EUROPEAN INITIATIVE TOWARDS ADVANCES IN FOURTH GENERATION

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Abstract
This paper reviews in brief four on-going European research projects in the field of mobile and wireless communications.

Introduction
European commission (EC) information Society technologies (IST) Sixth Framework programme (6FP) has launched several research projects towards the technological advances in the fourth generation (4G) including, MAGNET (My personal Adaptive Global NET), WINNER (Wireless World Initiative New Radio), Ambient Networks and PULSERS (Pervasive Ultra-wideband Low Spectral Energy Radio Systems).

This paper first presents an overview of these projects and then discusses the antennas and propagation issues to be investigated in the MAGNET project. Issues regarding access technology will also be introduced.

The MAGNET overall objectives are to design, develop, demonstrate and validate the concept of a flexible personal network (PN) that supports resource efficient, robust, ubiquitous service provisioning in a secure heterogeneous networking environment for nomadic users. Of paramount importance is the requirement that a PN will support its owner in all their private and business activities, without being obtrusive and while safeguarding the security and privacy of the users and their data.

The MAGNET project [1]
The MAGNET vision is that Personal Networks (PNs) will support the users' professional and private activities, without being obtrusive and while safeguarding their privacy and security. A PN can operate on top of any number of networks that exist for subscriber services or are composed in an ad hoc manner for this particular purpose. These networks are dynamic and diverse in composition, configuration and connectivity depending on time, place, preference and context, as well as resources available and required, and they function in co-operation with all the needed and preferred partners.

The project provides advances in the PN concept that include: a) Architecture concepts, b) Insight into business models for PNs and the related mobile data services in multi-network environments, c) Networking and interworking issues both at PN and PAN-level, in particular resource and context discovery, self-organization, mobility management, addressing and routing, service discovery, and co-operation between public and private, licensed and unlicensed networks,   d) Security and privacy issues in PNs, and e) Adaptive and (re)configurable radio access covering a wide range of data rates, system capabilities and requirements, optimized for low-power and cost-effectiveness.

Personal Networks (PNs) comprise potentially "all of a person's devices capable of network connection whether in his or her wireless vicinity, at home or in the office". The work towards enabling this vision transparently for users results in major extensions of the present Personal Area Networking (PAN) and Ambient Intelligence (AN) paradigms. PNs are configured in an ad-hoc fashion, as the opportunity and the demand arise to support personal applications. PNs consist of communicating clusters of personal and foreign digital devices, possibly shared with others, and connected through various suitable communications means. At the heart of a PN is a core Personal Area Network (PAN), which is physically associated with the owner of the PN. Unlike PANs, with a limited geographically coverage, PNs have an unrestricted geographical span, and may incorporate devices into the personal environment regardless of their geographic location. In order to extend their reach, they need the services of infrastructure-based, and possibly also ad-hoc, networks. A PN extends and complements the concept of pervasive computing. Figure 1 depicts the composition of PNs.
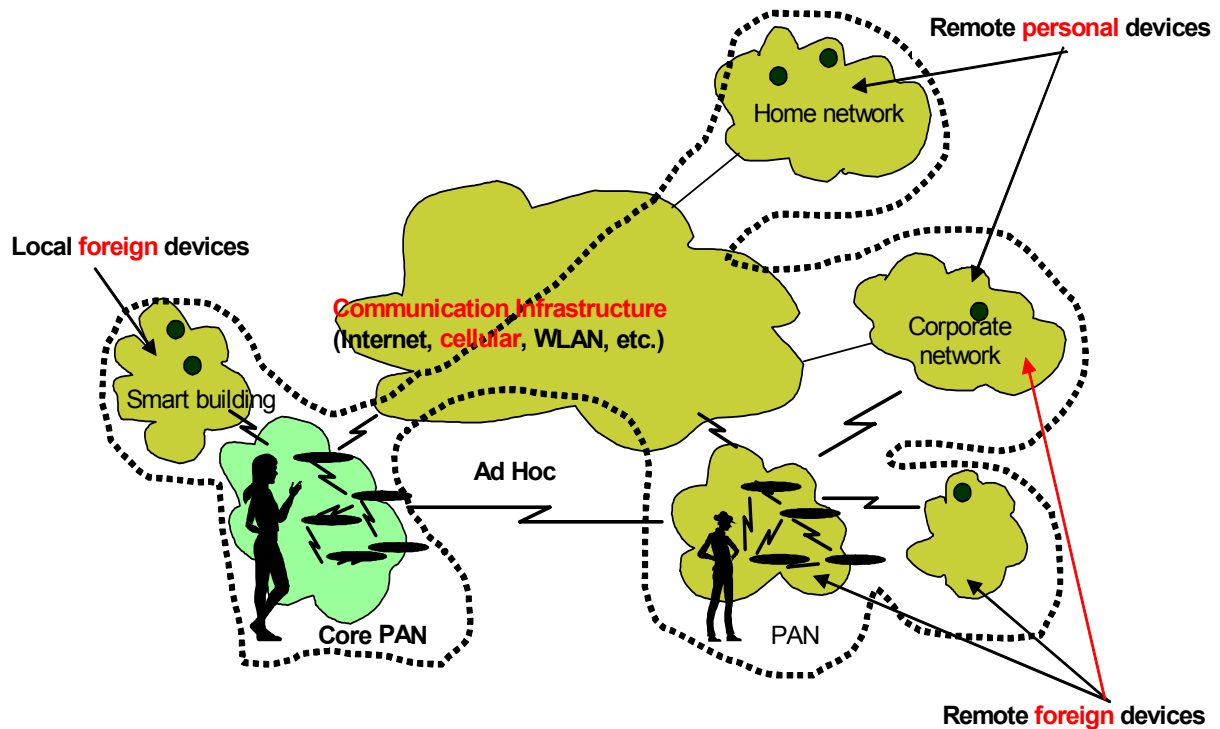
Figure 1: Personal Network composition

The main components of a PN are:

- A core PAN consisting of personal devices in the close physical vicinity of a user including devices moving around with him or her. The core PAN is an essential component of the PN.
- Local foreign devices or clusters thereof, which are owned by other parties and could either be reserved solely for the PN owner or be shared with others. They are linked to the core-PAN via communication infrastructures.
- Remote personal devices, which are grouped into co-operating clusters and which are linked to the core-PAN via communication infrastructures.
- Remote foreign devices or clusters thereof, which are linked via communication infrastructures, and again can be shared with many users or be reserved for the PN owner.
- Communication infrastructures, in principle wide area networks (WANs) making use of some sort of infrastructure-based resources (CN), which can be public (e.g., cellular, Internet) or private (e.g., leased lines), licensed or unlicensed (e.g., WLAN).

The WINNER project [2]

The Winner project ("Wireless World Initiative New Radio") will develop a new radio interface with significantly improved capabilities that enables a new mobile user experience and makes the international visions on mobile communications reality. The ubiquitous radio system concept will cover the full range of scenarios from short-range to wide-area and provide significant improvement compared to current systems in terms of performance, efficiency, coverage and flexibility.

The concept is based on a common radio interface technology that will adapt to user needs and scenarios by utilizing advanced and flexible network topologies, physical layer technologies and frequency sharing methods. The radio system will make efficient use of the radio spectrum to minimize the cost-per-bit by combining the enabling technologies researched in an efficient way to realize a future system through cost competitive infrastructure and terminals.

The WINNER project has created already in this early research phase a tight network of cooperation to support the international harmonization and consensus building process. For that purpose relations to other international bodies are currently being established, especially to ease future standardization.

The WINNER project will stimulate the next step of industrial revolution towards a more convenient and user-oriented mobile communication around the world.

The Ambient Network project [3]

The ambient Networks project addresses the creation of innovative network solutions for mobile and wireless systems beyond 3G. They will enable scalable and affordable wireless networking while providing rich and easy to use communication services for all. The work is geared towards increasing competition and cooperation in an environment populated by a multitude of user devices wireless technologies, network operators and business actors.

Ambient networks offers a fundamentally new vision based on the dynamic composition of networks to avoid additions to the growing patchwork of extensions to existing architectures. This will provide access to any network including mobile personal networks through instant establishment of inter-network agreements.

The project adopts the design paradigm or horizontally structured mobile systems that offer common control functions to a wide range of different applications and air interface technologies. Such a radical change requires the definition of new interfaces and a multitude of standards in key areas of future media- and context-aware, multi domain mobile networks.

The PULSERS project [4]

PULSERS (Pervasive Ultra-wideband Low Spectral Energy Radio Systems) will contribute towards realizing the IST vision "Optimally Connected Anywhere, Anytime". This will be accomplished by scientific investigations and the innovative development of short-range wireless systems and architectures based on ultra-wideband radio technology (UWB-RT), in particular, new PHY/MAC concepts and hardware/software platforms capable to support a diversity of user scenarios. The key objective of PULSERS is to provide contributions in the area of R&D related to UWB-RT with the ultimate goal to achieve benefits to human communication needs. By bringing together experts on the topic from various European countries and by including important UWB players from Asia, the PULSERS R&D organizations aim at advancing the state-of-the-art and further the deployment of UWB-RT in Europe and world-wide.

During the first 24 moths PULSERS aims at realizing the following objectives:
- Define and Specify User Application Scenarios
- Provide System Solution Concepts
  - based on Single Antenna Systems (SAS) and Multiple Antenna Systems (MAS)
- Provide Sophisticated PHY Concepts
- Provide Advanced and Optimized MAC Concepts
- Provide Advanced Enabling Technologies for UWB Exploitation
- Provide Influence on Regulation and Standards**.**

Antennas and Propagation [5]

New, reliable air-interfaces and adaptive medium access control schemes for PAN/BAN cannot be successfully implemented without a throughout analysis of the specific radio propagation channels.

The dynamic end-user scenarios that need to be considered span from very short range indoor or body-worn networks (1 to 2m) to access-point like scenarios (<10m) in typical environments, e.g. office, home, shopping areas, etc. In typical BAN scenarios, e.g. for small-size body-worn and hand-held devices, the radio propagation channel most likely will exhibit some interesting characteristics such as highly scattered paths, near-field and body proximity effects.

The PAN/ BAN radio channel investigations carried out in MAGNET, involve measurements and modelling of ultra wideband (UWB) systems operating in the 3GHz to 6GHz band with a bandwidth of at least 500MHz. These investigations are envisioned to target small-size communication devices, in both access point and body-worn device scenarios.

Multiple input - multiple output (MIMO) antenna configurations and systems are considered in the view of the specific PAN/BAN terminal/device design and user requirements.

The traditional channel measurement methodologies are not directly applicable to the investigation of the radio propagation within the PAN/BAN and new techniques have to be adopted.

Furthermore, the effects of the small, low profile antennas in realistic user terminals/devices will be included in the developed radio channel characterisation.

Air-interface improvements will be analysed and proposed in order to optimise the operation of the UWB communication system in the specific propagation conditions encountered in typical PAN/ BAN applications.

Figure 2 shows an example of body-worn device scenario. Extensions of these investigations for more realistic and dynamic end-user PAN scenarios will be carried out in the IST MAGNET project.
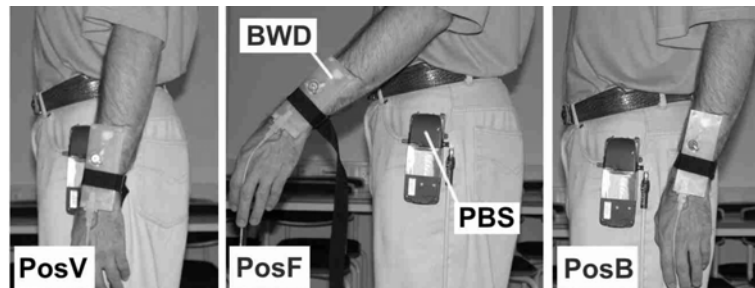
Figure 2: Examples of typical BAN scenario investigated for UWB communication systems
(PBS=portable base station; BWD=body-worn device; PosX=positions of the user arm)

Access Technology

Access technologies for the future wireless generation are under investigation at the CTIF. Orthogonal Frequency Division Multiplexing (OFDM) has been chosen as the access technique for the fourth generation (4G) wireless communication system. Due to its capabilities to support high data rates avoiding the inter symbol interference (ISI), more than ten times higher data rates than in 3G are expected. CTIF has put its main focus on the investigation of the coupling of OFDM with multiple access capabilities provided by T/C/S//FDMA. This combination breaks new ground for flexible air interface design for multiple scenarios such as cellular, wireless local area networks (WLAN) or personal area networks (PAN). The flexibility is used to support heterogeneous terminals with differ in size, display, energy consumption and complexity. To achieve this goal the cross layer optimization of protocol layers are exploited.

Conclusions

Convergence, adaptation, and personalization will be the key features of future wireless communications. These features have been heavily considered in the present research activities within Europe. The MAGNET Project especially focus on these three points.

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