Ambient Intelligence

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INTRODUCTION

"Ambient intelligence" (AmI) refers to both a theoretical and a practical orientation of technology, involving the most innovative areas of the ICT sector. Recognized as a powerful trend, Ambient Intelligence has an increasing impact in several domains of our contemporary society, the so-called "knowledge society".

Let us look at the two words "ambient" and "intelligence". Today we often use the attribute *intelligent* or *smart* referring to artifacts that show "a behavior", have "a memory", appear to take nontrivial "initiatives". Take, for instance, a smartphone, which is able, when there is an incoming call, to put up on the screen the image of our correspondent. The "*intelligence*" in the words "Ambient Intelligence" precisely refers to those special embedded capabilities of certain things around us, capabilities that we are not aware of until they come into action. The word *ambient*, means "existing in the surrounding space" and signals that there is a particular diffused property of such a space. It has an essential charateristic, which is neither explicit nor obtrusive, but widely exploited by our Knowledge Society: the capability to transmit information without the need of wires (wireless communications). Like its underlying technologies, Ambient Intelligence is an expanding, evolving concept, projected far into the future.

Ambient Intelligence was born in the United States and will be about 20 years old in 2007. In its history there is a remarkable difference between the period in the past century, characterized by laboratory programs and military use, and the period in the new millennium, showing international projects, industry investments and a progressive spread into the consumer domain.

BACKGROUND

AmI borrows its theoretical foundations from a variety of external disciplines, among which sociology, ergonomy, cognitive sciences and human computer interaction (HCI) have a relevant role. A definition of AmI in formal terms will be provided, but the simplest way to see it is as a set of objectives aimed at human progress, to be met progressively, that is, a *vision*.

The AmI Vision and Its Pioneers

The AmI *vision* is due to an American citizen, Mark Weiser, chief scientist at PARC, the prestigious Xerox laboratory in Palo Alto, California, in the years following 1988. Weiser was deeply concerned with the relationship between man and *computing* (meaning all forms of computing power), and was worried about the blatant unfriendliness of the computer and its obtrusiveness. His vision, expressed in a well-known paper in the journal *Scientific American*, is crystal-clear:

The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it. (Weiser, 1999, p. 1)

The aim of Weiser was to render technology "non-obtrusive" (also dubbed in his papers: *calm*, *invisible*, *disappearing*), contrasting the contemporary hype for VR (virtual reality). VR constrains the individual by imposing the adoption of awkward devices (e.g., goggles, sensitive gloves) and isolates him from the world. Moving in a completely different direction, Weiser and his team designed and built many innovative devices meant to replace the role of the personal computer. Their inventions anticipated most of today's mobile communication tools.

Besides Weiser, two other scientists are recognized as AmI pioneers: Donald Norman, an American, and Emile Aarts, a European. "Don" Norman, a cognitive psychologist and one of the top usability experts in the world, continued in the direction of Weiser the criticism of the personal computer (Norman, 1999). He pointed out the carelessness in the design of the "industrial" interfaces, that is, all the interfaces interposed between

man and the various electronic and nonelectronic appliances that surround him. Norman's thesis is well known, that when IT (information technology) is applied to objects for use, one of its key qualities should be "pleasurability" (Norman, 2003). Simplicity, versatility are also his keywords. His studies, for example his elaboration of the concept of *affordance* (Norman, 1988), are fundamental contributions to the AmI culture.

The period during which Norman's main works appeared, between 1999 and 2004, is also the time when the mix of ideas and studies around the "The Disappearing Computer" arrived in Europe and began to spread rapidly. "Building Disappearing Computers" (Russell, Streitz, & Winograd, 2005) had been an American vision, to which many high-profile scholars had applied themselves. Europe followed, and since then, in the Old Continent, the European Union has been giving ample support to the development of AmI. The very term "Ambient Intelligence" was coined in Europe at that time and ever since has been the name of this new and complex field of research and development. Ambient Intelligence is the merging of the American advances in computer technology and design principles (Winograd, 1996) with the European leadership in communications and Europe's strong concern about "lifelong and lifewide learning": the idea that technology should serve knowledge and that knowledge should be accessible by all social classes and at all ages.

The pioneer of AmI in Europe is Emile Aarts. He is senior vice-president Philips Research, senior scientist and scientific program director, Philips Electronics, Eindhoven, Netherlands. Aarts, a real champion for AmI, in many public occasions, with his books and through his own company incessantly advocates the AmI vision and its application in "everyday life" (Aarts & Encarnaçao, 2006; Aarts & Marzano, 2003).

This is our vision of 'ambient intelligence': people living easily in digital environments in which the electronics are sensitive to people's needs, personalized to their requirements, anticipatory of their behavior and responsive to their presence. (Philips Research, 2006, p. 1)

Philips is one on the leading company investing in AmI, but there are other leading-edge enterprises in this area, for example, Nokia, Vodafone, and Siemens in Europe; Intel, Microsoft, Sun and HP in the United States: NTT and Mitsubishi in Japan, as well as all the major car manufacturers worldwide.

Because of its evolutionary quality, amazing coverage of different disciplines and representation of new inventions, the knowledge about AmI is mostly located in the web and only very little material is available in print. At the same time, the number of international research centers and research groups that deal with AmI is very high, extending into most countries in the world. An indirect list can be obtained by consulting in print the projects projects presented in the very comprehensive book about AmI by Aarts and Encarnaçao (2006).

AMBIENT INTELLIGENT IN THE APPLICATION DOMAIN

AmI has been said to be the "megatrend" of ICT. Being a global trend with a wide scope, it involves numerous application domains and it is as pervasive as the technologies that underlie it. To move AmI out of the isolation of the research field, one key step was made 1999 by ISTAG, the advisory group to the European Community's Information Society Technologies Programme, which produced a fundamental report, giving a strategic orientation to all future IST programs. It is still current today:

The vision statement agreed by ISTAG members is to "start creating an ambient intelligence landscape (for seamless delivery of services and applications) in Europe relying also upon testbeds and opensource software, develop user-friendliness, and develop and converge the networking infrastructure in Europe to world-class. (ISTAG, 1999, p. 1)

The next event was the creation, by a large group of experts guided by the Institute for Prospective Technological Studies (IPTS, 2006), of a set of model application scenarios conceived to take place at the horizon of the year 2010. The document "*ISTAG, Scenarios for Ambient Intelligence in 2010 - Final report*" (Ducatel, Bogdanowicz, Scapolo, Leijten, & Burgelman, 2001) is a fundamental milestone for AmI and an absolute reference for the entire AmI community.

Ambient intelligence is understood as the sum, or convergence, of three continuously developing technologies: