

**Information Society Technologies Programme**

**Directorate D: Communication Networks, Security and Software –  
Applications**

**Unit D5: ICT for Business**

# **SMART WIRELESS TAGS RESEARCH NEEDS: CONSULTATION REPORT**

**Part of the Wide Consultation for the Definition of the Content  
of the Work-programme 2005-06**

# Smart Wireless Tags Research Needs Consultation Report

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## FOREWORD

Radio frequency identification (RFID) has been known and used for many years. However, driven by new applications, technology developments, and the ambient intelligence revolution, RFID is being transformed, and a new field of research has emerged, known as Smart Wireless Tags and Devices. These new technologies have many potential applications, not least of which relate to privacy, data protection and security. There are also many other potential innovative applications, beyond identification and tracking, relating to product lifecycle management and extended products. Smart wireless tags is one of the fastest growing information and communication technologies and the importance of the subject is demonstrated by the large interest in the online consultation and the follow-up workshop. The technology will be a key enabler for realising the vision of ambient intelligence and will lead to smart products that are able to communicate with each other and with their owners. However, there remain many challenges to address. Much research is required to further develop the technologies. Most importantly, there is a need for research into innovative applications across a wide range of domains. Both these issues are addressed in this report, which provides a detailed account of what needs to be done in this rapidly developing and exciting field of work.

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### EXECUTIVE SUMMARY

Smart wireless tags, or radio frequency identification (RFID) tags, are a key enabler for applications involving identification and verification of identity and authenticity. They can be applied to just about any item: product, transportation containers, passports, banknotes, etc. But smart wireless tags also have applications beyond identification and tracking, and will be an important technology to enable smart products.

Expected growth figures for these technologies amount to several billion euros per year. The industrial benefits are significant in terms of reduced costs, better responsiveness, and innovative business processes and products.

The technologies are attracting significant research and industrial interest, notably in the United States and Japan, and in the longer term the technologies are important enablers for the vision of ambient intelligence. However, the technologies are still at an early stage of development, and much research needs to be undertaken to improve their performance, reduce their cost and to apply them in businesses, public services and in the home. Significant barriers to their wide adoption also need to be overcome. One of the most important of these is concern about the threat that they pose to privacy: public concern about the technologies is already evident.

Interoperability is regarded as very important. International standardisation is the ideal way to ensure interoperability. Standardisation efforts are already underway, and while there appears to be no need at the present time to begin new standardisation activities, Europe should co-ordinate its actions and make a bigger contribution towards the development of standards to ensure that European circumstances and interests are taken into account.

The issues of spectrum allocation are also related to the matter of interoperability. International harmonisation of frequencies used for RFID is desirable. However, another important matter is the effect of electromagnetic fields on human health, public concerns about exposure to electromagnetic fields, and possible interference with other devices such as heart pacemakers. More research is needed in these areas and it is desirable to reduce the power levels used in RFID to overcome public concerns, even though from a technical perspective, the amount of exposure is likely to be quite small. In the medium term new standards addressing such issues may need to be developed, ideally with international agreement.

The consultation exercise indicates that many hold the view that privacy and security is a fundamental enabler or a *showstopper* of smart wireless tag technology. The responses also indicate that there is a belief that the fault lies with the technology and this needs to be modified to enable privacy and security. However, technology alone will not provide the answers. The solution to the problems lie in a combination of technical features, a lot of awareness, understanding, controls, a clear position from application developers using smart wireless tags, and a code of ethics. Enabling customers and the public to choose what to allow seems to be fundamental, for example, deciding at point-of-sale if smart wireless tags attached to products should be deactivated.

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With regard to applications research, there is a recognition that now is an appropriate time to move beyond applications such as logistics and retail supply chain management, which have dominated applications so far. The full range of applications in all sectors, and for a wide variety of purposes, should be researched. With regard to technology research, smart wireless tag cost and performance are the two big issues. Therefore, in the short term there should be a focus on reducing costs, and improving and extending the capabilities of smart wireless tags based on current technologies. In the longer term there should be a focus on developing new technologies and innovative concepts.

Two specific areas of research are therefore needed:

- ? Technology research focused on reducing the cost of smart wireless tags, extending their functionality and performance, and improving the privacy-friendliness of the technologies;
- ? Applications oriented research, focused on highly innovative, high-value added applications, and addressing the socio-economic issues surrounding smart wireless tag technologies;

Technological research should be based on improving the current generation of technologies, with a view to achieving lower cost smart wireless tags. This work should address the areas of microelectronics, antenna design and packaging. Ways to reduce the production costs and to enable high volume production should be investigated. Research into miniaturisation of the components is required and energy sources also need to be further investigated. Using current generation technologies, research into improving performance in terms of functions, lower power, extended reading ranges, inter-tag communications, etc. should be undertaken. The capabilities of smart wireless tags to provide improved privacy and security, in a manner transparent to the consumer, should be developed. This work should be started within the timeframe of the IST work-programme 2005-06. Many of these technological aspects are primarily relevant to the Strategic Objective *Micro and Nano Systems*, but also *Embedded Systems*.

Applications oriented research, focused on high-value added innovative applications that will contribute towards improving public acceptance, should be undertaken. Prime areas are healthcare, including medical devices and pharmaceutical tracking, food and beverages, health and safety, environmental monitoring, ticketing, personal and home security enhancement, and manufacturing, especially with regard to product enhancement and extended products.

The role of smart wireless tags in product enhancement and extended products in particular is considered to be of high potential value. Smart wireless tags could be important enablers for increased product customisation, addition of value enhancing services, and new ways of manufacturing products and managing them throughout the entire product lifecycle.

Within the context of applications research, issues such as privacy enhancing technologies, application specific privacy and security requirements, consumer attitudes, privacy and benefit trade-offs, the limitations of present regulations, impact on health and safety, and interference with other devices, should be investigated. Applications research should also investigate the effects of smart wireless tags on business and work processes, business models, backend systems, virtual enterprise operations, manufacturing and production methods, and product after sales

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activities. Cost effective backend functionality that takes account of smart wireless tags capabilities will need to be developed.

This application-oriented research should be started within the timeframe of IST work-programme 2005-06. This application oriented research is primarily relevant to the Strategic Objectives *Networked Businesses and Governments*, and *Products and Services Engineering 2010*, but there is applications research that is also relevant to other Strategic Objectives, such as *eHealth*, *eSafety for Road and Air Transport*, and *Improving Risk Management*.

In the longer-term, smart wireless tags should be further developed within the context of ambient intelligence systems. Longer-term research for smart wireless tags should also address new materials, new energy sources and nano-materials. These longer-term issues should be addressed within the context of Framework Programme Seven.

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## INTRODUCTION

Technologies that enable the unique identification of individual items, and their application in many areas of the information society, are the next major development in the field of information and communications technologies. This report presents the findings, conclusions and recommendations from the wide consultation exercise relating to the research needs for the topic of smart wireless tags, which are also known as RFID (Radio Frequency Identification) or smart tags. The consultation exercise was undertaken as part of the process for the preparation of the IST work-programme 2005-06. In addition however, the report also includes recommendations for longer-term research in the smart wireless tag area, research that naturally fits within the time scale of Framework Programme Seven, which will cover the period 2007-10.

*Smart wireless tags are tiny devices that can be attached to items. Information can be stored on the tag that enables the unique identification of the item. Tags are read using radio waves. Extension of the functionality of tags will enable many applications beyond identification and tracking.*

The long-term strategic objectives that emerged from the consultation exercise are described in the next section, along with mid-term and longer-term research. Following this, there is a description of the consultation rationale, method and process. A quantitative and qualitative analysis of the online consultation and the workshop then follows. The detailed technical outcome of the consultation is then presented. Recommendations for relevant prioritised RTD objectives are then given. The final section covers key actors in future research projects.

## LONG TERM VISION

The results from the online consultation and the workshop indicate that smart wireless tag technology has a longer-term dimension beyond the short term, track and trace type of applications being considered for industry, business and public services. These short-term applications are based on the capabilities of smart wireless tag technology to uniquely identify an item. However, as the technology advances and additional functionality is added to smart wireless tags, then the scope of applications should become much wider. Extensions to the functionality of smart wireless tags in the longer term, by the addition of more memory, computational capabilities, sensors, and the use of the technology in actuators, etc., and the peer-to-peer networking of tags, will enable the so-called *internet of things*. This will provide a basis for the creation of many different applications involving smart products. In the medium term, these applications may be related to product lifecycle management issues and enhanced product functionality. In the longer-term they are likely to involve complex applications of the type foreseen in the vision of ambient intelligence.

It is clear from the nature of smart wireless tag technologies that they are one of the key enablers for realising the vision of ubiquitous computing and ultimately that of ambient intelligent systems. In the longer-term therefore, smart wireless tags technology should be developed with

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this context in mind. A longer-term strategic objective for smart wireless tag technology would be the development of the enabling technologies for smart wireless tags with a view to the application of smart wireless tags in future ambient intelligent systems.

To enable this, there is a short and mid-term need to deal with the issues of privacy and security, and consumer acceptance. Privacy enhancing technologies should therefore be developed and any necessary changes to the regulatory regime identified and implemented. Confidence building measures, for example, through large-scale public pilots using smart wireless tag technologies, need to be considered. In the longer-term, there is a requirement to develop the next generation of technologies that will enable low-cost, reliable and highly and multi-functional smart wireless tags. The areas that should be addressed in this context include new materials, nano-materials, low cost production methods, antenna designs, and packaging.

The above mid and long term research clearly belongs within the timeframe of Framework Programme Seven, although work on addressing privacy enhancement, consumer confidence building, and smart wireless tag costs using current technologies needs to begin now, within the context of the IST work-programme 2005-06.

### **CONSULTATION RATIONAL, METHOD AND PROCESS**

The European Commission undertook a wide thematic consultation with industry and academia during March and April 2004, in preparation for the Framework Six, IST work-programme for the years 2005-06. Smart wireless tags were addressed as part of this wide consultation exercise. The wide consultation was undertaken to investigate the need for further research in the technology and application domains.

An initial workshop was held in Brussels in July 2003, involving a number of invited leading experts. These smart wireless tag experts came from the areas of technology, business software, standardisation, and distribution chain organisations. The criterion for selecting this group of experts was that they and their companies were involved in smart wireless tag applications, innovation, and research.

The second step in the wide consultation was an online survey, which took place from February to April 2004. The online consultation closed on April 12, 2004. The online consultation was focused around five questions plus a free format input. The five questions were based on the results of the initial workshop. The questions were:

- ? Q1: Is interoperability important? How to proceed on this?
- ? Q2: What smart wireless-tag application areas have a need for further research?
- ? Q3: What short term and longer-term technology research is still needed?
- ? Q4: What spectrum allocation issues exist? And is more regulatory action the right answer?
- ? Q5: Smart wireless tags could pose privacy and security issues – What is your opinion on this?

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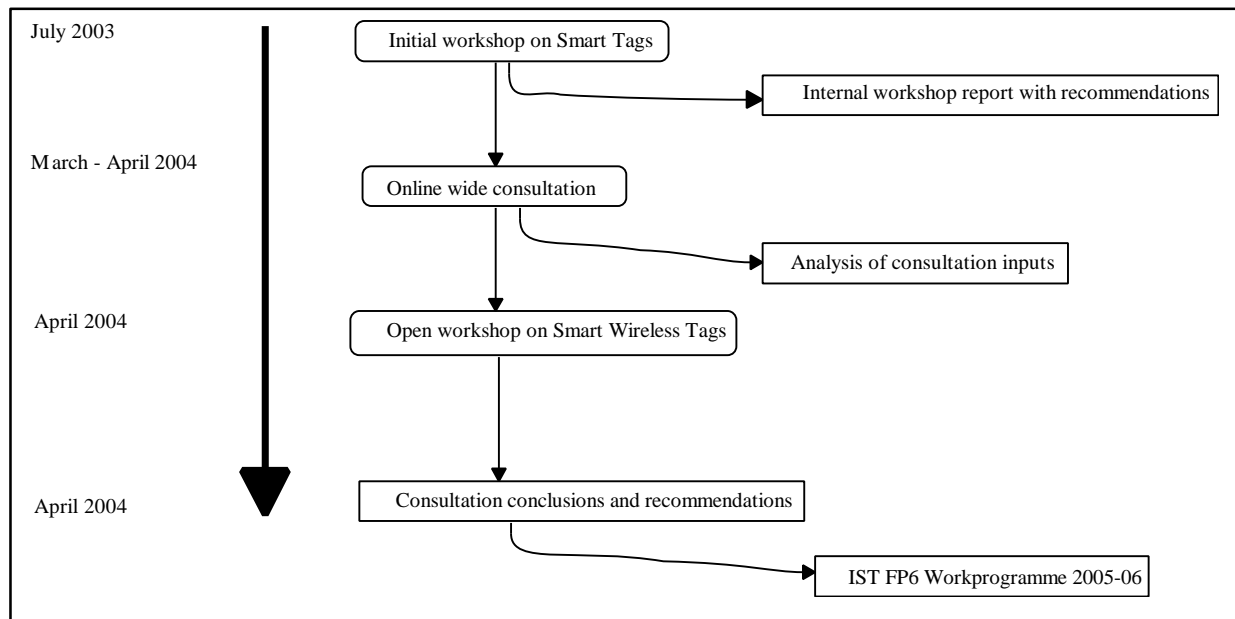
Further details about the conclusions of the initial workshop and these five questions can be found in Appendix 1.

The information that was provided on the online consultation web pages included the questions, as well as details about the workshop, and an online registration facility.

The purpose of the online consultation was to reach a large audience to obtain wide and representative value-added feedback on the conclusions resulting from the initial workshop. This second phase also provided the means to test the validity of the workshop conclusions and to gather various opinions and expectations from all those with an interest in smart wireless tags. The results of the survey would also provide a measure of the scale of the interest in the subject of smart wireless tags, and how important the topic is for European industry as a whole.

The results obtained from the wide online consultation were consolidated into a preliminary consultation report that was presented in a one-day public workshop (April 20, 2004) held in Brussels. A number of speakers were invited to moderate the discussions, using their own background knowledge and the results of the online consultation to stimulate discussions.

An overview of the consultation process is given in Figure 1.



**Figure 1: Overview of the wide consultation process**

To increase the awareness about the consultation exercise among the smart wireless tags community of interest, emails were sent to a number of organisations and experts. Those people known to the European Commission to be active in the areas were informed by email. These included those from industry involved in research, technology, applications and standardisation. Academic researchers and consultants were also told about the consultation. Information about the online consultation and the workshop was sent to the IST Programme National Contact Points, with a request to forward the information to interested people on the national databases.

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Emails were also sent to organisations engaged in some aspects of smart wireless tag development, such as those involved in co-ordinating the development of standards.

The result of the wide consultation process is a set of final conclusions and recommendations related to smart wireless tags for the Framework Six work-programme for 2005-06.

### QUANTITATIVE AND QUALITATIVE ANALYSIS OF THE RESPONSES

This section provides quantitative and qualitative information about the online consultations, its results and also the workshop.

#### **Online Consultation**

##### Respondent Statistics

A total 73 responses were received to the online consultation. The country of origin of these is shown in Figure 2. Four respondents did not identify their country of origin. Figure 3 shows the types of organisations to which the respondents belong.

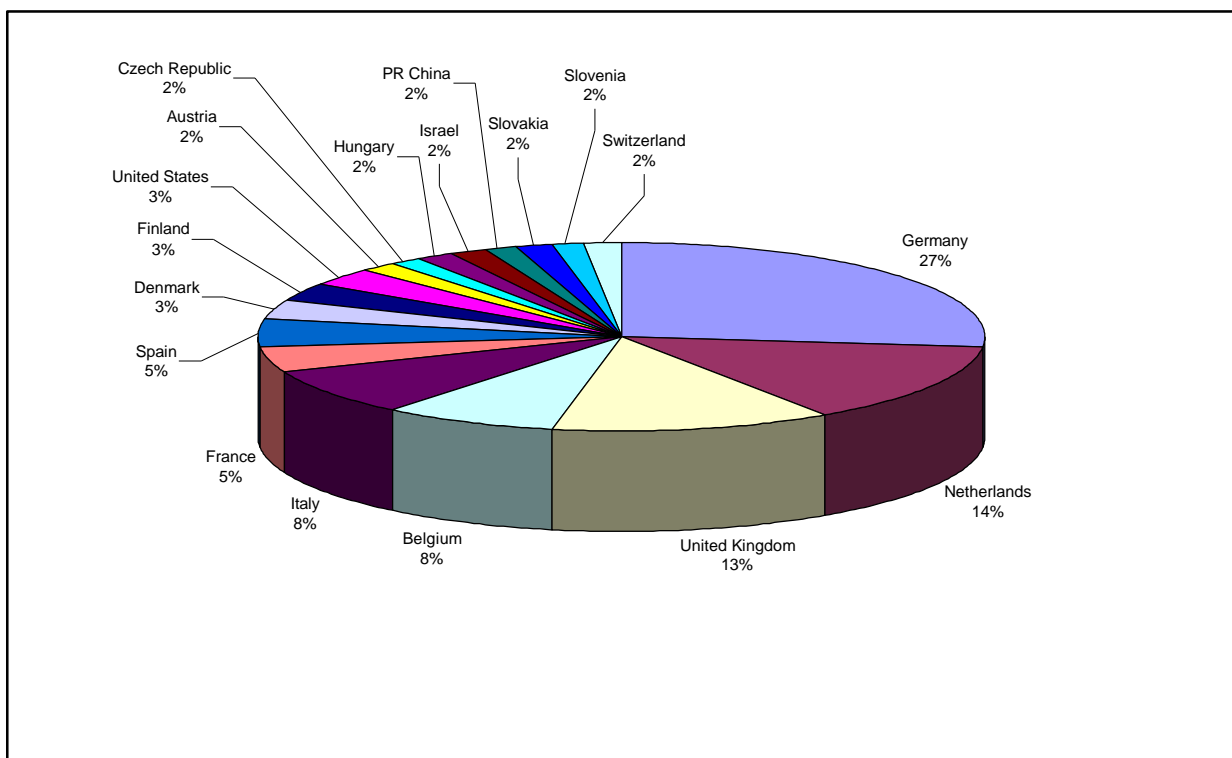
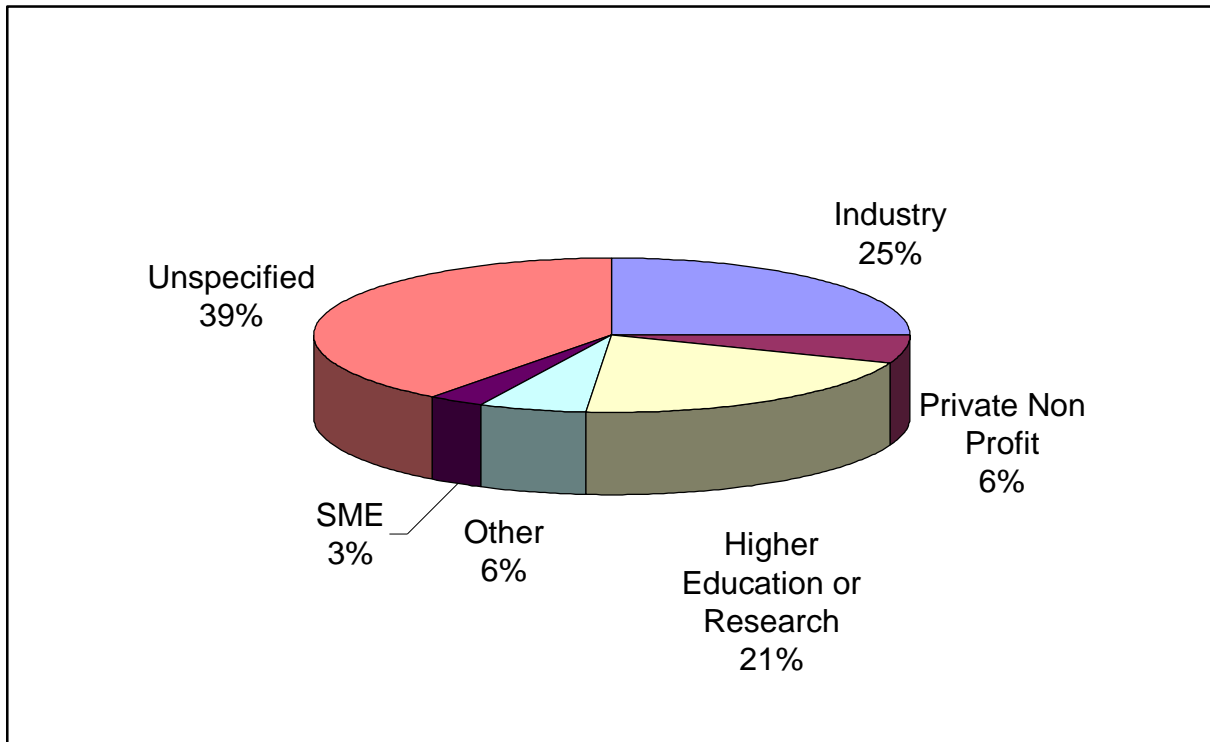


Figure 2: Respondents' countries of origin

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**Figure 3: Respondents' types of organisation**

The respondents represent a mix of interests and include technology and system providers, consumer and citizen representative groups, academics and researchers, technology and systems users, and consultants. Technology user organisations cover several sectors, including automotive, logistics, manufacturers of consumer goods, and technologies for disabled and elderly people. The technology and system providers include both large multinationals and some SMEs. The larger companies include both European and American suppliers.

Not all the respondents identified their gender, but approximately 93% are male.

The breakdown of organisational types per country is shown in Table 1.

Country	Industry	Private Non Profit	High Ed or Research	Other	SME	Unspecified
Germany	6		7	1		3
Netherlands	5				1	2
United Kingdom	2		4	1		3
Belgium	3	3		1		
Italy		2	1	1		2
France						3
Spain						3
Denmark						2

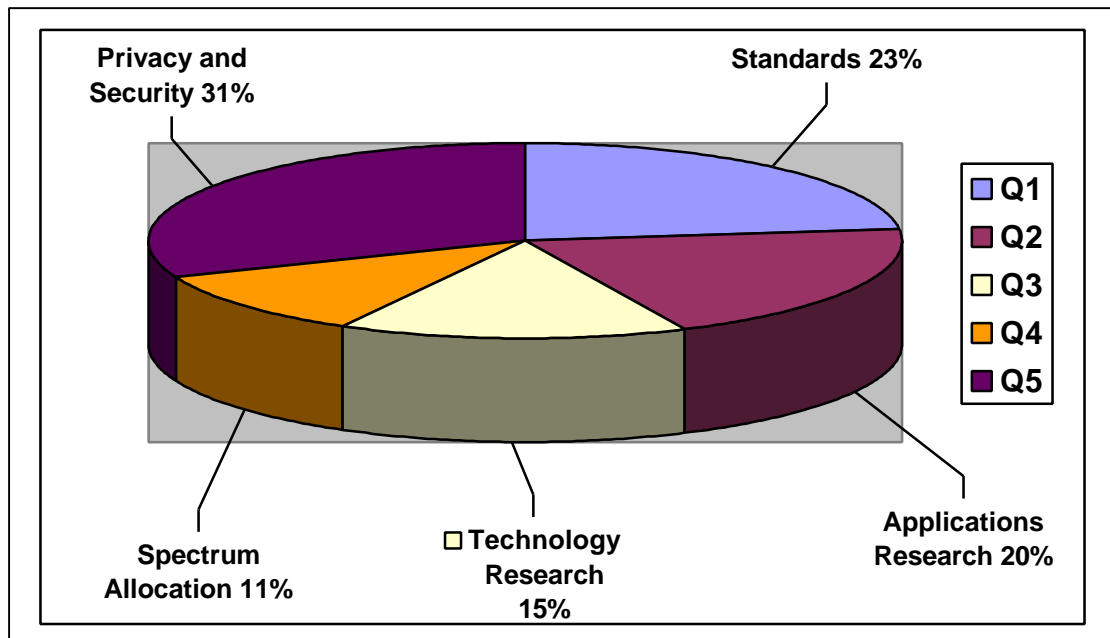
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Finland			2			
United States	1		1			
Austria	1					
Czech Republic				1		
Hungary						1
Israel						1
PR China						1
Slovakia					1	
Slovenia			1			
Switzerland						1

**Table 1: Respondents' types of organisation by country**

### Question Statistics

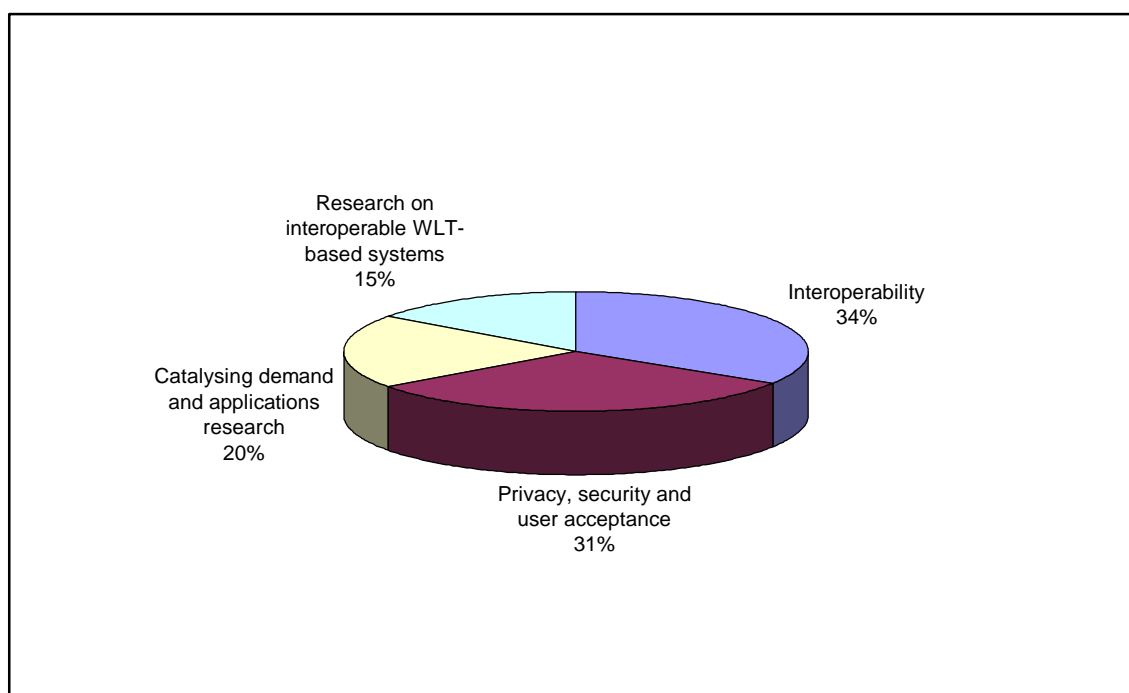
In terms of the total amount of comments and suggestions generated for each question, these are shown in percentage terms in Figure 4.



**Figure 4: Volume of comments and suggestions generated for each question**

Thus the issue of privacy, security and user acceptance provided the largest volume of comments and suggestions, followed in second place by the issue of standards. Spectrum allocation generated the smallest volume of comments and suggestions. However, standards and spectrum allocation are both related to the issue of interoperability. Thus, when these two issues are combined together, the results look a little different, as shown in Figure 5.

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**Figure 5: Volume of comments and suggestions generated for each issue**

Thus it appears, at least among the respondents, that the issue of interoperability and that of privacy, security and user acceptance are the two that dominate at the present time. Together they account for 65% of the comments and suggestions.

### Q1 Analysis

Question one dealt with the issue of interoperability. Specifically, is interoperability important and how to proceed on this? The primary focus of this question was on standards. The responses demonstrated a wide agreement that interoperability is an important issue and this is a fundamental enabler for wider adoption of the technologies, reducing costs and the competitiveness of the European smart wireless-tags industry. The responses also show that there is a preference for international open standards. They also demonstrate some concerns about the present circumstances with regard to standardisation in Europe. The responses also raise some concerns about current standardisation efforts led by EPCglobal with respect to the suitability of these standards to European needs.

Specific points raised in the responses are given in Table 2.

Specific Issue	Number of Respondents Raising this Issue	Type of Organisation Raising this Issue
Explicit recognition of the importance of interoperability	42	Full range of organisation types
Achieving international standards	11	Mostly industrial
Co-ordination with EC Standardisation Action Plan	7	Most types of organisations
Interoperability raises privacy and	5	Other or non profit organisations

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security concerns		
Avoid too many standards or too many organisations creating standards	5	Industry and research organisations
Concerns about present European harmonisation circumstances	4	Most types of organisations
Build on EPCglobal work	4	Mostly industrial
Synergies with smart cards	3	Mostly non industrial
Achieve open standards and architectures	3	Research and non profit organisations
Standards development under the co-ordination of one (independent) organisation	2	Industrial and research organisations
Concerns about EPCglobal results	2	SME and research organisation
Ensure that standardisation work does not stifle innovation or slow down developments	2	Research and other.

**Table 2: Specific issues arising from the responses to question one**

### Q2 Analysis

Question two dealt with the issue of catalysing demand and applications research. Specifically, what smart wireless-tag application areas have a need for further research? The responses show that there is a recognition that now is an appropriate time to move beyond applications such as logistics and retail supply chain management, which have dominated applications so far. The full range of applications in all sectors, and for a wide variety of purposes, should be researched. Healthcare, pharmaceuticals, food and beverages and ticketing applications are identified as mature opportunities for market adoption. This will help catalyse demand but will also help deal with issues such as consumer acceptance.

Specific applications research suggestions made in the responses are given in Table 3.

<b>Specific Issue</b>	<b>Number of Respondents Raising this Issue</b>	<b>Type of Organisation Raising this Issue</b>
Healthcare applications, including pharmaceuticals and medical devices	13	Most types of organisations
Logistics, transport and ticketing applications	9	Mostly industrial
Security applications	6	Most types of organisations
Food and beverages	4	Most types of organisation
Manufacturing applications	4	Most types of organisation
Identity and travel documents	4	Industry and other organisations
Other types of tracing applications	3	Industry, research and other
Ambience intelligence applications	2	Industry
Interference with other devices	1	Non profit
Product life cycle management	1	Industry
Credit card payment systems	1	Other
Privacy protection	1	Non profit
Robotics	1	Research
Agriculture	1	SME
Recycling	1	Other

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Automotive	1	Industry
Arts and culture	1	(Not specified)

**Table 3: Specific issues arising from the responses to question two**

### Q3 Analysis

Question three dealt with the issue of technological research. Specifically, what short term and longer-term technology research is still needed? A wide range of suggestions for short term and longer-term research is contained within the responses. These cover a multitude of issues relating to smart wireless tags. These can be grouped into four areas: privacy and security; technology, infrastructure and production; applications related; and user-related issues. Research related to the use of tags in ambient intelligence systems is highlighted as being of importance, including research relating to users.

Specific technology research suggestions made in the responses are given in Table 4.

Specific Issue	Number of Respondents Raising this Issue	Type of Organisation Raising this Issue
High volume manufacture, cost reduction, alternative technologies	8	Most types of organisations
Data security, privacy and security enhancing technologies and architectures	7	Most types of organisations
Integration with other technologies and systems	6	Mostly research
Antenna research	6	Most types of organisations
Data processing, communications and broadband	5	Most types of organisation
User acceptance	4	Research
Integration of tags into products	4	Industry and research
Reader technology	4	Most types of organisations
Reliability and dependability	3	Research
Energy storage	3	Industry and other
Users and interaction with ambient intelligence	3	Industry and research
Sensing	2	Research and other
Location ID	2	Industry and research
Tag materials	2	Industry
Combine tags and intelligent agents	2	Industry
Polymer based tags	2	Industry
Technology assessment, conformance and performance testing	2	Non profit and other
Active tags	2	Other
Interference	2	Non profit and not specified
Data fusion and mining	1	Research
Tag disabling	1	Non profit
Non volatile memory	1	Industry
HF tags	1	Research
Services based on tags	1	Research
3D integration	1	Industry
Re-use of tags	1	Industry

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Harsh environment tags	1	(not specified)
Liquid penetration capability	1	Industry
Ontology and knowledge management	1	Industry
Awareness	1	(not specified)
Adaptable tags	1	Research
Expanding information capacity	1	Research
Regulation	1	Research
Electro-magnetic issues	1	(not specified)
Smart dust	1	Research

**Table 4: Specific issues arising from the responses to question three**

### Q4 Analysis

Question four dealt with the issue of spectrum allocation. Specifically, what spectrum allocation issues exist, and are more regulatory actions the right answer? The responses demonstrate a desire for more harmonisation in Europe, as well as globally. The effects of smart wireless tags on human health and their impact on the operation of medical devices are both important issues emerging from the responses. The responses also show some disagreements about which frequency range should be used for RFID: low frequencies (LF), high frequencies (HF) or ultra high frequencies (UHF).

Specific points made in the responses are given in Table 5.

Specific Issue	Number of Respondents Raising this Issue	Type of Organisation Raising this Issue
Need to extend reading distance	6	Most types of organisations
Unified global regulation	6	Mostly industrial
Support new proposed European UHF regulations	3	SME, Other and non profit
Signal interference	3	Non profit and not specified
Support for use of UHF	3	Industry and non profit
Concerns about existing UHF regulations	3	Industry, non profit, and not specified
Raise issues with RSC and CEPT	3	Industry and research
Interest in HF and LF	2	Industry
Regulatory actions necessary	2	Research organisations
Other types of transmissions (IR etc.)	1	Research

**Table 5: Specific issues arising from the responses to question four**

### Q5 Analysis

Question five dealt with the issue of privacy and security. Specifically, respondents were asked their opinion if smart wireless tags could pose threats to privacy and security. The matter of privacy and security is recognised as an important issue in the responses to this question. The responses indicate that many hold the view that privacy and security is a fundamental enabler or a *showstopper* of smart wireless tag technology. The responses also indicate that there is a belief that the fault lies with the technology and this needs to be modified to enable privacy and security. However, technology alone does not provide the answer. The suggested solution lies in

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a combination of technical features, a lot of awareness, understanding, controls, a clear position from application developers using smart wireless tags, and a code of ethics. Enabling customers and the public to choose what to allow seems to be fundamental.

Specific issues raised in the responses are given in Table 6.

Specific Issue	Number of Respondents Raising this Issue	Type of Organisation Raising this Issue
Means of enabling customers and citizens to make choices (kill switches, etc.)	12	Most types of organisations
Need to improve security and privacy	8	Most types of organisations
More openness by industry about applications to gain customer confidence and allowing customers access to information	6	Most types of organisations
Developer guidelines and codes of practice	6	Most types of organisations
Better quality information for the public	5	Industry and research
Tags pose no greater issues than many other modern identification technologies	4	(not specified)
Regulation	4	Industry, research, non profit and not specified
Issue is over exaggerated or misrepresented by the media	3	Research and not specified
Achieve a balance between benefits and risks	3	Non profit and not specified
Apply data protection principles	3	Industry, non profit and other
Enterprise privacy and security policies	2	Non profit and other
Address customer confidence	2	Industry and other
Broaden the debate	2	Research and other

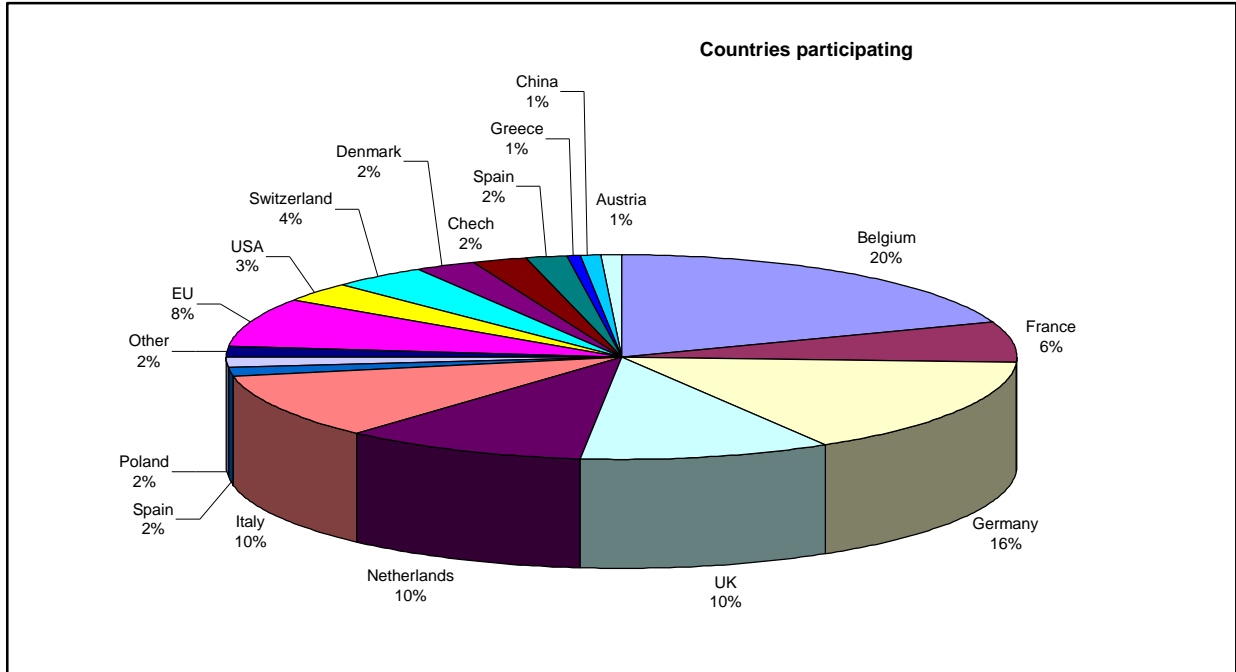
**Table 6: Specific issues arising from the responses to question five**

### ***Workshop***

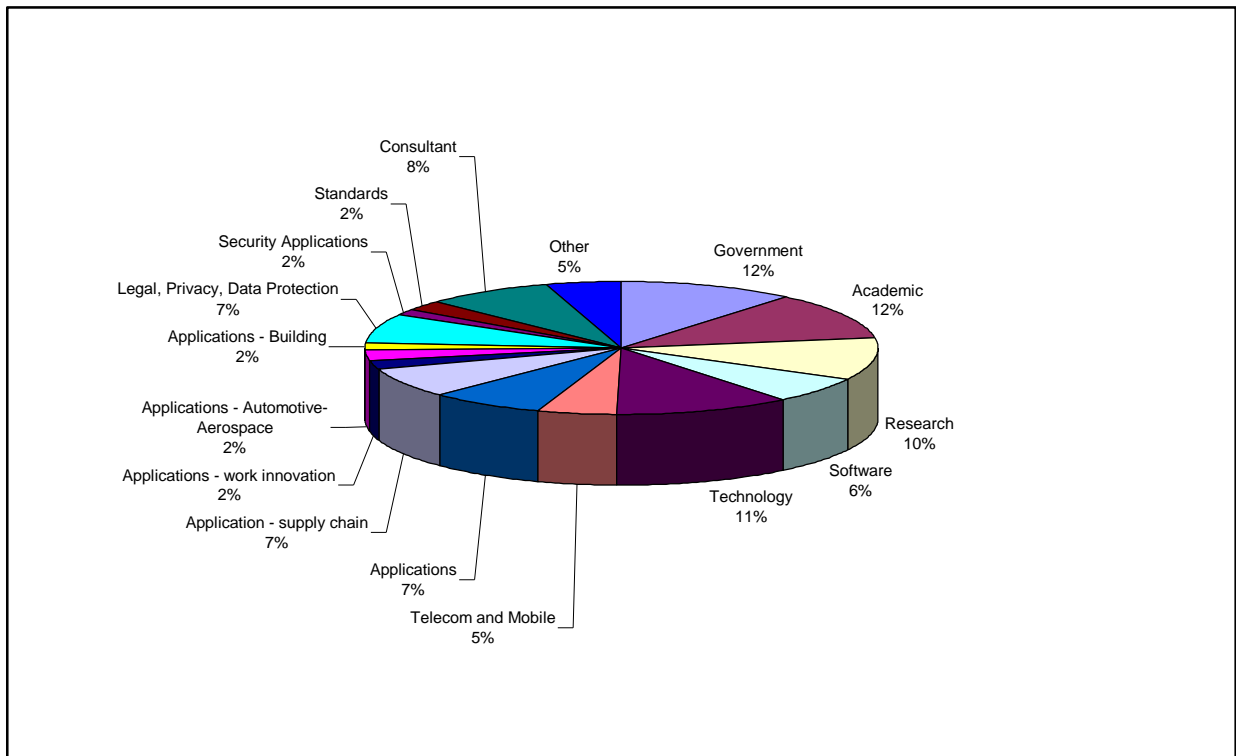
#### **Delegate Statistics**

The number of advance online registrations for the workshop was 139. A further 20 people registered by phone and email on the day before the workshop. In total about 110 people attended the workshop. A breakdown of the registered delegates by country of origin is shown in Figure 6 and a breakdown by type of organisation is shown in Figure 7.

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**Figure 6: Registered workshop delegates by country of origin**



**Figure 7: Registered workshop delegates by type of organisation**

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### Workshop Analysis

The workshop confirmed the importance of international standards in achieving interoperability. However, no new areas for standardisation activities were identified. Likewise, spectrum allocation was confirmed as important for interoperability. Understanding the consequences of smart wireless tags on health emerged as a major conclusion. The impact on health of the non-thermal effects of electromagnetic fields need to be better understood, as does interference with devices such as heart pacemakers. Also, even though the power levels used in RFID are low, attention should be paid to reducing these even further to avoid any concerns that the public may express over exposure. There is also a need for a global approach toward RFID safety.

The workshop succeeded in identifying in more detail, the short-term and longer-term technology research issues. The short-term issues are generally related to improving smart wireless tags performance using current technologies. The longer-term ones relate to the development of new smart wireless tag technologies.

Applications driven research was identified as important, with a focus on innovative applications. Topics identified from the online consultation emerged again during the workshop. Of particular note is the suggestion to focus on application that deliver high-added value to consumers and the public, which will help to improve customer acceptance of smart wireless tags. In the longer term, applications of smart wireless tags in ambient intelligence systems are important.

Finally, privacy and security was confirmed as a major issue of concern. The workshop highlighted a need to develop privacy enhancing technologies for smart wireless tags. In addition, the existing regulations may need to be reviewed in the light of smart wireless tag capabilities.

### **TECHNICAL OUTCOME OF THE CONSULTATION**

The online consultation and the workshop did not reveal any new topics for research and actions beyond the five identified in the workshop held in July 2003: technology; applications; spectrum; standards; and privacy and security. The results of the consultation are therefore presented grouped under these five topic headings. The consultation also provided strong evidence of the important of smart wireless tag technology for the competitiveness of European industry.

#### ***Smart Wireless Tags Technology Research Needs***

Reducing the cost of smart wireless tags is considered to be very important. The short-term focus should be on improving silicon technology. There is a need to reduce the size of smart wireless tags and to increase the size of the wafer. However, tag costs are not just related to the cost of the silicon chip. Whilst the chip accounts for 40% of the cost, the antenna accounts for 30% and the

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packaging 30%. To achieve low cost smart wireless tags requires reduction of all three cost elements. The issue of high volume manufacturing must also be addressed.

The high cost of smart wireless tags prevents the large-scale deployment of the technology. The aim should be to achieve tag costs at the euro-cent level, with tag readers at the €100 level.

Fitness for purpose should be addressed. Current technology can read tagged items and the performance is generally adequate for pallets, cases, and objects on a conveyor belt, manual scanning, and circumstances where there is no metal or little liquid between tag and reader. Research is needed however in cases where metal or liquid materials surround objects, or when many items are close together.

There are a number of technology challenges to improve the performance of smart wireless tags. Improvement in identification accuracy is needed in respect to orientation and position of tags, the material close to the tags, penetration (scanning of loaded pallets), and minimising transaction time between tag and reader. Coexistence issues also need to be addressed to reduce interference between smart wireless tags hardware and other wireless services. Development of a flexible and agile reader making extensive use of digital technology should be considered.

To take advantage of the new possibilities of identification and data transfer in comparison with barcodes, research is needed that addresses: simultaneous data acquisition from various tags; identification without line-of-sight; read, modify and write functionality; tags with integrated sensors (temperature, humidity, pressure, etc.); and encryption to protect the tag data. Issues such as adaptation of production and logistic processes need to be investigated.

Furthermore, backend IT systems will need to support the functionality provided by smart wireless tags. Increased security capabilities on tags will affect backend systems since these will require additional functionality. This will increase system costs. This topic needs to be further investigated to find cost-effective solutions.

Communications between smart wireless tags and readers has to be considered, since readers with advanced signal processing are required to read the small signals received from smart wireless tags. The communications problems that arise when many tags have to be read simultaneously need to be researched. Control of the communication area needs to be addressed to avoid location uncertainty and to overcome the limited read range.

Antenna related research is singled out as an important area. Antenna design research for real-life environments (warehouses, airports, etc.) should be undertaken, including work on multi-function and multi-frequency patch antennas. Further development is required on reader antenna deployment, particularly antenna arrays to cover larger read areas with the same controller. Further development is also needed for tag antenna designs (and tags) for higher frequencies (2, 4, 5, 20 GHz and above). In particular, matching of antenna design to the tagged item is under-developed. Effective work in this area will lead to competitive advantage for European industry.

One lesson learnt from applications work is that the technology for smart wireless tag deactivation needs to be addressed at an early stage in the development of tag technology and systems.

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With regard to the future, there are many longer-term issues to address:

- ? Process management for nano-scale manufacturing;
- ? Alternative materials such as polymers;
- ? Facilitating physical integration of smart wireless tags into products;
- ? Active smart wireless tags;
- ? Inter-tag communications;
- ? Ambient intelligence and user interaction in a way that is natural and intuitive.

One promising area of long-term research is organic electronics. This may provide a low-cost alternative to silicon electronics. This approach may provide the means of producing antenna, packaging and chip together on one substrate. Organic electronics uses substrates such as plastic, which are cheap and flexible, however it is necessary to explore the performance of different types of substrate materials.

*The United States Patent Office has granted 540 RFID-related patents and has 200 patent applications pending. There are two patents pending on nanotechnology based identifiers and there is intensified research on polymer based tags. Semi-active tags with new types of battery are also being researched.*

Increased demand for greater security will require tags with computation capabilities and memory. In the long-term, research is therefore needed into the construction of highly miniaturised devices. An associated challenge is to develop autonomous behaviour, which requires power provision and management, diagnostics, and accurate reference to the world. Of interest to power provision is energy harvesting using vibration, thermoelectric effects, piezoelectric effects, and solar cells. Miniaturisation, cost reduction, power provision, identification and localisation, communication through material other than air, and sensor and actuator integration are all major research challenges.

### **Smart Wireless Tags Applications Oriented Research Needs**

Application-driven research, with a focus on innovative applications, should be undertaken. The value ratio (functionality over cost) is a way of assessing importance. Value for customers is achieved by increasing functionality. Applications that improve health and safety are examples where high value can be achieved as well as public acceptance.

Previous developments have tended to focus on supply chain optimisation. Integration of the supply chain aspects with end-user value added services should be further addressed. These services (for example, health, food safety, etc.) should be developed and piloted to better grasp business cases, security requirements, and interoperability aspects.

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Patient safety and consumer safety driven applications in vertical value chains should be considered. Healthcare and pharmaceuticals, and food and beverages are mature opportunities for market adoption that will find positive acceptance by citizens (the final customer), as well as by policy makers. Such application domains will create the critical mass (in term of market and consensus) to make the change happen in the entire market. It must also be taken into account that in such market domains, services are delivered to large numbers of citizens. Thus, these applications could also be a test-bed for population-scale identity management issues (loyalty card and credit and debit cards). Such pilot environments are highly critical in terms of services, but less critical in terms of risks (for example, compared with passport id management and terrorism).

With regard to user related issues, the following suggestions were made:

- ? Awareness activities in the form of demonstration of technologies in different sectors is required;
- ? Research is needed on user and consumer acceptance. What trade-offs are users willing to make? What benefits do they expect in return for giving up some of their privacy? How can privacy be protected in a way that will increase user acceptance? How to make deactivation of tags visible to users? These are all questions that need to be answered;
- ? Novel interaction paradigms should be investigated;
- ? Investigations need to address how to introduce new systems to users, how users can easily take new products, applications and services into use, and what kind of systems are acceptable from the end users' perspective.

Regarding the strategy for co-ordination with retailers, which was proposed at the internal workshop, it is important to co-ordinate any such initiative with manufacturers, who are part of the same supply chain as retailers. Any retail application will have an effect on the manufacturing supply chain strategy. A co-ordination of retailer requirements will be essential. The European Union market is different from that in the United States where Wal-Mart sets the tone. Europe faces the risk of fragmentation by retailer (the retailer X tag, the retailer Y tag, etc.) which will reduce the European Union's competitive position.

One area for future research is collaborative smart items. Improved hardware capabilities, providing more information about what is happening, and improved communications using peer-to-peer communications, will enable this concept. The key features of this will be business logic on the product or item, and autonomous decisions and actions. Holistic service oriented architectures and the software layers of business services are also areas for research.

*The competitive advantage will come from (1) determining where and how to apply the technology to achieve business value, and (2) creating new business processes that are RFID-enabled to achieve concrete operational improvements.*

***Source: Global Commerce Initiative  
EPC Roadmap, Executive Brief***

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Research is required in the area of business processes, focusing on analysis, innovation and evaluation. A number of technical issues also need to be researched, including re-useable services, scalability and system maintenance and deployment.

Research in the area of socio-economic issues is also required. Research into consumer benefits is needed and potential consumer benefits should be used to shape the technology and the applications. The relevant social and policy issues should be addressed in IST research projects.

One way to gain greater public acceptance is to find consumer killer-applications; sometimes referred to as *loving Big Brother*. These may be extended product information, enhancing product safety, intelligent home, on-the-move applications, or increasing personal or property security or both. To create conditions for acceptance it will be necessary to educate the consumer about smart wireless tag capabilities and risks, and their advantages and disadvantages. Most importantly, it will be necessary to ensure consumer choice and that the consumer is in control. Another way to achieve consumer acceptance is to create applications with win-win outcomes. One possible win-win scenario may be the ability for a consumer to find a product more quickly.

Many other application areas are also candidates for research. Health and safety, and environmental applications are suggested. Topics to be considered include dangerous goods, workplace safety, and environmental monitoring. Another area is defence and security, covering emergency response, electronic seals, and defence and military applications. Another area is remote control and monitoring, dealing with process, plant and transport monitoring. Product lifecycle and asset management, preventative maintenance, facilities management, and home automation applications should also be addressed.

The role of smart wireless tags in product enhancement and extended products in particular is considered to be of high potential value. Smart wireless tags could be important enablers for increased product customisation, addition of value enhancing services, and new ways of manufacturing products and managing them throughout the entire product lifecycle. However, while product lifecycle and product enhancement is seen as an innovative area of research, use of smart wireless tags has many possible implications for business models and virtual enterprise operations. These implications will need to be investigated.

Current efforts on smart wireless tags developments are focusing on applications at (i) *single-item* level for rather simple consumer products such as those usually bought in supermarkets and department stores and (ii) *pallet* level. The main target of the efforts is to develop applications in the domain of logistics and marketing operations with possible extensions towards an integrated supply chain management system. In the case of complex products composed of many components or sub-systems, individually tagged, the following problems have to be clearly defined and investigated:

- ? How can networks of tags, communicating to each other, be managed?
- ? How can tags belonging to a network be aggregated at various levels?
- ? How can the communication between levels of aggregation be managed, from the individual component level up to the top product level?

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The issue of tags communicating with other embedded systems in a product, such as sensors, onboard computers etc. have to be addressed. The embedding of sensors in tags also needs to be researched.

The issues addressed in the above points open new ways towards a complete and integrated Product Lifecycle Management system for complex products that goes beyond the state-of-the-art, which tends to be limited to marketing and logistics applications.

### ***Spectrum Allocation Regulation and Actions***

Within Europe there are a number of limitations at UHF such as restrictions on the frequencies that can be used, and limits on the transmission time and the transmitted power. However, a new standard (EN 302 208) is in the process of preparation for using RFID at UHF. The new draft standard proposes means to achieve maximum utilisation of the available frequency bands. Included are mandatory requirements to check that no-one is transmitting (listen before talk), operation in sub-bands of 200 KHz, and transmit powers up to two watts. Smart wireless tags are classified as short-range devices, therefore there is no legal protection against other devices causing interference. Also, devices have to operate within shared bands, and manufacturers are only required to make a self-declaration (light regulation system). The new standard is a major step forward and will bring Europe closer to the United States and future Japanese standards. However the use of UHF is restricted in some European Union countries by the military. Hence a liberalisation effort is required.

It is important to understanding the consequences of RFID on health. Technical studies rely on physical theory, but practical implementation shows that there are other influences. Pilot studies are therefore needed to investigate health issues. The issue of human exposure to electromagnetic fields is an area that requires attention. Current standards consider only the thermal effects. Research is needed on non-thermal effects and the influence on heart pacemakers and similar devices. These may show that standards are needed to minimise any risks. CEN standards exist that deal with aspects of RFID safety, providing electromagnetic guidelines and safety levels. RFID products need to comply with these standards, but there is a need for a global approach.

*Much more work is needed in the areas of global spectrum harmonisation, and of interference with medical implant devices. It is quite possible for radio frequency identification tags to influence medical implants even when compliant with one of the various standards.*

**Source: IST 2003 Conference Report**

A technical perspective is that power limits on RFID scanners may seriously limit the range of applications possible with RFID tags. While the proposed new European regulatory standard for RFID at UHF will permit reading ranges up to 90% of what is achievable in the United States, consumer and public perceptions about safety need to be considered.

The new proposed European regulations allow a maximum transmission power of two watts for RFID tag readers. This complies with safety standards, but there is a danger that public perception will be that this power level is too high. Readers will be working over a distance of something like one metre from RFID tags,

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and therefore the surrounding air will attenuate the power transmitted. Thus, even at two watts, the amount of exposure will be very small. However, this is a technical argument, and the public will probably not understand this. Therefore, work should be undertaken to reduce the maximum power transmitted to avoid any health concerns being raised by the public.

Regulation may be necessary in the future to avoid electromagnetic pollution and interference. Regulation may also be required where the technology may cause dangers to health, for example in the form of endangering the function of heart pacemakers through strong pulsating radiation or long-term dangers, such as cancer. The health and safety consequences of RFID have not yet been sufficiently researched. Until this has been done, more regulation may be better than a too lenient approach.

Spectrum allocation rules should ensure proper and safe use of wireless applications. The limits in the regulations should reflect real life requirements and most importantly, international alignment should be encouraged. It is important that on the one hand the UHF band needs to be standardised globally, but also that there are several frequency-bands available for different applications. The LF and HF bands are still of great interest, and especially for item tagging. The advantages of achieving global harmonisation are that it will drive down the cost of developing and manufacturing RFID based technologies.

It is possible that the HF band is more interesting than the UHF band. There is still a question about whether or not UHF is the right frequency. Currently HF technologies offer greater potential and it is this area that should be given greater attention. Unfortunately, HF is mostly based on open standards and does not have strong commercial sponsors and is therefore often overlooked. HF tags have the right characteristics to meet supply chain requirements.

### **Standardisation**

Interoperability is widely recognised as an important issue. Reasons given for this include the following:

- ? Interoperability is needed to guarantee the success of real solutions: wide acceptance being a key factor;
- ? The lack of interoperability will reduce the value of wireless tags;
- ? Interoperability at all levels is critical to achieve low cost. Industry must be able to purchase tags, readers, and software with confidence that these will be interoperable. For example: tags from supplier X, must work with readers from supplier Y, and be linked with software from supplier Z. Hence the clear need for standards, preferably at global level;
- ? Interoperability will ensure an efficient and less costly implementation by reducing the cost of smart wireless tags and *scanning* hardware;
- ? Standards will allow more efficient protection and safety features and lower *per tag* fixed investment costs;
- ? Citizen confidence will improve if they have the guarantee that smart wireless tags have defined and controlled functionality;

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- ? Interoperability is essential for smart wireless tags to operate in open systems on a global basis;
- ? Supply chains for consumer goods are increasingly global. Transmission of information and movement of product needs to happen without disruption; supply chain operators need to be able to interconnect seamlessly;
- ? Interoperability is important for the further development of the smart wireless tag technology;
- ? Interoperability is essential for effective implementation of smart wireless tags.

Interoperability will become increasingly important as applications develop from local to global. Also, new applications can be expected to emerge faster, when standardised device-independent interfaces to relevant software platforms are available. Global applications (for example, identification of money originating from different countries, etc.) obviously demands global standards, and the European Commission can play an important role in assuring that the proposals of the European industry partners and knowledge centres are optimally included in the further evolution of such standards.

To achieve interoperability, high level, autonomous scientific and technical co-ordination at European level (as a minimum) is essential. However standardisation is a worldwide issue, not just a European one, so interoperability should be in line with the North American and Asia Pacific regions. It is therefore important to have worldwide standards and the European Union countries must work together to ensure that their interests are taken into account.

International open standards are generally seen as the way forward and existing standardisation efforts such as EPCglobal could be a starting point for European efforts in this area, and the European Commission's Standardisation Action Plan should take into account this work.

There is concern about the present circumstances with regard to standardisation in Europe. One concern is the lack of harmonisation in Europe in relation to present European initiatives (national and regional). Furthermore, the EPCglobal standards appear to be driven by the needs of big companies, while the requirements of SMEs do not appear to be adequately addressed. Another criticism is that the EPCglobal approach is naïve and does not meet the needs of the European business model. Early adopters have also found some weaknesses.

Some questions remain about whether EPCglobal will solve all problems. The basic standards provide a unique identification of an item. Other areas requiring attention are user needs and protocols. Much work still remains to be done testing the results in different operating environments.

*The Electronic Product Code (EPC) has been called the "next generation bar code" or "radio bar code," but it is much more than that. The EPC is a coding scheme [...] that can uniquely identify any individual item — whether that object is a consumer item, case, pallet, logistics asset, or virtually anything else.*

**Source: Global Commerce Initiative  
EPC Roadmap, Executive Brief**

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The issue of the use of different communication protocols in different applications environments should be considered. There is a need to ensure that the number of protocols is reduced to the minimum necessary.

Different standards are in use for barcodes, but it is possible to extract information from the United States barcodes for use in European systems. This possibility should be provided for in EPCglobal standards.

The key issue for Europe is that there should be collaboration to ensure that standards developed in the United States do not become (by default) the international standards. Standardisation work should not stifle innovation and should provide extension routes. There should not be too many organisations in Europe developing standards, and perhaps the best way forward may be to have a European umbrella organisation to take responsibility for co-ordinating European efforts. Possibilities to create synergies with developments in smart card technologies and to learn from standardisation efforts in that field should be considered.

Although standards are still under development, and a number of areas have been identified where further work is still needed, it seems that there is no need for additional new standards activities at the moment. However, interoperability raises serious concerns about security and privacy, and these will need to be addressed. EPCglobal does not focus on privacy issues, but acknowledges that these matters need to be addressed simultaneously with standards development. This is something that is not well addressed at the present time.

### ***Privacy, Data Protection and Security***

The consultation exercise revealed a high degree of concern about the privacy and security issues arising from the use of smart wireless tags. These issues need to be addressed by applications projects, as well as technology research projects.

Smart wireless tags present one of the most dangerous attacks on privacy in the digital age. They also pose dangers to safety. Privacy and security is a fundamental enabler or a *showstopper* of smart wireless tag technology. However, a combination of technical features, a lot of awareness, understanding, controls, a clear position from application developers using smart wireless tags, and a code of ethics will possibly solve the issue.

Consumers are concerned about smart wireless tags. It is not clear at this stage if the concerns will be justified. However, if it does turn out that there are problems associated with smart wireless tags, then it will be very expensive to solve them at a later stage. So the best way forward seems to be to work on the issues now to avoid any potential problems.

Use of smart wireless tag technology by the individual should be elective (just as it is, say, for cellular phones). It is important that legislation provides for *opting out* in particular circumstances (for example, mandatory provision of means for the removal of embedded smart wireless tags from consumer products at the retail purchase checkout). If tags pose privacy and security problems, the tags either have to be removable, or it should be possible to kill them, or to make them readable only by a limited sub-set of readers. Consumers need to have a choice if

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companies can use their information or not. Trading information for benefits like discounts or higher service (like for example, with loyalty cards) is a key area that should become available. However, if consumers decide not to share information, this should be guaranteed.

Privacy and security is a crucial element in user acceptance, particularly for consumer applications. However, the privacy barrier is typically easily lowered for security applications (compare with the use of security cameras in public places), or for applications with clear benefits (financial or other). Trust is as much an issue as is privacy directly: people already leave detailed digital traces behind, which are accepted, but this may change radically if there is misuse of the technology by trusted parties.

An alternative view is that privacy and security is a concern that has been greatly exaggerated. With the introduction of any new technology there is always a body of opinion that expresses doubts. It is important to distinguish between real issues and those that are only *perceived* as risks. There is currently a lack of information on the issues and misconceptions are being publicised by the media and some privacy advocates. There needs to be a constructive effort by the industry to spell out the benefits of the technology to all parties concerned.

One way to deal with privacy issues is to employ privacy-enhancing technologies (PETs). PETs may be an additional solution along with legislation. Typical smart wireless tag PETs are encryption, range limitation, read and write protection, kill switch and deep sleep mode, and anonymity or the use of pseudonyms. All these approaches need to be investigated within the contexts of different application requirements.

Limiting physical reading distances is one way of improving privacy and security. A pallet may need to be read at long range, but there is no need to read passports at long range, since a few centimetres would be sufficient. So perhaps there is a need to develop both long-range and short-range tags.

Privacy and security are both clearly crucial issues that must be resolved if smart wireless tag technology is to be accepted by the general public. This area has, so far, not been given adequate attention. However, in addition to undertaking the research proposed, there is a need to examine policy issues and to establish if existing regulations need to be strengthened to cover smart wireless tags.

### ***The Importance of Smart Wireless Tags for European Competitiveness***

The economic benefits of smart wireless tags are very significant and amount to billions of euros. They are expected to lead to savings for industry, for example in supply chain costs, and should also result in a transformation of the way business is conducted. Furthermore, sensor technologies are expected to be the next big market development for the information technology industry, with possible sales figures in the billions of euros range. Therefore, smart wireless tags are considered to be a very important area for industry, and their development and application will contribute towards the Lisbon goal of making Europe the most competitive and dynamic knowledge-based society in the world by the year 2010.

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### *Smart Wireless Tags Industrial Benefits*

- ? *1% costs reduction due to product quality improvement;*
- ? *2% reduction in working capital tied-up in raw materials;*
- ? *5% reduction in fixed asset costs*
- ? *5% reduction in stock costs;*
- ? *3% improvement in sales;*
- ? *65% labour cost reduction in physical product movement*
- ? *45% annual growth predicted for smart wireless tag technology and application providers;*
- ? *Source of a new set of new business models and creator of high technology quality jobs.*

***Source: RFID: Investing in the Next Multi-Billion Dollar IT Opportunity, Precursor Advisors (January 12, 2004).***

Smart wireless tags will create a wealth of business opportunities, enabling more efficient supply chain management and remote monitoring of work processes and flows. Examples include warehousing, inventory management, customer-supplier information systems, product tracking, secure access control, electronic identification and electronic billing systems. Moreover, by connecting enterprises to digitally enabled objects that represent their goods, services and assets, businesses can inexpensively capture detailed information that will enable better adaptation to the changing flow of their products and customer needs.

In retailing a typical future shop might use smart tagging for tagged pallets, backroom search of cases, distribution centre processes, track-and-trace, and an employees' information portal to data

about inventory, counting, technical evaluation and exception alarm reporting. Retailers will gain a number of benefits from this. These include improved on-shelf availability, elimination of shipping and receiving errors, reductions of in-store theft, and an ability to offer innovative information-based shopping facilities to customers.

In manufacturing smart wireless tags will be used both to support the manufacturing process, and to enhance the products themselves. Within the manufacturing process smart wireless tags will be used for production control, quality control, etc. and should help to enable increased customer responsiveness, more extensive product customisation, improved quality, and reduced costs. In the context of enhanced products, smart wireless tags will enable the storage of product information that can be accessed throughout a product's life for maintenance and eventual disposal and recycling. Tags will also enable communications between the products and the manufacturer (via the internet), which will enable the collection of operational data and provide the basis of value-added customer services. Smart wireless tags will also enable products to communicate with their owners and the surrounding environment, thus enabling the beginnings of ambient intelligence systems.

## RECOMMENDATIONS FOR PRIORITISED RTD OBJECTIVES

**I**n the context of the IST work-programme 2005-06, a number of demanding tasks will need to be addressed at European level. Two specific research areas need to be considered:

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- ? Technology research focused on reducing the cost of smart wireless tags, extending their functionality and performance, and improving the privacy-friendliness of the technologies;
- ? Applications oriented research, focused on highly innovative, high-value added applications, and addressing the socio-economic issues surrounding smart wireless tag technologies;

Technological research should be based on improving the current generation of technologies, with a view to achieving lower cost smart wireless tags. This work should address the areas of microelectronics, antenna design and packaging. Ways to reduce the production costs and to enable high volume production should be investigated. Research into miniaturisation of the components is required and energy sources also need to be further investigated. Using current generation technologies, research into improving performance in terms of functions, lower power, extended reading ranges, inter-tag communications, etc. should be undertaken. The capabilities of smart wireless tags to provide improved privacy and security, in a manner transparent to the consumer, should be developed. This work should be started within the timeframe of the IST work-programme 2005-06. Many of these technological aspects are primarily relevant to the Strategic Objective *Micro and Nano Systems*, but also *Embedded Systems*.

Applications oriented research, focused on high-value added innovative applications that will contribute towards improving public acceptance, should be undertaken. Prime areas are healthcare, including medical devices and pharmaceutical tracking, food and beverages, health and safety, environmental monitoring, ticketing, personal and home security enhancement, and manufacturing, especially with regard to product enhancement and extended products.

The role of smart wireless tags in product enhancement and extended products in particular is considered to be of high potential value. Smart wireless tags could be important enablers for increased product customisation, addition of value enhancing services, and new ways of manufacturing products and managing them throughout the entire product lifecycle.

Within the context of applications research, issues such as privacy enhancing technologies, application specific privacy and security requirements, consumer attitudes, privacy and benefit trade-offs, the limitations of present regulations, impact on health and safety, and interference with other devices, should be investigated. Applications research should also investigate the effects of smart wireless tags on business and work processes, business models, backend systems, virtual enterprise operations, manufacturing and production methods, and product after sales activities. Cost effective backend functionality that takes account of smart wireless tag capabilities will need to be developed.

This application-oriented research should be started within the timeframe of IST work-programme 2005-06. This application oriented research is primarily relevant to the Strategic Objectives *Networked Businesses and Governments*, and *Products and Services Engineering 2010*, but there is applications research that is also relevant to other Strategic Objectives, such as *eHealth*, *eSafety for Road and Air Transport*, and *Improving Risk Management*.

In the longer-term, smart wireless tags should be further developed within the context of ambient intelligence systems. Longer-term research for smart wireless tags should also address new

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materials, new energy sources and nano-materials. These longer-term issues should be addressed within the context of Framework Programme Seven.

The justification for the proposed research is as follows. The research will:

- ? Contribute towards the development of lower-cost smart wireless tags, thus enabling wider uptake of the technologies, leading to more applications;
- ? Provide the necessary knowledge and developments to enable European industry to benefit from the emergence of smart wireless tag technologies;
- ? Address the significant barrier of public acceptance;
- ? Improve privacy and security aspects to bring the technologies into line with European citizens' expectations concerning the right to privacy;
- ? Support the development of new policy and regulation that takes into account smart wireless tag capabilities;
- ? Provide further development of European capabilities in the field and a lead into longer-term research within the context of Framework Programme Seven.

### **IDENTIFICATION OF KEY ACTORS IN FUTURE RESEARCH PROJECTS**

An integrated approach is necessary. The applications oriented research should shape technology developments, so that emerging technologies conform to public expectations with regard to such aspects as safe operating levels for exposure to electromagnetic fields and demands for privacy and security. Such integration will also help to ensure the development of technologies that better conform to any new regulatory suggestions that might emerge, and reduce the risk of future (possible costly) improvements to technologies to achieve conformance at a later stage. Integration is also needed to ensure that possible contributions towards the development of international standards are co-ordinated at European level, and to enable Europe to speak with one voice in international standardisation forums.

This integrated approach can be best achieved through the use of integrated projects. Two integrated projects, one addressing technology research, the other addressing applications oriented research could enable the achievement of these research objectives. Co-ordination between the two projects would be required. Under the umbrella of the applications-oriented integrated project, several application domains could be structured to achieve economies in areas of common interest, such as public awareness, sharing and comparing results related to privacy, consumer attitudes, etc., and development of proposals for new regulations.

The research objectives proposed will require wide involvement of European stakeholders. The main manufacturers of smart wireless tags will need to be involved, as will those companies specialising in smart wireless tag technologies and applications, supported by academic research organisations and applied research institutes. Software suppliers that need to adapt their systems to smart wireless tag capabilities must also be involved. Given the privacy issues and consumer and public concerns that arise from the technologies, consumers' representative organisations and legal experts will need to participate.

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### Appendix 1 – Online Questionnaire

Summaries of the conclusions of the July 2003 internal workshop are listed below, along with the questions relating to the conclusions.

#### **Standards (Interoperability)**

Beyond the interoperability at hardware level, participants at the workshop expressed the need to harmonise application interfaces and data models and to support international standards. AUTO-ID Centre is producing technical specifications for wireless tags applications supported by leading companies in the area. In supporting widely recognised and industry-backed standards, this should be considered as a potential contribution of the EC Standardisation Action Plan.

Action proposed: Analyse possible co-ordination with the EC Standardisation Action Plan.

*Q1. Is interoperability important? How to proceed on this?*

#### **Catalysing the demand and applications research**

Participants considered that both private and public initiatives may be instrumental in catalysing the demand for these applications. For instance, the potential use of wireless tags in identification documents or the co-ordination of the strategies of retailers.

Actions proposed:

1. Explore initiatives to co-ordinate strategies of retailers with the support of Commission services;
2. Explore possibilities for co-operation with JAI for the use of wireless tags in passports.

*Q2. What Smart Wireless Tag application areas have a need for further research?*

#### **Research on interoperable WLT-based systems**

Participants considered the European research programmes to be a good framework to address the new challenges posed by wireless tags applications as a model of future ambient intelligence systems. It should therefore be considered to include within the future calls and work-programmes of IST (for example, call three or the WP2005-06) activities to research and demonstrate wireless tags based systems addressing interoperability, end user acceptance and catalysing the emergence of innovative applications in large sectors.

Action proposed: Explore the possibility of including specific actions on wireless tags applications in the coming calls.

*Q3. What short term and longer-term technology research is still needed?*

#### **Spectrum allocation (Interoperability)**

The invited experts insisted on the benefits, in terms of costs and operating range, of wireless tags operating in the UHF band as is the case in the United States and Japan. In Europe there is only limited capacity available in the UHF band (licence exempt band 862-870 MHz) and power

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limits are imposed on RFID scanners to avoid interference with other applications. This implies that RFID communication requires a closer distance between the tag and the scanner. Also, the European UHF bands foreseen for RFID are not identical with the United States bands, although it seems that the spectrum tolerance of RFID tags in UHF is sufficient to respond to scanner signals in both bands. It was recommended that industry provide a description of their requirements concerning the co-existence of wireless tags services operating in the UHF band with other services. It was noted that CEPT is already working on improving the accommodation of RFID in the UHF band.

Actions proposed:

1. Specifications from industry on possible co-existence of wireless tags operating in the European UHF band;
2. European Commission to examine whether there is a need for raising the matter in the Radio Spectrum Committee or with CEPT.

*Q4. What spectrum allocation issues exist? And is more regulatory action the right answer?*

### **Privacy, security and users acceptance**

To take a proactive (rather than defensive) attitude to gain consumer confidence in the use of wireless tags, since this is a key issue that will affect in the future not only wireless tags applications, but many other information society technologies and services.

Actions proposed:

1. Request the wireless tags industry to formulate clear recommendations, codes of conduct and guidelines on the appropriate use of these technologies, that can drive the debate;
2. To explore with other Commission services the challenges and options to address this issue.

*Q5. Smart Wireless Tags could pose privacy and security issues – What is your opinion on this?*

Smart Wireless Tags Research Needs  
Consultation Report

## Appendix 2 – Workshop Programme

10:00 – 10:15 **Welcome and General Introduction**

*Mrs Zobel, Director, Components and Subsystems – Applications*

10:15 – 11:30 **Smart Wireless Tags and the FP6 Work-programme**

*Chaired by R. Niepold, Head of Unit, Radio Spectrum Policy*

The wide work programme 2005 - 2006 consultation process

*Mr Michael Arentoft, European Commission*

Smart Tags coverage in calls open in 2004

*Mr. Paolo Garello, European Commission*

11:30 – 12:30 **Examples of Smart Tags Research Projects Selected in 2003**

*Morning sessions chaired by R. Niepold, Head of Unit, Radio Spectrum Policy*

Product Lifecycle Management using Smart Embedded Systems

*Mr Dimitris Kiritsis, EPFL, Switzerland*

Smart wireless tag technology in the IST programme: Some examples

*Mr Francisco Ibanez Gallardo, European Commission*

12:30 – 13:30 Lunch break

13:30 – 14:15 **Presentations of current and future research**

Towards the one-cent smart wireless tag

*Mr Christian Pacha, Corporate Research, Infineon Technologies*

From RFID to Smart Dust, a perception of future applications

*Mr Paul McCloskey, Ambient Intelligence Research, NMRC, Ireland*

14:15 – 14:30 **Quantitative findings of the online consultation**

*Mr Florent Frederix, European Commission*

14:30 – 16:00 **Interactive panel on consultation findings and the longer-term perspective**

*Chaired by Mr Florent Frederix, European Commission*

**Applications area moderator**

*Mr Uwe Kubach, Corporate Research, SAP, Germany*

**Technology, interoperability, standards and frequency spectrum moderators**

*Mr Dirk Heyman, Gillette, former chair of the technology board at the Auto ID lab @MIT*

*Mr John Falck, Chairman of ETSI TC ERM TG 34*

*Mr Eldor Walk, General Manager, FEIG electronic, Germany*

**Privacy, data protection and security moderators**

*Mr Jeroen Terstegge, Philips Privacy Office, Netherlands*

*Mr Thomas Ruddy, EMPA, Switzerland*

*Mr Stephan J. Engberg, Open Business Innovation, Denmark*

16:00 – 16:30 **Wrap up and first conclusions**

*Rapporteur*