# All the Toys I'll Ever Need

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**Abstract**

Imagine a technology, business model, and software distribution system that will place the power of a tablet PC on the hands of our toddlers and children. Our project aims at the creation of a "smart" programmable and configurable interactive toy that will offer entertainment and education to toddlers and children up to 16 years of age, through a collaborative, computer-aided creative play & learn experience. The toy will allow regular users with no particular computing experience (for example parents and educators) to configure, adapt or even create new applications such as games, educational tools, and experiments. These games will be distributed among different users through the internet, based on on-line user communities and the open source software model. The toy will be based on a general purpose Microsoft Tablet PC, packaged so as to be appropriate for use by toddlers and children, including a touch-screen to be used as a display unit and a configurable keyboard, as well as other input-output units (including PCMCIA, USB, Bluetooth) for supporting the various games and experiments. An external application that will run on a regular PC will allow non-expert users to download, adapt or create their games.

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# 2  Project Description

## 2.1  Background

Current interactive games for children can be grouped into three categories:

a) **Specialized Game Devices** These typically offer one or more interactive games, and proprietary dedicated input/output devices.

b) **General-purpose Game Consoles** They support games offered by the manufacturer or third-party developers under some contract agreement. In order to protect the manufacturer's business model, these consoles are programmed so as not to allow games from non-contracted third-parties to run on them. As an example we mention the use of specialized hardware media (optical disks, non-standard memory disks), as well as encryption techniques (see [TKN02] and the references therein).

c) **Software Games for General Purpose Personal Computers**

d) **General-purpose programmable hardware platforms. http://mindstorms.lego.com/**



**Figure 1 Specialized toddler game platforms**

Specialized devices (see Figure 1) offer limited interaction capabilities, and children typically get bored of them in a few days (see [HNR04] for a study of computer game evaluation by children). It is financially infeasible for the manufacturers of these devices to incorporate powerful processing units or advanced I/O peripherals (e.g. a high resolution color display), which would render them more interesting and attractive. These technical limitations and the resulting simplistic nature of the games do not allow for interesting games to be developed by the manufacturer and profitably marketed. As a result, these platforms typically offer a limited number of below-average quality games. As an example, the game on the left in Figure 1 offers two games (numbers and colors) selectable by a switch; the game at the bottom offers a limited number of touch and speak elements, selectable by turning the yellow "pages"; finally, note the tiny black and white display and non-configurable keyboard offered by the Winnie the Pooh "Computer". These, fairly typical, games are definitely not what Norman [Nor98], had in mind when he wrote that information appliances have the advantage of providing clear affordances for use and interaction. Furthermore, as games based on specialized devices are usually targeted towards the international market, they do not take into account the different local cultural, linguistic or even religious characteristics (the importance of specially designed and configured games is discussed in [GR04]). General-purpose consoles are manufactured so as to keep their cost at low levels (e.g. by requiring the use of an external monitor), and base their business model on income from the distribution of relatively expensive games. However the use of external hardware that requires wiring, mains power, or other hazardous equipment renders them inappropriate for toddlers and young children. Also, the cost of simple games that are addressed to young children would probably be unjustifiably high for what these games would offer. Also note that games for general-purpose consoles are often targeted by illegal copying activities [Spi03e].

Finally, games offered as software for general purpose PCs are limited by the inappropriate for children, I/O capabilities of the typical desktop PC (mouse, standard keyboard, fragile monitor, unprotected mains-power and cables).

In addition, in all the cases, the source code of the games is typically proprietary and not made available in a way that would allow parents and educators to read, understand, correct or expand on it [Spi03a].

The proposed system will address all the above limitations, as described in the next sections.

## 2.2 Vision Statement

Our vision in the proposed project is the creation of a configurable and interactive general purpose toy platform that:

- will be appropriate and safe for toddlers and children, will provide continuous stimulation and inspiration through the creation and distribution of a multitude of different games and educational/experimental setups that it will accommodate, and
- will be based on a financially viable software and hardware business model, so as to make it worthwhile for a company to undertake its development and marketing.

## 2.3 Objectives and Expected Outcomes

The objectives and expected outcome of this project are briefly the following:

- The design of the hardware and software components of the system (the programmable/configurable toy), which will be based on a Microsoft Tablet PC. The system, enclosed in a protective casing that will make it safe and appropriate for children, will consist of the main processing unit and a series of input/output units, including the touch screen (to be used as a display unit and as a configurable keyboard), speakers and microphone, vibrating unit, USB/PCMCIA/wireless ports, and various external add-ons such as temperature readers, GPS, lights, and even interactive objects (e.g. actimates, configurable/programmable robots, or an interactive pet—such as Aibo).
- The creation of a game design and management environment that will run on a regular PC and will allow non-expert users (parents and educators) to download, configure, adapt or create new games. A limited part of this functionality will also be available on the Tablet PC, when it is running in "educator mode"; thus the minimal setup in a home will be simply the game and a wireless

broadband router. Internally, the games will be stored, configured, manipulated, and transmitted using a domain-specific visual language expressed in XML [Spi01], [Spi02].

- An open source software distribution plan, upon which the wide adoption of the game and its applications will be based.
- The development of a clear, financially viable business plan for the introduction of the proposed system to the market, and
- The implementation, testing and evaluation (in terms of functionality and usability) of a prototype version of the proposed system, including the game design environment.
- The creation of the initial web presence for the community of users, in the form of a portal and on-line game repository.

## 2.4  Description

The proposed toy will interact with the child through various generated stimuli, either visual (e.g. the lighting of an area, the appearance of figures or text on the screen), audio (e.g. the pronunciation of a word, the playing of music or sounds, see also [VJ02]) or tactile (e.g. vibrations). It will also receive inputs though a configurable touch area that will appear on the touch screen, speech, sounds, etc. The system will also be extendable by various external add-ons for input or output, which may include temperature readers, GPS, various lights or moving components, digital camera, switches, digital to analog, or analog to digital converters. Particular attention will be paid to the issue of computer-human interaction and usability (see also [DDS+00]).

The entire system will be based on a Microsoft Tablet PC (see [MOR+88] for a description of its usability other merits), and will be enclosed in a hard, water-proof and child-safe casing. The casing will include a lock that will make it impossible for children to open. Apart from the main Tablet PC, the casing will include USB/PCMCIA adapters for uploading new games, as well as a power/battery charge input. Speaker and microphone will be also incorporated in the casing. Figure 2 illustrates the main system components.
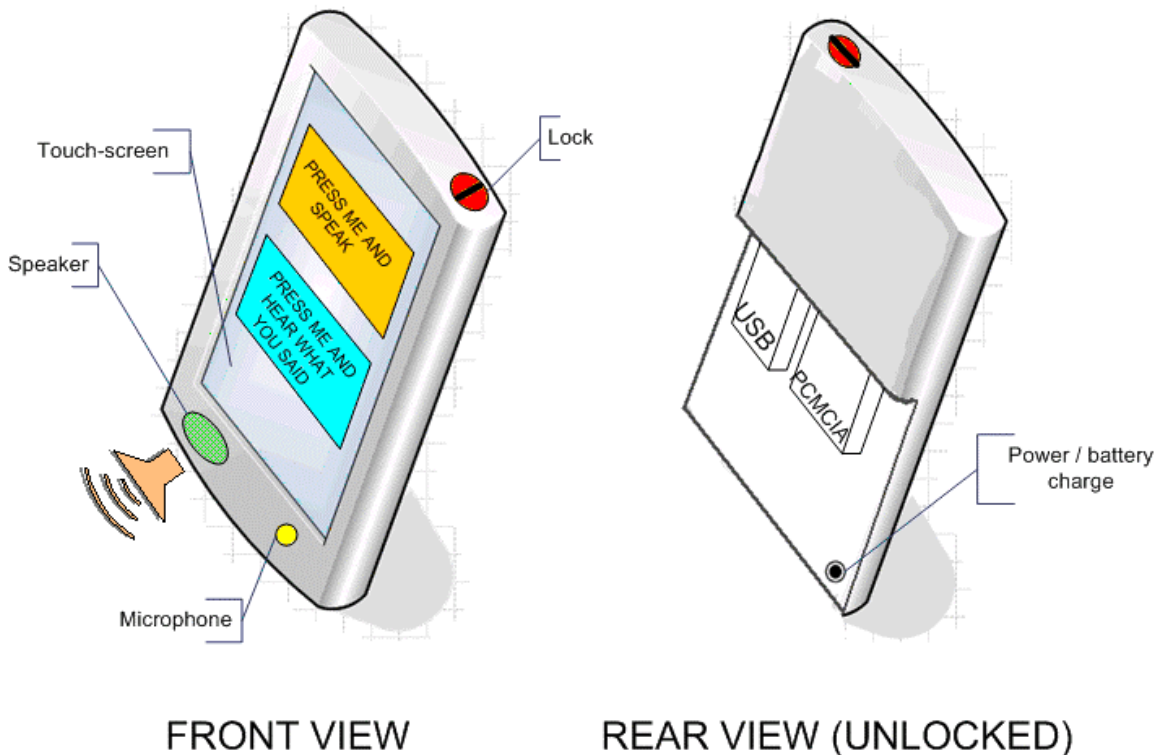


**Figure 2: The main components and appearance of the proposed system (Tablet PC form factor)**
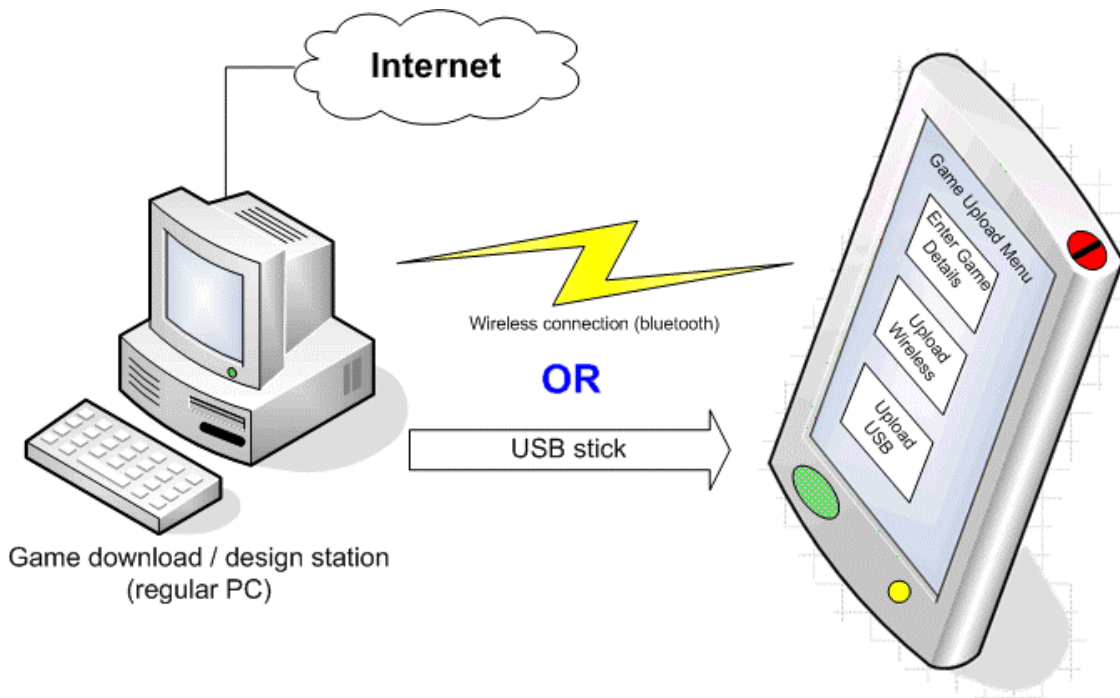
**Figure 3 Illustration of the way in which new games are downloaded, designed or configured, and then transferred to the toy**

Games are transferred / uploaded into the toy either through the USB port using a standard USB memory stick, or through a wireless connection with a PC (see Figure 3). The games can be:

- Downloaded from the internet onto a regular PC (see Figure 3 for the proposed game distribution model) and directly transferred to the toy.
- Downloaded from the internet onto a regular PC, changed, adapted or configured using the game design environment, and then transferred to the toy.
- Created from scratch on a regular PC using the game design environment, and then transferred to the toy.

The *game design environment* (game development studio) allows non-expert users, such as the parents, educational staff or other people to create or configure games. The system will provide a high-level UI programming toolkit, which will facilitate the development of new games by the parents [CS04b]. Figure 4 illustrates some simple ideas for potential games, although the possibilities are endless.  Note that the simplicity of the toddler games we illustrate would not allow the current game console business model (cheap consoles, expensive games) to work: the games simply can not command a premium price.  On the other hand their simplicity and need for local configuration (one of the games contains the actual pictures of the toddler's mum and dad and their voices) make them ideal for development and configuration by dedicated parents working as open-source contributors, as well as excellent tools for studying the behavior of children and the way in which they learn to play (see also [BL00], [Egl04]).

The proposed system will gain significantly from the creation of a community of users that will distribute developed games through the internet, using a web portal / repository. The games will be distributed following the open source software model, which will allow not only the development of a very large selection of games, but also the seamless introduction of local ethnic, cultural, religious or heritage characteristics to the games, as well as features relevant to the specific customs of each area.  Furthermore, the possibility of developing new games, both by experts and by regular users, without needing to come to an agreement with the manufacturer, allows the distribution of simple yet innovative games as well as their improvement and evolution according the open source software movement.
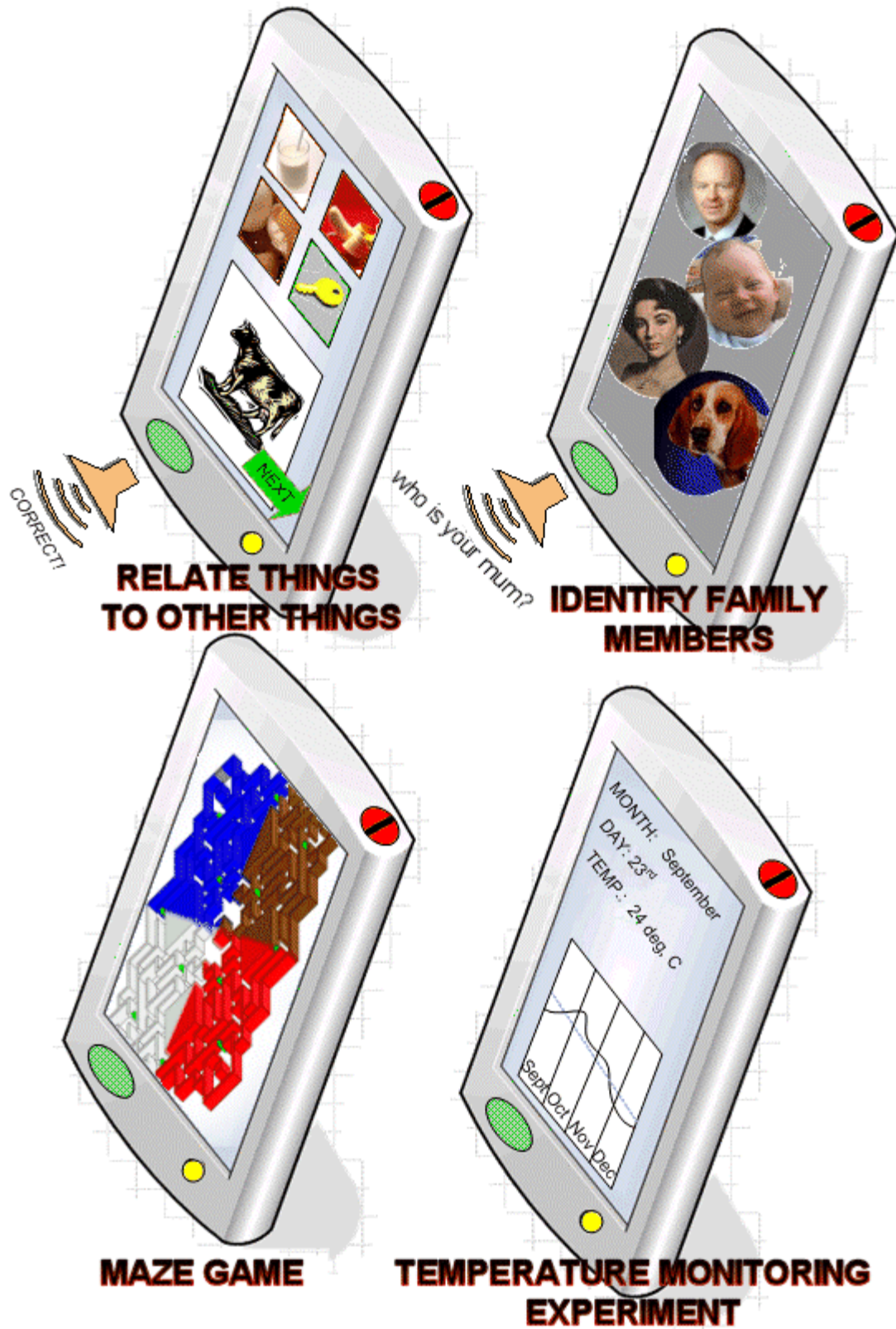
**RELATE THINGS TO OTHER THINGS**

**IDENTIFY FAMILY MEMBERS**

**MAZE GAME**

**TEMPERATURE MONITORING EXPERIMENT**

**Figure 4 Simple ideas for possible games that can be designed for the proposed toy**

The *game design environment* (game development studio), an open platform that will be made available for the development and exchange of the descriptions of these games will lead to societies of users altruistically exchanging and developing applications (games, in this case), leading to an abundance of original, innovative, high quality games (see also [Ray01]). In addition, the online toddler-game community sub-system will facilitate the exchange of experiences between the parents, with photos, videos, stories, and comments. The support of a web repository for the collection and distribution of such games will further boost the potential of the proposed project. Indeed, one of the central objectives of this proposal is to "jumpstart" this on-line community of users with the initial creation of the web portal and repository, and the production of the first games.

Finally, as the proposed system will be highly configurable and will be supporting a multitude of different game setups, the potential selling price will be higher than for a specialized game platform. As a result, the cost of manufacturing can be increased to include higher processing power and expensive interactivity features, such as the color touch-screen display, compressed audio input/output, and various I/O ports. This will make the system particularly appealing to children, and will significantly increase its entertainment and educational potential.

## 2.5  Social and Cultural Relevance

The proposed system, and in particular its game distribution, configuration and personalization properties, allow it to adapt to the social, cultural, religious or traditional characteristics of every area or household where it will be used. This is something that the typical current games platforms or consoles are not able to provide.  We propose the use of a wiki-like environment for localizing games.

The involvement of parents in the design, development of games might reinforce their participation in toddlers gameplay activities, which is a crucial factor for sustaining close relationships in the family. In addition, parents will be motivated into children gameplay by the online community, which in addition to games allows the sharing of related experiences, through multimedia (videos and photos).

## 2.6  Collaborative and interdisciplinary aspects

By its very nature, the proposed game will spawn, and ultimately rely upon, an entire community of users who will contribute their educational, entertainment or artistic input in the creation of a multitude of games that will reflect different disciplines and areas of interest.

The proposed project itself will rely on the disciplines of software and hardware design, development and integration, user interface design, web design and development, the research and design of a domain-specific visual language for describing games, and finally artistic and educational skills.

## 2.7  Dissemination and Intellectual Property Aspects

Our research group has a long tradition in publishing results of competitive funded research projects in conferences and academic journals (see for example [CLS03], [CS03], [CS04a], [CS04b], [ATS04a], and [ATS04b]).  We expect this tradition to continue with this project as well.

A number of elements of the proposed project can be protected as IPR.  Aspects of the device's design and operation can be protected through patents, while the corresponding software will be protected by copyright.  The elements can be protected as described in Clauses 8.3–8.12 of the Research Project Agreement.  We envision the games contributed by the online community to be licensed using an open-source model.

## 2.8  Industrial Transfer, Software Distribution.

The proposed plan for the industrial transfer and distribution of the proposed system includes the following aspects:

- The "toy" (tablet PC, casing, main I/O devices) will be marketed for profit (and not at a loss, as is currently the case for some game consoles).

- A number of games will be made available through a web portal that will be set up by the project. Registration to the portal can be either free, or comprise a small annual fee. Registered users will have the option to download or upload games, following the open source model.
- The game design environment, documentation etc. as well as future new releases or updates will also be made available for free through the portal.
- Additional hardware components (mainly I/O, such as camera, GPS etc) will be sold separately, also for profit, as they become available.

## 2.9  Applicability to Microsoft Technologies

The entire system will be designed around a Microsoft Tablet PC, the Windows XP Tablet PC edition 2005, and the Tablet PC SDK 1.7.  According to industry observers Microsoft is already readying a Tablet PC game software development kit and a new Tablet-PC-specific game, both meant to attract new developers and users for Tablet PCs. Specifically, Microsoft is co-developing both the SDK and the new game, called Arcs of Fire, in conjunction with software partner 3 Leaf Development. Our proposed project will build upon both the existing tablet PC technologies and the upcoming game SDK to create the toddler game.  Note that our proposed approach differs significantly from the Microsoft Tablet PC SDK in three ways: 1) the availability of a parent-friendly authoring platform for toddler games, 2) the development of an online community, and 3) a special hardware design, suitable for toddlers.

Two other Microsoft technologies we will consider employing are actimates [Str98], [SA99] and the MS Agent (animated character), which is particularly suited for dialog interaction with children. The animated characters could be used as instructors, partners, or for role playing.

# 3  Project Plan

## 3.1  Schedule

Following is the rough project schedule

| Task | Start month | End month |
|---|---|---|
| User requiments collection and analysis through rapid prototyping | 1 | 3 |
| System design and architecture definition | 1 | 5 |
| Design of game description language and environment | 1 | 5 |
| Main system software implementation | 4 | 9 |
| Game design environment software implementation | 4 | 9 |
| Prototype system hardware setup | 7 | 9 |
| Prototype system integration | 9 | 11 |
| Testing and evaluation | 10 | 12 |

## 3.2  Resources (HW/SW, documentation, etc)

Hardware: 2–3 tablet PCs, I/O units, keyboards, various components, USB flash memory keys, 1 desktop PC, h/w casing, containers, lock etc.

Software: Windows XP Tablet PC edition 2005, Tablet PC SDK 1.7, Tablet Game SDK (if released), Visual Studio .NET.

## 3.3  Budget

- Hardware: € 15,000
- Software: € 1,000 (most of the software is available to us through the MSDNAA)
- Labour: 4 researchers,  28 effort months X € 20300/EM (average cost) = € 56,000
- Travel: € 3,000
- **Total: € 75,000**

# 4 Supporting Information

## 4.1 Qualifications of the Research Team

The project brings together researchers from two institutions: Dr. Spinellis, and Mr. Androutsellis from AUEB and Dr. Chorianopoulos from Imperial College.

The **principal investigator** of the project, **Diomidis Spinellis**, is an Associate Professor at the Department of Management Science and Technology at the Athens University of Economics and Business, Greece. His research interests include pervasive computing, software engineering tools, programming languages, and computer security. He holds an MEng in Software Engineering and a PhD in Computer Science both from Imperial College (University of London, UK). He has written more than 70 technical papers in the areas of software engineering, information security, and ubiquitous computing. His book "Code Reading: The Open Source Perspective" received a "Software Development Productivity Award" in 2004. He is a member of the IEEE Software editorial board, contributing the regular "Tools of the Trade" column. Dr. Spinellis is a member of the ACM, the IEEE, the Greek Computer Society, the Technical Chamber of Greece, and a founding member of the Greek Internet User's Society. He is a co-recipient of the Usenix Association 1993 Lifetime Achievement Award. Of relevance to this project is his work on open source software development (he co-edited with Clemens Szyperski of Microsoft Research an IEEE Software special issue on the subject [SS04]), domain specific and visual languages (see the survey [Spi01] and the Visual Basic environment for setting up Unix pipelines [Spi02]), and device interoperability in pervasive and distributed computing applications [Spi03d], [Spi03b].

Dr. **Konstantinos Chorianopoulos** received his first degree (Electronics and Computer Engineering, 1999) from the Technical University of Crete and his MSc. (Marketing and Communication, 2001), Ph.D. (Management Science and Technology, 2004) from the Athens University of Economics and Business. Since 1997, he has been a member of three academic research labs (MUSIC, ELTRUN, ISN), which specialize in the areas of multimedia, e-commerce, intelligent systems and interaction design. He has participated in many EU research projects in the field of human-computer interaction for information, communication and entertainment applications in TV, mobile, and ubiquitous appliances. His research interests include user interfaces, business models, interactive television, and digital music. In 2002 he founded Understanding Interactive Television (UITV.INFO), which is a newsletter and web portal for interactive television research resources (papers, theses), news and events. Since March 2004, he is a Postdoctoral Researcher at the Intelligent Systems and Networks Group in the Electrical and Electronic Engineering department at Imperial College London. Of particular relevance to this project is his work on usability of computing devices in the home environment [CLS03], [CS03], [CS04a], and his experience with Microsoft Technologies [CS04b].

Mr. **Androutsellis-Theotokis** was born in Athens, Greece, in 1970. He holds a BEng in Information Systems Engineering and a MSc. in Engineering and Physical Sciences in Medicine both from Imperial College (University of London, UK), and a M.S.E. in Biomedical Engineering from Johns Hopkins University, MD, US. Currently he is a PhD candidate in the Department of Management Science and Technology at the Athens University of Economics and Business, Greece. He has worked in the industry as a software analyst and developer and has been involved in several EU funded R&D projects. Mr. Androutsellis-Theotokis is a member of the Technical Chamber of Greece and the IEEE. His research interests include Information Security, collaboration through peer-to-peer architectures and Software Engineering, and his current doctoral research concerns the design of transaction processing systems based on peer-to-peer architectures. Of relevance to this project is his work on internet-based collaboration technologies [ATS04a] and the corresponding business models [ATS04b].

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