

A window on Information Communication Technology

Edoardo Calia

The present and future of wireless communications: from mobile phones to “smart dust”

An overview of modern wireless technologies

The evolution of wireless communication technologies is one of the most significant technological phenomena of the last 15 years. The need for wireless communication and the basic technologies involved in it is not new, based as it is on more than a century of scientific research and important results. However, as in other technological sectors - and probably due to the strength of this starting point - the steps forward made by radio communications in the last decade are certainly the most evident to the general public. The design and implementation of new communication devices and technologies with very high performance (due to technological progress) but still affordable (due to the large number of users) grants millions of people access to information and entertainment services which were unthinkable only a few years ago.

The path followed by the technological evolution and diffusion of mobile communications among the general public is similar to that of Internet technology: for more than 80 years radio technologies were used by small communities, and they were oriented more toward professional rather than personal use. Only recently, with the success of cellular telephony in the last 15 years, a wider public became aware of its potential, and today everyone can communicate using small, sophisticated but still user-friendly devices.

To give a brief overview of the current deployment of wireless technologies, three main scenarios can be considered: wireless networks with wide coverage (cellular networks, generally managed by telecom operators), wireless networks with local coverage (Wireless Local Area Networks or WLAN), and the more recent short-range networks for personal use (Wireless Personal Area Networks or WPAN)

The sector of **wireless wide-area networks** offers mobile telephony users the possibility of using data communication solutions, such as broadband solutions like UMTS or i-Mode, at a theoretical speed of up to 2Mbps (in practice limited to around 400Kbps). The new standard WiMAX is already available and will offer faster network connections; it will be mainly used in the implementation of the so-called Wireless Local Loop (the “last mile”) in areas where cable services are not available.

In smaller areas and indoors, **wireless LANs** (Local Area Networks) are already widely used, allowing wireless interconnection of common computers (laptops and desktops). The WLAN technology is actually based on several standards and protocols which are constantly being improved and updated, such as the well-known WiFi, defined by IEEE (the Institute of Electrical and Electronics Engineers) as the “802.11” protocols family (802.11b, 802.11a, 802.11g, etc)

Advances in the sector of electronics miniaturization enable us to have wireless communication features in almost all portable computers, and this will be true in the near future for much smaller devices that people can wear or carry with them all the time, like mobile phones and PDAs. With the help of the so-called **Personal Area Networks** (PAN), digital communications will tend to become more and more pervasive and automatic, a natural part of our life.

From a technological point of view, PANs raise issues not found in the other wireless solutions described above: features such as low power consumption and the consequent long battery life, which will outweigh other aspects like communication speed. Initially dominated by infrared communications, WPANs today benefit from existing and widely deployed solutions based on Bluetooth - as well as newer technologies such as ZigBee, a short-range, low-speed communication protocol initially designed for home automation solutions which allows many small devices to communicate with each other.

The solutions and technologies described so far already belong to our present; devices are commercially available to implement the described scenarios. If we want to look ahead to the future, it is interesting to note that for several years researchers in the Silicon Valley have been studying and designing solutions to create something called **“smart dust”**: an extremely high number of micro-devices able to “sense” information from the environment and to pass data on to each other to reach a point where it can be examined and processed by powerful computers. We are still far from its development, but technological progress is clearly leading us in that direction: a “coarser” version of smart dust is already available today. Devices the size of a coin - with onboard sensors, microprocessors and radio electronics - are available to build miniaturized wireless sensor networks, which will be highlighted in an upcoming issue of this newsletter.

Edoardo Calia

Istituto Superiore Mario Boella
Via Pier Carlo Boggio 61
10138 Torino, ITALY

email: calia@ismb.it
tel: +39 011 2276201
fax: +39 011 2276299