networks (WLAN) and Satellite Systems. As usual, a list of Useful References is also included for those interested in learning more about this subject.

8 VoIP Services for Mobile Networks – Ai-Chun Pang and Yi-Bing Lin

This paper describes the UMTS all-IP solution for voice environments over IP (VoIP). The paper is centred on the functionality of IMS nodes (IP Multimedia Subsystem) and on SIP (Session Initiation Protocol) as a support for registrar and call generation operations.

12 WLAN Tracker: Location Tracking and Location Based Services in Wireless LANs – Can Komar and Cem Ersoy

The authors present the WLAN Tracker, a product developed jointly by two laboratories. Its purpose is to enable users (portable computers, PDAs, etc.) to be tracked throughout the entire coverage area of a WLAN.

15 Dissemination of Popular Data in Distributed Hot Spots – Mehmet Yunus Donmez, Sinan Isik, and Cem Ersoy

This article describes the WIDE (Wireless Information Delivery Environment) system, whose purpose is to distribute stored information in the so called hot spots, making use of an IEEE 802.11 infrastructure.

20 What is the Optimum Length of a Wireless Link? – M. Ufuk Çaglayan, Fikret Sivrikaya, and Bülent Yener

The authors offer solutions to power assignment in the form of two algorithms based on linear programming.

26 Capacity in WCDMA Cellular Systems: Analysis Methods – Luis Mendo-Tomás

The authors offer solutions to power assignment in the form of two algorithms based on linear programming.

31 A Perspective on Radio Resource Management in Cellular Networks – Oriol Sallent-Roig, Jordi Pérez-Romero, and Ramón Agustí-Comes

The authors believe that a plethora of technologies will emerge and coexist on the road towards 3G, and they discuss the need for interconnection and interoperability among them, and the demand for a global and common concept, RRM (Radio Resource Management).

38 Location Management Strategies in Next Generation Personal Communications Services Networks – Pablo García-Excalde and Vicente Casares-Giner

This paper is a study of the techniques and algorithms used in location management in present and future cellular mobile communication systems.

49 IP Mobility: Macromobility, Micromobility, Quality of Service and Security – Josep Manues-Alÿallay, Albert Cabells-Aparicio, René Serral-Gracià, Jordi Domingo-Pascual, Antonio Gómez-Skarmeta, Tomás P. de Miguel, Marcelo Bagnulo, and Alberto García-Martínez

This article deals with aspects related to mobility at IP level and above, placing special emphasis on macro-mobility mechanisms using the Mobile IP solution, micro-mobility mechanisms using the Cellular IP solution, quality of service and security issues.


Based on a practical case (the experimental application UbiquiMuseum) the authors discuss the use of Bluetooth and IEEE 802.11 as likely technologies of choice to provide network access to ubiquitous computing applications.

63 WPANs Heading towards 4G – Ramón Agüero-Calvo, Johnny Choque-Ollachica, José-Angel Irazorza-Teja, Luis Muñoz-Gutiérrez, and Luis Sánchez-González

The authors of this article outline their vision of 4G wireless systems and look into the role WPAN may play in the 4G of the future.

Mosaic

69 Integration of Application Data Using Static Variables and Multi-Threading – Yauheni Veryha, Eckhard Kruse, Jens Doppelhamer, Zaijun Hu, and Werner Schmidt

The paper presents a method for integrating applications data, aimed at data aggregation and transfer in software applications when integration of those applications has to be fast and should be done with minimum source code modifications.

74 News-Sheet: European Initiative for Growth. News from CEPS, EUCIP and ECDL.

* This monograph will be also published in Spanish (full issue printed; summary, abstracts and some articles online) by NOVÁTICA, journal of the Spanish CEPIS society ATI (Asociación de Técnicos de Informática) at <http://www.ati.es/novatica/>, and in Italian (online edition only, containing summary abstracts and some articles) by the Italian CEPIS society ALSI and the Italian IT portal Tecnoceta at <http://www.tecnoceta.it>.

Next issue (April 2004):

“Unified Modeling Language (UML)”
Wireless Access: Towards Integrated Mobile Communications

Vicente Casares Giner and Jordi Domingo Pascual

1 Introduction: A Brief Historical Outline

During the last century, telecommunications have been brought about a lifestyle revolution for humankind. The early milestones in the dawn of telecommunications are to be found in the 19th century which saw the invention of the telegraph in the 1830s by Samuel Finley Breese Morse (Charlestown 1791–New York 1872) and the telephone in 1876 by Alexander Graham Bell (Edinburgh 1847–Cape Breton 1922), though the latter invention was apparently made simultaneously by the American Elisha Gray.

In spite of the recent, pioneering experience of the telegraph, once the telephone was invented, telephone networks grew considerably faster than telegraph ones. The two services grew independently of each other, in terms of both technology and administration. In the mid 20th century telephone and telegraph services were provided over different networks, internationally regulated by different committees: the CCIF (Consultative Committee for International Telephony) on the one hand, and the CCIT (Consultative Committee for International Telegraphy) on the other, founded in 1924 and 1925 respectively. Later, in 1956, the CCIT and the CCIF were to merge, forming the Consultative Committee for International Telephony and Telegraphy (CCITT).

The 19th and 20th centuries also saw the early days and subsequent commercial consolidation of radio and television broadcasting services. In television, the first ideas about system design started to appear in the 1870s. Important contributions were made in the next decade, the most noteworthy of which came from the Frenchman Maurice Leblanc (1864–1941) in 1880 and the German Paul Nipkow (1860–1940) in 1884. In radio, after the pioneering work in the 19th century, 1920 saw the beginning of the first regular sound broadcasting from the Marconi studios, and in 1927 the Consultative Committee for International Radio (CCIR) was set up. Later, in 1941, regular radio broadcasts began to use a technique known as FM (frequency modulation), the invention of which is attributed to E. H. Armstrong (1890–1954).

In 1993 the CCITT and the CCIR disappeared to make way for the ITU (International Telecommunication Union, <http://www.itu.int/home/>), with two branches; the ITU-T (International Telecommunication Union – Telecommunication Standardization Sector) and the ITU-R (International Telecommunication Union – Radiocommunication Sector). The founding of

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those original committees and their subsequent merging were necessary steps to enable international interconnection between heterogeneous networks and to meet the needs created by the development of telecommunications more effectively. There is also a third branch, the ITU-D (International Telecommunication Union – Development Sector), whose basic mission is to help developing countries with telecommunications issues.

2 Cellular Radio as a Wireless Subscriber Loop

Nowadays, the telephone subscriber loop, the copper one, reaches practically every first world home. However, the need for mobility among certain social groups prompted the development of mobile radio technology. It was first tried out in 1921 in the USA when the Detroit Police Department used a mobile radio system operating at a frequency of around 2 MHz. Later, in 1940, the FCC (Federal Communications Commission, <http://www.fcc.gov/>) made further frequencies available for mobile radio in the 30 to 40 MHz frequency band. With the passage of time, mobile telephony became popular in the USA. In the 1960s, manual dialling was replaced by an automatic dialling service in the 450 MHz band, and this gave way to IMTS (Improved Mobile Telephone Service), which in turn developed into the US standard mobile telephony service. Other initiatives continued to shape the beginnings of cellular radio, culminating in the first commercial system, the AMPS-900 (Advance Mobile Phone Service), which came into service in the early 80s.

Expensive to install and maintain, the telephone copper pair has at times proved to be prohibitive even in countries with a high per capita income. Such was the conclusion reached by some Scandinavian countries with populations spread out over large tracts of land (e.g. Sweden has a mere eight million inhabitants but from north to south covers the same distance as from Copenhagen to Naples). The Scandinavian countries were pioneers in mobile telephony services, a technology which enabled them not only to tackle the issue of the expense of a traditional installation (subscriber loop) but also to provide the added value of mobility. In the early 80s mobile cellular telephony was also beginning to take hold in Europe. This decade saw the marketing of analogue cellular systems which were to be the first generation of cellular telephone systems. These included the American AMPS, the Scandinavian Nordic Mobile Telephony (NMT-450 and NMT-900), the British TACS-900 (Total Access Communications System, technologically similar to AMPS), the German system C (C-900), etc.

In Europe, the lack of interoperability between technologically different systems hindered cross-border roaming between operators. In 1982, under the auspices of the CEPT (Conférence Européenne des Postes et Télécommunications), the GSM (Groupe Spécial Mobile) embarked on work aimed at establishing a digital cellular mobile telephony system, which was to lead to the second generation GSM system. GSM is a pan-European system which provides greater capacity than its predecessors, allows roaming within Europe and can evolve to incorporate new technologies, services and applications. Its development was structured in chronological phases; the Phase 1 specification of the GSM system was completed 1991 with voice services and the first networks were deployed immediately. Phase 2 incorporated new services (Short Message Service –SMS–, new carrier services, etc.) and was completed in 1997. Phase 2+ incorporates GPRS services (General Packet Radio Service, using packet switched technology to transfer data in bursts, such as e-mail and WWW) and HSCSD (High Speed Circuit Switched Data, using circuit switched technology to transfer files and for mobile video applications). Although it was conceived in Europe, GSM has been adopted by other operators outside the old continent. GSM’s success has been such that, at the beginning of the 21st century, mobile GSM terminals GSM account for close to 70% of all the world’s mobile terminals.

The growing demand in the saturated mobile frequency spectrum prompted the FCC to look for a way to make the frequency spectrum more efficient. As early as 1971, AT&T came up with an idea for a possible technical solution to this problem, and the principle of cellular radio began to take shape. Various countries began to introduce cellular radio services in the early 80s, first with AMPS, NMT, ETACS (Extended Total Access Communications System), etc., a decade later with GSM, DAMPS (Digital Advanced Mobile Phone Service), PCD (Personal Digital Cellular), etc. and then early this century with UMTS (Universal Mobile Telecommunications System) and CDMA-2000 (Code Division Multiple Access 2000), not to mention GPRS WAP (Wireless Application Protocol), I-mode, etc. And not to forget 3G (Third Generation) services such as SMS (Short Message Service) which has been such a huge success, now accounting for a major percentage of operators’ revenues, and paving the way for MMS (Multimedia Messaging Service).

3 Wireless Access: Present Situation

Mobile phones now play a vitally important role in our society. The idea of mobility has penetrated deeply into our everyday habits, both in our work environments and in our private lives, during our working week and on our days off. The idea of always being in communication in time and space has become a need which has led to the design of new wireless access technologies and networks: These can be classified into families: in addition to cellular systems we also have cordless systems, wireless local area networks (WLAN) and satellite systems. We go on to outline the current situation of the first three systems.

3.1 Cellular Systems

Cellular systems are also known as WWAN (Wireless Wide Area Network) systems. Third generation (3G) systems with their greater coverage and higher speeds are expected to take over from second generation (2G) ones, providing a wide range of services: conversational (telephony, voice over IP – VoIP, etc.), interactive (web browsing web, access to databases, etc.), streaming (video, download on demand etc.) and background (e-mail, etc.).

While 2G cellular systems have been hugely successful due to its so called killer apps, such as high voice quality, SMS, etc.,
development of 3G systems has been slower than expected, possibly due to the slowdown in the economy, certain technological glitches in its implementation and also because of the appearance of alternative technologies with a lower cost and higher speed such as WLAN. One new fundamental component of 3G is the mainly European designed UMTS system. Together with the American CDMA-2000 and UWC-136 (Universal Wireless Communications) systems and the Asian Pacific ARIB-CDMA (Association of Radio Industries and Businesses – Code Division Multiple Access), it is the solution for IMT-2000, within the framework set out by the ITU for 3G. The new 3G services combine high speed mobile access with IP protocol based services. 3G systems are moving towards an all-IP solution, in order to offer the same advanced services that the Internet is providing today: high quality audio, VoIP, video on the move, and multimedia services in general. Some of these services are already starting to be available in 2.5G technologies (GSM/GPRS, I-mode, WAP, Bluetooth, etc., which act as a seamless migratory bridge towards 3G.

3.2 Cordless Systems
These are also known as ‘cordless telephony’. Initially their main purpose was to provide a standard quality telephone service to the Public Switched Telephone Network (PSTN) in ranges under 500 metres. They were designed to meet the need for local mobility in the home, in the office, and at high density locations (airports, railway stations, etc.).

The first generation (1G) of cordless systems came on the scene in the early 1980s, using analogue technology (CT0, CT1, … – meaning Committee Tn). After 1G cordless systems had enjoyed a brief existence, first 2G systems with digital technology (CT2, …) came on the scene, and then 3G systems (DECT, PHS, PACS, …). DECT (Digital European Cordless Telecommunications) is ETSI’s (European Telecommunications Standards Institute, 1991) cordless standard, while PHS (Personal Handyphone System) is the Japanese cordless standard from RCR (Research and Development Centre for Radio Communications) which was first marketed in East Asian countries in 1995. PACS (Personal Access Communications System) is the American cordless standard, under the auspices of ANSI (American National Standard Institute, 1996), previously known as WACS (Wide Area Communications System, 1994).

3G cordless systems can provide a number of applications, including residential telephony services, WLL (Wireless Local Loop) access and access to Wireless Local Area Networks (WLAN). All incorporate authentication and encryption mechanisms. Nevertheless, in spite of the high quality and diversity of applications, their future is somewhat in doubt, as 3G cellular systems are expected to absorb their functionalities.

3.3. WLAN Systems
The origins of WLAN date back to the late 70s, after the encouraging results obtained by IBM engineers looking to create a wireless local network in Switzerland working in the infrared band. Later came the desire to eliminate local network wiring in administrative environments and the demand for high speed connections between computers. Midway through 1985, the FCC assigned the ISM (Industrial, Scientific and Medicine) 2.4GHz band for the use of wireless networks with spread spectrum modulation.

In the present day there are two important standards, the IEEE802.11 and the HiperLAN (High Performance Radio Local Area Network). The IEEE802.11 group was formed in 1989 as a spin off from IEEE802, with the purpose of creating a standard for WLAN. The first draft appeared in 1994, and by 1999 the standard was considered to be complete. HiperLAN, promoted by the ETSI in 1996, created a standard with excellent results which received support from a great many companies in the sector (Nokia, Telia, Ericsson, etc.). However, it is currently the IEEE802.11 standard (more commonly known as WiFi – Wireless Fidelity) which is enjoying the greatest commercial success.

IEEE802.11 provides for two modes of operation: wireless network infrastructure and ad hoc network infrastructure. The former has the infrastructure of a wired fixed network and mobile terminals communicate directly with the designated network access points. It is a solution suited to environments in which access points are easy to install. The second is easier to deploy as it does not require a wired backbone network, all the nodes can move around freely and serve as routers, and the cost is very low. These networks are also known by the acronym MANET (Mobile Ad hoc Networks).

4. Structure of This Monograph
This monograph on wireless networks consists of a series of articles written by authors from several countries, European and abroad. They cover a wide range of topics: VoIP services, location services over WLAN networks, information systems in hot-spots, coverage and quality issues in ad hoc networks, capacity and radio resource management in 2G and 3G networks, mobile tracking issues, macro-mobility and micro-mobility management in IP environments, applications for ad hoc networks and the role of the WPAN (Wireless Personal Area Network) in 4G systems. The whole monograph serves as an overview of the state of the art of applications and some lines of research in cellular and WLAN networks. We will go on to give a brief summary of the contents of the articles.

The article “VoIP Services for Mobile Networks” by Ai-Chun Pang and Yi-Bing Li, describes the UMTS all-IP solution for voice environments over IP (VoIP). The paper is centred on the functionality of IMS nodes (IP Multimedia Subsystem) and on SIP (Session Initiation Protocol) as a support for registrar and call generation operations.

Location services IEEE802.11 networks are dealt with in the article “WLAN Tracker: Location Tracking and Location Based Services in Wireless LANs”, by Can Komar and Cem Ersoy. The authors present the WLAN Tracker, a product developed jointly by two laboratories. Its purpose is to enable users (portable computers, PDAs, etc.) to be tracked throughout the entire coverage area of a WLAN to an accuracy of ±12m, +−9m and +−5m when the mobile terminal has connectivity with one, two or three WAPs (Wireless Access Point) respectively.
The article “Dissemination of Popular Data in Distributed Hot Spots”, by Mehmet Yunus Donmez, Sinan Isik and Cem Ersoy, describes the WIDE (Wireless Information Delivery Environment) system, whose purpose is to distribute stored information in the so called hot spots, making use of an IEEE 802.11 infrastructure. The authors describe the architecture and the protocols it works over, and comment on reliability and communications security issues.

The impact of static power assignment in an ad hoc network is discussed in the article “What is the Optimum Length of a Wireless Link?” by M. Ufuk Çağlayan, Fikret Sivrikaya and Bülent Yener. Power assignment must be performed so as to strike a balance between maintaining high connectivity between the network nodes and keeping the amount of interference received by the mobile terminals to a minimum. The authors offer solutions in the form of two algorithms based on linear programming.

The capacity of 3G cellular systems is vitally important. The basic element is the carrier service, based on WCDMA (Wideband Code Division Multiple Access) technology. Heterogeneous services (interactive, conversational, background and streaming) must also be supported at the same time. The article “Capacity in WCDMA Cellular Systems: Analysis Methods” by Luis Mendo-Tomás looks at capacity analysis methods in 3G WCDMA systems and other related aspects. The study centres on the radio interface as the part of the network which limits capacity.

Convergence towards third generation (3G) cellular systems is expected to occur gradually. 2G systems like GSM will continue to evolve and provide new functionalities and services using GPRS, EDGE (Enhanced Data for GSM Evolution), HSCSD, etc., while the engineers get to grips with WCDMA technology and the marketing phase of 3G networks is prepared. The article “A Perspective on Radio Resource Management in Cellular Networks”, by Oriol Sallent-Roig, Jordi Pérez-Romero and Ramón Agustí-Comes, goes into the problem of resource management in 2G, 2.5G and 3G systems. The authors believe that a plethora of technologies will emerge and coexist on the road towards 3G, and they discuss the need for interconnection and interoperability among them, and the demand for a global and common concept, RRM (Radio Resource Management). On the subject of mobility management we have two articles: the first “Location Management Strategies in Next Generation Personal Communications Services Networks”, by Pablo García-Escalle and Vicente Casares-Giner, is a study of the techniques and algorithms used in location management in present and future cellular mobile communication systems. The second article, “IP Mobility: Macromobility, Micromobility, Quality of Service and Security”, by Josep Mangues-Bafalluy, Albert Cabellos-Aparicio, René Serral-Gracià, Jordi Domingo-Pascual, Antonio Gómez-Skarmeta, Tomás P. de Miguel, Marcelo Bagnulo and Alberto García-Martínez, deals with aspects related to mobility at IP level and above, placing special emphasis on macro-mobility mechanisms using the Mobile IP solution, micro-mobility mechanisms using the Cellular IP solution, quality of service and security issues.

With regard to ad hoc networks, the article “On the Use of Ad Hoc Networks for the Support of Ubiquitous Computing”, by Juan-Carlos Cano-Escrivá, Carlos-Miguel Tavares-Calafate, Manuel-José Pérez-Malumbres and Pietro Manzoni, is focused on applications which can be supported by an ad hoc network. They discuss the use of Bluetooth and IEEE 802.11 as likely technologies of choice to provide network access to ubiquitous computing applications, as in the case of the experimental application, UbiqMuseum, which is described as an example of the use of the above mentioned wireless technologies.

Wireless 4G systems are starting to be seen as an integration of many technologies co-existing in common scenarios. The final article, “WPANs Heading towards 4G”, by Ramón Aguero-Calvo, Johnny Choque-Ollachica, José-Ángel Irastorza-Teja, Luis Muñoz-Gutiérrez and Luis Sánchez-González, looks into the role WPAN may play in the 4G of the future. The authors outline their vision of 4G, which consists of facilitating access to a great variety of services in a totally transparent and ubiquitous manner, integrating technologies in one single environment and aiming at cooperation among different networks.

Finally, all that remains is for us to thank the authors for their invaluable collaboration in this monograph. Our thanks also goes to the editors of NOVÁTICA and UPGRADE for making this monograph possible and for all their work editing it. We hope and trust that you will all enjoy and benefit from reading it.

Translation by Steve Turpin
Useful References on Wireless Networks

Collected by Vicente Casares-Giner and Jordi Domingo-Pascual

Below is an inexhaustive list of resources on the subject of this monograph, a list which, in conjunction with the references included in the articles making up the monograph, will allow interested readers to pursue the topic further.

Books

Web sites
- 3rd Generation Partnership Project (3GPP): <http://www.3gpp.org/>.

Publications from Publishers
- Journals from Kluwer Academic Publisher, <http://www.wkap.nl/>:
  - Mobile Networks and Applications.
  - Wireless Networks. The Journal of Mobile Communications, Computation and Information.
- Journals from Wiley Europe, <http://www.wileyeurope.com>:
  - Wireless Communications & Mobile Computing.
- Journals from Wiley InterScience, <http://www3.interscience.wiley.com>:
  - European Transactions on Telecommunications.
  - Computer Communications.
  - Computer Networks.

Publications from Societies
- IEEE Communications Society, <http://www.comsoc.org>:
  - IEEE Communications Magazine.
  - IEEE Network.
  - IEEE Wireless Communications
  - IEEE Transactions on Communications.
  - IEEE Communications Letters.
  - IEEE Journal on Selected Areas in Communications.
  - IEEE/ACM Transactions on Networking
  - IEEE Transactions on Wireless Communications
  - ComSoc E-News
  - Global Communications Newsletter
  - Surveys & Tutorials
- IEEE Computer Society, <http://www.computer.org>:
- IEICE Society, <http://www.ieice.org>:
  - IEICE Trans. on Communications

Conferences and Congresses