Antenna Centre of Excellence

# A EUROPEAN CENTRE FOR IMPROVED ANTENNA RESEARCH

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## Introduction

The European Commission has created a new tool to support European research. This tool is called Network of Excellence, and its purpose is to assemble the best excellence in Europe in a specific area, improve the information exchange and restructure the research in this area. Although most European countries now belong to the European Union, the cooperation between scientists and engineers is not as strong as in the more homogeneous North American and the Japanese areas. This is due to historical traditions and the language barrier. The goal of the new tool is to amend this situation.

Information Society Technologies

An antenna Network of Excellence has been created on 1 January 2004 within the European Community 6th framework program in Information Society Technologies. Its name is "Antenna Centre of Excellence", ACE. It was proposed from members of the European COST 284 action in antennas (COST stands for "European Cooperation in the field of Scientific and Technical Research").

## Project summary

The ACE Network will structure the fragmented European antenna R&D, reduce duplications and boost excellence and competitiveness in key areas. ACE deals with the antenna function of radio systems. This includes the electromagnetic interface from conductors to free space radiated waves, the beam-forming functions, whether they are analogue or digital, and adaptive "smart" systems to optimize performance.

The project has a duration of two years, with start 1 January 2004. It has 45 participants from 13 European countries. 266 researchers and 96 PhD students are involved.

Antenna design has strong links to the applications; antennas must be specifically optimised for each case. On the other hand, antenna theoretical design and principles, software and test techniques can be common. In order to adapt to these two important facts, the work is divided in horizontal activities and vertical activities. The horizontal activities ensure the reuse of antenna technology and tools between the applications, while the vertical activities ensure the suitability of the technology for the different applications.

The vertical activities deal with the new and challenging antenna technologies: Antennas for high frequencies, wide bandwidth, multiband, advanced arrays and antennas for the new mobile communication systems.

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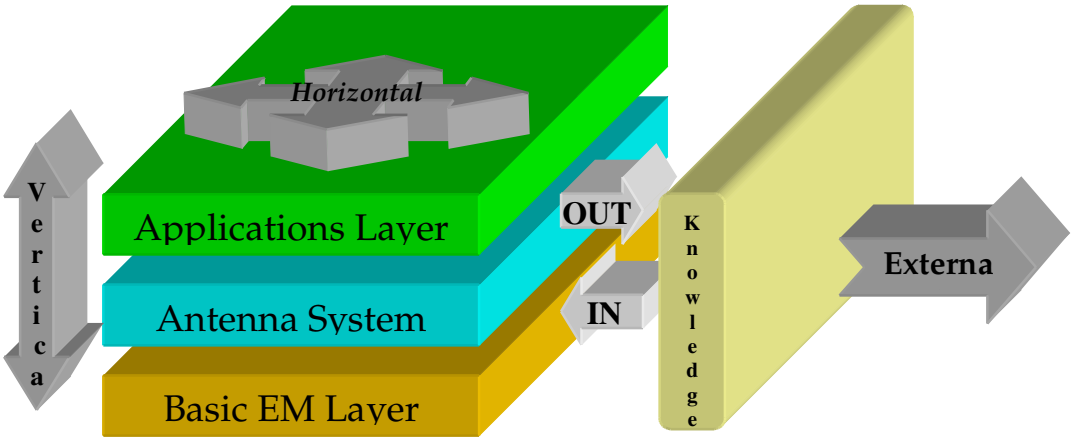


The horizontal activities deal with common problems: software, test techniques, education and dissemination.

At the heart of ACE, a ***Virtual centre of excellence (VCE)*** will serve as a knowledge base and communications centre.

**Organisation**
ACE has 45 members, which are universities, institutes or companies. The major decisions are taken by the Governing Board, in which each participant has one vote. It meets at least once a year and is chaired by the Network Coordinator. The technical work is lead by the Executive Board, chaired by the Technical Coordinator. The work is divided into 11 activities. Each activity has an activity leader, who is also part of the Executive Board. The activities are divided into work packages, with work package leaders. There are 35 work packages in total.
A Scientific Council of outstanding international experts will help ACE to reach its goals.

**Objectives**
The main purpose of ACE is to increase the efficiency and relevance of antenna research in Europe. It is also an intention to increase the innovation level by a more efficient flow of ideas. A careful preliminary investigation of the research structure has shown a number of application oriented research areas that need to be restructured. These are dealt with in the vertical activities. For these, coupling to the applications is ensured by involvement of industry and institutes, and also by involving universities with relevant system activities. The industry involvement will be with their long-term technical planning.
The objective of these vertical activities is to make the research more efficient by combining the resources from a few leading institutions, and to make it more relevant to the applications by including industries and users.
Horizontal activities will deal with software, testing, information, education and dissemination. The main objective is the integration of knowledge from different application areas, thereby avoiding duplication.
The long-term relevance of the research will be assured by establishing future needs within the different application areas, from knowledge inside and outside the network.

It is the intention that ACE will serve as a European centre for antennas even after the project with the European Commission has ended. This will allow a closer cooperation between the European countries, and will facilitate the contacts with the important antenna research going on outside Europe.

**Vertical activities**

***MM-& sub-mm waves/Integrated antennas***

Higher frequencies give larger bandwidth and possibilities for new sensor applications. The manufacturing of sub-mm-wave antennas requires new methods, which are not yet adequately developed. Such high frequencies also require integration with the active electronics in many cases. This area is also immature, and the ongoing research must be coordinated.
The activity aims to structure research on design, integration and manufacturing of high-frequency and integrated antennas.
It will benchmark manufacturing facilities, design tools and test facilities, and develop a coordinated approach for their use. It will also develop a coordinated vision for integrated antennas, and encourage new cooperation in this field.

***Small terminals and smart antenna systems***

The new generations of mobiles require higher bit rates and more frequency bands, giving new challenges to the antenna designers. A lot of antenna research goes on in this area, but it is often performed without sufficient systems background and connection to the market. The newest trends in terminal use have to be rapidly detected, as they will have a major influence on the requirements for antenna technology and design. Standardization is also important, in particular regarding specific test methods for terminals.
The activity aims to structure research on antennas for mobile phones and their system integration, and evaluate methods for characterization.
It will investigate the present status of small terminal antenna technology, and establish the future directions for requirements and technologies. It will also benchmark measurement methods and facilities. Further, MIMO systems and reconfigurable multiple antenna terminals will be studied, taking both electromagnetic and system aspects into account. Finally smart antenna strategies will be studied on the system level, including adaptive modulation approaches, MISO systems and context aware MIMO network optimisation.

***Wideband and multiband antennas***

Many applications have increasing demands on wideband or multiband performance. Research in the different application areas is not well coordinated. A common approach and stronger interactions between the applications are required.
The activity aims to structure research on multiband and wideband radiators and reflectors.
It will make a catalogue on wideband and multiband antenna designs and applications. The best approaches will be identified, and the future direction of research established. A special focus will be on wideband antenna design for surface penetrating radars, with their special needs for demining, medical, pipe location etc. This research is scattered around Europe, and will be coordinated setting up a joint test site to provide a common reference for antenna comparisons.
A separate group coordinates software for analysis and design of frequency and polarisation sensitive reflector surfaces such as FSS, grids, EBG surfaces etc.

***Planar and conformal arrays***

With the decreasing cost of active circuits, advanced active array antennas can be used for an increasing number of applications. Since the antenna function is created by not only the radiators, but also the active microwave devices, digital beamforming etc, their optimisation is difficult. For large arrays, traditional beamforming networks become prohibitively complicated. In many cases, conformal arrays are needed. All these areas need novel solutions, the existing ones, mainly from military applications, being too expensive.
The activity aims to structure research on the architecture, system analysis, beamforming networks and conformal application of array antennas.
A generic simulation tool will be built based on simplified models, allowing complete analysis of the antenna functions. It can then be used for optimising the individual components including the correct environment.
Beamforming techniques will be classified and evaluated, and assembled in a data-base.
Inventory of research on conformal antennas will be performed, selecting geometries, simulation methods and validation cases.

## Horizontal activities

### *Antenna software tools*

Antenna design is software intensive, and general electromagnetic solvers are often not adequate. Much good software has been developed at universities, but is not generally available. The objective is to establish a list of existing software and make comparisons between them by using test examples. Selected groups of software will be combined and made available with documentation and support.

### *Antenna measurements and facility sharing*

Many good test ranges exist in Europe. Since they are very expensive, a better use of these facilities is essential. A list with available test ranges, their capabilities and performance will be established. Reference test objects will be obtained, and used for evaluation of the test facilities. A number of test ranges will be made available for use with professional support. Courses and standardisation will also be included. The objective is to make good test ranges, test procedures and standards available.

### *Training and education*

Lots of good antenna courses are held in Europe, but there is little reuse of the material. ACE will make courses for doctor's degree open to all universities, combining the best available parts from different universities. Course material, both texts and computer exercises and simulations will be made available on the web. A virtual laboratory will allow use of educational software on the web. The objective is to make much better use of the good educational material already available in Europe.

### *Dissemination and knowledge transfer management*

The knowledge within ACE will be disseminated to users and industry, with emphasis on smaller facilities (SMEs and similar), which have limited capability to keep abreast of the development. The objective is that all organisations outside the network, which need antenna knowledge, will get it through our dissemination activities, and through them, come into contact with suitable partners for co-operation.
The organisation of technology exchange between antenna engineers and scientists within Europe and with organisations outside will be amended. The goal is to make the scientific antenna interaction within Europe and between Europe and the rest of the world more efficient. The organisations in North America and Japan will serve as models.

A web-based ***Virtual centre of excellence (VCE)*** is being created. It allows communications, vertically as well as horizontally. Educational material, reports from the activities, links to all participant's reports, doctors and master theses will be available, as well as software. The objective is to make knowledge and contacts easily available. It will contain both an internal part available for the members, and an external part that is open. The home page is www.antennasvce.org.

## Conclusion

ACE will harmonize the antenna research in Europe. Horizontal activities will make reuse of tools and technologies possible, and vertical activities will assure the relevance of the research ACE will also increase the interactions between the antenna researchers and engineers within Europe, and it will be a contact point for international cooperation, thus also giving increased possibilities for worldwide interactions.

The ACE project is flexible. During the course of the work, new problems and inefficiencies will be continuously identified. The results will be used, together with other information, to define modifications of the activities, and eventually new activities. Thus it will have a lasting impact on European antenna research.